Department of Planning and Environment

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SDLAM Locks 8 and 9 – CCB Creeks

Review of Environmental Factors

Water Infrastructure NSW | November 2022

Acknowledgement of Country

The Department of Planning and Environment acknowledges that it stands on Aboriginal land. We acknowledge the Traditional Custodians of the land and we show our respect for Elders past, present and emerging through thoughtful and collaborative approaches to our work, seeking to demonstrate our ongoing commitment to providing places in which Aboriginal people are included socially, culturally and economically.

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SDLAM Locks 8 and 9 – CCB Creeks

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1. Introduction

1.1. Project overview

In the lower River Murray, river regulation and the dominance of slow-flowing weir pool habitats has reduced hydraulic diversity and quality of in-stream habitat which in turn has affected ecological communities including native fish.

The New South Wales (NSW) Department of Planning and Environment (DPE) are proposing the NSW Locks 8 and 9 Project as part of the overall Sustainable Diversion Limit Adjustment Mechanism (SDLAM) works in the lower River Murray system. The **NSW Locks 8** (Figure 1-1) **and 9 Project** (Figure 1-2) includes:

- Weir pool manipulation of Locks 8 and 9
- Connectivity and permanent flowing water for existing Carrs, Capitts and Bunberoo Creeks (the CCB Creeks system)
- A fishway around the inlet regulator on Frenchmans Creek between the River Murray and Lake Victoria.

While all three components will ultimately work together to deliver the project objectives some practical interfaces were defined to enable the delivery of the project to be progressed under a NSW SDLAM Acceleration program.

The **Proposal** as assessed in this Review of Environmental Factors (REF) includes construction and operation of infrastructure within the CCB Creeks system only (Figure 1-3). The weir pool manipulation of Locks 8 and 9 and Frenchmans Creek fishway is not within the scope of this assessment and is being assessed separately.

1.2. Proposal overview

The CCB Creeks system (shown in Figure 1-3) is located within the Lower Murray catchment of the Murray Darling Basin (the Basin). The Lower Murray catchment is a complex operational environment, and operation of the CCB Creeks is heavily influenced by broader system settings in particular Lake Victoria operational protocols. River Murray operations including river flows, weir pool manipulation and the operation of Lake Victoria all determine what flows can be achieved through the CCB Creeks system and when.

The Proposal comprises construction of new flow control structures (regulators), fishways and crossings at seven sites within the CCB Creeks system. The new infrastructure would be required to be operated in unison to maximise delivery of project benefits. The proposed infrastructure, outlined in Table 1-1, would optimise in-stream habitat conditions for native fish within the broader

system operational settings. The Proposal site locations are shown on Figure 1-3 and further detail on each component of the Proposal is provided in Section 3.

Table 1-1 Summary of Proposal infrastructure

Site [1]	Location	Proposal infrastructure
2	Carrs weir No. 1	• Replacement of existing fixed crest weir with new structure that includes a regulator and vertical slot fishway • Single lane bridge for access
4	Off Carrs Creek	• New gated reinforced concrete box culvert to allow intermittent delivery of minor discharges to wetland features • Upgrade and raising of existing access track • New earth fill block bank abutments
6	Off Carrs Creek	• Partial removal of existing earth and rockfill blockbank • New gated reinforced concrete box culvert to allow minor flows and downstream fish passage • Upgrade and raising of existing access track
8	Carrs weir No. 2	• Replacement of existing fixed crest weir with new structure that includes regulator and vertical slot fishway • Single lane bridge for access
9	Bunberoo Creek	• New pre-cast bridge crossing • Realignment of existing access road
B	Mike's Runner weir	• Replacement of existing block bank with small sheet pile structure • Install regulator gate for flood management
10	Lake Victoria Inlet Regulator floodrunner	• New causeway with flowthrough rockfill to allow vehicle access while allowing natural flow path above pool level

Notes: [1] Site ID and location relates to the *NSW Locks 8 and 9 SDLAM Project 70% Detailed Design Report* (Jacobs & GHD, August 2021) (see Appendix A) and are not necessarily sequential for the Proposal.

1.3. Purpose of this document

The purpose of this Review of Environmental Factors (REF) is to describe the Proposal, document the likely impacts on the environment, and detail measures to mitigate impacts that cannot be avoided. The REF is the key document which Water Infrastructure NSW (WINSW) would use to fulfil its duty under section 5.5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), including taking into account those factors listed under section 171 of the Environmental Planning and Assessment Regulation 2021 (EP&A Regulation) (see Appendix B).

The findings of the REF would be considered when assessing:

- Whether the project is likely to have a significant impact on the environment and therefore the requirement for an environmental impact statement (EIS) to be prepared and approval sought from Minister for Planning under division 5.2 of the EP&A Act.
- The significance of any impact on threatened species as defined by the *Biodiversity Conservation Act 2016* (BC Act) and *Fisheries Management Act 1994* (FM Act) (referred to in section 1.7 of the EP&A Act) and therefore the requirement for a Species Impact Statement (SIS) or a Biodiversity Development Assessment Report (BDAR).
- The potential for the project to significantly impact on matters of national environmental significance (MNES) or Commonwealth land and the requirement to make a referral to the Australian Government Department of Climate Change, Energy, the Environment, and Water (DCCEEW) for a decision by the Commonwealth Minister for the Environment and Water on whether assessment and approval is required under the *Environmental Planning and Biodiversity Conservation Act 1999* (EPBC Act).

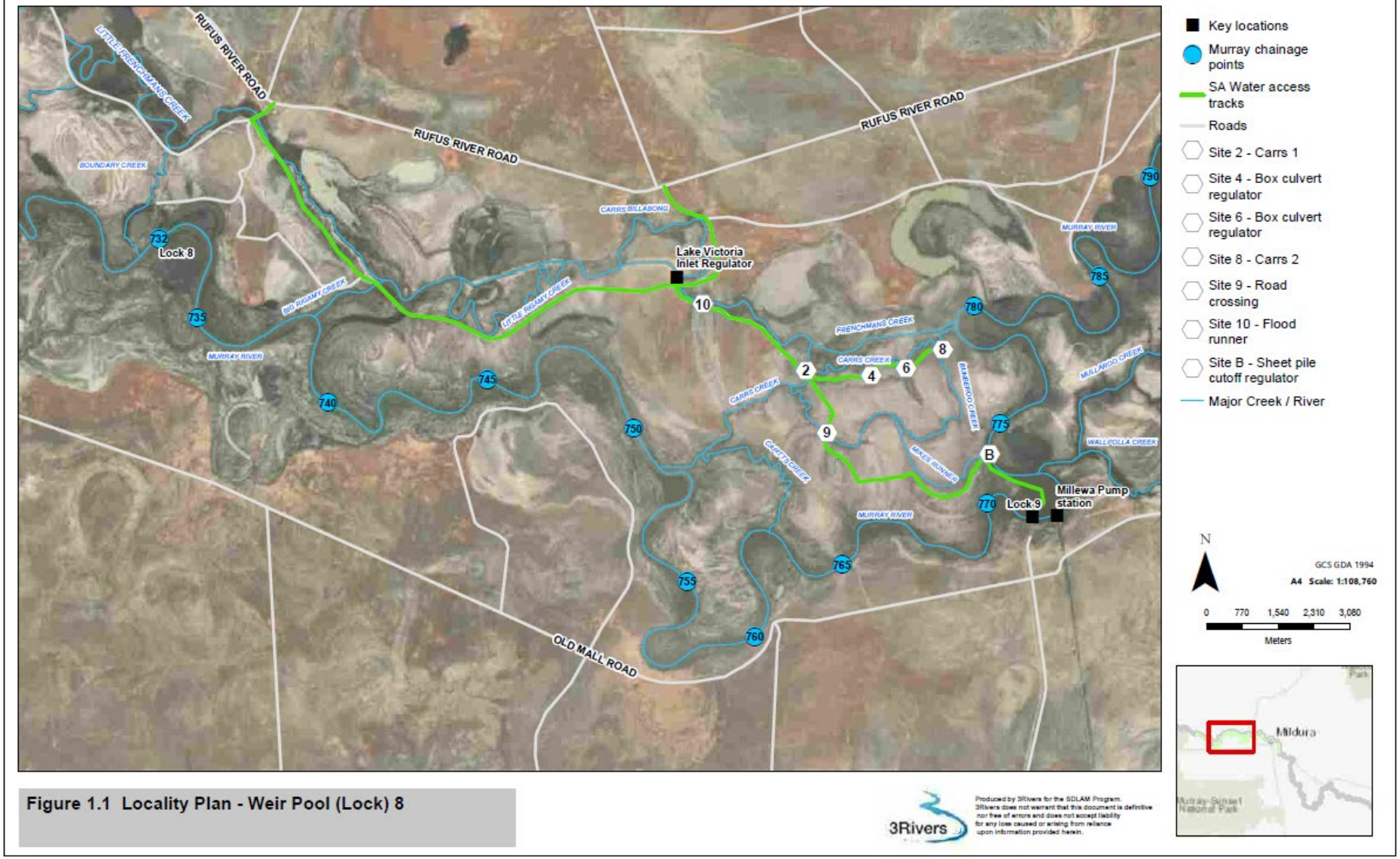


Figure 1.1 Locality Plan - Weir Pool (Lock) 8

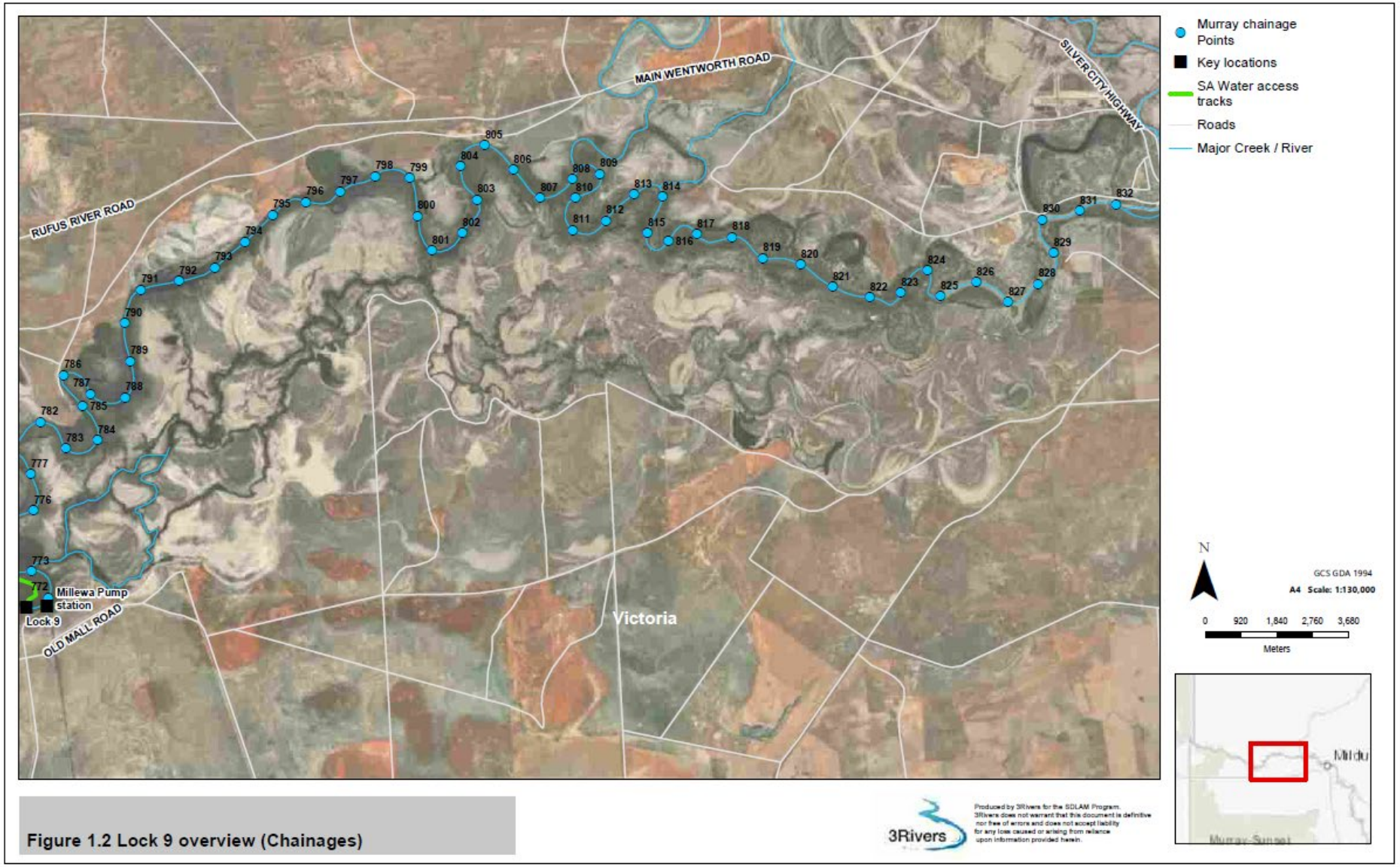
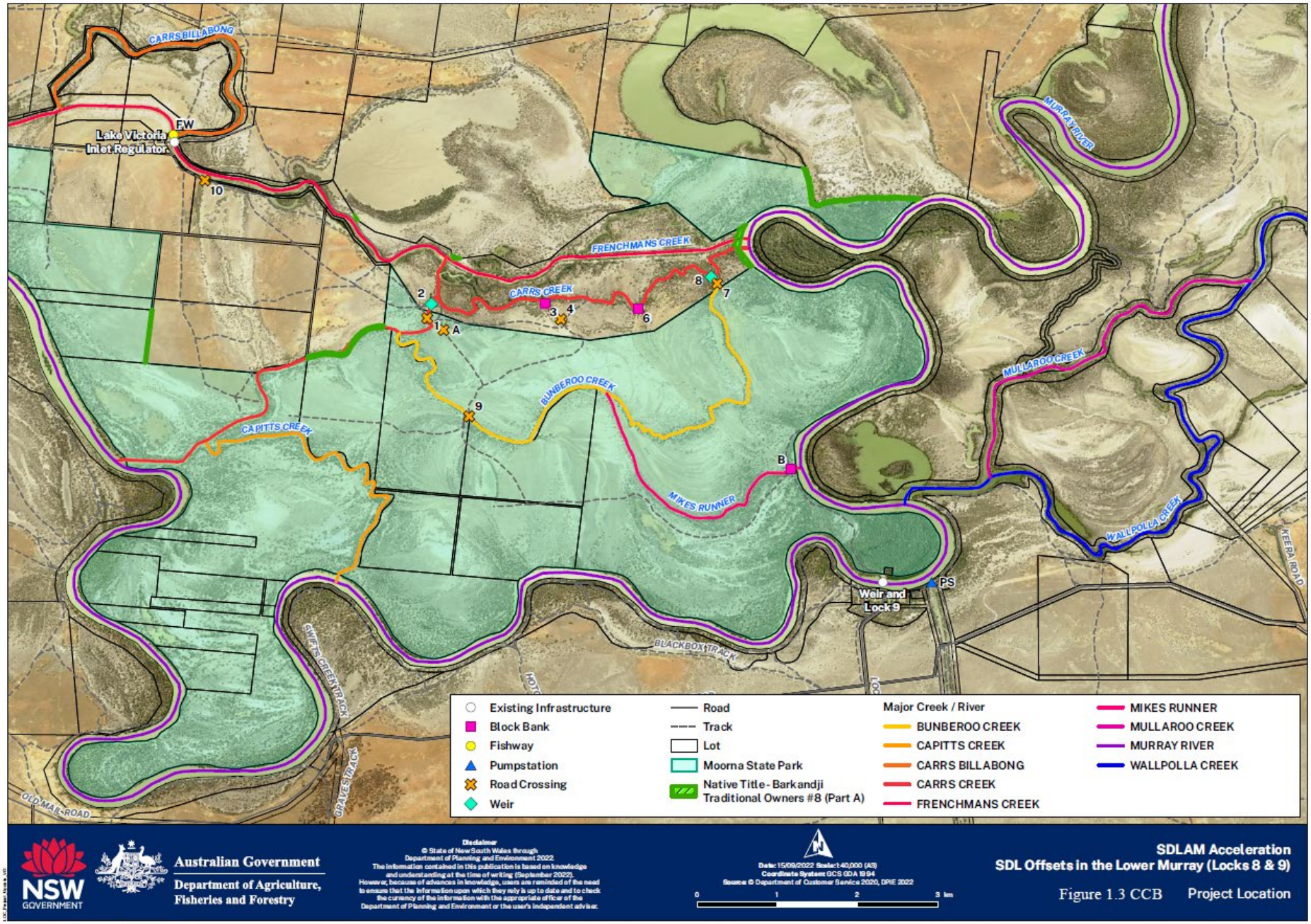


Figure 1.2 Lock 9 overview (Chainages)


CARRS BILLABONG
Lake Victoria Inlet Regulator
FW
10
FRENCHMANS CREEK
CARRS CREEK
2
3
4
6
8
7
1
A
BUNBEROO CREEK
9
CAPITTS CREEK
MURRAY RIVER
MULLAROO CREEK
B
MIKES RUNNER
WALLPOLLA CREEK
KEERA ROAD
Weir and Lock 9
PS
BLACKBOX TRACK
SWIFTS CREEK TRACK
GRAVES TRACK
OLD MAIL ROAD
Existing Infrastructure
Block Bank
Fishway
Pumpstation
Road Crossing
Weir
Road
Track
Lot
Moorna State Park
Native Title - Barkandji Traditional Owners #8 (Part A)
Major Creek / River
BUNBEROO CREEK
CAPITTS CREEK
CARRS BILLABONG
CARRS CREEK
FRENCHMANS CREEK
MIKES RUNNER
MULLAROO CREEK
MURRAY RIVER
WALLPOLLA CREEK
Australian Government
Department of Agriculture, Fisheries and Forestry
NSW GOVERNMENT
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The information contained in this publication is based on knowledge and understanding at the time of writing (September 2022).
However, because of advances in knowledge, users are reminded of the need to ensure that the information upon which they rely is up to date and to check the currency of the information with the appropriate officer of the Department of Planning and Environment or the user's independent adviser.
Date: 15/09/2022 Scale: 1:40,000 (A3)
Coordinate System: GCS GDA 1994
Source: © Department of Customer Service 2020, DPIE 2022
0
1
2
3 km
SDLAM Acceleration
SDL Offsets in the Lower Murray (Locks 8 & 9)
Figure 1.3 CCB Project Location

2. Proposal need and justification

2.1. Background to proposal

The SDLAM Program carries high-level significance across the Murray-Darling Basin and is fundamental to the health of the rivers, connected systems, ecosystems and communities to maintain a productive Basin with improved social and economic outcomes.

2.2.1 SDLAM

The Murray Darling Basin Plan (Basin Plan) includes a SDLAM for Basin States to offset the remaining gap between their current extractions and meeting the desired 2,750 GL water saving. The ability to do this is subject to the implementation of a suite of projects, which includes the *Locks 8 & 9 project.*

A consistent process was adopted for assessing the benefits of all SDLAM projects. Subsequent to the formal project 'notification' the SDLAM projects were assessed by the Murray Darling Basin Authority (MDBA) including modelling of operational arrangements in MSM-BigMod (MDBA, 2017) to confirm the contribution to the overarching program objectives.

The SDL Adjustment Stocktake Report (MDBA, August 2015) indicates that the Murray Weirs Proposal has a high confidence level for supply contribution of between 5GL and 10GL. More contemporary updates indicate that he most significant contribution to benefits of the Locks 8 & 9 project will be achieved by implementing a variable weir pool operation which can provide, when combined with other SDLAM actions within the Lower Murray, between 0GL to 30GL of SDL offset [nominally attributed to project as 17.5GL] (MDBA, 2016). The Locks 8 & 9 Project is listed by MDBA as significant at a 'reach' scale rather than local scale (MDBA, 2020) meaning that the full benefits to the reach will be realised by enabling the Basin Plan's ecological objectives for the lowland reaches of the River Murray and Darling Rivers to be met more efficiently (using less water). MDBA has previously noted that 'SDLAM supply measures must be considered as a package of projects for the purposes of determining a supply contribution as part of the SDL adjustment process 'It is expected that a reconciliation to be completed in 2024 will provide a final account of the SDL volume. Other projects within the river reach are the Victorian Lindsay Stage 2 and Wallpolla projects.

2.1.2 Locking the River Murray

The historic creation of works and measures on the River Murray are described in a paper by Jeannete Hope (Hope, J. unknown). "*Locking of the River Murray was one of the first major projects of Federated Australia".* "Locks 1 - 6 were on the South Australian Murray …. the South Australian Government built Locks 7 – 9 on the NSW Murray and the Lake Victoria storage". "The detailed plans for the construction of the storage: the regulators, the artificial inlet channel, and the

embankments, were approved in December 1918, the first contract was let in July 1919, and work commenced on 7 August 1919 on excavating Channel No. 1, the artificial Inlet Channel from Frenchmans Creek into the lake. Three regulators were built: the Inlet Regulator on Frenchmans Creek about 3k from its junction with the Murray, the Control Regulator on Frenchmans Creek near the southern edge of the lake, and the Outlet Regulator on Rufus River where it crosses the edge of the old Pleistocene Lake basin. Three locks were constructed on the Murray, Lock 7, just east of the Rufus-Murray junction, Lock 8, further east at Wangumma, and Lock 9 downstream from the Frenchmans-Murray junction, to maintain a weir pool for the Inlet Regulator. Several new channels were dug, and in all 52km of banks were built".

Since the weirs were constructed in 1926 the availability of regulated water to the CCB system has been severely reduced. The proposed Carrs Cappitts and Bunberoo Creek works are generally described as enabling works which will assist in returning the operation of local locks and weirs in the project area to a more flexible regime. The CCB works components collectively aim to restore flows, connectivity and hydrodynamic diversity in the waterways that comprise the Carrs, Capitts and Bunberoo (CCB) Creeks system.

It is for the above reasons that the Locks 8 and 9 project has been developed as an integrated package of works and measures, each of which is important to the overall outcomes.

2.2. Project objectives for CCB works

Prior to the Lake Victoria works, the CCB Creeks system was part of a complex mosaic of waterways and billabongs prior to the construction of Lock 9 and the Frenchmans Creek channel to Lake Victoria. The physical barriers that were constructed at several points along the CCB Creeks system to maintain water within the Lock 9 weir pool and allow increased flow into Lake Victoria via the Lake Victoria Inlet Regulator (LVIR) resulted in the key creeks being depleted of regular flowing water.

The Proposal, as part of the NSW Locks 8 and 9 Project, seeks to restore flows, connectivity and a diverse hydrodynamic regime within the CCB Creeks system. The waterways to have flow re-activated as a result of CCB works is around 7km in Bunberoo Creek and around 7km in Carrs Creek (below the Carrs 1 weir). In addition to this a number of backwater areas and connections between waterways will commence to fill and potentially flow during operational modes that provide flow pulses. The timing and volumetric rates associated with pulses is outlined in Section 6.1.

The operation of the system will in turn increase the diversity and quality of aquatic habitat, promote fish populations by providing regionally important spawning and nursery areas, and support bird breeding events through habitat and food provision.

2.3. Existing infrastructure

Carrs weirs No.1 and No.2 (Sites 2 and 8)

The existing Carrs weirs No. 1 and 2 are fixed crest weirs which are used to prevent water from the Lock 9 weir pool flowing down Carrs Creek and Bunberoo Creek respectively. The existing weirs

were constructed in 1926 as part of the construction of Lake Victoria works and have been in operation for around 90 years. The weirs are permanently inundated on the Carrs Creek side and are only overtopped in River Murray high flow (and flood) events, which provide the only significant through flow of water in the system. As a result, they have largely isolated the CCB Creeks system from regular flow events.

Normal operational levels at Lock 8 (24.6m AHD) cause backwater to inundate a large proportion of the Carrs Creek waterways (refer Figure 2-1).Water is stagnant and has been shown to be unsuitable as habitat without the water movement created by discharge overtopping the weirs. Fish surveys conducted by Murray Darling Freshwater Research Program (MDFRP, 2013) provide evidence of the effects that barriers have created in the CCB system. Analysis of discharge and level data in River Murray shows that the overtopping occurs at River Murray flows of between 40,000ML/d to 50,000ML/d.

The two weir structures are almost identical and comprise reinforced concrete buttressed walls sitting on an unreinforced concrete foundation slab, with a concrete apron extending downstream and upstream. Carrs weir No.1 (Figure 2-2) is the larger of the two, with a buttress wall height of 4.52 m, compared to 2.62 m at Carrs weir No. 2 (Figure 2-3). The age of the assets has become problematic for asset integrity including:

- Carrs weir No. 2 has previously failed resulting in construction of an upstream isolation bank (coffer dam) by SA Water.
- Carrs weir No. 1 is exhibiting signs of piping failure and is unlikely to remain serviceable without intervention.

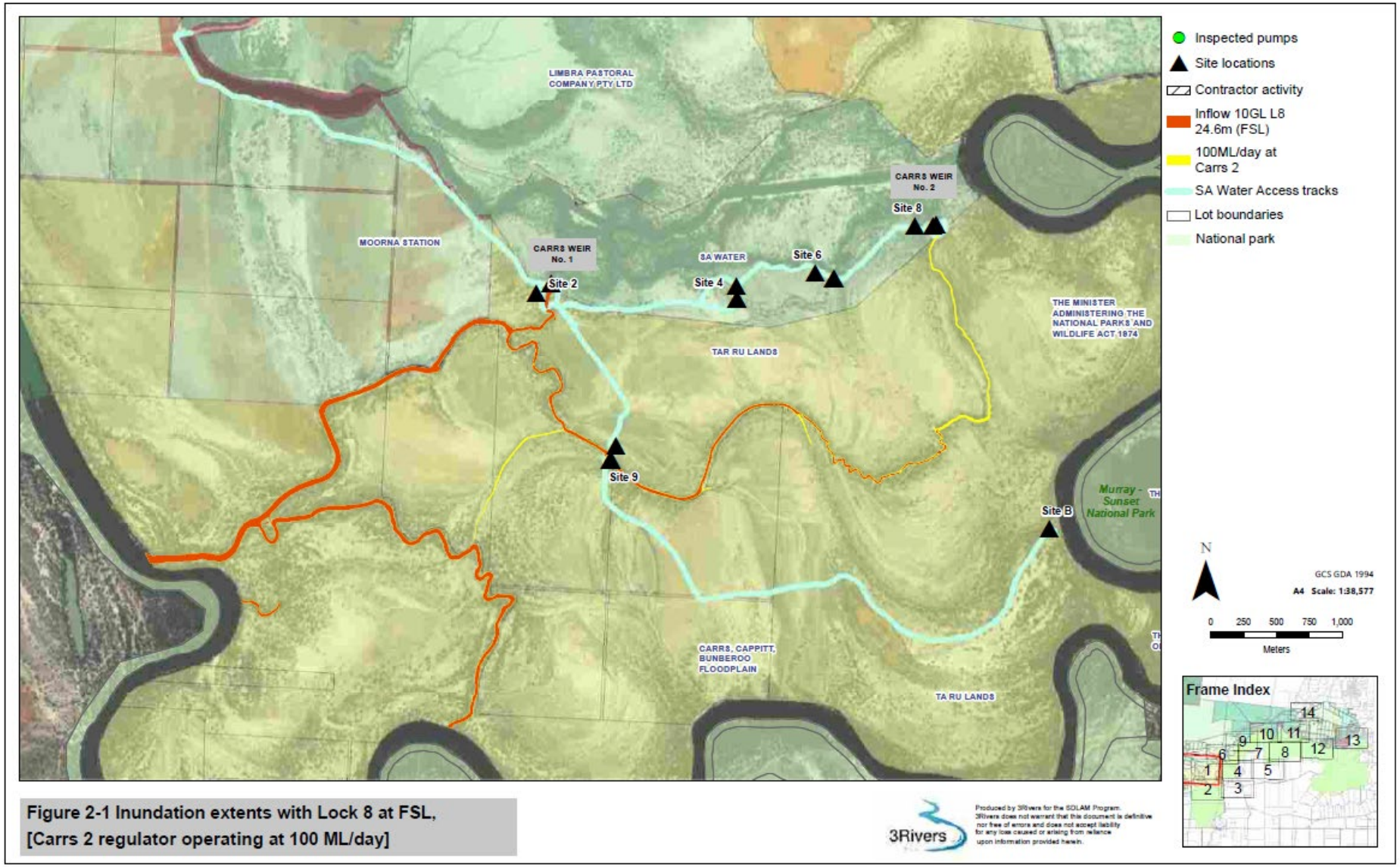

Figure 2-1 Inundation extents with Lock 8 at FSL, [Carrs 2 regulator operating at 100 ML/day]

Figure 2-1 Existing Carrs weir No.1 structure (with piping leaks on left downstream abutment)

Figure 2-2 Existing Carrs weir No.2 structure (with upstream coffer dam)

Existing road crossings (Sites 4, 6 and 9)

There are existing block banks located at Sites 4 and 6 to prevent flows entering the CCB Creeks system from Carrs and Frenchmans Creeks. The block banks are constructed as earth and rock embankments (refer Figure 2-4 and Figure 2-5). The Bunberoo Creek road crossing (Site 9) previously incorporated a pipe culvert although it was mostly not operable due to lack of maintenance, as shown in Figure 2-6.

Figure 2-3 Existing road crossing at Site 4 (downstream of site 3 block banks)

Figure 2-4 Existing road crossing at Site 6 (looking east)

Figure 2-5 Existing Bunberoo Creek crossing at Site 9 (eastern side of causeway looking north)

Mike's Runner weir (Site B)

An existing block bank is located at the confluence of Mike's Runner and the River Murray (Figure 2-7). The block bank is constructed as an earth and rock embankment. Survey information indicates that the bank elevation is approximately 27.7mAHD which will be subject to the potential overtopping and erosion when the weir pool elevation is raised under the proposed weir pool manipulation regime.

Figure 2-6 Existing block bank at Mike's Runner (Site B) with River Murray on left

Lake Victoria Inlet Regulator floodrunner

The only way to access the CCB system using vehicles is via an SA Water access track which extends east from the LVIR along the banks of Frenchmans Creek. The presence of a large floodway between Frenchmans Creek and Carrs Creek means that the CCB access track passes through some low-lying land adjacent to Frenchmans Creek.

Currently the CCB access track is trafficable across the floodway in normal water level conditions but there is no formal creek crossing infrastructure at this location, making the track to Carrs weir No. 1 inaccessible at raised Lock 9 operating levels. The proposal is to construct a structure that maintains consistent vehicular access while allowing the flood runner to operate in most higher flow conditions.

2.4. Options and alternatives considered

Justification for the Locks 8 & 9 project was developed through the NSW SDLAM Options Evaluation Framework which is documented in the strategic business case (Fifteen50, 2020). Subsequent to the preferred project option being endorsed several engineering design options were considered to achieve the CCB Creeks system connectivity objectives for the Lock 8 and 9 Project.

2.4.1 Assessment

The engineering options considered for Sites 1 to 9 and Site B were assessed in the *NSW SDLAM Locks 8 and 9 Project Structures Options Assessment* (SA Water, October 2021 attached in Appendix K). This assessment considered a number of objectives including structural capacity assessment, hydraulic gate assessment and fishway functionality. Opportunities were also identified through this options assessment process to reduce the overall environmental footprint of the works. Part of this assessment included a site inspection with DPE Fisheries staff to understand site specific issues. The options considered for consolidating sites into a final design proposal are summarised in this section. The arrangement for each structure under each of the following three broad options is described in Table 2-1.

Option 1 – Retrofitting the existing Carrs weir No. 1 and No. 2 with gates and a vertical slot fishway and providing reinforced concrete box culverts (RCBC) for access over waterways. The intent of this option is that the existing weir will be refurbished to provide the ability to control downstream discharges into Carrs Creek. The majority of the existing concrete structure is intended to be retained.

Option 2 – New regulator structures with fishways near the Carrs weirs No.1 and No.2 sites and bridge crossings rather than box culverts. The bridges will provide less constriction to the waterway area and fish passage. This option provides structures at the same locations as Option 1 with improved functionality for operators and improved environmental outcomes. The bridge design would comprise pre-cast spans of about 18 m. An intermediate pier would be required in the centre of the waterway where more than one span is required.

Option 3 — This option **combines new regulator structures with fishways and bridges near the Carrs weirs No.1 and No.2 sites**. The incorporation of bridges over both the Carrs weirs No.1 and No.2 sites removes the need for a crossing over Carrs Creek at Site 1 and Bunberoo Creek at Site 7. A single cell RCBC road crossing with a gated outlet will also be provided at Site 4, combining Site 3 and 4. Approach roads to the new structures would be required and could be located to minimise site disturbance.

Options for Mike's Runner weir (Site B) and the Lake Victoria Inlet Regulator (Site 10) flood runner was not considered in detail, but the preferred structures at those sites were informed by the typical metrics assessed for the other sites. Accordingly, a relatively simple flow control structure and causeway are proposed at these sites to support the Proposal, as described in Section 3.

Table 2-1 Option details

Site [1]	Location	Option 1	Option 2	Option 3 (Preferred Option)
1	Carrs Creek (access crossing)	33m span box culvert road crossing over Carrs Creek for access to the CCB floodplain and Lock 9. Replace existing twin pipe culverts and earth embankment.	Precast bridge crossing over Carrs Creek, nominal span 17 m	Structure not required at this site - See Site 2 below where bridge incorporated in new Carrs weir No.1 Regulator
2	Carrs weir No. 1 Gated regulator and fishway	**Modify existing structure** to provide regulation of flows into Carrs Creek and provide fish passage. New overshot gates to provide up to 1,500 ML/d.	**New structure** to provide regulation of flows into Carrs Creek and provide fish passage. New overshot gates to provide up to 1,500 ML/d.	**New structure** to provide regulation of flows into Carrs Creek and provide fish passage. New overshot gates to provide up to 1,500 ML/d. Incorporate single lane bridge deck.
3	Carrs Creek 1 cell RCBC with gated outlet	Partially remove existing earth and rockfill blockbank to allow construction of a single cell gated RCBC (2.5 m wide). Target flow rate 50 ML/d. No upstream fish passage. Single lane operational vehicle access over crest. Raise adjacent embankment to EL 28.21 m.	Same as Option 1.	Structure not required at this site – See Site 4 below where a gated regulator and vehicle access incorporated at Site 4.
4	Off Carrs Creek	16 m span box culvert road crossing over unnamed creek for access to Carrs weir No. 2. Replace existing pipe culvert and earth embankment.	Precast bridge crossing over Carrs Creek, nominal span 17 m.	Single cell RCBC regulator and incorporate guardrail to provide vehicle access. Site 4 selected for regulator to minimise vegetation disturbance.

Site [1]	Location	Option 1	Option 2	Option 3 (Preferred Option)
6	Carrs Creek 1 cell RCBC with gated outlet	Partially remove existing earth and rockfill blockbank to allow construction of a single cell gated RCBC (2.5 m wide). Target flow rate 50ML/d. No upstream fish passage. Single lane operational vehicle access over crest. Raise adjacent embankment to EL 28.21 m.	Same as Option 1.	Same as Option 1.
7	Bunberoo Creek (access scrosisng downstream Carrs 2)	18.6 m span box culvert road crossing over Bunberoo Creek for access to the left bank. Replace existing pipe culvert and earth embankment.	Precast bridge crossing over Bunberoo Creek, nominal span 18 m.	Not required, access incorporated at Site 8.
8	Carrs weir No. 2 Gated regulator and fishway	**Modify existing structure** to provide regulation of flows into Carrs Creek and provide fish passage. New overshot gates to provide up to 500ML/d.	**New structure** to provide regulation of flows into Carrs Creek and provide fish passage. New overshot gates to provide up to 500 ML/d.	**New structure** to provide regulation of flows into Carrs Creek and provide fish passage. New overshot gates to provide up to 500 ML/d. Incorporate single lane bridge deck.
9	Bunberoo Creek	30 m span box culvert road crossing over Bunberoo Creek for access to Lock 9. Replace existing damaged earth embankment.	Precast bridge crossing over Bunberoo Creek. Span 36 m with a central pier.	Precast bridge crossing over Bunberoo Creek for access to Lock 9, nominal span 18 m. Remove existing damaged earth embankment.
A	Access across existing flood runner	10 m span box culvert road crossing over flood runner for access to Lock 9. Replace existing twin pipe culverts and earth embankment.	Precast bridge crossing over Carrs Creek, nominal span 10 m.	Adopt cheapest of precast culvert and bridge. Note that inspection with SA Water indicated existing maintenance works are adequate for this site

2.4.2 Preferred option

A qualitative multi-criteria analysis was carried out to assess the relative advantages and disadvantages of each CCB option alongside the capital cost. Each option was assessed against essential and desirable outcomes including:

- Capital cost
- Fish passage
- Hydraulic functionality
- Design life
- Data gaps/residual risk/uncertainty
- Disturbance to environment and cultural heritage sites (construction activity zone).

A weighting and score were applied to each outcome to allow qualitative scoring of the three options. The weighting of each criterion was chosen based on value of importance and (essential and desired) outcomes. Assigned scores were based on the ability of each option to achieve each desired outcome.

Option 1 scored poorly with regard to functional outcomes, risk/uncertainty and environmental impacts. Based on non-cost related criteria, Option 2 had the highest score because its functionality was best and had lower residual risk or uncertainty. However, the considerably higher total capital cost and high weighting applied to capital cost meant that Option 2 received the lowest overall score.

Option 3 was determined to be the preferred option due to the lowest environmental impact, high functionality and design life scores and a mid-range capital cost score, giving it the best overall desired outcome score.

Refer for further details to *NSW SDLAM Locks 8 and 9 Project Structures Options Assessment* (SA Water, October 2021) (see Appendix K).

3. Proposal description

3.1. Overview

The Proposal comprises construction of new flow control structures, fishways and crossings at seven sites within the Carrs, Cappits and Bunberoo Creeks (the CCB Creeks system). The new infrastructure would be required to be operated in unison to maximise delivery of project benefits. A summary of the Proposal infrastructure is provided in Table 1-1 and the Proposal site locations are shown on Figure 3-1. Where the proposed creek crossings are not aligned with existing tracks, tie-in works are also required to realign existing tracks to the proposed new structures.

The 'Proposal area' at each Proposal site includes:

- A 'clearing area' where vegetation clearing and ground disturbance would occur; and
- A 'Contractor Activity Zone' (CAZ) where general construction activities would occur (e.g. lay down of machinery and materials, stockpiling, placement of sheds) but while avoiding any vegetation impacts or significant ground disturbance.

Assessment of impact to threatened species, populations and ecological communities has determined that the Proposal is unlikely to have a significant impact on these species, populations or communities. The assessment was conducted in accordance with State and Commonwealth significant impact criteria (refer to Appendix H).

Further detail on each component of the Proposal is provided in the following sections.

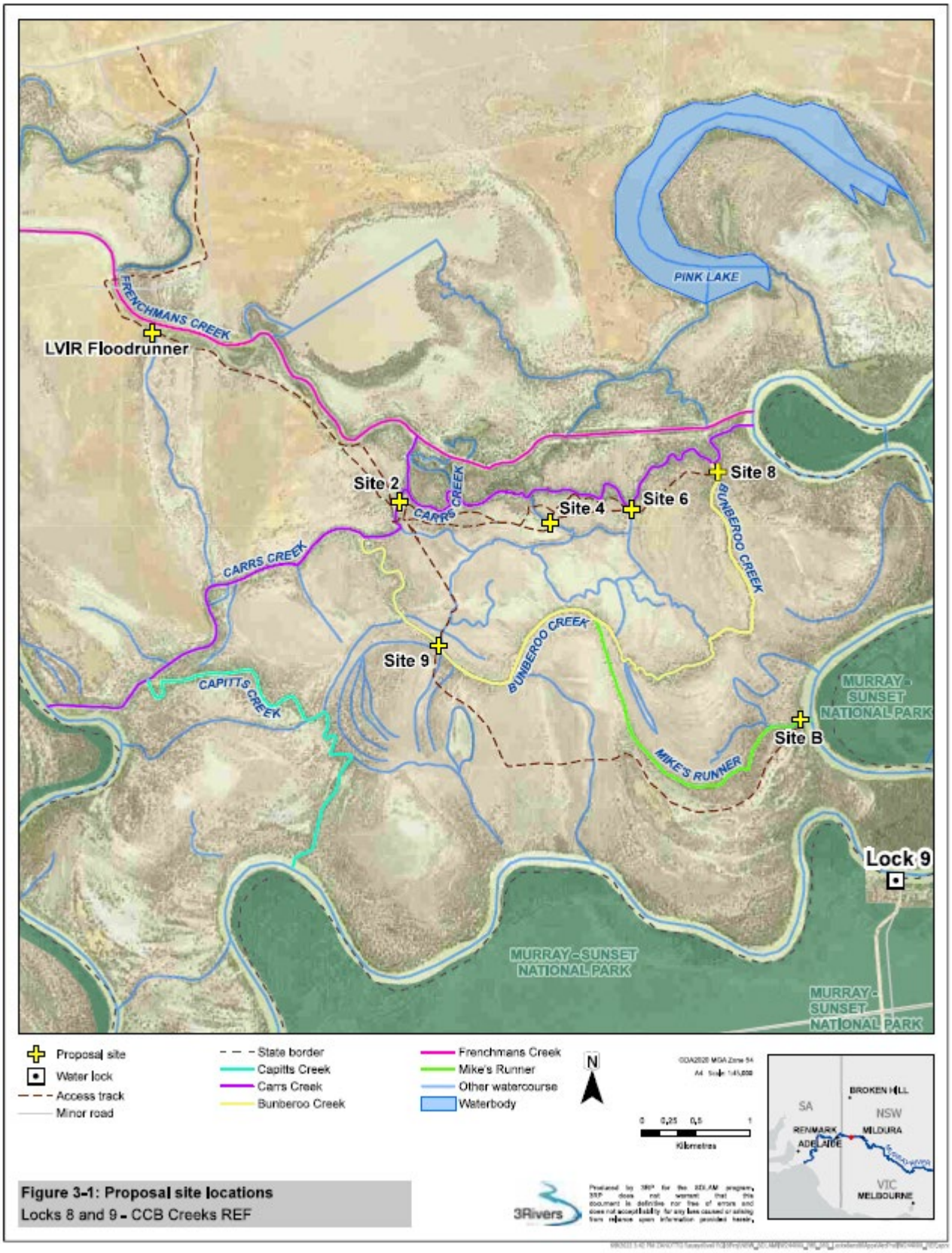

Figure 3-1: Proposal site locations
Locks 8 and 9 – CCB Creeks REF

3.2. Regulators with fishways and bridges (Sites 2 and 8)

New regulators with fishways and a bridge deck are proposed at Sites 2 and 8. The general arrangements for the regulators have similar geometry but slightly different size (refer Table 3-1). The proposed site layout is shown on Figure 3-2 and Figure 3-3. Detailed design (70%) drawings are provided in Appendix C, which include general arrangement plans, cross sections and engineering details of each of the proposed structures. Key components of the proposed new flow regulators include:

- A central cast insitu reinforced concrete structure
- Layflat gates that can be rotated from near vertical to near horizontal providing overshot flow over a wide headwater range for flow regulation
- A vertical slot fishway for upstream fish movement
- A single lane bridge over the structure adopting precast Rocla M-lock beams
- Earth fill (clay) abutments with road pavement surfacing for the access roads and laydown areas
- Parking area for use during operation of the regulator
- A sheet pile cut-off for seepage control and downstream sheet pile for scour protection
- Rock riprap erosion protection on the batters and downstream channel.

There will also be instrumentation on the regulators including upstream and downstream gauge boards to allow manual recording of water level, survey pins, piezometers and gauges to measure gate opening.

The regulators have been designed to allow for a headwater range between 28.03mAHD (0.63m above the Lock 9 pool level or 'top of piers') to 26.2mAHD (1.2 metres below the Lock 9 pool level). The key dimensions for each structure are provided in Table 3-1.

Table 3-1 Key dimensions of the proposed regulators

Metric	Carrs weir No.1 (Site 2)	Carrs weir No.2 (Site 8)
Height of concrete structure	Approx. 5.3 m	Approx. 3.6 m
Number of gates	3	2
Gate width	3 m	3 m
Gate height	4.24 m	2.58 m
Freeboard	• 450 mm to top of concrete for abutments to provide sufficient freeboard for wave action. • 200 mm to the soffit of bridges (which may result in higher than 500 mm to top of concrete because the bridge deck depth is more than 300 mm). This elevation difference will be accounted for by providing a grade transition on the bridge approach slab.	

Metric	Carrs weir No.1 (Site 2)	Carrs weir No.2 (Site 8)
	• Finished elevation of earth fill abutments for the structures will commence at the freeboard of the concrete structure and transition to level of the adjacent road as soon as practicable.	

