

Billabong Creek Regulators

Environmental Impact Statement

October 2024





Acknowledgement of Country

The New South Wales Department of Climate Change, Energy, the Environment and Water 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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Glossary

Term	Description
Amendment	A change in what the proponent is seeking approval for during the assessment. It requires changes to the project description in the EIS or modification report and amendments to the associated infrastructure application or modification request. Applications can only be amended with the agreement of the Planning Secretary.
Amendment report	A report prepared by the proponent to support amendments to an infrastructure application or modification request (see the State Significant Infrastructure Guidelines – Preparing an Amendment Report).
Approval authority	The approval authority for an SSI application or SSI modification request. This will be the Minister for Planning and Public Spaces.
Base case	Base case scenario. This is a computer modelling scenario comparable to current conditions, including the existing weirs at Hartwood and Wanganella as well as current water operations across the Yanco Creek system
Basin Plan	The Murray-Darling Basin Plan (MDBA, 2012). The aim of the Basin Plan is to bring the Basin back to a healthier and sustainable level. The Basin Plan sets sustainable diversion limits for each catchment or group of catchments.
Change case	Change case scenario. This is a computer modelling scenario which represents the potential impacts of the operation of the proposal together with the concurrent operational changes across the Yanco Creek system as detailed in the operations. The concurrent operational changes include continued use of irrigation areas to more efficiently deliver water into the mid sections of the Yanco and Billabong creeks, and new environmental baseflow provisions.
Clearing area	This is the area required to construct the proposed infrastructure. Within this area it is assumed that all vegetation would be removed, including trees and ground cover vegetation. Borrow pits also include a clearing area.
Construction activity zone (CAZ)	The area surrounding and including the ‘clearing area’ that would be used for construction purposes e.g., laydown, site sheds, parking. It is assumed topsoil will need to be removed/cleared, with some re-grading to create level areas with grubbing and clearing of small shrubs/grasses. Trimming of trees may be required. Tree removal would not occur in portions of the CAZ outside of a clearing area.
Cumulative case	Cumulative change case scenario. This is a computer modelling scenario which represents the potential impacts of the change case plus the operation of other new works proposed as part of the Yanco Creek Modernisation program. This is primarily the addition of the Forest Creek return flows project to the modelled cumulative change scenario. The Forest Creek return flows project will allow the diversion of excess flows in Forest Creek back into Billabong Creek.
Cumulative impacts	The combined impacts of the project on a matter with other relevant future projects (see the Department’s Cumulative Impact Assessment Guidelines for State Significant Projects).
Declaration	A REAP may declare the EIS, for a State significant project are in accordance with the EP&A Regulation and the Registered Environmental Assessment Practitioner Guidelines before they are submitted to the Department.
Department	Department of Planning, Housing and Infrastructure.

Term	Description
Determination	A decision by an approval authority for an SSI application to either approve the application subject to modifications or conditions or refuse the application.
Environmental impact statement (EIS)	An environmental impact statement prepared by the proponent to support an SSI application.
Environmental planning instrument (EPI)	Means an environmental planning instrument (including a SEPP or Local Environmental Plan) made under part 3 of the EP&A Act.
Matter	An element of the environment that may be affected by an SSI (e.g. air, amenity, biodiversity, economic, social).
Mitigation	Actions or measures to reduce the impacts of the project.
Modification	Changing the scope or terms of an SSI approval, including revoking or varying a condition of approval. A modification requires approval under the EP&A Act.
Planning Secretary	The Secretary of the Department of Planning, Housing and Infrastructure
Operations plan	The plan that outlines the operating requirements for regulating structure with the Yanco Creek system. The operations plan forms part of the larger NSW SDLAM program funded by the Australian Government.
Proponent	The proponent seeking approval for an SSI application or modification request.
Proposal	A proposed project that is not yet the subject of a lodged SSI application.
Proposal footprint / proposal site	The proposal footprint (also known as the disturbance area) includes all locations, terrestrial and in-stream, where the proposal directly impacts the land surface or water body. This includes clearing areas, construction activity zones, access tracks and power supply routes.
Refinement	A change that fits within the limits set by the project description and does not change what the proponent is seeking approval for or require an amendment to the infrastructure application for the project.
Registered environmental assessment practitioner (REAP)	A person who is registered or certified under a professional scheme that is specified as a registered environmental assessment practitioner scheme in the Accredited Registered Environmental Assessment Practitioner (REAP) Schemes published on the NSW Planning Portal.
Scoping	The process of identifying the matters that require further assessment in an EIS.
Scoping report	A report prepared by the proponent to inform the setting of SEARs for an SSI project (see the State Significant Infrastructure Guidelines – Preparing a Scoping Report).
SEARs	The Planning Secretary’s environmental assessment requirements for the preparation of an EIS for an SSI project.
State significant infrastructure (SSI)	Infrastructure that is declared to be State significant development under section 5.12 of the EP&A Act.
Submission	A written response from an individual or organisation, which is submitted to the Department during the public exhibition of an EIS, amendment report or modification report for SSI.
Submissions report	A report prepared by the proponent to respond to the issues raised in submissions (see the State Significant Infrastructure Guidelines – Preparing a Submissions Report).

Abbreviations

Abbreviations	Definitions
AADT	annual average daily traffic
ABN	Australian Business Number
ABS	Australian Bureau of Statistics
ACHA (R)	Aboriginal Cultural Heritage Assessment (Report)
AEP	Annual exceedance probability
AHIMS	Aboriginal Heritage Information Management System
AHD	Australian Height Datum
ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
BAM	Biodiversity Assessment Method
BDAR	Biodiversity Development Assessment Report
BOM	Bureau of Meteorology
CEEC	critically endangered ecological community
CEMP	Construction Environment Management Plan
CLM Act	<i>NSW Contaminated Land Management Act 1997</i>
CSWMP	construction soil and water management plan
Cth DCCEEW	Department of Climate Change, Energy, the Environment and Water, Commonwealth (Cth)
CSIRO	Commonwealth Science and Industrial Research Organisation
Cth	Commonwealth
dBA	Decibel
DP	Deposited Plan
DPE	NSW Department of Planning and Environment, now renamed as Department of Planning, Housing and Infrastructure
DPI	NSW Department of Primary Industries
DPIE	NSW Department of Planning, Industry and the Environment
EIA	Environmental impact assessment
EIS	Environmental impact statement
EP&A Act	<i>Environmental Planning and Assessment Act 1979 (NSW)</i>
EP&A Regulation	<i>Environmental Planning and Assessment Regulation 2021</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999 (Cth)</i>

Abbreviations	Definitions
ESCP	Erosion and Sediment Control Plan
ESD	Ecological sustainable development
EWR	Environmental water requirement
FM Act	<i>Fisheries Management Act 1994</i> (NSW)
GDEs	Groundwater dependent ecosystems
GL	Gigalitre
ICNG	Interim Construction Noise Guideline (DECC, 2009)
ICOMOS	Australia International Council on Monuments and Sites
km	kilometre
LEP	Local Environmental Plan
LGA	Local government area
L/s	Litres per second
m	metre
MDBA	Murray-Darling Basin Authority
ML	Megalitre
ML/d	Megalitre per day
MNES	matters of national environmental significance (under the EPBC Act)
NARCLiM	NSW and ACT Government Regional Climate Modelling
NMLs	Noise management levels
NPfI	Noise Policy for Industry
NSW	New South Wales
NSW DCCEEW	New South Wales Department of Climate Change, Energy, the Environment and Water formerly Water Infrastructure NSW
NSW EPA	NSW Environment Protection Authority
pcu	Passenger car units
PCT	Plant community type
PMF	Probable maximum flood
POEO Act	<i>Protection of the Environment Operations Act 1997</i>
RAP	Registered Aboriginal Party
RTA	NSW Roads and Traffic Authority which became Roads and Maritime Services (currently known as Transport for NSW)
SAII	Serious and irreversible impact

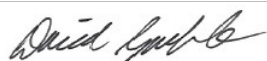
Abbreviations	Definitions
SCADA	supervisory control and data acquisition (a control system for supervision of machines and processes)
SDLAM	Sustainable diversion limit adjustment mechanism
SEARs	Secretary's environmental assessment requirements
SEPP	State Environmental Planning Policy. A type of planning instrument.
SES	NSW State Emergency Service
SIA	Social impact assessment
SSI	State Significant Infrastructure
TMP	Traffic Management Plan
TfNSW	Transport for NSW
vcr	Vehicle volume to capacity ratio
WARR Act	Waste Avoidance and Resource Recovery 2001
WQO	NSW Water Quality Objectives

Declaration

Project details	
Project name	Billabong Creek Regulators
Application number	SSI-50831979
Address of the land on which the infrastructure is to be carried out	Land at two locations along Billabong Creek in the localities of Hartwood (1 / DP707463; 28 / DP756330) and Wanganella (7005 / DP1024202; 7004/DP1024203)
Proponent details	
Proponent name	NSW Department of Climate Change, Energy, the Environment and Water
Proponent address	4 Parramatta Square, 12 Darcy Street, Parramatta NSW 2150
Details of the person by whom this EIS was prepared	
Name	D Chubb
Address	Level 15, 133 Castlereagh Street Sydney NSW 2000 Australia
Professional qualifications	BSc, MSc
Declaration by registered environmental assessment practitioner	
Name	David Gamble
Registration number	REAP Registration no. R80043
Organisation registered with	GHD Pty Ltd
Declaration	The undersigned declares that this EIS: • has been prepared in accordance with Schedule 2 and Part 10 of the Environmental Planning and Assessment Regulation 2021; • contains all available information relevant to the environmental assessment of the development, activity or infrastructure to which the EIS relates; • does not contain information that is false or misleading; • addresses the Planning Secretary's environmental assessment requirements (SEARs) for the project; • identifies and addresses the relevant statutory requirements for the project, including any relevant matters for consideration in environmental planning instruments; • has been prepared having regard to the Department's State Significant infrastructure Guidelines - Preparing an Environmental Impact Statement;

Project details

- contains a simple and easy to understand summary of the project as a whole, having regard to the economic, environmental and social impacts of the project and the principles of ecologically sustainable development;
- contains a consolidated description of the project in a single chapter of the EIS;
- contains an accurate summary of the findings of any community engagement; and
- contains an accurate summary of the detailed technical assessment of the impacts of the project as a whole.



Date

25 October 2024

Part A

Summary

Summary

Overview

New South Wales Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW) is proposing to replace two existing weirs along Billabong Creek with new regulators (the proposal). The two existing weirs to be replaced are Hartwood Weir and Wanganella Weir, both built in the early 20th century and currently in states of declining condition and functionality. Billabong Creek is within the Yanco Creek system in south-west NSW as shown on Figure S1.

It is intended that WaterNSW would own and operate the new regulators once constructed.

The proposal is subject to environmental and planning approvals under Part 5 Division 5.2 of the *NSW Environmental Planning and Assessment Act 1979* and in accordance with the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. This Environmental Impact Statement has been prepared to support the application for approval and address the Secretary's Environmental Assessment Requirements (SEARs) issued by the NSW Department of Planning, Housing and Infrastructure on 17 October 2024.

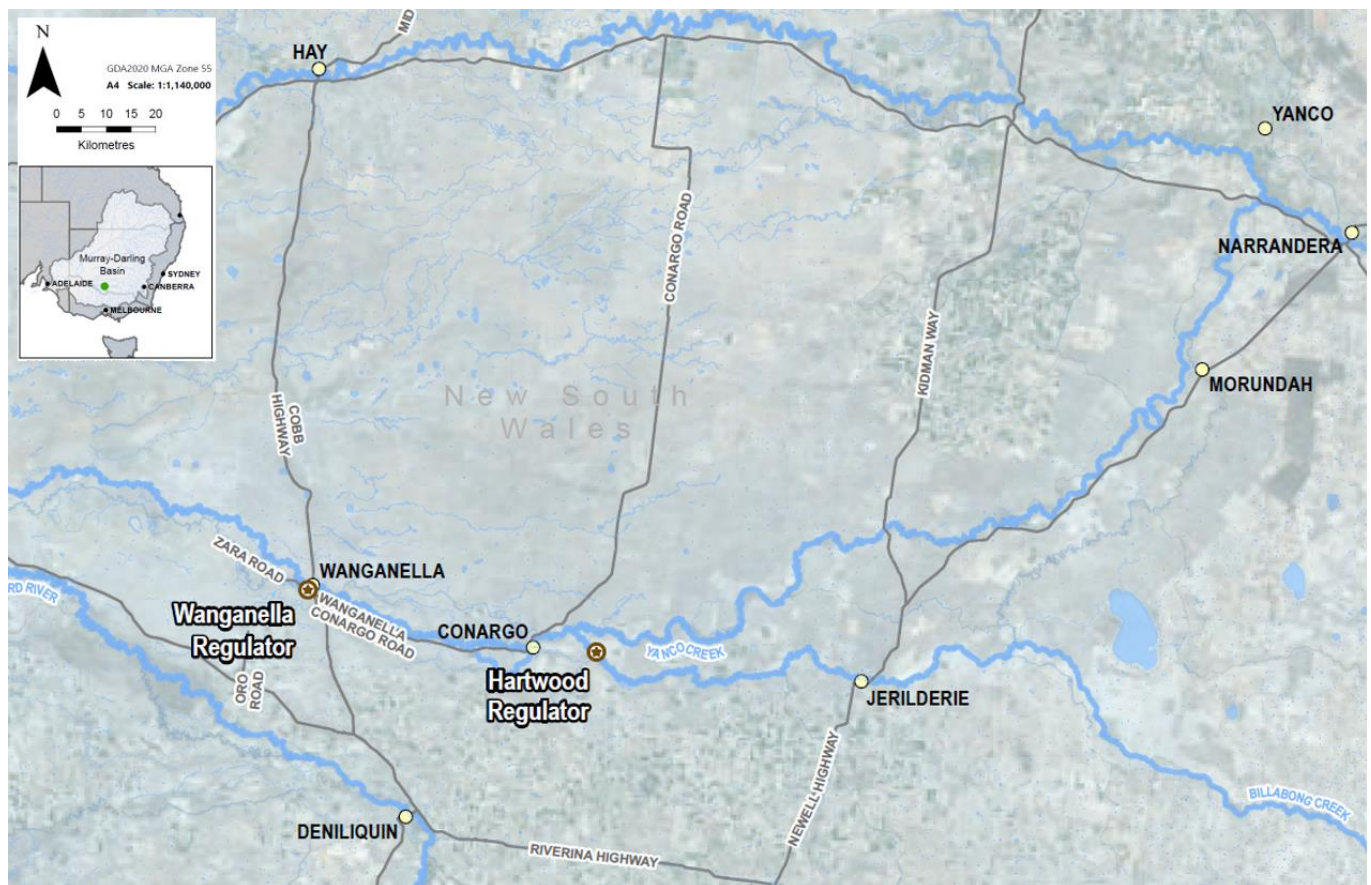


Figure S1 Location of the proposal

Need for the proposal

The proposal is needed to improve the efficiency of water management in Billabong Creek by improving:

- the ability to deliver the right amount of environmental and consumptive (town and irrigation) water to the right place at the right time
- the passage of native fish through the system.

The proposal would assist delivery of improved environmental outcomes compared to current conditions. This would support the aim of the Murray-Darling Basin Plan adopted in November 2012 and NSW DCCEEW's Yanco Creek modernisation program which aims to upgrade of infrastructure to enable smarter use of water in the Yanco Creek system.

The proposal has evolved through multiple optioneering studies, technical studies, a detailed business case and ongoing community and stakeholder engagement. These activities:

- reduced the original scope of the proposal down from the replacement of four weirs to two
- refined the design to improve beneficial outcomes of the design and minimise adverse impacts.

In summary, the proposal would contribute to the modernisation program through a focus on delivering improved environment outcomes through upgraded infrastructure and smarter use of water.

Proposal objectives

The objectives of the Billabong Creek Regulators proposal are to:

- modernise ageing infrastructure
- provide service for water users
- improve fish passage
- improve delivery of environmental water.

The design of the proposal would meet the objectives listed above while avoiding and minimising impacts on the local and regional environment, and impacts on the local community and businesses, as far as possible.

Description of the proposal

The proposal involves replacing two existing weirs along Billabong Creek with new regulators. The core structure of the two regulators is similar and would include:

- a regulator structure including concrete piers with maintenance bulkhead slots, concrete apron downstream of the structure concrete wingwalls upstream and downstream of the structure, fixed concrete crests and automated layflat gates across the crest of the structure to assist with flow management
- a fishway comprising a low turbulence 'keyhole' type vertical slot fishway with allowances for variable headwater to provide upstream fish passage and automated sidewinder gates within the vertical slot fishway to allow for variable headwater conditions
- regulator access from a trafficable deck (Hartwood Regulator only) and a pedestrian walkway access part way across Wanganella Regulator structure for maintenance
- regulator automated controls comprising an electrical control house and Supervisory Control and Data Acquisition (SCADA) control system
- fencing of the structures to prevent public access
- crushed rock maintenance pads, access and turnaround areas adjacent to the structure
- rock beaching upstream and downstream of structure for erosion protection.

An indicative layout of a regulator is shown in Figure S2. This example is of a five gate regulator with a fish passage (on the left) and trafficable deck for maintenance vehicles.



Figure S2 Indicative layout of a regulator

The proposal would also involve the following elements:

- Power supply to the regulators would be provided by a mix of underground and overhead electricity cables connecting the structures to the grid.
- Access to the regulators would require permanent tracks for maintenance and some additional tracks to support construction only. Track upgrades include a new drainage culvert at Hartwood.
- The existing Forest Creek block bank, associated with the Hartwood Regulator, is in a degraded condition. This will be replaced with a similar earthen structure in the same location.
- The Wanganella flood bypass channel would be constructed to reduce potential upstream flooding impacts from the Wanganella Regulator. The channel would enable flood waters to drain between the billabongs in the Wanganella Reserve during flood events.
- An existing privately owned borrow pit on lot 56 / DP756322 near Hartwood Weir would be extended to provide material for the construction of Hartwood Regulator and Forest Creek block bank.

Operation of the regulators

It is intended that the regulators would be operated by WaterNSW, in accordance with the operating requirements established by NSW DCCEEW in consultation with WaterNSW. These operating requirements are contained in the Yanco Creek System operations plan (the operations plan). The operations plan is in draft format and being developed in consultation with WaterNSW as the intended new asset owner, key government agencies and community stakeholders. The operations plan forms part of the larger NSW sustainable diversion limit adjustment mechanism program funded by the Australian Government.

The Yanco Creek operations plan includes the following content:

- operating principles for the water resources across the Yanco Creek System
- governance arrangements for implementing, reporting and amending the plan
- guidance for implementing and adapting operations, including the protection of environmental baseflows, the use downstream storages by preference for supply and setting operating levels for the proposal
- operating principles and limits for key water regulating structures in the Yanco Creek System
- specifying environmental flow provisions for the Yanco Creek System
- factors that could contribute to the refinement of the plan.

The proposed regulators would provide greater control of water levels which would be operated to meet environmental and water supply objectives.

Construction of the proposal

Construction of the proposal is anticipated to start in 2025 and be completed by 2026. The construction period is anticipated to be around 18 months. Construction would pause during periods of high flow.

The key phases of the construction works for each site include:

- site establishment including vegetation clearance, access track upgrades, environmental requirements, i.e., exclusion area fencing, compound site set up
- in-stream pre-construction works such as installation of sediment curtains
- construction of the regulators and fishways
- utility services construction
- demolition of existing weirs
- site rehabilitation and demobilisation.

Benefits of the proposal

The proposal focuses on delivering equivalent and/ or improved environment outcomes through upgraded infrastructure and the smarter use of water. The expected benefits include:

- more efficient delivery of environmental water
- improved fish passage (e.g. new fishways)
- improved knowledge and understanding of First Nations cultural heritage
- improved connection to Country
- an economic, training and employment boost for local communities
- improved levels of service for water users (e.g. more flexible irrigation scheduling)
- reduced risk of further non-strategic water market purchases from the southern-connected Basin to meet Murray-Darling Basin Plan commitments.

Community and stakeholder engagement

NSW DCCEEW's goal has been to work collaboratively with stakeholders to advocate for and deliver smarter use of water across the Yanco Creek system meeting the requirements of the sustainable diversion limit adjustment mechanism program.

Key objectives include:

- ensuring key stakeholders are effectively engaged and enabled to provide meaningful feedback on the project using appropriate feedback channels
- ensuring stakeholders are well informed of project activities and progress using accurate, appropriate, and easily accessible communications materials
- building, maintaining, and strengthening NSW DCCEEW's relationships with key stakeholders and community representatives as part of community and government partnership
- building community capacity and generate shared understandings.

Community engagement for work related to modernising the Yanco Creek system, including the proposal, began in late-2018. In late 2019, NSW DCCEEW developed a community engagement plan in partnership with

the Yanco Creek and Tributaries Advisory Council. Stakeholder engagement has continued with the principal groups consulted as follows:

- government agencies
- community including landowners and First Nations groups
- Yanco Creek and Tributaries Advisory Council members
- Technical Advisory Group
- other stakeholders consulted specifically on the EIS and EPBC referral.

Should the project be approved, NSW DCCEEW would continue to engage with the community and stakeholders in the lead up to, and during construction.

Environmental impact assessment

Design refinements

This environmental impact assessment is based on a preliminary design of the proposal that NSW DCCEEW has developed over a number of years in close consultation with WaterNSW and other key stakeholders. Impacts have been avoided or minimised through the design development process, where possible. Key design changes to minimise impacts include:

- Reduction of proposal scope to two regulators – The original scope of the proposal was to replace four weirs. Further hydrological modelling established the majority of water delivery efficiency could be obtained through replacement of just two weirs. This avoided impacts to landowners and communities close to the locations of Caroonboon and Piccaninny Weirs and reduced biodiversity impacts.
- Construction staging of new regulators – Downstream, in-stream construction was chosen for the new regulators, with the new regulators being completed before removal of the existing weirs. This reduced the need for earthworks, had higher community support and reduced environmental impacts. This methodology would mean the weir pools would be retained behind the existing weirs while the regulators are constructed, avoiding significant changes to the availability of weir pool supply.
- Alignment of access tracks – The alignment of the access track for the Forest Creek block bank was changed to avoid impacting upon a heritage feature. The was altered following consultation with the First Nations groups. Other track alignments were refined to minimise impacts to biodiversity.
- Power lines – Following consultation with land owners, a corridor identified for an above ground electrical power line was changed to an underground asset to accommodate the land owners' needs. Other power line alignments were refined to minimise impacts to biodiversity.
- Wanganella flood bypass channel – The channel was designed to reduce flood levels in Wanganella Village for the two per cent and less frequent annual exceedance probability flood events.
- Access track floodway – The flood impacts assessment identified that the originally proposed access track to the Hartwood Regulator crossed a flood runner. If this flood runner is blocked this would lead to a minor increase in flood levels upstream. The access track design was modified to incorporate a floodway through this part of the track.
- Sustainable development principles – the design has considered how the principles (as defined in section 193, division 5, part 8 of the *Environmental Planning and Assessment Regulation 2021*) could be incorporated in the proposal. This has included an assessment against an accredited ecological sustainable development rating system and climate modelling in accordance with NSW Government Regional Climate Modelling.

Construction

Measures to minimise the identified potential impacts would be implemented through the design development and construction planning phases, taking into account the input of stakeholders and the local community.

The majority of potential impacts would be managed through standard mitigation and management measures. Other potential impacts are discussed below:

Hydrology – The existing weirs will remain in place for the majority of the construction timeframe, only being demolished once the new regulators are fully installed. Therefore, the weirs will continue to have a similar influence on hydrology during the construction period similar to current conditions. In addition, the proposed construction methodology would involve partial coffer-damming of Billabong Creek allowing passing flows to meet irrigation and consumptive demands and environmental water provisions. Therefore, it is considered unlikely construction of the proposal would have a material adverse effect on the hydrology of Billabong Creek, either upstream or downstream.

Flooding – The flood inundation modelling has demonstrated the one in five year event impacts are contained within the creek channel. Construction activity zones outside of the channel would not be impacted in these events. The likelihood of a flood event of a greater magnitude occurring during the 18 month construction period is considered low and flood impacts are not considered a significant risk.

Surface water quality and aquatic ecology – There would be potential for sediment runoff from areas disturbed by construction to impact water quality through increased turbidity if this risk is not appropriately managed. Areas presenting a high risk of soil erosion include areas cleared of vegetation close to the creek bank and disturbance of the creek bed. With the implementation of safeguards and management measures it was determined the risk is low. As such it is expected that the water quality objectives and aquatic ecosystem values in the study area, including threatened species and key fish habitat, would be protected during construction.

Terrestrial flora and fauna – During construction some vegetation would need to be cleared. The proposal would remove up to 16.23 hectares of native vegetation across the proposal footprint. The impacted vegetation includes ecosystem and credit species habitat for the purposes of the Biodiversity Offset Scheme for six plant community types, one plant species and the following fauna species: Little Eagle, Bush Stone-curlew, Southern Bell Frog, Southern Myotis, Plains-wanderer. An assessment of serious and irreversible impacts has been prepared for the Plains-wanderer due to the removal of 1.96 hectares of mapped important habitat for this species. Assessments of significance have been prepared for threatened species listed under the EPBC Act that are likely to be impacted by the proposal. The outcome of these assessments is that the proposed action is not likely to result in a significant impact to any terrestrial threatened species or communities listed under the EPBC Act.

Aboriginal heritage – Four Aboriginal cultural heritage items would be directly impacted. This would comprise of the total loss of three sites including the removal of two scar trees and one earth mound. Additionally partial loss of value due to tree trimming would occur at a scarred tree. Excavation may also impact currently unidentified subsurface Aboriginal objects.

Non-Aboriginal heritage – Two heritage items, assessed as being of local significance, would be directly impacted by the proposal. Harwood Weir is locally listed on the state agency heritage register, WaterNSW Section 170 State Agency Heritage and Conservation register (WaterNSW S170 4550110). Wanganella Weir is not listed but is assessed as having local significance. The majority of features above the waterline serving as a visual reminder of the location of the historical weir, would be removed. As such, the overall level of impact on both weirs would be major. Mitigation proposed includes interpretation options and salvage of the Harwood Weir engraving.

Social – There would be no public access to Wanganella Weir and the adjacent campsite during construction. This area would be restricted to maintain public safety.

Operation

Hydrology – Overall, the hydrological analysis shows that the operation of the proposal will have some minor localised effects on hydrology (i.e. water balance, seasonality, flow variability, and flow sizes) which are consistent with the aims of the proposal and the broader system changes outlined in the operations plan. As such, the overall hydrological characteristics of Billabong Creek within the proposal study area or the broader Yanco Billabong System will not substantially alter as a result of the proposal. Operation of the proposal will result in an overall improvement in the frequency of achieving requirements for a number of Environmental Water Requirement categories to support key ecological values of the system. The proposal is also not anticipated to negatively impact key hydrological aspects of the Yanco Creek System, including the proposal study area, when taking into consideration potential cumulative effects associated with other projects in the study area.