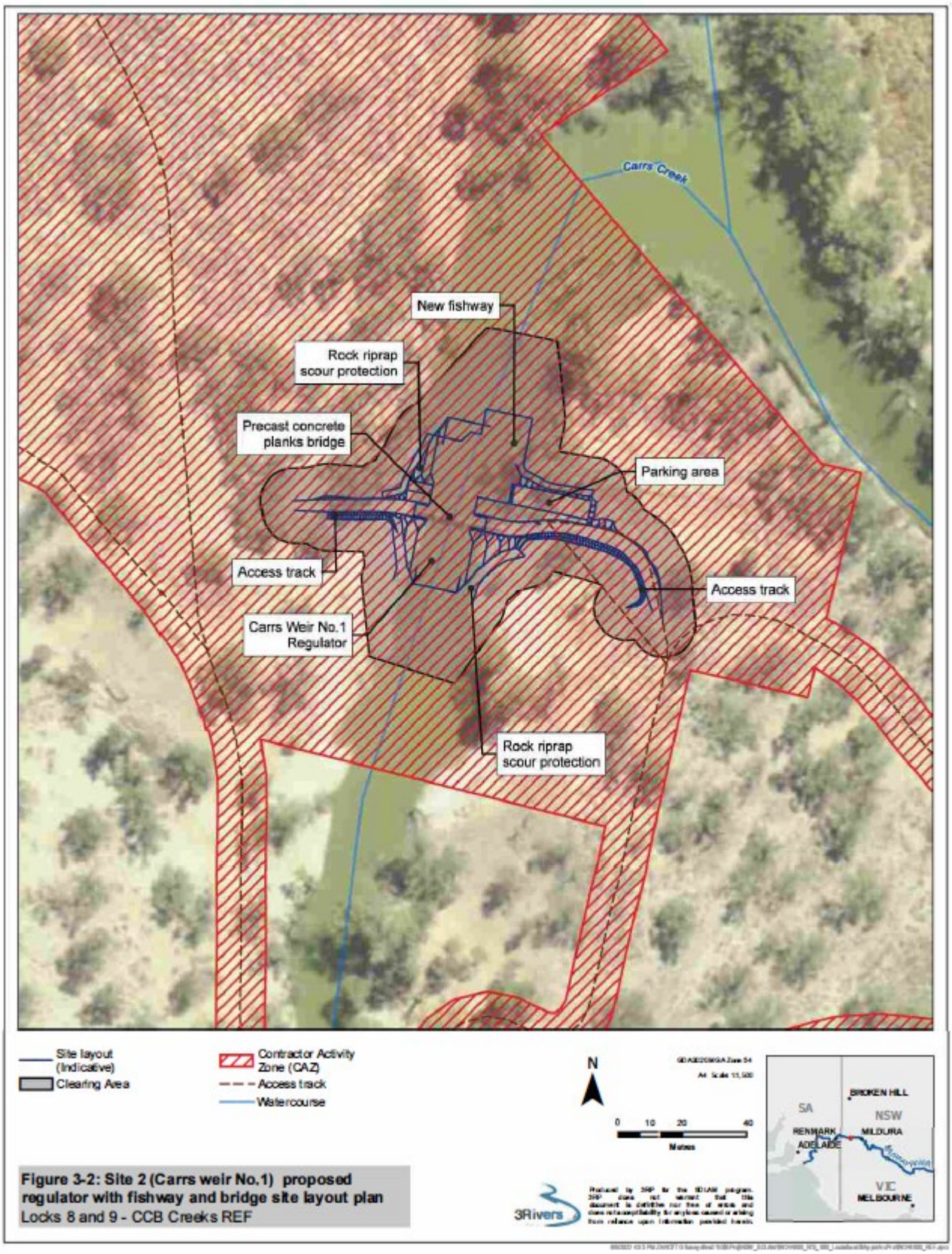

Figure 3-2: Site 2 (Carrs weir No.1) proposed regulator with fishway and bridge site layout plan
Locks 8 and 9 - CCB Creeks REF

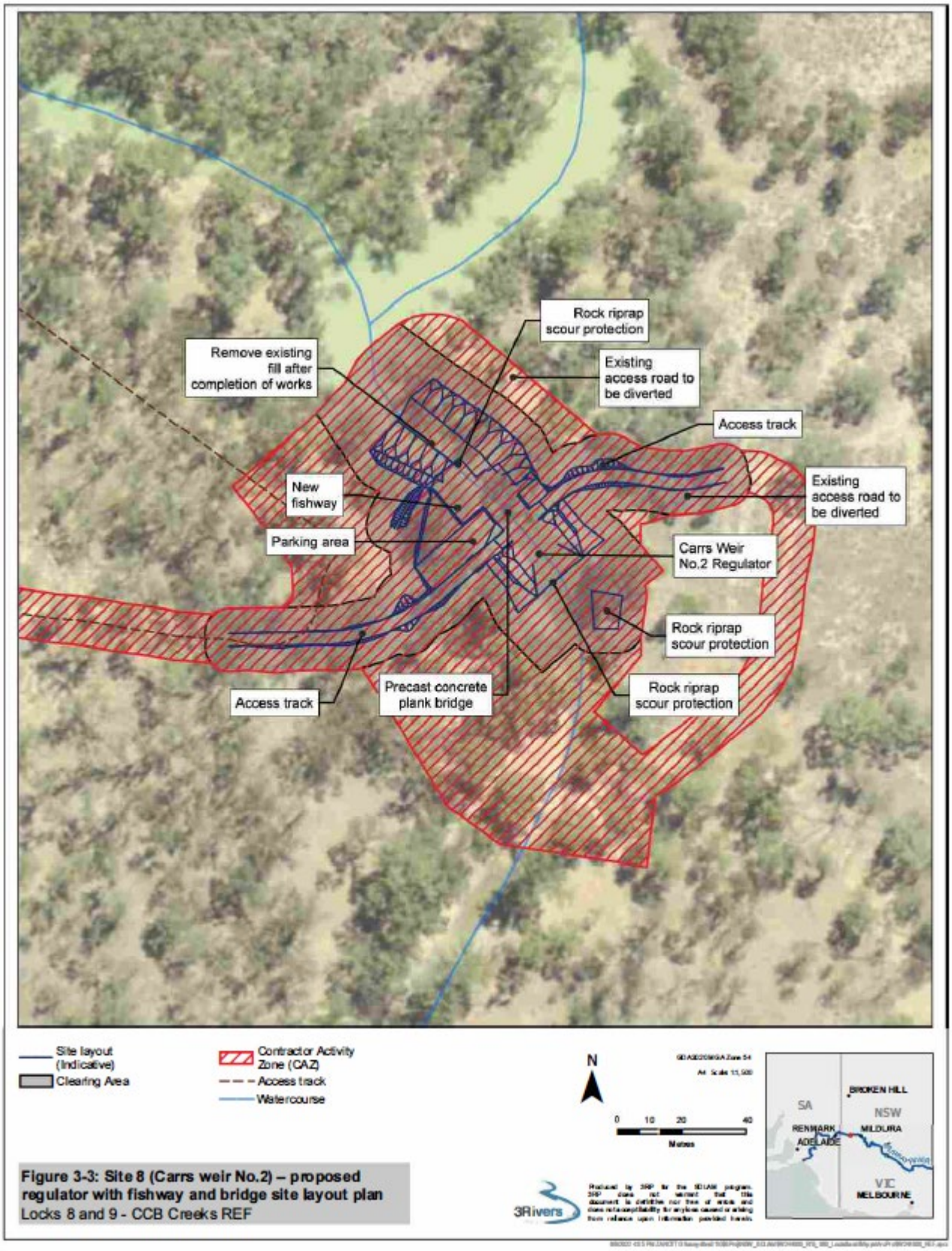

Figure 3-3: Site 8 (Carrs weir No.2) – proposed regulator with fishway and bridge site layout plan
Locks 8 and 9 - CCB Creeks REF

Active fishways have been designed for the proposed Carrs weirs No. 1 and No. 2 replacement gated regulator structures in consultation with DPI Fisheries (refer Section 5). The *NSW Locks 8 and 9 SDLAM Project 70% Detailed Design Report* (Jacobs & GHD, August 2021 - see Appendix A) outlines the design criteria for the fishways in detail including:

- Operating objectives
- The fish community target
- Fish movement
- Biological requirements
- Headwater and tailwater ranges.

The new gated regulator structure at Carrs weir No. 1 (Site 2) incorporates a 26-slot, 'key-hole' type vertical slot fishway, to enable the upstream passage of the target small, medium and large-sized native fish past the structure. The fishway has a single downstream entrance and four gated upstream exits, suitable for the design headwater range. Fish moving upstream along Carrs Creek will be attracted to the fishway entrance slot at the left abutment of the regulator and enter the fishway. Fish pass through the fishway channel via a series of 'key-holed' vertical slots and resting pools before exiting back to Carrs Creek upstream of the Carrs weir No. 1 regulator via a gated upstream exit slot. Hydraulic and biological modelling (including regulator gate operation for optimal fish passage) informed the fishway design and extensive design details, functional provisions and hydraulic performance targets expected to be achieved by the final fishway design are outlined in the *NSW Locks 8 and 9 SDLAM Project 70% Detailed Design Report* (Jacobs & GHD, August 2021 see Appendix A).

The fishway at Carrs weir No. 1 (Site 2) is located at the eastern abutment of the replacement structure, in order to avoid disturbance of two scar trees in the western abutment that were identified during a site survey and have moderate scientific value. Some potential habitat trees at the eastern abutment would require removal to facilitate the construction of the fishway.

The new gated regulator structure at Carrs weir No. 2 (Site 8) incorporates a 13-slot, 'key-hole' type vertical slot fishway, to enable the upstream passage of the target small, medium and large-sized native fish past the structure. The fishway has a single downstream entrance and four gated upstream exits, suitable for the design headwater range. The Carrs weir No. 2 fishway is similar in its design and functionality to the Carrs weir No. 1 fishway. Fish moving upstream along Bunberoo Creek will be attracted to the fishway entrance slot at the western abutment of the regulator and enter the fishway. Fish pass through the fishway channel via a series of 'key-holed' vertical slots and resting pools before exiting back to Bunberoo Creek upstream of the Carrs weir No. 2 regulator via a gated upstream exit slot.

The decision flowchart shown in Figure 3-4 was developed as part of the *Interim operating plan for Carrs, Capitts and Bunberoo Creeks for the commissioning phase of Carrs 1 and 2 regulators* (Alluvium, 2022 - see Appendix E).

Ecological field investigation was completed (see Appenidx H – Biodiversity assessment) and archaeological investigations were completed (see Section 6.4) to inform site condition assessment at this site.

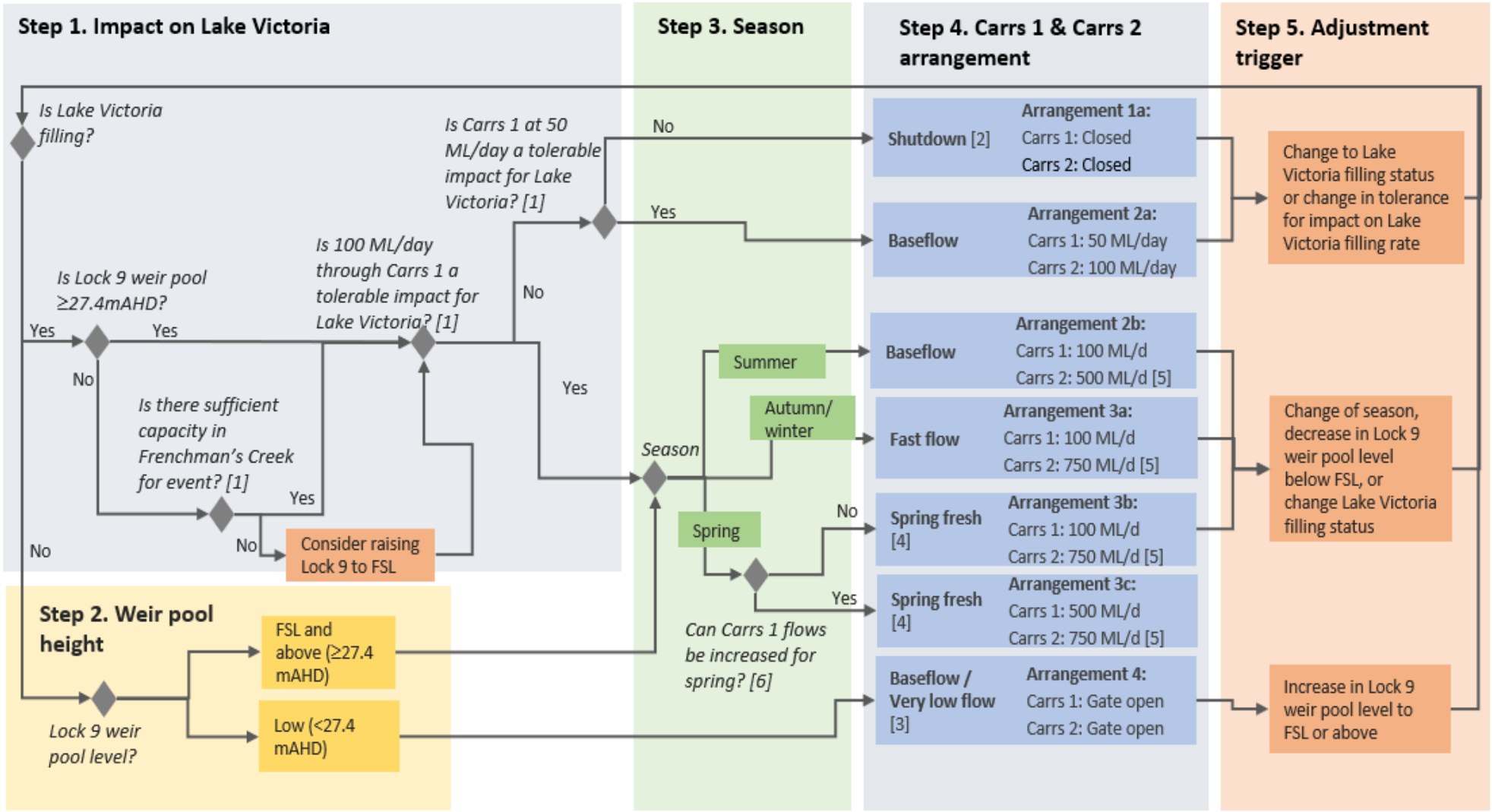

Figure 3-1 CCB Operational decision framework

Construction

The new Carrs weir No.1 and No.2 regulators and fishways are proposed to replace the existing structures. Construction will require temporary works (e.g. coffer dam/s) and demolition of the existing weirs which was allowed for in the footprint for undertaking site surveys. The existing Carrs weir No. 1 and No.2 do not currently allow bypass flows and no diversion flows are required during construction. The key construction activities planned include:

1. Site establishment

   Where required and consistent with the ACHAR and to ensure the protection of identified sites during works, an exclusion zone in the form of a physical barrier shall be erected. The barrier shall be equivalent to the diameter of the tree canopy plus 3 - 5m. Where no canopy exists a 2m x 2m area around the tree will be sufficient. The sites shall be fenced and marked as 'no-go' areas. They shall be marked on maps used by all personnel accessing the site as part of this project.

2. Dewatering. The site will only retain water trapped by the creation of a coffer dam. It is envisaged that an earth fill coffer dam would be constructed by placing fill into the waterway upstream to create a dry site, then subsequently excavating through the centre of the fill to construct an engineered fill core. Alternatively, if in-situ conditions are found to be unsuitable, sheet piles may be used for the coffer dam or central waterproof element.

   Note that the existing Carrs weir No. 2 weir has been dewatered by previous construction of an upstream block bank. This block bank is retaining the Lock 9 pool level and is expected to be suitable, subject to contractor risk assessment, to act as a coffer dam for construction of the new Carrs weir No. 2 regulator and fishway.

3. Hardstand. A hardstand area has been nominated on construction footprints and will be constructed to allow for site facilities including delivery and storage of materials. This would be on the existing footprint (nomianted parking area on the design Drawings) to mitigate potential environmental impact. The hardstand would be utilised for storage of materials, namely sheet piles, precast items (M Planks) and backfill material. The hardstand surface level will be graded so as to be free draining and bunded if required.

4. Removal of existing weir. The concrete elements of the existing weir would be broken up with an excavator and removed by truck or reused onsite where deemed suitable (excluding instream uses) measures. The drawings of the existing weirs do not show any deep foundation elements (piles or sheet piles) or other elements that would present a difficulty for demolition.

5. Construct bridge foundation and new regulator.

   a. The foundation for the access bridge and new regulator will be excavated to the appropriate level with an excavator. The foundation shall be prepared by removal of topsoil and any organic matter and compacted in accordance with the design Drawings and Specification.

   b. The sheet piles will be driven as per design with a piling rig from the prepared foundation. The sheet piles will be trimmed on site to required design levels and any

wastage shall be removed off site. Sheet piling is used for cutoff to prevent seepage and may also assist in structural stability.

c. A nominal concrete blinding layer may be poured as a working platform for the base slab and sloped abutments. Upon completion of blinding layer, the base slab reinforcement is tied as per design and the edges formed. Once inspected, the base slab is formed with starter bars protruding for the sloped abutments and centre piers. The base slab is poured from a concrete boom pump established on the hardstand, upon which concrete trucks deliver to.

   All poured concrete required on site shall be delivered to site via concrete trucks. Any excess concrete shall not be disposed on site. A wash down bay shall be nominated. In circumstances where access is difficult, the contractor shall co-ordinate a concrete boom pump to mitigate risk associated with reach.

   Note: Due to remoteness of this site, the contractor may opt to install precast items where possible to minimise site works and mitigate risk associated with labour, remoteness of site and time critical activities.

d. The formwork for the sloped bridge abutments, centre piers and wing walls are installed, and the reinforcement is tied. Once inspected, the formwork is closed, and concrete poured. Due to the large scale and varying reduced levels, the base slab, sloped bridge abutments, centre piers and wing walls will be poured sequentially as determined by the contractor.

e. Upon completion of appropriate concrete curing time, the formwork shall be stripped and concrete back filled with appropriate fill (where required). The fill may be insitu or delivered to site via trucks. An excavator and roller (and or moon buggie) shall be utilised for placement and compaction in earthworks layer lifts as per specification.

f. Regulator gates (qty 3) will be prefabricated off site. They will be delivered to site and installed with a crane into the recesses in the centre piers and secured in accordance with manufacturer specifications.

6. <u>Construct fishway</u>

   a. The foundation for the new fishway will be excavated to the appropriate level with an excavator.

   b. The sheet piles will be driven as per design with a piling rig from the prepared foundation. The sheet piles will be trimmed on site to required design levels and any wastage shall be removed off site.

   c. The foundation is prepared for the base slab and footings with an excavator and roller to compact as required. A nominal concrete blinding layer may be poured as a working platform for the base slab and wingwalls.

   d. The reinforcement is tied as per design and the edges formed. Once inspected, the base slab is formed with starter bars protruding for the wing walls and baffles. The concrete slab and footings shall be several concrete pours sequentially due to the complexity and varying reduced levels in the fishway.

e. The fishway walls and baffles shall be formed and reinforcement tied. Once inspected, the formwork is closed and concrete poured. As per the base slabs, the concrete pours shall be several concrete pours due to the complexity and varying reduced levels in the fishway.

f. Upon completion of appropriate concrete curing time, the formwork shall be stripped and concrete back filled where required.

g. The fishway gate slots will be prefabricated off site. They will be delivered to site and installed with a crane into the recesses and secured in accordance with manufacturer specifications.

7. Impermeable fill shall be placed on the access track approaches to the bridge in accordance with the design. This shall be delivered to site by dump trucks, spread with a grader and or excavator and compacted with a roller in controlled earthworks lifts.

8. Bridge construction and walkway

    a. The sloped bridge abutments are backfilled with structural fill in accordance with the design and specification. This shall be delivered via dump trucks via designated access tracks and placed as close as practicably possible on site to minimise double handling. The excavator shall place the fill in nominated lifts as per design and specification and a roller shall compact the fill as per design requirements.

    b. The bridge beams shall be M-Lock planks cast off site. They shall be delivered to site via articulated trucks and may be stored on the nominated hard stand. A crane shall be mobilised and set up for the installation of the M Lock bridge planks. The bridge planks shall be installed sequentially and end planks secured with guard rail as per design. The planks shall be bolted in accordance with manufacturers specifications and infill grouted.

    c. Once the fill has been placed to the underside of the bridge approach slab, the base slab shall prepared, reinforcement tied, formed and poured.

    d. A prefabricated walkway and handrail shall be installed on the sloped abutments for the fishway with a crane from the hardstand.

9. Unsealed Pavement

    a. Pavement shall be constructed on the bridge approaches and in the car parking area as per design drawings. This includes 3 layers of imported road base. Road base will be placed with dump trucks and spread with excavator and / or graders, nominal depth 175mm. A roller shall compact the material to nominated compaction.

10. Landscaping

    a. Swale drains shall be formed with an excavator as per design drawings to ensure effective water passage to Carrs Creek.

    b. Batters shall be trimmed with an excavator to ensure profile is as per design. Rock shall be delivered to site by dump trucks and placed by excavator as per design drawings.

Operation

The *Interim operating plan for Carrs, Capitts and Bunberoo Creeks for the commissioning phase of Carrs 1 and 2 regulators* (Alluvium, 2022) (see Appendix E) has been developed to guide operation of the proposed Carrs weir No. 1 and No. 2 regulators to optimise instream habitat conditions for native fish within broader River Murray and Locks 8 and 9 system operational settings. The Operating Plan has been developed to guide management of the CCB Creeks system to ensure seasonally appropriate flow pulses are achieved, while limiting CCB flows to baseflow level during summer months. This aims to balance the competing needs for maximising fast-flowing fish habitat and hydraulic diversity in the heavily regulated Lower Murray with supporting ecosystems adapted to natural seasonal hydrology.

The proposed regulators at both Carrs weir No.1 and Carrs weir No.2 will be operated according to one of three operating modes:

- Normal (default) operation – provides regular baseflow

  The baseflow scenario is the default operating condition for CCB and provides the minimum flow for the system. Baseflow is provided during autumn and winter or when other scenarios are not operating. Baseflow provides the minimum extent of flowing habitat. Baseflows also contribute to the objective of a permanent flowing anabranch which is important for maintaining native fish populations, such as Murray cod. Where there are cease-to-flow events, even short term (i.e. days) then native fish can be expected to migrate back to the River Murray, often via fishways.
- Pulse operation – providing for Autumn and Spring freshes / pulses

  Spring fresh will be provided over a period of 3 to 4 months starting in around September. This scenario involves increasing inflows to inundate instream benches and shallow areas at the edge of backwaters. This will encourage seasonal growth, increase available organic content and may increase nesting habitat for Murray cod. Reach velocities between 0.3 m/s and 0.5 m/s are achieved in these periods. Water levels remain within banks except for locations where connectivity to floodplain features occurs. Further details are included in Section 6.
- Flood - functionality allows gates to be opened during large natural flood events.

  Under natural flood events when river levels exceed the regulating capacity of Lock 9:

  - The new structures must minimise the impact of the passage of natural flood flows across the floodplain
  - The new structures may be overtopped during flood flow events which exceed the design levels, and it is anticipated that some maintenance may be required following large natural overtopping events
  - The regulators will be fully opened to assist in equalisation of upstream and downstream levels
  - Gates are to be clear of the waterway (raised above bridge obvert level or lowered to be horizontal) to minimise the impact on the passage of natural flood flows. It is not envisaged that gates will be removed during these events or raised above 1956 flood level.
  - Gates should be capable of being reinstated quickly as the flood recedes.

Once construction works have been completed and the system has been in operation through a full annual cycle, outcomes of monitoring system behaviour, ecological response and identified risks, along with progressed governance arrangements will inform a revised and updated CCB operating plan.

3.3. Gated box culverts (Sites 4 and 6)

There are two existing block banks, constructed as earth and rock embankments, to prevent escape of water from Frenchmans and Carrs Creek into the CCB Creeks system. Reinforced concrete box culverts are proposed through the banks at Sites 4 and 6, with vertical gates to control environmental and cultural water releases to provide water supply to wetland features (e.g. pigsfoot lagoon). The proposed site layout is shown on Figure 3-5 and Figure 3-6. Detailed design (70%) drawings are provided in Appendix C, which include general arrangement plans, cross sections and engineering details of each of the proposed structures.

The gated box culverts both compromise of single 2,400 mm wide by 2,100 mm high box culverts with a cast insitu concrete base slab and wingwalls. Dual leaf combination gates at the upstream side of the culverts will regulate minor flows into downstream waterways and wetlands. The proposed road formation over the culvert is unsealed with one-way cross fall to match the existing adjacent access road. The culverts include a sheet pile cut-off extending to 5 m beneath the structure and 6 m into each abutment to minimise risk of seepage and piping. The maximum design pool level is 28.03 m AHD in Carrs Creek.

The following minimum freeboard has been adopted for design of the culverts:

- 300 mm typically to road surface for the culvert and approach abutments above design water level
- 100 mm to obvert of culvert above design water level.

This allows SA Water operational access between the Inlet Regulator and Lock 9 for up to a 100,000 ML/d river flow, noting water depth over the deck/crest of the structure may be 0.3 m in this situation.

Bridge lane widths would not be less than the approach road lane widths and guardrails and kerbs would be provided as required by design criteria. Handrails and a steel operating platform are included at the gate regulator, as well as handrails along the downstream wingwalls as the fall height is more than 1.5 m.

Ecological field investigation was completed (see Appenidx H – Biodiversity assessment) and archaeological investigations were completed (see Section 6.4) to inform site condition assessment at this site.

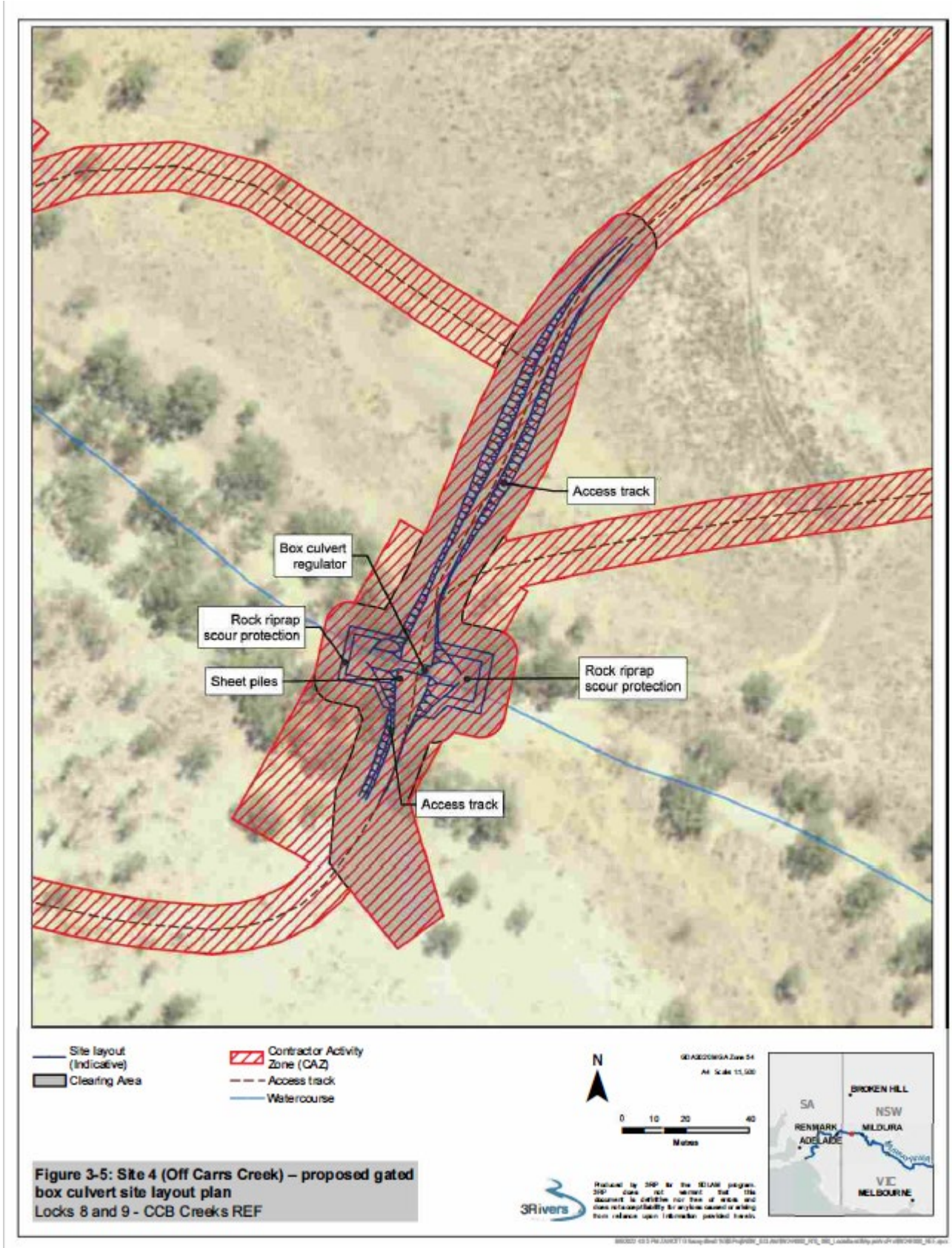

Figure 3-5: Site 4 (Off Carrs Creek) – proposed gated box culvert site layout plan
Locks 8 and 9 - CCB Creeks REF

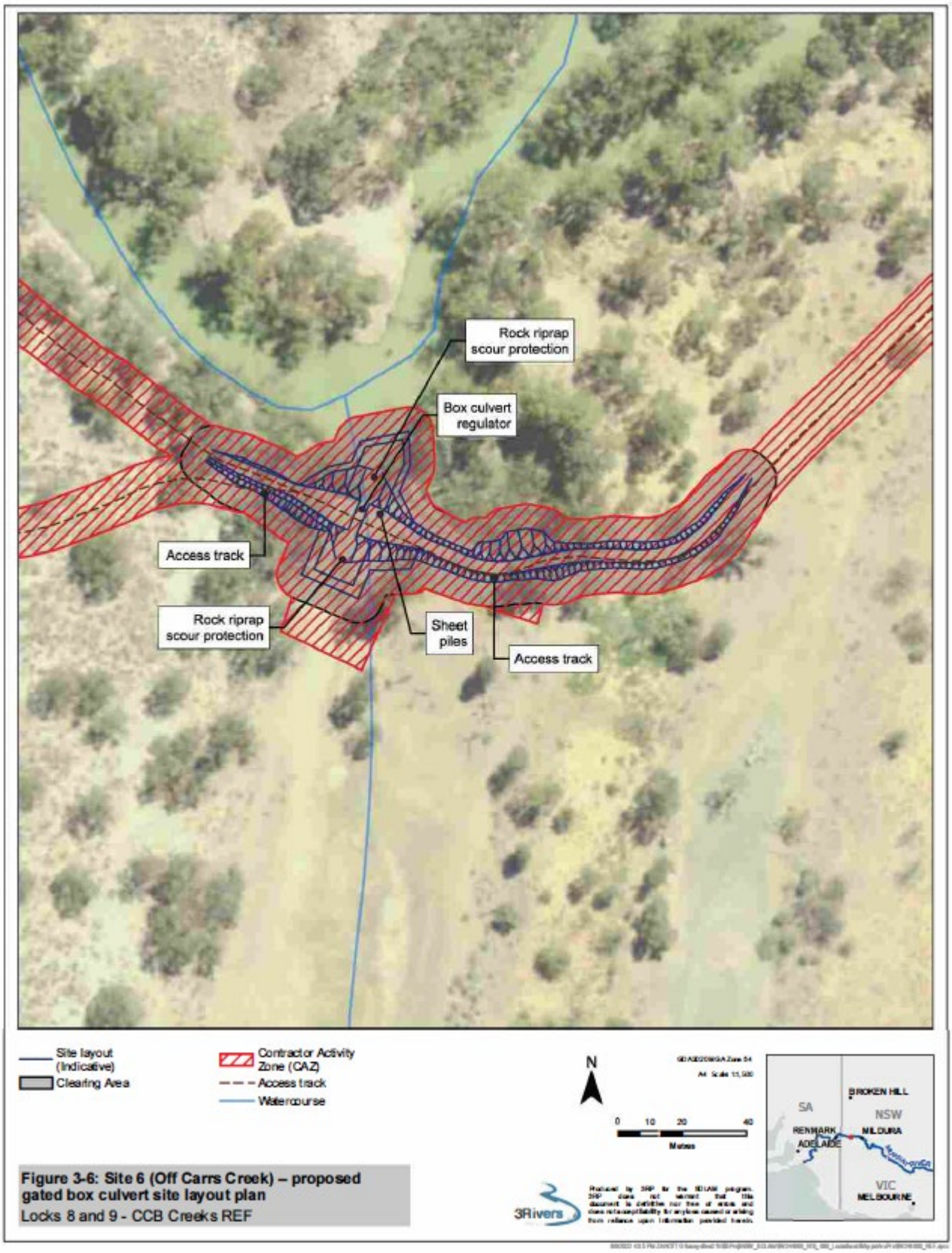

Figure 3-6: Site 6 (Off Carrs Creek) – proposed gated box culvert site layout plan
Locks 8 and 9 - CCB Creeks REF

Construction

The new gated box culverts at Site 4 and Site 6 are proposed to replace the existing block banks. Construction would require temporary works (e.g. coffer dam) and demolition of the existing earthworks. The existing works at these sites do not currently allow bypass flows and no diversion flows are required during construction.

The following steps indicate a typical construction sequence:
Site establishment

Before any works occur at site 4 and 6 (consistent with the AHIP and ACHAR recommendations), sites identified within the ACHAR are collected prior to any works taking place. All Aboriginal objects collected during the archaeological testing and anticipated community collection (under the approved AHIP) will be reburied onsite at the nominated location or taken to a keeping place by the local Traditional Owners or custodians of the land.

Where required and consistent with the ACHAR and to ensure the protection of identified sites during works, an exclusion zone in the form of a physical barrier shall be erected. The barrier shall be equivalent to the diameter of the tree canopy plus 3-5m. Where no canopy exists a 2m x 2m area around the tree will be sufficient. The sites shall be fenced and marked as 'no-go' areas. They shall be marked on maps used by all personnel accessing the site as part of this project.

1. Dewater. The site 4 & 6 would not normally require dewatering. Site 4 is protected by block blanks upstream (Site 3). However, Site 6 will likely require construction of a coffer dam adjacent to Carrs Creek and minor dewatering.
2. Hardstand. A nominated hardstand at Site 2: Carrs 1 work site (as mentioned above) would allow for the delivery and storage of box culverts and gates. This would be on the existing footprint (nominated parking area on the design drawings) to mitigate environmental impact.
3. Removal of existing block bank and rock pitching. The earth and rock elements of the existing bank would be removed with an excavator. (Rock would be stored and used for future beaching in accordance with design drawings).
4. Construct new box culvert and aprons.
    a. The foundation for gated box culvert and aprons will be excavated to the appropriate level with an excavator. The foundation shall be prepared by removal of topsoil and any organic matter and compacted in accordance with design Drawings and Specification.
    b. The sheet piles will be driven as per design with a piling rig from the prepared foundation. The sheet piles will be trimmed on site to required design levels and any wastage shall be removed off site. Sheet piling is used for cut-off to prevent seepage and may also be required for stability.
    c. A nominal concrete blinding layer may be poured as a working platform for the base slab and wing walls. Upon completion of blinding layer, the base slab reinforcement is tied as per design and the edges formed. Once inspected, the base slab is formed with reinforcement starter bars protruding for the wing walls. The base slab is poured from concrete trucks.

Concrete shall be delivered to site via concrete trucks. Any excess concrete shall not be disposed on site. A wash down bay shall be nominated. In circumstances where access is difficult, the contractor shall co-ordinate a concrete boom pump to mitigate risk associated with reach.

Note: the base slab and aprons may be constructed and poured sequentially bases on varying reduced levels, joints and access restrictions.

d. The concrete box culverts shall be transported from Site 2 and shall be placed on the base slab in the recesses with a mobile crane.

c. The adjoining wing walls both downstream and upstream will then be constructed. Reinforcement will be tied as per design drawings and tied in with base slab starter bars. One side of the formwork shall be installed and supported and propped appropriately. Once inspected, the formwork is closed, and concrete poured. Due to the large scale and varying reduced levels, the wing walls may be poured sequentially as determined by the contractor. Once cured sufficiently in accordance with specification, the formwork will be removed.

d. Regulator gate(s) will be prefabricated off site. They will be delivered to site and installed with a crane and secured to culverts in accordance with manufacturer specifications.

5. Road works and backfill.

a. Fill shall be delivered to site via dump trucks and shall be placed on the access track and box culvert approaches in accordance with the design and specification. It shall be spread with a grader and/or excavator and compacted with a roller in controlled earthworks lifts. It shall be tested in accordance with specifications. When in proximity to the box culverts and wingwalls, it shall be compacted with wacker packs and / or moon buggies.

b. Pavement shall be constructed on the access track as per design drawings. Imported road base will be placed with dump trucks and spread with excavator and / or graders.

6. Landscaping.

a. Swale drains shall be formed with an excavator as per design drawings to ensure effective water passage to relief points.

Batters shall be trimmed with an excavator to ensure profile is as per design. Rock shall be delivered to site by dump trucks and placed by the excavator as per design drawings.

Operation

Site 4

Retaining water in Frenchmans Creek and Carrs Creek is critical to the efficient operation of Lake Victoria. Creating block banks along these waterways to prevent water leakage has seen a reduction in the frequency of water reaching floodplain areas including Pigsfoot Lagoon. The new structure will be used to provide improved connectivity within the Carrs creeks system and safe vehicle access to Carrs Weir 2.

The gate regulates minor flows into downstream waterways and wetlands and minimises vegetation disturbance. Limited upstream fish passage is provided through the opened structures as the sites are expected to be operated for short duration (i.e 2 days). The structure is also expected to be operated infrequently (one every 2 years) to deliver environmental water to Pigsfoot lagoon which requires around 50 ML to fill.

Site 6

Like Site 4, the existing block banks were created to prevent leakage from the creek but they have reduced the amount of water reaching Pigsfoot Lagoon, resulting in a loss of natural vegetation. Currently, there is an earth and rock embankment preventing natural flows into the lagoon. A new reinforced concrete box culvert (RCBC) is required to allow for the more efficient flow of water within the Carrs Creek system and vehicle access for water managers to Carrs Weir 2.

The new structure will regulate minor flows for safe fish passage and minimise vegetation disturbance to downstream waterways and wetlands. Limited upstream fish passage will be available (as per notes for Site 4 above). The sole purpose of the proposed RCBC is to allow environmental water managers to deliver water to specific wetlands on an as-needed-basis.

In flood conditions, the gates are to be lifted to above the obvert of the box culverts to allow unrestricted flows, providing safe downstream fish passage. Limited upstream fish passage is provided through the opened structures. There are no specific requirements for fish passage through these minor structures in the waterways where controlled release is not required.

3.4. Bunberoo Creek bridge (Site 9)

A new bridge crossing is proposed over Bunberoo Creek for operational access to allow SA Water operational access between the Inlet Regulator and Lock 9. Existing access will be inadequate with the proposed re-activation of Bunberoo Creek discharge through Carrs weir No. 1 regulator, and the proposed access will also allow safe access for up to a 100,000 ML/d river flow. Consequently, the proposed bridge deck level is RL 28.4 mAHD, noting water depth over the deck may be 0.3 m in this situation. The bridge would replace an existing damaged earth embankment/causeway. The proposed site layout is shown on Figure 3-7. Detailed design (70%) drawings are provided in Appendix C, which include general arrangement plans, cross sections and engineering details of each of the proposed structures.

The Bunberoo Creek Bridge at Site 9 will be constructed with a single lane approximately 4.2 m wide and 0.3 m wide shoulders for a total width of 4.8 m. The bridge will consist of a precast reinforced concrete bridge deck that would span 15 m between spill through batter abutments. The bridge deck will be supported by a precast reinforced concrete abutment headstock with three driven precast reinforced concrete piles at each abutment. The abutments would include riprap protection. The approaches to the bridge deck would be in-situ reinforced concrete slabs of a minimum of four metres in length. The underside (soffit) of the bridge would be a minimum of RL 26.52 mAHD to allow a freeboard of 0.2 m for the maximum design flow.

There are no separated footpaths or additional width for pedestrians or bicycles. However, a bridge barrier and guardrail would be provided, as well as appropriate signage to be finalised through the

detailed design process. The design of the new Bunberoo Creek bridge will be undertaken in accordance with the appropriate standards including consideration of Australian Standard *AS5100 Bridge Design.*

Ecological field investigation was completed (see Appenidx H – Biodiversity assessment) and archaeological investigations were completed (see Section 6.4) to inform site condition assessment at this site.

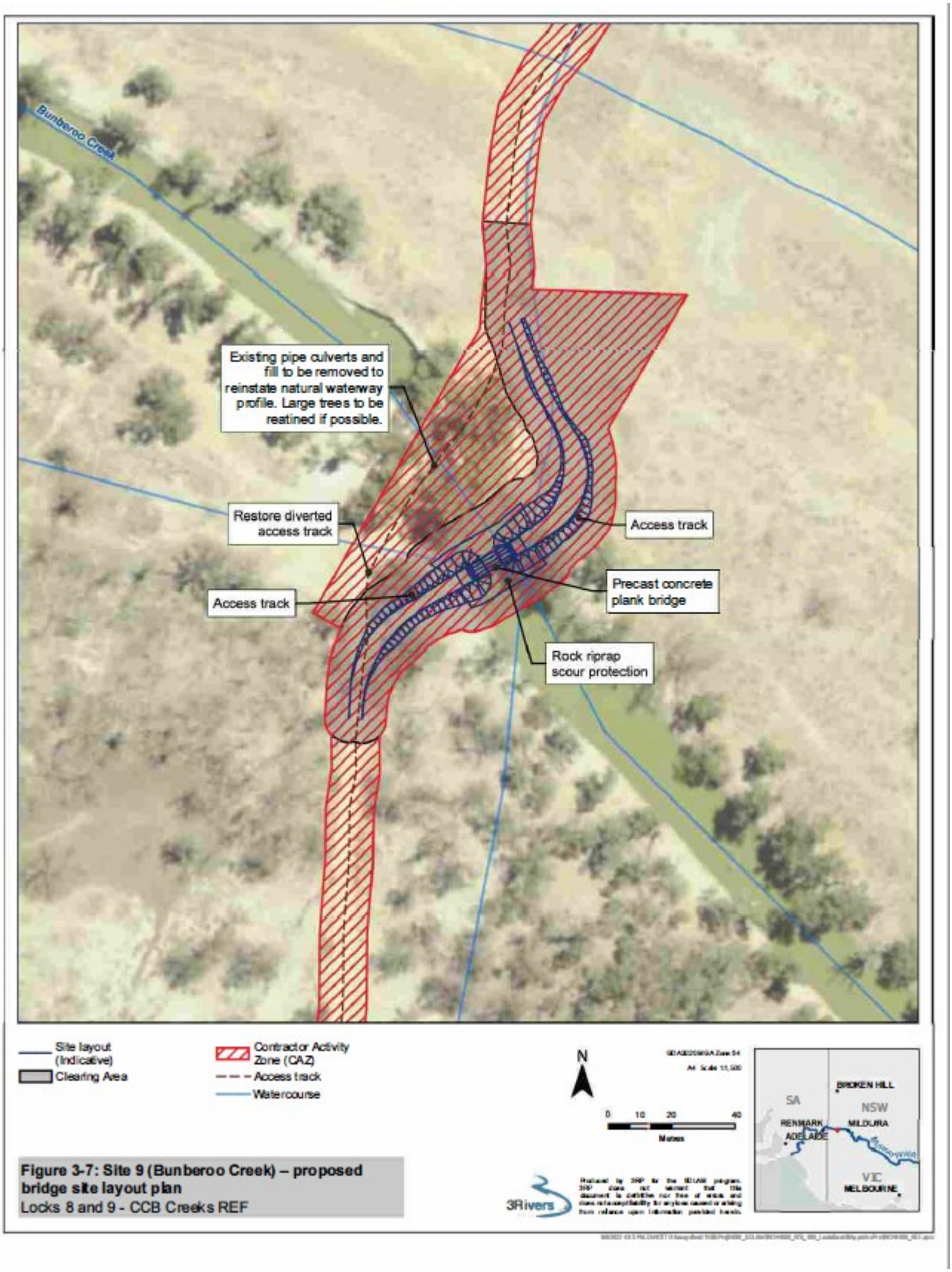

Figure 3-7: Site 9 (Bunberoo Creek) – proposed bridge site layout plan
Locks 8 and 9 - CCB Creeks REF

Construction

Typical construction sequence for Bunberoo Creek Bridge:

1. Site establishment

   Dewatering is not expected to be required for construction of the Bunberoo Creek bridge as there is an existing earth and rock block bank upstream at Carrs 2 weir and downstream at the existing causeway.

2. Roadworks

   The foundation track approaches to Bunberoo Creek Bridge shall be be prepared in accordance with design and specifications. This is likely to involve the following:

   a. Topsoil strip. The foundation shall be prepared by removal of topsoil and any organic matter and subgrade compacted in accordance with design Drawings and Specification. This shall be done with a grader and excavator for the removal of topsoil and where required for compaction, a roller.

   b. Earthwork fill. Clean fill shall be delivered to site via dump trucks and shall be placed on the access track and approaches in accordance with the design and specification. It shall be spread with a grader and or excavator and compacted with a roller in controlled earthworks lifts. It shall be placed to the underside of pavement and headstock. It shall be tested in accordance with specifications.

3. Construct Bunberoo Creek Bridge.

   b. The abutments will be excavated to the foundation level for access and for driving the concrete piles. The foundation shall be prepared by removal of topsoil and any organic matter and compacted in accordance with design drawings and specification.

   c. Concrete piles will be precast and delivered to site via trucks. Concrete piles will be driven with a piling rig and each of the abutments with a nominal amount protruding as per design. (Depending on the pile, the holes may need to be pre-drilled). The exposed part of the precast concrete pile will be broken back to expose reinforcement for the pile/ headstock connection. This is typically broken back with jack hammers.

   d. The precast headstock(s) for each abutment will delivered to site and lifted into position with a crane. The headstock has voids to accomocate the exposed concrete pile reinforcement. Once the headstock is in the correct position, the voids are filled with grout to provide a connection of pile to headstock.

   e. Backfill of headstock to underside of pavement. Controlled earthwork lifts shall continue again. When in proximity to the headstock, it shall be compacted with wacker packers or similar.

   f. A bearing strip is place on the headstock prior to installing the bridge planks. Bolts are screwed into the headstocks ferrules. The bolts act to secure the planks to be installed, but also as a guide during installation.

g. The planks are delivered to site by articulated trucks and stored at a nominated laydown area. The planks are installed by crane and lifted into position. Planks are checked to ensure they are installed securely , with bolts securing to the headstock and also laterally to adjoining planks. There is a longitudinal gap along the planks that is grouted.

h. Additonal back fill shall be placed with dumptrucks, spread with an excavator and compacted with a roller.

i. Reinforcement for the approach slabs shall be tied, edges formed and upon inspection, concrete shall be poured via concrete trucks. Once sufficiently cured, the formwork shall be stripped. Concrete trucks shall be taken off site to nominated wash down bay.

7. Unsealed pavement construction. Pavement shall be constructed on the access track as per design Drawings. This includes roadbase placed with dump trucks and spread with excavator and / or graders. A roller shall compact the material to nominated compaction.

8. Landscaping & finishing works

    a. Batters shall be trimmed with an excavator to ensure profile is as per design. Rock shall be delivered to site by dump trucks and placed by excavator on the bridge abutments at a nominal 500mm depth layer to provide batter protection and mitigate against erosion, consistent with design Drawings.

    b. Minor civil works will be conducted to remove redundant access track and open the waterway,. The waterway shall be locally excavated to match existing, although the extent will not remove all material and existing mature trees within the embankment would be retained. This is consistent with design drawings.

    c. Guard rail shall be installed as per design on the bridge deck and access track. This is fabricated offsite and installed in accordance with manufacturer specifications.

Figure 3-2 Site 9 (Bunberoo Creek) – existing causeway site and clearing for new bridge

Operation

No flow regulation is proposed at the Bunberoo Creek bridge (Site 9). Modelling has demonstrated potential for erosion is minimal, rock beaching has been incorporated into the design to minimise any potential erosion.

3.5. Mike's Runner weir (Site B)

This structure is proposed to replace an existing blocking bank at the confluence of Mike's Runner and the River Murray. A small sheet pile regulator with no vehicle crossing and mechanically actuated gates is proposed. The intent of the structure is to prevent flow back into Bunberoo Creek via Mike's Floodrunner when the Lock 9 weir pool is raised above fully supply level. The combination gates can be lowered to provide regulated flows if required. The proposed site layout is shown on Figure 3-9. Detailed design (70%) drawings are provided in Appendix C, which include general arrangement plans, cross sections and engineering details of each of the proposed structures.

The presence of high value trees in the vicinity of the structure led to a preference to design a structure that required minimal construction footprint and minimal tree clearing. To minimise disturbance, allowance for permanent vehicle access during Lock 9 operating water levels is not proposed, and any gate operations would need to be completed manually. Proposed stainless steel combination gates would be consistent with those proposed at the gated box culverts (Sites 4 and 6).