Flooding – Overall, the flood assessment has demonstrated that there will be no significant detrimental increases to properties, assets, and infrastructure. As there is fundamentally no change in the flood characteristics due to the proposals, it can be concluded that the flood hazard and hydraulic functions of flow conveyance in floodways and flood storage characteristics remain consistent with current conditions and the Conargo Local Environment Plan. Further, as there is no fundamental change to the flooding conditions the existing emergency management, evacuation and access.

Surface water quality and aquatic ecology – The design of the new regulators would allow for improved control of environmental flows and fish passage resulting in improved connectivity for native aquatic species. Relatively minor changes to flow and velocity are predicted regardless of the operating flow setting (maximum or minimum) and are unlikely to negatively impact the native aquatic community. Based on the assessment of the existing water quality and aquatic environments, the design of the new regulators, and the proposed safeguards and management practices, it was concluded that water quality objectives and aquatic ecosystem values within the study area would be adequately protected during operation of the proposal.

Non-Aboriginal heritage – The remaining features of the locally heritage significant weirs would comprise the in-creek base slabs and a wingwall at Wanganella. These structures were constructed to withstand water flows of various levels and speeds. The remaining heritage significance would not be further impacted by any additional hydrological impacts from changes to the water flow due to the operation of the new regulators.

Social – The operational social impacts are generally beneficial to the local community and include improved water management, delivery and availability contributing to business and economic outcomes, particularly agricultural industries. The proposal will support the overall health and wellbeing of current and future surrounding communities through improved water supply, management and security. It will also support Aboriginal values associated with environmental protection and flows. The proposal would provide direct and indirect employment opportunities and regional economic growth, supporting livelihoods and wellbeing.

Next steps

NSW DCCEEW is seeking approval from the Minister for Planning and Public Spaces for the construction and operation of the proposal. Steps in the process are shown in Figure S3.

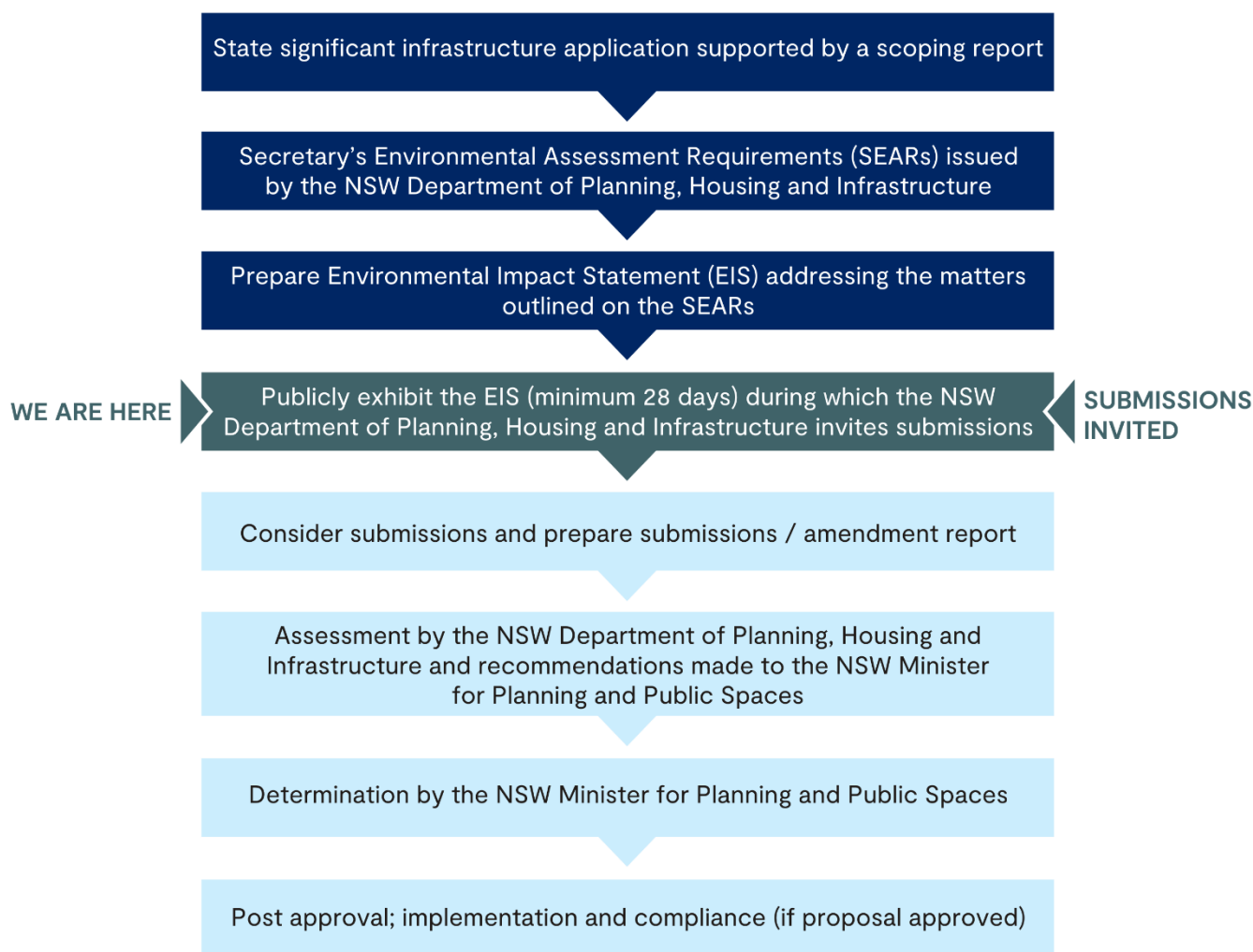


Figure S3 Approval and consultation process

The Minister for Planning and Public Spaces would then make a decision on the proposal and, if approved, set conditions of approval.

Consultation with the community and stakeholders would continue throughout the detailed design and construction phases as required.

During the exhibition period, the environmental impact statement will be available for viewing on the Major project planning portal at planningportal.nsw.gov.au/major-projects/projects/billabong-creek-environmental-water-regulators

Written submissions can be made to the NSW Department of Planning, Housing and Infrastructure. All submissions received will be placed on the proposal website. Submissions can be made by creating an account at planningportal.nsw.gov.au/major-projects/projects/on-exhibition. This allows you to save a submission in progress and stay up to date with the progress of an application.

Part B

Introduction and
proposal context

1. Introduction

This chapter of the environmental impact statements (EIS) provides an overview of the proposal, including the proponent, a summary of the proposed works, and a background to the proposal development.

1.1. Proponent details

The details of the proponent are provided in Table 1.1.

Table 1.1 Proponent details

Proponent details	
Proponent name	New South Wales Department of Climate Change, Energy, the Environment and Water
Proponent address	4 Parramatta Square, 12 Darcy Street, Parramatta NSW 2150
ABN	27 578 976 844

1.2. Proposal description

New South Wales Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW) is proposing to replace two existing weirs along Billabong Creek with new regulators (the proposal). The two existing weirs to be replaced are Hartwood Weir and Wanganella Weir. These structures are situated on Billabong Creek within the Yanco Creek system in south-west NSW (refer Figure 1.1).

These weirs were built in the early 20th century and have been used to control flows through Billabong Creek by creating weir pools for irrigation and, in the case of Wanganella Weir, provide town water supply. Hartwood Weir also provides the water level required to divert water by gravity out of Billabong Creek into Forest Creek. The weirs are currently in states of declining condition and functionality, and are barriers to the movement of fish through the creek. Their design and condition limits their ability to regulate flows through the Yanco Creek system and leads to inefficiencies in how water is delivered to the environment and irrigators.

The new regulators would be fully automated and remotely operated meaning that operators could control the delivery of water more efficiently. The proposal is needed to improve the operator's ability to deliver the right amount of water to the right place at the right time. The new regulators would also feature fishways to enable fish movement past the new structures.

It is intended that WaterNSW would own and operate the new regulators once constructed.



-  Regulator
-  Town
-  Major Watercourse
-  Main Road
-  Water Bodies



GDA2020 MGA Zone 55
A4 Scale: 1:1,140,000

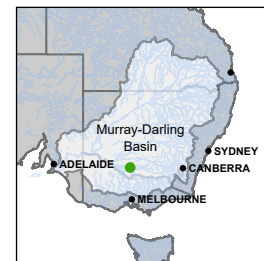
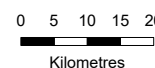


Figure 1-1 Location of the proposal



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The objectives of the proposal are to:

- modernise ageing infrastructure
- provide service for water users
- improve fish passage
- improve delivery of environmental water.

The new regulators would be constructed downstream and in close proximity to the existing weirs and would be constructed using an in-stream method. The proposal has gone through a rigorous options selection process (refer to section 2.5) and has been informed by extensive stakeholder engagement (refer to chapter 5). Impacts are expected to be minimised by the proposal's design and operating rules as well as use of best practice in construction and operation.

The regional location of the proposal is shown in Figure 1.1 and details of the regulators and their supporting infrastructure, is discussed in chapter 3.

The proposal is subject to environmental and planning approvals in accordance with the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The proposal is State significant infrastructure (SSI), and the Minister for Planning and Public Spaces is the approval authority. An environmental impact statement (EIS) is required to accompany the application for approval of the proposal.

This EIS has been prepared to support the application for approval of the proposal under Part 5 Division 5.2 of the EP&A Act (SSI-50831979). It addresses the Secretary's Environmental Assessment Requirements (SEARs) issued by the NSW Department of Planning, Housing and Infrastructure (DPHI) on 17 October 2024 and the form and content requirements of Sections 190 and 192 of the *Environmental Planning and Assessment Regulation 2021* (EP&A Regulation) and the *State Significant Infrastructure Guidelines – Preparing an Environmental Impact Statement* (Department of Planning, Industry and Environment (DPIE), 2021a).

1.3. Proposal background

1.3.1. Program background

The Murray-Darling Basin Plan

The Federation drought between 1895 and 1902 provided a catalyst to bring the states together to agree on the management of the Murray River. The River Murray Waters Agreement commenced in 1915 involving the governments of New South Wales, Victoria, South Australia and the Australian Commonwealth Government. The formation of the River Murray Commission followed in 1917.

In 1987, the first Murray-Darling Basin Agreement was reached, which established the Murray-Darling Basin Commission. The millennium drought that lasted over a decade between 1997 and 2009 in much of the Basin increased understanding of environmental management constraints and water management requirements, highlighted the limits and weaknesses of how water in the Basin was managed, and highlighted the need for continuing reform. In response, the *Water Act 2007* (Cth) (the Water Act) was enacted.

As a requirement of the Water Act, the Murray-Darling Basin Authority was set up and was required to develop a plan to manage how much water could be used by industries and communities in the Basin. The Murray-Darling Basin Plan (the Basin Plan) was adopted in November 2012 (MDBA, 2012). 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 plan sets the amount of water that can be taken from the Basin each year.

There are several key components of water management in the Basin, which work as an integrated package:

- water entitlements – a permanent share/allocation of water within a catchment
- water trade – the ability to sell water entitlements and/or allocations
- water resource plans – management plans that define how water in a catchment can be used sustainably
- sustainable diversion limits – how much water can be used in the Basin while leaving enough water for the environment
- monitoring and accounting
- compliance.

Sustainable Diversion Limits and the Adjustment Mechanism

The Basin Plan sets sustainable diversion limits for each catchment or group of catchments. The existing sustainable diversion limits were lower than the amount of water that was being used at the time. As a consequence, water has to be recovered from the Basin's already allocated water to meet the limit. Across the Basin, the additional amount of water needed to meet the diversion limits and improve river and wetland health is an average of 2,750 gigalitres (GL) per year. It is estimated that 2,107 GL of water had been recovered by September 2021.

To provide flexibility, the Basin Plan includes a mechanism to adjust sustainable diversion limits to achieve equivalent social, economic and environmental outcomes with less water recovery. The Sustainable Diversion Limit Adjustment Mechanism (SDLAM) allows the sustainable diversion limits to be adjusted within defined limits to offset the remaining gap between extractions and the desired 2,750 GL water saving. The ability to do this, and make additional water available for communities, is subject to implementing a range of projects, which include:

- supply projects – improving the efficiency of how water is delivered to the environment
- efficiency projects – projects or activities that change water use practices and save water for the environment
- constraints projects – projects that aim to overcome some of the physical barriers and river management practices that impact the ability to move environmental water around the Basin.

Yanco Creek modernisation

NSW DCCEEW's Yanco Creek modernisation program is progressing the upgrade of infrastructure to enable smarter use of water in the Yanco Creek system, including Yanco, Billabong, Colombo and Forest Creeks. It encompasses a series of initiatives aiming to improve water management as part of commitments within the SDLAM program.

The modernisation of the Yanco Creek system aims to:

- create a community and government partnership to maintain and improve flows
- keep the Yanco, Billabong, Forest and Colombo Creeks flowing
- be smart in the use of available water
- modernise ageing infrastructure
- ensure project benefits for irrigators, town water supplies, native fish, water birds, culture and heritage, and recreational use.

The modernisation focuses on delivering equivalent and/ or improved environment outcomes through infrastructure and smarter use of water. Some of the expected benefits in the Yanco, Billabong, Forest, Colombo creeks and Murrumbidgee River system include:

- more efficient delivery of environmental water
- improved fish passage (e.g. new fishways)
- improved knowledge and understanding of First Nations cultural heritage
- improved connection to Country
- an economic, training and employment boost for local communities
- improved levels of service for water users (e.g. more flexible irrigation scheduling)
- a reduced risk of further non-strategic water market purchases from the southern-connected Basin to meet Basin Plan commitments.

The Yanco Creek modernisation is also progressing the construction of works that will restore fish passage along creeks and enable native fish to safely negotiate barriers to movement.

1.3.2. History of the proposal

The Yanco Creek system has been a focus of water regulation works since the 1880s (Beal et al., 2004), and continues to receive regulated flows of water diverted from the Murrumbidgee River at Yanco Weir. The two existing weirs included in this proposal were built in the early 20th century and have a limited ability to manipulate flow in the system. The potential to improve the delivery of water in the Yanco Creek system has been investigated for many years to manage more effectively the amount of water diverted from the Murrumbidgee River to the Yanco Creek system.

Extensive investigations have been undertaken to identify opportunities for improving water management in the Yanco Creek system since 2015. The first investigation was the *2015 Business case for modernising supply systems for effluent creeks – Murrumbidgee River* (WaterNSW, 2015) (available at: industry.nsw.gov.au/_data/assets/pdf_file/0018/165132/Modernising-Supply-Systems-for-Effluent-Creeks-Murrumbidgee-River-Business-case.pdf). This identified that there was potential to modernise the supply arrangement for diversions in the Yanco Creek system to create water savings.

The Yanco Creek system was identified as a potential site to improve water efficiency partly because there are few operational controls in the Yanco Creek system and very long order periods for water. The long order period means water moves relatively slowly through the system, such that WaterNSW must maintain high levels of flow through the year to avoid the risk of non-supply. This means flows throughout the system are greater than would be required to meet water orders for a range of purposes including environmental, irrigation, town water supply and stock and domestic use.

The 2015 Business Case suggested a range of modernisation options. These options and others were then refined and developed through consultation with the Yanco Stakeholder Advisory Group and the Yanco Technical Advisory Group.

The modernisation options were evaluated in accordance with the NSW SDLAM options evaluation framework (Alluvium, 2020). This evaluation identified a shortlist of options:

- Part 1: Environmental water efficiency
- Part 2: Billabong Creek regulators
- Part 3: Yanco Creek / Mundoora / Wilson Anabranh reconfiguration
- Part 4: Forest Creek return flows via Piccaninny Creek
- Part 5: Flow measurement

- Part 6: Review of irrigation escape flows
- Part 7: Improved use of technology
- Part 8: Improved riparian management.

This proposal relates to Part 2: Billabong Creek regulators.

1.3.3. Strategies to reduce impacts of the proposal

The design of the proposal, as well as its construction methodology, and operation rules have been strategically formed to minimise impact to the environment. These strategies are discussed in Table 1.2.

Table 1.2 Key strategies to reduce the impact of the proposal

Area	Strategy
Sustainability Assessment	A sustainability assessment was carried out on the construction and operational design and assessment. This process identified aspects of the proposal which could be refined to improve the sustainability of the design. Recommendations are detailed in section 2.8 and comprised: • environmental Compliance and Monitoring • energy and carbon management: • climate risk and resilience • circular Resource Management • water Stewardship and Efficiency • biodiversity. A total of twelve climate change risks were identified, based on hazards including extreme rainfall, storms, bushfires, and temperature. Six were categorised as 'Low' and six as 'Medium' for the 2090 timeframe. The risks identified are presently manageable with appropriate mitigation measures in place.
Selection of weirs	The original concept design proposed in the scoping report for the EIS (DPE 2022a) included new regulators at the Caroonboon and Piccaninny weirs. Following the submission of the EIS scoping report the proposed works at Caroonboon and Piccaninny were excluded from the proposal. Further hydrological modelling established that about 90 per cent of the water delivery efficiency gains could be obtained through replacement of just two weirs assuming that the design full supply level for Wanganella Regulator was raised by a further 600 millimetres. In addition the reduction to two weirs avoids impacts to biodiversity values, notable for Caroonboon Weir, if works at these locations were progressed.
Design	The new regulators would be built downstream of the existing weirs. This would mean that that the existing weirs would be able to continue to be used and operated during construction of the new regulators. The fishways have been designed to be applicable to the fish populations within the Yanco Creek system to support their movement along the creek system. The structure would comprise a low turbulence 'keyhole' type vertical slot fishway with allowances for variable headwater to provide upstream fish passage and include automated sidewinder gates to allow for variable headwater conditions. A flood bypass channel was added to the design for the Wanganella Regulator to ensure that the works do not result in an increase to upstream flooding of Wanganella village. This channel would start to flow in about a one in fifty year flood event.

Area	Strategy
Construction methodology	The new regulators would be built within the existing creek channel instead of on the adjacent creek bank. This means that the creek would not need to be rerouted through the new regulator. Construction with the creek channel would mean: • less vegetation clearing would be required • less earthworks would be required • there would be a lower risk of impacting Aboriginal heritage items • stream morphology impacts would be less. Preliminary environmental investigations have allowed the boundaries of the proposal's Construction Activity Zones to be amended to avoid impacts to sensitive environmental features.
Operation	The new regulators would be operated in accordance with operational rules that take into account: • water use efficiency • fish passage and fish habitat health • native vegetation watering • environmental baseflow provisions. The operational rules would help to ensure that the new regulators are operated with the goal of reducing impacts and increasing benefits to the environment.

1.4. Related development

This proposal comprises part of NSW DCCEEW's Yanco Creek modernisation program. This program is progressing the upgrade of infrastructure to enable smarter use of water in the Yanco Creek system, including Yanco, Billabong, Colombo and Forest Creeks. This proposal would contribute to the series of initiatives aiming to improve water management as part of commitments within the SDLAM program. These related programs are discussed further in section 1.3.2.

The other developments related to modernising the Yanco Creek system (refer section 1.3.2) are independent to the proposal, and would be subject to separate development approvals. However, these projects are considered within the cumulative impact assessment in chapter 23.

2. Strategic context

This chapter provides a strategic justification of the proposal and a brief description of the existing site. Context to the strategic policy relating to the proposal is presented. The process to consider alternatives to the proposal are summarised, and a justification for the selection of the preferred option is provided.

2.1. Justification of the proposal

The proposal will improve the efficiency of water management in Billabong Creek by improving the ability to deliver the right amount of environmental and consumptive (town and irrigation) water to the right place at the right time and to improve the passage of native fish through the system. The proposal will assist in the delivery of improved environmental outcomes compared to current conditions.

More detail on the justifications for the proposal are provided in Table 2.1.

Table 2.1 Justifications for the proposal

Justification	Detail
Sustainable Diversion Limits and the Adjustment Mechanism supply projects	• As discussed under section 1.3.1, the Basin Plan provides flexibility by allowing the Sustainable Diversion Limits to be offset using supply projects such as the proposal. • In early 2019, NSW signed a funding agreement with the Australian Government to undertake detailed planning for several projects, including the proposal, under the SDLAM Program. • The NSW Government has brought forward five of its remaining SDLAM projects, including the proposal, through the NSW SDLAM Acceleration Program (the Acceleration Program). • The proposal would deliver equivalent or better environmental outcomes compared to those achieved under current Basin Plan settings, using an estimated 16 GL less water when combined with the Computer Aided River Model Project. • No additional water is required for the operation of the proposal. • SDLAM projects are designed to deliver better environmental outcomes without the need for additional water recovery, changing rules to deliver water to high value environmental sites and changing the way rivers are managed. The Yanco Creek Modernisation program is part of the SDLAM acceleration program which will deliver up to 45GL of the outstanding amount needed to reach the 605GL target required by the Basin Plan each year. (NSW DCCEEW 2024). • The Murray-Darling Basin Authority (MDBA) (2020) identified that supply and constraint projects are complex projects that together make a substantial contribution to the overall sustainable diversion limit adjustment. These projects include the modernising of water delivery infrastructure in Yanco Creek to improve the operation of Yanco Creek and its environmental outcomes. The MDBA made an estimate of the volumetric contribution of projects to the SDLAM offset, using two methods to develop an estimated range of potential supply contributions for supply projects. The estimated contribution range for the Yanco Creek Modernisation program is that it will deliver between seven and 16GL of water savings per year (MDBA 2020).

Justification	Detail
Modernising ageing infrastructure	- The weirs are ageing and are in different states of deteriorating condition and have very limited to no ability to control flow, as shown in Figure 2.1 and Figure 2.2. - The proposal would replace these weirs with regulators to meet contemporary demands for water supply and efficient delivery of water.
Improving service for water users	- There are currently long ordering periods for water, of up to 26 days to the lower Billabong Creek, between releases from the headwater dams and final delivery of water to licensees (Cooling and Gippel, 2018; WaterNSW, 2015). - Long delivery times for water in the creek make it difficult to implement effective order management or control (WaterNSW, 2015). - As a result, WaterNSW maintains high levels of flow in the Yanco Creek system throughout the season to avoid risks of non-supply (WaterNSW, 2015). - Thus, flows within the system are greater than would be required to meet actual irrigation demand and so end of system flows at Darlot are generally higher than the target set in the <i>Murrumbidgee Regulated River Water Sharing Plan</i> (WaterNSW, 2015). - The proposal would improve operational flexibility and reduce over supply of consumptive water.
Improving fish passage	- The native fish community is highly degraded and fragmented in the Yanco Creek system, with over 30 weirs and barriers reducing fish movement in the Yanco Creek system and only one of which has a fishway (Stuart, 2022). - The proposal would remove existing barriers to fish passage at location of the two weirs associated with the proposal. This will support unimpeded fish passage for native fish species, including Murray Cod (<i>Maccullochella peelii</i>). The existing distances of unimpeded fish passage will be increased by around 14 kilometres, at Wanganella and 16 kilometres at Hartwood.
Improved delivery of environmental water	- Hartwood regulator would help to improve the efficiency of the delivery of environmental water into the Forest Creek system including important environmental wetlands in the Wanganella area. - The proposal would improve environmental water managers' ability to achieve ecological outcomes in the Yanco Creek system.



Figure 2.1 Examples of deterioration at the existing Hartwood Weir



Figure 2.2 Examples of deterioration and missing drop boards at the existing Wanganella Weir

2.2. Regional land use planning context

The proposal is situated in rural south-west NSW at two principal locations within Edward River Local Government Area (LGA). The weirs are located as follows:

- Hartwood Weir (about 10 kilometres east of Conargo village)
- Wanganella Weir (one kilometre southwest of Wanganella village).

The closest regional centre to the proposal is Deniliquin (about 40 kilometres south-east of Wanganella and 30 kilometres south-west of Conargo).

Land in the vicinity of the proposal is mostly used for dryland and irrigated cropping and grazing. Agricultural is the greatest employment industry for people in the Edward River LGA (18.1 per cent), followed by health and care (13.1 per cent) and retail trade (11.1 per cent) (Edward River Council, 2020).

The creeks within the Edward River LGA are important natural features in the region and provide:

- water for irrigation and drinking
- environmental watering of key environmental assets in the Yanco Creek system: Wanganella Swamp, Rhyola Lake and Rhyola Swamp
- river-based activities such as walking, biking, swimming, kayaking, camping, bird watching, and fishing
- regional tourism including creek-front accommodation such as at Wanganella Cottage, Wanganella Creek Camp Park and Wanganella Fishermen's Cottage.

The Yanco Creek system is also home to the Wiradjuri, Yorta Yorta, Barapa Barapa and Wamba Wamba nations who have a cultural and spiritual link to the creek system (Element, 2020).

Regionally important infrastructure include:

- key roadways which connect the proposal such as Conargo Road, Cobb Highway and Zara Road
- Yanco Offtake which diverts flows from the Murrumbidgee River into the Yanco Creek.

The Edward River Local Strategic Planning Statement highlights climate change, flooding and bushfire as priority hazards to manage in the area (Edward River Council, 2022).

2.3. Key features of the existing site

2.3.1. Hartwood

The existing Hartwood Weir, completed in 1916, is downstream of the Billabong Creek and Forest Creek junction and can share the regulated flows between the two creeks by creating a weir pool to divert water to Forest Creek (Alluvium, 2013).

Hartwood Weir, shown in Figure 2.3, now largely operates as a fixed crest weir with a concrete apron and abutments. The weir contains manual drop boards that would have been used historically to regulate flows past the weir and are now only removed in high flows.

The extent of the existing weir pool at full supply level, upstream of the structure, is around 16.5 kilometres.

WaterNSW owns the land on which Hartwood Weir is located. Downstream of this land includes both private and Crown land. Land on the right bank (eastern side) of the creek is privately-owned agricultural land. Billabong Creek around the weir is a Crown Waterway. The land on the left bank (western side) is Crown Land and includes a Crown License (R92577) and a Crown Enclosure Permit (R30139).

The existing Forest Creek block bank was constructed of clay and rock in an excavated channel between Billabong Creek and Forest Creek. The structure is trafficable and connects access tracks on both sides of the creek, but is currently in poor condition. The structure controls flow into Forest Creek from Billabong Creek, used for irrigation and other uses. It is located within the Crown Enclosure Permit. The existing Forest Creek block bank is unlicensed and therefore has no formal ownership.