The hydraulic design features of the proposed Mike's Runner weir include:

- Ability to retain water to raised pool level of 28.03 m AHD plus a nominal allowance for wave runup. The top of structure level is set at 28.2 mAHD.
- Through-flow provisions are limited to two gate bays, each 1.1 m wide, to provide operational flexibility to release water into Bunberoo Creek to gradually equalise levels during flood events as required.

Ecological field investigation was completed (see Appendix H – Biodiversity assessment) and archaeological investigations were completed (see Section 6.4) to inform site condition assessment at this site.

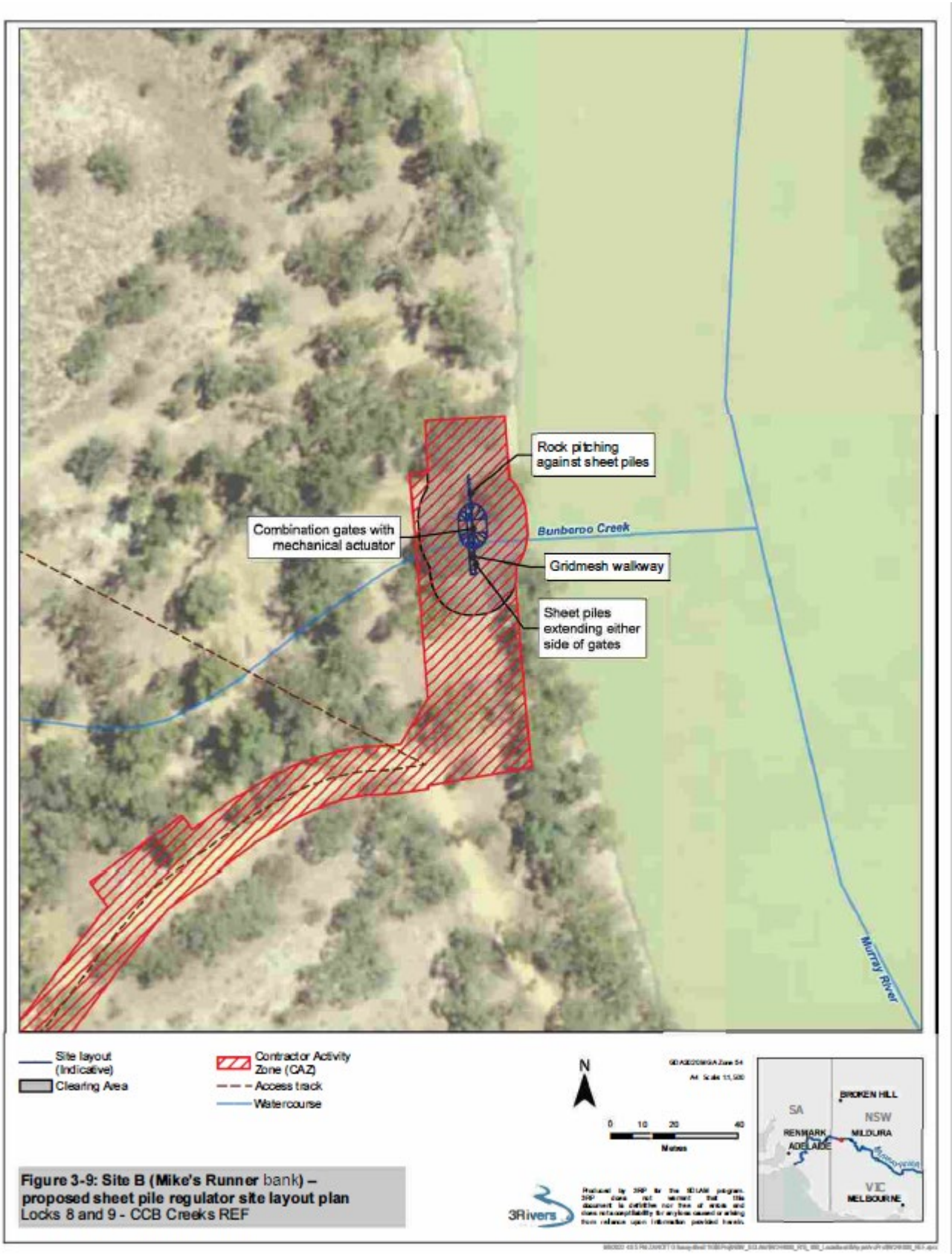

Figure 3-9: Site B (Mike's Runner bank) **– proposed sheet pile regulator site layout plan**
Locks 8 and 9 - CCB Creeks REF

Construction

The site is currently an earth fill block bank with rock pitching providing erosion protection. The rock is in good condition indicating that it is fit for purpose at the site. The design envisages removing only a portion of the rock pitching to allow installation of the sheet piles and a channel at the location of the gates. New rock would match the existing rock.

The following steps indicate a typical construction sequence:

1. Site establishment

   Where required and consistent with the ACHAR and to ensure the protection of identified sites during works, an exclusion zone in the form of a physical barrier shall be erected.

2. Dewater. The site may be required to be dewatered by the creation of a coffer dam. It is envisaged that an earth fill or sheet pile coffer dam would be constructed to create a dry site.

3. Hardstand. A nominated hardstand would be constructed to allow for the delivery and storage of materials. This would be on the existing access track to mitigate environmental impact. The hardstand would be utilised for storage of materials, namely sheet piles & prefabricated items and backfill material.

4. Removal of block bank. The existing weir block bank would be removed by an excavator and removed by truck or reused as part of the erosion protection measures.

5. Sheet piling. The sheet piles will be driven as per design with a piling rig from the prepared foundation. The sheet piles will be trimmed and cut on site to required design levels and any wastage shall be removed off site. Sheet piling is used for cutoff to prevent seepage and may also be required for stability. The profile of the two gates would be cut form the sheet pile.

   The Mild Steel stopboard support frame made (incorporating a waler) would be fabricated offsite and delivered to site. The waler is supported by the sheet pile wall and would be welded to sheet pile.

6. Gate installation. Two combination gates would be installed in the sleeve/recess of the stopboard support frame by a crane (franna) and secured as per manufacturer recommendations.

7. Walkway. The prefabricated walkway frame would be delivered to site pre-assembled in sections. The remainder sections would be bolted together on site and lifted into positions by crane and propped and secured to the sheet pile wall as per design Drawings.

The surrounding upstream and downstream entrance / exit shall be excavated as per design. Geotextile would be rolled out and secured with pins prior to the placement of rock along the apron and batters.

Operation

A walkway is provided along the sheet pile structure to the gates to allow operation and the gates would have a mechanical actuator that can be operated with a portable power pack like a portable drill.

3.6. Lake Victoria Inlet Regulator floodrunner causeway

Hydraulic modelling identified that an area near the existing Lake Victoria Inlet Regulator was below the proposed maximum Lock 9 pool level and would allow bypass flows around Carrs weir No. 1 regulator into Carrs Creek. To avoid this uncontrolled flow, a trafficable causeway is proposed.

The proposed site layout is shown on Figure 3-10. Detailed design (70%) drawings are provided in Appendix C, which include general arrangement plans, cross sections and engineering details of each of the proposed structures.

Construction

All works would be within the existing road corridor. The existing road surface would be excavated, using an excavator, to the surrounding surface level with strip foundation at nominal depth of 0.15 m. Impermeable fill would be carted to site by dump trucks and used to build up the slope on each side of the road substructure (basecourse), which would be 0.3 m thick. This would be placed and spread with an excavator and compacted as required with a roller.

A geotextile would be laid down onto the fill and basecourse. The geotextile would be secured with pins and then, layered with appropriately sized rock fill to create the permeable floodway. The rock would be carefully placed with an excavator bucket so as not too damage with geotextile.

Finally, the road surface would be laid, which would include rolling and grading as required. Material would be imported by dump trucks and spread with an excavator and grader. Once level, it will be compacted with a roller in accordance with design and specification and finally trimmed on grade with a grader.

Operation

The proposed floodway would act as a water retaining structure with heavy vehicle access until water reaches the top elevation of the impermeable fill at EL 28.4 m AHD, then water can flow through the rockfill beneath the road surface while light vehicles can continue to drive over the pavement. The intent is that water flows through the rockfill and begins to fill the area downstream to balance out water levels and minimise the erosion that occurs if the pavement is eventually overtopped. The rock fill acts as a spillway to prevent erosion of the structure. However, overtopping would likely cause some erosion and damage to the wearing course and some maintenance will be required.

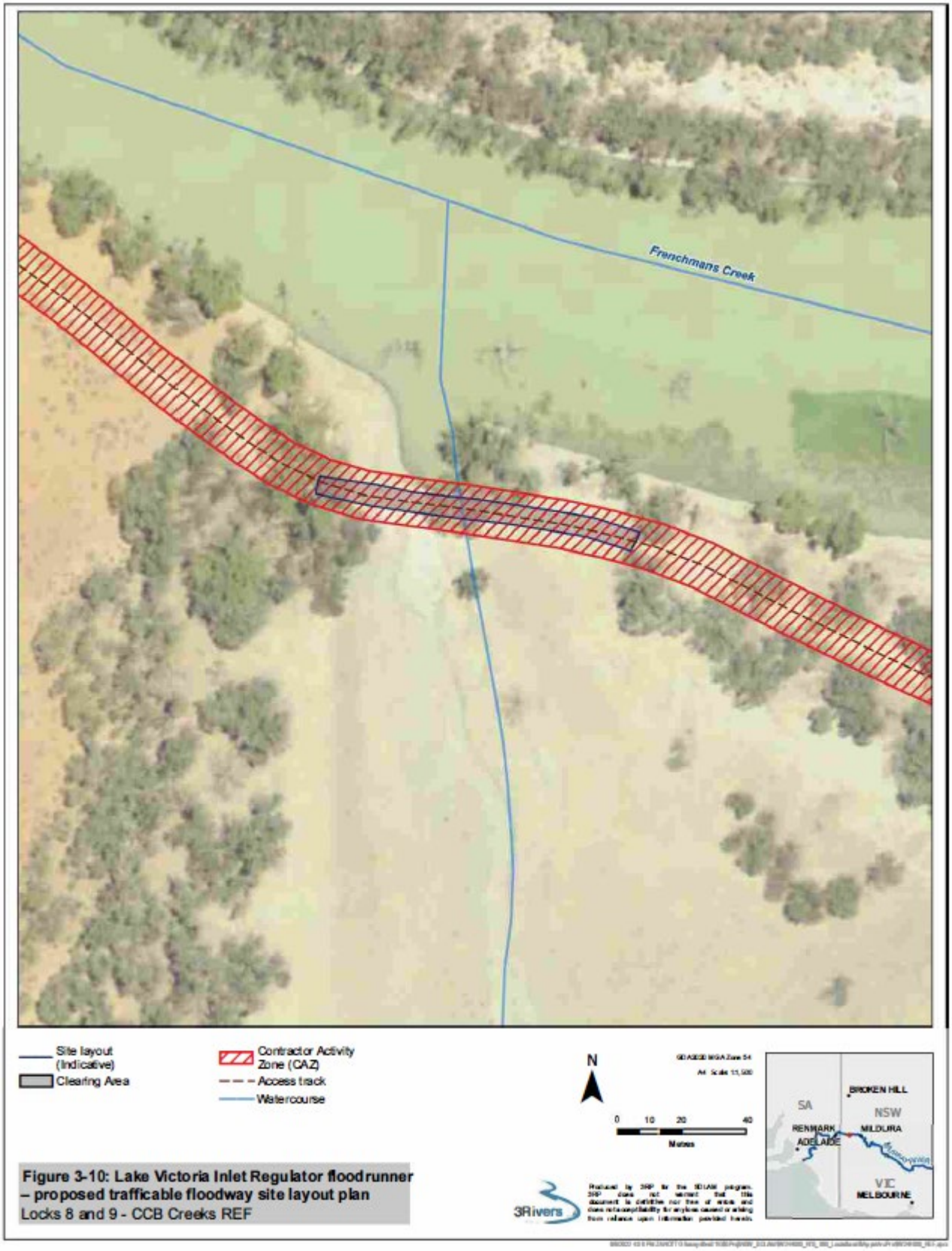

Figure 3-10: Lake Victoria Inlet Regulator floodrunner – proposed trafficable floodway site layout plan
Locks 8 and 9 - CCB Creeks REF

3.7. Realignment of access tracks

Where the proposed creek crossings are not aligned with existing tracks, tie-in works are also required to realign existing tracks to the proposed new structures. The proposed realignment of access tracks is shown on Figure 3-2 to Figure 3-10. Existing track alignment is followed as much as possible to minimise impacts on the adjacent land whilst ensuring that a practical alignment is provided.

A road type 4C is proposed based on Austroads Unsealed Roads Manual assuming a low trafficked access road in rural settings. The adopted design speed is 40 km/h for access roads and 20 km/h over bridges and culverts. The surface of proposed new access tracks would be unsealed and would largely depend on locally available materials, but may include:

- Crushed rock (quarry material) class 2 or 3
- Crushed rock class 4 (quarry material) with a class 3 ground granulated blast-surface/lime stabilised limestone
- Lime stabilised clay
- Cement stabilised crushed rock.

The proposed realigned sections of access tracks would be a single lane design about 3 m wide with 0.5 m wide shoulders, resulting in a typical total width of 4 m. The tracks would be built up from foundation level using impermeable fill with a typical crossfall of three percent and batter slopes of 1:4. The minimum radius of any curves along new sections of track would be 60 metres, and the maximum vertical grade would be eight percent. Detailed design (70%) drawings are provided in Appendix C, which include typical cross sections of the proposed new access tracks. No safety barriers are proposed for access tracks beyond the approach and departure zones of regulator and culvert structures.

Construction

Construction of the proposed new sections of realigned access track would involve:

- Vegetation clearance, as required
- Excavation of strip foundations to a depth of 0.2 m involving removal of topsoil organics, soft clay or sand
- Laydown of impermeable fill material
- Laydown of surface material
- Rolling and/or grading of access track surface and batter slopes.

During construction of the Proposal, it is expected that there would be an average of six truck movements a day (12.5 m semi-trailer truck assumed).

Operation

During operation of the Proposal, it is assumed that traffic volumes would generally be about one passenger vehicle per day.

The realigned sections of access tracks would be designed and constructed to withstand modest levels and duration of inundation, however some maintenance is expected to be required following natural flood events.

3.8. Timing and staging

Construction of the various pieces of Proposal infrastructure is generally planned to occur concurrently from approximately February 2023 to February 2024 with the peak of construction activities being about mid-2023. Construction of Carrs weirs No. 1 and No. 2 regulators, fishways and bridges would take approximately nine months each, while Bunberoo Creek bridge, the gated box culverts crossings and the floodrunner causeway would take between two and six months each.

SA Water have confirmed that construction of the Proposal will take place during standard construction hours. These are outlined in the Construction Noise and Vibration Guideline (CNVG) (NSW Roads and Maritime Service, 2016) as follows:

- Monday to Friday 7 am to 6 pm
- Saturday 8 am to 1 pm
- No work on Sundays or public holidays.

Cleared native vegetation not designated for specific uses during site revegetation and rehabilitation (i.e. hollow-bearing limbs from cleared trees) will be mulched and stockpiled for use during rehabilitation. All construction equipment and materials would be removed from the Proposal sites at completion and the sites suitably rehabilitated.

3.9. Construction plant and equipment

The complete list of plant and equipment required for construction of the Proposal would be confirmed during detailed design and construction planning. An indicative list of required plant and equipment includes:

- Excavators (20 - 30 Tonne)
- Backhoe
- Wheeled loader
- Articulated dump trucks (30 - 40 tonne)
- Road grader
- Vibrating rollers (12 – 15 tonne)
- Bobcat
- Pile driving rig
- Delivery trucks
- Concrete trucks
- Cranage for site facilities - franna crane

- Concrete boom pump
- Water cart
- 4WD utes
- Minor construction tools and equipment.

3.10. Ancillary facilities

Ancillary facilities (construction compounds) would be minimal and limited to one or two portable toilets, ablutions and site office sheds within the assessed construction activity zone at each Proposal site. Laydown of plant and material would also be within the assessed construction activity zones and would not require any vegetation clearing.

3.11. Operation and maintenance responsibilities

The proposed operation of the CCB works has potential to overlap with existing River Murray Operations Joint Venture (RMO JV) assets, which enable Lake Victoria storage operations vital to maintaining South Australia's entitlement flow. The operational plan has been designed to account for potential impacts and can be modified / revised if impacts are discovered during first operations.

The Proposal has been accepted by the Joint Venture via endorsement of papers by the River Murray Operations Committee (RMOC), Joint Venture Budget and Performance Committee (JVBPC), Basin Officials Committee (BOC) and Ministerial Council (MinCo).

SA Water currently undertakes regular surveillance of the CCB sites as part of its asset management role. Upon commissioning and handover of the Proposal, SA Water will continue its responsibility of operating and maintaining the structures on behalf of the RMO JV.

4. Legislative context

4.1. Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) and its associated regulation provide the framework for assessing the environmental impacts of proposed developments in NSW. The EP&A Act allows for the creation of environmental planning instruments (EPIs) including Local Environmental Plans (LEPs) and State Environmental Planning Policies (SEPPs). The applicable EPIs and the Environmental Planning and Assessment Regulation (2000) (EP&A Regulation) made under the EP&A Act collectively determine the relevant planning approval pathway and the associated environmental assessment requirements for proposed development activities.

This REF has been prepared with consideration of section 171 of the Environmental Planning and Assessment Regulation 2021 (summarised in Appendix B), the *Biodiversity Conservation Act 2016*, the *Fisheries Management Act 1994*, and the *Environmental Protection and Biodiversity Conservation Act 1999*. In doing so, the REF helps to fulfil the requirements of section 5.5 of the EP&A Act that WINSW examine and take into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of the activity.

4.2. State Environmental Planning Policies

State Environmental Planning Policy (Transport and Infrastructure) 2021

State Environmental Planning Policy (Transport and Infrastructure) 2021 (Transport and Infrastructure SEPP) aims to facilitate the effective delivery of infrastructure across the State.

The Proposal consists of various infrastructure types. The permissibility of each infrastructure type is addressed separately in the Transport and Infrastructure SEPP:

- Regulators with fishways and bridges (Sites 2 and 8) – Water storage facility is defined in the dictionary of the Standard Instrument as a dam, weir or reservoir for the collection and storage of water. As regulators are used to collect and store water they are considered to be a water storage facility. Sites 2 and 8 are located on land zoned SP2 Infrastructure in the Wentworth Local Environmental Plan 2011 (refer to Table 6-27). Development for the purpose of water storage facilities may be carried out without consent if it is carried out by or on behalf of any public authority on land in Zone SP2 Infrastructure in accordance with clause 2.159(2) of the Transport and Infrastructure SEPP. Fishways and access ways developed in connection with a water storage facility are also permissible without consent in accordance with clauses 2.159(6)(a) and (d) respectively of the Transport and Infrastructure SEPP
- Gated boxed culverts (sites 4 and 6) – Gated box culverts are also used to collect and store water and therefore are considered to be a water storage facility too. Sites 4 and 6 are located on land zoned SP2 Infrastructure (refer to Table 6-27). The development of the proposed gated box

culverts would be permissible without consent in accordance with clause 2.159(2) of the Transport and Infrastructure SEPP as explained above

- Bunberoo Creek bridge (Site 9) – Clause 2.108 of the Transport and Infrastructure SEPP defines 'road infrastructure facilities' to include bridges. Development for the purpose of road infrastructure facilities may be carried out by or on behalf of a public authority without consent on any land in accordance with clause 2.109(1) of the Transport and Infrastructure SEPP.
- Mike's Runner weir (Site B) – The regulator proposed to replace the Mike's Runner Weir (which is technically not a weir, but rather a block bank) is required to prevent flood waters into Bunberoo Creek, and is considered to meet the definition of flood mitigation work, which is defined under clause 2.55 of the of the Transport and Infrastructure SEPP to means *work designed and constructed for the express purpose of mitigating flood impacts*. Under clause 2.56(1), development for the purpose of flood mitigation work may be carried out by or on behalf of a public authority without consent on any land.
- Lake Victoria Inlet Regulator floodrunner causeway – Clause 2.108 of the Transport and Infrastructure SEPP defines 'road infrastructure facilities' to include causeways. Development for the purpose of road infrastructure facilities may be carried out by or on behalf of a public authority without consent on any land in accordance with clause 2.109(1) of the Transport and Infrastructure SEPP.

Realignment of access tracks – Access ways developed in connection with a water storage facility are permissible without consent in accordance with clauses 2.159(6)(d) respectively of the Transport and Infrastructure SEPP.

Part 2.2 Division 1 of the Transport and Infrastructure SEPP contains provisions for public authorities to consult with local councils and other public authorities prior to the commencement of certain types of development. Transport and Infrastructure SEPP consultation requirements relevant to the Proposal are considered in Chapter 5 of this REF.

State Environmental Planning Policy (Biodiversity and Conservation) 2021

River Murray Lands

Chapter 5 of SEPP (Biodiversity and Conservation) 2021 (Biodiversity and Conservation SEPP) contains provisions for environmental approvals and consultation relating to activities proposed on the riverine land of the River Murray (formerly administered under the Murray Regional Environmental Plan No 2-Riverine Land).

Part 5.2 outlines the general planning principles (section 5.8) and specific planning principles (section 5.9) guiding developments on River Murray lands. These principles are applicable as the Proposal is identified under section 5.7(b) as development by a public authority which does not require consent but which has the potential to adversely affect the riverine environment of the River Murray. Part 5.3 outlines the consultation and planning requirements relevant to developments identified under section 5.7, with section 5.10 detailing specific planning control and consultation requirements relevant to the Proposal.

The Planning Control and Consultation Table in Part 5.3, section 5.12- No 3 in the Planning and Control Table of the SEPP states that bank and/or bed work *which relate to the excavation, dredging*

or alteration to the alignment or shape of the bank or bed of the River Murray (including construction of weirs and floodgates, boat ramps and bank stabilisation works) are subject to:

- Council planning consent (except work by or for NSW Department of Planning and Environment (DPE) or Victoria Department of Environment, Land, Water and Planning). However, council planning consent is not required as WINSW is part of DPE Water (formerly the NSW Department of Water Resources (DWR), to which the Section refers).
- Consultation with Transport for NSW where the development may affect boating safety
- Consultation with NSW DPE if the development is likely to significantly affect threatened species and in the flood planning area.

Under section 5.12 9 the destruction of native vegetation is defined as "…the clearing, logging, removal or damaging of any species of trees and shrubs that are indigenous to the River Murray floodplain and that are on land shown on the map as native vegetation." Native vegetation destruction is subject to Council planning consent unless it constitutes destruction of native vegetation in the Western Division. The Proposal is located in the Western Division and, therefore, vegetation removal required as part of the Proposal is not subject to section 5.12 9.

Section 5.12- No9 in the Planning and Control Table of the SEPP also requires consultation with NSW DPE if the development is likely to significantly affect threatened species within the meaning of section 7.2 of the BC Act.

Section 5.12 - No 10 in the Planning and Control Table of the SEPP states that flood control works *"…which change the natural or existing condition or topography of land (such as the construction or alteration of levees, channels and mounds) and which are likely to affect the hydrology of the River Murray system,"* are subject to:

- Council planning consent (except work by or for NSW Department of Planning and Environment (DPE) or Victoria Department of Environment, Land, Water and Planning). However, council planning consent is not required as WINSW is part of DPE Water (formerly NSW DWR to which the section refers).
- Consultation with NSW DPE.

Biodiversity and Conservation SEPP consultation requirements relevant to the Proposal are considered in Section 5 of this REF.

Koala habitat protection

Chapter 3 and Chapter 4 of the Biodiversity and Conservation SEPP contains provisions for development control of koala habitats, koala plans of management and other environmental planning measures formerly administered under the State Environmental Planning Policy (Koala Habitat Protection) 2020 and (State Environmental Planning Policy (Koala Habitat Protection) 2021 respectively. The Biodiversity and Conservation SEPP Chapter 3 koala habitat protection 2020 aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline.

Wentworth Council Local Government Area (LGA) is listed in Schedule 1 of the Koala habitat protection SEPP 2021 and Schedule 2 of the Biodiversity and Conservation SEPP. As per the interim measure announced by the NSW Government on 8 March 2021, Koala SEPP 2020 continues to apply

for all RU1, RU2 and RU3 zoned land outside of the Sydney Metropolitan Area and the Central Coast, including in the Wentworth LGA. However, WINSW is not bound by the provisions of the Koala SEPP 2021 for Division 5.1 assessments.

The Proposal would require clearing of River Red Gum trees which are listed as a koala use tree species in the Riverina koala management area in Schedule 3 of the Biodiversity and Conservation SEPP and provides suitable foraging habitat for koalas. However, the biodiversity assessment carried out as part of this REF (refer Section 6.3) has assessed koalas as unlikely to occur in the Proposal area and therefore further assessment is not necessary.

Other SEPPs

The Proposal does not require development consent or approval under State Environmental Planning Policy (Resilience and Hazards) 2021, State Environmental Planning Policy (Planning Systems) 2021 or State Environmental Planning Policy (Precincts–Regional) 2021.

4.3. Wentworth Local Environmental Plan 2011

The Proposal is located within the Wentworth Shire local government area (LGA). The Wentworth Local Environmental Plan (LEP) 2011 applies to land with within the Wentworth Shire LGA. Clause 1.9 of the Wentworth LEP states that the Plan is subject to the provisions of any SEPP that prevails over this Plan. As discussed in Section 4.1, the Proposal is subject to the provisions of the Transport and Infrastructure SEPP and, as such, development consent from council is not required.

The Wentworth LEP considers land use objectives for land zones within the Wentworth Shire LGA. The Proposal is located within lands that are zoned SP2 Infrastructure, RU1 Primary Production and RU3 Forestry and consistency with each zone's objectives is outlined in Table 4-1.

Table 4-1 Consistency of the Proposal with Wentworth LEP zone objectives

Zone	Objectives	Consistency of the Proposal with the zone objective
SP2 Infrastructure	• To provide for infrastructure and related uses. • To prevent development that is not compatible with or that may detract from the provision of infrastructure.	The Proposal involves the construction and operation of a water supply system, comprised of weirs, bridge crossings, regulators and fishways. The Proposal is considered compatible with this zone objective.

Zone	Objectives	Consistency of the Proposal with the zone objective
RU1 Primary Production	• To encourage sustainable primary industry production by maintaining and enhancing the natural resource base. • To encourage diversity in primary industry enterprises and systems appropriate for the area. • To minimise the fragmentation and alienation of resource lands. • To minimise conflict between land uses within this zone and land uses within adjoining zones. • To provide for a range of tourism-related uses that support the agricultural industry or are compatible with agricultural uses.	The Proposal would improve in-stream conditions for native fish between Lock 8 and 9 and assist in restoring fish passage between Lake Victoria and the River Murray. This in turn would promote fish growth, breeding and dispersal. The Proposal would also contribute to reduction in water loss during summer for the Lower Murray. The Proposal is considered compatible with this zone objective.
RU3 Forestry	• To enable development for forestry purposes. • To enable other development that is compatible with forestry land uses.	The Proposal would not impact forestry. The Proposal is considered compatible with this zone objective.

The Proposal is consistent with the objectives of land use zoning under the Wentworth LEP. Under Section 1.9 of the Transport and Infrastructure SEPP, the SEPP prevails over the LEP as provided in Section 3.28 of the EP&A Act.

Wentworth Local Strategic Planning Statement

The Wentworth Local Strategic Planning Statement (Wentworth LSPS) was developed by Wentworth Shire Council, the DPIE's (now DPE) Chief Planner's office and Western Region staff. The LSPS outlines Council's vision for land use in the Shire for the next 20 years and functions alongside the *Wentworth Community Strategic Plan 2017 - 2037*. It gives effect to the goals and directions of the *Far West Regional Plan 2036* and is informed by other regional and statewide policies.

The Wentworth LSPS seeks to recognise and understand land use trends and anticipate changes to optimise economic growth and infrastructure for future populations. The three trends identified under the LSPS are:

- the agriculture industry,
- the demand and opportunities for new tourism enterprises and
- the demand and opportunities for new residential development.

The above trends have been used to inform the Planning Priorities outlined within the Wentworth LSPS. The Proposal is consistent with two key planning priorities:

- Planning Priority 9 – Sustainable river systems
- Planning Priority 11 – Protect areas of environmental value.

The Proposal is considered consistent with the three land use trends and two key planning priorities identified within the Wentworth LSPS as the proposed works involve the repair and upgrade of in-stream structures (such as fishways, gated box culverts and other flow regulating works) along the CCB Creeks System. These works (in unison with other SDLAM works) aim to reinstate a more natural flow regime to the River Murray in order to deliver improved water quality and ecological outcomes, and provide overall environmental and socioeconomic benefits.

4.4. Other NSW legislation

National Park Estate (Riverina Red Gum Reservations) Act 2010

The *National Park Estate (Riverina Red Gum Reservations) Act 2010* aims to *transfer certain State Forest land in the Riverina area to the national park estate; to make provision with respect to forestry operations in that area; to amend certain Acts; and for other purposes*.

Moorna State Forest, now known as Tar-Ru lands, vested to the NPW Minister on 1 July 2010 for transfer to Aboriginal ownership in accordance with Section 4 of Schedule 6 of the *National Park Estate (Riverina Red Gum Reservations) Act 2010*. Tar-Ru lands are proposed to be transferred to Barkandji Native Title Aboriginal Corporation free of any easements in accordance with Section 10(1) of the *Act*. Following the transfer, the land will be managed by the Barkandji Maraura Elders Council (BMEC). Bunberoo Creek bridge (Site 9) and Mike's Runner weir (Site B) are located on the land subject to this transfer (refer to Section 6.10).

NSW Government is currently in the process of transferring Tar-Ru lands to the Barkandji Native Title Prescribed Body Corporate (PBC). This process is ongoing and currently a date for official handover is unknown. In the interim, National Parks and Wildlife Service (NPWS) has confirmed that it is not legally able to implement any encumbrances on the land (e.g. easements). Approval of any changes requires agreement from both NPWS and Barkandji Native Title PBC.

Nominated Barkandji representatives have been involved in ongoing Project consultation (refer Section 5.1) and WINSW has been working with the Barkandji board to progress an agreement (potentially in form of an Indigenous Land Use Agreement (ILUA)) specific to the Project.

National Parks and Wildlife Act 1974

As discussed above in Section 6.10, Bunberoo Creek bridge (Site 9) and Mike's Runner weir (Site B) are located within National Park (Tar-Ru lands) on land that vested to the NPW Minister on 1 July 2010 for transfer to Aboriginal ownership. In accordance with Section 10(2) of the *National Park Estate (Riverina Red Gum Reservations) Act 2010*, the purposes for which the lands may be dealt with under Part 11 of the *National Parks and Wildlife Act 1974* include the vesting of any of the land in an Aboriginal landholding body

The Proposal is consistent with the matters of the *National Parks and Wildlife Act 1974* (NPW Act) and would continue the protection of the values on which the land is reserved.

Under Section 151 of Part 12 of the NPW Act, the Minister may grant a lease or licence of land within a reserve (including any buildings or structures on the land) authorising any one or more of the following:

(a) the exclusive use of the land, buildings and structures concerned,
(b) the erection of a new building or structure on the land concerned,
(c) the modification of an existing building or structure on the land concerned.

A lease or licence is also subject to the provisions of the NPW Act, National Parks and Wildlife Regulation 2019 and relevant plan of management.

Section 151E of Part 12 of the NPW Act contains special provisions relating to leases and licences of Aboriginal land. It states that *the Minister may only grant a lease or licence under section 151 of land reserved under Part 4A* [Aboriginal land] *with the concurrence of the relevant board of management for the land concerned*.

Tar-Ru lands are due to be transferred to Barkandji Native Title Aboriginal Corporation, as discussed in Section 6.10. In the interim, National Parks and Wildlife Service (NPWS) has confirmed that it is not legally able to implement any encumbrances on the land (e.g. easements). Consequently, agreement from both NPWS and Barkandji Native Title Aboriginal Corporation will be obtained prior to construction of Bunberoo Creek bridge (Site 9) and Mike's Runner weir (Site B).

The NPW Act is also the primary legislation dealing with Aboriginal cultural heritage in NSW. Items of Aboriginal cultural heritage (Aboriginal objects) or Aboriginal places (declared under Section 84) are protected and regulated under the NPW Act. Aboriginal objects are protected under section 86 of the Act. Under section 90(1) of the Act the Director-General may issue an Aboriginal heritage impact permit (AHIP) for an activity which would harm an Aboriginal object. Assessment of potential impacts to Aboriginal cultural heritage is provided in Appendix I. The assessment found that impacts resulting from the Proposal would be limited to two low density artefact scatters of low scientific and cultural significance at Site 4 and Site 6. An AHIP would be required for the Proposal prior to construction to collect and relocate and/or rebury these artefacts. Heritage NSW is managing this requirement as the location overlaps with an existing MDBA AHIP application for the Lake Victoria Scheme.

The Proposal is not anticipated to cause or exacerbate the occurrence of flooding on lands administered under the NPW Act. This is discussed in greater detail in the operational impacts of Section 6.1 - Hydrology and in Appendix E of this REF.

Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) aims to conserve, develop and share the fisheries resources of the State for the benefit of present and future generations, including conserving fish stocks and key fish habitats and promoting ecologically sustainable development. The FM Act applies to all waters within the limits of the State, except where Commonwealth legislation applies.

Threatened species, populations and ecological communities of fish and marine vegetation are protected under the FM Act. Part 7A Division 4 of the Act prohibits the carrying out, without a licence, of activities that damage habitats or harm threatened species, populations or ecological communities.

In addition, an object of the FM Act is to conserve key fish habitat. Frenchmans Creek, Carrs Creek and Bunberoo Creek are classified as key fish habitats. The Proposal would contribute to the following 'key threatening processes' (KTPs) identified under Schedule 6 of the FM Act:

- Degradation of native riparian vegetation along New South Wales water courses, and

- Removal of large woody debris from New South Wales rivers and streams.

The management of large woody debris (snags) is subject to referral and approval from DPI's Department Contact Officer. Consultation is required with DPI Fisheries regarding the removal and/or relocation of snags in order to minimise impacts to aquatic habitats and fauna, and riparian vegetation.

The potential impacts of the Proposal on the aquatic biodiversity of these creeks, the KTPs identified under the FM Act and the safeguards proposed are discussed in Section 6.2 and Appendix H of this REF.

Construction of the Proposal meets the definition of dredging and reclamation work under Section 198A of the FM Act. Under Section 199 of the FM Act, the Minister for Primary Industries must be notified of a proposal if dredging or reclamation work is to be carried out in a key fish habitat, and any matters raised by the Minister must be considered thereafter a part of the proposal.

Section 5 outlines consultation carried out with NSW Department of Primary Industries (DPI) Fisheries for the Proposal. A notification prior to construction commencing may still be required to meet the requirements of Section 199 of the FM Act.

Pursuant to Section 218 of the FM Act, a public authority that proposes to construct, alter or modify a dam, weir or reservoir on a waterway (or to approve of any such construction, alteration or modification):

(a) must notify the Minister of the proposal, and

(b) must, if the Minister so requests, include as part of the works for the dam, weir or reservoir, or for its alteration or modification, a suitable fishway or fish by-pass.

DPI Fisheries has been formally notified in accordance with section 218 and have been involved in all aspects of the fishway design.

Heritage Act 1977

The *Heritage Act 1977* (Heritage Act) aims to protect items of State and local heritage significance and outlines the process for the approval of development that may impact on items of heritage significance.

Matters protected under the Act include items subject to an Interim Heritage Order and items listed on the State Heritage Register, the heritage schedules of local council LEPs, and the heritage and conservation registers established under section 170 of the Act by NSW Government agencies (section 170 Registers). The Act also provides for the protection of archaeological 'relics', being any deposit, object or material evidence that relates to the non-Aboriginal settlement of NSW and is of State or local heritage significance.

No listed non-Aboriginal heritage items were identified within the Proposal area. Construction and operations of the Proposal are unlikely to damage, displace or destroy an item of heritage value under this Act. The Proposal's potential to interact with or impact on items of heritage significance is assessed in Section 6.5.

Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) regulates activities which may result in pollution impacts (e.g. land, air, water and noise pollution). Part 3.2 of the POEO Act requires an Environment Protection Licence (EPL) for scheduled development work and to carry out scheduled activities as identified in Schedule 1 of the POEO Act.

The Proposal would not meet the requirements for scheduled activities.

The POEO Act also identifies a number of pollution offences. Chapter 5 of the POEO Act describes environment protection offences. Part 5.3, section 120 of the Act describes water pollution offences and section 123 outlines the maximum penalties for water pollution offences.

A water pollution offence committed by a corporation under section 120 attracts special executive liability for directors or others involved in the management of that corporation under section 169 of the POEO Act. The construction contractor and WINSW are obliged to notify the NSW Environmental Protection Authority (EPA) if a pollution incident occurs that causes or threatens material harm to the environment.

Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act) aims to conserve biological diversity and promote ecologically sustainable development; to prevent extinction and promote recovery of threatened species, populations and ecological communities; and to protect areas of outstanding biodiversity value. The BC Act provides a listing of threatened species, populations and ecological communities, areas of outstanding biodiversity value, and key threatening processes (KTPs). The Proposal would contribute to the following 'key threatening processes' identified under Schedule 4 of the BC Act:

- Clearing of native vegetation
- Removal of hollow-bearing trees, and
- Removal of dead wood and dead trees.

Part 7 of the BC Act requires that the significance of the impact on threatened species, populations and ecological communities listed under the BC Act are assessed using a five-part test. Where a significant impact is likely to occur, a Species Impact Statement (SIS) or Biodiversity Development Assessment Report (BDAR) must be prepared.

An assessment of potential terrestrial biodiversity impacts of the Proposal is provided in Section 6.3 including an assessment of significance that addresses the requirements of the BC Act. It concluded that the Proposal is unlikely to have a significant impact on any listed threatened species, ecological communities or critical habitat, and a species impact statement is therefore not required.

Water Management Act 2000

The aims of the *Water Management Act* 2000 (WM Act) are to provide for the sustainable and integrated management of the State's water sources for the benefit of both present and future generations. The WM Act implicitly recognises the need to allocate and provide water for the environmental health of rivers and groundwater systems, while also providing license holders with

more secure access to water and greater opportunities to trade water through the separation of water licenses from land.

Section 89 of the WM Act requires a water use approval for the use of water for a particular purpose at a particular location. If water is proposed to be extracted from the water source during the construction phase for use in the construction works it would require a water use approval.

Section 90 of the WM Act requires an approval to undertake a water management work, which includes water supply work and flood work:

- A water supply work is defined in the dictionary of the Act as including any work (such as a weir) that has, or could have, the effect of impounding water in a water source. The works proposed at Sites 2, 4, 6 and 8 would involve impounding water during their construction and operation phases and would therefore require a water management work approval. The construction works at Site 9 and the Lake Victoria Inlet Regulator floodrunner causeway site may also impound water, and so they too may require a water management work approval
- A flood work is defined in the dictionary to include a work (such as a causeway or embankment) situated in or in the vicinity of a river or lake or within a floodplain and that is likely to have an effect on the flow of water to or from a river or lake. The operation of the works at Lake Victoria Inlet Regulator floodrunner causeway site are a flood work and would therefore require a water management work approval.

Section 91 of the WM Act requires an 'activity approval' to carry out a 'controlled activity' in, on or under waterfront land. The definition of a controlled activity includes the carrying out of work, the removal of material or vegetation from land, the deposition of material on land and the carrying out of any other activity that affects the quality or flow of water in a water source. Waterfront land is defined in the Act's dictionary as including the bed and banks of rivers as well as land that is 40 metres inland of the highest bank of the river. Rivers are defined as including any watercourse, whether perennial or intermittent and whether comprising a natural channel or a natural channel artificially improved, and any tributary, branch or other watercourse that flows into or from that watercourse. Accordingly, the proposed works are on waterfront land and, therefore, are a controlled activity. However, clause 41 of the Water Management (General) Regulation 2018 (WM Regulation) exempts public authorities from requiring a controlled activity approval to carry out a controlled activity in, on or under waterfront land. A controlled activity approval is therefore not required for the Proposal.

Section 91 of the WM Act also requires an activity approval to carry out an aquifer interference activity. Clause 7 of Schedule 4 of the WM Regulation identifies lawfully carrying out excavation required for the construction of a road or infrastructure as part of an authorised project as an aquifer interference activities for which an activity approval is not required provided that no more than three megalitres of groundwater is taken up for the authorised project in a water year and the taking of that groundwater is not for the purpose of its consumption or supply. Clause 21(6) of the WM Regulation requires aquifer interference activities that are exempt from requiring an activity approval to make and keep records of the water taken during these activities. The construction phase of the proposal is an aquifer interference activity but it would be exempt from requiring an activity approval provided records are made and kept showing that no more than three megalitres of water was taken during a water year.

Section 50 of the WM Act allows for the preparation of water sharing plans, which establish rules for the sharing of water in a particular water source between water users and the environment, and rules for the trading of water in a particular water source. The relevant water sharing plan for the Proposal sites is the *Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016* (the WSP, see below).

Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016

The environmental objectives of the WSP are detailed in clause 9(1) and include maintaining and enhancing the ecological condition of the water sources and their dependent ecosystems (instream, riparian and floodplain ecosystems) and contribute to the enhancement of downstream processes, habitats and water quality over the long term.

The WSP includes the core provisions of water sharing plans required in Section 20 of the WM Act. Requirements for water supply work approvals for water supply works in the water sources are provided in Section 66 of the WSP. The requirements are primarily concerned with the taking of water.

The Proposal would be operated consistent with the WSP and supports the environmental objectives of the WSP because it would improve ecological conditions and enhance downstream habitats, processes and water quality within the CCB Creeks system, Frenchmans Creek, Lake Victoria and the wider River Murray over the long term.

Biosecurity Act 2015

Under the *Biosecurity Act 2015* (Biosecurity Act), all plants including weeds are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.

The Biosecurity Act and its regulations provide specific legal requirements for high-risk activities and State level priority weeds. Section 6.3 provides an assessment of potential terrestrial biodiversity impacts of the Proposal and identified three priority weeds: *Carthamus lanatus* (Saffron Thistle), *Phyla canescens* (Lippia) and *Xanthium occidentale* (Noogoora Burr) in the Proposal area. Proliferation of weed species due to clearing activities is a potential indirect impact of the Proposal. Section 6.3 also outlines appropriate safeguards to limit the spread and germination of weeds.

4.5. Commonwealth legislation

Environment Protection and Biodiversity Conservation Act 1999

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) a referral is required to the Australian Government for proposed actions that have the potential to significantly impact on matters of national environmental significance (MNES) including nationally listed threatened species, ecological communities and migratory species, or the environment of Commonwealth land.

A search of the Commonwealth Protected Matters database via the online DCCEEW Protected Matters Search Tool (PMST) was carried out on 31 March 2022 and potential impacts to MNES are assessed in Table 4-2 and Section 6.2 and Section 6.3 of this REF.

The assessment of the Proposal's impact on MNES including nationally listed threatened species, ecological communities and migratory species, and the environment of Commonwealth land, found that there is unlikely to be a significant impact on MNES. Accordingly, the Proposal has not been referred to the Australian Government DCCEEW under the EPBC Act.

Table 4-2 Matters of National Environmental Significance

MNES	Impact
World heritage areas	**Nil**.
National heritage places	**Nil**. The nearest Nationally listed heritage place is Wallpolla Islands east of the Proposal area, located on the opposite side of the River Murray.
Wetlands of international significance (RAMSAR)	**Nil**. The nearest RAMSAR wetland is Riverland located approximately 40-50 km's downstream from the Proposal.
Commonwealth marine areas	**Nil.** There would be no impact to Commonwealth marine areas by the Proposal.
Great Barrier Reef Marine Park	**Nil**. There would be no impact to the Great Barrier Reef Marine Park by the Proposal.
Listed threatened species and communities	**Unlikely**. Potential biodiversity impacts of the Proposal are outlined in Section 6.2 and Section6.3. The Proposal is unlikely to result in a significant impact on nationally listed threatened species or ecological communities.
Listed migratory species	**Nil**. Migratory species that are likely to occur in the Proposal area are assessed in Section 6.2. The Proposal would not impact these listed migratory species as they are highly mobile and have a wide ranging habitat.
Nuclear action	**Nil**. The Proposal does not involve a nuclear action (including uranium mining).
Commonwealth land	**Nil**. There would be no direct or indirect impact to Commonwealth land by the Proposal.
Protection of water resources from coal seam gas development and large coal mining development	**Nil**. The Proposal does not involve coal seam gas development or large coal mining development.

Native Title Act 1993

The main objective of the *Native Title Act 1993* is to recognise and protect native title. A successful native title claim results in the recognition of the particular rights, interests or uses claimed by the registered party. If a native title claim is recognised under the Act, any actions by Government on that land must be consistent with the claim.

As outlined in Section 6.10, Bunberoo Creek bridge (Site 9) and Mike's Runner weir (Site B) are located within National Park (Tar-Ru lands). Tar-Ru lands are proposed to be transferred to Barkandji Native Title Aboriginal Corporation free of any easements in accordance with Section 10(1) of the *National Park Estate (Riverina Red Gum Reservations) Act 2010*. Following the transfer, the land will be managed by the Barkandji Maraura Elders Council (BMEC).

NSW Government is currently in the process of transferring Tar-Ru lands to the Barkandji Native Title Prescribed Body Corporate (PBC). This process is ongoing and currently a date for official handover is unknown. In the interim, NPWS has confirmed that it is not legally able to implement any encumbrances on the land (e.g. easements). Approval of any changes requires agreement from both NPWS and Barkandji Native Title PBC.

Nominated Barkandji representatives have been involved in ongoing Project consultation (refer Section 5.1) and WINSW has been working with the Barkandji board to progress an agreement (potentially in the form of an Indigenous Land Use Agreement (ILUA)) specific to the Project.

The site of the Proposal was the subject of a much larger native title claim by Barkandji Native Title Group Aboriginal Corporation. The claim (Barkandji Traditional Owners #8 (Part A), National Native Title Tribunal file no. NCD2015/001) was determined on 16 June 2015 with native title determined to exist both exclusively and non-exclusively across parts of the claim area. The Tar-Ru lands were excluded from the claim and native title was determined to have been extinguished on land or waters on which there is public works (including public roads) which were constructed or established prior to 23 December 1996. As there are existing public works (including drainage facilities, weirs, other devices for management of water flows and public utility access tracks) established prior to 1996 at the Proposal sites, the Proposal is not be affected by this native title claim.

In the meantime, WINSW are still required to provide notice of the Proposal to the Barkandji Native Title Aboriginal Corporation under section 24KA of the Act and must invite comment on the Proposal. This will be completed prior to construction.

Water Act 2007

The *Water Act 2007* (the Water Act) provides the legislative framework for ensuring that the Murray-Darling Basin – Australia's largest water resource – is managed in the national interest.

The Murray-Darling Basin Authority (MDBA) operates under the Water Act as a single body responsible for overseeing water resource planning in the Murray-Darling Basin as a whole, rather than state by state.

In 2007, there was widespread agreement across government that a plan was needed to manage water carefully and protect the Murray-Darling Basin for future generations. The Water Act required the MDBA to prepare a strategic plan for the integrated and sustainable management of water

resources. As a result the Basin Plan was developed to manage the Basin as a whole connected system.