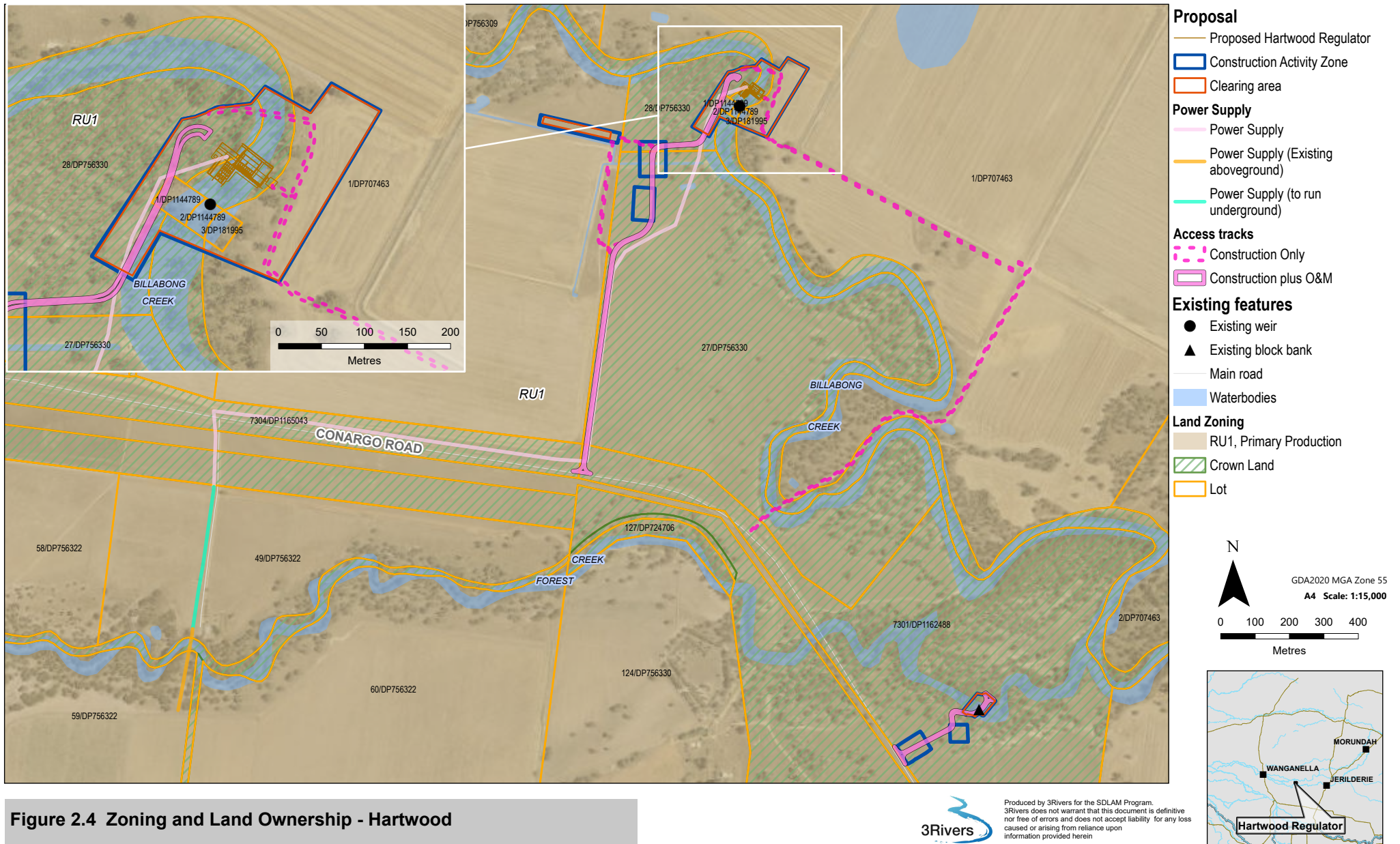
Table 2.2 provides key details on land ownership and land use at Hartwood Weir. Figure 2.4 shows the landownership, lot references and zoning in the area.



Figure 2.3 Hartwood Weir

Table 2.2 Location and land use details of Hartwood Weir

Weir	Weir Ownership	Reference lot and DP	Land zone	Land ownership	Surrounding land use
Hartwood	Owned and operated by WaterNSW	1 / DP1144789 2 / DP1144789 3 / DP181995	RU1 Conargo Local Environmental Plan 2013	- located on land owned by WaterNSW - Crown land on the downstream west bank - private land on the downstream east bank.	- cropping and grazing - travelling stock reserve



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2.3.2. Wanganella

Wanganella Weir, shown in Figure 2.5, is located on Billabong Creek and contains eleven drop board bays to regulate flows, however the drop boards are no longer in place as they were removed in the 1980s. It now operates as a fixed crest weir with a concrete apron and abutments. The weir was constructed for the Wanganella village water supply. The extent of the weir pool at full supply level upstream of the structure is around 13 kilometres.

Wanganella village is located around one kilometre north of the site. The site is part of the Wanganella Recreation Reserve, known to local residents as Wanganella Common. The area is a Crown land reserve (R88408) as shown in Figure 2.6, for the preservation of fauna and for public recreation. It is understood to be managed by Edward River Council. Billabong Creek at this location is a Crown Waterway. Existing access to the site is from the Cobb Highway on the western side of the Creek. Zara Road is located on the eastern side of the creek but there is no formed access track on this side. Zara Road also intersects with another Crown Reserve (R58165).

Table 2.3 provides key details on land ownership and land use at the proposal site around Wanganella Weir. Table 2.3 shows the landownership, lot references and zoning in the area.



Figure 2.5 Wanganella Weir

Table 2.3 Location and land use details of Wanganella Weir

Weir	Weir Ownership	Reference lot and DP	Land zone	Land ownership	Surrounding land use
Wanganella	Edward River Council	7004 / DP1024203 7005 / DP1024202	RU1 Conargo Local Environmental Plan 2013	Crown land	• Wanganella Recreation Reserve including recreation and camping area • nearby residential area in Wanganella village • cropping and grazing

2.4. NSW and regional planning provisions, goals and strategic planning objectives

The planning provisions, goals and strategic planning objectives which are considered relevant to this proposal are discussed in Table 2.4.

Table 2.4 Planning provisions and strategic planning objectives

Plan or policy	Contribution of the proposal
NSW Premier's Priorities	The priority with most relevance to this proposal comprises developing '<i>well connected communities with quality local environments</i>'. This proposal will be designed to control the delivery of water more efficiently. The objectives of the proposal will contribute to the priority through: • providing service for water users • improving fish passage • improving delivery of environmental water. Further details are provided in section 1.2.
The Murray-Darling Basin Plan (MDBA, 2012)	The aim of the Basin Plan is to bring the Basin back to a healthier and sustainable level. The Basin Plan sets sustainable diversion limits for each catchment or group of catchments. This proposal has been developed to contribute to the meeting of these diversion limits. Further details are provided in section 1.3.1.
Draft Murrumbidgee Regional Water Strategy (DPE 2022b)	This strategy guides how the NSW Government address water-related challenges to support the Murrumbidgee region. The proposal would support the delivery of four of the objectives, namely to: • deliver and manage water for local communities – improve water security, water quality and flood management for regional towns and communities • enable economic prosperity – improve water access reliability for regional industries • recognise and protect First Nation's water rights, interests and access to water – Including Aboriginal heritage assets • protect and enhance the environment.
Draft Murray Regional Water Strategy (DPE, 2022c)	The proposal would support the delivery of a number of options and commitments outlined in the strategy, including: • insufficiently integrated land and water planning and management – to better integrate water resource management • current water sharing arrangements based on 125 years of data – to consider the adequacies of existing water sharing and management arrangements in the region under a more variable and changing climate • degradation of riverine and floodplain ecosystems – to address the risk to the environment, the ecology and groundwater dependent ecosystems and improve the health of the region's rivers and groundwater sources • limits to water availability in times of a changing climate – to better understand water use behaviour, and to develop strategies and information to build greater resilience.

Plan or policy	Contribution of the proposal
Flood Risk Management Manual (DPE, 2023d)	This manual provides for the development and implementation of sustainable strategies for managing human occupation and use of the floodplain. It provides for evaluation of strategies and formulation of plans that achieve effective flood risk management outcomes accounting for social, economic, ecological and cultural factors, together with community aspirations for the use of flood prone land. This proposal considers the requirements of this manual and includes hydrology and flooding assessment (see Appendix H (Flooding)) to identify and manage risks identified.
State Infrastructure Strategy 2018 – 2038: Building the Momentum (Infrastructure NSW, 2018)	The strategy outlines a number of objectives which include to ‘support the growth, productivity and liveability of metropolitan and regional communities by ensuring that water security, quality and wastewater services protect public health and the environment’. This proposal would help support this objective and several of the key recommendations including to: • reduce the potential impacts of climate change on the management of water • improve the water security in priority catchments.
NSW Aquifer Interference Policy (DPI, 2012)	A groundwater assessment (see Appendix I (Groundwater)) has been carried out to identify if this proposal would lead to more than minimal harm through penetration, interference or obstruction of the flow of water in an aquifer.
Guidelines for Controlled Activities on Waterfront Land (Natural Resources Access Regulator, 2018)	This proposal has considered impacts on waterfront land and carried out assessment to analyse this, including biodiversity (see Appendix K (Surface water and aquatic ecology)) and geomorphology (see Appendix J (Geomorphology)). This is to meet, where possible, the objectives of the guidelines, through: • minimising disturbance and harm to the riparian corridor / vegetated riparian zone • minimising the number of creek crossings.
NSW Weirs Policy (NSW Government, 1995)	The goal of the NSW Weirs Policy is to halt and, where possible, reduce and remediate the environmental impact of weirs (DPI, n.d.). One of the management principles of this policy is that where weirs are retained, owners should “ <i>undertake structural changes to weirs to reduce their environmental impact on the environment</i> ” (DPI, n.d.). This proposal would remove existing weirs with declining condition and functionality, that are barriers to the movement of fish through the creek. These would be replaced with regulators that could control the delivery of water more efficiently, deliver the right amount of water to the right place at the right time while also supporting native fish movement past the new structures.
Policy and Guidelines for Fish Habitat Conservation and Management (DPI 2013)	This policy is aimed at maintaining and enhancing fish habitat for the benefit of native fish species, including threatened species. This proposal supports this policy by removing existing weirs that are barriers to the movement of fish and replacing them with regulators that feature fishways to support fish movement. The main policies of the NSW Department of Primary Industries (DPI) mentioned in the guidelines, supported by the proposal include: • conservation of biodiversity and fish populations • comprehensive environmental assessment • adaptive management.

Plan or policy	Contribution of the proposal
Riverina Murray Regional Plan 2041 (DPE, 2023a)	The plan guides the NSW Government's land use planning priorities through providing an overarching framework to more detailed plans, development proposals and infrastructure funding decisions. The proposal would help deliver some of the goals of the plan, such as Goal 2 '<i>a healthy environment with pristine waterways</i>', and its associated actions. The plan is a 20-year land use plan to guide strategic development within a group of LGAs. The proposal will support the plan in relation to the objectives of: • protect, connect and enhance biodiversity throughout the region • manage development impacts within riverine environments • increase natural hazard resilience.
Reconnecting River Country Program	The Reconnecting River Country Program aims to achieve a balance of economic, social, cultural and environmental outcomes across southern NSW by improving wetland and floodplain connectivity. The program focuses on delivering local community benefits, as part of the NSW Government's policy on delivering sensible, community driven Murray-Darling Basin Plan outcomes. The program focuses on relaxing or removing some of the constraints or physical barriers impacting the delivery of water for the environment. One area of focus is the Murrumbidgee River in the southern-connected Murray-Darling Basin. The program is part of the Sustainable Diversion Limit Adjustment Mechanism (SDLAM), which aims to achieve improved environmental outcomes using existing water for the environment.

2.5. Analysis of alternatives

The proposal and its design have been developed in partnership with the Yanco Stakeholder Advisory Group and the Yanco Technical Advisory Group. This partnership will continue during further detailed design in parallel with, and beyond the EIS. Details on the members and activities of these groups is provided in Appendix E and chapter 5.

2.5.1. Option identification

A joint government enterprise was set up following the Snowy River Inquiry in 2004. This aimed to identify and implement water savings projects in the Murray, Murrumbidgee and Goulburn rivers in order to return flows to the Snowy River and Murray River. Following this, as discussed in section 1.3.2, extensive investigations have been undertaken to identify opportunities for improving water management in the Yanco Creek system since 2015. The first investigation was the *2015 Business case for modernising supply systems for effluent creeks – Murrumbidgee River* (WaterNSW, 2015).

Broadly this investigation considered the following:

- alternate supplies to supplement current flows in the creeks that are sourced from the Murrumbidgee
- control upgrades including to existing infrastructure and provision of new control infrastructure.

Following the investigation, the business case selected a prioritised program of works that will deliver the best return for the investment. A major suite of measures was identified that involved interventions to provide WaterNSW with greater management over flows within the creeks in order to implement effective controls. The development of the recommended suite of works involved assessment of a number of options comprising:

- Block banks and weirs: many installed over the last 150 years to supplement supplies at the local scale but which now interrupt and frustrate flow management of the creeks. Previous studies have identified a program of works to remove and modify these installations.
- Regulators: WaterNSW needs greater controls on flows within the creek system to be able to manage the delivery of diversions demands efficiently and with least loss. A range of options were reviewed for additional controls on existing fixed crest weirs to identify a cost effective package that also minimised interventions in the creek to retain 'natural flows'. That review included:
 - Puckawidgee regulator
 - Hartwood regulator
 - Wanganella regulator
 - Gauging stations regulator.

2.5.2. Option analysis

An evaluation of the options identified in the 2015 Business Case (DPI, 2015) was undertaken. In addition, further options developed through consultation with the Yanco Technical Advisory Group and the Yanco Stakeholder Advisory Group were also evaluated. This evaluation assessed the options based on:

- SDLAM objectives including water saving achieved, value for money and deliverability
- environmental, heritage, social, economic and outcomes
- likelihood of being approved.

Multi-criteria analysis was carried out based on readily available “desktop” information, supported by technical advice as required. Following completion of the multi-criteria analysis, outcomes were discussed with the Yanco Stakeholder Advisory Group and the Yanco Technical Advisory Group to agree and confirm the proposed recommended options.

Through the evaluation, a number of projects were selected as a priority for further design and assessment. This included the following infrastructure upgrades:

- Hartwood Weir: removal of part or all of the existing weir and replacement with a new regulator
- Wanganella Weir: removal of part or all of the existing weir and replacement with a new regulator
- Caroonboon Weir: removal of part or all of the existing weir and replacement with a new regulator
- Piccaninny Weir: removal of part or all of the existing weir and replacement with a new regulator.

These four infrastructure upgrades were combined into one project to be progressed to concept design, and hydrological modelling and value engineering. The value of progressing all four structures was reviewed in this process with the results presented in section 2.5.3 and section 2.5.4.

2.5.3. Concept design

Concept designs for the proposal were developed in consultation with the Yanco Design Focus Group and members, including WaterNSW, and with consideration to the following design criteria:

- relevant Australian Standards
- local industry and other national standards and practices

- current NSW DCCEE standards or work practices.
- WaterNSW standard and specifications.

As part of concept design, refinements were investigated to enhance the positive outcomes of the proposal and minimise impacts. The design criteria were developed in consultation with the Yanco Technical Advisory Group and included requirements concerning:

- Fishways including differential head, slot water velocity, fishway floor slope, head loss and flow passing requirements.
- Fish passage including separate criteria for active fish passage on a main creek and passive fish passage on a flow return path or on an upper floodplain site. Criteria including differential head, slot water velocity, fishway floor slope and head loss, passage delays and ramp slopes.
- Gates for regulators including number, arrangement, design condition and maintenance provisions.
- Erosion control including control measures for vegetation, rock, synthetic matting, gabion walls and concrete aprons.
- Levees and blocking banks including crest design (width, level and freeboard, batter slope, foundations, bank stability, seepage control, material specification, filters and spillways).
- Access tracks and roads including access plans, track type and class, materials for construction, signage, grades, and temporary access tracks.

To develop concept designs for the proposal that met the design criteria, information was gathered from:

- a series of workshops with key stakeholders
- preliminary hydrologically modelling conducted by the former DPE-Water exploring potential environmental equivalence / water savings achieved by potential designs
- a conceptual fish model for the Yanco Creek system.

2.5.4. Concept design alternatives

Process for analysing alternatives

The following alternatives were considered at concept design:

- need and justification for each regulator
- location of the regulators within the creek system
- core structures
- types of fish passage
- source and alignment of power supply
- access track locations
- construction methodology.

Design choices were supported by a multi-criteria analysis which considered the following issues:

- base cost (approximate capital cost)
- environmental issues
- cultural heritage issues
- landowner issues
- operations, maintenance and safety
- constructability.

The findings of the multi-criteria analysis were analysed in a series of workshops attended by NSW DCCEEW, contractors, and technical advisory group members. The analysis found that constructing the new regulators in the dry, outside of the existing stream channel, raised construction benefits including the management of groundwater and risks associated with construction during high flows. However, this method of construction was also found to have issues and would require further landowner consultation, including:

- excavation and stockpiling management
- environmental, social and cultural heritage impacts
- geomorphology
- land use impacts
- material resourcing
- construction activities and transportation
- cost.

Key changes to the concept design

As a result of the analysis of alternatives and a review of the need for each new regulator, significant improvements to the concept design were identified.

Downstream, in-stream construction was chosen for the new regulators due to the option's reduced need for earthworks, higher community support and reduced environmental and cultural heritage impacts.

The original concept design proposed in the scoping report for the EIS (DPE, 2022a), included new regulators at the Caroonboon and Piccaninny Weirs. Following the submission of the EIS scoping report additional assessment was carried out resulting in the proposed works at Caroonboon and Piccaninny being excluded from the proposal. These proposed works were excluded primarily due to:

- Impact to biodiversity. Ecology surveys undertaken for the EIS determined that significant biodiversity values may be impacted if works at these locations were progressed.
- Further hydrological modelling established the majority of water delivery efficiency could be obtained through replacement of just two weirs.
- Considerable upgrades required to access tracks and power supply constraints at these two locations.
- Poor value for money considering the potential environmental impacts and low levels of water delivery efficiency.

The reduced scope of the proposal provided substantial environmental benefits, in particular:

- potential impact to biodiversity values at these two locations would be avoided
- reduced social impacts from avoidance of construction activities affecting noise, air quality, local traffic conditions and land use
- water delivery efficiency benefits would still be obtained from construction of just Wanganella and Hartwood Regulators.

2.5.5. Consequences of not doing the proposal

The consequences of not doing the proposal would be the following:

- increased risk of additional water market purchases to meet Sustainable Diversion Limits defined in the Basin Plan
- the existing weirs would continue to degrade
- water delivery to consumptive users and the environment would continue to be slow and inefficient
- fish movement would continue to be impeded.

2.6. Potential cumulative impact

The potential for cumulative impacts has been included as part of relevant technical assessments of the EIS. The cumulative assessment has considered the *Cumulative Impact Assessment Guidelines for State Significant Projects* (DPIE, 2021a). Chapter 23 provides a summary of the cumulative assessment.

The proposal is part of the regional SDLAM program which combined is being developed to improve the efficiency of water management across the Yanco Creek System. Cumulatively the SDLAM projects would benefit Billabong Creek by improving the ability to deliver the right amount of environmental and consumptive (town and irrigation) water to the right place at the right time and to improve the passage of native fish through the system. The proposal would assist delivery of improved environmental outcomes compared to current conditions. This is further discussed in section 2.1.

The proposal has been developed to minimise the potential for adverse cumulative impacts through hydrological modelling which has enabled the design of the proposal to design out impacts where possible. The proposal also included mitigation and management measures to avoid or minimise potential adverse cumulative impacts (refer to Appendix F).

There is some potential for adverse cumulative impacts even after mitigation and management measures have been incorporated, which relate principally to biodiversity and heritage.

2.7. Third party agreements

Third party agreements would be required for this proposal to proceed. Agreement would be required for the following activities:

- permanent access track easements
- provision of power and power corridor easements
- leasing of land for construction activity zones, borrow pits and construction access tracks.

Further details on property requirements are provided in section 3.5.

2.8. Sustainability assessment

A sustainability assessment has been conducted for the concept design of the proposal which included the following aspects:

- An assessment against an accredited ecological sustainable development (ESD) rating system aiming to meet as a minimum the following rating scheme target level. An ESD assessment report is included as Appendix S to the EIS.
- Climate modelling in accordance with NSW and ACT Government Regional Climate Modelling (NARCLiM) version 1.5 or later. A climate risk assessment report is included as Appendix S to the EIS.
- Consider how ecological sustainable development principles (as defined in section 193, division 5, part 8 of the EP&A Regulation) could be incorporated in the proposal.

The ESD Assessment has been conducted to address the SEARS and determine how the proposal can adhere to the ESD principles. Due to the nature of the proposal, it poses a relevant opportunity to provide positive sustainability impacts to the community and the environment.

The Infrastructure Sustainability Essentials rating tool has been recognised as a suitable pathway for compliance with the ESD principles. This tool is recognised by the Infrastructure Sustainability Council as the most widely used sustainability rating scheme for infrastructure projects in Australia. This assessment resulted in a list of recommended key issue conditions to help achieve SEARs requirements and, where feasible, mitigate or manage residual sustainability risks and impacts. Recommendations comprised:

- Environmental Compliance and Monitoring: The proposal must achieve a minimum Essentials 'Design' and 'As Built' Rating (Version 2.1).
- Energy and carbon management: The proposal must be designed in detailed design and built stage to minimise the embodied and operational greenhouse gases emissions to the maximum feasible extent possible, and to replace the use of fossil fuels with renewable sources of energy.
- Climate risk and resilience: The proposal must be designed to withstand any high to very high risks identified in detailed design associated with climate change to year 2100 using an assessment comprising RCP8.5 (AR5) and SSP5-8.5 (AR6) scenarios with timeframes of 2050, 2070 and 2090 in accordance with climate information assets. This should include, but not be limited to, the NSW Common Planning Assumptions as well as the Climate Change Considerations chapter of *Australian Rainfall and Runoff: A Guide to Flood Estimation*. Noting that no high to very high risks were identified in concept design.
- Circular Resource Management: The proposal should have a comprehensive waste management plan that promotes recycling and responsible disposal of construction materials. This plan should be developed in detailed design stage and updated in built stage.
- Water Stewardship and Efficiency: The proposal must develop and implement an integrated water management plan for the proposal construction and operation, encompassing impact modelling, goal setting, measure identification, and monitoring aligned with water quality goals. This plan should be developed in detailed design stage and updated in built stage.
- Biodiversity: The proposal must incorporate design strategies to minimise impacts, develop management plans for ecological outcomes, and model post-development ecological values to ensure no quantifiable loss compared to its pre-development state. This plan should be developed in detailed design stage and updated in built stage.

A climate risk assessment has been conducted to address the SEARs and determine how the proposal can address climate risks. The assessment was prepared in alignment with Australian Standard 5334:2013 for Climate Change Adaptation for Settlements and Infrastructure. Utilising NARCLiM 1.0 and 1.5 and projections from the Commonwealth Science and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology (BOM), the assessment provides an understanding of potential climate change impacts on the proposal's assets.

NARCLiM version 2.0 was published shortly before the finalisation of this EIS and after the ESD and climate risk assessment was completed for the proposal. Due to the remote in-land location of the proposal sites, it is anticipated that any change to the risks or level of risk identified due to the new data published with NARCLiM 2.0, would be minimal.

A total of twelve climate change risks were identified, based on hazards including extreme rainfall, storms, bushfires, and temperature. Notably, none of these risks were rated as 'High' or 'Extreme' (refer to Appendix S). Six were categorised as 'Low' and six as 'Medium' for the 2090 timeframe. The risks identified are presently manageable with appropriate mitigation measures in place.

Emerging climate change risks would be considered by WaterNSW, as needed and appropriate, during the life of the regulators, to ensure the resilience of the proposal's assets.

3. Proposal description

This chapter provides a description of the proposal including activities associated with construction and operation of each component of the proposal. The proposal described in this chapter is based on a concept design and design information available at the concept design stage. Flexibility has been provided in the description of the proposal to allow for refinement during detailed design and in response to ongoing consultation and public exhibition of this EIS. The final design of the proposal may therefore vary from the concept design described in this chapter.

3.1. The proposal

3.1.1. Proposal overview

The proposal comprises the construction of two new regulators to replace two existing weirs along Billabong Creek. The two existing weirs to be replaced are Hartwood Weir and Wanganella Weir. The new regulators would be fully automated and remotely operated. It is intended that WaterNSW would own and operate the new regulators, and would be subject to execution of a Delivery Deed between NSW DCCEE and WaterNSW.

Table 3.1 and Table 3.2, provide a simple overview of the proposal including the main elements of construction and operation. The estimated development cost for the proposal as a whole is \$83,550,900.

Table 3.1 Proposal summary – Hartwood Regulator

Proposal element	Summary of the proposal	Figure reference
Hartwood proposal site size	About 15.05 hectares (refer to Table 3.4 for details)	Figure 3.1, Figure 3.2
Proposal location	Edward River LGA. Around 10 kilometres east of Conargo village	Figure 1.1
Regulator Lots	1 / DP707463; 28 / DP756330	Figure 2.4
Land zoning	RU1 Primary Production	Figure 2.4
Haul road locations	Generally between Conargo Road and the proposal site	Figure 3.1, Figure 3.2
Power lines	Generally between the proposal site and Conargo Road	Figure 3.1, Figure 3.2
Supporting infrastructure	Forest Creek block bank upgrade: upstream of Hartwood Weir on 7301/ DP1162488 Hartwood borrow pit: west of Hartwood Weir on 56 / DP756322 Culvert at private drainage channel: southwest of Hartwood Weir on 27 / DP756330 Permanent access tracks Overhead and underground power lines	Figure 2.4, Figure 3.1, Figure 3.2
Commencement of operations	Construction is anticipated to start in 2025, and be completed by 2026, once all required approvals for the proposal have been obtained. The construction period is anticipated to be around 18 months.	-
Design life	Up to 100 years	-
Construction workforce	It is estimated that up to 26 personnel would be required on site.	-

Table 3.2 Proposal summary – Wanganella Regulator

Proposal element	Summary of the proposal	Figure reference
Wanganella proposal site size	About 6.24 hectares (refer to Table 3.4 for detail)	Figure 3.3
Proposal location	Edward River LGA. Around one kilometre southwest of Wanganella village	Figure 1.1
Regulator Lots	7005 / DP1024202; 7004/DP1024203	Figure 2.6
Land zoning	RU1 Primary Production	Figure 3.3
Haul road locations	Generally between Zara Road (Crown land) and the proposal site and Cobb Highway and the proposal site	Figure 3.3
Power lines	Generally between the proposal site, along Zara Road (Crown land) to the Cobb Highway	Figure 3.3
Supporting infrastructure	Flood bypass channel: north of Wanganella landfill on 7004 / DP1024203 Permanent access tracks Power lines	Figure 2.6, Figure 3.3
Commencement of operations	Construction is anticipated to start in 2025, and be completed by 2026, once all required approvals for the proposal have been obtained. The construction period is anticipated to be around 18 months.	-
Design life	Up to 100 years	-
Construction workforce	It is estimated that up to 26 personnel would be required on site.	-

3.1.2. Footprint of the proposal

The footprint of the proposal including construction activity area, vegetation clearing, access tracks, and power connections is shown in Figure 3.1 and Figure 3.3. A description of key activities shown on the figure are provided in Table 3.3.

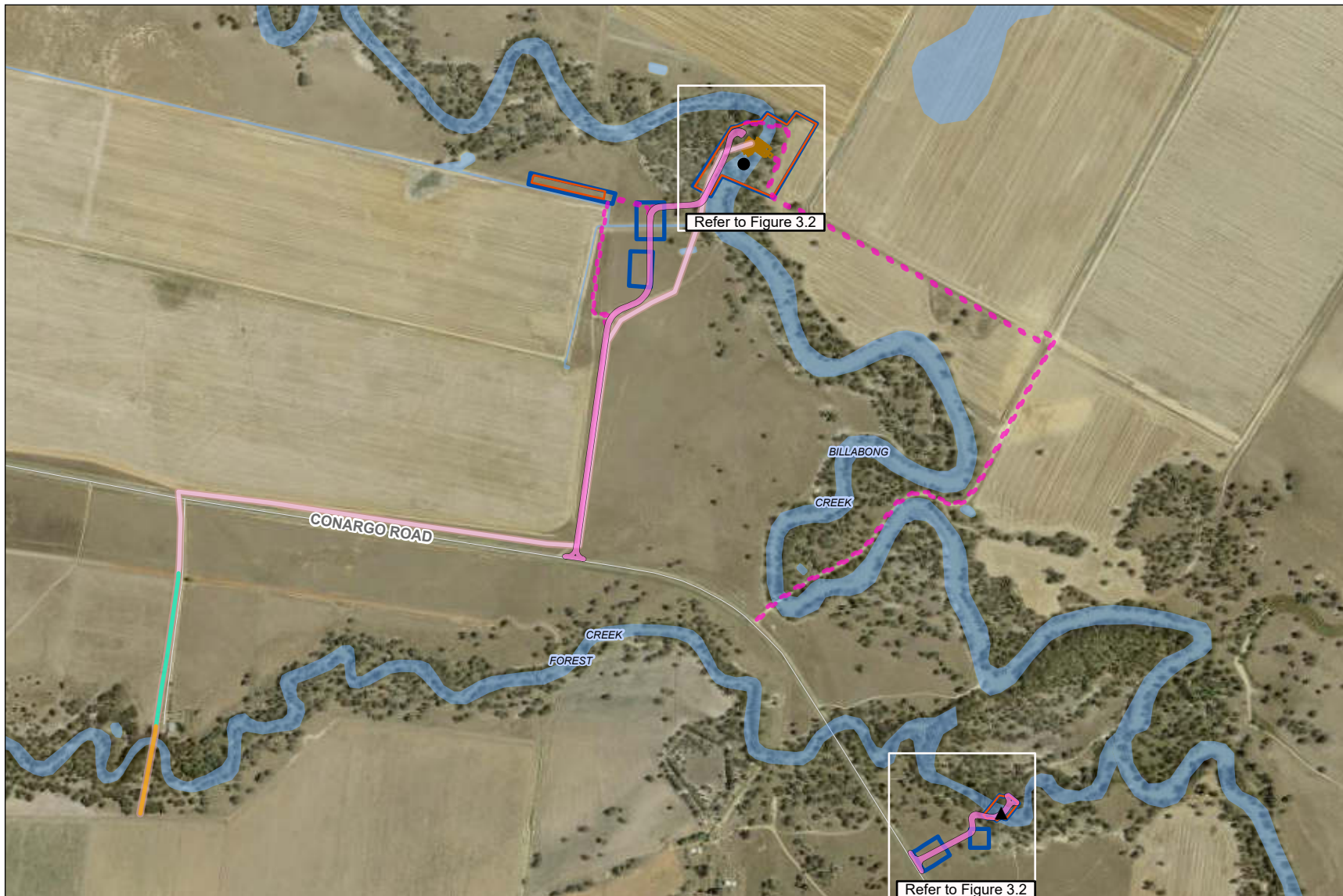
Table 3.3 Proposed activities

Proposed activities	Description of activity
Proposal footprint / proposal site	The proposal footprint (also known as the disturbance area) includes all locations, terrestrial and in-stream, where the proposal directly impacts the land surface or water body. This includes clearing areas, construction activity zones, access tracks and power supply routes.
Clearing area	This is the area required to construct the proposed infrastructure. Within this area it is assumed that all vegetation would be removed, including trees and ground cover vegetation. Borrow pits also include a clearing area. However this is a conservative assumption and contractors would be encouraged to avoid removal where they can (through proposed mitigation measures).
Construction activity zone (CAZ)	The area surrounding and including the 'clearing area' that would be used for construction purposes e.g., laydown, site sheds, parking. It is assumed topsoil will need to be removed/cleared, with some re-grading to create level areas with grubbing and clearing of small shrubs/grasses. Trimming of trees may be required. Tree removal would not occur in portions of the CAZ outside of a clearing area.
Access tracks	It is expected that some upgrade works would be required to provide access during construction. They may include construction of new access tracks or improvements to existing tracks, to make them suitable for the construction activities. Upgrades may include some light grading, resurfacing and compaction. Tree trimming may be required. It is assumed all tracks would be 5.0 metres wide. This is unless there are constraints that require a narrower corridor at a specific location, for example to avoid impacts to biodiversity. Within the access track corridor removal of all vegetation is assumed.
Power supply	Each site would require electricity supplied to the regulators, to power the equipment. The infrastructure would include both overhead and underground cables. A corridor for the power supply is assumed to be 20 metres wide, within which all vegetation is assessed as being cleared to maintain necessary minimum safety clearances. However the corridor is likely to be narrower in some locations where the cable is underground and vegetation trimming or clearing would only be required for the width of the trench and construction access. A section of existing overhead power line, south of Forest Creek, would require re-cabling. Existing poles, easement and access to the established powerline would continue to be used.

Table 3.4 provides a breakdown of the different areas of potential impact for the proposal site, at each location.

Table 3.4 Proposal site area breakdown

Activity	Wanganella (including bypass channel) (hectares)	Hartwood (including Forest Creek block bank) (hectares)
Total construction footprint	6.24	15.05
<i>The areas listed below are totals for each feature, including overlap with other features</i>		
Construction activity zone	5.64	7.42
Clearance areas	4.37	4.88
Access track corridors (construction only)	0.09	1.22
Access track corridors (Permanent)	0.84	0.82
Power supply corridors	1.83	6.51



Proposal

- Proposed Hartwood Regulator
- Construction Activity Zone
- Clearing Area

Power Supply

- Power Supply
- Power Supply (Existing aboveground)
- Power Supply (to run underground)
- Power Supply Buffer

Access Tracks

- Construction Only
- Construction plus O&M

Existing features

- Existing Weir
- ▲ Existing block bank
- Main Road
- Water Bodies

N



GDA2020 MGA Zone 55

A4 Scale: 1:16,000

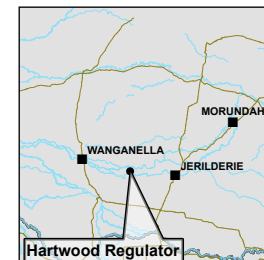
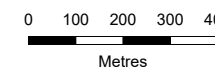
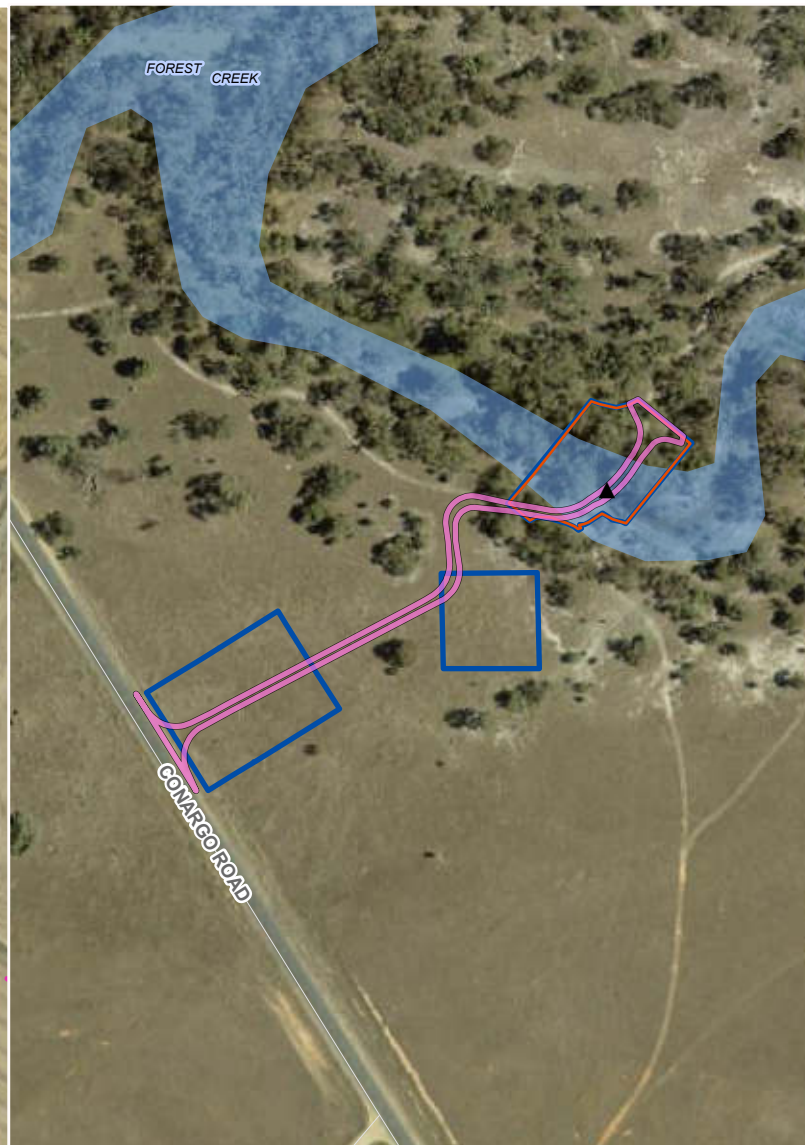
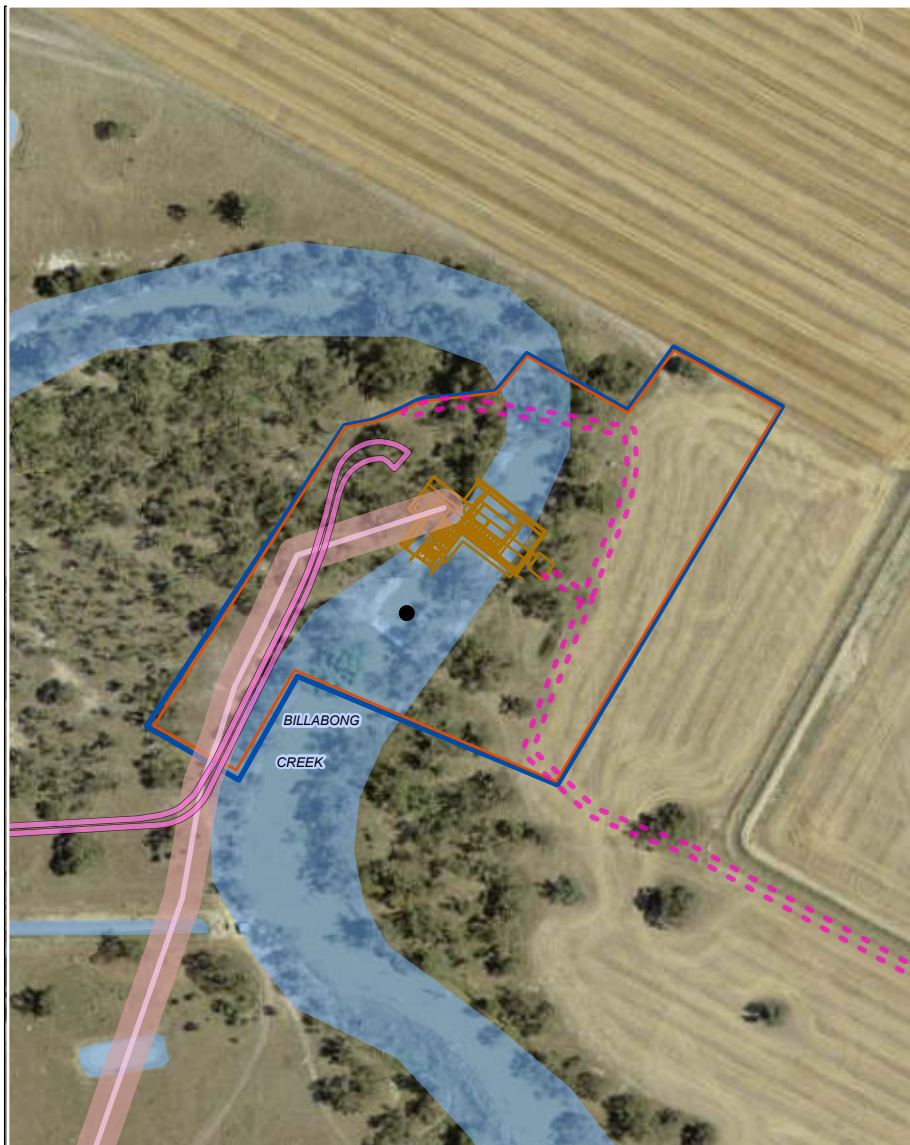


Figure 3.1 Location of Hartwood Regulator and Proposed Works



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- Proposal**
- Proposed Hartwood Regulator
 - Construction Activity Zone
 - Clearing Area
- Power Supply**
- Power Supply
 - Power Supply (Existing aboveground)
 - Power Supply (to run underground)
 - Power Supply Buffer
- Access Tracks**
- Construction
 - Permanent
- Existing features**
- Existing Weir
 - Existing Block Bank
 - Main Road
 - Water Bodies

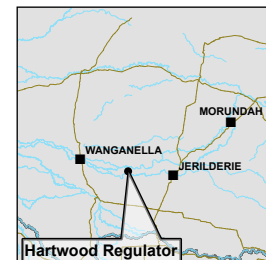
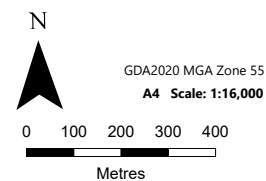


Figure 3.2 Location of Hartwood Regulator and Proposed Works



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3.1.3. Key features of the proposal

The proposal involves replacing two existing weirs along Billabong Creek with new regulators including fishways.

The core structure of the two regulators is similar and would include:

- concrete piers with maintenance bulkhead slots
- automated layflat gates across the crest of the structure to assist with flow management and downstream fish passage
- a low turbulence 'keyhole' type vertical slot fishway with allowances for variable headwater to provide upstream fish passage
- automated sidewinder gates within the vertical slot fishway to allow for variable headwater conditions
- fixed concrete crests on the opposite side of the gates to the vertical slot fishway
- concrete apron downstream of the structure
- concrete wingwalls upstream and downstream of the structure
- access from a trafficable deck for maintenance (Hartwood Regulator only)
- pedestrian walkway access part way across Wanganella Regulator structure to facilitate housing of gate actuators and for maintenance
- walkway grating over gates to facilitate operations and maintenance
- crushed rock maintenance pads, access and turnaround areas adjacent to the structure
- rock beaching upstream and downstream of structure for erosion protection
- control house
- sheet pile cut-off walls beneath the structure
- fencing of the structures to prevent public access
- SCADA control system.

An indicative layout of a regulator is shown in Figure 3.4. This layout provides an example of a regulator with five gates, a fishway (on the left) and a trafficable deck for maintenance access.



Figure 3.4 Indicative layout of a regulator

The proposal would also involve the following elements:

- Power supply to the regulators would be provided by a mix of underground and overhead electricity cables connecting the structures to the grid. Discussed further in sections 3.3.5 and 3.4.6.
- Access to the regulators would require permanent tracks for maintenance and some additional tracks to support construction only. Track upgrades include a new drainage culvert at Hartwood. Discussed further in sections 3.2.2 and 3.3.12.
- The existing Forest Creek block bank, associated with the Hartwood Regulator, is in a degraded condition. This will be replaced with a similar earthen structure in the same location. This structure is described in section 3.2.2.
- The Wanganella flood bypass channel would be constructed to reduce potential upstream flooding impacts from the Wanganella Regulator. The channel would enable flood waters to drain between the billabongs in the Wanganella Reserve during flood events. This feature is described in section 3.2.2.
- An existing privately owned borrow pit on lot 56 / DP756322 near Hartwood Weir would be extended to provide material for the construction of Hartwood Regulator and Forest Creek block bank. This feature is described in section 3.2.2.

3.1.4. Design

This section provides a detailed description of the concept design of the proposal. Concept design plans are provided in Appendix B. The design would be further refined at the detailed design stage.

Design criteria

Relevant standard and guidelines have been adopted to ensure the proposal is designed to be safe, effective, well-planned, and easily maintained. These include standards and guidelines from, but not limited to, the following sources:

- Aus Standards
- Austroads
- Australian road research board guidelines

- Australian National Committee of Large Dams
- WaterNSW
- design guidelines from suppliers
- utility supplier standards.

Key design considerations included:

- asset ownership
- design standards
- design life and material selection
- flow measurement and water quality monitoring
- safety in design and constructability
- amenity
- character or appearance of the infrastructure or works
- cultural and heritage considerations
- quality of the infrastructure
- social impacts related to access
- site management and rehabilitation.

The relevant design criteria adopted for the proposal are summarised in Table 3.5.

Table 3.5 Design criteria

Criteria	Relevant regulator	Requirement
Water management	Hartwood	• manage and maintain flows through Forest Creek
	Wanganella	• maintain weir pool for town water supply
	Both	• increase operational flexibility
Fish passage	Both	• provide low turbulence 'key-hole' type vertical slot fishway designs, with allowances for variable headwater to provide upstream passage for fish • provide layflat gates, where possible
Access	Both	• provide secure construction and maintenance access
Impacts	Both	• limit impacts to upstream pump stations and other third-party assets • limit impacts to environment and heritage matters
Control	Both	• provide automated and remote operation to river operators

3.1.5. Constraints and risks

Building and operating the proposal poses a number of engineering, social, and environmental constraints and risks. Constraints and risks have been identified through constructability workshops and stakeholder engagement and were considered during the design development.

Table 3.6 lists the main constraints and risks and discusses how they have been addressed in the concept design.

Table 3.6 Constraint and risks to the proposal

Constraint	Provision
Billabong Creek	Flow levels and changes have to be managed within the capacity of Billabong Creek in accordance with the design criteria of the proposal: - to maintain minimum flows required for existing users - manage maximum flows to avoid negative flooding impacts - manage water height changes to support key species. The designs of the regulators have considered minimum and maximum water heights required and have operating principles in place to govern their use (refer section 3.4.1).
Aboriginal heritage	There are numerous Aboriginal cultural heritage sites in the vicinity of the proposal sites (refer chapter 12). Impacts to Aboriginal cultural heritage sites were considered during development of the design and have been avoided where possible. In-channel construction was chosen to reduce the proposal's disturbance footprint and lower the risk of impacting Aboriginal cultural heritage sites.
Flooding risk	The regulator options were analysed with an aim to reduce the risk of flooding to nearby properties (refer to chapter 7).
Riparian vegetation	There is native vegetation along the riparian corridor of Billabong Creek that should be retained, where possible. In-channel construction was chosen to reduce the clearing that is required for the proposal.
Land acquisition / easements	The proposal sites are located on a combination of private and Crown land. Private landholders were consulted to find acceptable options (refer section 3.5).
Utility supply	Provision of electricity to the new infrastructure to power the gates. Feasibility and constraints of both solar power and new utility lines were considered.
Access	Access to the proposal site is via a number of existing roads and tracks. While some portions of tracks would be upgraded to facilitate heavy machinery access, the extent and composition of upgrade is dependent on the permanency and existing condition of any present tracks. None of the existing tracks would be sealed as part of the proposal. As such, construction would need to follow communication protocol to manage access (refer section 3.3.11).

3.2. Major design features

3.2.1. Regulator structures

An indicative cross section of the regulators is shown in Figure 3.5. and a horizontal cross section in Figure 3.6. The base of the regulator would be made of a concrete layer poured to provide a clean and all-weather working platform.

The concrete abutments and piers of the regulator, as well as the fishway, would sit atop the concrete base. The concrete piers would be fitted with maintenance bulkhead slots and would house layflat gates. On one side of the gates, a vertical slot fishway will be constructed with the regulator abutments on the other side acting as a fixed concrete crest.

A permanent sheet wall would be installed upstream of the regulators. A geotextile layer and rock beaching would be placed on the creek bed for about 3.0 metres upstream and downstream of the regulator. The rock beaching would help to protect the creek bed from erosion.

At Hartwood Regulator, a precast trafficable deck would be constructed on top of the regulators to enable access. Walkway grating would be placed over the gate bays and would house the actuators for the gates and allow for maintenance activities. These structures would be for maintenance purposes only and would be gated off to prevent public access.

At Wanganella Regulator, a walkway grating would be placed over the gate bays for maintenance activities and a short elevated walkway would be built to house the actuators for the gates.

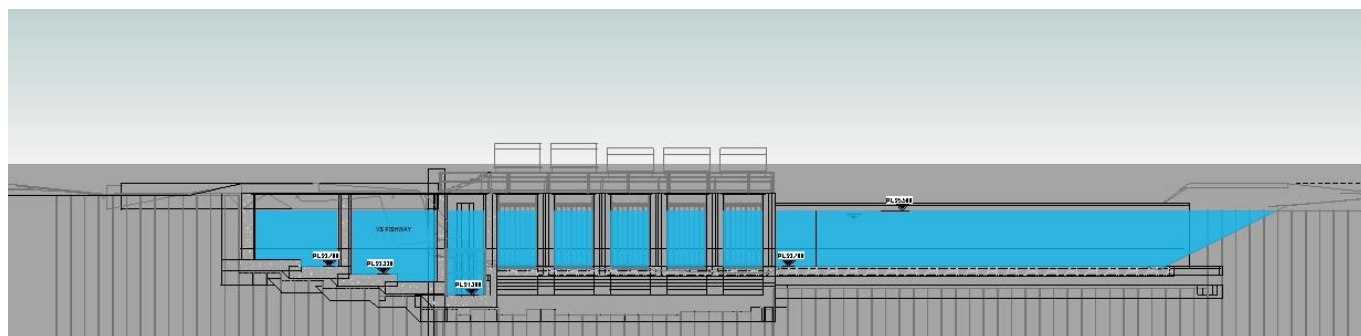


Figure 3.5 Indicative cross section of a regulator

Layflat gates

The regulators would contain automated layflat gates which would lie across the crest of the structures. The layflat gates would be controllable and would allow river regulators to let flow through at a desired rate. They would also measure flows as they passed and enable fish to move downstream of the regulators through the provision of a plunge pool and stilling basin downstream of the gates.

The number and sizing of the gates was informed in consultation with the Yanco Design Focus Group after initial hydraulic modelling. Subsequent modelling indicates that Hartwood Regulator would have five layflat gates 2.0 metres in width and Wanganella Regulator would have four layflat gates 2.0 metres in width. The height of the gates differs for each site at around 2.40 metres at Wanganella and around 3.34 metres at Hartwood, from the upstream concrete sill to the top of gate. Figure 3.6 illustrates how a layflat gate operates in the creek.

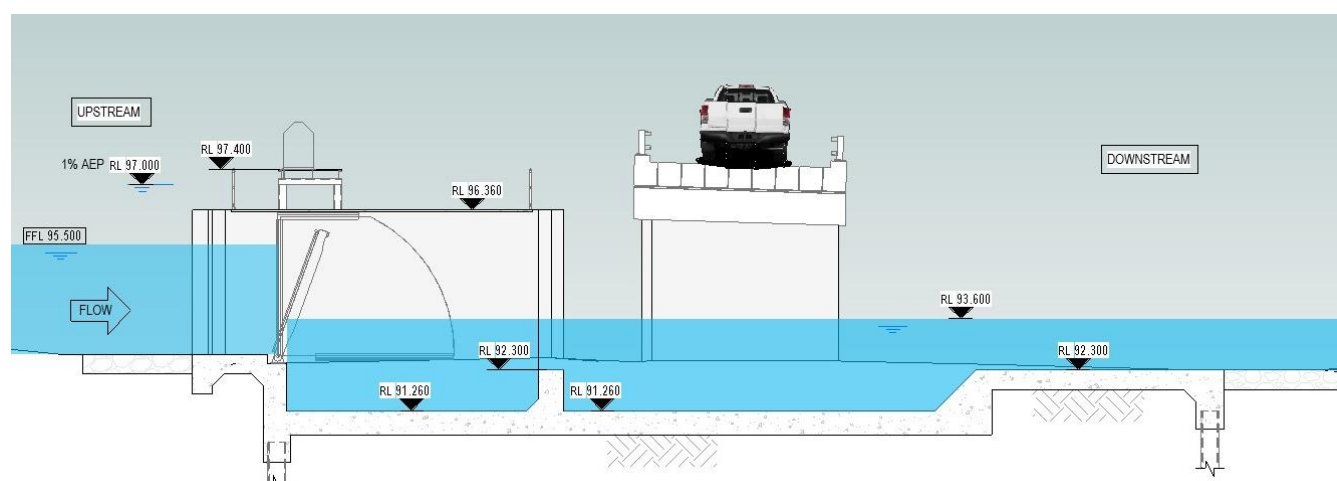


Figure 3.6 Indicative horizontal cross section of a regulator, showing the action of a regulator gate

Keyhole type vertical slot fishways

Each regulator would include a low turbulence 'keyhole' type vertical slot fishway. These fishways would be positioned adjacent to the regulators (as shown in Figure 3.5) and would enable fish to move upstream of the structures.

The fishway designs were informed by fish modelling (Stuart, 2022) and are intended to provide upstream passage for fish sized 3 to 100 centimetres long.

Control system and control house

The regulators would be controlled using the SCADA control system. This would enable the operator to remotely operate the structures.

Data would be relayed to the SCADA control system from monitoring and recording equipment located in the control houses located on land adjacent to the regulators. Each control house would be surrounded by a fence around 1.8 metres high.

Power supply

Power supply to the regulators would be provided by a mix of underground and overhead electricity cables connecting the structures to the grid. Proposed power routes and connection points are shown in Figure 3.1 and Figure 3.3. Power supply controls would be located within the control houses.

Access

Access to the regulators would require permanent tracks for maintenance and some additional tracks to support construction only. These would be provided by existing roads and tracks, where possible, as shown in Figure 3.1 and Figure 3.3.

Key features of the access tracks include:

- The majority of permanent access tracks will require upgrading. Upgrades would include improvements to the track surface and minor refinement to existing alignments, i.e. to straighten sections where needed and provide suitable turning curves for the types of vehicles requiring access (refer to section 3.3.12).
- As part of the access track upgrades at Hartwood Weir, a new culvert would be installed within an existing farm irrigation channel to provide a crossing point for vehicles.
- The flood impacts assessment identified that a section of the proposed access track to the Hartwood Regulator crossed a flood runner. If this flood runner is blocked this would lead to a minor increase in flood levels upstream. The access track has been modified in the design to incorporate a floodway through this section to design out this potential impact
- Permanent access for maintenance activities would use tracks which have a negotiated right of carriageway or easement for access.