The Water Act establishes mandatory requirements for the Basin Plan, including:

- Limits on the amount of water (both surface and ground water) that can be taken from the Basin's water resources on a sustainable basis – known as sustainable diversion limits.
- Identifying risks to the Basin's water resources, such as climate change, and strategies to manage those risks
- Requirements for state water resource plans
- An environmental watering plan to optimise environmental outcomes for the Basin
- A water quality and salinity management plan
- Rules about trading of water rights in relation to the Basin's water resources.

The aim of the Basin Plan is to bring the Basin back to a healthier and sustainable level, while continuing to support farming and other industries for the benefit of the Australian community.

The Murray-Darling Basin Agreement sets out rules and plans for dividing the water in the River Murray to support a reliable supply of water for communities and environments along the River Murray across New South Wales, South Australia and Victoria. Before water is available for the states, system demands must be met. These include conveyance water (water that is needed to deliver water) and reserves for the following year.

Basin state governments and the Australian Government have all signed the Agreement, and each state contributes funding for managing the River Murray based on its level of water use.

The MDBA is responsible for calculating each state's share of water in the River Murray system, while Basin state governments allocate water within each water catchment, depending on how much water is available.

In 2008, the Agreement was incorporated into the Water Act 2007. Under Schedule 1 to the Water Act 2007, the Murray Darling Basin Agreement, operating levels for the River Murray weirs can only be changed through approval of the Minsterial Council. This approval is yet to be obtained.

Clause 50 under the Agreement provides that the MDBA must, in exercising its powers or functions, or in implementing works or measures under the Agreement, examine and take into account any possible effects which the exercise of those powers or functions or those works or measures may have on water and other natural resources within the Murray Darling Basin.

The Basin Plan requires all Murray-Darling Basin states to prepare water resource plans (WRPs) to meet the Basin Plan goal of recovering 2,075 gigalitres per year of environmental water by setting sustainable diversion limits on the amount of water available for urban, industrial and agricultural use.

Basin state governments are currently developing WRPs. Each WRP sets out the rules for how water is used at a local or catchment level, including new limits on how much water can be taken from the system, how much water will be made available to the environment, and how water quality standards can be met. Basin state governments are responsible for complying with WRPs and accounting for water taken from the river system.

The Basin Plan divides the Murray-Darling Basin into 19 surface water and 19 groundwater WRP areas. The Proposal is located in the geographic area covered by the NSW Murray and Lower Darling Surface WRP area (SW8) and the NSW Murray Darling Basin Porous Rock groundwater WRP area (GW6).

The NSW Government has formally submitted the proposed NSW Murray and Lower Darling Surface WRP and NSW Murray Darling Basin Porous Rock groundwater WRP for assessment to the MDBA under the Water Act. A recommendation on accreditation has not yet been made by the MDBA to the Commonwealth Minister for the Environment and Water.

MDBA and the NSW Government signed a bilateral agreement in June 2020 to bring key Basin Plan commitments into effect in anticipation of the WRPs (MDBA, 2020). The bilateral agreement ensures that better management of water for the environment remain in effect from 1 July 2020, even if WRPs have not been accredited by that date.

The NSW Murray and Lower Darling Surface WRP is relevant to the Proposal because the Proposal aims to optimise the ecological benefits of environmental watering of the CCB Creeks system.

4.6. Summary of licences and approvals

The Proposal is categorised as development for the purpose of a water supply system and is being carried out by or on behalf of a public authority. Under clause 2.159(2) and 2.56(1) of the Transport and Infrastructure SEPP the Proposal is permissible without consent. The Proposal is not State significant infrastructure or State significant development. The Proposal can be assessed under Division 5.1 of the EP&A Act.

WINSW is the proponent and determining authority for the Proposal. This REF fulfils WINSW's obligations under section 5.5 of the EP&A Act including to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the activity.

Any licences or approvals identified in this legislative context section as required by the Proposal are summarised in Table 4-3.

Table 4-3 Summary of licenses and approvals

Legislation	Key considerations	Summary of requirements
Fisheries Management Act 1994 (NSW)	Frenchmans Creek, Carrs Creek and Bunberoo Creek are classified as key fish habitats and construction of the Proposal meets the definition of dredging and reclamation work under Section 198A of the FM Act. Potential impacts of the Proposal on these creeks are assessed in Section 6.2 of this REF. Under Schedule 6 of the FM Act the "Removal of large woody debris from NSW rivers and streams," and "Degradation of native riparian vegetation along New South Wales water courses" are listed as a Key Threatening Processes.	Under Section 199 of the FM Act, the Minister for Primary Industries must be notified of a proposal if dredging or reclamation work is to be carried out in key fish habitat. The management (including relocation and removal) of large woody debris (snags) is subject to referral and approval from DPI's Department Contact Officer. It is noted that the preference is to relocate any removed snags in consultation with DPI Fisheries. Refer to Section 5 Consultation of this REF and the Safeguards sections of Section 6.1 and Section 6.2 of this REF.
Environmental Planning and Assessment Act 1979 (NSW)	This REF helps to fulfil the requirements of Division 5.1 of the EP&A Act by considering the environmental and social impacts associated with the Proposal. The factors listed in clause 171(2) of the Environmental Planning and Assessment Regulation 2021, have also been considered to assess the likely impacts of the proposed activity on the environment. Refer to Appendix B of this REF.	Section 5.5 of the EP&A Act requires the determining authority, WINSW, to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the activity. Private landholders (Moorna Station) will be consulted to acquire consent for access to sites prior to works. Private landowners (Moorna Station) will be consulted and consent acquired prior to construction and realignment of access tracks as necessary.

Legislation	Key considerations	Summary of requirements
National Parks and Wildlife Act 1974 (NSW)	As assessed in Section 6.10, Bunberoo Creek bridge (Site 9) and Mike's Runner weir (Site B) are located within National Park (Tar-Ru lands). The Proposal is consistent with the matters of the NPW Act and would continue the protection of the values on which the land is reserved. The Proposal is consistent with the matters of the NPW Act and would continue the protection of the values on which the land is reserved. An assessment of potential impacts to Aboriginal cultural heritage is provided in Section 6.4. The assessment found that impacts resulting from the Proposal would be limited to two low density artefact scatters of low scientific and cultural significance at Proposal site 4 and Site 6.	Agreement from both NPWS and Barkandji Native Title Aboriginal Corporation will be obtained prior to construction of Bunberoo Creek bridge (Site 9) and Mike's Runner weir (Site B). An Aboriginal Heritage Impact Permit (AHIP) would be required for the Proposal prior to construction to collect and relocate and/or rebury artefacts identified at Proposal sites 4 and 6.
Water Management Act 2000 (NSW)	As assessed in Section 4.4, approvals under Section 89 (water use) and Section 90 (water management (supply) works) of the WM Act are required to permit the construction and operation of the Proposal. The WM Regulations outlines exemptions relating to public authorities carrying out controlled activities (clause 41) and aquifer interference activities (clause 21((6)) and Schedule 4, clause 7) are applicable to the Proposal (refer to Section 4.4 of this REF).	The relevant licenses and approvals under the WM Act and WM Regulation will be obtained prior to contruction. Groundwater extraction is not expected to occur during construction. If the construction phase of the proposal was considered an 'aquifer interference activity' it is exempt from requiring an activity approval provided records are made and kept showing that no more than three megalitres of water was taken during a water year under clause 21(6) of the WM Regulation.

Legislation	Key considerations	Summary of requirements
Native Title Act 1993 (C'wealth) *and* *National Park Estate (Riverina Red Gum Reservations) Act 2010 (NSW)*	As assessed in Section 6.10, Bunberoo Creek bridge (Site 9) and Mike's Runner weir (Site B) are located within National Park (Tar-Ru lands). Tar-Ru lands are proposed to be transferred to Barkandji Native Title Aboriginal Corporation free of any easements in accordance with Section 10(1) of the Act. Following the transfer, the land will be managed by the Barkandji Maraura Elders Council (BMEC). In the meantime, WINSW are still required to provide notice of the Proposal to the Barkandji Native Title Aboriginal Corporation under section 24KA of the Native Title Act and must invite comment on the Proposal.	Agreement from both NPWS and Barkandji Native Title Aboriginal Corporation will be obtained prior to accessing these sites. Refer to Section 5 Consultation of this REF.
Water Act 2007 (Cth)	Under Schedule 1 of the Murray Darling Basin Agreement, approval from the Ministerial Council is required to make any changes to Joint Venture assets.	MDB Ministerial Council approval has been obtained.

5. Consultation

5.1. Community and stakeholder consultation

The Project recognises that communities have the local knowledge and help guide the best investment decisions. Community and stakeholder consultation has been used to collaboratively determine the best options for proposed investment to achieve project objectives.

The following key stakeholders have been identified to provide feedback on the Locks 8 and 9 Project:

- SA Water
- Murray Darling Basin Authority (MDBA)
- Murray Darling Wetlands Working Group
- Commonwealth Environmental Water Office
- Barkandji Native Title Board
- Barkandji Maraura Elders Board
- Dareton Local Aboriginal Land Council
- Wentworth Shire Council
- Oz Fish
- Wentworth Angling Club
- Wingillie Station
- Moorna Station
- Murray Off-Road Adventures
- Private landholders.

Consultation with these stakeholders has occurred to date via Stakeholder Advisory Group (SAG) meetings. The purpose of the SAG meetings is to provide Project updates and seek feedback in relation to:

- Project scope and objectives
- Funding and approvals
- Options evaluation
- Design elements
- Hydraulic modelling
- Surveys and technical studies (e.g. ecology and salinity) and their findings
- Aboriginal land ownership and the associated consultation processes
- Constructability issues and construction planning and

- The draft Operating Plan.

Other key issues raised at the SAG meetings to date are summarised in Table 5-1.

SAG members were also directed to a dedicated website which provided information on technical reports, meeting papers and project maps.

Table 5-1 Key issues raised at SAG

Key issue	Response
'Water savings', environmental flows and the Basin Plan Clarification was sought of the objectives of the Project in relation to these terms.	It was confirmed the 'water savings' from the Project would contribute to the SDLAM target of 605 GL water recovery as part of the Basin Plan. While the main driver of the Project is to deliver 'water savings' through weir pool manipulation (i.e recovery of physical water savings) the Project is also credited with water offsets by delivering environmental outcomes with equivalent or less volumes of water. MDBA modelling is the final determinant of the Projects' contribution to the 605 GL target.
Traditional Owners engagement and land use Traditional Owners requested ongoing consultation. Discussions with Barkandji Native Title Board to progress an agreement specific to the Project. The relative merits of an AHIP versus an ILUA were discussed. The potential for Aboriginal employment as part of operating plans or monitoring requirements was raised.	It was advised that the SAG meetings were a primary means of consultation with Traditional Owners. A cultural values workshop was carried out in October 2020 and a walk on country was in March 2022. Potential employment opportunities associated with the infrastructure (e.g. site monitors, ranger positions etc) is still to be determined. (Aboriginal heritage is assessed in Section 6.4 of this REF.) WINSW will continue to consult with Aboriginal stakeholders about the management of Aboriginal cultural heritage within the Proposal area throughout detailed design and construction of the Proposal.
Options evaluation Questions were raised about the criteria and weighting of the options evaluation, especially the scoring of cultural values and environmental and social outcomes	An options evaluation framework user guide was circulated which clarified how each of these values were weighted and scored. The options assessment was also presented to the SAG prior to being finalised. (Project options assessment is reviewed in Section 2.4 of this REF)
Acid sulfate soils Noting the importance of monitoring ASS when lowering weir pools	Noted (Acid sulfate soils are assessed in Section 6.6 of this REF)
Recreational fishing Potential impacts when weir pools are lowered	WINSW to investigate if a letter can be provided to Wentworth Angling Club and Ozfish to support grant applications.

Key issue	Response
Salinity Concern for the impact on salinity within Locks 7, 8 and 9 resulting from the Project	Suggestions to mitigate salinity impacts. (Salinity is assessed in Section 6.1 of this REF)
Native plant regeneration A question was raised whether research has been undertaken for native plant regeneration, as the Project sites have been dry for extended periods.	Anecdotal evidence suggests several native species can self-propagate and others require seeding. (Terrestrial biodiversity is assessed in Section 6.3 of this REF.)
Carp management The SAG asked if there would be controls to prevent carp entering the CCB Creeks system.	Carp management options to be further investigated.
Third party impacts Potential impacts to private water pumps and boat ramps were presented.	The SAG agreed that there was no substantial basis for compensation in relation to impacts of water changes at individual pump sites.

5.2. DPI Fisheries consultation

The Locks 8 and 9 Project has funded a partnership agreement between WINSW and DPI Fisheries for development of the works. DPI Fisheries have also been involved in Project consultation meeting the requirements of the *Fisheries Management Act 1994* (refer Section 4.4). DPI Fisheries have reviewed the following design documents:

- NSW Locks 8 and 9 SDLAM Project Design Criteria (December 2020)
- *NSW Locks 8 and 9 SDLAM Project Structures Options Assessment* (SA Water, October 2021)
- SDLAM Lock 8 and 9 Ecology Assessments (April 2021)
- Locks 8 and 9 weir pool manipulation ecological response evaluation (DPIE (EES), June 2021)
- *NSW Locks 8 and 9 SDLAM Project 70% Detailed Design Report* (Jacobs & GHD, August 2021)
- *Interim operating plan for Carrs, Capitts and Bunberoo Creeks for the commissioning phase of Carrs 1 and 2 regulators* (Alluvium, 2022)

Feedback from DPI Fisheries has ensured that key objectives of the Proposal are implemented with appropriate consideration of regulations for providing suitable fish passage. In addition, DPI fisheries have been in attendance at the following:

- Technical Advisory Group meetings
- Operational Plan Workshops
- Design Decision workshops with fishway designers.

DPI Fisheries will be notified prior to construction and will be consulted throughout the construction phase of the Proposal regarding the management of large woody debris (snags) to minimise impacts to aquatic habitats and fauna, and riparian vegetation.

5.3. Transport and Infrastructure SEPP consultation

Part 2.2, Division 1 of the Transport and Infrastructure SEPP contains provisions for consultation with public authorities prior to the commencement of certain types of development. Table 5-2 lists the consultation requirements under the Transport and Infrastructure SEPP and relevant issues identified are:

- Bunberoo Creek bridge (Site 9) and Mike's Runner weir (Site B) are located within National Park (Tar-Ru lands). Consequently, agreement from both NPWS and Barkandji Native Title Aboriginal Corporation will be obtained prior to construction.

Table 5-2 Transport and Infrastructure SEPP Consultation

Is consultation required the Transport and Infrastructure SEPP?	Yes	No
Will the proposed activity have a substantial impact on stormwater management services provided by a council?	☐	☒
Is the proposed activity likely to generate traffic to an extent that will strain the capacity of the road system in a local government area?	☐	☒
Will the proposed activity involve connection to, and a substantial impact on the capacity of, any part of a sewerage system owned by a council?	☐	☒
Will the proposed activity involve connection to, and use of a substantial volume of water from, any part of a water supply system owned by a council?	☐	☒
Will the proposed activity involve the installation of a temporary structure on, or the enclosing of, a public place that is under a council's management or control that is likely to cause a disruption to pedestrian or vehicular traffic that is not minor or inconsequential?	☐	☒
Will the proposed activity involve excavation that is not minor or inconsequential of the surface of, or a footpath adjacent to, a road for which a council is the roads authority under the *Roads Act 1993* (if the public authority that is carrying out the development, or on whose behalf it is being carried out, is not responsible for the maintenance of the road or footpath)?	☐	☒
Is the proposed activity likely to affect the heritage significance of a local heritage item, or of a heritage conservation area, that is not also a State heritage item, in a way that is more than minor or inconsequential?	☐	☒

Is consultation required the Transport and Infrastructure SEPP?	Yes	No
Is the proposed activity located on flood liable land? If so, will the works change flooding patterns to more than a minor extent?	☐	☒
Is the proposed activity land that is within a coastal vulnerability area and is inconsistent with a certified coastal management program that applies to that land?	☐	☒
Is the proposed activity located on flood liable land and permissible without development consent under the following provision of Part 2.3 of the Transport and Infrastructure SEPP: (a) Division 1 (Air transport facilities), (b) Division 2 (Correctional centres and correctional complexes), (c) Division 6 (Emergency services facilities and bush fire hazard reduction), (d) Division 10 (Health services facilities), (e) Division 14 (Public administration buildings and buildings of the Crown), (f) Division 15 (Railways), (g) Division 16 (Research and monitoring stations), (h) Division 17 (Roads and traffic), (i) Division 20 (Stormwater management systems). * This section does not apply in relation to the carrying out of minor alterations or additions to, or the demolition of, a building, emergency works or routine maintenance.	☐	☒
Is the proposed activity located adjacent to a national park, nature reserve or other area reserved under the *National Parks and Wildlife Act 1974*, or on land acquired under that Act? If 'yes', consultation with the National Parks is required.	☒	☐
Is the proposed activity located on land in Zone E1 National Parks and Nature Reserves?	☐	☒
Does the proposed activity include a fixed or floating structure in or over navigable waters?	☐	☒
Will the proposed activity increase the amount of artificial light in the night sky within the dark sky region as identified on the dark sky region map?	☐	☒

Is consultation required the Transport and Infrastructure SEPP?	Yes	No
Is the proposed activity located on defence communications facility buffer land within the meaning of clause 5.15 of the Standard Instrument?	☐	☒
Is the proposed activity within a mine subsidence district within the meaning of the Mine Subsidence Compensation Act 1961?	☐	☒

5.4. Biodiversity and Conservation SEPP consultation

Clause 5.10(1) of the Biodiversity and Conservation SEPP provides that, for activities proposed within the riverine land of the River Murray, consultation must be carried out by a public authority before carrying out the development. Clause 5.11(1) defines the general provisions for consultation. The Proposal is considered to be consistent with the aims and objectives of Section 5 of the Biodiversity and Conservation SEPP and is not expected to have a significant environmental effect along the River Murray, nor affect boating safety. Therefore consultation under the SEPP is not required for the Proposal.

5.5. Ongoing stakeholder and community consultation

Stakeholders and community will be kept informed of any further changes to the Proposal resulting from future consultation process or detailed design. Once determined, this REF will be placed on public display for information via the WINSW and NSW DPE Water websites.

Ongoing consultation will be carried out with water users downstream of Lock 8 and Lock 9.

Barkandji Native Title Aboriginal Corporation, NPWS, MDBA, private landowners and other permanent stakeholders would be notified at least five days before any work begins. Notification would outline the proposed duration of work, and any access changes. Contact details for a project representative would be included in the notification.

A works access agreement is being negoatiated with the owner/s of a land parcel associated with Moorna Station and is expected to be finalised prior to construction commencement.

6. Environmental assessment

6.1. Hydrology, groundwater and salinity

The *Interim operating plan for Carrs, Capitts and Bunberoo Creeks for the commissioning phase of Carrs 1 and 2 regulators* (Alluvium, 2022 – see Appendix E) has been developed to guide operation of the proposed Carrs weirs No. 1 and No. 2 regulators to optimise instream habitat conditions for native fish within broader system operational settings. It also addresses identified potential hydrology and salinity impacts from the Proposal.

The *NSW Locks 8 & 9 SDLAM Geotechnical Investigation Report* (Jacobs & GHD, 2021 – see Appendix F) identifies potential groundwater impacts resulting from the project.

The *Salinity impact assessment for weir pool operations at Locks 8 and 9* (CDM Smith, 2021 – see Appendix G) identifies potential salinity impacts from the Project.

The interim operating plan and assessments are summarised in this section.

Existing environment

Hydrology

The project is located within the Lower Murray catchment of the Murray-Darling Basin. The catchment covers about 35,000 square kilometers and spans from the confluence of the River Murray and Darling River at Wentworth, NSW to the Murray Mouth at Goolwa, South Australia. The Lower Murray catchment is sparsely populated.

The semi-arid climate of the catchment means that the only substantial water source is the River Murray itself. Large floodplains have formed along the path of the River Murray, including the Riverland-Chowilla Floodplain where the CCB Creeks system is located. The floodplain located on the northern side of the River Murray is less than 2km and features a series of billabongs that connect to the river during high flows. Frenchmans Creek flows roughly parallel to the River Murray and connects to the river via the CCB Creeks system. Three wetlands on the NSW floodplain connect to the Lock 8 weir pool (which extends up to Lock 9). The floodplain south of the River Murray is much wider, and spans until Wallpolla Creek (which is located roughly 2km south-east of the project). Flow does not occur at the Lock 9 weir pool when River Murray flows are less than 20,000 ML/y (Ecological Associates, 2013).

The River Murray has a long history of flow regulation along the reach of the river where the Project is located. Since 1926, infrastructure was built to divert water into Lake Victoria:

- Lock 9 was built to raise water levels to create a sufficient head gradient to divert water to Lake Victoria along Frenchmans Creek. Locally, this created a three-metre head difference between upstream and downstream of the Lock 9 weir pool.

- Frenchmans Creek was channelised to increase the capacity to consistently deliver water into the lake.
- The hydraulic head created by raising the Lock 9 weir pool also provides opportunity to deliver higher flows through the CCB Creeks. For a given regulator position at Carrs weirs No.1 and No. 2, the height of the Lock 9 weir pool determines the rate of inflows into CCB Creeks.
- Fixed-crest weirs and blocking banks were built to restrict flows into Carrs, Capitts and Bunberoo Creeks. These structures currently sit at 0.26 m above the Lock 9 full supply level of 27.4 m AHD.
- Lock 8 was built to aid permanent navigation between the Murray mouth and Wentworth to provide relatively constant pool levels. The height of the Lock 8 weir pool does not influence flow rates into the CCB Creeks through the regulators, however as the Lock 8 weir pool height increases, tailwater from the weir pool encroaches further into the CCB Creeks. This has potential to impact on the amount of flowing habitat that can be achieved through the creeks, as they meet the Lock 8 weir pool.

The construction of these locks and weirs, combined with catchment-wide flow regulation, irrigation development and climate change has led to the development of a flow regime that is substantially different from natural conditions. The flow restrictions into the CCB Creeks mean that they only receive flows during extremely high flows or a flood and the system is generally adapted to low water velocities, even during floods.

The operation of CCB Creeks sits within the broader context of operation of the River Murray, Menindee Lakes and Lake Victoria. A simplified conceptual diagram for the broader system, as relevant to the operation of CCB Creeks is provided in Figure 6-1.

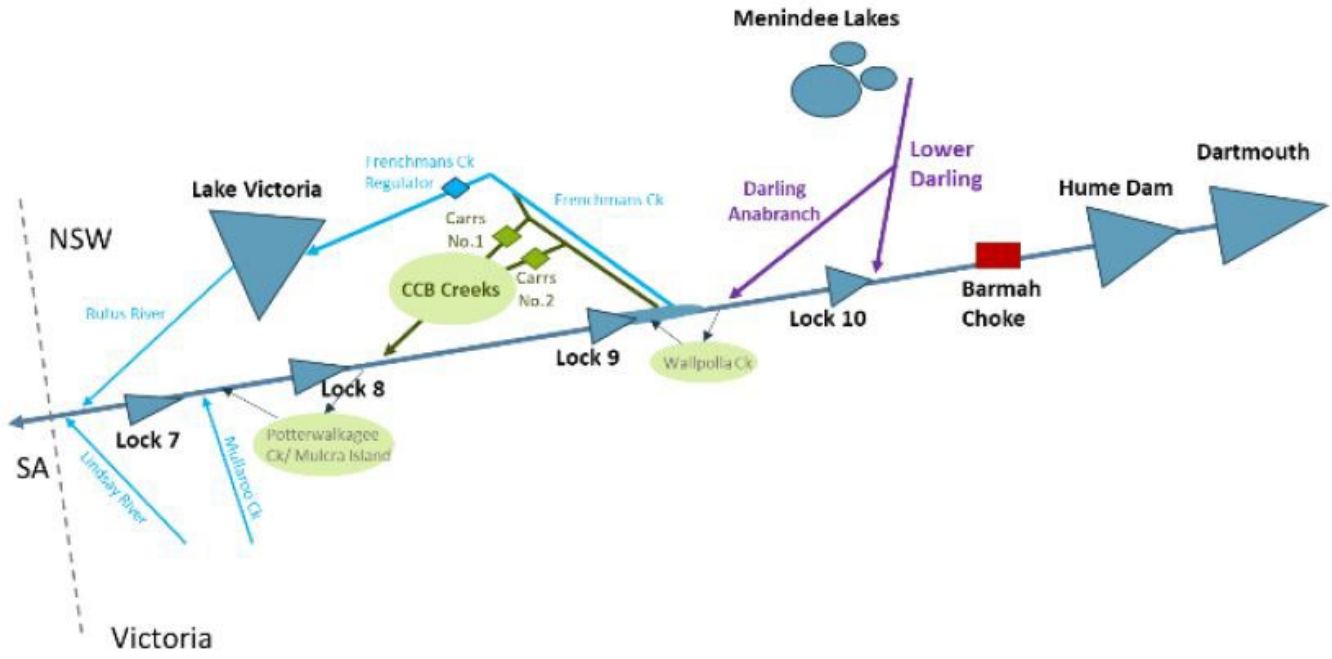

Figure 6-1 Simplified conceptual diagram of the broader system as it relates to CCB Creeks (not to scale) (Alluvium, 2022).

Groundwater

The Lower Murray catchment contains extensive alluvial groundwater systems throughout. Groundwater systems are highly connected to surface water, and the River Murray tends to gain water from the groundwater system in this catchment.

Due to the proximity of the Proposal sites to the River Murray, Lake Victoria and associated creeks, groundwater was expected to be shallow. The groundwater archives from South Australian Government Water Connect website (www.waterconnect.sa.gov.au) indicated that groundwater levels in the vicinity of the Proposal sites ranged from 2.7 m below ground level (BGL) to 4.4 m BGL. Groundwater levels observed during the geotechnical investigation typically ranged from 2.5 m BGL to 7.5 m BGL, which is reasonably consistent with the historical data. The groundwater was generally encountered within the sand layer close to the base of overlying clays.

The groundwater level will be influenced by seasonal fluctuations due to the proximity of the sites to the River Murray, Lake Victoria and associated creeks.

Salinity

Other than by evapotranspiration, the River Murray essentially forms the only outlet by which groundwater can discharge from the Murray Basin. Given that much of the groundwater in the Murray Basin is naturally saline (particularly within the Parilla Sand aquifer), the river receives saline groundwater discharge as part of a natural process. However, land use change (such as clearing of native vegetation and irrigation development) can exacerbate these processes and increase the rate of salt discharge to the river. Floodplain processes (e.g. evapotranspiration) and the nature of groundwater-surface water interactions (which are influenced strongly by weir pool operations) are superimposed on these regional influences.

Figure 6-2 plots the salinity of the river over time. While being highly variable, it declined steadily from 1995 to the early 2000s and has remained at relatively low levels since then.

The River Murray and CCB Creeks have a freshening influence on groundwater salinity. Groundwater near the river is mostly fresh to brackish, while away from the river it is saline to hypersaline. Smaller creeks are less influential and groundwater near the CCB Creeks is mostly saline to hypersaline.

At a Basin and valley scale, the Basin Plan sets salinity objectives and targets. In addition, end of valley targets are set in Schedule B of the *Murray-Darling Agreement* (*Water Act 2007* (Cwlth) Schedule 1) and implemented through the *Basin Salinity Management 2030 Strategy*. While no specific targets are provided for the CCB Creeks, nor for Locks 8 and 9, these operations must have regard to the flow management targets for salinity under s9.14 of the Basin Plan. The nearest downstream Basin Plan reporting site is the River Murray at Lock 6, with a target value of 580 Electrical Conductivity (EC) (μS/cm).

Salinity management in the River Murray provides for several optional flow paths, providing a framework to optimise salinity levels. When salinity is high in the main river channel and weir pools, but low in Frenchmans Creek and Lake Victoria, flows can be delivered via Frenchmans Creek, Lake Victoria and Rufus River, bypassing Locks 7 to 9. Alternatively, if lower salinity water is available from Menindee, this can be used to dilute saline water in the main river and weir pools. Similarly, if salinity is higher in Lake Victoria and Frenchmans Creek, then delivery via the main river may be favoured, unless fresh water is available to dilute salinity levels in the Lake and Frenchmans Creek.

The CCB system has a limited capacity to respond to changing salinity conditions in the broader system. Inflows to CCB are primarily sourced from Frenchmans Creek, with some direct contribution from the Lock 9 weir pool to Carrs weir No.2 inflows to Bunberoo Creek. While this presents the option to draw exclusively from Frenchmans Creek, or a mix of main river and Frenchmans Creek, flow volumes through the CCB system are unlikely to be sufficient for Murray system flow path considerations to factor into decision making around CCB Creeks operations.

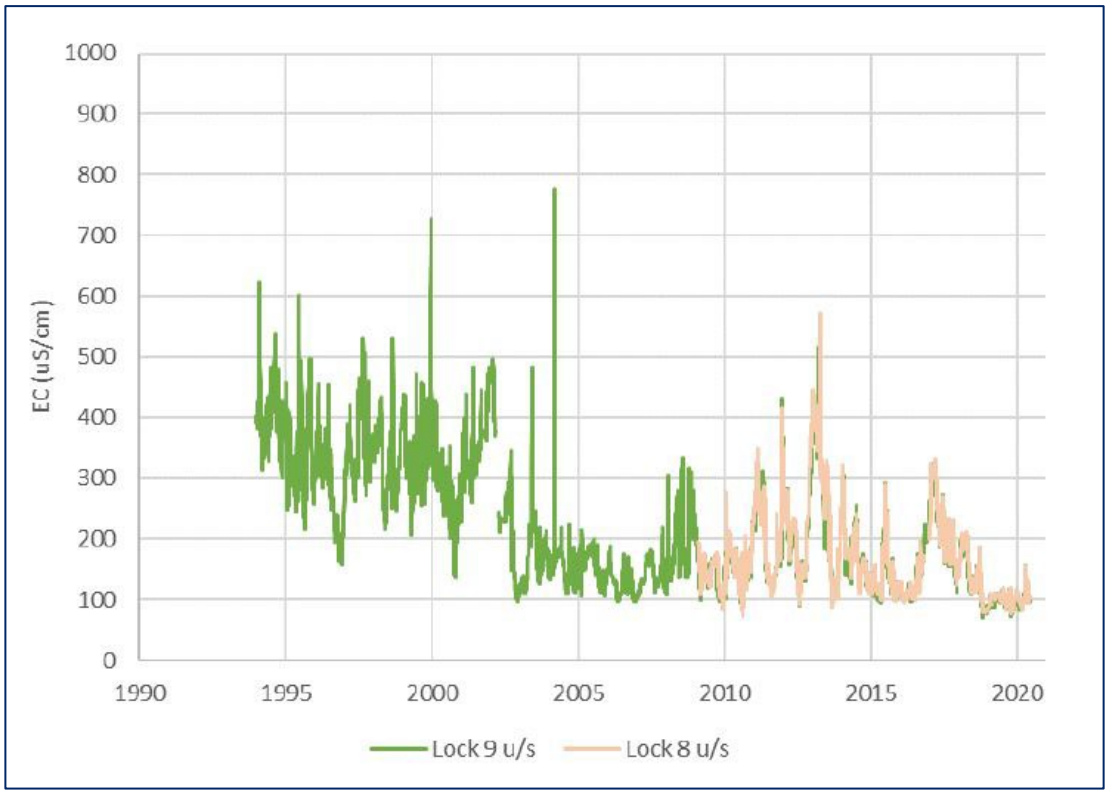

Figure 6-2 River Murray salinity (CDM Smith, 2021).

Impacts

Construction

Hydrology

The proposed Carrs weir No.1 and No.2 regulators and fishways would replace existing fixed crest weir structures. Construction would require temporary works (e.g. coffer dam) and demolition of the existing weirs as described in Section 3.2.

The existing Carrs weir No. 1 and Carrs weir No.2 do not allow bypass flows and no diversion flows are required during construction. There would therefore be no significant hydrology impacts due to temporary works.

Dewatering is not expected to be required for construction of the gated box culverts at Sites 4 and 6, Bunberoo Creek bridge (Site 9) or Mike's Runner weir (Site B) where there are existing earth and rock block banks.

Existing flow restrictions along the reach of the River Murray where the Project is located and into the CCB Creeks mean that they only receive flows during extremely high flows or a flood.

The Lake Victoria Inlet Regulator floodrunner causeway and realignment of access tracks would be constructed across a dry floodrunner or on floodplains, without having any influence on CCB Creeks hydrology during construction.

Groundwater and salinity

The watertable is expected to be relatively shallow at most Proposal floodplain sites, however evidence shows that there is no obvious discharge to the surface/bed of Bunberoo Creek (see Figure 6-3 below) despite the higher elevation of water in Carrs Creek behind the nearby coffer dam. As shown in Figure 6-4 the design excavation requires removal of material down to approx. 24.25mAHD (top base slab EL24.85mAHD minus 0.6m thickness). The existing level of the downstream apron of the Carrs 2 structure is approx. 24.7mAHD (top apron @ 25.0mAHD minus 0.3m thickness) meaning that any excavation of the bed will be less than 0.5m.

Analysis of levels at Carrs 1 regulator indicates that excavation requirements will be similar.

Figure 6-3 No existing groundwater discharge at Carrs 2 site

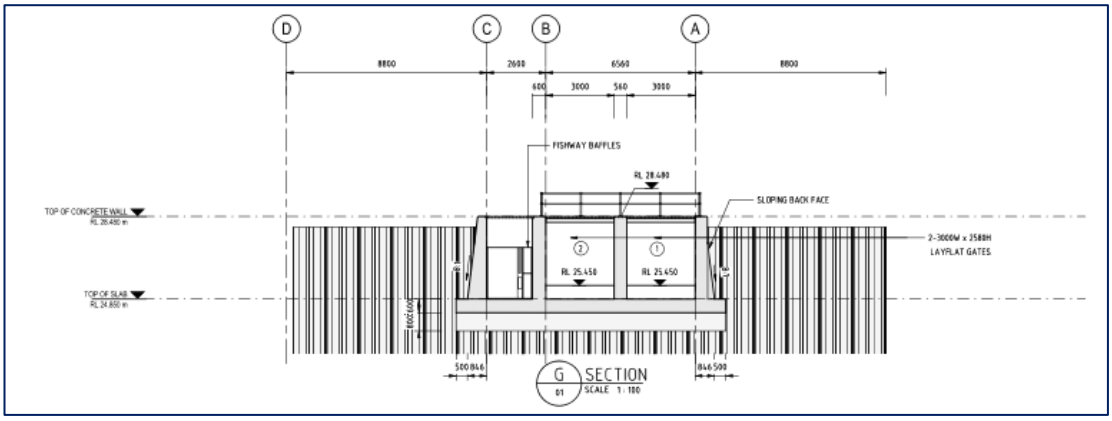

Figure 6-4 Proposed excavation depths for replacement structure (extract from 70% design Drawing L034560-07-00003_06)

This proposed construction levels relative to existing structure levels indicate that the risk that groundwater could be encountered during excavations required to form the foundations of

particular structures is likely to be small or minor. The excavation activity is very localised and will not have any material interaction with regional aquifers. Any required dewatering would likely have localised and temporary impacts to groundwater, and construction impacts to regional groundwater systems or salinity are expected to be insignificant. If there is a requirement, groundwater being dewatered in this situation, itwould be stored on-site and used for dust suppression, irrigated by sprinkler nearby or discharged into the creek.

As discussed in Section 4, approvals under section 89 (water use approval), section 90 (water management work approvals) and section 91 (activity approvals) of the WM Act are required for the Proposal.

Regarding section 91, clause 7 of Schedule 4 of the WM Regulations provides for exemptions relevant to aquifer interference activities (such as groundwater extraction and dewatering) under section 91 of the WM Act, while clause 21(6) of the WM Regulation requires aquifer interference activities that are exempt from requiring an activity approval to make and keep records of the water taken during these activities.

Operation

Hydrology

Locks 8 and 9 weir pool manipulation

An evaluation of expected ecological outcomes of Lock 8 and Lock 9 weir pool manipulation (DPIE, 2021) was conducted as part of the NSW Locks 8 and 9 Project. That evaluation recommended that a variable operational regime that mimics natural variation is likely to achieve the best ecological outcomes in a system that has evolved in response to highly variable water regimes.

The recommended operational hydrographs for Locks 8 and 9 (with constraints to maintain operation of the fishway) have maximum surcharge levels of +0.5 m and +0.3 m, for Locks 8 and 9 respectively, and drawdown limits of -1.2 m and -0.4 m respectively. These limits may change in future to support operational and/or ecological outcomes. Weir pool heights can be adjusted within these upper and lower limits, to provide variability in line with water availability in the Basin.

The evaluation recommends maximum inundation extent in winter-spring and early summer coupled with weir pool drawdown in summer-autumn.

Operation of the Lock 8 and Lock 9 weir pools determines the flow rates that can be achieved in the CCB Creeks through headwater level set by the Lock 9 position, and the length of flowing creek habitat as the Lock 8 weir pool determines tailwater height. Under Schedule 1 to the *Water Act 2007*, the Murray Darling Basin Agreement, operating levels for the River Murray weirs can only be changed through approval of the Minsterial Council. This approval is yet to be obtained.

The design of the structures that interface with Carrs Creek and Lock 9 pool levels have all been designed to operate with the range of weir pool operating levels contemplated in weir pool manipulation.

Regulator operation and flow hydraulics

The *Interim operating plan for Carrs, Capitts and Bunberoo Creeks for the commissioning phase of Carrs 1 and 2 regulators* (refer Section 3.2) was developed primarily to define how the Carrs weir No. 1 and No. 2 regulators will need to be operated in order to optimise in-stream habitat conditions for native fish within broader River Murray and Frenchmans Creek system operational settings.

The aim of the operating plan is to balance the competing needs for maximising fast-flowing habitat and hydraulic diversity in the heavily regulated Lower Murray with supporting ecosystems adapted to natural seasonal hydrology. The seasonal operating objective has been defined in the form of an annual hydrograph, shown in Figure 6-5 below, which has been developed to ensure seasonally appropriate flow and velocity profiles can be achieved. The proposed annual hydrograph has been shaped to allow for summer baseflow as well as autumn and spring pulses. These pulses provide for faster and deeper flows through Autumn and Spring to maximise conditions for fish throughout the system.

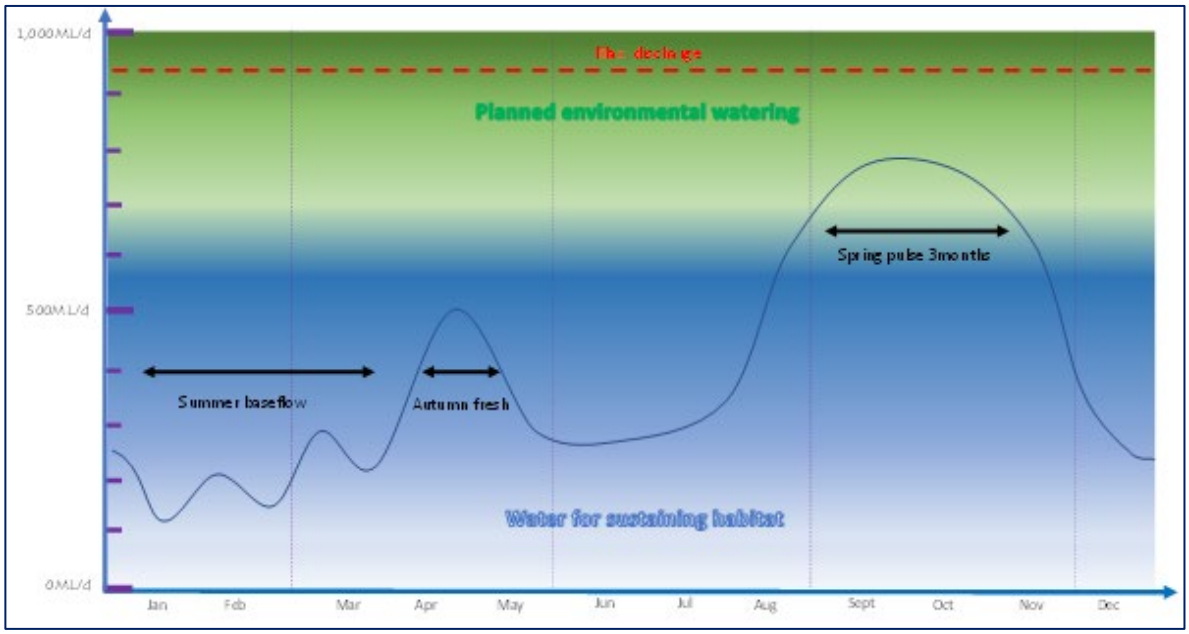

Figure 6-5 - Generalised bunberoo creek hydrograph

One of the design objectives is to allow CCB baseflows to maintain a minimum waterway depth during summer months. Table 6-1 shows the minimum and ideal depths for fish passage, which is able to be achieved with a baseflow of approximately 100ML/d in Bunberoo Creek. This demonstrates that connectivity can be achieved subject to the baseflow rate being supplied as part of the Lock 9 weir pool system.

Table 6-1 - Minimum and ideal depths for fish movement

Fish category	Ideal depth	Min. tolerable
Small	0.4m	0.25m
Medium	0.75m	0.6m

Fish category	Ideal depth	Min. tolerable
Large	1.00m	0.8m

Hydraulic modelling was also undertaken to define the potential water levels and waterway impacts that the range of flow rates shown in Figure 6-5 above could potentially generate. A number of model outputs have been generated to assess potential impacts on the Bunberoo Creek waterway including water level, inundation changes, potential scouring / erosion and archaeological material.

Figure 6-6 shows how specific flow rate setting at the Carrs 2 regulator will effect water depth along Bunberoo Creek as the gate settings are changed throughout the season. Gate operations at Carrs 1 and Carrs 2 regulators will be managed by SA Water as nominated operator of Joint Venture assets under the Murray Darling Basin Agreement. Further details about gate operation are included in the *Interim operating plan for Carrs, Capitts and Bunberoo Creeks for the commissioning phase of Carrs 1 and 2 regulators* (Alluvium, 2022 – see Appendix E).

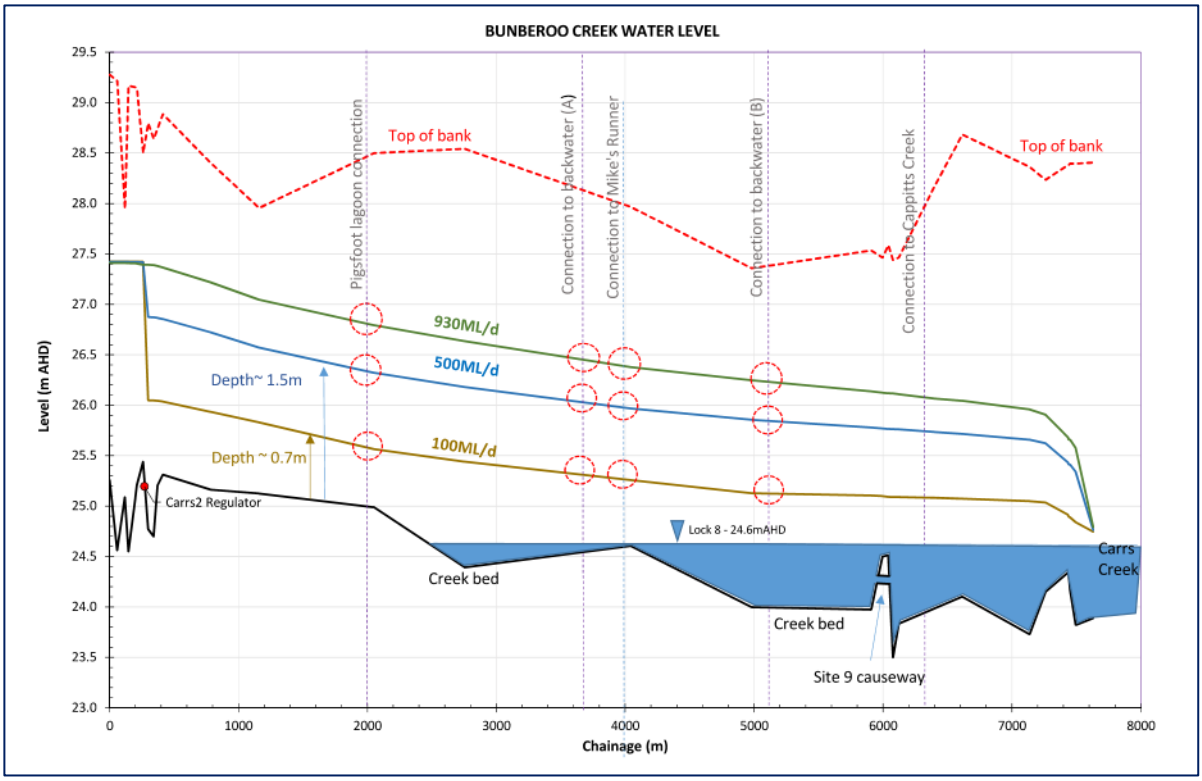

Figure 6-6 - Operational hydrographs for Bunberoo Creek

The Operating Plan has been informed by hydraulic modelling of flow conditions, and consideration of potential risks and assumptions around ecological response to a range of flow types through the CCB Creeks. However, as operation of the CCB Creeks system is dependent on broader River Murray operational settings, there is a risk that the flows able to be achieved through the CCB Creeks system will be insufficient to achieve the intended environmental benefits. A monitoring and

evaluation program has been developed and will enable ongoing improvement to the operation of the system through adaptive management. In the case of the Proposal not achieving the intended environmental benefits, measures would be implemented to improve the performance of the CCB Creeks system in doing so.

Endorsement of the CCB Operating plan is a requirement of MDBA in order to declare the works effective (under Clause 58 of Agreement).

Impact of CCB operation on Lake Victoria filling rate

Water sourced to fill Lake Victoria is diverted from the River Murray at Lock 9 weir pool into Frenchmans Creek. An inlet regulator is used to control the flow in Frenchmans Creek into Lake Victoria. The inlet regulator is located on Frenchmans Creek downstream of the junction with Carrs Creek. The capacity of the Frenchmans Creek at the inlet regulator is nominally 10,000 ML/day. However, the maximum rate at which water can be diverted into Lake Victoria is also affected by the water level in the Lake and the weir pool level at Lock 9.

Lock 9 is typically raised by up to 0.1m (27.5mAHD) to assist the filling of Lake Victoria. When the level of Lake Victoria is higher, the final filling phase requires a higher level in Lock 9, typically +0.2m (27.6mAHD) to ensure sufficient head difference to fully fill Lake Victoria.

Operation of the CCB system (specifically Carrs 1 regulator) draws water from Carrs and Frenchmans Creeks, potentially reducing inflows to Lake Victoria. This can affect the Lake Victoria filling rate. The degree to which operating the CCB system impacts the rate of inflows to Lake Victoria is determined by the seasonal gate settings primarily at Carrs 1 regulators.