The top of the Hartwood Regulator would also be trafficable by maintenance vehicles but secured with a gate from the public. Wanganella Regulator would have a pedestrian walkway only, also secured with a gate.

3.2.2. Other supporting infrastructure

Forest Creek block bank

The existing Forest Creek block bank, associated with the Hartwood Regulator, would be replaced with a similar earthen structure to the existing. This would include two concrete sills to define the upstream and downstream top of bank and armoured with rock beaching and crushed rock for erosion protection. The new structure would be around 0.6 metres above the existing height. The extent of work depends on the outcomes from hydraulic modelling.

The existing vehicle access across the block bank would be maintained with the new structure.

The existing Forest Creek block bank is unlicensed. It is intended that WaterNSW would own and maintain the new block bank once constructed.

Wanganella Flood bypass channel

A flood bypass channel would be constructed to reduce potential upstream flooding impacts from the Wanganella Regulator. The channel would enable flood waters to drain between the billabongs in the Wanganella Reserve during flood events. It would be 85 metres long, around 40 metres wide and 1.7 metres deep at the deepest point and located north of the Wanganella landfill. Once completed the channel sides and base would be natural and vegetated with a local native grass species.

For further information refer to the flooding assessment in chapter 7.

Irrigation channel culvert

A new track would be constructed to provide access to the eastern side of Hartwood Regulator. This would require installation of a culvert where the proposed access track crosses an irrigation channel used for farming.

Borrow pit

Construction would require soil material from borrow pits. An existing privately owned borrow pit on lot 56 / DP756322 near Hartwood Weir would be extended as part of the proposal. This material would be used during construction of Hartwood Environment Water Regulator and Forest Creek block bank.

Waterway safety equipment

Safety features would be included to provide warnings to swimmers and water craft of structures within the waterway.

Temporary features would be provided during construction around the works areas.

Permanent features include a physical floating buoy system which would be installed across the waterway upstream of the structure, to restrict access to the structure and to delineate a no-go zone within the creek for boats and recreational users. Site warning signage would be provided to complement this.

3.3. Construction activities

3.3.1. Construction timing and duration

Construction of the proposal is anticipated to start in 2025, and be completed by 2026, once all required approvals for the proposal have been obtained. The construction period is anticipated to be around 18 months. Construction would pause during periods of high flow.

Standard construction hours would be adopted in accordance with the *Interim Construction Noise Guideline* (ICNG) (DECC, 2009) as shown in Table 3.7. Most construction activities would be undertaken during this time.

Table 3.7 Standard construction hours

Day	Start time	Finish time
Monday to Friday	7.00 am	6.00 pm
Saturday	8.00 am	1.00 pm
Sundays and public holidays	No regular work	

Notwithstanding this, the *Interim Construction Noise Guideline* (DECC, 2009) acknowledges that the following activities may need to be undertaken outside the recommended construction hours:

- emergency work
- delivery of oversized plant or structures
- works for which it can be demonstrated that there is a need to operate outside the recommended standard hours.

3.3.2. Work methodology

Construction of the proposal would be designed to enable water to be flowing through part of the creek throughout construction. To achieve this, the construction methodology proposed would be to undertake works on one half of the creek while the other half of the creek remains unobstructed to maintain the flow of water. This is achieved by utilising a temporary cofferdam around the work zone using sheet piles.

Generally, site establishment works would occur, then the structures would be installed and finally the site would be rehabilitated.

Final construction methodology would be defined by the construction contractor, but would be designed to enable water to be flowing through part of the creek bed throughout construction.

3.3.3. Site establishment

Site establishment would include vegetation removal, access track upgrades, establishment of construction activity zones, and hardstand areas.

Vegetation removal would be required as a part of site establishment, including for the establishment of:

- access tracks
- crane pad(s)
- crane's slew zones
- borrow pit.

In the clearance areas tree removal would be required, but minimised where possible. Within the construction activity zones, grubbing of surface vegetation may be required, but tree removal would not occur.

During site establishment, exclusion areas i.e. Aboriginal heritage areas, would be fenced off. Trees to be retained would be identified and provided with protection measures, where required.

Compound and laydown areas would be established to support construction (refer section 3.3.13). Access tracks would also be upgraded, where required (refer section 3.3.11).

A hardstand area would be constructed within the proposal site at the main works area at each site. The hardstands would facilitate the establishment of site facilities, laydown areas and parking segregation for both light vehicles and heavy plant. This hardstand areas would be cleared and grubbed and overlaid with a layer of crushed rock road base to create the hardstand.

3.3.4. Demolition of the existing weirs and block bank

The existing weirs would be demolished after the regulators have been completed and commissioned. They would be demolished using an excavator and a rock breaker. Earthworks would be carried out to the proposed design levels and the creek reshaped.

The majority of the structures would be demolished and removed, apart from the base slabs of both weirs and the Wanganella northern wingwall. Some parts of the structure sunk well down in the existing ground level will be left in-situ after the visible elements have been cut off.

The main demolition activities would include:

- Hartwood Weir
 - remove both wingwalls (abutments) down to the level of the existing floor of the structure
 - remove drop boards, walkways and concrete diaphragm walls (the main vertical slab that stops the water) down to the concrete base slab (apron level)
 - broken concrete surface will be roughly trimmed only
 - retain a small step, (around 300 millimetres) at the edge of the base slab on the waterway face of the wingwalls
 - reinstate the wingwall removal area with placement of fill (rock) to reinstate creek banks with appropriate beaching protection of any new earthworks
- Wanganella Weir
 - remove the northern wingwall (abutment) only down to the level of the existing floor of the structure
 - retain the southern wingwall (bank will collapse if this is removed)
 - remove drop boards, any steelwork and concrete diaphragm walls (the main vertical slab that stops the water) down to the concrete base slab (apron level)
 - remove and trim concrete wall at the face of the southern wingwall
 - broken concrete surface will be roughly trimmed only
 - retain a small step, (around 300 millimetres) at the edge of the base slab at the waterway face of the northern wingwall
 - reinstate the wingwall removal area with placement of fill (rock) to reinstate northern creek bank with appropriate beaching protection of any new earthworks.

The existing Forest Creek block bank is built of clay and rock and is currently in poor condition. In addition, the changes in water levels in the Billabong Creek would increase the frequency of overtopping of the bank in future. It is proposed to remove the bank and reconstruct it with local borrow soil and imported rock for

beaching. During the construction it may be possible to protect the site from flooding by a temporary reduction in the Hartwood weir pool level, otherwise a temporary coffer dam will be constructed on the upstream side. The temporary coffer dam is expected to be constructed using soil from the existing bank, that will later be removed.

The structure would continue to be trafficable and will maintain the existing access track connections on either side of the creek.

3.3.5. Utility service

Each site would require electricity supplied from the grid to the regulators, to power the equipment. The infrastructure would include both overhead and underground cables, owned by Essential Energy.

The overhead line construction methodology includes installation of new poles and cables. Construction activities would include:

- Poles are directly embedded into ground. The holes for the poles are mechanically drilled, as per required hole diameter and depth.
- Before installation the poles are dressed with strain insulators.
- The poles are installed in the pre-drilled holes via a mobile crane.
- After positioning of poles, foundations are backfilled. Backfill is compacted and sloped away from pole to the natural surface level.
- Vegetation clearance areas, to provide a 20 metre easement are required for safety around any overhead cables, to prevent vegetation damaging the infrastructure. Any tree trimming required would be completed by a qualified tree surgeon in accordance with advice from an Arborist, prior to connection of the overhead wires.
- Cables are then attached to the poles and connected to the existing grid.

The works would be managed and carried out by Essential Energy Level 1 Accredited Service Provider.

The underground section of the electricity cable installation would be undertaken using open trench methods with conventional earthworks machinery (e.g., hydraulic excavators). The excavation of the open trench would require the following steps:

- Detailed survey of the cable route including location and protection of adjacent buried services (ensure that the installation of the conduit adheres to the separation requirements of the nearby asset authority).
- Coordination with relevant stakeholders including landowners.
- Excavate trench with a hydraulic excavator. The presence of any soft or wet (deleterious) material at foundation level shall be undercut and replaced with an approved fill material.
- The excavation would be backfilled either by the original spoil or imported spoil where required.
- The works would be managed and carried out by Essential Energy or their contractors.

The works would be managed and carried out by Essential Energy Level 1 Accredited Service Provider.

A small section of the cable alignment south of Forest Creek, at Hartwood would use an existing overhead line. The works would require connecting with this existing line on the northern side of Forest Creek. The existing line would require removal of the old cable and re-stringing of a new cable south of Forest Creek. The existing poles, easement and access to that area would be used.

3.3.6. Site rehabilitation

The sites would be rehabilitated and restored to previous condition, as far as possible.

Due to the remote location of the regulator sites and the site's natural landscape, a frequent maintenance program is not cost effective or in keeping with the existing environment.

At detailed design a rehabilitation strategy and planting schedule would be developed. This would consider the following design strategies:

- Endemic plant species would be planted in a natural planting design to replicate the existing environment and encourage natural re-vegetation.
- Stabilisation of the riverbanks through of re-vegetation of endemic species. Recycled rock and gravel edge interspersed with endemic riparian grass species would screen the fishway and regulator and integrate it into the surrounding landscape character while adhering.
- Encouragement of natural revegetation through provision of suitable ground surface. This would include:
 - back filling excavations with spoil from on site, where possible
 - the storage and re-use of top soil from any grubbing and levelling activities
 - using material from local borrow pits where possible, when additional material is needed.
- Weed management at completion to construction to reduce competition with newly planted native species and improve the appearance of the sites.
- Once vegetation is established, a maintenance program would not be required.

An excavator with a rock grab would be used to place rock on the excavated river embankment as scour protection.

At Wanganella camping reserve, picnic benches or other community features such as litter bins, that needed to be temporarily moved would be re-installed at completion of the construction program.

3.3.7. Construction workforce

The construction workforce is expected to fluctuate depending on the phase of construction and associated activities.

It is anticipated that up to around 26 personnel per day would be on site. This would relate to the more labour intensive activities including the regulator and fishway construction. Other activities, such as mobilisation and site setup would require less personnel on site each day.

3.3.8. Plant and equipment

The equipment expected to be used for construction of the proposal is listed in Table 3.8. The final equipment list would be identified by the construction contractor.

Table 3.8 Indicative construction equipment list

Indicative equipment		
Light vehicles (e.g. 4 wheel drive)	Various truck combinations including: - truck and trailer combinations - concrete truck.	Cranes including: - fixed crane 160-220 tonne capacity pin jab crawler crane - track or crawler crane (60 tonne) - mobile crane - franna crane.
Crew bus	Water cart	Concrete pump
Frontend loader	Compactor	Concrete vibrator
Dump truck	Pneumatic hammer	Sumps and dewatering pumps
Asphalt truck & sprayer	Grader	Piler driver (vibratory)
Smooth drum roller	Roller (large pad foot)	Vibratory roller
Bulldozer D9	Tub grinder/ mulcher	Power generator
Crew boat or barge	Excavator (25 tonnes and 13 tonnes)	Light tower
Scraper 651	Chainsaw 4-5 hp	

3.3.9. Earthworks, materials and waste

Earthworks and spoil

The proposal would involve earthworks for the following:

- clearing the creek bed of debris and silt, and removing some silt behind the existing weirs, if needed to gain access during the weir demolition works
- installation of cofferdams
- upgrades to access tracks.

The estimated quantities of material associated with earthworks are provided in Table 3.9. These volumes indicate there is expected to be an addition 3,250 cubic metres of material which would need disposal from Hartwood, and 1,490 cubic metres at Wanganella. The estimated quantities of how much fill can be reused and what would need off site disposal is provided in Table 3.10.

Table 3.9 Indicative earthwork quantities

Material	Hartwood Volume (cubic metres)	Wanganella Volume (cubic metres)
Spoil (total cut)	4,850	1,500
Material needed (total fill)	1,900	10

Table 3.10 Estimated volumes of re-usable fill

Material	Hartwood Volume (cubic metres)	Wanganella Volume (cubic metres)
Re-useable cut from site	3250	930
Re-useable cut minus the fill volume required (ie could be reused for another project)	1350	920
Unusable cut to be exported (requires disposal)	1,500	580
Total cut export	3,000	1,500
Fill to be imported	0	0

Excavated spoil would be reused for backfilling where possible and if the material is suitable. Surplus material that cannot be used on-site or on other projects would be classified in accordance with the *NSW EPA Waste Classification Guidelines* (NSW EPA, 2014a) and disposed of at an approved materials recycling or waste disposal facility. Further details of potential disposal sites are discussed in chapter 22. Otherwise, materials would be sourced from appropriately licensed facilities. It is likely that fill material and rock would be sourced from local quarries or landowners. Similarly, wherever possible materials would be sourced from commercial suppliers in nearby areas. This would be confirmed during detailed design.

Resources

The amount of water that would be required during construction is unknown at this stage. Water would be used for concrete pouring, compaction of work areas and access roads, and dust suppression. Water would be obtained from Billabong Creek.

Other key resources required for the proposal would include

- prefabricated regulator parts
- concrete
- electricity poles and cables
- ancillary apparatus such as signage and river safety equipment

As with spoil, wherever possible materials would be sourced from commercial suppliers in nearby areas.

Waste

The existing weirs and Forest Creek block bank would be demolished, resulting in some concrete waste. Further details are provided in section 3.3.4. In order to access the weir during demolition some creek silt may need to be removed from immediately adjacent to the structure, this is estimated conservatively to be up to around 50 cubic metres.

Waste generated during the construction of the proposal that cannot be beneficially reused would be disposed at a suitably licenced waste facility.

Waste that could be reused could includes:

- top soil for rehabilitation of construction activity zones
- salvaged tree hollows and logs during vegetation clearance, to be positioned on site for fauna habitat, where practicable.

Materials for disposal would likely to go to either Deniliquin Landfill Depot, Pretty Pine Landfill or Blighty Waste Disposal Depot. Further details of potential waste streams and potential disposal sites are discussed in chapter 22.

It should be noted that the Wanganella Village rural landfill would not be used by the proposal, as agreed with Edward River Council.

3.3.10. Water management

In creek construction is proposed to be undertaken in two phases; half of the creek needs to remain unobstructed to maintain continuous flow of water while construction is undertaken on the other side. Cofferdams, sumps and pumps would be used to separate and dewater the half of the creek undergoing construction as shown in Figure 3.7 and Figure 3.8.

Final construction methodology would be defined by the construction contractor, but would be designed to enable water to be flowing through part of the creek bed throughout construction.

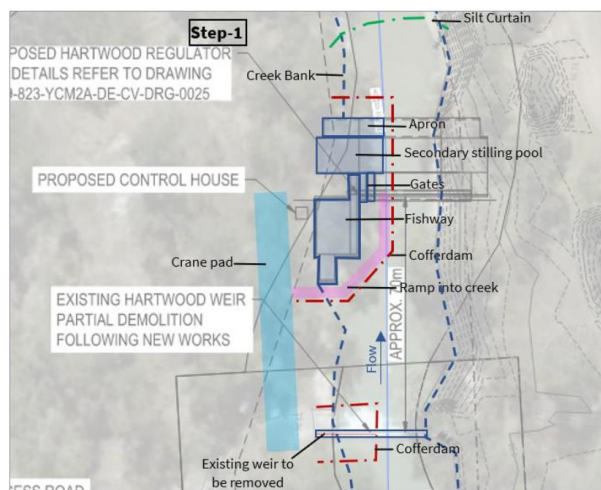


Figure 3.7 Indicative cofferdam alignment step 1

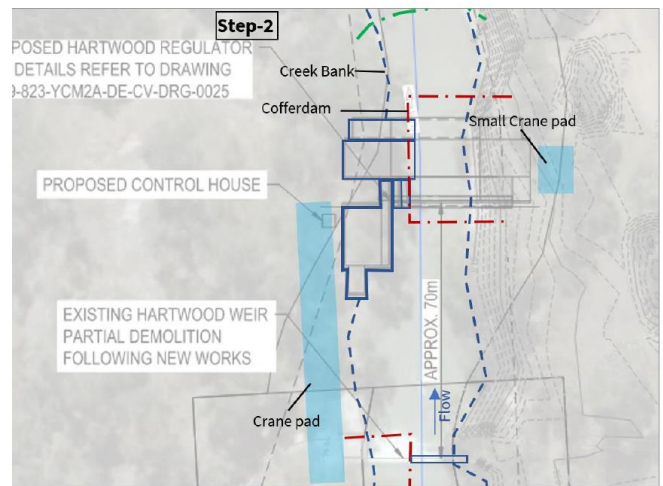


Figure 3.8 Indicative cofferdam alignment step 2

The excavation would not go lower than around one metre above subgrade before the sumps and drains are installed. Sumps will be about 1.8 metres deep to ensure ground water is at least one metre below subgrade to prevent the hydraulic pressure causing boils and springs.

As part of the access track upgrades at Hartwood Weir, a new culvert would be installed within an existing irrigation channel to provide a crossing point for vehicles. A temporary water diversion will be required to maintain flow for irrigators. This would be achieved through either pumping or providing a diversion trench and pipes under the access track.

Coffer dams

Sheet piles would be installed using a vibratory hammer attached to a crawler crane to construct a cofferdam at the existing weir and new regulator sites. A boat would be used to position the sheet piles and check if the sheets are interlocked correctly. Once a cofferdam is installed the construction area would be dewatered using multiple pumps that would be operational for several days until the water is removed. Water pumped out of the construction areas would be discharged downstream of the construction area but upstream of the silt curtain to manage sedimentation. Desludging of existing unsuitable material will be removed from within the cofferdam using excavators and dump trucks.

A small temporary coffer dam would be installed in an existing irrigation channel south of Hartwood Weir to enable construction of a culvert during for the access track.

Sumps

Residual water in construction areas would be managed using temporary sumps. The number and depth of sumps will be depended on the ground conditions and amount of water ingress. The sumps involve excavating a hole to a depth of a few metres, followed by the placement of steel drum barrel with perforation and wrapped in geofabric. The area surrounding the sumps would then be backfilled with screenings to the surface. A pump would be placed in each sump to remove the incoming water. Small channels around the perimeter of the construction zone may also be used to direct surface water into the sumps. The pump would be suitably sized to exceed the ingress of water.

3.3.11. Construction of structures

Sediment and erosion controls

A floating silt curtain would be installed downstream of each work area to capture any potential silt or debris mobilised from construction activities to minimise turbidity within the creek. In addition, silt fencing would be installed along the toe of the batters to prevent the flow of silt in the creek. Jute matting would also be placed on the batter to help reduce sediment transportation.

Cranage

The structures would be assembled by a nominally 160 to 220 tonne crane. The exact crane to be utilised will ultimately depend on the Contractor undertaking a detailed crane study for each site. Depending on the size of the crane selected, assembling would occur from both sides of the creek, or all from one.

Cofferdams

As discussed in section 3.3.2, construction of each regulator would be designed to enable water to be flowing through part of the creek bed throughout construction. It is anticipated the construction methodology would involve retaining portions of the cofferdam from work on the first half of the creek until sections of the cofferdam are installed on the other side of the creek and the gates are operational (refer Figure 3.9).

Once the cofferdam is installed, the construction zone would be dewatered in accordance with the water management method described in section 3.3.10.

During pre-construction works the construction contractor would review the construction methodology and may identify an improved method. This method would need to retain a constant flow though the creek bed throughout the construction period.

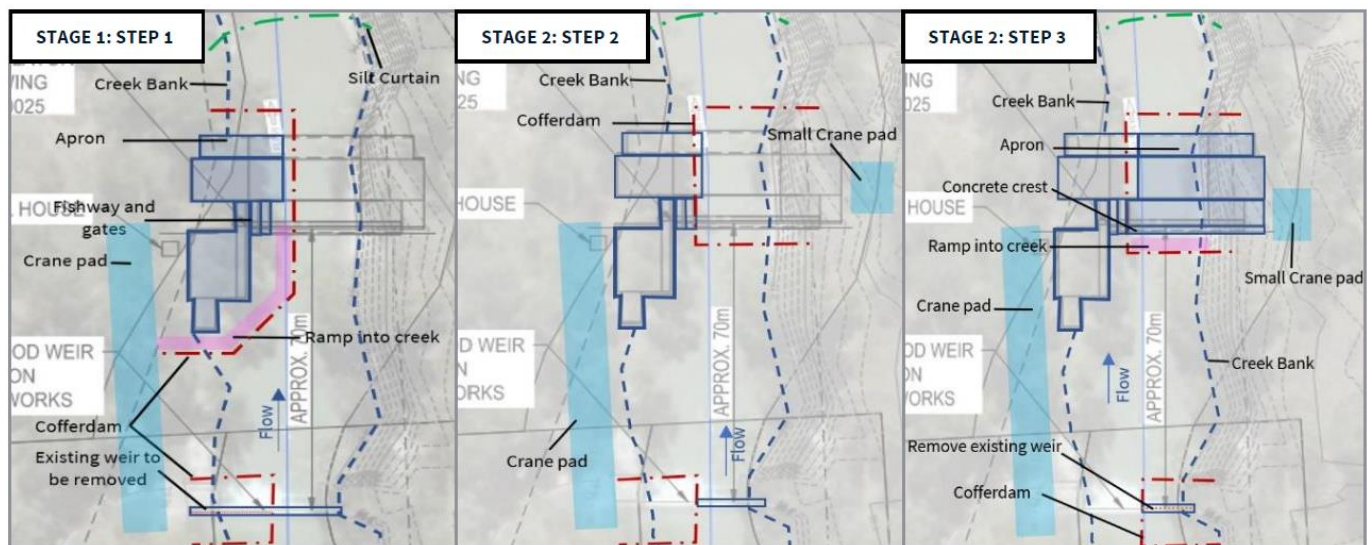


Figure 3.9 Indicative phasing of works at each site

Working platform

The creek bed would then be cleared of debris and silt. The structure footprint would be proof-rolled to create a solid working platform. The working platform would generally consist of a with crushed rock road base for minor sections and ballast for larger sections that need to be bridged. A capping layer of road base would then be placed on the entire work area. The working platform would then be proof-rolled again and detailed excavation would occur around the location of the permanent sheet piles and stilling pool.

Construction of structures

Key activities of the main construction components are outlined in Table 3.11. Works would be similar for each weir location.

A permanent sheet wall would be installed upstream of the regulators, most likely using a vibratory hammer.

A blinding layer made of a lean mix concrete and an in-situ concrete slab would be poured on top of the hardstand.

Other required in-situ concrete slabs would be constructed using industry standard form, reinforce and pour methods. Required in-situ concrete walls and beams would be fabricated onsite on the hardstand area and installed using the crane.

The prefabricated baffles, grates handrails and walkways, lay-flat gate unit and all other steelwork would be installed using the crawler crane.

Table 3.11 Indicative activities for construction components of the proposal

Phase	Activities
Fishway and layflat gates	• construct hardstands for the compound, laydown areas and crane pad(s) • install site facilities and mobilise plant • demolish small section of existing weir to allow cofferdam through structure • install all the temporary cofferdams around new structures and old weirs separately and dewater work areas • prepare subgrade and initial earthworks including any remediation if required • install permanent sheet pile wall • form, reinforce and pour all slabs (fixed crest structure, stilling pool, apron and fishway) • form, reinforce and pour all walls (gates and fishway) • install scour protection and finalise backfill of new structure • demolish existing weir including reshaping of creek bed • install and commission layflat gates and fishway furniture • flood cofferdam and remove the sheet piles around the new structure only
Fixed crest structure	• install temporary sheet pile cofferdam for the fixed crest weir section and seal against the new structure (at this point the new gates will be operational) • remove the cofferdam around the existing weir and reinstall around the other side of the existing weir • dewater the two new work zones • prepare subgrade and initial earthworks including any remediation if required • install remaining permanent sheet pile wall • form, reinforce and pour remaining slabs (fixed crest structure, stilling pool and apron) • form, reinforce and pour remaining walls (fixed crest structure) • install scour protection and finalise backfill of other side • demolish other side of the existing weir including reshaping of creek bed • flood both cofferdams and remove the sheet pile • rehabilitate work areas and demobilise from site

3.3.12. Traffic management and access

Access upgrades

Access to the proposal site is via a number of existing, unsealed roads and tracks and small sections of proposed new track. Necessary upgrades and construction of vehicular access tracks will be carried out to provide safe and efficient movement of light and heavy vehicles to the proposal sites.

The access tracks require minimum width and height clearance for heavy machinery. Vegetation removal would be required to meet heavy machinery access requirements. After clearing, subgrades would be applied to any unsealed access tracks. Minor remediation works would also be undertaken. Unsealed tracks would then be capped with a layer of crush rock road base.

Key features of the access track upgrades include:

- Minor refinement to existing alignments, i.e. to straighten sections where needed and provide suitable turning curves for the types of vehicles requiring access.
- As part of the access track upgrades at Hartwood Weir, a new culvert would be installed within an existing farm irrigation channel to provide a crossing point for vehicles.

- A section of track at Hartwood has been modified in the design to incorporate an existing overland floodway.
- Permanent access for maintenance activities would use tracks which have a negotiated right of carriageway or easement for access.
- Further refinement of access track alignments would be continued during detailed design to improve entrance/exit sight distances.
- Tracks would be upgraded during the first phase of construction (early works). Where tracks are to be upgraded, existing track alignments would be used where necessary, until upgraded tracks are completed.

Access management

Property accesses would be maintained at all times during construction of the proposal. As some access tracks go through private property, gates would left as they are found, such as being closed if that was how they were found. The Contractor shall manage gate keeping especially on heavy truck movements for certain activities. Temporary cattle grids or boom gates may also be installed with landowner consultation.

None of the existing tracks would be sealed as part of the proposal, however, upgrades with crushed rock would be required for existing tracks. Access would be impacted during wet weather and have limited capacity. As such, construction vehicles would follow a strict communication protocol on single lane access tracks.

Traffic management

A Traffic Management Plan (TMP) would be prepared in accordance with *Transport for NSW Traffic Control at Work Sites* (TfNSW, 2020) and *Roads and Maritime Specification G10 – Control of Traffic* (Roads and Maritime, 2015). The TMP would provide details of the traffic management to be implemented during construction to ensure that traffic flow on the surrounding network is maintained where possible.

Construction vehicle movements

Construction of the proposal would generate heavy vehicle movements. These heavy vehicle movements would mainly be associated with:

- delivery of construction materials
- spoil removal
- delivery and removal of construction equipment and machinery, including cranes.

Light vehicle movements would be required for the movement of construction personnel, including contractors, site labour force and specialist supervisory personnel.

Estimated construction traffic numbers are provided in Table 3.12 for each of the two locations. Peak daily movements are a conservative prediction for the most vehicle intensive activities and would not occur throughout the construction work.

Table 3.12 Construction traffic estimates

Location	Total vehicle movements – light vehicles	Total vehicle movements – heavy vehicles	Peak daily Movement – light vehicles	Peak daily Movement – heavy vehicles
Hartwood	8,183	1,643	39	51
Wanganella	7,757	1,289	39	32

3.3.13. Ancillary facilities

Site facilities would be provided within a construction activity zone at both Hartwood and Wanganella sites. An indicative layout of site facilities is shown in Figure 3.10, and would likely include:

- toilet blocks
- lunchroom
- meeting room/office
- fuel and equipment containers
- skip bin
- car parking.

The Contractor may also choose to set up site offices within nearby towns. This would be decided during detailed design.

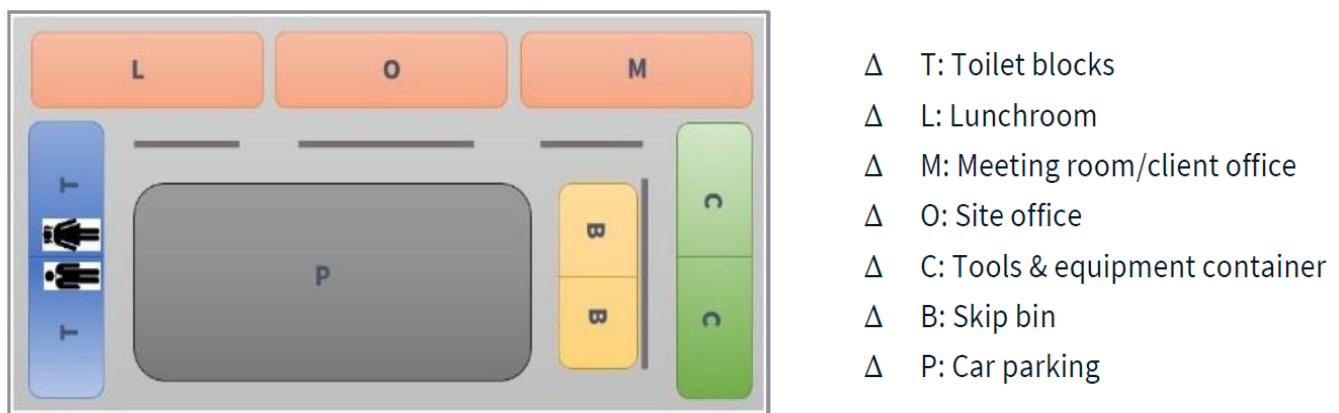


Figure 3.10 Typical site facilities

Stockpiles would be required for the duration of construction. Construction stockpile sites would temporarily store materials for construction, or materials generated from within the construction site. This could include road base constituents, stripped topsoil, and excess spoil unsuitable for use for the proposal. Site establishment activities for all stockpile sites would include activities such as the erection of site fencing and establishment of sediment and erosion control measures. Stockpiling locations would be within the proposal site and would be confirmed during detailed construction planning.

3.3.14. Decommissioning of regulators

Both regulators have a design life of 100 years. As the life of the asset nears its end, the need to continue to maintain, to upgrade or to decommission the structure would be made.

If decommissioning is considered the appropriate course of action then the following would be considered:

- A thorough assessment of the structure's condition and environmental impact is conducted. This includes evaluating the integrity of the concrete, the functionality of the gates, and the state of the electrical systems.
- A detailed decommissioning plan is developed, outlining the sequence of activities, safety measures, and environmental protections. The process typically begins with the isolation and disconnection of electrical systems to ensure safety. The sequence of activities are likely to include:
 - The gates are dismantled, often requiring specialized equipment and techniques to manage the heavy and potentially hazardous components.

- The concrete structure is then methodically broken down, with debris being removed and disposed of in accordance with environmental regulations.

Throughout the process, continuous monitoring is essential to mitigate any adverse environmental impacts, such as sediment release or water quality degradation. Finally, the site is restored to a natural or pre-determined state, which may involve re-vegetation and habitat restoration efforts.

3.4. Operation

It is intended that the regulators would be operated by WaterNSW, in accordance with the operating requirements established by NSW DCCEEW in consultation with WaterNSW and other key stakeholders and agencies. These operating requirements are contained in the Yanco Creek System operations plan (the operations plan), and the applicable requirements are detailed in section 3.4.1. The operations plan is being developed in consultation with WaterNSW as the intended new asset owner, key government agencies and community stakeholders. The operations plan forms part of the larger NSW SDLAM program funded by the Australian Government.

The Yanco Creek operations plan includes the following content:

- operating principles for the water resources across the Yanco Creek System
- governance arrangements for implementing, reporting and amending the plan
- guidance for implementing and adapting operations, including the protection of environmental baseflows, the use downstream storages by preference for supply and setting operating levels for the proposal
- operating principles and limits for key water regulating structures in the Yanco Creek System
- specifying environmental flow provisions for the Yanco Creek System
- factors that could contribute to the refinement of the plan.

A copy of the plan is provided in Appendix U (Operations Plan). This plan is draft and requires ongoing refinement and inclusion of any necessary conditions of approval specific to operations. DCCEEW are not seeking approval of the plan as part of this application.

3.4.1. Yanco Creek Operations plan governance

The Yanco Creek operations plan is aligned with water management regulations and plans, including the following:

- Murrumbidgee Water Resource Plan (Surface Water) (DPIE 2020a)
- Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016
- Murrumbidgee Long Term Water Plan (DPIE 2020b).

Water resource plans are required by the Basin Plan. They must comply with a number of requirements which include describing water rights, compliance with sustainable diversion limit and the provision of environmental water. The Murrumbidgee Water Resource Plan reflects the arrangements in the water sharing plan and the guidance for environmental watering provided by the long term water plan. The Water Sharing Plan manages access to water resources and river operations, and regulates how water is shared between the environment, instream uses and extractive water use. The long term water plan informs annual decision-making for the environmental watering requirements of priority environmental assets and ecosystem functions.

The operations plan includes environmental baseflow provisions for the Yanco Creek system which will be met by the overall management of flows through the system and subject to the provisions of the water sharing plan and water licensing. The implementation of these flows are proposed to commence concurrent with the operations of the new regulators. The specific environmental baseflow provisions required by the regulators are contained in section 3.4.3.

For the proposal, the operations plan specifies requirements at each regulator. These include downstream flows, flood operations, limits to rates of rise and fall to accommodate fish breeding requirements and limits to storage levels to protect riparian zones. The plan is to form part of the requirements of the water supply work approval issued to WaterNSW for the Murrumbidgee regulated river water source. The water supply work approval is further discussed in section 4.2.1. The proposed regulators will provide greater control of water levels which will be operated to meet environmental and water supply objectives. The water levels will be more variable (either higher or lower) than that currently stored behind the existing weirs, in accordance with the proposed operations plan.

3.4.2. Operating principles for the new regulators

An outline of the proposed general operational principles set out in the operations plan, including the differences between the regulators, is provided in Table 3.13.

Table 3.13 General operating principles of the regulators

Regulator	General operating principles
Hartwood Regulator	• primarily used to maintain a weir pool height sufficiently high enough to deliver normal regulated flow requirements (including managed environmental flows) at the Forest Creek offtake • used to create a pumping pool for seven irrigation pumps within the influence of the weir pool and to provide re-regulation capacity for flows in Billabong Creek • some stock and/or domestic pumps also extract water from within the influence of the weir pool • regulator gates to be fully open during moderate to large unregulated flow events at every possible opportunity to enable unrestricted fish passage opportunities • equitable sharing of adverse outcomes across water access licence holders during unexpected supply shortfalls (i.e. when WaterNSW cannot deliver water order requests) • optimisation of weir pool operations to minimise the risk of adverse environmental outcomes • distribution of flows downstream across the regulator gates to maximise the effectiveness of the vertical slot fishway
Wanganella Regulator	• primarily used to create a pumping pool for Wanganella's town water supply, one irrigation pump and to provide re-regulation capacity for flows in Billabong Creek: – some stock and/or domestic pumps also extract water from within the influence of the weir pool – another irrigation pump benefits from the weir pool when operated within upper parts of the yellow zone (i.e. at or near the full supply level) • regulator gates to be fully open during moderate to large uncontrolled flow events at every possible opportunity to enable unrestricted fish passage opportunities • equitable sharing of adverse outcomes across water access licence holders during unexpected supply shortfalls (i.e. when WaterNSW cannot deliver water order requests) • optimisation of weir pool operations to minimise the risk of adverse environmental outcomes • distribution of flows downstream across the regulator gates to maximise the effectiveness of the vertical slot fishway

3.4.3. Operations of the new regulators

The proposed new regulators would be incorporated into the broader Yanco Creek operations plan. This plan contains a framework for the operations of the proposed regulators to guide decisions about their day to day operations. The plan contains details about how the regulators could be operated in different scenarios, including downstream releases for the environment.

Hartwood Regulator

Figure 3.11 shows the proposed operating levels for different operating zones of the existing and proposed Hartwood Regulator. Full supply level is the maximum operating level. The top of green zone is the median operating level and corresponds to the typical median flow level at the existing Hartwood Weir. The bottom of green zone is the minimum operating level and corresponds to the typical top of drop board level at the existing Hartwood Weir.

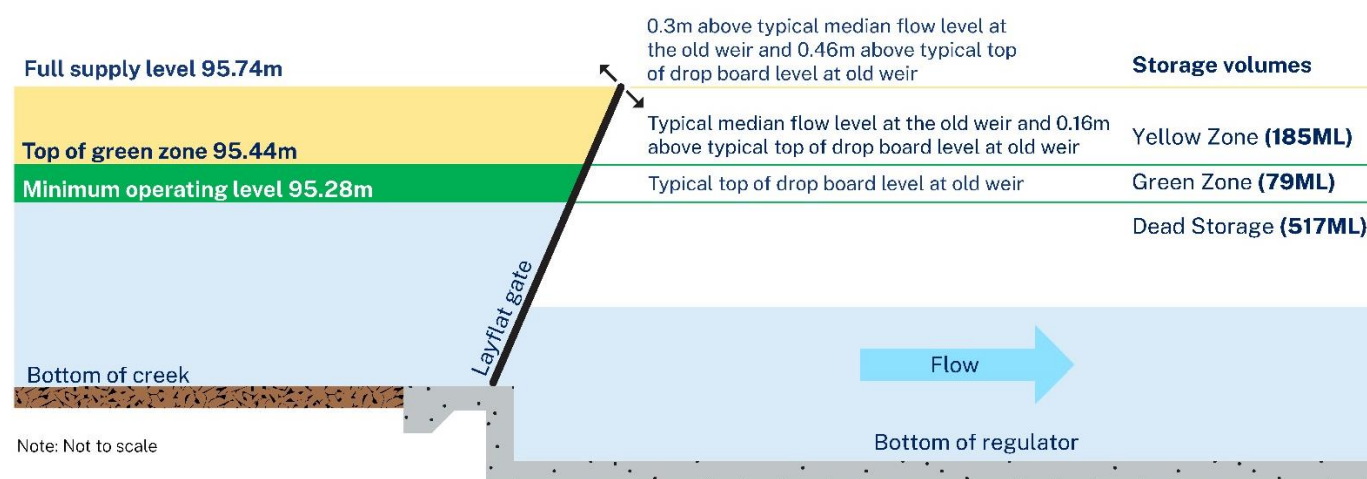


Figure 3.11 Hartwood Regulator operating zones

The regulator will be commonly operated within the green zone. Different target levels for operation within the green zone will apply (Table 3.14). This is to ensure that there is always water available for downstream requirements, with a higher target level identified for the irrigation season when greater demand is likely.

Table 3.14 Hartwood Regulator pool target levels

Time period	Regulator Pool Target Level	Difference from Full Supply Level
1 November to 30 April	95.44 m AHD	-0.03 m
1 May to 31 October	95.32 m AHD	-0.42 m

Operations of the regulator within the yellow zone would occur when catchment rainfall provides stream flows that could be captured by the regulator. This would reduce the quantity of regulated water required by the Yanco Creek system and allow more responsive delivery of irrigation and environmental water from the regulator.

The operations plan proposes that the yellow zone should be primarily used during the irrigation season and is for the capture of the end of an unregulated flow event allowing the rise and peak of the flow event to continue downstream, capturing a portion of the water in the recession of the peak flow. The water stored in the yellow zone would be held until used and this would depend on water demands downstream. In the event of a second unregulated event in the upstream catchment, the operations plan proposes to temporarily draw down the storage to the green zone and refilling the yellow zone on the recession of the second event.

The operations plan defines maximum rates of rise and fall of regulated water stored by the regulator. These are designed to limit impacts to bank stability and any nesting of native fish. The maximum rate of fall is 100 millimetres per day and the maximum rate of rise is 300 millimetres per day.

During periods of high unregulated events following rainfall, at flows larger than 1200 ML of water per day, the gates at Forest Creek Offtake would be fully open to allow high flows into Forest Creek. At that time the operations of the proposed Hartwood Regulator would be as follows:

- the regulator gates will be operated initially at the top of the green zone
- when water levels downstream are equal to the top of the green zone upstream, the gates will be fully opened
- when water levels downstream fall below the top of the green zone, the gates will be operated at the top of the green zone.

Wanganella Regulator

Figure 3.12 shows the proposed operating levels for different operating zones of the existing and proposed Wanganella Regulator. Full supply level is the maximum operating level. The top of green zone is the median operating level and corresponds to the typical median flow level at the existing Wanganella Weir. The bottom of green zone is the minimum operating level and corresponds to the sill of the existing Wanganella Weir, as drop boards are no longer functional at this weir.

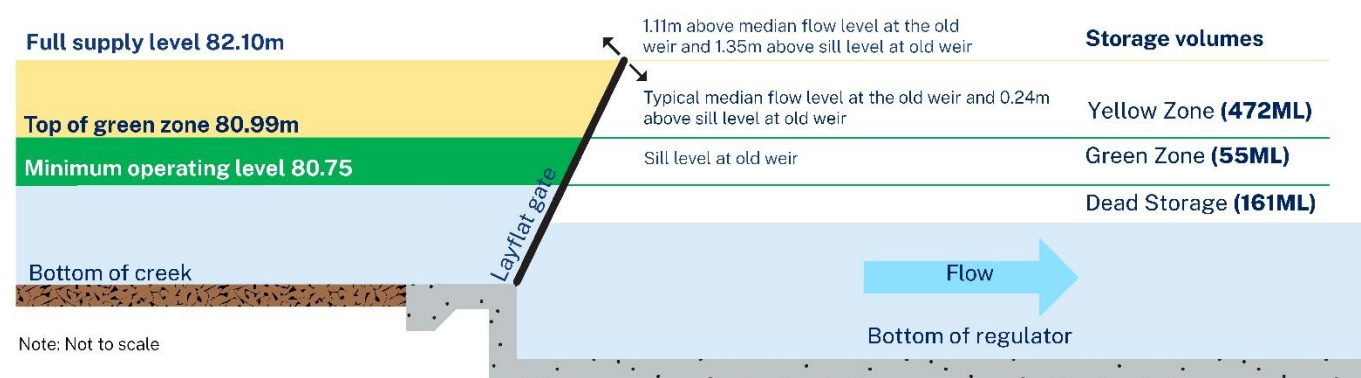


Figure 3.12 Wanganella Regulator operating zones

As for the Hartwood Regulator, the Wanganella Regulator will be commonly operated within the green zone. Different target levels for operation within the green zone will apply (Table 3.15). This is to ensure that there is always water available for downstream requirements, with a higher target level identified for the irrigation season when greater demand is likely.

Table 3.15 Wanganella Regulator pool target levels

Time period	Regulator Pool Target Level	Difference from Full Supply Level
1 November to 30 April	80.99 m AHD	-1.11 m
1 May to 31 October	80.82 m AHD	-1.28 m

Operations of the regulator within the yellow zone would occur when catchment rainfall provides stream flows that could be captured by the regulator. This would reduce the quantity of regulated water required by the Yanco Creek system and allow more responsive delivery of irrigation and environmental water from the regulator.

The operations plan proposes that the yellow zone should be primarily used during the irrigation season and is for the capture of the end of an unregulated flow event allowing the rise and peak of the flow event to continue downstream, capturing a portion of the water in the recession of the peak flow. The water stored in the yellow zone would be held until used and this would depend on water demands downstream. In the event of a second unregulated event in the upstream catchment, the operations plan proposes to temporarily draw down the storage to the green zone and refilling the yellow zone on the recession of the second event.

The operations plan defines maximum rates of rise and fall of regulated water stored by the regulator. These are designed to limit impacts to bank stability and any nesting of native fish. The maximum rate of fall is 100 millimetres per day and the maximum rate of rise is 300 millimetres per day.

During periods of high unregulated events following rainfall that cannot be controlled by the proposed Wanganella Regulator, the regulator would be operated as follows:

- the regulator gates will be operated initially at the top of the green zone
- when water levels downstream are at 80.82 m Australian Height Datum (AHD), the gates will be fully opened
- when water levels downstream fall below 80.82 m AHD, the gates will be operated within the green zone at the relevant pool target level.

Environmental flow provisions

The operations plan contains the following specific environmental provisions at or downstream of the proposal:

- An environmental baseflow of 25 ML/d in Billabong Creek downstream of Hartwood Regulator at all times.
- An environmental baseflow of 50 ML/d in Billabong Creek downstream of the Darlot gauging station at all times.
- An environmental baseflow of 10 ML/d in Forest Creek downstream of the offtake from Billabong Creek when the annual available water determination for general security water entitlements are set at 15 per cent or more.
- A maximum daily rate of fall of nine per cent per day of volume at Darlot gauging station when flows are between 250-1,000 ML/d in the period 14 September to 16 November to protect fish breeding. This applies when the available water determination is set at 15 per cent or more and the creek has not been subject of a small fresh flow.
- A small fresh is required with a minimum flow of 200 ML/d for 14 consecutive days between 1 February and 31 March as measured at the Darlot gauging station. This applies when the available water determination is set at 15 per cent or more.

3.4.4. Weir pool extents

Operation of the proposal would result in minor changes to the upstream extent of the hydraulic influence of the existing weirs. Preliminary modelling shows that there will be small changes to the existing weir pool extents and small changes to the areas providing slow, moderate, fast and very fast water velocity.

The existing weir pool extents and the increase in that extent resulting from the proposal are illustrated in Figure 3.13 for the Wanganella weir pool and Figure 3.14 and Figure 3.15 for the Hartwood weir pool. The extents are based on there being the maximum operating flow within the creek of 500 ML/d at Hartwood and 400 ML/d at Wanganella.

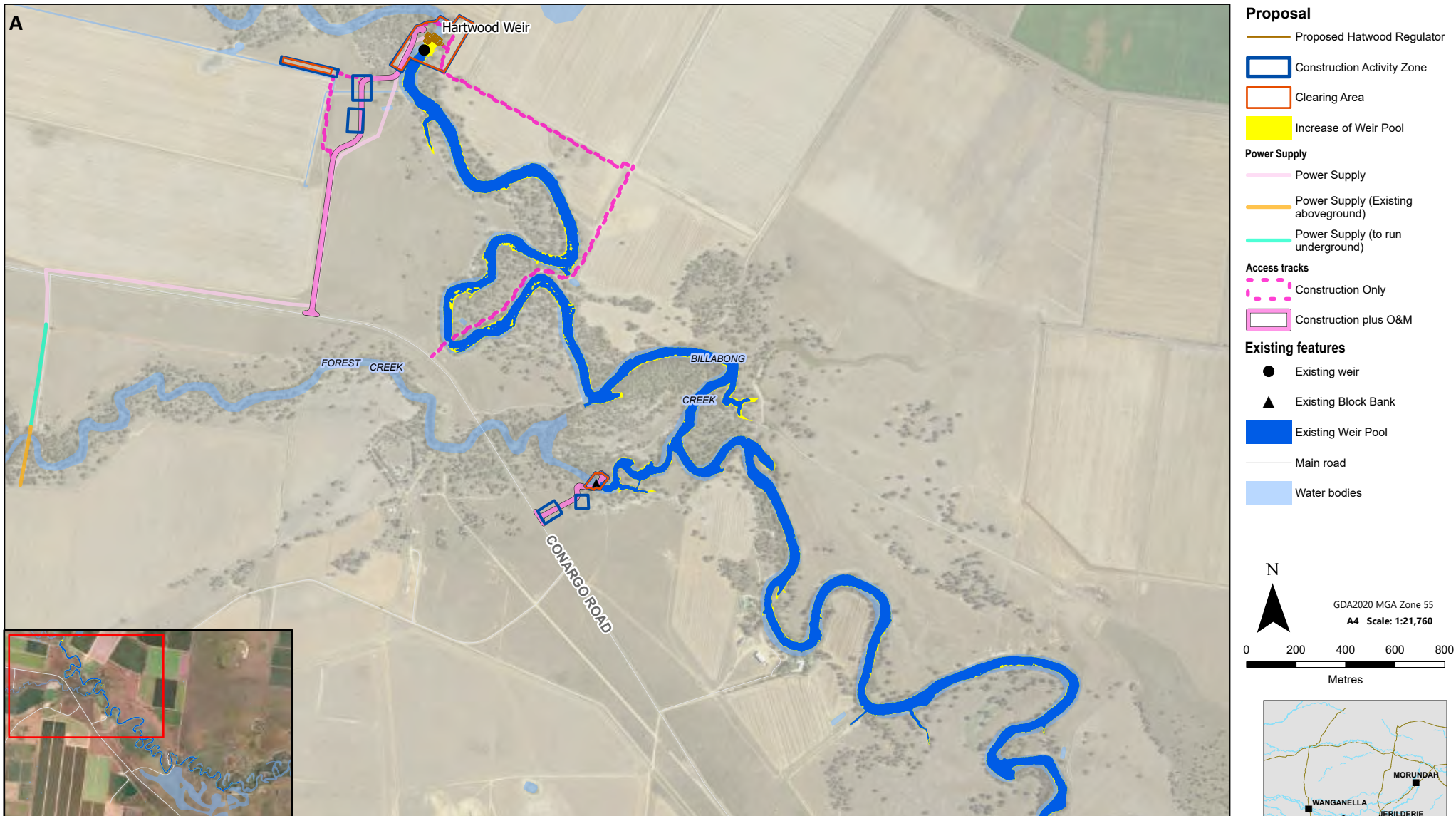


Figure 3.13 Changes to Hartwood Weir Pool Extent - A



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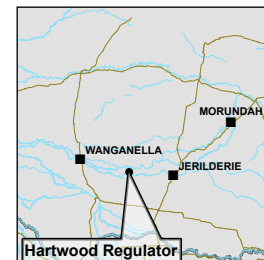
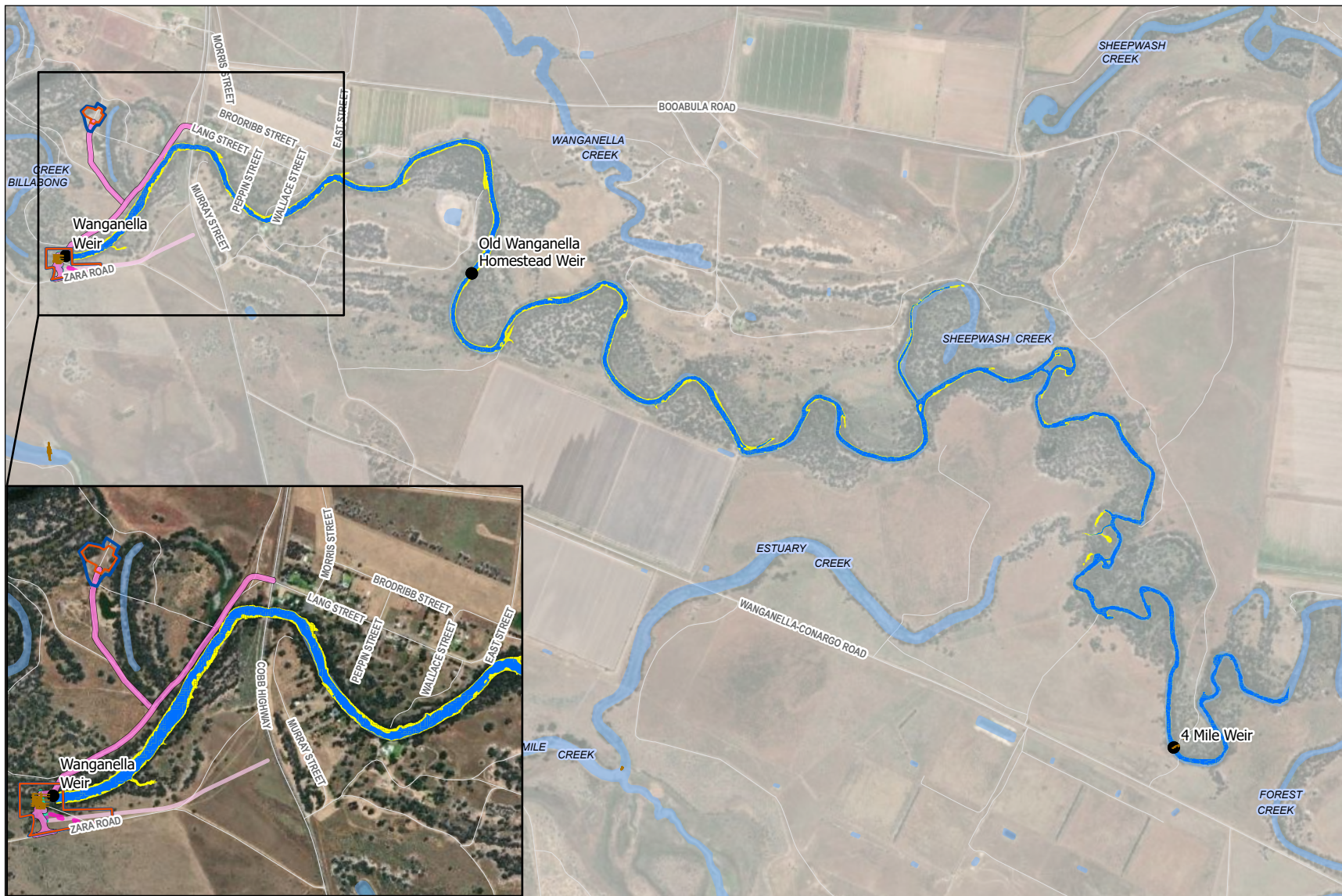




Figure 3.14 Changes to Hartwood Weir Pool Extent - B and C



Proposal

Proposed Wanganella Regulator

Contractor Activity Zone

Clearing Area

Increase of Weir Pool

Power Supply

Power Supply

Power Supply (Existing aboveground)

Power Supply (to run underground)

Access tracks

Construction Only

Construction plus O&M

Existing features

Existing weir

Existing Weir Pool

Water bodies

Main road



GDA2020 MGA Zone 55

A4 Scale: 1:33,537

0 200 400 600 800

Metres

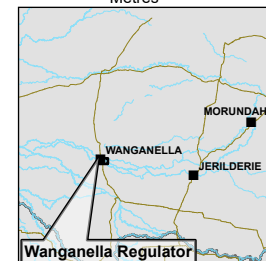


Figure 3-15 Changes to Wanganella Weir Pool Extent



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3.4.5. Weir pool heights and water storage

A comparison of the maximum water level controlled by the existing weirs and proposed new regulators and weir pool depths at the structures is provided in Table 3.16 and Table 3.17.