Hydraulic modelling has been undertaken to quantify the impact of a range of operational scenarios for CCB creeks on the Lake Victoria filling rate (MHL, 2021). For CCB inflows ranging from 100 ML/d to 1,000 ML/d, and Frenchmans Creek discharge of 2,000 ML/d to 8,000 ML/d, the impact on Lake Victoria filling rate is expected to vary between <1% and 14%. Discusison of operational tolerances with SA Water has indicated that rates above the range of 1% to 2% cannot be tolerated and that rates in this range (typically the range that Carrs 1 regualtor baseflow creates) may not be acceptable at particular times.

The operational plan therefore has an inbuilt assumption that Lake Victoria operations take priority over operation of the CCB system to avoid impacts on Lake Victoria filling during the filling phase. The 'tolerable' impact on Lake Victoria filling rate (the degree of impact deemed an acceptable in operating the CCB system to achieve stated benefits) is likely to vary year on year based on varying water availability and operation of the broader River Murray system. Impact on Lake Victoria filling rate is least desirable during autumn / winter when operational rules require inflows to Lake Victoria to be at their greatest. Accurately predicting water availability, stream flows, rainfall and temperatures in the River Murray System is difficult as these conditions are highly variable

Opportunities to offset impact on the Lake Victoria filling rate include additional surcharging of Lock 9 to increase flows through Frenchmans Creek, and expanding the duration of the filling phase by a period equivalent to the impact of operating the CCB system, however such opportunities may result in other disadvantages, such as impact to cultural heritage within the Lake Victoria area with expanded filling duration.

Achieving the objectives of the project depends on the continuous operation of the CCB system. Periods of zero tolerable impact on Lake Victoria filling rate may result in temporary shutdown of the CCB system. The degree to which shutting the system down will impact objectives, will be influenced by the timing, duration, and frequency of the shutdown period.

Flows into Bunberoo Creek through Carrs 2 regulator draw largely from the Lock 9 weir pool, and therefore have less of an effect on Frenchmans Creek flows and the Lake Victoria filling rate. This regulator has therefore been agreed as the primary operational asset for achieving connectivity and fast flowing water objectives of the project.

Groundwater and salinity

The operation of regulators would result in downstream water level increases which have potential to create additional losses to groundwater. As shown in Figure 6-6 the water level to be created in Bunberoo Creek are modest and are typically within bank. Operating within the propsoed flow ranges limits the potential for the operational regime to drive significant groundwater processes.

The Lock 8 and 9 weir pool manipulation works have been identified as the more likely contributor to any salinity impacts of the Project. The CCB system has a limited capacity to respond to changing salinity conditions in the broader system. Long-term salinity impacts from the changed operation of Lock 8 and 9 and the CCB Creeks will be assessed under Schedule B to the Murray Darling Basin (MDB) Agreement, and if required the salinity impacts will be recorded in the Salinity Registers. A Basin Salinity Management procedure has been developed for environmental water salinity accountability. Any salinity debits arising from the operation of Sustainability Diversion Limit (SDL) adjustment works or measures can be offset by credits (if available) held by the Commonwealth from the dilution benefits of delivering Basin Plan water.

Safeguards

Measures proposed to avoid, minimise or manage potential hydrology, groundwater and salinity impacts as a result of the Proposal are detailed in Table 6-2.

Table 6-2 Safeguards for hydrology, groundwater and salinity

Timing	Impact	Safeguard	Responsibility
Operation	Hydrology	The works are to be operated in accordance with the CCB Operating Plan	WINSW / SA Water
Operation	Hydrology	Once the Proposal structures have been in operation through an appropriate cycle, the CCB Operating Plan will be updated taking into account system monitoring results, identified operating risks and ecological response.	WINSW / SA Water

Timing	Impact	Safeguard	Responsibility
Operation	Long-term salinity impacts	Long-term salinity impacts from the changed operation of Lock 8 and 9 and the CCB Creeks will be assessed under Schedule B to the MDB Agreement, and if required the salinity impacts will be recorded in the Salinity Registers.	WINSW

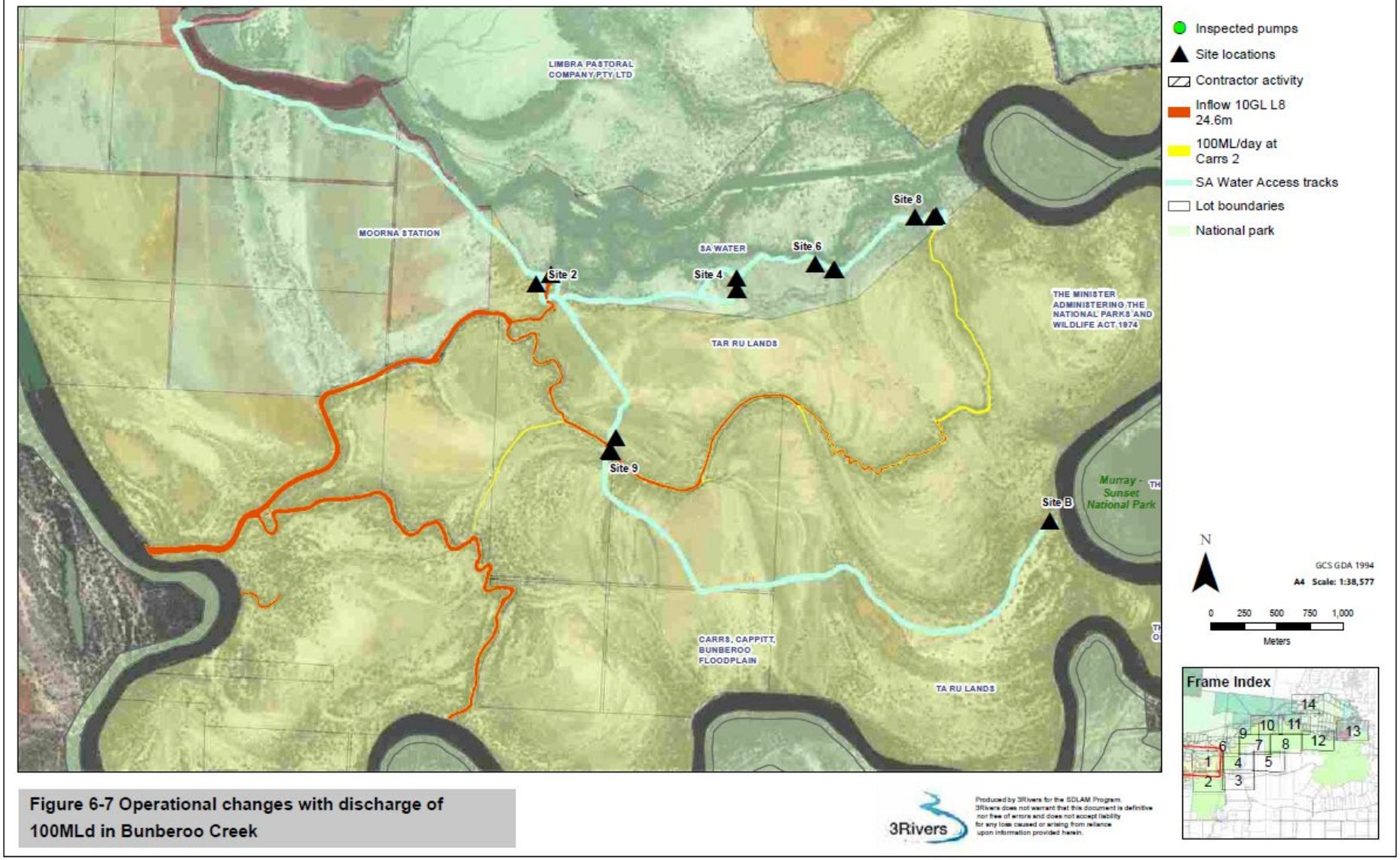

Figure 6-7 Operational changes with discharge of 100MLd in Bunberoo Creek

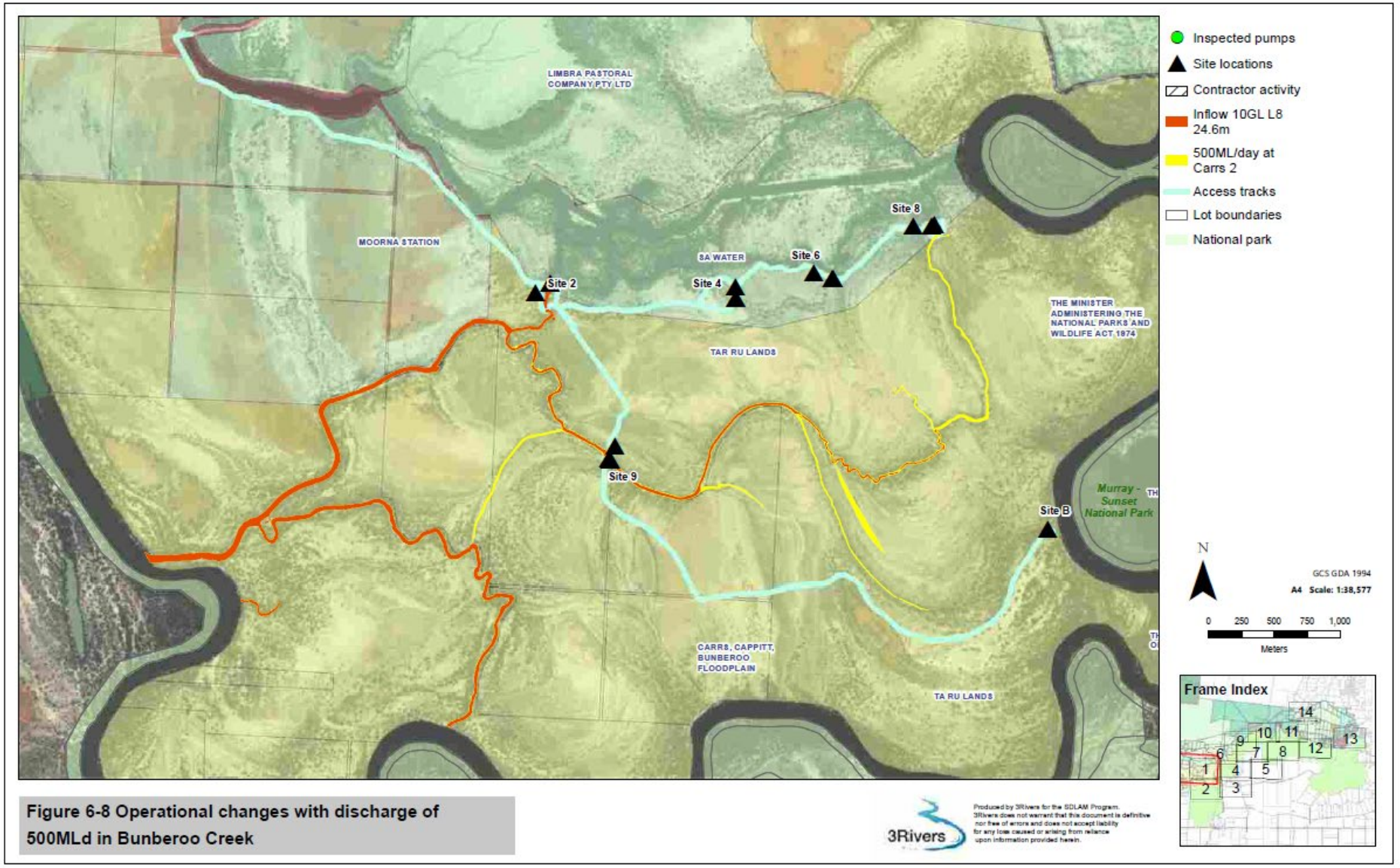

Figure 6-8 Operational changes with discharge of 500MLd in Bunberoo Creek

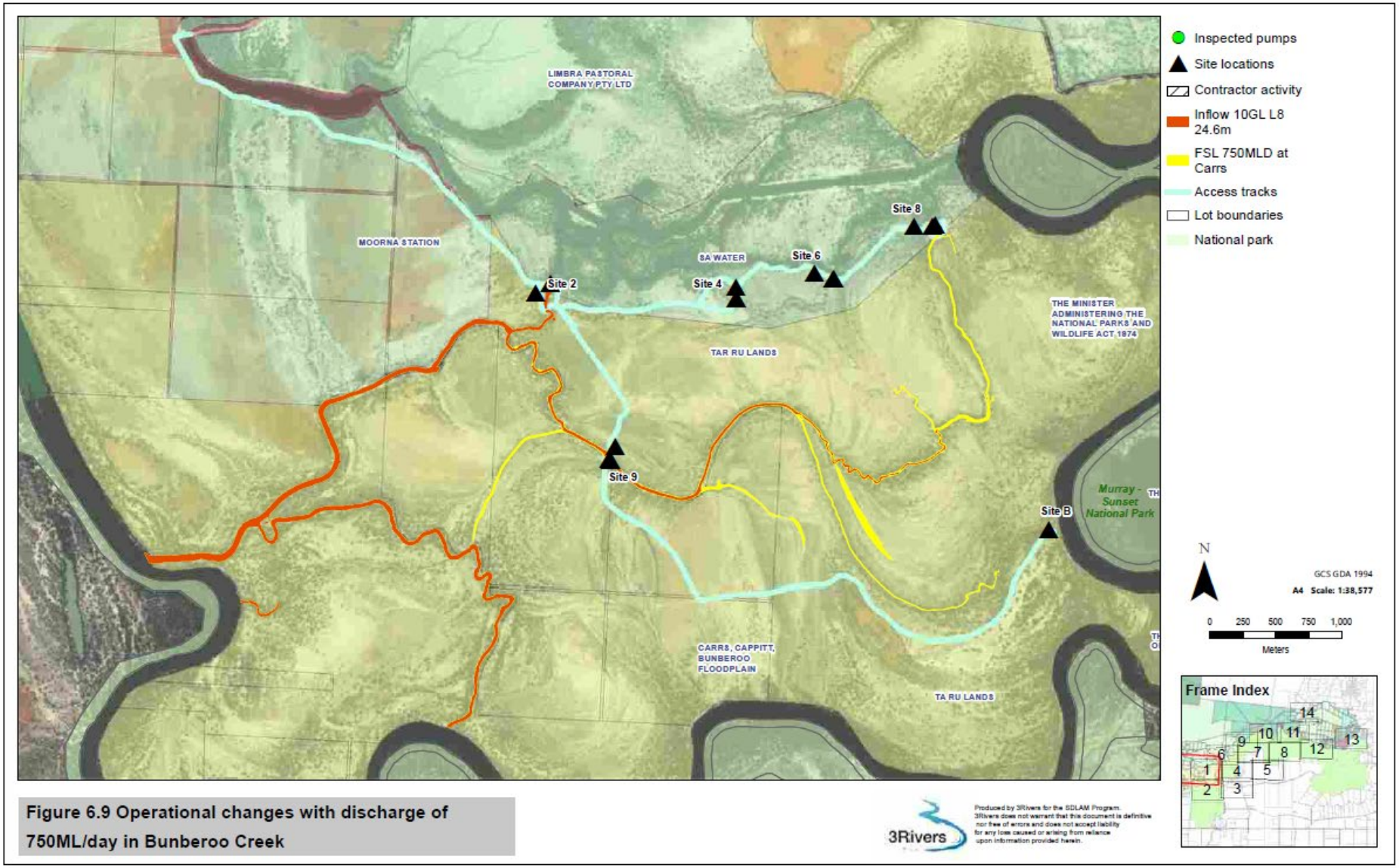

Figure 6.9 Operational changes with discharge of 750ML/day in Bunberoo Creek

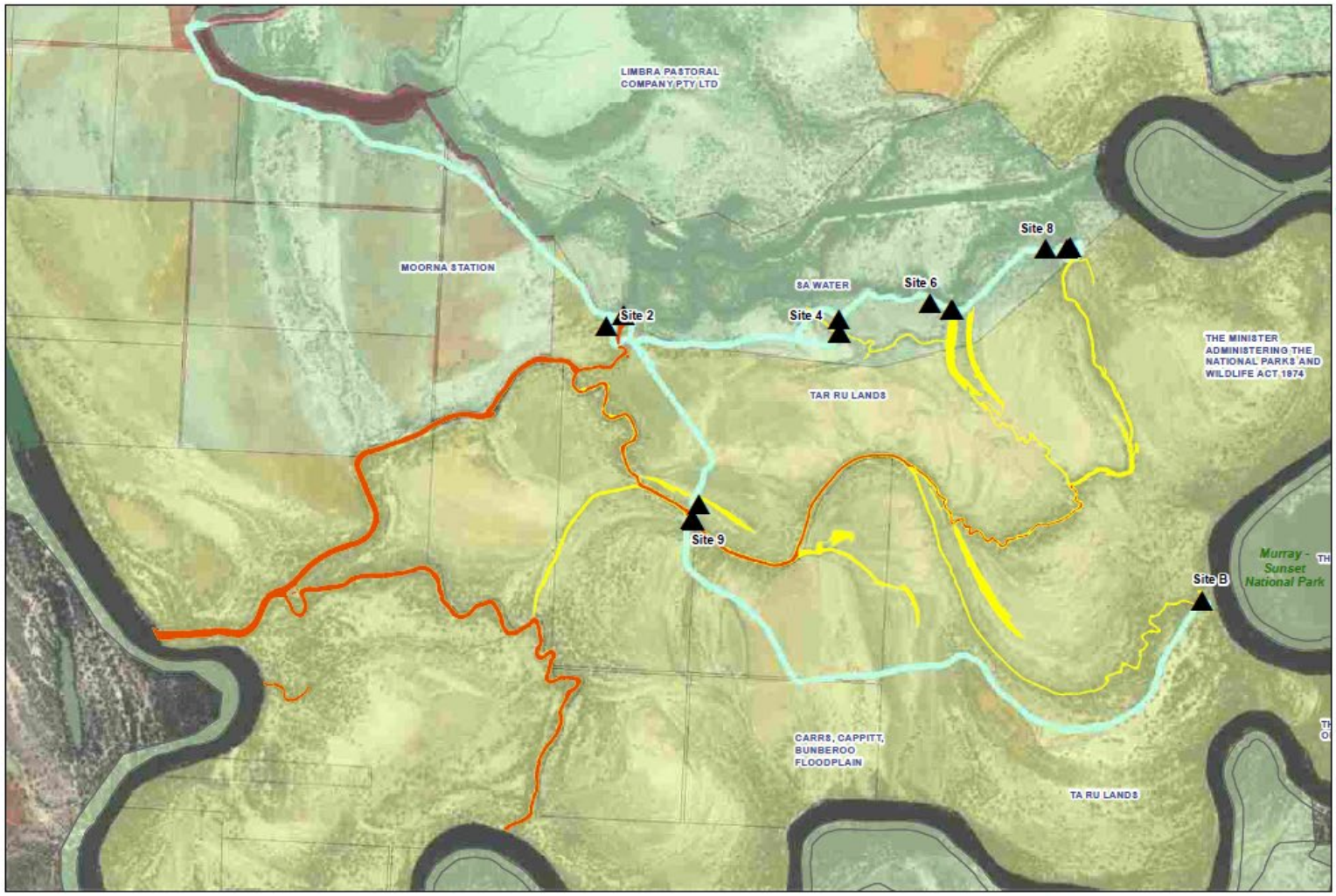

Figure 6-10 Operational changes with discharge of 930MLd in Bunberoo Creek

6.2. Water quality and aquatic biodiversity

The *Carrs, Capitts and Bunberoo Creeks Biodiversity Assessment* (Jacobs, 2022) identifies potential water quality and aquatic biodiversity impacts from the Proposal. The assessment is provided in Appendix H and is summarised in this section.

The *Interim operating plan for Carrs, Capitts and Bunberoo Creeks for the commissioning phase of Carrs 1 and 2 regulators* (Alluvium, 2022) (see Appendix E) has been developed to guide operation of the proposed Carrs weirs No. 1 and No. 2 regulators to optimise instream habitat conditions for native fish within broader system operational settings. It also identifies potential water quality and aquatic biodiversity impacts from the Proposal.

Methodology

The aquatic and terrestrial biodiversity assessment consisted of a desktop study and field survey of the Proposal sites (refer Figure 3-1) and a broader study area adopted for the biodiversity assessment.

The following database searches and regional mapping reviews were carried out with a 5 km buffer applied to the Proposal sites to determine vegetation communities, threatened species, ecological communities, migratory species and habitat values likely to occur . The likelihood of occurrence of a species was based on previously recorded sightings in the search area and the potential for suitable habitat within the Proposal sites. The desktop database review also guided the requirement for any targeted field surveys. Search dates are specified in the *Carrs Cappitts and Bunberoo Creeks Biodiversity Assessment* (Jacobs, 2022 - Appendix H).

- Atlas of Living Australia
- EPBC Act Protected Matters Search Tool (PMST)
- BioNet – the Atlas of NSW Wildlife and Threatened Biodiversity Data Collection
- BioNet Vegetation Classification database
- DCCEEW Directory of Important Wetlands
- Groundwater Dependent Ecosystems Atlas
- Fisheries NSW Spatial Data Portal
- Crown Land Manager Reserves Portal
- Travelling Stock Reserves - State Classification Map
- State Vegetation Type Map: Western Region
- NSW Biodiversity Values Map and Threshold Tool.

A field survey was undertaken across the Proposal area from 01 to 03 December 2020 by qualified ecologists and included:

- Ground-truthing findings of the desktop study, especially vegetation mapping
- Identifying and describing vegetation communities and flora species present

- A high-level fauna habitat survey (opportunistic bird survey and identification of general terrestrial and aquatic habitat features of importance to threatened species)
- Mapping of large old trees and tree hollows
- Assessment of ground disturbance including grazing pressure and weed occurrence.

The potential for impact to threatened species listed under the EPBC Act, BC Act and FM Act was determined using relevant criteria including DoE (2013) Significant Impact Assessment Criteria, a five-part test (BC Act) and seven-part test (FM Act). Limitations of the biodiversity assessment are outlined in Section 3.4 of Appendix H.

Existing environment

Carrs, Capitts and Bunberoo Creeks are part of the Riverland – Chowilla Floodplain hydrologic indicator site under the Basin Plan. Anabranches through this area provide diverse aquatic habitats including deep and shallow sections with varied flow velocities and both steep and sloping banks. Dense stands of aquatic macrophytes are supported during wet periods and significant amounts of instream woody debris are present. The diversity of habitats within anabranches has significant potential to support fish, aquatic invertebrates, frogs and birds, including some that are threatened or uncommon (Alluvium, 2022).

Typically the lower sections of the waterway are permanently inundated as shown in Figure 6-11 below. Given that this water is mostly stagnant in periods when River flows are not high enough to spill across the Carrs 1 and 2 regulators there are currently relatively few controls possible to achieve ecological objectives.

Figure 6-7 – Bunberoo Creek below Site 9 (left) and Carrs Creek lower (right) inundated at normal Lock 8 operating levels

Water quality

Basin governments and the Murray Darling Basin Authority have a long history of working together to manage water quality and salinity issues. This includes managing flows to reduce salinity levels and operating salt interception schemes that divert saline groundwater away from the River Murray. The Basin Plan sets water quality targets and objectives to protect water quality in the Basin's rivers for people and livestock as well as for wetlands and floodplains. The Basin Plan requires

water managers to consider water quality targets when making decisions about environmental watering and running the river.

Threats to water quality in the Basin include physical and chemical stressors such as high salinity levels, toxins generated by blue-green algal blooms or inappropriate use of chemicals; high levels of nutrients including phosphorus and nitrogen from agricultural activity, stormwater and erosion; high and low temperature extremes, and low dissolved oxygen levels.

Impacts can be local but can also intensify as water flows down through the system. Sustained low flow conditions exacerbate many of the above stressors for example by reducing dilution of salt loads, toxins and nutrients or reducing turbulence and connectivity in the system. The Basin Plan responds to many of the impacts from the above water quality stressors.

The CCB operating plan will deliver water through a floodplain environment which will cause waterway changes similar to what is shown in Figure 6-12. The potential impacts of this improved watering activity have also been assessed through modelling.

Figure 6-8 – Bunberoo Creek upstream of Site 9 casueway without throughflow (left) and with throughflow (right)

The study area is susceptible to changes in salinity from adjoining waterways (River Murray and Frenchman's Creek) and there is potential for the creation of newly waterlogged soil profiles to expose acid sulphate soils. High salinity levels and the release of acid sulphates can affect water quality, ecosystem health and cause economic loss in irrigated agriculture. When some acid sulphate soils are disturbed, it can cause oxygen to be removed from the water causing blackwater. The potential risks of ASS have been assessed and included in Section 6.8.

Increasing the flows of the CCB Creeks system has the potential to lead to increased rates of creek channel erosion. In the same way, changes in inflows through the Carrs 1 and Carrs 2 regulators will introduce temporal variability to velocity and associated erosion risk. Hydraulic modelling outputs have incoporated velocity and bed shear stress metrics along the waterways and design responses have been included where locations of potential scour have been identified.

Assessment of impacts in water quality are specified in the *Carrs, Capitts and Bunberoo Creeks Biodiversity Assessment* (Jacobs, 2022) (see Appendix H)

Aquatic biodiversity

Aquatic habitat

The River Murray, CCB Creeks, Mike's Runner and Frenchmans Creek are mapped as key fish habitat (KFH) according to NSW DPIE Fisheries mapping (DPI, 2022). Key fish habitat is considered important for the general maintenance of fish populations and the survival and recovery of threatened aquatic species.

The CCB Creeks support emergent aquatic and littoral vegetation communities. The communities range from sparse to dense and tall sedgelands and reed beds which line the banks of the permanent waterways such as Carrs Creek. Table 6-3 lists aquatic habitat attributes at each of the Proposal sites.

Table 6-3 Aquatic habitat

Site	Location	Aquatic habitat attributes
2	Carrs weir No. 1	Bullrush (*Typha domingensis*) tall sedgeland line Carrs Creek bank upstream of the existing weir. Carrs Creek mapped as KFH for Silver Perch. North of Site 2 Carrs Creek is mapped as habitat for Hanley's River Snail.
4	Off Carrs Creek	Dry at time of survey, limited structural aquatic habitat present.
6	Off Carrs Creek	Bullrush tall sedgeland line Carrs Creek bank (approximately 30 m of frontage within proposed clearing area). Permanent water of Carrs Creek adjoins northern parts of the Proposal site.
8	Carrs weir No. 2	Bullrush tall sedgeland lines Carrs Creek bank (approximately 45 m frontage within proposed clearing area). Mapped as KFH and for Hanley's River Snail. Bunberoo Creek meets Carrs Creek approximately 150 m downstream of Carrs weir No. 1.
9	Bunberoo Creek	Approximately 30 m of shallow water and sparse open sedgeland habitat upstream of the current road crossing. Backup from Lock 8 at FSL can extend upstream from the existing crossing but is limited by the blockage of pipe culvert.
B	Mike's Runner weir	Site adjoins main channel of River Murray. Sparse and patchy tall sedgeland and adjacent deep flowing water habitat along main channel.
10	Lake Victoria Inlet Regulator floodrunner	Existing access track adjacent left bank. Open, flowing water habitat in Frenchmans Creek with limited emergent aquatic vegetation present.

Aquatic fauna and threatened aquatic fauna

The native fish of the River Murray are often considered in two groups: small-bodied species and large- bodied species. The smaller species tend to be wetland specialists, though many are also found in main river channels and many have a close relationship to aquatic vegetation beds. Larger bodied fish such as Murray cod have, in general, a preference for larger, strong flowing main river channels, especially where there is high quality snag habitat. The native catfish (*Tandanus tandanus*) is a larger species and spends time in deep channel habitat but occurs predominantly in wetlands during breeding seasons. More recently, the large and medium-bodied native fish species (e.g. golden perch, Murray cod, silver perch and freshwater catfish) generally occur in low abundances in the region.

The following threatened aquatic fauna were identified as possibly or likely occurring within the Proposal area based on indicative habitat mapping and field survey, and are outlined in Table 6-4:

- Four threatened fish species
- One threatened amphibian species
- One threatened population and
- One endangered ecological community.

Table 6-4 Threatened aquatic fauna considered possible or likely to occur within the proposal area

Species	Common Name	EPBC Act Status[1]	FM Act Status[1]	Likelihood of Occurrence	Preferred habitat and comments
Bidyanus bidyanus	Silver Perch	CE	V	Possible	Typically inhabits deeper flowing waters of the River Murray and larger tributaries. They have been recorded in the River Murray (Site B) and are assumed to be potentially present in Carrs Creek and Frenchmans Creek. There is suitable main channel or deep flowing water habitat adjacent to Sites 2, 6, 8 and B.
Craterocephalus fluviatilis	Murray Hardyhead	E	-	Possible	Species occurs in still and slow-flowing waters including billabongs, lakes and margins and backwaters of lowland rivers. Only population known in NSW at Little Frenchmans Creek, Wingillie Station which was translocated there in 2018. There have been no reconnection events to allow for dispersal out of Little Frenchmans Creek.

Species	Common Name	EPBC Act Status[1]	FM Act Status[1]	Likelihood of Occurrence	Preferred habitat and comments
Maccullochella maquariensis	Trout Cod	E	-	Possible	Prefers deeper waters of main channel of River Murray and larger tributaries. Suitable habitat in River Murray (Site B) and deeper permanent water of Carrs and Frenchmans Creek (Sites 2 and 6).
Maccullochella peelii	Murray Cod	V	-	Possible	Prefers deeper waters of main channel of River Murray and larger tributaries. Suitable habitat in River Murray (Site B) and deeper permanent water of Carrs and Frenchmans Creek (Sites 2 and 6).
Litoria raniformis	Southern Bell Frog	V	E	Possible	BioNet records from 2006 to 2008 include approximately 130 m downstream of Site 6 in Carrs Creek and approximately 1.3 km west of Site B in Bunberoo Creek. Permanent wetlands and floodplain habitats adjacent or upstream of proposal sites would provide potential habitat for this species. However, following extensive drought periods presence of large populations is unlikely and occurrences are likely to be localised to permanent habitat.
Tandanus	Murray-Darling Basin population of the Eel Tailed Catfish	-	E	Possible	Eel tailed Catfish are naturally distributed throughout the Murray-Darling system. They prefer still and slow flow waterways and wetlands, especially those with substantial submerged vegetation. The Murray River in the study area has been mapped as potential habitat for Eel tailed catfish, and the species is considered to occur despite no recent records within the locality

Species	Common Name	EPBC Act Status[1]	FM Act Status[1]	Likelihood of Occurrence	Preferred habitat and comments
Aquatic Ecological Community in the Natural Drainage System of the Lower Murray River Catchment	Lowland Murray River aquatic ecological community	-	E	Likely	Species of fish, macroinvertebrates, crustaceans, and molluscs listed as representative of this community are likely to be present in the waterways of the Proposal area. The River Murray, Frenchmans Creek and associated flood runners and effluent channels are listed as representative waterways.

Notes: [1] Status: CE = Critically Endangered, V = Vulnerable species, E = Endangered species.

The native fish species and threatened aquatic fauna outlined above were considered in the design and operation of fishways and other Proposal elements and is discussed in greater detail below.

The Hanley's River Snail is listed as 'Critically Endangered' under the FM Act. Areas within and adjacent to the proposal sites are mapped as habitat for the Hanley's River Snail, however there are no specific BioNet Atlas records of the species. Flows in the area do not currently provide for habitat and the species is considered unlikely to occur (discussed further in Appendix H).

Impacts

Construction

Water quality

Construction activities which have the potential to result in soil erosion and subsequent sedimentation in downstream environments include:

- Vegetation clearing within the construction activity zones are shown in Figure 3-2 to 3-10. However, vegetation within the construction activity zones is typically sparse. Section 6.3 identifies that up to 3.7 ha of vegetation (including up to 2.91 ha of native vegetation) would be cleared as part of the Proposal. Vegetation removal would expose soils to weathering processes, increasing the risk of erosion and sedimentation.
- Earthworks including stripping topsoil, excavations and placement of fill as required. Soils exposed during earthworks have the potential to be mobilised to downstream environments via wind and stormwater runoff. Excavation of the creek banks may cause short-term localised erosion should a large flow event occur during construction.
- Construction traffic and heavy vehicles could cause ground disturbance that leads to increased risk of erosion and sedimentation.

The impacts of erosion and sedimentation on water quality and aquatic environments may include:

- Increased turbidity and poor water clarity, which can potentially lead to smothering aquatic ecology.

- Sediments may also contain high concentrations of nutrients which can lead to algal blooms, and subsequently lower dissolved oxygen content in water and reduced light penetration that limits the growth of aquatic vegetation.
- Mobilised sediments may contain elevated concentrations of metals and other contaminants which can negatively impact aquatic ecology that may be sensitive to changes in water quality.

Waterway contamination from accidental spills or leaks of fuels, oils and chemicals (such as hydraulic oils) during construction is considered unlikely but possible. Accidental spills or washout of concrete can pollute waterways and alter the pH of downstream waterways, with potentially harmful effects to aquatic ecology that may be sensitive to changes in water quality.

Blackwater events may occur if acid sulphates are released which can cause flora to die and damage fauna habitat. Disturbing acid sulphate soils can cause oxygen to be removed from the water (blackwater) and rainfall can wash acid sulphates and toxic metals into waterways, poisoning fish and other aquatic organisms. These risks would be managed by suitable safeguards during construction.

While sediment-laden runoff and pollutants from soil disturbance have the potential to temporarily reduce downstream water quality, it is unlikely to cause major or long-term impacts to the overall condition of waterways as they would be managed with the implementation of erosion and sediment controls.

Aquatic biodiversity

The Proposal would contribute to the following 'key threatening processes' identified under Part 2, Schedule 6 of the FM Act:

- Degradation of native riparian vegetation along New South Wales water courses
- Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams, and
- Removal of large woody debris from New South Wales rivers and streams.

The Proposal would potentially clear up to 0.72 ha of emergent and submerged aquatic vegetation and in-stream woody debris (snags) which is listed as a key threatening process under the PM Act. This potential impact is considered minor in the context of the existing environment and is outweighed by the long-term aquatic biodiversity improvements intended to be provided by operation of the Proposal. No habitat critical to the survival of any threatened aquatic fauna species or populations occur within the Proposal clearing areas. Mitigation measures and planning and consultation controls related to these KTPs are detailed further in Table 6-6.

Localised, temporary dewatering for construction of the new Carrs weir No. 1 regulator as described in Section 3.2 has the potential to strand fish and other aquatic fauna if not managed appropriately.

Inundation of catchment surfaces that have not been inundated for a prolonged period can cause 'blackwater' events that impact on in-stream biota. This is caused by the inundation of accumulated organic matter, which drives a rapid productivity boost to the river. Accelerated bacterial growth from the breakdown of organic matter can consume significant amounts of dissolved oxygen from the water column, greatly reducing the availability of oxygen for organisms such as fish.

Any 'blackwater' effect during commissioning of the Proposal is expected to be insignificant since intermittent inundation of these creeks through natural flood events preceding commissioning are likely to prevent accumulation of organic material from reaching problematic levels.

The potential for significant impact to threatened species, populations and ecological communities has been assessed in accordance with State and Commonwealth significant impact criteria (refer to Appendix H). The assessments determined that the construction o the Proposal is unlikely to have a significant impact on these species, populations or communities. Table 6-6 outlines residual impacts to threatened aquatic fauna.

Operation

Water quality

Targeting fast flows for fish through CCB Creeks has the potential to introduce shear stress to creek channels and could result in increased rates of erosion where shear stresses are high. Erosion and deposition of channel sediments are natural geomorphic processes, particularly in lowland floodplain areas, and are typically only of concern where erosion and deposition rates become elevated above background levels, causing loss of valuable habitat.

Variation in channel characteristic throughout CCB Creeks means that even under stable discharge, flow velocities and bed shear stress will vary spatially throughout the system. Similarly, changes in inflows through the Carrs weir No. 1 and Carrs weir No. 2 regulators will introduce temporal variability to velocity and associated erosion risk.

Stream bed shear stress has been modelled for a range of flow scenarios through the CCB system (see Figure 6-7 to Figure 6-10). Modelled values throughout the CCB system across the range of modelled scenarios were typically greatest immediately downstream of the regulators and ranged from 0 N/m^2 to 9.9 N/m^2 (the latter occurring in Carrs Creek downstream of Carrs 1 with Carrs 1 fully open and high water level in Lake Victoria and Lock 9).

Gippel et al. (2008) states that for clay banks, 11 N/m^2 represents a critical shear stress value below which erosion risk is considered negligible, with a low erosion risk considered between 11 and 17 N/m^2, suggesting that risk of erosion across all modelled scenarios may be low, based on clay channels throughout the system.

Erosion control measures are required upstream and downstream of structures where flow velocities are expected to exceed those occurring under natural conditions, where turbulence is created within flows and where flows drop over a structure. The design intent is to minimise erosion and maintain the structural integrity of the receiving creeks. However, it is recognised that some erosion may occur adjacent the new structures or in other parts of the system, and that this is a natural process which is preferable to rock lining all the channels. The selected erosion control measures are shown in the detailed design (70%) drawings provided in Appendix C. For the regulating structures and armoured containment bank sections, rock protection is considered the best option for erosion control, as explained by the *NSW Locks 8 and 9 SDLAM Project 70% Detailed Design Report* (Jacobs & GHD, August 2021). The use of broken down (crushed) clean concrete (devoid of fines and hazardous materials) salvaged from the demolition of the existing weir structures shall be assessed on site its for suitability for reuse (with the exception of areas below the top of bank (ie instream)).

The primary location where modelled stream bed shear stress could be of concern is at the confluence of Bunberoo and Carrs Creeks. Model results identified potential for high erosion risk at this location when Lock 8 levels are low. In response to this additional bathymetric survey was collected as a baseline for monitoring. Erosion rates will be monitored in CCB Creeks following commissioning and operation of the Carrs weir No.1 and Carrs weir No.2 regulators with particular focus on the confluence of the two creeks to determine if additional erosion controls are required.

General operation of the Proposal could result in spills or leaks as a consequence of plant or equipment malfunction or unplanned maintenance. Accidental spills may occur as a result of inappropriate storage, handling and use of plant and equipment (including vehicles) on-site. Suitable spill response measures form part of SA Water's environmental management protocols.

The proposal would facilitate a more natural and improved river hydrology by increasing a network of narrow creek channels, restoring flows, connectivity, and a diverse hydrodynamic regime within the CCB Creeks system. Overtime this would increase the diversity and quality of aquatic and wetland habitat, KFH and waterways for native and threatened species. The benefits of reinstating a more natural hydrology would also contribute to an overall higher basal quality of food resources, increased carbon and nutrient transport, increased in-stream and floodplain productivity, increased diversity of refugia and increased flows into downstream environments.

Aquatic biodiversity

The CCB Creeks Proposal, as part of the NSW Locks 8 and 9 Project, seeks to restore flows, connectivity and a diverse hydrodynamic regime within the CCB Creeks system. This would in turn increase the diversity and quality of aquatic habitat, promote fish populations by providing regionally important spawning and nursery areas, and support bird breeding events through habitat and food provision.

Table 6-5 shows the biological design criteria as detailed in NSW Locks 8 and 9 SDLAM Project 70% Detailed Design Report (Appendix A) were adopted for the design of the Carrs Weir 1 and Carrs Weir 2 vertical slot fishways.

Table 6-5 - Fishway Biological Design Criteria

Fish Category	Fish Size Range	Maximum average pool turbulence (W/m³)		Minimum pool water depth (m)		Maximum average slot velocity (m/s)	
		Preferred	Absolute	Preferred	Absolute	Preferred	Absolute
Small-sized native fish	20 – 70mm	30	35	0.40	0.25	1.10	1.20
Medium-sized native fish	70 – 600mm	50	70	0.75	0.60	1.20	1.40
Large-sized native fish	600 – 1,200mm	80	100	1.00	0.80	1.40	1.80

The table above shows the target 'preferred' and 'absolute' values of maximum average pool turbulence, minimum pool water depth and maximum average velocity in the vertical slots, for the various fish sizes. The Carrs Weir 1 and Carrs Weir 2 vertical slot fishway designs were assessed against these key criteria to confirm the biological functionalities of the designs for the upstream passage of small, medium and large-sized native fish.

The *Interim operating plan for Carrs, Capitts and Bunberoo Creeks for the commissioning phase of Carrs 1 and 2 regulators* (Alluvium, 2022) (Appendix E) has been developed to guide operation of the proposed Carrs weir No. 1 and Carrs weir No. 2 regulators to optimise in-stream habitat conditions for native fish within broader system operational settings. The Operating plan incorporates a continuous improvement process where the performance can be reviewed and operations amended to achieve improvements. Monitoring of fish movements via a PIT TAG system has also been incorporated into the design to allow tracking of tagged fish through the fishway.

The potential risks to aquatic biodiversity as a result of poor stream flow (hydrology) outcomes being delivered by the Project include:

- Fish stranding risk – Providing variable flows to CCB creeks, with the possibility of intermittent shutdown of the CCB system, there is a risk that receding flows may cause fish to be trapped in isolated pools, or below fishways where minimum flow thresholds are not met. Variable seasonal flows may also facilitate adverse impacts to nesting sites through the exposure of snags. These risks are particularly relevant to large fish species such as the Murray Cod. (Alluvium 2022).
- Invasive and pest species – The proposal also has the long term potential to enhance Carp recruitment by providing increased distribution associated with the restoration of flows and habitat when floodplains and waterways are flooded (DPIE, 2021). Carp compete with native species for resources and stir up silt and erode the banks of the river causing an increase in sediment and muddying of the water. Increased sedimentation can impact on waterway health and accumulate in areas of slow flow, potentially smothering bottom dweller species. Long-term or short-term impacts would be mitigated with coffer dams and disposal of Carp which are captured.
- 'Blackwater' events are not considered a significant risk during operation since flows through the CCB Creek system under normal (not flood) operations are expected to remain in channel, where inundation of large amounts of organic matter is not likely to occur. As operation of the CCB system is dependent on broader River Murray operational settings, it is possible that the flows achieved through the CCB Creeks system will be insufficient to meet the proposal objectives. The flows associated with the Proposal are assessed in more detail as part of potential operational hydrology impacts at Section 6.1 of this REF. The level of risk associated with blackwater events from these operational flows are generally found to be low risk as the design basis provides significant operational flexibility.

WINSW has prepared a draft Monitoring Plan (DPIE, 2022 – Appendix L) that proposes monitoring arrangements for the CCB Creeks system during a commissioning and first operation phase. The Monitoring Plan is intended to provide a validation process for the design approach that has been adopted and will provide a framework to identify any issues that need to be addressed as part of commissioning. The draft monitoring plan includes:

- Ecological monitoring objectives
- Flow monitoring
- Fish movement and species monitoring
- Water quality sampling
- Governance responsibilities
- Monitoring costs

As data is gathered and more information regarding the operating principles of the CCB system are processed and understood, WINSW will make refinements to the Monitoring Plan prior to project handover in June 2024. This plan will then be updated by SA Water as operator as needed.

The potential for significant impact to threatened species, populations and ecological communities has been assessed in accordance with State and Commonwealth significant impact criteria (refer to Appendix H). The assessments determined that the operation of the Proposal is unlikely to have a significant impact on these species, populations or communities. Table 6-6 outlines residual impacts to threatened aquatic fauna.

Table 6-6 Threatened aquatic fauna impact assessment

Species	Common Name	Assessment	Potential impact (construction and operation)
Bidyanus bidyanus	Silver Perch	Main-channel specialist with suitable habitat limited to the Murray River and potentially the permanent sections of Carrs Creek and Frenchmans Creek. There is suitable main channel or deep flowing water habitat adjacent to Sites 2, 6, 8 and B. Localised impacts possible, temporary disturbance to banks and channels of waterways.	Low – Proposal areas unlikely to provide habitat critical to the survival of the species at the local or regional scale. Works are confined to relatively small areas associated with existing structures and areas of disturbance. Works are likely to benefit species at the local and regional scale by improving fish passage opportunities and increasing access to suitable fish habitat.
Craterocephalus fluviatilis	Murray Hardyhead	Some habitat present. Localised, temporary disturbance to banks and channels of waterways.	Low – not recorded in the Proposal area. Proposal areas unlikely to provide habitat critical to the survival of the species at the local of regional scale. Works are confined to relatively small areas associated with existing structures and areas of disturbance.
Maccullochella maquariensis	Trout Cod	Main-channel specialist with suitable habitat limited to the Murray River. Localised impacts possible, temporary disturbance to banks and channels of waterways	Low – Proposal areas unlikely to provide habitat critical to the survival of the species at the local of regional scale. Works are confined to relatively small areas associated with existing structures and areas of disturbance. Works are likely to benefit species at the local and regional scale by improving fish passage opportunities and increasing access to suitable fish habitat.
Maccullochella peelii	Murray Cod	Localised impacts possible, temporary disturbance to banks and channels of waterways.	Low – not recorded in the Proposal area. Works areas unlikely to provide habitat critical to the survival of the species at the local of regional scale. Works are confined to relatively small areas associated with existing structures and areas of disturbance. Works are likely to benefit species at the local and regional scale by improving fish passage opportunities and increasing access to suitable fish habitat.

Species	Common Name	Assessment	Potential impact (construction and operation)
Tandanus tandanus	Eel tailed catfish	Localised impacts possible, temporary disturbance to banks and channels of waterways.	Low – not recorded in the Proposal area. Works areas unlikely to provide habitat critical to the survival of the species at the local of regional scale. Works are confined to relatively small areas associated with existing structures and areas of disturbance. Works are likely to benefit species at the local and regional scale by improving fish passage opportunities and increasing access to suitable fish habitat.

Safeguards

Measures proposed to avoid, minimise or manage potential water quality and aquatic biodiversity impacts as a result of the Proposal are detailed in Table 6-7.