Table 3.16 Water levels at the Hartwood existing weir and new regulator

Water levels at the existing weir and the new regulator	Existing weir	Regulator
Maximum water control level (metres above AHD)	95.28	95.74
Weir pool depth (height between creek bed and the maximum water control level, in metres)	2.58	3.04

Table 3.17 Water levels at the Wanganella existing weir and new regulator

Water levels at the existing weir and the new regulator	Existing weir	Regulator
Maximum water control level (metres above AHD)	80.75	82.10
Weir pool depth (height between creek bed and the maximum water control level in metres)	0.55	1.90

The changes to the water storage volumes as a result of the new structures are outlined in Table 3.18

Table 3.18 Additional storage volumes for the proposed regulators

Volume of water storage (ML)	Hartwood	Wanganella
Existing water storage volume (weir)	517	161
Additional volume for general operations (regulator)	79	55
Additional volume for periodic operations (regulator)	185	472
Total additional storage volume provided by regulator	264	527
Proposed total storage volume	781	688

The operations plan sets weir pool minimum height target levels. The target levels are the lowest in-creek water levels expected during normal dry conditions. It is expected that in wetter conditions weir pool levels are often above the target level. The proposed target levels are outlined in Table 3.19.

Table 3.19 Weir pool height target levels for the proposed new regulators

Time period	Hartwood	Wanganella
1 November to 30 April	95.44 m AHD 0.30 m below full supply level	80.99 m AHD 1.11 m below full supply level
1 May to 31 October	95.32 m AHD 0.42 m below full supply level	80.82 m AHD 1.28 m below full supply level

The operations plan also sets unregulated flow operations principles. For example, following rainfall events that result in higher than planned flows in Billabong Creek which cannot be controlled by water management infrastructure.

The estimated weir pool inundation areas of the new regulators compared to the existing weirs is provided in Table 3.20. The inundation areas are provided for the full supply level, normal operating level and minimum operating level at the new regulators. The estimates of the areas are based on there being the maximum operating flow within the creek of 500 ML/d at Hartwood and 400ML/d at Wanganella. The estimate for the minimum operating level of the proposed regulator at Hartwood is based the maximum operating flow being accommodated within that level, whilst for the existing weir it is the level of that flow over the existing weir.

Table 3.20 Estimated weir pool inundation areas for the proposed regulators

Estimated weir pool inundation area (hectares)	Hartwood	Wanganella
Existing weir	107	40
Full supply level (regulator)	112	51
Normal operating level (regulator)	103	40
Minimum operating level (regulator)	96	40

3.4.6. Public utility adjustment

The regulators would not require connection to water, sewers, gas, internet cables or phone cables. As discussed, power lines would be constructed as part of the proposal to provide electricity to the regulators. The power lines would be connected to the public electricity grids at the locations shown in Figure 3.1 and Figure 3.3.

3.4.7. Maintenance activities during operation

A limited range of activities would be required to operate the proposal.

WaterNSW would periodically inspect the new regulator. This would include inspecting the gates, erosion protection measures and the weir pool immediately upstream of the regulator. WaterNSW would need to carry out routine and periodic maintenance including refurbishment and renewal throughout the life of the regulator.

WaterNSW would routinely inspect the fishway, the fishway gates and approach pool. Mud and debris may occasionally need to be removed from the fishway to ensure that the fishway functions as designed and fish passage is facilitated. This may require the use of a vacuum truck and/or an excavator.

Traffic generation during operations is expected to be minimal. It is predicted the following activities would be required:

- Average estimated truck movements to each of the weirs would be average about 10 per month, and 20 per month during the first two years due to the commissioning of the fishway. It is noted that these volumes would fluctuate slightly, depending on the time of the year, however on average the operation and maintenance of the proposal would generate less than one inbound and outbound vehicle movement per day.
- At times, the maintenance may span over a couple of days, or for major items approximately a week.
- After the first two years, on-going maintenance activities would include operations and monitoring (monthly), SCADA, hydrometric monitoring and the occasional site visit (tour).

In the event that there is a disruption to the electricity supplying the regulator gates, an automated alarm will be activated in the WaterNSW control centre. Maintenance staff would then be directed to check the structure and equipment, as needed, and determine the required solution. The closest control centre to the proposal is located at Deniliquin, within one hour's travel to the sites.

3.5. Property requirements

The proposal will require would require in total about 6.24 hectares at Wanganella and around 15.05 hectares of land at Hartwood, for the construction and operation of the proposal (see section 3.1.2). Depending on the stage of the project that land is required, the use of this land would be through the following methods:

- property acquisition, for permanent infrastructure which is required to be contained to land owned by WaterNSW
- easements, including right of carriageway, for permanent infrastructure which is required to traverse adjacent properties with easement to ensure ongoing use of this land under the property titles (i.e. electricity cables and permanent access tracks)
- leasing, which relates to land which is required for construction purposes only and is required to be leased from the existing landowner.

Minor property adjustments resulting from acquisitions or easements would be carried out in consultation with landowners. This may include boundary adjustments for example to property fencing or gates.

The sections below outline the property requirements for the proposal, with some properties having land which is to be used under potentially multiple of the methods outlined above. The following sections outline the each of these methods.

3.5.1. Property acquisition

Small areas of four properties would be partially acquired as a result of the proposal, with two at Hartwood and two at Wanganella. No buildings or residential properties are impacted by the proposal.

The areas needed would be for the regulator structures where they adjoin the creek bank, to accommodate bankside infrastructure and for the Wanganella flood bypass channel and Forest Creek block bank. The impacted lots are:

- Hartwood – 1/DP707463, 7301/DP1162488 and 28/DP756330 (see Figure 2.4)
- Wanganella – 7005/DP1024202 and 7004/DP1024203 (see Figure 2.6).

The extent of property impacts would be refined and confirmed during detailed design in consultation with the property owners. Property adjustment plans would be developed in consultation with property owners.

All acquisitions would be conducted in accordance with New South Wales Department of Climate Change, Energy, the Environment and Water policy and compensation would be based on the requirements of the *Land Acquisition (Just Terms) Compensation Act 1991*. WaterNSW would be consulted throughout the acquisition process.

3.5.2. Easements

In addition to the acquisition of land outlined in section 3.5.1, the proposal would establish easements on the title for adjacent properties for some elements of the proposal to ensure that access across these properties is legally obtained for access during operation.

Properties easements are proposed to be established would generally consist of the following widths:

- power (underground) – maximum of 20 metres, however anticipated to be narrower for some sections of the corridor
- power (aboveground) – 20 metres
- permanent access – around 5.0 metres.

The impacted lots are:

- Hartwood – 1/DP707463, 1/DP1144789, 27/DP756330, 7304/DP1165043, 58/DP756322, 7301/DP1162488 and 28/DP756330 (see Figure 2.4)
- Wanganella – 7005/DP1024202, 7009/DP1024201, 3/DP759045 and 7004/DP1024203 (see Figure 2.6).

The electricity works, south of Forest Creek in Lot 59/DP756322 relate to existing electricity infrastructure that was erected prior to 2006. Access would therefore be permissible at this location in accordance with the provisions of Section 53 of the *NSW Electricity Supply Act 1995*.

3.5.3. Leasing

Some land would only be required for the construction of the proposal due to temporary ancillary facilities (for example laydowns and borrow site areas), construction activity zones for key infrastructure and for construction access tracks. These areas are proposed to be leased from the relevant land owners. The need for lease arrangements would be confirmed by the contractor and through consultation with the identified landowners prior to work commencing. Agreements would be established outlining the land to be leased and any requirements of the use.

The lots where land would be temporarily leased during construction of the proposal are:

- Hartwood – 1/DP707463, 1/DP1144789, 27/DP756330, 7304/DP1165043, 58/DP756322, 7301/DP1162488 and 28/DP756330 (see Figure 2.4)
- Wanganella – 7005/DP1024202, 7009/DP1024201, 3/DP759045 and 7004/DP1024203 (see Figure 2.6).

3.6. Further design refinement

The proposal assessed in this EIS is based upon concept designs. Further refinement of the proposal would be developed during detailed design. This will consider submissions received on the EIS from the community and stakeholders and continued consultation with WaterNSW, Edward River Council and other agencies. Key features to be further refined at detailed design include:

- bridge design
- confirmation of gate configuration, number and specification
- structural design
- height of sill for Wanganella flood bypass channel
- safety in design requirements
- access track alignment and pavement design
- geotechnical design
- computational fluid dynamics (hydraulic modelling) and physical creation and testing of the fishway
- electrical design (mains power and site electrical).

4. Statutory context

This section identifies the relevant statutory requirements for the proposal and addresses the legal pathway under which approval of the proposal is being sought, other approvals that are required to carry out the proposal and why they are required, and provides a summary of the assessment process.

4.1. Approval pathway and permissibility

4.1.1. Approval pathway

The proposal is declared State significant infrastructure by operation of Part 5, Division 5.2 of the EP&A Act, *State Environmental Planning Policy (Planning Systems) 2021* (the Planning Systems SEPP), and *State Environment Planning Policy (Transport and Infrastructure) 2021* (the Transport and Infrastructure SEPP).

Section 5.12(2) of the EP&A Act provides that a State environmental planning policy may declare any development, or any class or description of development, to be State significant infrastructure. The Planning Systems SEPP (section 2.13(1)) provides that development is State significant infrastructure if it is permissible without development consent under Part 4 of the EP&A Act and it is specified in the categories of development in Schedule 3 of the Planning Systems SEPP.

4.1.2. Approval permissibility

The proposal is permissible without consent as a result of the operation of the Transport and Infrastructure SEPP. Section 2.159(2A) of the Transport and Infrastructure SEPP states that “Development for the purposes of the maintenance or replacement of existing water storage facilities may be carried out by or on behalf of a public authority without consent on any land”.

As the proposal is appropriately characterised as being for the purpose of a water storage facility in accordance with the definitions provided in section 2.158 of the Transport and Infrastructure SEPP, and is being undertaken by a public authority, it can be carried out without consent on any land.

Schedule 3 (Section 4) of the Planning Systems SEPP identifies that development for the purpose of a water storage facility carried out by a public authority and having a value of greater than \$30 million. The proposal would be undertaken by a public authority and have a value of greater than \$30 million and it meets the requirements of Section 4 of Schedule 3 of the Planning Systems SEPP.

As the proposal is permissible without consent and meets Section 4 of Schedule 3 of the Planning Systems SEPP, it is declared State significant infrastructure. As declared State significant infrastructure, the NSW Minister for Planning and Public Spaces is the approval authority for the proposal.

4.1.3. Environmental assessment requirements

The proposal is subject to environmental and planning approvals in accordance with the EP&A Act and the Commonwealth EPBC Act. As the proposal is State significant infrastructure, it is subject to the environmental assessment requirements in Part 5 Division 5.2 of the EP&A Act and the SEARs.

This EIS has been prepared to support the application for approval of the proposal under Part 5 Division 5.2 of the EP&A Act. It addresses the Secretary's Environmental Assessment Requirements (SEARs) issued by the NSW Department of Planning, Housing and Infrastructure (DPHI) on 17 October 2024 and the form and content requirements of sections 190 and 192 of the EP&A Regulation and the State Significant Infrastructure Guidelines – Preparing an Environmental Impact Statement (Department of Planning, Industry and Environment (DPIE), 2021b).

This EIS provides the information required to support NSW DCCEE application for approval of the Billabong Creek Regulators proposal and addresses relevant legislative requirements and the SEARs. The form and content requirements for the EIS are contained in sections 190 and 192 of the EP&A Regulation. These requirements, and how they are addressed by the EIS, are provided in Appendix A. In addition each technical report provided in Appendices G to S outline in more detail the SEARs that relate to each technical subject.

4.2. Other approvals required

4.2.1. Approvals under NSW legislation

Approvals not required

In accordance with section 5.23 of the EP&A Act the following approvals, which may otherwise have been required, are not required for declared State significant infrastructure:

- a permit under sections 201, 205 and 219 of the *Fisheries Management Act 1994* (FM Act)
- an approval under Part 4 or an excavation permit under section 139 of the *Heritage Act 1977*
- an Aboriginal heritage impact permit under section 90 of the *National Parks and Wildlife Act 1974*
- a water use approval under section 89, a water management work approval under section 90 or an activity approval under section 91 of the *Water Management Act 2000* (WM Act)
- a water supply works approval is not required for SSI. However NSW DCCEE Water Licensing is proposing to amend the existing water supply works approval for Hartwood Weir to reflect the amended operating regime. This will include key elements of the Operations Plan being incorporated into the works approval. This would comprise including the flow conditions and the minimal operating levels for Hartwood and Wanganella regulators.
- Works carried out on waterfront land are regulated by the WM Act as controlled activities. The WM Act defines where an approval is required for controlled activities. Guidelines are provided works requiring approval. A controlled activity approval is not required but the guidelines have been considered in this assessment of this EIS.

Approvals that must be applied consistently

In accordance with section 5.24 of the EP&A Act, approvals under other specified NSW legislation that may apply to the proposal cannot be refused and must be applied consistently with the approval for the State significant infrastructure. Those approvals relevant to the proposal include:

- a consent under section 138 of the *Roads Act 1993* (see Table 4.1).

Other approvals and requirements

Approvals required under other relevant NSW legislation are summarised in Table 4.1.

Table 4.1 Other approval required under NSW legislation

Act	Approval requirement	Relevance/where considered
Roads Act 1993	Section 138 of the <i>Roads Act 1993</i> provides that consent from the relevant road authority is required to disturb, erect a structure, or carry out a work in, on or over a public road. Clause 5(1) of Schedule 2 exempts public authorities from this requirement, except in relation to works on or over classified and Crown roads.	The proposal includes the following works on or over Conargo Road and the Cobb Highway both of which are classified roads. Works at these locations would potentially involve intersection works for haul roads and the installation of an overhead transmission line (Conargo Road only). Approval would be sought under Section 138 of the <i>Roads Act 1993</i> .
Crown Land Management Act 2016	Section 5.21 of the <i>Crown Land Management Act 2016</i> (CLM Act) outlines the need for a licence for the use or occupation of Crown Land.	Both sites (Hartwood and Wanganella) include works located on Crown Land and an Ongoing Licence Application would be required to be submitted to Crown Lands. Zara Road is Crown Land although management of it is by Edward River Council. The existing weirs are subject to existing licences and therefore consultation with Crown Lands would be undertaken to confirm the need for a new licence or the need to amend the existing licence.
Fisheries Management Act 1994	Section 199 of the FM Act states that a public authority undertaking dredging and/or reclamation work must before works commence give the Minister for Agriculture written notice of the proposed work and to consider any matters raised by the Minister within 21 days after giving the notice.	The proposal is being undertaken by a public authority and involves excavation works within Billabong Creek at both the Hartwood and Wanganella weir sites, such works are defined as dredging in accordance with the FM Act. Notification is therefore required to the Minister prior to works occurring.
Fisheries Management Act 1994	Section 218(5) of the FM Act states that when a public authority proposes to construct, alter or modify a dam, weir or reservoir on a waterway, that they must notify the Minister for Agriculture of the proposal and where the Minister requests the inclusion of a suitable fishway or fish by-pass.	The proposal is being undertaken by a public authority and involves works to replace two existing weirs on Billabong Creek. The proponent is therefore required to notify the Minister of the works. As the proposal includes fishway and fish by-pass it is unlikely the Minister will require further works to be included.

4.2.2. Approvals under Commonwealth legislation

In accordance with the EPBC Act, proposed actions with the potential to significantly impact matters protected by the EPBC Act must be referred to the Australian Minister for the Environment and Water to determine whether they are controlled actions and require approval from the Minister. The following matters are defined as protected matters by Part 3 of the EPBC Act:

- matters of national environmental significance
- the environment of Commonwealth land
- the environment in general if they are being carried out by a Commonwealth Government agency.

The proposal is not being carried out by a Commonwealth Government agency and no significant impacts on the environment of Commonwealth land have been identified. The proposal has the potential to impact on the following matters of national environmental significance:

- threatened species (both flora and fauna)
- ecological communities
- migratory species.

Although no significant impacts on these species have been predicted, the proposal was referred to the Australian Minister for the Environment and Water. The decision on the referral (024/09939) was made on 17 September 2024. This decision under Section 75 of the EPBC Act was that the proposal is not a controlled action.

Further information on the potential impacts on Commonwealth-listed threatened species and ecological communities and migratory species is provided in chapter 11.

4.3. Pre-conditions and mandatory considerations

The statutory pre-conditions relevant to the application for approval of the proposal, which must be met by the proponent before the approval authority can exercise its power to grant approval, are listed in Table 4.2.

Mandatory considerations are the matters that the approval authority is required to consider in deciding whether to grant approval. These considerations are also listed in Table 4.2, together with a reference to where relevant information is provided in the EIS.

Section 5.22(2)(a) of the EP&A Act provides that environmental planning instruments (such as State environmental planning policies and local environmental plans) do not apply to or in respect of State significant infrastructure, except where they apply to the declaration of State significant infrastructure. The application of the Transport and Infrastructure SEPP and the Planning Systems SEPP to the declaration of the proposal as State significant infrastructure is considered in section 4.1. Although not a mandatory consideration for the proposal, Table 4.2 also notes how the environmental issues addressed by other relevant environmental planning instruments have been considered in the EIS.

Table 4.2 Pre-conditions and mandatory considerations

Reference	Requirement/consideration	Where addressed in the EIS
Pre-conditions/mandatory considerations		
EP&A Act Section 2 Objects of Act	The objects of the EP&A Act are guiding principles that need to be considered by planning authorities when making decisions under the Act.	Table C.3 in Appendix C
EP&A Act Division 5.2	Section 5.14(1) provides that the approval of the Minister for Planning is required to carry out State significant infrastructure. Section 5.17(1) provides that the proponent must submit an EIS for approval to carry out the State significant infrastructure.	This chapter. This EIS has been prepared in accordance with the requirements of Division 5.2.
EP&A Regulation Part 8 (Infrastructure and environmental impact assessment)	The SEARs require the EIS to be prepared in accordance with Part 8 of the EP&A Regulation (see Appendix A (SEARs compliance table)). Part 8 provides requirements in terms of the form and contents of the EIS.	Table C.1 in Appendix C documents where the requirements of Part 8 have been addressed in the EIS. The EIS is also consistent with the form and content requirements of the current EP&A Regulation as defined by sections 190 and 192 of Division 5 of Part 8.
<i>Biodiversity Conservation Act 2016</i>	Sections 7.9(1)(b) and 7.9(2) provide that an application for approval of State significant infrastructure must be accompanied by a biodiversity development assessment report unless the proposed development is not likely to have any significant impact on biodiversity values. Section 7.14(2) provides that, when determining an application in accordance with the EP&A Act, the Minister for Planning must take into account the likely impact of a proposed development on biodiversity values as assessed in the biodiversity development assessment report.	A Biodiversity Development Assessment Report has been prepared (Appendix L of this EIS). Potential biodiversity impacts are considered in chapter 11.
Consideration of other relevant environmental planning instruments		
State Environmental Planning Policy (Resilience and Hazards) 2021 (Resilience and Hazards SEPP)	Chapter 3 of the Resilience and Hazards SEPP provides a process to ensure that, in considering an application to carry out potentially hazardous or offensive development, the consent authority has sufficient information to assess whether a development is hazardous or offensive and to impose conditions to reduce or minimise any adverse impact. Chapter 4 of the SEPP provides for a coordinated State-wide planning approach to the remediation of contaminated land, defining the requirements in relation to contaminated or potentially contaminated land that must be considered by a consent authority.	Potential contamination impacts are assessed in chapter 20. Potential hazards associated with the proposal are considered in chapter 18.

4.4. Assessment process and requirements

The key steps in the assessment process are described below and shown in Figure 5.1.

4.4.1. Environmental assessment requirements

In accordance with section 5.15(2) of the EP&A Act, an application for State significant infrastructure needs to describe the infrastructure and contain any other matter required by the Planning Secretary. The SEARs for the proposal, issued on 17 October 2024, define the matters the Secretary requires the EIS to address. The requirements detailed in the SEARs, together with where they are addressed by this EIS, are provided in Appendix A.

4.4.2. Public exhibition and submissions

If the EIS is considered to meet the SEARs, the DPHI will place it on public exhibition for at least 28 calendar days and invite submissions. At the end of the exhibition period, DPHI will provide NSW DCCEEW with a copy of the submissions and may ask NSW DCCEEW to provide a response to the issues raised in submissions.

DPHI may also request that a preferred infrastructure report be prepared in accordance with section 5.17(6)(b) of the EP&A Act. The preferred infrastructure report may be made available to the public.

NSW DCCEEW may also elect to provide an amendment report that outlines any proposed changes to the proposal to minimise its environmental impact or deal with other issues raised during the assessment of the application. The amendment report may be made available to the public.

Further information on the proposed approach to consultation during the exhibition period is provided in chapter 5.

4.4.3. Assessment and approval

Following the exhibition period, DPHI will, on behalf of the Minister for Planning and Public Spaces, review the EIS, the submissions report and any amendment report or preferred infrastructure report. DPHI will prepare an assessment report, which is submitted to the Minister and Public Spaces for consideration. The Minister for Planning and Public Spaces may refuse the proposal or approve it with such conditions and modifications as the Minister determines. The Minister's decision and the assessment report will be published on NSW DCCEEW's Major Projects' website following determination.

The EPBC Act referral notification confirmed that the potential impacts of the proposal on matters of national environmental significance listed by the EPBC Act will be assessed under the assessment bilateral agreement with NSW. Following consideration of the results of the assessment by the Department, the Australian Minister for the Environment and Water will make a separate decision whether or not to approve the proposal under the EPBC Act.

5. Engagement

This section provides a summary of consultation undertaken by NSW DCCEEW with relevant local, NSW and Commonwealth government authorities, service providers, community groups and affected landowners. It outlines how feedback received has influenced the design of the proposal. The full consultation report is provided in Appendix E.

5.1. Engagement approach

5.1.1. Goals and objectives

NSW DCCEEW goal has been to work collaboratively with stakeholders to advocate for and deliver smarter use of water across the Yanco Creek system that meet the requirements of the SDLAM program.

Key objectives include:

- ensure key stakeholders are effectively engaged and enabled to provide meaningful feedback on the project using appropriate feedback channels
- ensure stakeholders are well informed of project activities and progress using accurate, appropriate, and easily accessible communications materials
- build, maintain, and strengthen the department's relationships with key stakeholders and community representatives as part of community and government partnership
- build community capacity and generate shared understandings.

A consultation report providing details of the consultation program and outcomes is provided in Appendix E (Consultation Report). A summary of this report is provided below.

5.1.2. Stakeholders

The key stakeholders and groups established for the proposal and other SDLAM projects, identified are listed in Table 5.1.

Table 5.1 Stakeholder groups consulted

Group	Stakeholders
Government	NSW Government Ministers NSW Government agencies and bodies including: • NSW DCCEEW • NSW DPI Fisheries • NSW Public Works Authority • WaterNSW • Water Administration Ministerial Corporation • Transport for NSW • DPHI Crown Lands. Australian Government Ministers Australian Government agencies including: • Commonwealth DCCEEW • Murray Darling Basin Authority. Members of Parliament – state and federal for Murray and Farrer areas Public landholders Public asset owners Local councils including Murrumbidgee Council, Edward River Council and Federation Council.
Community	Nations – Yorta Yorta, Wiradjuri, Wemba Wemba Berapa Berapa Local Aboriginal Lands Council's – Deniliquin and Cummergunja, Registered Aboriginal Parties, including Bangerang Five townships including Morundah, Jerilderie, Conargo, Wanganella and Moulamein Community and interest groups including environmental groups, advocacy groups, fishing groups, farming groups, recreational groups and water user groups. Industry and local business. Media
Yanco Creek and Tributaries Advisory Council members	Creek Country Alliance; Murrumbidgee Field Naturalists; NSW Farmers Association; Recreational Fishing Clubs; First Nations; Federation Council; Edward River Council; Murrumbidgee Council; WaterNSW; DPI Fisheries; Environment and Heritage Group; Commonwealth Environmental Water Office
Technical Advisory Group	DPI Fisheries; Murray Irrigation Limited; Commonwealth Environmental Water Office; Coleambally Irrigation; Murray Darling Basin Authority; Yanco Creek and Tributaries Advisory Council; 3Rivers (Engineering companies Jacobs and GHD)
Other bodies consulted specifically on the EIS and EPBC referral	State Emergency Services Transport for NSW – navigation department NSW DCCEEW – Biodiversity Conservation Division Commonwealth DCCEEW

5.2. Engagement carried out

Community engagement for work related to modernising the Yanco Creek system began in late-2018. In late 2019, New South Wales Department of Climate Change, Energy, the Environment and Water developed a community engagement plan (DPIE 2019) in partnership with the Yanco Creek and Tributaries Advisory Council. The Yanco Creek and Tributaries Advisory Council has been a long-term advocate, together with the broader community, for improvements to the water supply operations and environmental outcomes for the Yanco Creek system.

The principal engagement phases comprised:

- feedback on potential benefits and possible options
- feedback to refine options
- feedback during detailed investigations
- EIS consultation

Over 130 people provided written submissions and attended drop-in sessions to provide feedback on the plan. This feedback informed the community engagement approach currently being used for works relating to the modernisation of the Yanco Creek system, including the following:

- community information sessions every six months up until September 2022
- improved information products to facilitate community input and advice
- clear details about the outcomes of proposed options
- establish advisory groups to guide the development of works related to the modernisation of the Yanco Creek system
- ensure industry and local government representation on advisory groups.

A Community Advisory Group was first established in 2019 and now meets as the Stakeholder Advisory Group. The Stakeholder Advisory Group membership includes peak bodies and representatives from council, government agencies, industry, tourism, recreational fishing, and First Nations' groups.

The Stakeholder Advisory Group meets regularly, to discuss the proposals progress and provide community input at various stages of the Yanco Creek modernisation, including to the review and evaluation of Yanco Creek modernisation options.

Complementing the contributions of the Stakeholder Advisory Group, NSW Department of Planning and Environment – Water has held three community information sessions for the general community. These sessions are held up to twice a year as advised by the Yanco Stakeholder Advisory Group and are intended to continue throughout the life of the proposal.

NSW DCCEEW has held information sessions at five different locations spanning the proposal area. These sessions were held in March 2021, March 2022 and September 2022, at Wanganella, Moulamein, Conargo, Jerilderie and Morundah. The sessions in September 2021, were held online due to health requirements in response to the COVID-19 pandemic. During the October and November 2022 floods, key engagement and fieldwork was respectfully suspended to allow landowners and community to focus on recovery. Fieldwork and engagement recommenced in February 2023.