Table 6-7 Safeguards for water quality and aquatic biodiversity

Timing	Impact	Safeguard	Responsibility
Detailed design	Erosion and sedimentation	Final detailing of rock erosion protection will be performed for the next design deliverable - 100% detailed design.	WINSW
Prior to construction	Water quality	Baseline water quality data would be established prior to construction. This will allow more accurate assessment and management of potential impacts during construction.	WINSW
Prior to construction	Aquatic fauna	Construction activities with direct contact to the waterway are not to take place at sites (Sites 6 and 10) which have identified spawning habitat for fish species during breeding season (spring and summer).	Contractor / WINSW
Prior to construction	Aquatic fauna	A dewatering plan will be prepared for construction of the new Carrs weir No. 1 regulator to avoid potential impacts to aquatic fauna such as fish stranding and blackwater events.	Contractor / WINSW
Prior to construction	Aquatic habitat	Permission will be gained from NSW DPI – Fisheries prior to removal and relocation if any in-stream snags are proposed to be removed	Contractor / WINSW
Construction	Erosion and sedimentation	Erosion and sediment controls should be established prior to commencement of construction activities (including vegetation clearing). This would be in accordance with CEMP (including a Flood Response Plan)	Contractor

Timing	Impact	Safeguard	Responsibility
Construction	Aquatic habitat	Degradation of native riparian vegetation along NSW water courses is listed as a KTP under the FM Act. Disturbance to riparian vegetation and snags would be limited to the assessed clearing areas and avoided wherever possible. This would be in accordance with CEMP (including a Flood Response Plan)	Contractor
Construction	Water quality	Site specific controls to manage the risk of accidental spills or leaks of fuels, oils and chemicals (such as hydraulic oils), or concrete, during construction will be outlined in the CEMP (including a flood response plan).	Contractor
Construction	Water quality	Degradation of native riparian vegetation along NSW water courses is listed as a KTP under the FM Act. Stockpiles will not be placed within 20m of creek channels and will be covered when not in use to prevent sediment runoff to ensure impacts to aquatic habitats and riparian vegetation are minimised.	Contractor
Construction	Erosion and sedimentation	Disturbed areas will be revegetated with endemic riparian and floodplain species or otherwise stabilised at the completion of construction. This would be in accordance with the CEMP.	Contractor
Operation	Aquatic habitat	The first operation of the CCB Creeks system is to be monitored in accordance with the Ecological Monitoring Plan (DPIE, 2022).	WINSW
Operation	Aquatic habitat	The Ecological Monitoring Plan (DPIE, 2022) is to be reviewed and updated prior to project handover.	WINSW
Operation	Erosion and sedimentation	Erosion and sediment controls, including semi-permanent controls along the creek bed and bank as required, will be maintained post construction until disturbed areas are stabilised.	Contractor / SA Water

Timing	Impact	Safeguard	Responsibility
Operation	Erosion and sedimentation	Sites identified with higher potential for erosion will be monitored in CCB Creeks following commissioning and operation of the Carrs weir No.1 and Carrs weir No.2 regulators with particular focus on the confluence of the two creeks to determine if additional erosion controls are required.	SA Water
Operation	Water quality	Site environmental management, inclusive of spill response measures, will be in accordance with broader SA Water O&M and environmental management procedures for River Murray Operations.	SA Water
Operation	Monitoring waterway / flow	Daily discharge will be monitored based on measured water levels and gate settings. Gate position will be set in accordance with the Operating Plan.	SA Water

6.3. Terrestrial biodiversity

The *Carrs, Capitts and Bunberoo Creeks Biodiversity Assessment* (Jacobs, 2022 - Appendix H) identifies potential terrestrial biodiversity impacts from the Proposal. This assessment is summarised in this section.

Methodology

The methodology for the aquatic and terrestrial biodiversity assessment is described in Section 6.2.

Existing environment

Flora

Biodiversity values mapping

Areas of Outstanding Biodiversity Value (AOBV) are special areas with irreplaceable biodiversity values that are important to the whole of NSW, Australia or globally. These are declared by the Minister for the Environment under the BC Act. There are no AOBV mapped in the biodiversity study area. The nearest AOBV occurs in the Central Tablelands of NSW approximately 1,000 km north-east in Wollemi National Park, NSW.

Riparian land along the River Murray and Carrs Creek is identified as 'protected riparian vegetation' by the NSW Biodiversity Values Map. Accordingly, the Proposal design and placement seeks to avoid and minimise disturbance to riparian vegetation and habitat within 20 m of the bed or bank.

Native vegetation communities and threatened flora

The field survey confirmed the presence of two Plant Community Types (PCTs) within the Proposal sites:

- PCT 11 River Red Gum - Lignum very tall open forest or woodland wetland on floodplains of semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
- PCT 13 Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)

These PCTs are shown on Figure 6-13 – Figure 6-19.

The PCTs are not listed as Threatened Ecological Communities (TECs) under the EPBC Act or BC Act.

No threatened flora species are likely to occur within the Proposal sites. The species determination was based on a lack of detection during the field survey, a lack of suitable habitat and/or a lack of previous records within the locality.

According to the Bureau of Meteorology's Groundwater Dependent Ecosystems Atlas (BoM, 2020) the Proposal area has an aquatic ecosystem supplied by a floodplain water body and is identified as a moderate potential groundwater dependant ecosystem (GDE). It is likely that the vegetation communities in the Proposal area have some level of dependence on groundwater.

Weeds and pathogens

Disturbance across the Proposal area has been assessed as moderate, with all Proposal sites having been partially cleared for the construction and maintenance of existing infrastructure. There has been historical cattle grazing at Carrs weir No. 1 and Carrs weir No. 2 and total grazing pressure was assessed as moderate with sheep and kangaroo grazing impacts recorded across the Proposal area during the field survey.

Several localised infestations of priority weed species listed under the NSW *Biosecurity Act 2015* were recorded during the field survey:

- *Carthamus lanatus* (Saffron Thistle) – localised infestations at Carrs weir No. 1 (Site 2)
- *Phyla canescens* (Lippia) – small infestation within Mike's Runner weir (Site B) Proposal site
- *Xanthium occidentale* (Noogoora Burr) – small infestation within Mike's Runner weir (Site B) Proposal site.

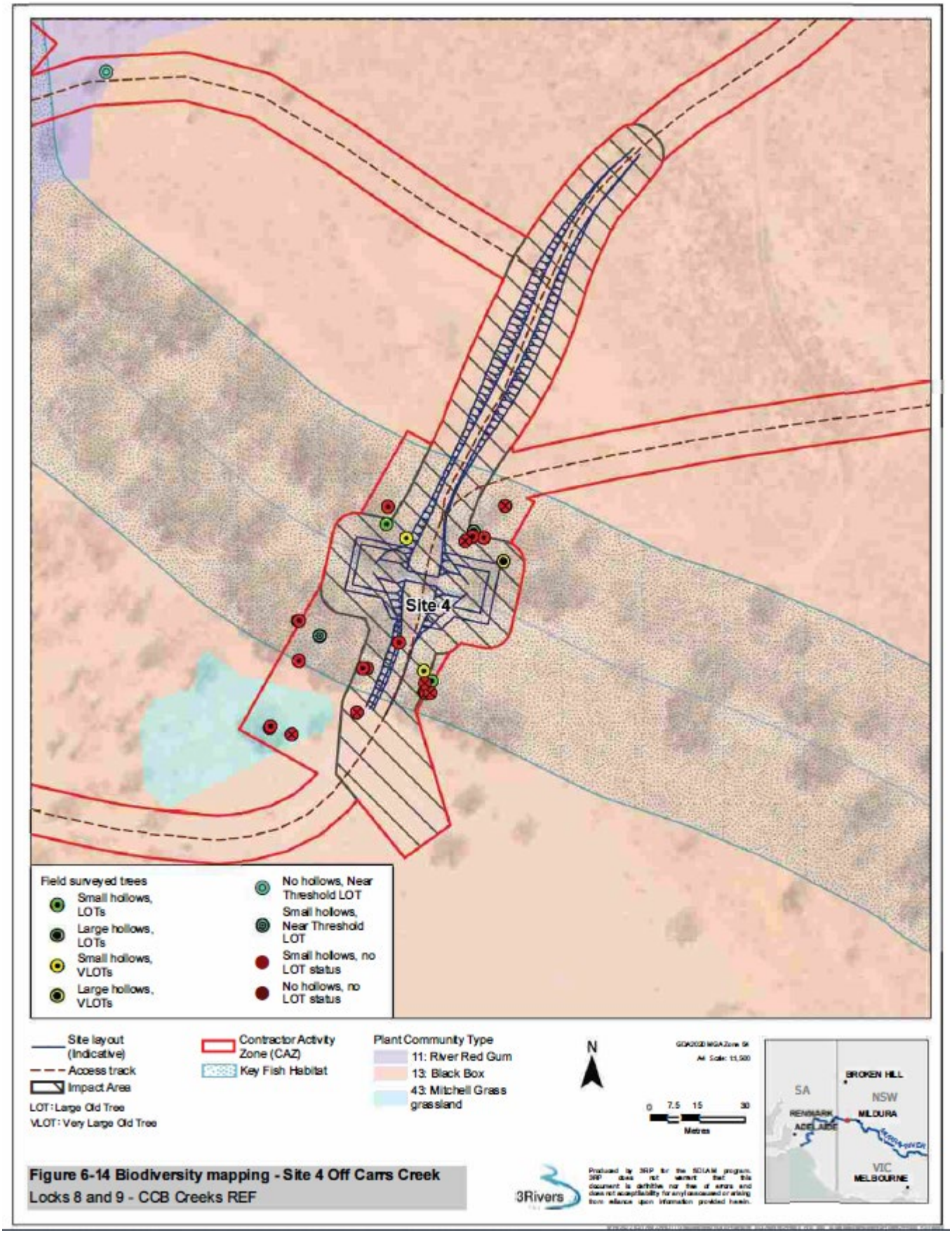

Figure 6-14 Biodiversity mapping - Site 4 Off Carrs Creek
Locks 8 and 9 - CCB Creeks REF

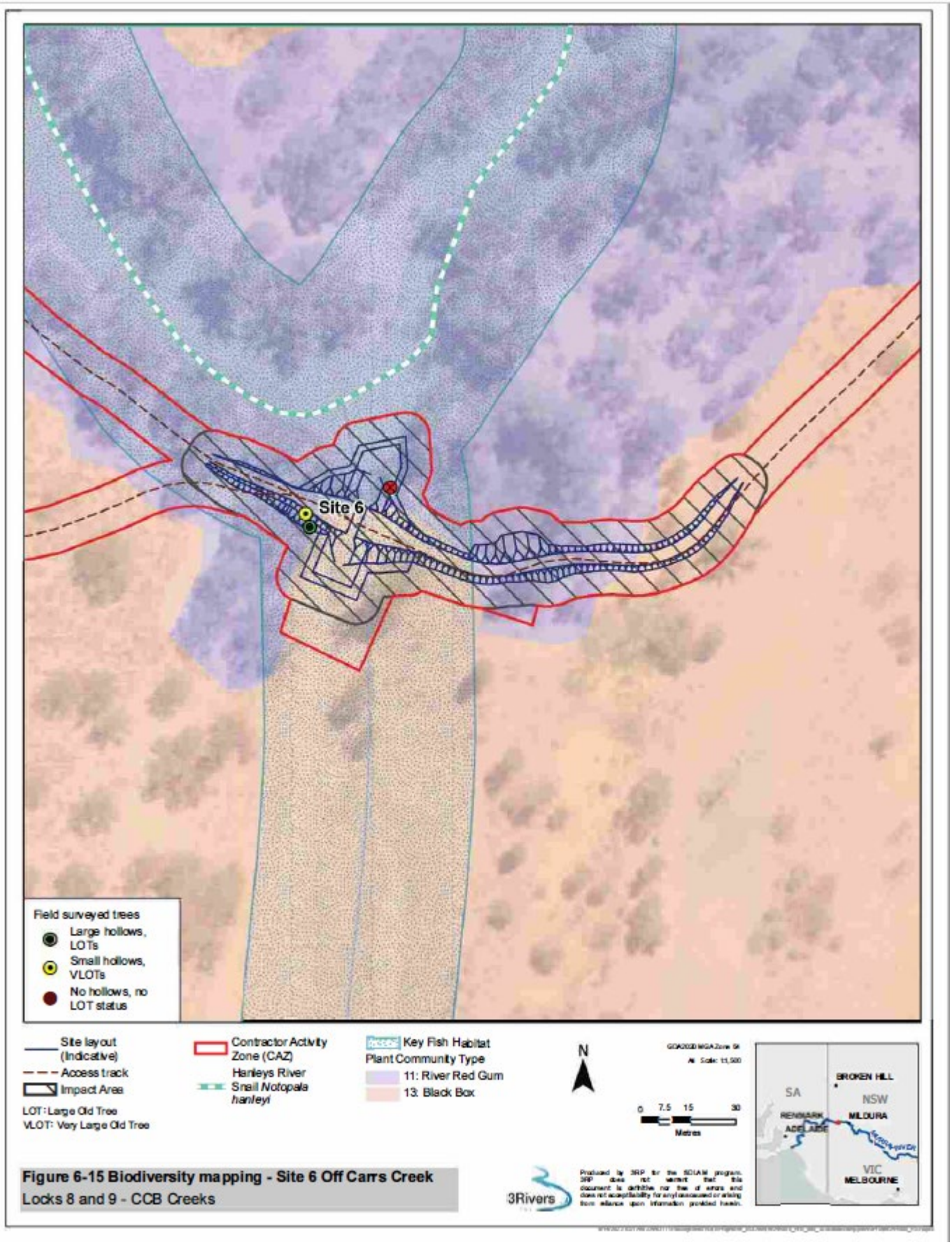

Figure 6-15 Biodiversity mapping - Site 6 Off Carrs Creek
Locks 8 and 9 - CCB Creeks

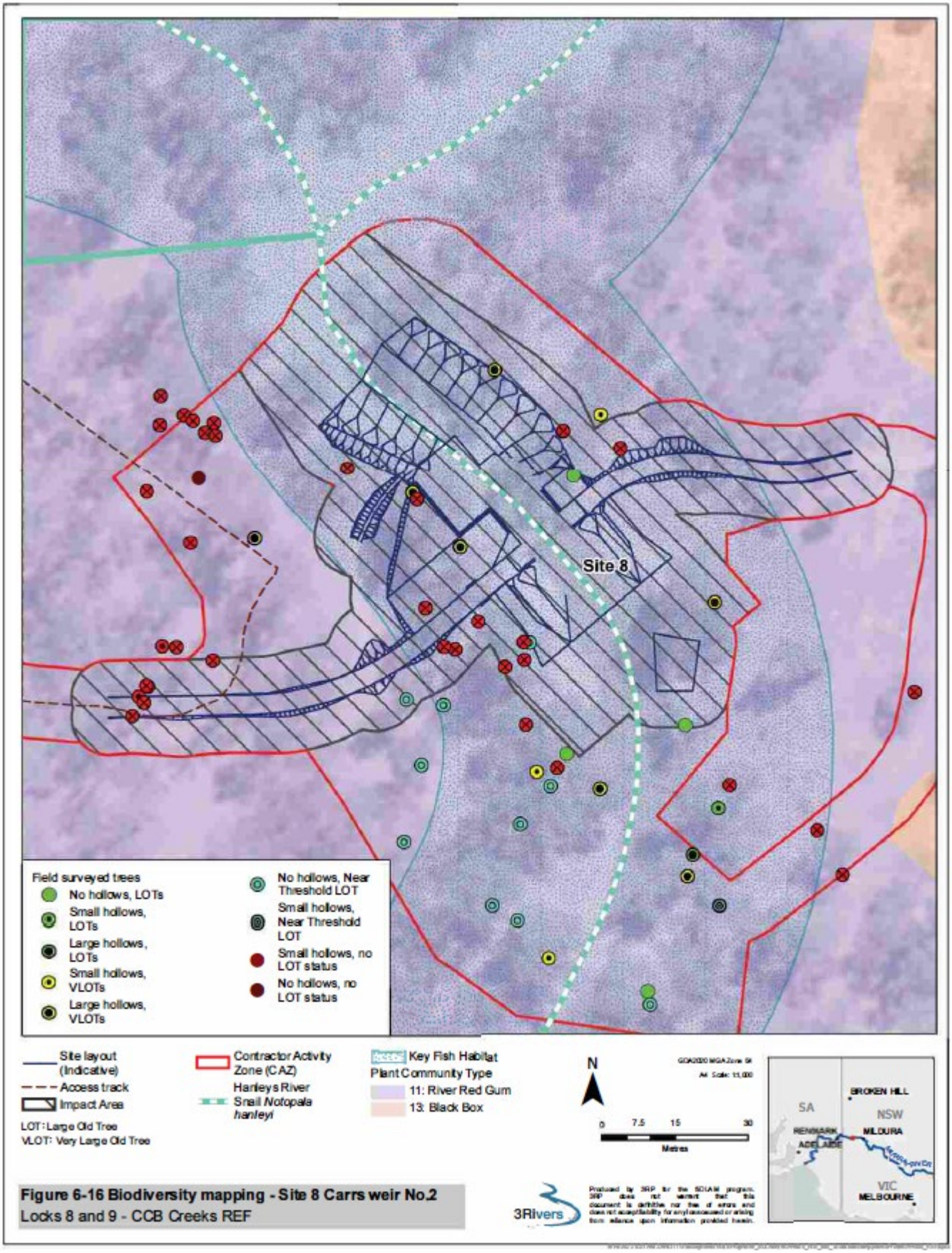

Figure 6-16 Biodiversity mapping - Site 8 Carrs weir No.2
Locks 8 and 9 - CCB Creeks REF

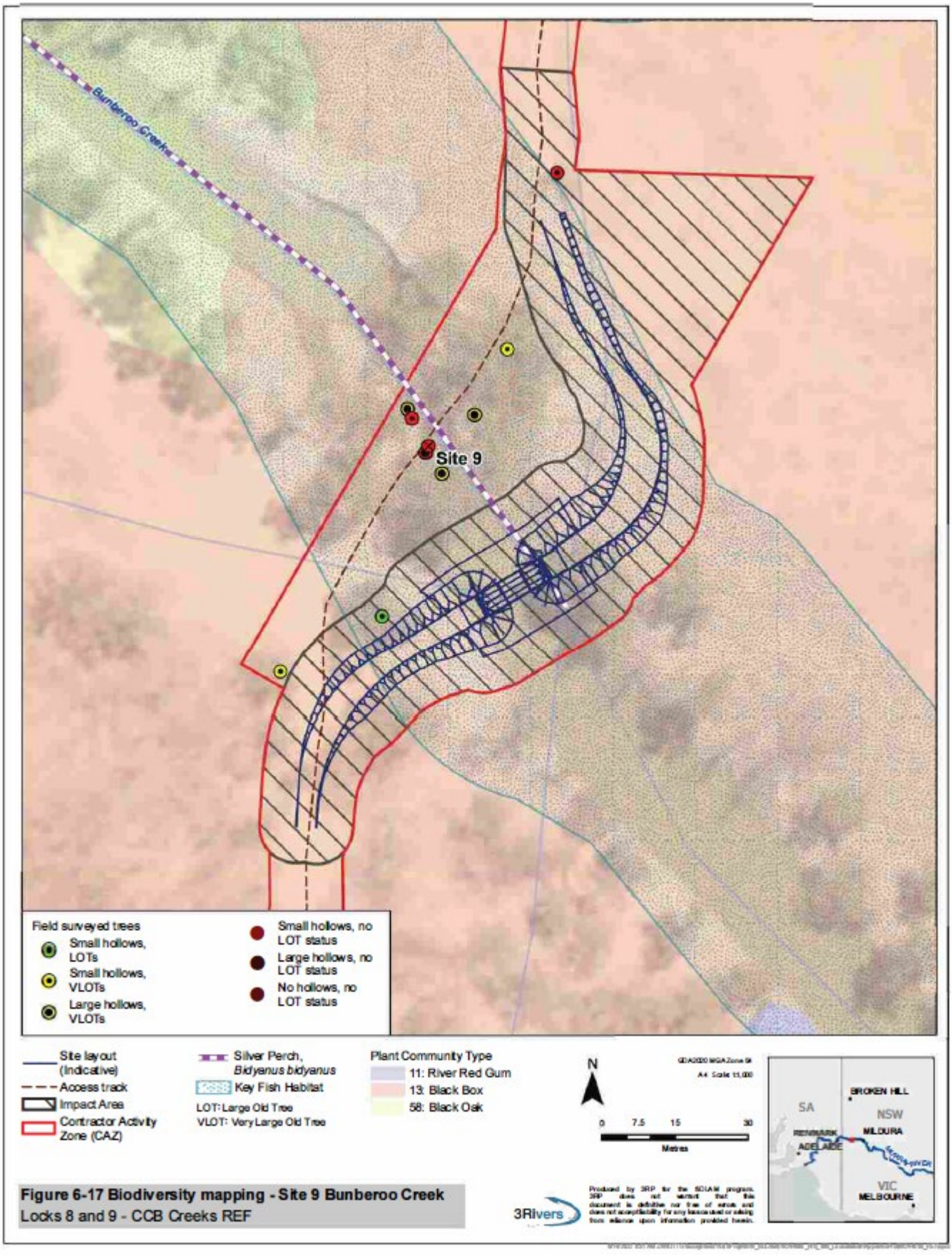

Figure 6-17 Biodiversity mapping - Site 9 Bunberoo Creek
Locks 8 and 9 - CCB Creeks REF

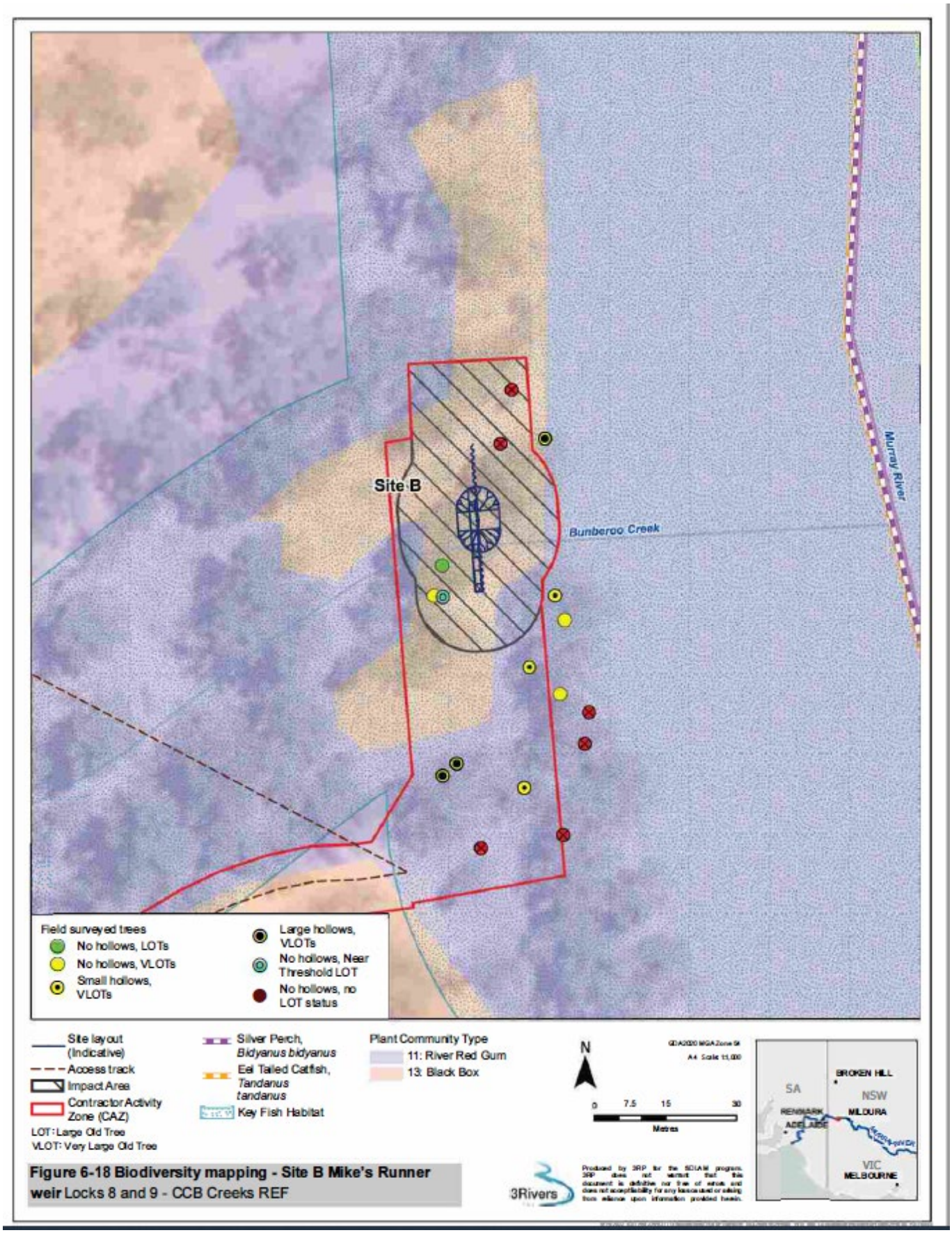

Figure 6-18 Biodiversity mapping - Site B Mike's Runner weir Locks 8 and 9 - CCB Creeks REF

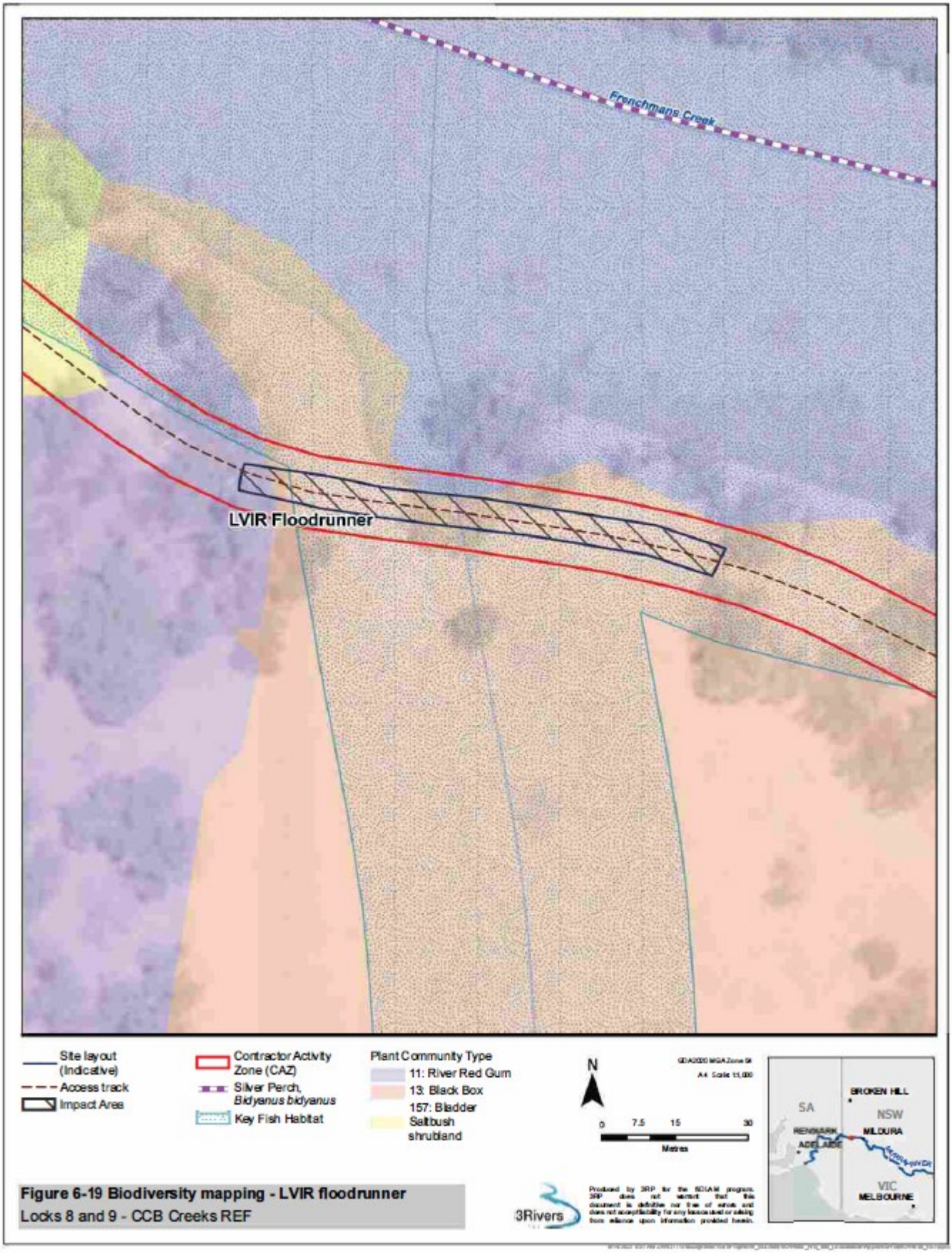

Figure 6-19 Biodiversity mapping - LVIR floodrunner
Locks 8 and 9 - CCB Creeks REF

Fauna

Threatened birds and threatened migratory birds

Sixteen threatened bird species listed under the BC Act including two threatened bird species listed under the EPBC Act and have been assessed as possibly or likely occurring within the Proposal area based on the presence of preferred habitat and recent records of the species. One migratory bird species listed under the EPBC Act, *Apus pacificus* (Fork-tailed Swift,) is considered a possible fly-over species. These species are listed in Table 6-8.

The Proposal area is not within an 'important area' identified and mapped for migratory shorebirds under the provisions of the BC Act and Biodiversity Assessment Method (DPIE, 2020).

Table 6-8 Threatened birds

Species	Common Name	EPBC Act Status[1]	BC Act Status[1]	Likelihood of Occurrence	Preferred habitat and comments
Botaurus poiciloptilus	Australasian Bittern	E	E	Possible	Preferred habitat is permanent and seasonal freshwater wetlands with tall dense sedgeland communities. Small areas of Typha tall sedgeland are present within the study area associated with permanent water of Carrs Creek at a number of infrastructure sites.
Polytelis anthopeplus monarchoides	Regent Parrot (eastern subspecies)	V	E	Possible	Typical nest trees are large, mature healthy trees with many spouts (though dead trees are also used) and are usually located close to a watercourse. Mallee woodland within 20 km of nesting sites is critical foraging habitat for breeding birds. Old growth Red Gum and Black Box woodland/ open forest with large tree hollows, present at most infrastructure sites, provides potential nesting habitat, with Mallee communities present within 20 km providing potential foraging habitat.
Ardeotis australis	Australian Bustard	-	E	Possible	Nomadic species often recorded in arid areas following significant rainfall events. May occur within the study area as a vagrant.

Species	Common Name	EPBC Act Status[1]	BC Act Status[1]	Likelihood of Occurrence	Preferred habitat and comments
Artamus cyanopterus	Dusky Woodswallow	-	V	Possible	Scattered records along the River Murray including near Lake Victoria State Forest. Species may occur as a vagrant within the study area.
Circus assimilis	Spotted Harrier	-	V	Possible	Prefers grassy open woodland including inland riparian woodland. Potential foraging habitat within study area and species may occur as a vagrant.
Daphoenositta chrysoptera	Varied Sittella	-	V	Possible	Preferred open woodland habitat is present a most infrastructure locations and portions of the access tracks.
Epthianura albifrons	White-fronted Chat	-	V	Likely	Preferred open forbland and low open shrubland present at most infrastructure locations and access tracks.
Falco subniger	Black Falcon	-	V	Possible	Large, highly mobile falcon that prefers woodland and open forest vegetation often along inland waterways. Species may occur as a vagrant within the study area due to the presence of potential suitable foraging and nesting habitat.
Haliaeetus leucogaster	White-bellied Sea-Eagle	-	V	Possible	This species may intermittently utilise areas of open water within the study area as foraging habitat and adjacent open forest provides potential nesting habitat.

Species	Common Name	EPBC Act Status[1]	BC Act Status[1]	Likelihood of Occurrence	Preferred habitat and comments
Hamirostra melanosternon	Black-breasted Buzzard	-	V	Possible	Lives in a range of inland habitats, especially along timbered watercourses which is the preferred breeding habitat. Hunts over grasslands and sparsely timbered woodlands. Species may intermittently use the study area as foraging habitat.
Hieraaetus morphnoides	Little Eagle	-	V	Possible	Occupies open eucalypt forest, woodland or open woodland including riparian woodlands of interior. Species may possibly occur in the study area.
Lophochroa leadbeateri	Major Mitchell's Cockatoo	-	V	Possible	Inhabits a wide range of treed and treeless, arid and semi-arid inland habitats, always within easy reach of water. No preferred mallee habitat present but may occur as a vagrant within the study area.
Oxyura australis	Blue-billed Duck	-	V	Possible	Prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. May occur as a vagrant within the study area.
Pachycephala inornata	Gilbert's Whistler	-	V	Possible	Prefers mallee habitat but also recorded in River Red Gum forests along River Murray. May occur as a vagrant within the study area.
Pachycephala inornata	Redthroat	-	V	Likely	Prefers low open shrubland including Pearl Bluebush, Saltbush and Nitre Goose-foot communities.

Species	Common Name	EPBC Act Status[1]	BC Act Status[1]	Likelihood of Occurrence	Preferred habitat and comments
Stictonetta naevosa	Freckled Duck	-	V	Possible	Prefers narrow, often lignum-lined channels for foraging and breeding. Possible that this species may occur during floods.
Apus pacificus	Fork-tailed Swift	M	-	Possible	Highly mobile, almost entirely aerial species, flying <one metre to 1,000 m above the ground - seldom recorded on the ground. The species occurs aerially over a wide range of habitats, which vary from rainforests to treeless plains. Nearest record from Wentworth but given widespread nature and use of aerial habitat has potential to occur above the study area as an overfly visitor.

Notes: [1] Status: M = Migratory species, V = Vulnerable species, E = Endangered species.

Threatened mammals

One threatened mammal species listed under the EPBC Act and BC Act was assessed as possibly occurring within the Proposal area based on the presence of preferred habitat and recent records of the species. This species is shown in Table 6-9.

Table 6-9 Threatened mammals

Species	Common Name	EPBC Act Status[1]	BC Act Status[1]	Likelihood of Occurrence	Preferred habitat and comments
Nyctophilus corbeni	Corben's Long-eared Bat	V	V	Possible	Roosts in tree hollows, crevices, and under loose bark. Most records are from Eucalyptus gracilis Mallee, Buloke and Black Box Woodlands (Lumsden, 1994), however it has been recorded across a broader range of woodland types including River Red Gum Forest. Nearest records approximately 10 kilometres east of study area within Black Box/River Red Gum woodland. Suitable habitat is widespread around the study area.

Notes: [1] Status: V = Vulnerable species.

Threatened amphibians

One threatened frog species listed under the EPBC Act and BC Act was assessed as possibly occurring within the Proposal area based on the presence of preferred habitat and recent records of the species. This species is shown in Table 6-10.

Table 6-10 Threatened amphibians

Species	Common Name	EPBC Act Status[1]	BC Act Status[1]	Likelihood of Occurrence	Preferred habitat and comments
Litoria raniformis	Southern Bell Frog	V	E	Possible	Usually found in or around permanent or ephemeral Black Box/Lignum/Nitre Goosefoot swamps, Lignum/Typha swamps and River Red Gum swamps or billabongs along floodplains and river valleys. Permanent wetlands and floodplain habitats adjacent or upstream of impact areas within the study area would provide potential habitat for this species. However, following extensive drought periods presence of large population is unlikely and occurrences are likely to be localised to permanent habitat.

Notes: [1] Status: V = Vulnerable species, E = Endangered species.

Habitat trees

Large old trees and trees which are hollow bearing provide habitat for a wide range fauna species. These habitat trees, mostly River Red Gum and Black Box trees, were found to be present at most of the Proposal sites, and those within the proposed clearing areas are listed in Table 6-11. The largest numbers of habitat trees are present at the Carrs weir No. 1 and No. 2 (Proposal sites 2 and 8) and at Proposal site 4 off Carrs Creek. Habitat trees are shown on Figure 6-13 – Figure 6-19.

Table 6-11 Habitat trees within proposed clearing areas

Site	Location	Total trees within clearing area	Small and medium hollows	Large hollows	Large old trees	Total habitat trees potentially cleared	Total non-habitat trees potentially cleared
Site 2	Carrs weir No. 1	20	9	4	9	13	7
Site 4	Off Carrs Creek	14	10	1	4	11	3
Site 6	Off Carrs Creek	3	1	1	2	2	1

Site	Location	Total trees within clearing area	Small and medium hollows	Large hollows	Large old trees	Total habitat trees potentially cleared	Total non-habitat trees potentially cleared
Site 8	Carrs weir No. 2	24	0	4	6	8	16
Site 9	Bunberoo Creek	2	2	0	1	2	0
Site B	Mike's Runner weir	5	0	0	2	3	2
Site 10	Lake Victoria Inlet Regulator floodrunner	0	0	0	0	0	0
Total		**68**	**22**	**10**	**24**	**39**	**29**

Note: Habitat trees to be potentially cleared can contain more than one hollow and contain hollows of various sizes

Impacts

Construction

Flora

The design and placement of the proposed infrastructure and the associated construction disturbance seeks to avoid the clearing of native vegetation, including riparian vegetation, wherever possible. However, construction of the Proposal would require unavoidable removal of up to 2.91 hectares of native vegetation, and up to 0.79 hectares of non-native vegetation. The impact to native vegetation is based on broad scale vegetation mapping and clearing areas shown in Figure 6-13 – Figure 6-19, and is outlined in Table 6-12.

Table 6-12 Native vegetation within proposed clearing areas

Site	Location	PCT 11 (ha)	PCT 13 (ha)	Total native vegetation (ha)
Site 2	Carrs weir No. 1	0.14	0.35	0.49
Site 4	Off Carrs Creek	0	0.66	0.66
Site 6	Off Carrs Creek	0.31	0.24	0.55
Site 8	Carrs weir No. 2	0.59	0	0.59
Site 9	Bunberoo Creek	0.48	0	0.48
Site B	Mike's Runner weir	0.02	0.12	0.15

Site	Location	PCT 11 (ha)	PCT 13 (ha)	Total native vegetation (ha)
Site 10	Lake Victoria Inlet Regulator floodrunner	0	0	0
Total		**1.54**	**1.37**	**2.91**

Conditions for weed growth and spread and the introduction of soil-borne pathogens such as *Phytophthora cinnamomi* (dieback) and *Uredo rangelii* (Myrtle Rust) may be facilitated by construction activities such as clearing and grubbing. Some variations of weed seeds spread by floating on water and could be carried to downstream and/or newly inundated environments. These potential impacts would be mitigated by safeguards outlined in Table 6-14.

Fauna

As per Table 6-11, construction of the Proposal would require clearing up to 39 habitat trees (large old trees or hollow bearing trees) including up to 32 hollows, which would potentially displace fauna species using those trees for habitat, especially hollow dependant species. However, implementation of proposed safeguards to manage impacts to habitat trees is expected to reduce residual impacts to common and threatened species to be nil to low.

During construction, there is potential for terrestrial fauna to be injured by vehicle strike by construction vehicles. Mammals, reptiles, amphibians and birds are all at risk of vehicle strike, particularly common species (birds) that are tolerant of disturbance and remain during construction activities. Displaced fauna would be more at risk of injury during construction activities. However, the risk is low given the low amount of construction traffic proposed (refer Section 6.7).

Noise and vibration from construction activities such as vegetation clearing, ground disturbance, machinery and vehicle movements, and general human presence can potentially disturb resident fauna and may disrupt foraging, reproductive or movement behaviours. Impacts from noise and vibration are likely to be minor as they would be localised and temporary.

Summary of assessment (impacts to flora and fauna)

The potential for significant impact to threatened species, populations, ecological communities and migratory species has been assessed in accordance with State and Commonwealth significant impact assessment criteria (refer to Appendix H). The assessments determined that the Proposal is unlikely to have a significant impact on these species, populations or communities. Table 6-13 outlines residual impacts to threatened terrestrial fauna.

The Proposal has potential to contribute to the following 'key threatening processes' identified by the BC Act or FM Act:

- Clearing of native vegetation (BC Act)
- Removal of hollow-bearing trees (BC Act)
- Removal of dead wood and dead trees (BC Act)

Except for clearing of native vegetation and removal of dead wood and dead trees, impact of most KTPs would be reduced or avoided by implementing hygiene and weed control measures.

The biodiversity offset scheme (BOS) does not apply to development that is an activity subject to assessment under Division 5.1 of the EP&A Act unless the proponent chooses to opt into the BOS. If the proponent chooses to opt-in to the BOS, they must engage an accredited assessor to apply the Biodiversity Assessment Method (BAM) to the proposal. The test of significance undertaken for this proposal determined that the proposed activity is not likely to significantly affect threatened species or ecological communities, or their habitats, therefore entry into the BOS or additional environmental impact assessment are not required unless the proponent chooses.

While construction of the Proposal may result in minor impacts to native vegetation and habitat, impacts would be localised and short-term. Longer-term impacts associated with the removal of large old and/or hollow bearing trees will be largely mitigated through the provision of compensatory habitats for hollow-dependant species at a 1:1 ratio. Retention of hollow logs removed and placed in adjacent retained habitat would further reduce impact to displaced fauna.

The proposed safeguards and mitigation of impacts are expected to ensure construction and operation of the Proposal aligns with the with longer-term benefits to aquatic and terrestrial species expected aligning with the objectives of the Proposal and the SDLAM Lock 8 and Lock 9 Project.

Table 6-13 Threatened terrestrial fauna impact assessment

Species	Common Name	Assessment	Potential construction and operational impact
Apus pacificus	Fork-tailed Swift	Highly mobile migratory species seldom recorded on the ground.	Nil – no interaction with terrestrial environments of study area.
Artamus cyanopterus	Dusky Woodswallow	Localised impact on woodland habitat. Mobile species not dependent on habitat in study area.	Nil – species is mobile and wide ranging; suitable surrounding habitat is widespread. Species likely to benefit from overall long-term improvements to habitat.
Botaurus poiciloptilus	Australasian Bittern	Small areas / edges of potential wetland habitat to be cleared/disturbed. Study area offers marginal habitat only and not considered core habitat.	Low – unlikely to adversely affect habitat critical for the species survival or reduce the species area of occupancy. Species (if present) likely to benefit from improved aquatic habitat.
Circus assimilis	Spotted Harrier	Highly mobile raptor not dependent on habitat within study area.	Nil - species is mobile and wide ranging, suitable surrounding habitat is widespread. Species likely to benefit from overall improvements to habitat.
Haliaeetus leucogaster	White-bellied Sea-Eagle	Localised clearance of forest/woodland near open water. Highly mobile raptor not dependent on habitat within study area.	Nil - species is mobile and wide ranging, suitable surrounding habitat is widespread. Species likely to benefit from overall improvements to aquatic habitat.
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	Common western subspecies is present, not eastern subspecies. Small areas of preferred woodland habitat to be cleared. Habitat widespread throughout study area.	Nil – species is mobile and wide ranging; suitable surrounding habitat is widespread. Common subspecies that is present is likely to benefit from overall improvements to habitat.
Daphoenositta chrysoptera	Varied Sittella	Small areas of preferred woodland habitat to be cleared. Habitat widespread throughout study area.	Nil – species is mobile and wide ranging; suitable surrounding habitat is widespread. Species likely to benefit from overall improvements to habitat.

Species	Common Name	Assessment	Potential construction and operational impact
Epthianura albifrons	White-fronted Chat	Small areas of low open shrubland to be cleared. Habitat widespread throughout study area and species population not dependent on study area.	Nil – species is mobile and wide ranging; suitable surrounding habitat is widespread. Species likely to benefit from overall improvements to habitat.
Falco subniger	Black Falcon	Highly mobile raptor not dependent on habitat within study area.	Nil – species is mobile and wide ranging; suitable surrounding habitat is widespread. Species likely to benefit from overall improvements to habitat.
Hamirostra melanosternon	Black-breasted Buzzard	Highly mobile raptor not dependent on habitat within study area.	Nil – species is mobile and wide ranging; suitable surrounding habitat is widespread. Species likely to benefit from overall improvements to habitat.
Hieraaetus morphnoides	Little Eagle	Highly mobile raptor. Individuals and local population not dependent on habitat within study area.	Nil – species is mobile and wide ranging; suitable surrounding habitat is widespread. Species likely to benefit from overall improvements to habitat.
Lophochroa leadbeateri	Major Mitchell's Cockatoo	Highly mobile species that prefers mallee habitat. Individuals and local population not dependent on habitat within study area.	Nil – species is mobile and wide ranging; suitable surrounding habitat is widespread. Species likely to benefit from overall improvements to habitat.
Oxyura australis	Blue-billed Duck	Localised clearance/disturbance of edges of wetland habitat. Individuals and local population not dependent on habitat within study area.	Nil - species is mobile and wide ranging, suitable surrounding habitat is widespread. Species likely to benefit from overall improvements to aquatic habitat.
Pachycephala inornata	Gilbert's Whistler	Wide ranging species. Prefers some shrub cover, open woodland. Small areas of suboptimal open woodland habitat with limited shrubs to be cleared. Potential habitat widespread throughout study area.	Nil – species is mobile and wide ranging; suitable surrounding habitat is widespread. Species likely to benefit from overall improvements to habitat.

Species	Common Name	Assessment	Potential construction and operational impact
Polytelis anthopeplus monarchoides	Regent Parrot (eastern subspecies)	Clearance of potential nesting trees with large hollows. Suitable nesting habitat trees are common and widespread throughout broader study area and species including local population not dependent on habitat within study area.	Low – unlikely to adversely affect habitat critical for the species survival or reduce the species area of occupancy. Species (if present) likely to benefit from improved habitat.
Pyrrholaemus brunneus	Redthroat	Prefers shrublands with Acacia and chenopods, also in mallee and Cypress pine woodlands. Some habitat present, but limited core habitat with shrubby understorey. Small areas of suboptimal open woodland habitat with limited shrubs to be cleared. Potential habitat widespread throughout study area.	Nil – species is mobile and wide ranging; suitable surrounding habitat is widespread. Species likely to benefit from overall improvements to habitat.
Stictonetta naevosa	Freckled Duck	Localised clearance/disturbance of edges of wetland habitat. Individuals and local population not dependent on habitat within study area.	Nil - species is mobile and wide ranging, suitable surrounding habitat is widespread. Species likely to benefit from overall improvements to aquatic habitat.
Nyctophilus corbeni	Corben's Long-eared Bat	Clearance of potential roosting trees with hollows. Species including local population not dependent on habitat within impact areas. Core population occurs in NSW Piliga Scrub, distant from the site.	Low – species is mobile and wide ranging; suitable surrounding habitat is widespread. Species likely to benefit from overall improvements to habitat.
Litoria raniformis	Southern Bell Frog	BioNet records from 2006 to 2008 include approximately 130 m downstream of Site 6 in Carrs Creek and approximately 1.3 km west of Site B in Bunberoo Creek. Suitable habitat occurs adjacent or upstream of Sites 2, 6, 8, 9 and Site B. Study area is not core habitat for known population. Localised, temporary disturbance to adjacent or upstream wetland areas and banks of waterways.	Low – Known core population and optimal habitat does not occur at the Proposal sites. Species (if present) would likely to benefit from overall future improvements to aquatic habitat and breeding opportunities. Significant impacts to the species as a whole are unlikely.

Operation

Consistent baseflows through the CCB Creeks system would maintain soil moisture for riparian and floodplain vegetation, while seasonal flows (inundation and drawdown of Locks 8 and 9) would initiate the seasonal growth. Overall, the extent and condition of riparian and floodplain vegetation communities, the health of the canopy trees and the diversity of fringing non-woody vegetation is expected to improve, further encouraging vegetation growth and regeneration.

The operation of the proposal would enhance the overall ecosystem values and habitats available within the study area and the lower Murray. An increase in total waterbird abundance, breeding and diversity is expected across all functional groups in association with a greater extent and condition of waterbird habitats (mudflat exposure and adjoining wetlands). The benefits of the operation of the Proposal to waterbirds and other terrestrial species are detailed in Appendix H.

Safeguards

Measures proposed to avoid, minimise or manage potential terrestrial biodiversity impacts as a result of the Proposal are detailed in Table 6-14.

Table 6-14 Safeguards for terrestrial biodiversity

Timing	Impact	Safeguard	Responsibility
Prior to construction	Vegetation clearing	The limits of the assessed clearing area and Contractor Activity Zone will be clearly marked on-site.	Contractor
Construction	Vegetation clearing	During clearing and excavation, topsoil will be retained and stored for reuse during site rehabilitation.	Contractor
Construction	Habitat	Habitat trees and other habitat features (e.g. nests, logs and snags) will be identified and marked during a pre-clearing survey carried out within 48 hours of the commencement of clearing activities. Habitat trees and other habitat features will be cleared adopting the following 'soft-felling' techniques: • All habitat trees and other habitat features will be inspected prior to clearing and any fauna relocated nearby (subject to availability of suitable habitat). • Before felling, habitat trees will be knocked with a machine to alert any animals that may be inside, and fauna given time to escape. • The tree will then be felled as carefully as practical, with hollow sections cut and lowered to the ground. • The tree is to be inspected once on the ground and any animals relocated nearby (subject to availability of suitable habitat). If an animal cannot be captured the section of tree will be left intact at the site.	Contractor

Timing	Impact	Safeguard	Responsibility
		• Any injured animals will be taken to a veterinarian or wildlife carer. • Hollows will be retained for placement within retained vegetation or reuse during site rehabilitation.	
Construction	Habitat	Compensatory habitat in the form of nest boxes will be provided at a ratio 1:1 per hollow removed. Nest boxes will be placed in comparable habitat.	Contractor/WINSW
Construction	Spread of weeds	Vegetation clearing and disposal will be carried out in a manner that prevents the spread of existing weed species.	Contractor
Construction	Pest control	Putrescible waste from lunch sheds and the like will be stored in inaccessible bins and disposed off-site regularly to prevent pests.	Contractor
Construction	Fauna	Construction vehicles movements will be limited to daytime only and a speed limit implemented to reduce the risk of vehicle strike to fauna.	Contractor

6.4. Aboriginal heritage

The draft *Locks 8 & 9 Lake Victoria Aboriginal Cultural Heritage Assessment* (Austral Archaeology, February 2022) (ACHA) assesses the potential for Aboriginal archaeological material to occur within the Proposal area. The assessment is provided in Appendix I and is summarised in this section. A supplementary survey was also conducted (Austral Archaeology, October 20220) to provide further assessment of waterways that will be influenced by operational outcomes of the works.

Existing environment

Landscape context

The study area has various important hydrological features such as creeks, rivers, lakes and billabongs. The River Murray is one of the very significant features within the study area, which has played an important role in shaping the present-day landscape surface features. Lake Victoria is another such significant landscape feature within the study area and is the largest lunette lake on the River Murray. The lake system has acted as a sand trap, creating a massive dune along its eastern bank.

The study area has two main stratigraphical sequences, one associated with Lake Victoria and lunettes and the second associated with the River Murray. The lunette consists of three geological units: Nulla Nulla Sand (30 m thick), Talgarry Sand (10 m thick) and the Dunedin Park Sand.

Ethnographic context

The study area was originally occupied by Aboriginal people of the Barkindji language group. The sub-dialects of this language group include Barindji, Barkindji, Danggali, Maraura and Wiljakali. Ethnographic accounts have indicated that it likely that the Maraura people occupied the study area (Tindale 1974, p.130).

The Barkindji people lived a semi-sedentary lifestyle, mostly near large water sources where they would often live in large congregations (New South Wales Archaeology Pty Limited 2007, p.31, Hardy 1976). The Barkindji people were seasonal hunters and gatherers, with thirty to fifty per cent of their diet sourced from rivers, lakes and other waterways. When there were ecological fluctuations, the Barkindji people would move further inland to visit soaks, often in smaller, more thinly spread groups (Mitchell 1839, p.307, Pardoe 2003, p.50).

Human occupation in the Lake Victoria region dates back to 21,000 years ago (Balme & Hope 1990, Cupper & Duncan 2006). Sites related to Lake Victoria include burial mounds, artefact scatters and shell middens. Both early and recent ethnographic research in the vicinity of the study area has shown that Lake Victoria is believed to be a place where spirits of the dead transform into their totemic form to follow Nurelli (the All-father) into the sky. As a result of this belief system, it is believed that there could be as many as 15,000 burials near Lake Victoria (Jacobs Pty Ltd 2019, p.18).

In 1829-30, the European explorer known as Charles Sturt made the first recorded contact with the Barkindji people. Following this, several conflict incidents occurred between the Barkindji people and European overlanders. As a result, several Aboriginal people were killed. By 1877, the remaining Barkindji population and other tribal groups in the region were removed from their land and were placed in missions along the River Murray.

It is important to note that this ethnohistory should be employed with caution and Hiscock (2008, p.17) has argued that even very early historical accounts may not be a suitable basis for analogy. As Aboriginal groups had to change their economic, cultural and political practices in order to cope with the social impacts of disease in the historic period, he argues that it is likely that similar drastic changes happened in the past in response to “altered cultural and environmental circumstances” following the arrival of Europeans.

Archaeological context

The Murray and Darling Rivers, including Lake Victoria, the Menindee Lakes and Great Darling-Barka Anabranch, have a long history of human occupation. Since the mid-20th century, the Menindee Lakes have been subject to extensive Aboriginal heritage research, with efforts targeting exposed Pleistocene sediments and areas of extensive soil deflation.

Lunettes are considered to have high archaeological potential, preserving sediments and soils (Hope & Dare-Edwards 1980, p.1). Evidence of occupation associated with lunettes includes stone artefacts, campfires, shell midden material, fish, mammal and bird bones, and emu shells (Hope & Dare-Edwards 1980, p.1). Earlier archaeologists believed that techniques used to excavate River Murray sites and the archaeological sites at the Willandra Lakes had the potential to be relevant to

archaeological sites along the Darling-Barka (Hope & Dare-Edwards 1980, p.2). Pardoe (2003a) has subsequently recorded that the density of relics is related to the distance from streams or lake-water and that the reduction of sites and artefacts which occurs the further away from water the site is relatively dramatic (Pardoe 2003, p.44). Midden sites have been recorded to predominantly be located at the junctions of waterways, with shell scatters, evidence of the site being a "dinner time camp", being found along waterways and ephemeral creeks and lagoons (Bonhomme 1993, p.59).

Stone tools were known to be utilised by Aboriginal people; however, it is believed that the material to produce the stones were traded or transported into the region rather than naturally occurring in the area (Appleton 1996, p.7).

Burials within the central Murray and lower Darling rivers are predominantly found in sources bearing dunes and lunettes (Bonhomme 1987, Littleton 1999). Individual burials are also scarce with 95% of sites containing two or more burials, with 24% of sites that have over 10 individuals containing more than 20 exposed burials (Littleton 1999, p.6). Many of these sites are considered to be cemeteries due to the burials being constrained to a lunate or a dune (Bonhomme 1987, Littleton 1999).

The Project has aimed to construct new water infrastructure in areas of high previous disturbance and therefore areas of low archaeological potential. It is noted that the whole of the Lake Victoria landscape, including feeding streams, have an extensive archaeological record. In the case of the Inlet, Site 2, Site 4, Site 6 and Site 8, these sites are so highly disturbed from recent modification that the archaeological record has been destroyed or removed within the Proposal site.

Search of heritage registers

A search of the Heritage NSW Aboriginal Heritage Information Management System (AHIMS) database was undertaken on 4 August 2021. An AHIMS search was conducted for each Proposal site. A five kilometres radius search centred on the site was conducted for the Inlet, Site 4, Site 8 and Site 9. The rest of the sites required a ten kilometre radius search centred on the site. The results from the AHIMS search identified 93 previously recorded sites within these search areas. These AHIMS sites were found to predominately be burial sites (38.7%) followed by hearths (22.6%), artefacts (21.5%), shell (10.8%), modified tree (11.8%) and Aboriginal ceremony and dreaming sites (1.08%). All of the AHIMS identified sites were located adjacent but outside of the ACHA study areas. AHIMS sites located adjacent to the ACHA study area are listed in Table 6-15 and shown in Figure 6-20.

Table 6-15 AHIMS identified sites

Name	AHIMS No.	Type	Location Landform	Cadastral Boundary	Within/Adjacent
TAR-RU Lands (Moorna) 10	#46-2-0167	Modified Tree	Alluvial Creek Bank	Lot 31 DP 756181	Adjacent to Bunberoo Creek bridge (Site 9)
Lock 9 TRE0001	#46-2-0331	Modified Tree	River Bank	Lot 775 DP 1184283	Adjacent to Mike's Runner weir (Site B)

Name	AHIMS No.	Type	Location Landform	Cadastral Boundary	Within/Adjacent
7	#46-2-0025	Artefact	River Bank	Lot 775 DP 1184283	Adjacent to Mike's Runner weir (Site B)
Frenchmans Creek TRE0002	#46-2-0316	Modified Tree	Creek Bank	Lot 1 DP 414712	Adjacent to LVIR Floodrunner
Frenchmans Creek SHL0004	#46-2-0321	Shell	Creek Bank	Lot 1 DP 414712	Adjacent to LVIR Floodrunner

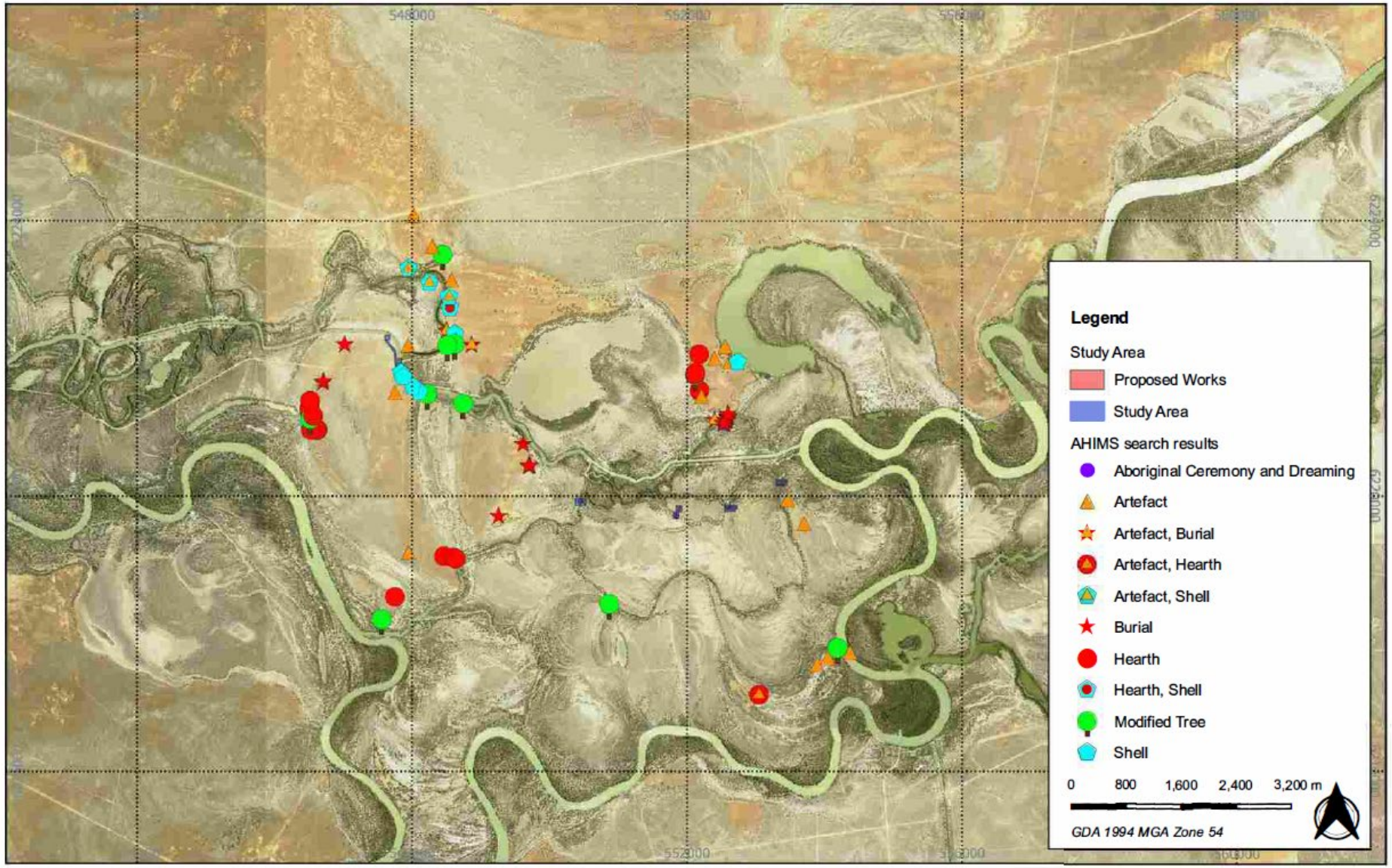

Figure 6-20 AHIMS sites within 10 kilometers of each study area

21091 - Lake Victoria

Source: NSW LPI Aerial *Drawn by: ARH Date: 2022-02-22*

AUSTRAL ARCHAEOLOGY

Archaeological survey and test excavations

Archaeological surveys and test excavations were undertaken within the ACHA study areas by qualified archaeologists who were accompanied by Registered Aboriginal Parties (RAPs), to determine the presence of surface and subsurface heritage items. The surveys were undertaken as follows:

- Works sites survey - 18 and 19 November 2021 (2 days)

  Eight sites that were previously unidentified during the AHIMS search were found during the surveys and test excavations. These sites include six scarred trees and two artefact scatters. Details of the sites are listed in Table 6-16.

- Test excavations - 18 and 19 January 2022 (2 days)
- Supplementary waterways survey – 30 August to 1 September 2022 (3 days)

  Numerous sites associated with Tar-Ru country were previously identified through a survey conducted in 2013 and fourteen additional sites were identified in the supplementary survey which are listed in Table 6-17.

The AHIMS register has been notified of these sites and they are awaiting AHIMS approval. Lake Victoria Locks Scarred Tree 1 is located outside of any of the Proposal sites and is therefore not considered further by this REF.

Table 6-16 Archaeological survey/text excavation identified sites (works areas)

Site name	Feature(s)	Testing area/Survey Unit	Landform
Lake Victoria Locks AS 1	Artefacts	Site 4	Flood Plain
Lake Victoria Locks AS 2	Artefacts	Site 6	Flood Plain
Lake Victoria Locks Scarred Tree 1	Scarred Tree	Inlet site	Flood Plain
Lake Victoria Locks Scarred Tree 2	Scarred Tree	Site 2	Flood Plain
Lake Victoria Locks Scarred Tree 3	Scarred Tree	Site 2	Flood Plain
Lake Victoria Locks Scarred Tree 4	Scarred Tree	Site 2	Flood Plain
Lake Victoria Locks Scarred Tree 5	Scarred Tree	Site 2	Flood Plain
Lake Victoria Locks Scarred Tree 6	Scarred Tree	Site 4	Flood Plain

Table 6-17 Archaeological survey/text excavation identified sites (operational waterways)

Site name	Feature(s)	Survey Unit	Landform
Upper Bunberoo ST1*	Modified Tree (Scarred Tree)	Upper Bunberoo	Floodplain
Upper Bunberoo ST2	Modified Tree (Scarred Tree)	Upper Bunberoo	Channel bank
Upper Bunberoo ST3	Modified Tree (Scarred Tree)	Upper Bunberoo	Channel bank
Upper Bunberoo ST4	Modified Tree (Scarred Tree)	Upper Bunberoo	Channel bank
Middle Bunberoo ATF 1	Isolated artefact	Middle Bunberoo	Channel bank
Middle Bunberoo ATF 2*	Isolated artefact	Middle Bunberoo	Floodplain
Middle Bunberoo SHELL & ST	Modified Tree (Scarred Tree) & shell	Middle Bunberoo	Channel bank
Middle Bunberoo ST 1*	Modified Tree (Scarred Tree)	Middle Bunberoo	Floodplain
Middle Bunberoo ST 2*	Modified Tree (Scarred Tree)	Middle Bunberoo	Floodplain
Middle Bunberoo ST 3*	Modified Tree (Scarred Tree)	Middle Bunberoo	Floodplain
Middle Bunberoo ST 4	Modified Tree (Scarred Tree)	Middle Bunberoo	Channel bank
Middle Bunberoo ST 5*	Modified Tree (Scarred Tree)	Middle Bunberoo	Channel bank
Middle Bunberoo ST 6	Modified Tree (Scarred Tree)	Middle Bunberoo	Channel bank
Middle Bunberoo ST 7	Modified Tree (Scarred Tree)	Middle Bunberoo	Channel bank

Assessment of significance

An assessment of significance for each of the identified sites within the ACHA study areas has been undertaken using the Burra Charter significance values and relevant NSW guidelines (DECCW 2010c, OEH 2011, Australia ICOMOS 2013a). The assessments are summarised in Table 6-18 and Table 6-19.

Table 6-18 Assessment of significance (works sites)

Site name	Statement of significance
Lake Victoria Locks AS 1	Lake Victoria AS 1 is an artefact scatter containing 2 artefacts. Neither of the artefacts have any unique or rare values that provide research, potential, are representative or have educational potential. Therefore, their significance is considered **low**.
Lake Victoria Locks AS 2	Lake Victoria AS 2 is an artefact scatter consisting of 4 artefacts, 3 silcrete flakes and a quartzite manuport. None of the artefacts have characteristics that have unique or rare values provide research potential, are representative or have educational potential. Therefore, their significance is considered **low**.
Lake Victoria Locks Scarred Tree 2	Lake Victoria Locks Scarred Tree 2 is one of several scar trees within Site 4. It is not common to have numerous scar trees within close proximity to each other. Therefore Lake Victoria Locks Scarred Tree 2 has **moderate scientific value** at a local level.
Lake Victoria Locks Scarred Tree 3	Lake Victoria Locks Scarred Tree 3 is one of several scar trees within Site 4. It is not common to have numerous scar trees within close proximity to each other. Therefore Lake Victoria Locks Scarred Tree 3 has **moderate scientific value** at a local level.
Lake Victoria Locks Scarred Tree 4	Lake Victoria Locks Scarred Tree 4 is one of several scar trees within Site 4. It is not common to have numerous scar trees within close proximity to each other. Therefore Lake Victoria Locks Scarred Tree 4 has **moderate scientific value** at a local level.
Lake Victoria Locks Scarred Tree 5	Lake Victoria Locks Scarred Tree 5 is one of several scar trees within Site 4. It is not common to have numerous scar trees within close proximity to each other. Therefore Lake Victoria Locks Scarred Tree 5 has a **moderate scientific value** at a local level.
Lake Victoria Locks Scarred Tree 6	Lake Victoria Locks Scarred Tree 6 is one of several scar trees within Site 4. It is not common to have numerous scar trees within close proximity to each other. Therefore Lake Victoria Locks Scarred Tree 6 has a **moderate scientific value** at a local level.

Table 6-19 Assessment of significance (waterway)

Site name	Statement of significance
Upper Bunberoo ST1*	Upper Bunberoo ST1 is a scar tree in fair condition and is not associated with any other sites. This form of scar tree is common within the surrounding region. It offers very little educational or research potential. Scar trees, however, continue to slowly decrease in number due to the cultural material being associated with a living organism. Therefore, Upper Bunberoo ST1 has a moderate scientific value at a local level.
Upper Bunberoo ST2	Upper Bunberoo ST2 is a scar tree in good condition and is not currently associated with any other sites. This form of scar tree is common within the surrounding region. It offers very little educational or research potential. Scar trees, however, continue to slowly decrease in number due to the cultural material being associated with a living organism. Upper Bunberoo ST2 could not be accessed but based on observation during the survey this site has a moderate scientific value at a local level.
Upper Bunberoo ST3	Upper Bunberoo ST3 is a scar tree in good condition and is not associated with any other sites. This form of scar tree has been identified as a canoe tree and is uncommon compared to other forms of scars within the surrounding region. It offers educational or research potential as an example of a canoe tree. Therefore, Upper Bunberoo ST3 has a high scientific value at a local level.
Upper Bunberoo ST4	Upper Bunberoo ST4 is a scar tree in good condition and is not associated with any other sites. This form of scar tree is common within the surrounding region. Scar trees, however, continue to slowly decrease in number due to the cultural material being associated with a living organism. It offers very little educational or research potential. Therefore, Upper Bunberoo ST4 has a moderate scientific value at a local level.
Middle Bunberoo ATF 1	Middle Bunberoo ATF 1 is an isolated ground stone that is made from silcrete and is only a fragment of the original artefact. The artefact does not have characteristics that are unique or rare within the region. Due to the artefact being isolated from other sites it does not provide research or educational potential. Therefore, Middle Bunberoo ATF 1 is considered to be of low scientific significance.
Middle Bunberoo ATF 2*	Middle Bunberoo ATF 2 is an isolated milling slab that has been broken in two. Though milling slabs are not rare within the region, the material and condition of this artefact are not commonly identified within the area. Despite the artefact being isolated from other sites, it does provide research or educational potential through residue and use-wear analysis. Therefore, Middle Bunberoo ATF 1 is considered to be of moderate scientific significance.
Middle Bunberoo SHELL & ST	Middle Bunberoo SHELL & ST is unique in that scar trees are often not identified along side other features. The shell scatter is extensive and analysis of its contents would enable the identification of the molluscs that were eaten and used by the indigenous community. The scar tree is in fair condition and is common for the region. Therefore, Middle Bunberoo SHELL & ST is considered to be of high scientific significance.

Site name	Statement of significance
Middle Bunberoo ST 1*	Middle Bunberoo ST 1 is potentially associated with a wider archaeological complex and has a moderate scientific value at a local level. The scar tree was identified in association with a high number of scar trees located in the vicinity of the study area. Middle Bunberoo ST 1 contains features that provide research and educational potential in an archaeological complex as well as being a representative sample of scar trees in the region.
Middle Bunberoo ST 2*	Middle Bunberoo ST 2 is potentially associated with a wider archaeological complex and has a moderate scientific value at a local level. The scar tree was identified in association with a high number of scar trees located in the vicinity of the study area. Middle Bunberoo ST 2 contains features that provide research and educational potential in an archaeological complex as well as being a representative sample of scar trees in the region.
Middle Bunberoo ST 3*	Middle Bunberoo ST 3 is potentially associated with a wider archaeological complex and has a moderate scientific value at a local level. The scar tree was identified in association with a high number of scar trees located in the vicinity of the study area. Middle Bunberoo ST 3 contains features that provide research and educational potential in an archaeological complex as well as being a representative sample of scar trees in the region.
Middle Bunberoo ST 4	Middle Bunberoo ST 4 is potentially associated with a wider archaeological complex and has a moderate scientific value at a local level. The scar tree was identified in association with a high number of scar trees located in the vicinity of the study area. Middle Bunberoo ST 4 contains features that provide research and educational potential in an archaeological complex as well as being a representative sample of scar trees in the region.
Middle Bunberoo ST 5*	Middle Bunberoo ST 5 is a scar tree in fair condition and is associated with AHIMS Site #46-2-0196. This form of scar tree has been identified as a canoe tree and is uncommon compared to other forms of scars within the surrounding region. It is especially uncommon for a canoe to be made from the bark of black box trees. It offers educational or research potential as an example of a canoe tree. Therefore, Upper Middle Bunberoo ST 5 has a high scientific value at a local level.
Middle Bunberoo ST 6	Middle Bunberoo ST 6 is a scar tree in fair condition and is not currently associated with any other sites. This form of scar tree is common within the surrounding region. It offers very little educational or research potential. Scar trees, however, continue to slowly decrease in number due to the cultural material being associated with a living organism. Upper Middle Bunberoo ST 6 could not be accessed but based on observation during the survey this site has a moderate scientific value at a local level.

Site name	Statement of significance
Middle Bunberoo ST 7	Middle Bunberoo ST 7 is a scar tree in good condition and is not associated with any other sites. This form of scar tree is common within the surrounding region. It offers very little educational or research potential. Scar trees, however, continue to slowly decrease in number due to the cultural material being associated with a living organism. Therefore, Middle Bunberoo ST 7 has a moderate scientific value at a local level.
Upper Bunberoo ST1*	Upper Bunberoo ST1 is a scar tree in fair condition and is not associated with any other sites. This form of scar tree is common within the surrounding region. It offers very little educational or research potential. Scar trees, however, continue to slowly decrease in number due to the cultural material being associated with a living organism. Therefore, Upper Bunberoo ST1 has a moderate scientific value at a local level.
Upper Bunberoo ST2	Upper Bunberoo ST2 is a scar tree in good condition and is not currently associated with any other sites. This form of scar tree is common within the surrounding region. It offers very little educational or research potential. Scar trees, however, continue to slowly decrease in number due to the cultural material being associated with a living organism. Upper Bunberoo ST2 could not be accessed but based on observation during the survey this site has a moderate scientific value at a local level.
Upper Bunberoo ST3	Upper Bunberoo ST3 is a scar tree in good condition and is not associated with any other sites. This form of scar tree has been identified as a canoe tree and is uncommon compared to other forms of scars within the surrounding region. It offers educational or research potential as an example of a canoe tree. Therefore, Upper Bunberoo ST3 has a high scientific value at a local level.
Upper Bunberoo ST4	Upper Bunberoo ST4 is a scar tree in good condition and is not associated with any other sites. This form of scar tree is common within the surrounding region. Scar trees, however, continue to slowly decrease in number due to the cultural material being associated with a living organism. It offers very little educational or research potential. Therefore, Upper Bunberoo ST4 has a moderate scientific value at a local level.

The study area is located within close proximity to numerous water sources, including Lake Victoria, the River Murray and the Darling River. All of these permanent water bodies are an important part in Aboriginal daily life and their Dreamings. As a result, the study area is an important landscape to cultural values and plays an important role in the significance of the area.

Impacts (works sites)

The Proposal would result in impacts to two out of the seven identified Aboriginal sites. The assessment of harm to all of the identified sites are outlined in Table 6-20 and the location of impacted sites, Lake Victoria AS1 and Lake Victoria AS2, are shown in Figure 6-21 and Figure 6-22.

Table 6-20 Assessment of harm

Site name / AHIMS No.	Type of harm	Degree of harm	Consequence of harm
Lake Victoria Locks AS 1	Direct	Total	Total loss of value
Lake Victoria Locks AS 2	Direct	Total	Total loss of value
Lake Victoria Locks Scarred Tree 2	None	None	No loss of value
Lake Victoria Locks Scarred Tree 3	None	None	No loss of value
Lake Victoria Locks Scarred Tree 4	None	None	No loss of value
Lake Victoria Locks Scarred Tree 5	None	None	No loss of value
Lake Victoria Locks Scarred Tree 6	None	None	No loss of value

Impacts would be limited to Lake Victoria AS1 and Lake Victoria AS2, which are both low density artefact scatters of low scientific and cultural significance. The soil surface on which they occur are highly disturbed and therefore it is unlikely that the cultural materials are *in situ.* An Aboriginal Heritage Impact Permit (AHIP) would be obtained to collect and either rebury or relocate these artefacts to a keeping place. It is unlikely that subsurface deposit exists and therefore the impact to the cultural heritage at these two sites is considered low. Given the works sites overlap with an existing MDBA AHIP application for the Lake Victroia scheme the AHIP process will be guided by Heritage NSW.

Lake Victoria Locks Scarred Tree sites would not be impacted for CCB works.

Impacts (waterway)

The Proposal would not result in impacts to any of the fourteen identified Aboriginal sites. The assessment of harm to all of the identified sites are outlined in Table 6-20.

Table 6-21 Assessment of harm (waterway)

Site name / AHIMS No.	Type of harm	Degree of harm	Consequence of harm
Upper Bunberoo ST1*	None	None	No loss of value
Upper Bunberoo ST2	None	None	No loss of value
Upper Bunberoo ST3	None	None	No loss of value
Upper Bunberoo ST4	None	None	No loss of value

Site name / AHIMS No.	Type of harm	Degree of harm	Consequence of harm
Middle Bunberoo ATF 1	None	None	No loss of value
Middle Bunberoo ATF 2*	None	None	No loss of value
Middle Bunberoo SHELL & ST	None	None	No loss of value
Middle Bunberoo ST 1*	None	None	No loss of value
Middle Bunberoo ST 2*	None	None	No loss of value
Middle Bunberoo ST 3*	None	None	No loss of value
Middle Bunberoo ST 4	None	None	No loss of value
Middle Bunberoo ST 5*	None	None	No loss of value
Middle Bunberoo ST 6	None	None	No loss of value
Middle Bunberoo ST 7	None	None	No loss of value
Upper Bunberoo ST1*	None	None	No loss of value
Upper Bunberoo ST2	None	None	No loss of value

WINSW will continue to conslt with Aboriginal stakeholders about the management of Aboriginal cultural heritage within the Proposal area (refer Section 5).

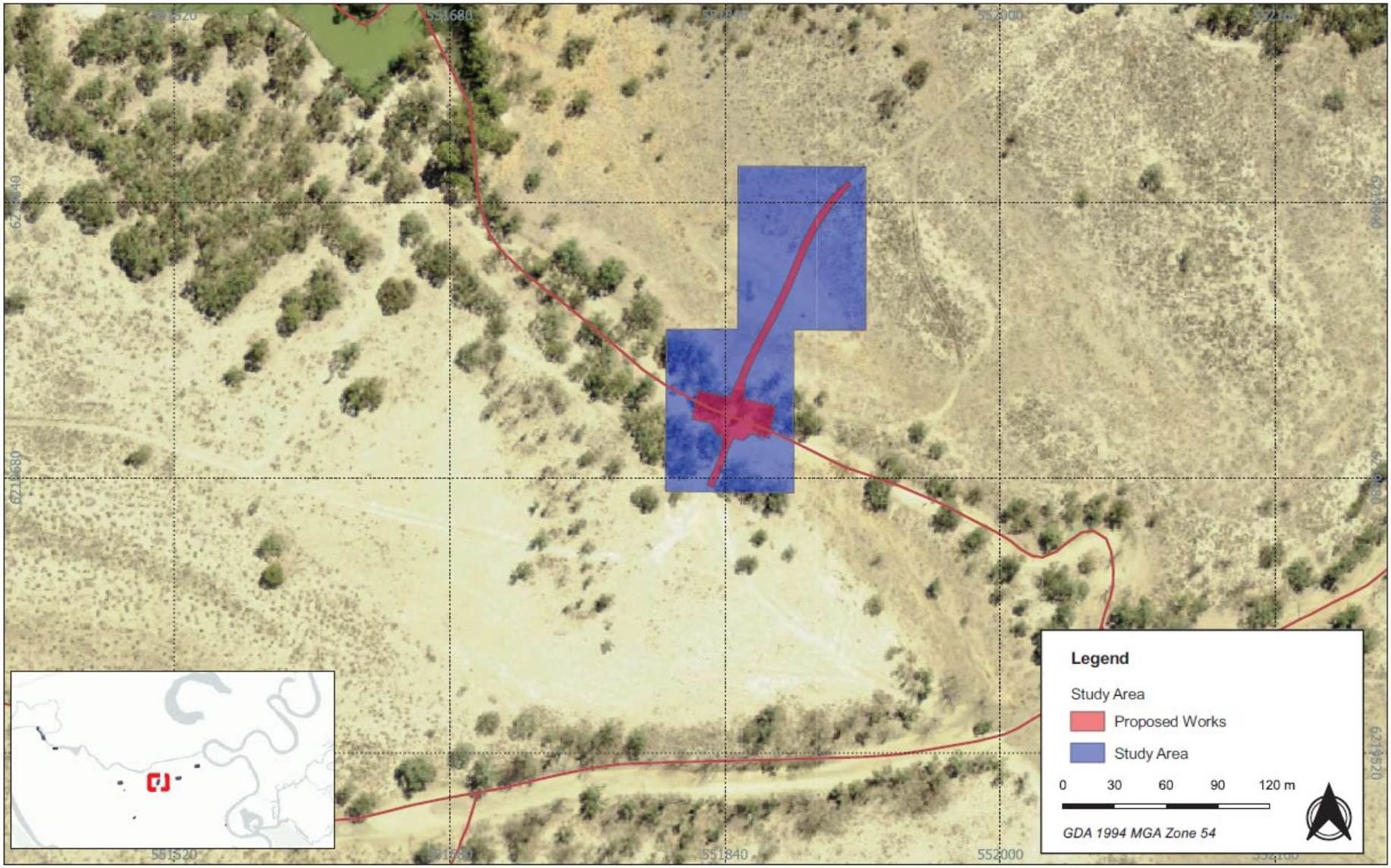

Figure 6-21 Lake Victoria AS1 and AS2 Aboriginal heritage sites near Proposal site 4

21091 - Lake Victoria

Source: NSW LPI Aerial

Drawn by: ARH Date: 2022-05-26

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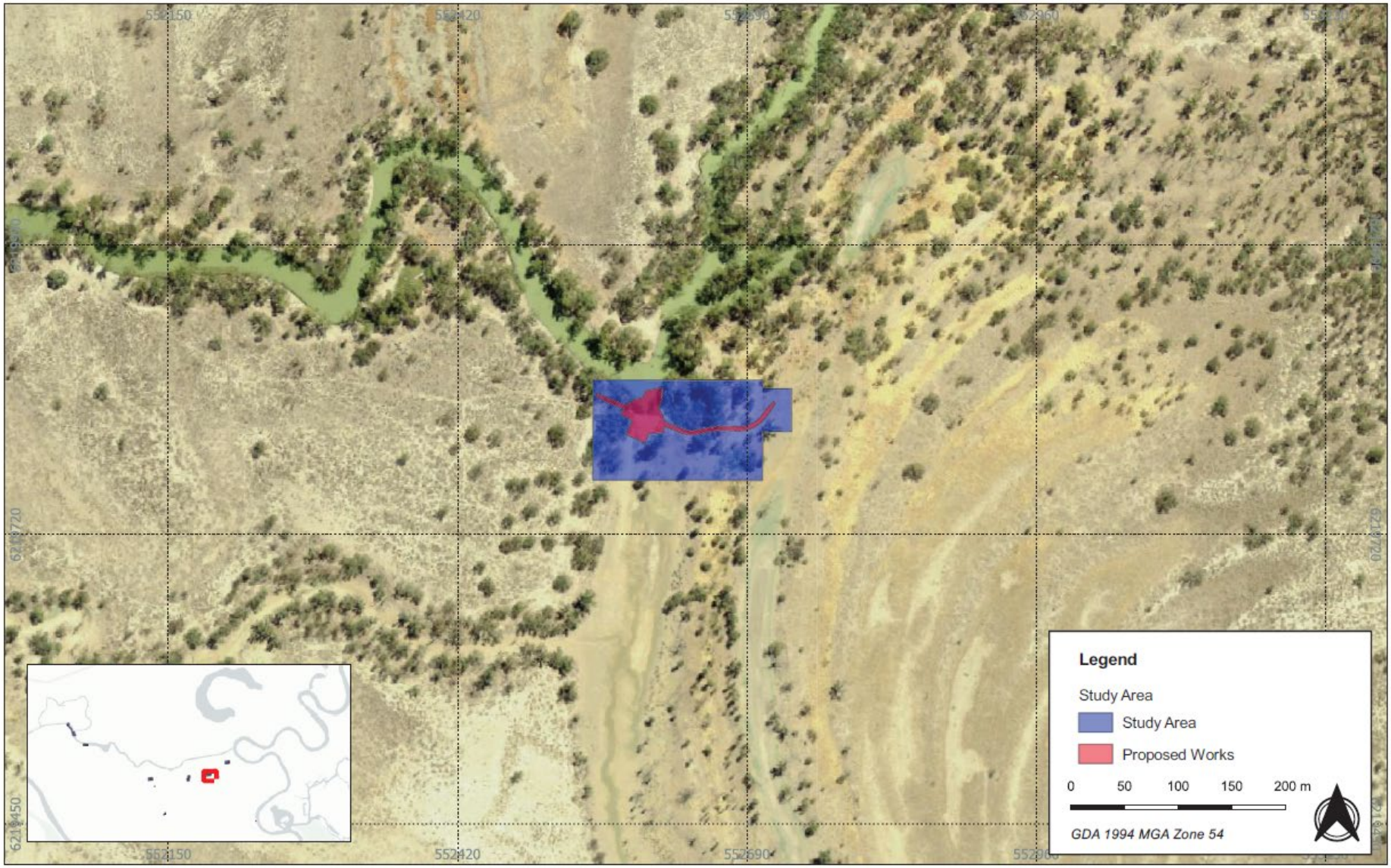

Figure 6-22 Lake Victoria AS1 and AS2 Aboriginal heritage sites near Proposal sites 6

21091 - Lake Victoria

Source: NSW LPI Aerial

Drawn by: ARH Date: 2022-05-26

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Safeguards

Measures proposed to avoid, minimise or manage potential Aboriginal heritage impacts as a result of the Proposal are detailed in Table 6-22.

Table 6-22 Safeguards for Aboriginal heritage

Timing	Impact	Safeguard	Responsibility
Prior to construction	Impact to Lake Victoria Locks AS1 and AS2	An AHIP would be obtained prior to construction to destroy Lake Victoria Locks AS1 and Lake Victoria Locks AS2 at Site 4 and Site 6. The following would be implemented: • Lake Victoria Locks AS1 and Lake Victoria Locks AS2 are collected prior to any works taking place • All Aboriginal objects collected during the archaeological testing and anticipated community collection (under the approved AHIP) will be reburied onsite at the nominated location or taken to a keeping place by the local Traditional Owners or custodians of the land.	WINSW
Prior to construction	Preventing impact to Lake Victoria Locks Scarred Trees	A 'no-go' physical barrier would be erected around Lake Victoria Locks Scarred Trees 2 to 6, with a 3-5 m barrier around the diameter of the tree canopy (or 2 square metre area around the tree if there is no canopy).	Contractor
Construction	Unexpected finds	If unexpected finds occur during any activity within the study area, all works in the vicinity must cease immediately. The find must be left in place and protected from any further harm. Depending on the nature of the find, the following processes must be followed: • If an Aboriginal object is identified, it is a legal requirement under Section 89A of the NPW Act to notify Heritage NSW, as soon as possible. Further investigations and an AHIP may be required prior to certain activities recommencing. • If human skeletal remains are encountered, all work must cease immediately and NSW Police must be contacted, they will then notify the Coroner's Office. Following this, if the remains	Contractor/ WINSW

Timing	Impact	Safeguard	Responsibility
		are believed to be of Aboriginal origin, then the Aboriginal stakeholders and Heritage NSW must be notified.	

6.5. Historic heritage

Existing environment

A desktop search of the following non-Aboriginal heritage registers was carried out on 14 April 2022:

- World Heritage List
- Commonwealth Heritage List
- Register of the National Estate (non-statutory archive)
- NSW State Heritage Register
- Section 170 Heritage and Conservation Register (Sydney Trains, Water NSW, Australian Rail Track Corporation)
- Wentworth LEP.

No listed non-Aboriginal heritage items were identified within the Proposal area.

The two weirs (Carrs 1 and Carrs 2) were constructed in around 1926 as part of the Lake Victoria scheme described in paper by Hope, J (unknown date).

Impacts

There are no listed non-Aboriginal heritage items identified within the Proposal area. Hope (Hope, J. unknown) provides some context around the River Murray Locks being the predominant sites of heritage status/value.

Discussions with the owners of the asset (SA Water) indicated that the two weirs are classified as 'works' under the Murray Darling Basin Agreement. Other works associated with the Lake Victoria Scheme include inlet, control and outlet regulators and associated earthen channel (Frenchmans Creek) and retaining banks / levees. Given the minor nature of the Carrs 1 and Carrs 2 'works' in relation to the broader Lake Victoria Scheme operations they are not considered by SA Water as relics the way that relics are contemplated under the Act.

Interactions with the project Stakeholder Advisory Group also indicates that the existing works are not perceived to be of local heritage value within the community and the important outcome is that the proposed replacement structures will provide a return to natural heritage value while maintaining the same function of the weirs required by the Lake Victoria Scheme.

Construction and operation of the Proposal is unlikely to affect any non-Aboriginal heritage item.

Safeguards

Measures proposed to avoid, minimise or manage potential historic heritage impacts as a result of the Proposal are detailed in Table 6-23.

Table 6-23 Safeguards for historic heritage

Timing	Impact	Safeguard	Responsibility
Construction	Unexpected finds	If unexpected items are discovered during construction, all work will cease in the area. The Contractor will inform the site super visor and Project Manager, and a Historical Archaeologist will be engaged to assess the item's significance. Local Council and the Environment, Energy and Science Group of DPE/NSW Heritage Office will be notified by the Project Manager if required.	Contractor/WINSW

6.6. Topography, geology and soils

The *NSW Locks 8 & 9 SDLAM Geotechnical Investigation Report* (Jacobs & GHD, 2021- see Appendix F) incorporating an Acid Sulfate Soils (ASS) assessment (Jacobs, 2021 Appendix J) was carried out under SA Water direction to inform the 70% and subsequent 100% design. The investigation identifies potential geotechnical impacts from the Proposal and relevant environmental aspects are summarised in this section.

Existing environment

The Project area has a low elevation which ranges between 28 m AHD and 37 m AHD and is characterised by Tertiary and Quaternary sediments deposited from lakes and rivers. The geomorphology of the study area is a complex interplay between the deposition regimes of riverine, alluvial, and lacustrine environments. Sub-surface soil conditions comprise of gravel, clay/sandy clay, and sand in order of decreasing elevation.

Previous reach-scale ASS investigations reported as shown in Table 6-24 by Ecology Associates (Ecology Assoc., 2013 - reference to Table 35, pg 58) sumamrised the overall risk as low noting that there are some sites with potential to discover ASS. The two sites closest to the Project area (but still outside it) are highlighted below.

Table 6-24 Previous acid sulphate assessment (Ecology Associates, 2013)

Wetland	ASS Risk (Shand et al. 2008)	ASS Indicators (Reid et al. 2009)	Sulfidic Sediment (Hall et al. 2006)
Lock 9 Weir Pool			
Wetland 367 Thegoa	n.s.	n.s.	Unlikely to be present
Wetland 1026 Wallpolla Creek	Moderate	n.s.	n.s.
Wetland 643 Purda	Low	soil sulfate >10 mg/L	n.s.
Wetland 696	High	none	n.s.
Wetland 351	Moderate	soil sulfate >10 mg/L sediment pH<4.5	Definitely present
Wetland 351 Nielpo	n.s.	n.s.	Unlikely to be present
Wetland 642	Moderate	soil sulfate >10 mg/L	n.s.
Wetland 220 Darling Anabranch below regulator	Low	soil sulfate >10 mg/L sediment pH<4.5	n.s.
Wetland 3740 Darling Anabranch above regulator	Moderate	n.s.	n.s.
Lock 8 Weir Pool			
Wetland 1014 Capitts Creek	Low	n.s.	n.s.
Wetland 954 Carrs Creek	High	sediment pH<4.5	n.s.
Wetland 757 Big Rigamy	Moderate	sediment pH<4.5	n.s.
Wetland 581 Wangumma	High	none	Probably present

Further work was undertaken to understand the site-specific risks within the construction footprint. The *NSW Locks 8 and 9 Sustainable Diversion Limits Adjustment Mechanism Acid Sulfate Soils Investigation* (Jacobs, 2021) (see Appendix J) found that acid sulfate soils are unlikely to occur within the Project area. The investigation reported a total of 77 primary and four duplicate soil samples were submitted for pH screening (pH_F and pH_{FOX}) analysis and an assessment of the pH screening results against the National Guidance screening criteria found:

- No pH_F results were returned below the actual acid sulfate soils screening criteria (<4 pH units), indicating an absence of ASS
- No pH_{FOX} results were returned below the potential acid sulfate soils screening criteria.

Impacts

Construction

Construction activities associated with each of the Proposal elements are outlined in Chapter 3. Proposed earthworks include stripping topsoil, excavations and placement of fill across the Contractor Activity Zones shown in Figure 3-2 to Figure 3-10.

Soil and rock fill material would be required for the construction of the proposed structures. This material would be sourced both on and off site, with some material potentially reused from demolition of existing structures. Concrete salvaged from demolition of the existing weir structures may be broken down to form part of the erosion protection measures.

Ancillary sites and laydown areas would be established on existing disturbed areas and would not require significant earthworks.

Operation

Operation of the project would not impact topography, geology or soils, outside of any potential hydrology and erosion impacts assessed in Section 6.1 and 0, respectively.

Safeguards

Measures proposed to avoid, minimise or manage potential topography, geology and soils impacts as a result of the Proposal are detailed in Table 6-25.

Table 6-25 Safeguards for topography, geology and soils

Impact	Safeguard	Responsibility	Timing
Acid sulfate soils	Requirement for an acid sulfate soils management plan (ASSMP) would be confirmed after final detailed design. The final 100% detailed design would be reviewed prior to construction to ensure that construction impacts are in-line with the depths of investigation and assumptions outlined in the *NSW Locks 8 & 9 SDLAM Geotechnical Investigation Report* (Jacobs & GHD, 2021) (see Appendix F) including Acid Sulfate Soils (ASS) assessment (Jacobs, 2021).	WINSW	Detailed design

6.7. Traffic and access

Existing environment

Rufus River Road is the nearest public road located about 4.6 kilometres north of the Proposal area. This mostly unsealed road is typical of a rural road, experiencing very low traffic volumes.

- For construction and operation of Sites 2, 4, 6 and 8, access is via one private land owner and also SA Water. Private access is through a land parcel that is part of Moorna Station. Access to the Proposal from Rufus River Road is via existing unsealed access tracks that extend from Lock 8 to the Frenchmans Creek inlet regulator and continue on to the right side of Lock 9 and the various structures on the CCB Creeks. The tracks are located on one private property as well as land owned by SA Water. SA Water already currently uses these access tracks to inspect, maintain and operate the Frenchmans Creek inlet regulator and the various structures on the CCB Creeks as well as to access the right side of Lock 9. It is proposed that access to the work sites for the Proposal would be via these same access tracks in accordance with the existing arrangements

for their use. For the duration of construction, there will be a construction works agreement in place with Moorna Station (only property owner impacted by access).

- Access through SA Water land. As mentioned above, the construction and operation of the Proposal would include the use of current SA Water access tracks on SA Water land.

For Site 9 and Site B, access is via Tar-Ru land which is being addressed as follows:

- Access for construction activities on Tar- Ru is via a propsoed works access agreement with NPWS. It is understood that Barkandji will be required to provide support for the works in order for NPWS to enter into an agreement.
- Ongoing access for operation and maintenance activities, as well as other water management activities outside of the project scope, will be discussed further with a number of affected parties which includes MDBA, SA Water and Barkandji.

Impacts

Construction

Tie-in access tracks would be constructed to provide access between existing access tracks and the proposed new road crossings. A suitable speed limit would be adopted along access tracks as agreed with the relevant landowner and to reduce potential fauna impacts.

Construction vehicles include a 12.5 metre semi-trailer truck, various smaller trucks, excavators (20-30t) and cranes (20 tonne). These vehicles would utilise main roads from Wentworth, and the access tracks to the Proposal sites. There is expected to be an average of six truck movements per day. The rural road network has a large capacity to accommodate construction vehicles, and so traffic impacts during construction would be negligible. No roads closures would be required for the works. Construction vehicles would park within the Proposal sites.

Operation

Operation of the Proposal is expected to require one passenger vehicle per day. The impact of this on the rural road network would be negligible.

The impacted roads are designated access tracks through land owned by private landholders (Moorna Station), SA Water, as well as lands overseen by the Minister administering the NPW Act.

Safeguards

Private landowners will be consulted regarding specific access requirements and consents acquired where access to or through private property boundaries is required for the proposed works.

6.8. Waste, contamination, and hazards

Existing environment

A search of the NSW Environment Protection Authority (EPA) Contaminated sites register was undertaken on 14 April 2022 to identify records within the Wentworth Council LGA. No contaminated sites were found within the 200 metres of the Proposal.

Land surrounding the Proposal area is predominately used for forestry and otherwise not developed. The land use suggests a low likelihood of site contamination. A site walkover inspection completed by ecologists between 1 and 3 December 2020 as part of the biodiversity assessment did not find any signs of contamination. Carrs weirs No.1 and No.2, which are proposed to be demolished and replaced, are not known to contain asbestos.

The Proposal sites are not located within Bushfire Prone Land or vegetation buffer (buffer from bushfire vegetation category classes 1, 2 and 3) according to the *Wentworth Local Environmental Plan 2011*.

Impacts

Construction

Small quantities of waste may be generated during construction. Waste streams would include:

- Green waste from cleared vegetation
- Concrete and rock riprap materials from removal of existing structures
- Excess fill material from any excavation of soil and fill embankments
- Oil, grease, and other liquid waste from the maintenance of construction plant and equipment
- Dried surplus concrete and minor quantities of other surplus construction materials such as timber, scrap metal, paints, glues and other incidental chemicals used in construction
- General wastes and sewage from ancillary facilities and offices

Hazardous wastes are not expected to be generated during construction of the Proposal, and the work would not require handling of hazardous chemicals or dangerous goods.

Waste management for the Proposal would be based on the waste management hierarchy established by the objectives of the *Waste Avoidance and Resource Recovery Act 2001*. This includes reducing the amount of waste produced as much as possible, maximising waste reuse, and disposing waste as the last option and doing so appropriately.

A site assessment of salvaged concrete from demolition of existing structures shall be conducted to determine suitability for reuse (with the exception of areas below the top of bank (ie instream)). The Proposal would further minimise construction waste through:

- Sustainable selection of construction materials
- Detailed estimation and accurate ordering of quantities of materials required
- Balancing earthworks to minimise the demand for imported fill or the need to export/dispose of excess spoil material

Localised contamination from accidental spills or leaks of fuels, oils and chemicals (such as hydraulic oils) during construction is considered unlikely but possible and the risk would be managed by suitable safeguards.

Operation

Operation and maintenance of the Proposal would generate negligible quantities of waste and pose a negligible contamination risk.

No significant operational hazards are presented by the Proposal structures. The *NSW Locks 8 and 9 SDLAM Project 70% Detailed Design Report* (Jacobs & GHD, August 2021) notes that the peak of a flood wave resulting from the proposed regulator structures would be a similar impact to water flow when the regulator gates are fully opened and remains within creek banks.

Safeguards

Measures proposed to avoid, minimise or manage potential waste, contamination, and hazards impacts as a result of the Proposal are detailed in Table 6-26.

Table 6-26 Safeguards for waste, contamination, and hazards

Timing	Impact	Safeguard	Responsibility
Construction	Contamination	Site specific controls to be developed to manage the risk of accidental spills or leaks of fuels, oils and chemicals (such as hydraulic oils) during construction. This would be in accordance with the CEMP (including a flood response plan).	Contractor
Preconstruction	Waste	A waste management plan would be developed to detail how waste generated during the works would be managed and disposed of.	Contractor
Construction	Waste	All construction and operation waste would be classified in accordance with the *Waste Classification Guidelines* (EPA, 2014) and would be disposed of at licensed waste receiving facilities.	Contractor
Construction	Waste	Only suitably cleaned and appropriately classified concrete, devoid of hazardous materials to be reused on site, following a suitability assessment.	Contractor
Construction	Hazard	Emergency contacts and response procedures will form part of the CEMP and site inductions.	Contractor

Timing	Impact	Safeguard	Responsibility
Operation	Hazard	Emergency contacts and response procedures will form part of the SA Water operation and maintenance procedures which will be incorporated into an O&M manual.	SA Water

6.9. Visual

Existing environment

The Proposal area and surrounds are typical of a rural setting, with land users generally limited to Traditional Owners, farmers and inlet/weir operators. The nearest sensitive receivers are located about 4.3 kilometres from the Proposal sites.

Existing infrastructure at the Proposal sites is described in Section 2.3 and is generally low profile (in the case of existing earth and rock road crossings at sites 4, 6, 9 and B) or largely screened by surrounding trees (in the case of Carrs weirs No. 1 and 2 at sites 2 and 8 respectively).

Impacts

Construction

During construction, there would be temporary visual amenity impacts at each of the sites due to the presence of construction equipment and vehicles. Visual impacts during construction would be temporary in nature and are considered minor due to the lack of sensitive receivers.

Operation

Proposed replacement infrastructure is described in Chapter 3. The proposed structures made of concrete, steel and rock riprap would only be visible from nearby and not visible to any sensitive receivers. Visual impact is therefore considered negligible.

The proposed earth fill causeway and realigned sections of access track would be low profile and blend in with the surrounding environment such that their visual impact would also be negligible.

Safeguards

There are no specific safeguards proposed to address negligible visual impacts as a result of the Proposal.

6.10. Property and land use

Existing environment

Land ownership and zoning near the Proposal is shown in Figure 6-23 and Figure 6-24 respectively and summarised in Table 6-27.

Access to the Proposal sites from the nearest public road, Rufus River Road, is via existing access tracks that extend from Lock 8 to the Frenchmans Creek inlet regulator and continue to the right side of Lock 9 and the various structures on the CCB Creeks. The tracks are located on private property as well as land owned by SA Water. SA Water currently uses these access tracks to inspect, maintain and operate the Frenchmans Creek inlet regulator and the various structures on the CCB Creeks as well as to access the right side of Lock 9. It is proposed that access to the Proposal sites would be via these same access tracks in accordance with the existing arrangements for their use.

Table 6-27 Land ownership and zoning near the Proposal

Site [1]	Location	Lot and DP	Ownership	Zoning
2	Carrs weir No. 1	Lot 1 DP762331	Minister for River Murray SA – SA Water	SP2 – Infrastructure (Water Supply System)
4	Off Carrs Creek			
6	Off Carrs Creek			
8	Carrs weir No. 2			
9	Bunberoo Creek	Lot 775 DP1184283	Minister administering the NSW NPW Act (Tar-Ru Lands)	RU3 – Forestry
B	Mike's Runner weir	Lot 775 DP1184283	Minister administering the NSW NPW Act (Tar-Ru Lands)	RU3 – Forestry
10	Lake Victoria Inlet Regulator floodrunner	Lot 24 DP756181	Moorna Station	RU1 – Primary production
		Lot 47 DP191790	Minister for River Murray SA - SA Water	SP2 – Infrastructure (Water Supply System)

Notes: [1] Site ID relates to the *NSW Locks 8 and 9 SDLAM Project 70% Detailed Design Report* (Jacobs & GHD, August 2021) and are not necessarily sequential for the Proposal.

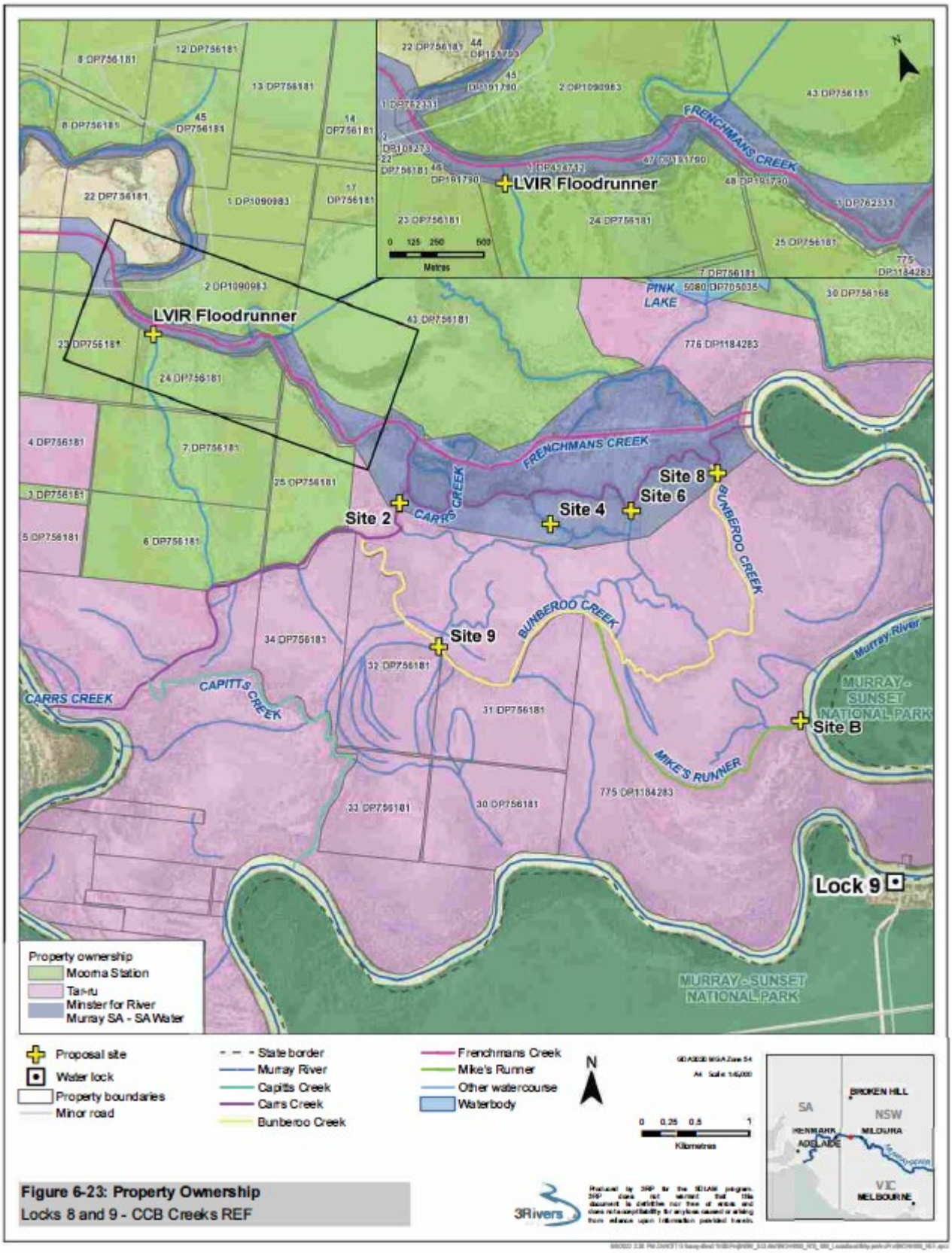

Figure 6-23: Property Ownership
Locks 8 and 9 - CCB Creeks REF

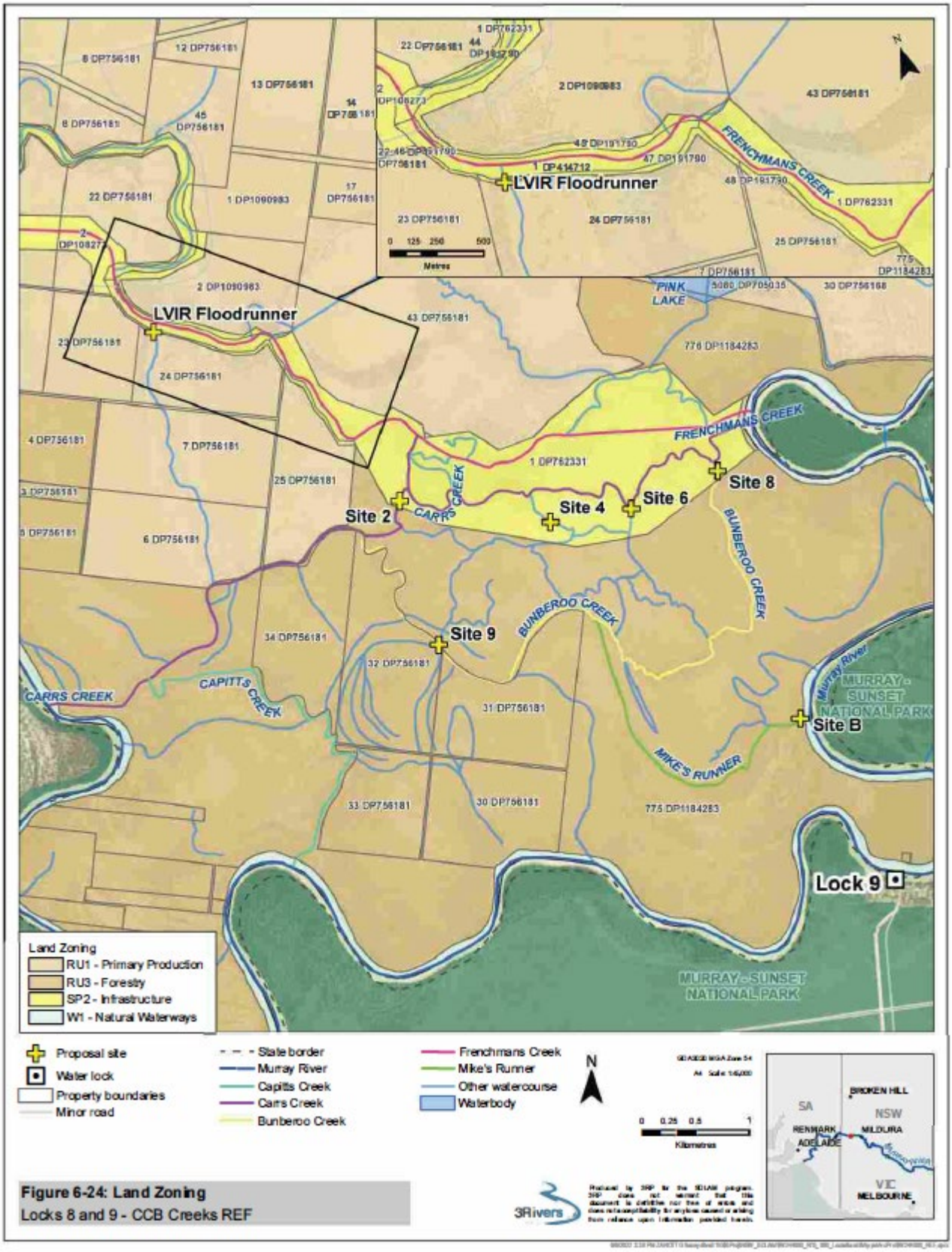

Figure 6-24: Land Zoning
Locks 8 and 9 - CCB Creeks REF

Impacts

Bunberoo Creek bridge (Site 9) and Mike's Runner weir (Site B) are located within National Park (Tar-Ru lands). Tar-Ru lands are due to be transferred to Barkandji Native Title Aboriginal Corporation free of any easements in accordance with Section 10(1) of the *National Park Estate (Riverina Red Gum Reservations) Act 2010*. Following the transfer, the land will be managed by the Barkandji Maraura Elders Council (BMEC).

NSW Government is currently in the process of transferring Tar-Ru lands to the Barkandji Native Title Prescribed Body Corporate (PBC). This process is ongoing and currently a date for official handover is unknown. In the interim, National Parks and Wildlife Service (NPWS) has confirmed that it is not legally able to implement any encumbrances on the land (e.g. easements). Approval of any changes requires agreement from both NPWS and Barkandji Native Title PBC.

Nominated Barkandji representatives have been involved in ongoing Project consultation (refer Section 5.1) and WINSW has been working with the Barkandji Board to progress an agreement (potentially to be an Indigenous Land Use Agreement (ILUA)) specific to the native title implciations of the Project.

The site of the Proposal was the subject of a much larger native title claim by Barkandji Native Title Group Aboriginal Corporation. The claim (Barkandji Traditional Owners #8 (Part A), National Native Title Tribunal file no. NCD2015/001) was determined on 16 June 2015 with native title determined to exist both exclusively and non-exclusively across parts of the claim area. The Tar-Ru lands were excluded from the claim and native title was determined to have been extinguished on land or waters on which there is public works (including public roads) which were constructed or established prior to 23 December 1996. As there are existing public works (including drainage facilities, weirs, other devices for management of water flows and public utility access tracks) established prior to 1996 at the Proposal sites, the Proposal is not affected by this native title claim.

Safeguards

There are no specific safeguards proposed to address property and land use impacts as a result of the Proposal. Consultation with landowners will continue, as described in Section 5.5.

6.11. Socio-economic

Existing environment

The Project is situated within the Lower Murray Catchment of the Murray-Darling Basin. The population of the catchment is sparse, with few towns in the region. There are pastoral grazing holdings to the north of the River Murray and large dryland cropping enterprises to the south. The nearest town to the Proposal is Wentworth, located approximately 33 kilometres east, which has a population of 1,221 (ABS, 2016). There are several medium sized towns established on the banks of the River Murray which support a diverse horticultural industry and dryland agriculture. Tourism based around the river environment and water activities is important to the regional economy.

The catchment is the traditional land of many First Nations groups including the Barkindji, Maraura, Muthi Muthi and Nyeri Nyeri First Nations. The River Murray and floodplains that flow through the catchment have great spiritual significance to the First Nations groups.

Impacts

Construction

There may be infrequent visits by Traditional Owners to land near the Proposal area. Local amenity impacts from construction noise and dust may cause some discomfort during these visits. Traditional Owners would be notified of the timing of construction works so impacts can be avoided where possible.

There are no permanent residents near the Proposal area which would experience amenity impacts during construction.

Construction of the Proposal may provide temporary economic benefits to Wentworth and other local towns in the Lower Murray Catchment through the sourcing of local jobs and supplies. Construction of the Proposal is unlikely to significantly affect local tourism.

Operation

The Lock 8 and 9 weir pool manipulation works would be the major contributor to any impacts to agriculture (hydrology, groundwater and salinity impacts) related to the Project, as described in Section 6.1.

Operation of the Locks 8 and 9 Project including the Proposal would restore flows and connectivity within the CCB Creeks system. This would increase the diversity and quality of aquatic habitat within the creek system as well as downstream. This impact would enhance amenity and fishing conditions and improve bird breeding events. Traditional Owners and other visitors would benefit from these positive outcomes, and there could be flow on tourism benefits for the region.

Safeguards

There are no specific safeguards proposed to address negligible socio-economic impacts as a result of the Proposal. Ongoing consultation will be carried out with water users downstream of Lock 8 and Lock 9 (refer Section 5.5).

6.12. Air quality

Existing environment

Air quality in the Proposal area is typically very good due to its rural setting. The nearest sensitive receivers are located about 4.3 kilometres from the Proposal.

Impacts

Construction

Dust may be generated by construction activities such as:

- Vegetation clearing
- Rock and concrete crushing
- Earthworks including stripping topsoil, excavations and placement of fill
- Materials handling and storage
- Ancillary facilities operations and construction traffic

Air quality impacts would be localised and temporary and no sensitive receivers would be affected.

Operation

There would be no impacts to air quality during the operation of the Proposal.

Safeguards

Measures proposed to avoid, minimise or manage potential air quality impacts as a result of the Proposal are detailed in Table 6-28.

Table 6-28 Safeguards for air quality

Timing	Impact	Safeguard	Responsibility
Construction	Air quality	Dust suppression would be applied by means of water spray during any construction activities causing substantial dust.	Contractor

6.13. Noise and vibration

Existing environment

Background noise levels are typical of a rural environment and are considered low. There nearest sensitive receivers are about 4.3 kilometres from the Proposal.

Impacts

Construction

There may be localised and temporary noise impacts during construction, however, construction noise would be inaudible at the nearest sensitive receivers.

SA Water have confirmed that construction of the Proposal will take place during standard construction hours. These are outlined in the Construction Noise and Vibration Guideline (CNVG) (NSW Roads and Maritime Service, 2016) as follows:

- Monday to Friday 7 am to 6 pm
- Saturday 8 am to 1 pm
- No work on Sundays or public holidays

Operation

There are no motors or ongoing operational noise sources associated with the proposed new flow control structures, fishways and bridges.

Safeguards

There are no specific safeguards proposed to address negligible noise and vibration impacts as a result of the Proposal. Standard construction practices would be followed.

6.14. Cumulative

Existing environment

The Proposal forms part of the overall Locks 8 and 9 Project, which aims to restore and enhance river habitat across the interconnected Frenchmans Creek and CCB Creek System. The other works proposed as part of the Locks 8 and 9 Project include changes to the operating principles for locks 8 and 9, and a fishway around the inlet regulator between Frenchmans Creek and Lake Victoria. Lock 8 is located downstream approximately 15 kilometres west of the Proposal sites, and lock 9 is located upstream approximately two kilometres south-east of the Proposal sites. The Lake Victoria inlet regulator is approximately 0.5 kilometre north-west of the proposed floodrunner causeway.

There are no other known projects within the Project area.

Impacts

Construction

Given the relatively low environmental impacts associated with the Proposal, and the remote locations of the Project elements, any potential cumulative impacts during construction would be negligible.

Operation

The *Interim operating plan for Carrs, Capitts and Bunberoo Creeks for the commissioning phase of Carrs 1 and 2 regulators* (Alluvium, 2022) (see Appendix E) has been developed to guide operation of the proposed Carrs weirs No. 1 and No.2 regulators to optimise instream habitat conditions for native fish within the broader Lock 8 and 9 system operational settings. A monitoring and evaluation

program targeting these key inputs and outputs will enable ongoing improvement to the operation of the system through adaptive management.

Safeguards

Measures proposed to avoid, minimise or manage potential cumulative impacts as a result of the Proposal are detailed in Table 6-29.

Table 6-29 Safeguards for cumulative impacts

Timing	Impact	Safeguard	Responsibility
Construction	Cumulative	Construction of the various components of the NSW Lock 8 and 9 Project, including infrastructure within the CCB Creeks system, would be coordinated by WINSW to minimise any potential cumulative impacts.	WINSW

7. Environmental management

7.1. Construction environmental management

A number of safeguards have been proposed in this REF to avoid, minimise or manage potential environmental impacts of the Proposal. Should the Proposal proceed, these safeguards will be incorporated into the detailed design and applied during construction and operation of the Proposal.

A Construction Environmental Management Plan (CEMP) will be prepared prior to construction to outline site specific environmental management measures and performance targets that will be adopted during construction of the Proposal. The CEMP will detail how the safeguards proposed in this REF will be implemented, including who will be responsible for their implementation and when.

The CEMP will be a 'live' working document, subject to ongoing change and updated as necessary to respond to site specific developments and outcomes of construction activities.

7.2. Operational environmental management

As discussed in Section 3.2, an interim Operating Plan has been prepared to inform the initial commissioning phase of the new Carrs weir No.1 and Carrs weir No.2 regulators. Once construction works have been completed and the system has been in operation through a full annual cycle, a monitoring and evaluation program will enable ongoing improvement to the operation of the system through adaptive management. In the case of the Proposal not achieving the intended environmental benefits, measures would be implemented to improve the performance of the CCB Creeks system in doing so. Outcomes of monitoring system behaviour, ecological response and identified risks, along with progressed governance arrangements will inform a revised and updated CCB operating plan.

Further, as described in Appendix L, an Ecological Monitoring Plan has been prepared that proposes monitoring arrangements for the CCB Creeks system during commissioning and operation. The Ecological Monitoring Plan is intended to provide a validation process for the design approach that has been adopted and will provide a framework to identify any issues that need to be addressed as part of commissioning.

Additionally, a number of safeguards have been proposed in this REF to avoid, minimise or manage potential environmental impacts during operation of the Proposal. These are summarised in Table 7-1.

7.3. Summary of safeguards

A summary of all measures proposed to avoid, minimise or manage potential environmental impacts of the Proposal, as identified throughout Chapter 6, are detailed in Table 7-1.

Table 7-1 Summary of safeguards

Timing	Impacts	Safeguards	Responsibility
Detailed design	Erosion and sedimentation	Final detailing of rock erosion protection will be performed for the next design deliverable - 100% design.	WINSW
Detailed design	Acid sulfate soils	Requirement for an acid sulfate soils management plan (ASSMP) would be confirmed after final detailed design. The final 100% detailed design would be reviewed prior to construction to ensure that construction impacts are in-line with the depths of investigation and assumptions outlined in the *NSW Locks 8 & 9 SDLAM Geotechnical Investigation Report* (Jacobs & GHD, 2021) (see Appendix F) including Acid Sulfate Soils (ASS) assessment (Jacobs, 2021).	WINSW
Prior to construction	Water quality	Baseline water quality data would be established in Carrs Creek prior to construction. This will allow more accurate assessment and management of potential impacts during construction.	WINSW
Prior to construction	Aquatic fauna	A dewatering plan will be prepared for temporary works associated with the construction of the new Carrs weir No. 1 regulator to avoid potential impacts to aquatic fauna such as fish stranding and blackwater events.	Contractor / WINSW
Prior to construction	Aquatic fauna	Construction activities with direct contact to the waterway (sites 6 and 10) are not to take place at sites which have identified spawning habitat for fish species during breeding season (spring and summer).	Contractor / WINSW
Prior to construction	Aquatic habitat	Permission will be gained from NSW DPI – Fisheries prior to removal and relocation of in-stream snags	Contractor / WINSW

Timing	Impacts	Safeguards	Responsibility
Prior to construction	Vegetation clearing	The limits of the assessed clearing area and Contractor Activity Zone will be clearly marked on-site.	Contractor
Prior to construction	Impact to Lake Victoria Locks AS1 and AS2	An AHIP would be obtained prior to construction to salvage / destroy Lake Victoria Locks AS1 and Lake Victoria Locks AS2 at Site 4 and Site 6. The following would be implemented: • Lake Victoria Locks AS1 and Lake Victoria Locks AS2 are collected prior to any works taking place All Aboriginal objects collected during the archaeological testing and anticipated community collection (under the approved AHIP) will be reburied onsite at the nominated location or taken to a keeping place by the local Traditional Owners or custodians of the land.	WINSW
Prior to construction	Preventing impact to Lake Victoria Locks Scarred Trees	A 'no-go' physical barrier would be erected around Lake Victoria Locks Scarred Trees 2 to 6, with a 3-5 metre barrier around the diameter of the tree canopy (or 2 square metre area around the tree if there is no canopy).	Contractor
Prior to construction/Construction	Traffic and access	Private landowners will be consulted and consent acquired regarding specific access requirements where access to or through private property boundaries is required for the proposed works.	WINSW/Contractor
Construction	Aquatic fauna	Implement regular inspections of adjacent waterways to detect and mitigate impacts to the aquatic environment.	Contractor/WINSW
Construction	Erosion and sedimentation	Erosion and sediment controls would be established prior to commencement of construction activities (including vegetation clearing).	Contractor

Timing	Impacts	Safeguards	Responsibility
Construction	Aquatic habitat	Degradation of native riparian vegetation along NSW water courses is a listed as a KTP under the FM Act Disturbance to riparian vegetation and snags would be limited to the assessed clearing areas and avoided wherever possible.	Contractor
Construction	Water quality	Site specific controls to be developed to manage the risk of accidental spills or leaks of fuels, oils and chemicals (such as hydraulic oils), or concrete, during construction. This would be in accordance with the CEMP.	Contractor
Construction	Water quality	Degradation of native riparian vegetation along NSW water courses is listed as a KTP under the FM Act. Stockpiles will not be placed within 20 m of creek channels and will be covered when not in use to prevent sediment runoff to ensure impacts to aquatic habitats and riparian vegetation are minimised.	Contractor
Construction	Erosion and sedimentation	Disturbed areas will be revegetated with endemic riparian and floodplain species or otherwise stabilised at the completion of construction.	Contractor
Construction	Vegetation clearing	During clearing and excavation, topsoil will be retained and stored for reuse during site rehabilitation. Stockpiles are to be identified and managed in accordance with the CEMP.	Contractor

Timing	Impacts	Safeguards	Responsibility
Construction	Habitat	Habitat trees and other habitat features (e.g. nests, logs and snags) will be identified and marked during a pre-clearing survey carried out within 48 hours of the commencement of clearing activities. Habitat trees and other habitat features will be cleared adopting the following 'soft-felling' techniques: • All habitat trees and other habitat features will be inspected prior to clearing and any fauna relocated nearby (subject to availability of suitable habitat). • Before felling, habitat trees will be knocked with a machine to alert any animals that may be inside, and fauna given time to escape. • The tree will then be felled as carefully as practical, with hollow sections cut and lowered to the ground. • The tree is to be inspected once on the ground and any animals relocated nearby (subject to availability of suitable habitat). If an animal cannot be captured the section of tree will be left intact at the site. • Any injured animals will be taken to a veterinarian or wildlife carer. • Hollows will be retained for placement within retained vegetation or reuse during site rehabilitation.	Contractor
Construction	Habitat	Compensatory habitat in the form of nest boxes will be provided at a ratio 1:1 per hollow removed. Nest boxes will be placed in comparable habitat.	SA Water / Contractor
Construction	Spread of weeds	Vegetation clearing and disposal will be carried out in a manner that prevents the spread of existing weed species.	Contractor
Construction	Pest control	Putrescible waste from lunch sheds and the like will be stored in inaccessible bins and disposed off-site regularly to prevent pests.	Contractor

Timing	Impacts	Safeguards	Responsibility
Construction	Fauna	Construction vehicles movements will be defined in a site access plan which could include a limitation to access site during daytime only and a speed limit implemented to reduce the risk of vehicle strike to fauna.	Contractor
Construction	Unexpected finds	If unexpected finds occur during any activity within the study area, all works in the vicinity must cease immediately. The find must be left in place and protected from any further harm. Depending on the nature of the find, the following processes must be followed: • If an Aboriginal object is identified, it is a legal requirement under Section 89A of the NPW Act to notify Heritage NSW, as soon as possible. Further investigations and an AHIP may be required prior to certain activities recommencing. • If human skeletal remains are encountered, all work must cease immediately and NSW Police must be contacted, they will then notify the Coroner's Office. Following this, if the remains are believed to be of Aboriginal origin, then the Aboriginal stakeholders and Heritage NSW must be notified.	Contractor/WINSW
Construction	Unexpected finds	If unexpected items are discovered during construction, all work will cease in the area. The Contractor will inform the site super visor and Project Manager, and a Historical Archaeologist will be engaged to assess the item's significance. Local Council and the Environment, Energy and Science Group of DPE/NSW Heritage Office will be notified by the Project Manager if required.	Contractor/WINSW

Timing	Impacts	Safeguards	Responsibility
Construction	Contamination	Site specific controls to be developed to manage the risk of accidental spills or leaks of fuels, oils and chemicals (such as hydraulic oils) during construction. This would be in accordance with the CEMP (including a flood response plan).	Contractor
Construction	Waste	All construction and operation waste would be classified in accordance with the *Waste Classification Guidelines* (EPA, 2014) and would be disposed of at licensed waste receiving facilities.	Contractor
Construction	Hazard	Emergency contacts and response procedures will form part of the CEMP and site inductions.	Contractor
Construction	Air quality	Dust suppression would be applied by means of water spray during any construction activities causing substantial dust.	Contractor
Construction	Cumulative	Construction of the various components of the NSW Lock 8 and 9 Project, including infrastructure within the CCB Creeks system, would be coordinated by WINSW to minimise any potential cumulative impacts.	WINSW
Operation	Hydrology	Once the Proposal structures have been in operation through an appropriate operational cycle, the CCB Operating Plan will be updated taking into account system monitoring results, identified operating risks and ecological response.	WINSW / SA Water
Operation	Long-term salinity impacts	Long-term salinity impacts from the changed operation of Lock 8 and 9 and the CCB Creeks will be assessed under Schedule B to the MDB Agreement, and if required the salinity impacts will be recorded in the Salinity Registers.	WINSW

Timing	Impacts	Safeguards	Responsibility
Operation	Erosion and sedimentation	Erosion and sediment controls, including semi-permanent controls along the creek bed and bank as required, will be maintained post construction until disturbed areas are stabilised.	Contractor / SA Water
Operation	Erosion and sedimentation	Sites identified with higher potential for erosion will be monitored in CCB Creeks following commissioning and operation of the Carrs weir No.1 and Carrs weir No.2 regulators with particular focus on the confluence of the two creeks to determine if additional erosion controls are required.	SA Water
Operation	Monitoring flow	Daily discharge will be monitored based on measured water levels and gate settings. Gate position will be set in accordance with the Operating Plan.	SA Water
Operation	Water quality	Site environmental management, inclusive of spill response measures, will be in accordance with broader SA Water O&M and environmental management procedures for River Murray Operations.	SA Water
Operation	Hazard	Emergency contacts and response procedures will form part of the SA Water operation and maintenance procedures which will be incorporated into aan O&M manual	SA Water

8. Conclusion

8.1. Justification

In the lower River Murray, river regulation and the dominance of slow-flowing weir pool habitats has reduced in-stream habitat quality and hydraulic diversity for native fish. The NSW Department of Planning and Environment are proposing the NSW Locks 8 and 9 Project as part of the overall Sustainable Diversion Limit Adjustment Mechanism (SDLAM) works in the lower River Murray system. The NSW Locks 8 and 9 Project includes:

- Weir pool manipulation of Locks 8 and 9
- Connectivity and permanent flowing water for existing Carrs, Capitts and Bunberoo Creeks (the CCB Creeks system)
- A fishway around the inlet regulator between Frenchmans Creek and Lake Victoria.

The CCB Creeks Proposal, as part of the NSW Locks 8 and 9 Project, seeks to restore flows, connectivity and a diverse hydrodynamic regime within the CCB Creeks system. This would in turn increase the diversity and quality of aquatic habitat, promote fish populations by providing regionally important spawning and nursery areas, and support bird breeding events through habitat and food provision.

Potential environmental impacts of the Proposal have been identified and assessed in Chapter 6 and found to be minor or insignificant.

Required native vegetation removal would be limited and over time it is expected that vegetation will regenerate in areas cleared during construction. The Proposal is unlikely to significantly impact threatened species, populations, ecological communities or migratory species.

Safeguards specific to the Proposal and the Proposal sites have been developed to avoid, minimise or manage these potential impacts.

The minor potential environmental impacts of the Proposal are outweighed by the broader, long-term benefits of the Proposal and the Proposal is considered to be in the public interest.

8.2. Objectives of the EP&A Act

A review of the Proposal's consistency with the objectives of the *Environmental Planning and Assessment Act 1979* (EP&A Act) is presented in Table 8-1. The Proposal is found to be consistent with the EP&A Act.

Table 8-1 Consideration of the objectives of the EP&A Act

Objective	Proposal response
To promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources.	The key objectives of the Proposal are about delivering improved environmental outcomes for the CCB Creeks system, as discussed in Section 2.1. This is also expected to deliver positive outcomes for the local community, with negligible adverse socio-economic impacts, as described in Section 6.11.
To facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment.	This REF comprehensively assesses potential environmental impacts of the Proposal, including potential socio-economic impacts, and has found them to be primarily positive. Potential adverse environmental impacts are minor or insignificant.
To promote the orderly and economic use and development of land.	The Proposal is not expected to significantly affect land use in the region. Agreement from both NPWS and Barkandji Native Title Aboriginal Corporation will be obtained prior to construction of Bunberoo Creek bridge (Site 9) and Mike's Runner weir (Site B) on Tar-Ru lands.
To promote the delivery and maintenance of affordable housing.	N/A
To protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats.	Design has sought to minimise impacts. A comprehensive biodiversity assessment considering aquatic and terrestrial biodiversity has been completed (refer to Sections 6.2 and 6.3) and found that the Proposal is unlikely to have a significant impact on threatened species, populations, ecological communities and migratory species.
To promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage).	Potential impacts to Aboriginal heritage and historic heritage have been assessed in Sections 6.4 and 6.5 respectively. An Aboriginal Heritage Impact Permit (AHIP) would be obtained prior to construction to destroy Lake Victoria Locks AS1 and Lake Victoria Locks AS2 at Site 4 and Site 6.
To promote good design and amenity of the built environment.	Potential visual impacts of the Proposal area assessed in Section 6.9 and were found to be negligible.
To promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants.	N/A

Objective	Proposal response
To promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State.	As described in Section 1 and Section 4 of this REF, the Proposal would not require approval from the Commonwealth government. The Proposal is unlikely to significantly impact on matters of national environmental significance (MNES) including nationally listed threatened species, ecological communities and migratory species, or the environment of Commonwealth land.
To provide increased opportunity for community participation in environmental planning and assessment.	Completed and ongoing community and stakeholder consultation is described in Section 5, and this REF will be placed on public display for information once determined by NSW Department of Planning.

8.3. Ecological sustainable development

A review of the Proposal's consistency with the four key principles of ecologically sustainable development (ESD), as defined in Clause 7 of Schedule 2 of the Environmental Planning and Assessment Regulation 2000, is presented in Table 8-2. The Proposal is found to be consistent with the key principles of ESD.

Table 8-2 Consideration of the key principles of ecologically sustainable development

Principle of ESD	Proposal response
The precautionary principle This principle states: 'if there are threats of serious or irreversible damage, lack of scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation'	The key objectives of the Proposal are about delivering improved environmental outcomes for the CCB Creeks system, as discussed in Section 2.1. This REF comprehensively assesses potential environmental impacts of the Proposal, including potential socio-economic impacts, and has found them to be primarily positive. Potential adverse environmental impacts are minor or insignificant.
Intergenerational equity This principle states: 'the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations'.	
Conservation of biological diversity and ecological integrity This principle states: 'the diversity of genes, species, populations and communities, as well as the ecosystems and habitats to which they belong, must be maintained and improved to ensure their survival'.	A comprehensive biodiversity assessment considering aquatic and terrestrial biodiversity has been completed (refer to Sections 6.2and 6.3) and found that the Proposal is unlikely to have a significant impact on threatened species, populations, ecological communities and migratory species, and residual biodiversity impacts are low.

Principle of ESD	Proposal response
Improved valuation, pricing and incentive mechanism This principle is defined as: 'Improved valuation, pricing and incentive mechanisms, namely, that environmental factors should be included in the valuation of assets and services, such as: i. polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement, ii. the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste, iii. environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems'.	As discussed in Section2.4, a qualitative multi-criteria analysis was carried out to assess the relative advantages and disadvantages of each CCB option alongside the capital cost. The preferred option was selected due to the lowest environmental impact, high functionality and design life scores and a mid-range capital cost score, giving it the best overall desired outcome score.

8.4. Conclusion

The Proposal outlined herein is subject to assessment under Division 5.1 of the EP&A Act. This REF has examined and taken into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the proposed activity.

The site selection, options assessment and concept design development of the Proposal aimed to minimise environmental impacts, and the Proposal as described in this REF best meets the project objectives. However, the Proposal would still have some minor environmental impacts as identified in this REF. Safeguards outlined in this REF would avoid, minimise or manage these potential impacts to ensure that the residual impacts of the Proposal would be low.

The Proposal would provide broader, long-term environmental benefits to the CCB Creeks channel and floodplain ecology and, on balance, the Proposal is considered justified.

The Proposal is unlikely to cause a significant impact on the environment. Therefore, an environmental impact statement and approval from the Minister for Planning under Division 5.2 of the EP&A Act is not required. A Biodiversity Development Assessment Report or Species Impact Statement is also not required. The Proposal is subject to assessment under Division 5.1 of the EP&A Act and consent from Council is not required.

The Proposal is unlikely to have a significant impact on matters of national environmental significance or the environment of Commonwealth land within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999* and a referral to the Australian Government Department of Climate Change, Energy, the Environment and Water is not required.

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10. Terms and abbreviations

ACHA	Aboriginal Cultural Heritage Assessment
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
AHIP	Aboriginal Heritage Impact Permit
ASS	Acid Sulfate Soils
ASSMP	Acid Sulfate Soils Management Plan
BAM	Biodiversity Assessment Method (DPIE, 2020)
Basin Plan	The Basin Plan as developed by the Murray-Darling Basin Authority under the *Water Act 2007*
BC Act	*Biodiversity Conservation Act 2016*
BDAR	Biodiversity Development Assessment Report
BGL	Below Ground Level
CCB Creeks	Carrs, Capitts and Bunberoo Creeks
CEMP	Construction Environmental Management Plan
DoAWE	Australian Government Department of Agriculture, Water and the Environment
DPE	NSW Department of Planning and Environment
DPI	Department of Primary Industries
EC	Electrical Conductivity
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EPI	Environmental Planning Instrument

EPL	Environment Protection Licence
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Reg	Environmental Planning & Assessment Regulation 2021
FM Act	*Fisheries Management Act 1994*
GDE	Groundwater Dependent Ecosystem
KFH	Key Fish Habitat
LEP	Local Environmental Plan
LGA	Local Government Area
MDB	Murray Darling Basin
MDBA	Murray Darling Basin Authority
MNES	Matters of National Environmental Significance
NPW Act	*National Parks and Wildlife Act*
NPWS	National Parks and Wildlife Service
NSW	New South Whales
PCT	Plant Community Type
PMST	Protected Matters Search Tool
POEO Act	*Protection of the Environment Operations Act 1997* (NSW)
RAP	Registered Aboriginal Party
RCBC	Reinforced Concrete Box Culverts
REF	Review of Environmental Factors
RL	Reduced Level
SAG	Stakeholder Advisory Group
SDL	Sustainability Diversion Limit

SDLAM	Sustainable Diversion Limit Adjustment Projects
SEPP	State Environmental Planning Policy
SIS	Species Impact Statement
WINSW	Water Infrastructure NSW
WM Act	*Water Management Act 2000*

Appendix A - NSW Locks 8 and 9 SDLAM Project 70% Detailed Design Report

Available on request by emailing winsw.engagement@dpie.nsw.gov.au

Appendix B – Clause 171 Environmental Factors Checklist

The following factors listed in clause 171(2) of the Environmental Planning and Assessment Regulation 2021, have also been considered to assess the likely impacts of the proposed activity on the environment. These are provided in the table below. These considerations are required to comply with sections 5.5 and 5.7 of the *Environmental Planning and Assessment Act 1979*.

Environmental Factor	Impact
(a) the environmental impact on the community	The key objectives of the Proposal are about delivering improved environmental outcomes for the CCB Creeks system, as discussed in Section 2.1. This is also expected to deliver positive outcomes for the local community, with negligible adverse socio-economic impacts, as described in Section 6.11.
(b) the transformation of the locality	The Proposal is not expected to significantly affect land use in the region. The Proposal is replacing existing infrastructure at most sites. Potential visual impacts of the Proposal area assessed in Section 6.9 and were found to be negligible.
(c) the environmental impact on the ecosystems of the locality	A comprehensive biodiversity assessment considering aquatic and terrestrial biodiversity has been completed (refer to Sections 6.2 and 6.30) and found that the Proposal is unlikely to have a significant impact on threatened species, populations, ecological communities and migratory species, and residual biodiversity impacts are low.
(d) reduction of the aesthetic, recreational, scientific or other environmental quality or value of the locality	This REF comprehensively assesses potential environmental impacts of the Proposal and has found them to be primarily positive. Potential adverse environmental impacts are minor or insignificant.

Environmental Factor	Impact
(e) the effects on any locality, place or building that has— (i) aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance, or (ii) other special value for present or future generations	Potential impacts to Aboriginal heritage and historic heritage have been assessed in Sections 6.4 and 6.5 respectively. An Aboriginal Heritage Impact Permit (AHIP) would be obtained prior to construction to destroy Lake Victoria Locks AS1 and Lake Victoria Locks AS2 at Site 4 and Site 6.
(f) the impact on the habitat of protected animals, within the meaning of the *Biodiversity Conservation Act 2016*	A comprehensive biodiversity assessment considering aquatic and terrestrial biodiversity has been completed (refer to Sections 6.2 and 6.3) and found that the Proposal is unlikely to have a significant impact on threatened species, populations, ecological communities and migratory species, and residual biodiversity impacts are low.
(g) the endangering of a species of animal, plant or other form of life, whether living on land, in water or in the air	
(h) long-term effects on the environment	This REF comprehensively assesses potential environmental impacts of the Proposal and has found them to be primarily positive. Potential adverse environmental impacts are minor or insignificant.
(i) degradation of the quality of the environment	
(j) risk to the safety of the environment	The Proposal is replacing existing infrastructure at most sites, and improving road crossings over creeks. Traffic guard rails and handrails are included as part of the proposed structure designs as described in Section 3.
(k) reduction in the range of beneficial uses of the environment	The key objectives of the Proposal are about delivering improved environmental outcomes for the CCB Creeks system, as discussed in Section 2.1. The Proposal is not expected to significantly affect land use in the region. The Proposal is replacing existing infrastructure at most sites.
(l) pollution of the environment	There is a low potential for minor impacts to water quality due to erosion and sedimentation during construction, as assessed in Section 6.2. This risk is readily managed by standard construction practices and additional safeguards outlined in Table 6-7.

Environmental Factor	Impact
(m) environmental problems associated with the disposal of waste	Waste management during construction of the Proposal is a minor risk and would be readily controlled by construction practices and safeguards outlined in Section 6.8.
(n) increased demands on natural or other resources that are, or are likely to become, in short supply	Concrete and steel quantities used for construction of the flow control structures are widely available and would deliver long-term beneficial environmental outcomes by operation of the Proposal. Re-use of materials is discussed in Section 6.8.
(o) the cumulative environmental effect with other existing or likely future activities	As discussed in Section 6.14, concurrent construction of the Locks 8 and 9 Project infrastructure is not expected to cause any cumulative environmental impacts given the relatively low environmental impacts associated with the Proposal, and the remote locations of the Project elements.
(p) the impact on coastal processes and coastal hazards, including those under projected climate change conditions	N/A
(q) applicable local strategic planning statements, regional strategic plans or district strategic plans made under the Act, Division 3.1	As the Proposal is considered a water supply system under section 2.158 of the Transport and Infrastructure SEPP, development consent from council is not required. The Proposal is to be assessed under Division 5.1 of the EP&A Act with Water Infrastructure NSW (WINSW) being the determining authority.
(r) other relevant environmental factors.	This REF comprehensively assesses potential environmental impacts of the Proposal, including potential socio-economic impacts, and has found them to be primarily positive. Potential adverse environmental impacts are minor or insignificant.

Appendix C – Detailed design (70%) drawings

Available on request by emailing winsw.engagement@dpie.nsw.gov.au

Appendix D – Agency consultation

Available on request by emailing winsw.engagement@dpie.nsw.gov.au

Appendix E - Interim operating plan for Carrs, Capitts and Bunberoo Creeks for the commissioning phase of Carrs 1 and 2 regulators

Available on request by emailing winsw.engagement@dpie.nsw.gov.au

Appendix F - NSW Locks 8 & 9 SDLAM Geotechnical Investigation Report

Available on request by emailing winsw.engagement@dpie.nsw.gov.au

Appendix G - Salinity impact assessment for weir pool operations at Locks 8 and 9

Available on request by emailing winsw.engagement@dpie.nsw.gov.au

Appendix H - Carrs, Capitts and Bunberoo Creeks Biodiversity Assessment

Available on request by emailing winsw.engagement@dpie.nsw.gov.au

Appendix I - Locks 8 & 9 Lake Victoria Aboriginal Cultural Heritage Assessment

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Appendix J – NSW Locks 8 and 9 Sustainable Diversion Limits Adjustment Mechanism Acid Sulfate Soils Investigation

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Appendix K – NSW SDLAM Locks 8 & 9 Project Structures Options Assessment

Available on request by emailing winsw.engagement@dpie.nsw.gov.au

Appendix L – NSW SDLAM Locks 8 & 9 Monitoring Plan

Available on request by emailing winsw.engagement@dpie.nsw.gov.au