The format of the community sessions was guided by feedback from the community and the Stakeholder Advisory Group and included: a Stakeholder Advisory Group member presenting their perspective on how the proposal is progressing, proposal manager update on progress over the previous six months and plan for the next six months. Each session also included an opportunity for questions from the community. Where possible, updates on other NSW DCCEEW programs, such as Better Bidgee and Reconnecting River Country were also provided. Each session was customised to that location, to make it as relevant as possible to the attendees.

Engagement with directly affected landowners (i.e. property owners with infrastructure) is ongoing. There has been positive feedback regarding how landowners have been engaged to date. Future engagement will continue to build on this work.

The proposal also consults a Technical Advisory Group and Design Focus Group. These groups include representatives from the Stakeholder Advisory Group together with representatives of key State and Australian government agencies. A full list of the Technical Advisory Group and Design Focus Group membership is provided in Appendix A. The Technical Advisory Group has met 13 times and discusses various technical elements of the proposal including: draft concept designs, hydraulic and hydrologic modelling updates, and fish movement reports.

5.2.1. First Nations consultation

The Yanco Creek system traverses the ancestral lands of the Wiradjuri, Bangerang, Yorta Yorta, Barapa Barapa, and Wamba Wamba peoples. The project's boundaries intersect with the jurisdictions of the Local Aboriginal Land Councils of Leeton, Narrandera, Cummeragunja, and Deniliquin.

A comprehensive Aboriginal Community Engagement Strategy was developed to identify and engage appropriate Aboriginal stakeholders. Additionally, an Aboriginal Cultural Strategy was formulated to ensure active participation of First Nations people in project matters affecting their cultural heritage. This strategy has been pivotal in safeguarding cultural practices, language, knowledge, and identity throughout the project's assessment phase.

Five Registered Aboriginal Parties (RAPs) have been key to developing the Aboriginal Cultural Heritage Assessment (ACHA), which involved over 100 interactions and 45 days of on-site engagement. Details of the communication log are provided in Annexure B and the ACHA.

In addition, First Nations representatives have been consulted in respect to Aboriginal heritage features within and surrounding the proposal sites. This is discussed further in chapter 12 (Aboriginal Heritage).

5.3. Community views

Key issues raised to date from all community and stakeholder engagement activities are:

- concern about perceived risk of less water and/or low flow rates in the Yanco Creek system because of changes to infrastructure and the related Yanco Creek Operations Plan
- concern about the proposed project rescope, reducing project works
- fatigue and frustration with perceived lack of project progress
- concern about potential water buybacks and impact on the Yanco Creek system.

These issues are expanded upon in in Table 5.2. Key issues highlighted by the community, such as flow changes in the Yanco Creek system, have been assessment in the EIS.

Table 5.2 Summary of community and stakeholder feedback

Summary of community and stakeholder feedback	
Importance of river flows	Stakeholders stress the importance of maintaining river flows for cultural, environmental and community and economic purposes. Keeping the Yanco, Billabong, Colombo and Forest Creeks flowing is highly valued. Other concerns stakeholders have regarding flows include: - the environment and creek system are important to First Nations people, as is getting water at the right time for Country - concern that there may be less water in the Yanco Creek system - effects of any flow changes in the upper Yanco Creek - need to integrate with other water plans - need holistic understanding of any changes and baseline conditions - ensuring supply in the creeks is maintained to ensure town water supply.
Consideration of alternatives and support for the proposal	Stakeholders value adequate consideration of alternative infrastructure solutions to ensure the best solution is progressed. Alternative solutions discussed with stakeholders include: - location of regulators and construction methods such as in-stream construction, out of stream construction or a hybrid model - consideration of other locations such as existing weirs in the Colombo Creek - a regulator in Yanco Creek was considered but not progressed following a lack of support from key stakeholders. Issues raised in relation to the current proposal include: - support for fishways new infrastructure and ensuring that all fishways are maintained - ensuring that weir pools are not drained as a result of the new infrastructure and that minimum operating levels are set to sill heights of the existing weirs - ensuring that ongoing operations and maintenance costs are adequately considered and included in the proposal - a desire by stakeholders for a guarantee in operation rules to allow future planning - ensure that minimum flow requirements are regulated.
Collaboration and engagement	Stakeholders value ongoing consultation and expressed a strong desire to work collaboratively for the duration of the proposal. - community updates at local venues are supported and a desire for these to continue - ongoing proposal communications are supported including targeted stakeholder discussions as required - establishment and operation of the Registered Aboriginal Parties is working well and is supported.
Key matters for assessment in the EIS	Refer to section 5.4.2.

A number of issues were also raised during engagement activities that are beyond the scope of this proposal. These issues relate to other programs within the Yanco Creek system and Murrumbidgee catchment, and water supply operations. Information regarding other programs is being shared with stakeholders to ensure awareness of wider water management initiatives and to align consultation processes and other activities, as appropriate.

5.4. Engagement related to the EIS

5.4.1. Consultation stages

A scoping report for the proposal was placed on display by the NSW DCCEEW for public comment in November 2022. Following this Secretary's Environmental Assessment Requirements (SEARs) for the proposal, were issued on 17 October 2024, and define the matters the Secretary requires the EIS to address.

The majority of consultation considered all projects within the SDLAM program in addition to this proposal. In addition to this specific consultation for the EIS was carried out for:

- the Social Impact Assessment as required by the Social Impact Assessment Guideline (DPE, 2023b) and the Technical Supplement – Social Impact Assessment Guideline for State Significant Projects (DPE, 2023c).
- consultees required by the SEARs not captured in any existing NSW DCCEEW engagement activities, including the SES and TfNSW Navigation team.
- First Nations consultation specifically on the proposal footprint presented in the EIS.

5.4.2. Consultation feedback related to the EIS

Feedback received from stakeholders and the community that relate to the proposal and the EIS is outlined in Table 5.3. The table also indicates the principle locations these issues are discussed in the EIS.

Table 5.3 Summary of community and stakeholder feedback for the EIS

Key matters for assessment in the EIS	Where addressed in the EIS
Accuracy of the modelling used for identifying changes to stream flows	Chapter 6 (Hydrology)
Operating rules for the proposal	Section 3.4
Ensuring reach by reach minimum baseflows are maintained	Section 3.4 and chapter 6 (Hydrology)
Impact during construction such as water quality and impact to private properties	Chapter 7 (Flooding) and chapter 10 (Surface water quality and aquatic ecology)
Effects of weir operations on upstream users	Section 3.4 and chapter 6 (Hydrology)
Reduced flows downstream will encourage vegetation encroachment	Chapter 6 (Hydrology) Chapter 10 (Surface water quality and aquatic ecology)
Ongoing desire and need for environmental monitoring and reporting.	Chapter 24 (Approach to environmental management and mitigation) Appendix F (Mitigation measures)
Cultural and environmental Impacts need to be assessed	Chapter 12 (Aboriginal heritage) to chapter 13 (non-Aboriginal heritage)
Who will manage the new assets?	Section 1.2 and section 24.3

Key matters for assessment in the EIS	Where addressed in the EIS
Water management and quality - Concern about perceived risk of less water and/or low flow rates in the Yanco Creek system because of changes to infrastructure and the related Yanco Creek Operations Plan. - Some stakeholders raised concerns about potential water buybacks and impact on the Yanco Creek system. In particular, 'paper water savings' versus 'real water savings' (e.g. reduced flows in the top part of the Yanco Creek System). - Some stakeholders raised concerns about potential impacts to water quality.	Section 20.3.2 and Appendix R (Social impact assessment)
Aboriginal cultural values and heritage	Chapter 12 (Aboriginal heritage) and chapter 19 (Social)
Landholders – Desire for landholders to be engaged and kept informed regarding projects that directly impact them.	Section 5.1 and chapter 19 (Social)
The weirs would meet the definition of an obstructions to navigation in the marine legislation, and therefore, in line with section 23(1) of the <i>Marine Safety Regulation 2016</i>, "The owner of any obstruction to navigation must ensure that it is marked and lit so that it does not cause a danger to navigation." Even though navigation in these areas is limited, it does occur and ongoing marking of these hazards should be considered and implemented	Section 3.2.2 and section 18.3.1
Consider the impact of flooding on the proposed infrastructure and any changes of flooding to the community as a consequence of the new weirs, up to and including the Probable Maximum Flood (PMF), along with the impact of climate change on the flood risks. We note a flood and impact assessment is proposed for the later stages of the proposal which will include hazards and risk. We would like to receive a copy of the assessment with an opportunity for consultation.	Section 18.3.1 and section 24.2.1
Carefully consider the impacts of both riverine flooding and flash flooding in your emergency management planning on the workers and the ability to quickly and safely evacuate them from the site.	Section 18.3.1 and section 24.2.1
Ensure workers and people on site are aware of the flood risk, for example through site inductions and by using signage.	Section 18.3.1 and section 24.2.1
Consider closing the worksite and securing all materials and equipment prior to the start of the working day if there is a risk of flooding, on receipt of advice from the Bureau of Meteorology (BoM), or when other evidence leads to an expectation of flooding. During site works, check the BoM website prior to start of the workday for any Flood Warnings.	Section 18.3.1 and section 24.2.1
Request information is provided on the probable maximum flood levels.	Chapter 6 and Appendix G (hydrology) Chapter 7 and Appendix H (flooding)
SES requests a copy of the GIS shape files for the existing flood levels	This will be provided to the SES.
Request information on at what heights of inundation would the regulator gates drop.	Section 3.4.3 Chapter 7 and Appendix H (flooding)
What happens if the electricity supply is interrupted to the regulators?	Section 3.4.7
What consultation has been happening, has council been involved?	Chapter 5 Appendix E (consultation report)

5.4.3. Display of the EIS

Following completion of the EIS NSW DCCEEW will place on public exhibition for at least 28 days for public comments. Figure 5.1 Illustrates the process for approval and the current consultation stage.

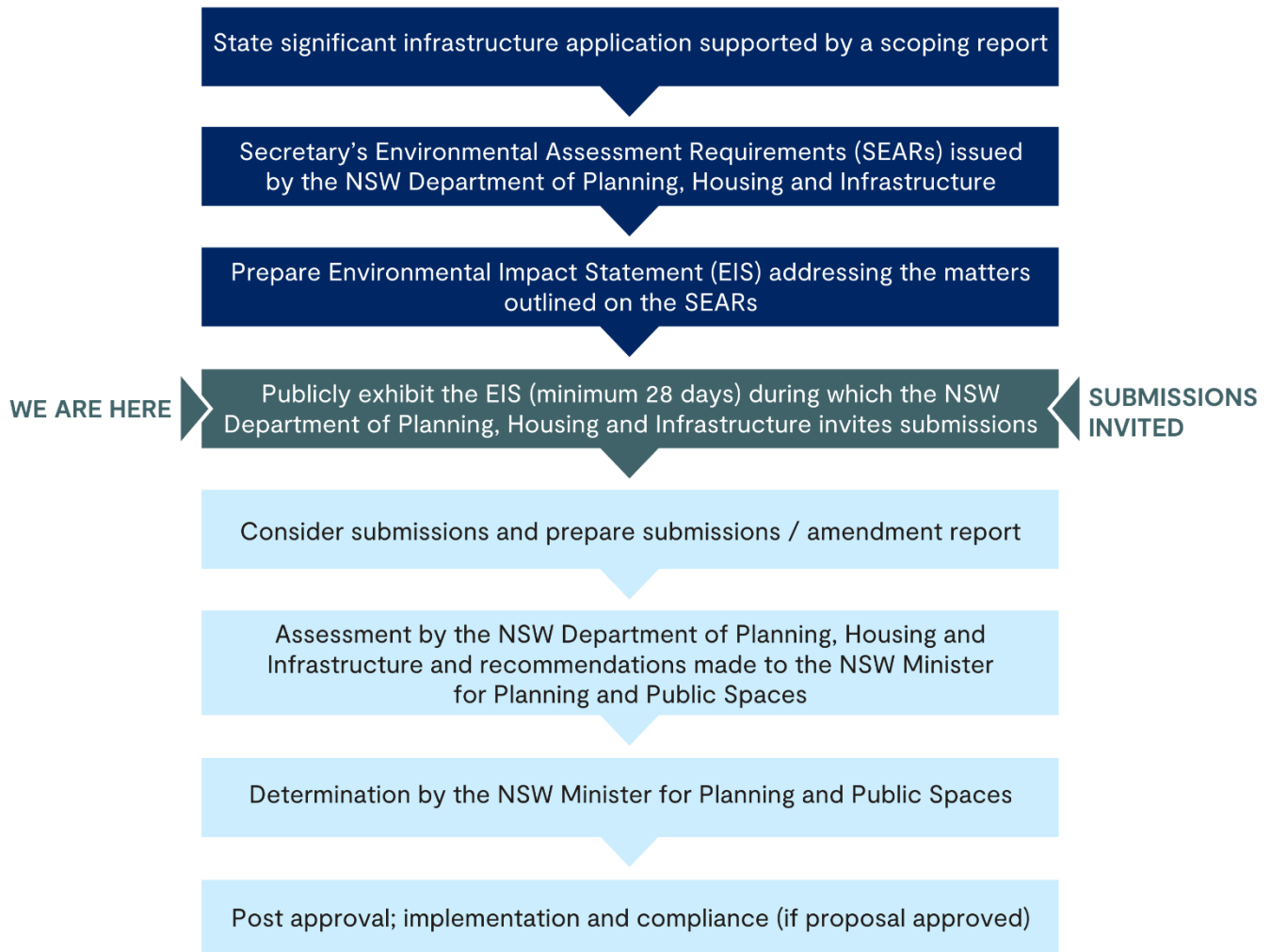


Figure 5.1 Approval and consultation process

5.4.4. Consultation activities

At a minimum, advertisements will be placed in local newspapers to advise of the exhibition, provide details of where the EIS can be viewed and information about other consultation activities during the exhibition period.

During the exhibition period any stakeholder can make a formal submission regarding the proposal. Submissions will be collated into a report and will be considered in the assessment of the EIS and further development of the proposal.

Communication and engagement to support the exhibition will include:

- community displays at local councils, libraries, and land council offices
- community information sessions and stakeholder forums
- community update and newsletter
- digital engagement tools (such as online meetings and opportunities to provide feedback)

- EIS summary document
- government agency engagement
- independent facilitator updates to Stakeholder Advisory Group
- landowner meetings
- media releases
- proposal email and phone number for enquires
- proposal webpage and Frequently Asked Questions
- stakeholder briefings.

5.4.5. Future activities

At the end of the exhibition period, DPHI will provide NSW DCCEEW with a copy of the submissions and may ask NSW DCCEEW to provide a response to the issues raised in submissions. The Department may also request that a preferred infrastructure report be prepared in accordance with section 5.17(6)(b) of the EP&A Act, if significant changes to the proposal are required. The preferred infrastructure report would be made available to the public.

Part C

Environmental impact
assessment

6. Hydrology

The purpose of this chapter is to provide a summary of the hydrology assessment report provided in Appendix G. This assesses the potential hydrology issues both upstream and down stream from the construction and operation of the proposal, and where required, identifies feasible and reasonable mitigation and management measures.

6.1. Methodology

6.1.1. Approach to assessment

An eWater Source model was developed by NSW DCCEEW for the Murrumbidgee Regulated River System (including Yanco and Billabong creeks) downstream of Burrinjuck and Blowering Dams to Balranald Weir. This Source model is the best available estimate of how this complex system interacts and behaves under a range of different scenarios. This Source model is the basis of the hydrology model developed to assess the potential hydrology impacts from the construction and operation of the proposal.

The scenarios modelled for the Yanco Creek system were the following:

- Base case – this is comparable to current conditions, including the existing weirs at Hartwood and Wanganella as well as current water operations across the Yanco Creek system.
- Change case – this represents the potential impacts of the operation of the proposal together with the concurrent operational changes across the Yanco Creek system as detailed in the Yanco Creek system operations plan (provided in Appendix U). The concurrent operational changes include continued use of irrigation areas to more efficiently deliver water into the mid sections of the Yanco and Billabong creeks, and new environmental baseflow provisions.
- Cumulative change case – this represents the potential impacts of the change case plus the operation of other new works proposed as part of the Yanco Modernisation Project. This is primarily the addition of the Forest Creek return flows project to the modelled cumulative change scenario. The Forest Creek return flows project will allow the diversion of excess flows in Forest Creek back into Billabong Creek.

The source model has potential limitations in accurately predicting flows outside of the regulated flow range (i.e. very low flows and very large flows). The Source model is calibrated to perform well (i.e. high degree of confidence that modelled results are a good representation of reality) in the regulated flow range. However, it is not possible for a model to represent the entire flow spectrum perfectly.

The following quantitative and qualitative assessments were undertaken to assess the impacts of the proposal:

- change in key upstream and downstream flow regime characteristics across the area of investigation, using Source modelling
- change in Environmental Water Requirement (EWR) achievement across the area of investigation, using Source modelling and the EWR tool
- change in water extractions (irrigation + town water supply) across the area of investigation, using Source modelling
- change in effective general security allocations across the area of investigation, using Source modelling
- impact on achievement of the relevant NSW River Flow Objectives across the area of investigation.

A full copy of the hydrology assessment report is provided in Appendix G.

6.1.2. Study area

The area investigated for this assessment includes the proposal site and surrounding area, with the potential to be directly or indirectly affected by the proposal. For the hydrology assessment this is defined as follows:

- Study area – the area includes the footprint of the proposal and the waterways with the potential to be directly or indirectly affected by the operation of the proposal. The study area for the hydrology assessment comprises Billabong Creek between Jerilderie and Darlot. Jerilderie is upstream and provides upstream gauged stream flow data for water entering that section of Billabong Creek in which the new regulators would be located. The locality of Darlot provides downstream gauged stream flow data for flows affected by the operations of the new regulators.
- Investigation area – the area that would be subject to operational changes, including environmental flow provisions and water transfer efficiencies, as contained in the Yanco Creek system operations plan (Appendix U). These operational changes are intended to be implemented concurrent with proposed operating rules for the new regulators. This hydrology assessment has assessed these changes, which NSW DCCEEW has modelled, as they influence river sections upstream and downstream of the study area.

6.1.3. Legislative and policy context

The hydrology assessment has been undertaken in accordance with the following key plans, policies and guidelines:

- Murray-Darling Basin Plan 2012
- Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2020
- Water Sharing Plan for the Murrumbidgee Unregulated River Water Sources 2012
- Murrumbidgee Surface Water Resource Plan (DPIE 2020a)
- Murrumbidgee Long Term Water Plan 2020 (DPIE 2020b & 2020c)
- Guidelines for controlled activities on waterfront land (Guidelines) Natural Resources Access Regulator (2018)
- Policy and Guidelines for Fish Habitat Conservation and Management 2013 (Fairfull 2013)
- NSW Water Quality and River Flow Objectives (Objectives)
- Draft Yanco Creek system operations plan (Appendix U)
- Draft Murrumbidgee Regional Water Strategy (Strategy) (DPE 2022b).

6.1.4. Method to assess changes to flow regimes

The metrics and analyses adopted to assess the flow regime characteristics are described in Table 6.1.

Table 6.1 Flow regime characteristics and the corresponding metrics and analyses adopted to assess hydrological impacts of the proposal

Flow regime characteristic	Metrics adopted at key locations within area of investigation	How the results have been used
Flow volume	Change in mean annual water balance from Base Case scenario results over the modelling time period of 1 July 1895 to 30 June 2022	To understand at an annual timestep where water goes in the Yanco Creek System, and how this changes under the Change Case scenario and Cumulative Change scenario
Seasonality of flow	Change in mean monthly flows from Base Case scenario results over the modelling time period	To understand the seasonality of flows, and how this changes under the Change Case scenario and Cumulative Change scenario
Flow variability	Change in total annual flows and mean daily flows from Base Case scenario results over the modelling time period	To understand how flow varies across years and days, and how this changes under the Change Case scenario and Cumulative Change scenario
Flow size	Change in mean daily flow duration percentiles from Base Case scenario results over the modelling time period	To understand what portion of daily flows sit in different flow categories, and how this changes under the Change Case scenario and Cumulative Change scenario

The key locations where these flow regime characteristics have been assessed are described in Table 6.2, illustrating the locations corresponding Planning Units (PU) defined in the Murrumbidgee Long Term Water Plan (DPIE 2020c). Planning Units correspond to a particular river reach and its associated floodplain.

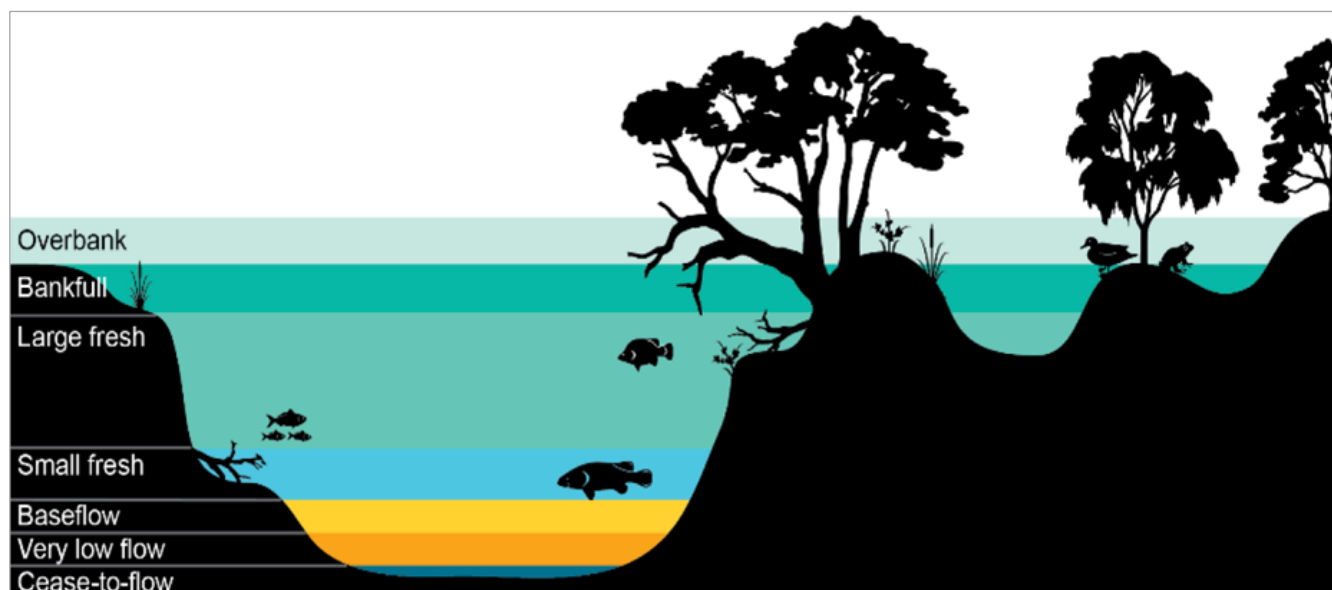
Table 6.2 Planning Unit for each key location where flow regime characteristics have been assessed

Planning Unit	Key location assessed (and associated gauge number)
PU10: Upper Yanco Creek	410007 Yanco Offtake
PU11: Colombo & Billabong Creeks	410014 Colombo Creek at Morundah 410016 Billabong Creek at Jerilderie 410168 Billabong Creek at DS Hartwood Weir
PU12: Lower Yanco Creek to Lower Billabong Creek	410015 Yanco Creek at Morundah 410169 Yanco Creek at Yanco Bridge
PU13: Lower Billabong and Intersecting Streams	410148 Forest Creek at Warriston Weir 41010810 Billabong Creek at Wanganella 410134 Billabong Creek at Darlot

6.1.5. Method to assess change based on environmental water requirements

As defined in the NSW long-term water plans (DPIE 2020b and 2020c), an environmental water requirement (EWR) describes a set of recommended flow characteristics (flow threshold or volume, duration, timing, frequency, maximum inter-event period) at a certain location (river gauge) to meet a particular set of environmental objectives for a Planning Unit.

A number of EWRs are defined for each river gauge location covering a range of flow categories including, but not limited to, cease-to-flows, baseflows, small and large freshes and overbank flows. These flow categories are illustrated in Figure 6.1.



Source: Murrumbidgee Long Term Water Plan Part A: Murrumbidgee catchment (NSW DPIE 2020b)

Figure 6.1 Conceptual diagram of different flow categories

An EWR is the flow or inundation regime that a species, or community, needs to ensure its survival and persistence. It can also be the flow regime needed to meet the water requirements of a range of species in a defined geographic area. EWRs are based on knowledge of a species' biological and ecological needs, such as what it needs to feed, breed, disperse and migrate (DPIE 2020b). The environmental outcomes associated with each flow category are expected to begin occurring at the bottom end of the flow ranges. Greater and sometimes substantially increased outcomes are likely to occur (e.g. for wetland connecting large freshes and overbank flows) as flows increase in size (DPIE 2020b).

The EWR assessment tool (EWR Tool) assesses the occurrence of flow conditions that meet or partially meet the Long-Term Water Plan EWRs in observed or modelled flow time series (NSW DCCEEW 2024). It was originally developed by the Murray–Darling Basin Authority and further refined by NSW DCCEEW for the development of the Long-Term Water Plans (NSW DCCEEW 2024e) and their EWRs for New South Wales. Version 0.0.5 of the EWR Tool was used to compare EWR achievement between the Base Case, Change and Cumulative Change scenarios.

The EWR Tool has been specifically developed to reflect detailed analysis used in the development of EWRs for NSW Long-Term Water Plans. The outputs of the EWR Tool have been used to inform this hydrological impact assessment of the new regulators

6.1.6. Method to assess change based on river flow objectives

The River Flow Objectives for controlled rivers with altered flows (regulated creeks) presented in Table 6.3 are applicable to Billabong Creek below the Colombo Creek confluence (NSW Water Quality and River Flow Objectives: Water Quality Objectives – Murray River). An assessment of the river flow impacts of the proposal during operation, to the extent of proposal influence up and down stream, has been undertaken. This was carried out under the Change and Cumulative Case scenarios in comparison to the Base Case scenario.

Table 6.3 River Flow Objectives for Billabong Creek below the Colombo Creek confluence

River Flow Objectives	Description
Protect natural low flows	Protect natural low flows that would occur under pre-development conditions without any water regulating infrastructure or demands on the system
Protect important rises in water levels	Protect or restore a proportion of moderate flows ('freshes') and high flows
Maintain wetland and floodplain inundation	Maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems
Mimic natural drying in temporary waterways	Mimic the natural frequency, duration and seasonal nature of drying periods in naturally temporary waterways
Maintain natural flow variability	Maintain or mimic natural flow variability in all streams
Maintain natural rates of change in water levels	Maintain rates of rise and fall of river heights within natural bounds
Manage groundwater for ecosystems	Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems
Minimise effects of weirs and other structures	Minimise the impact of instream structures

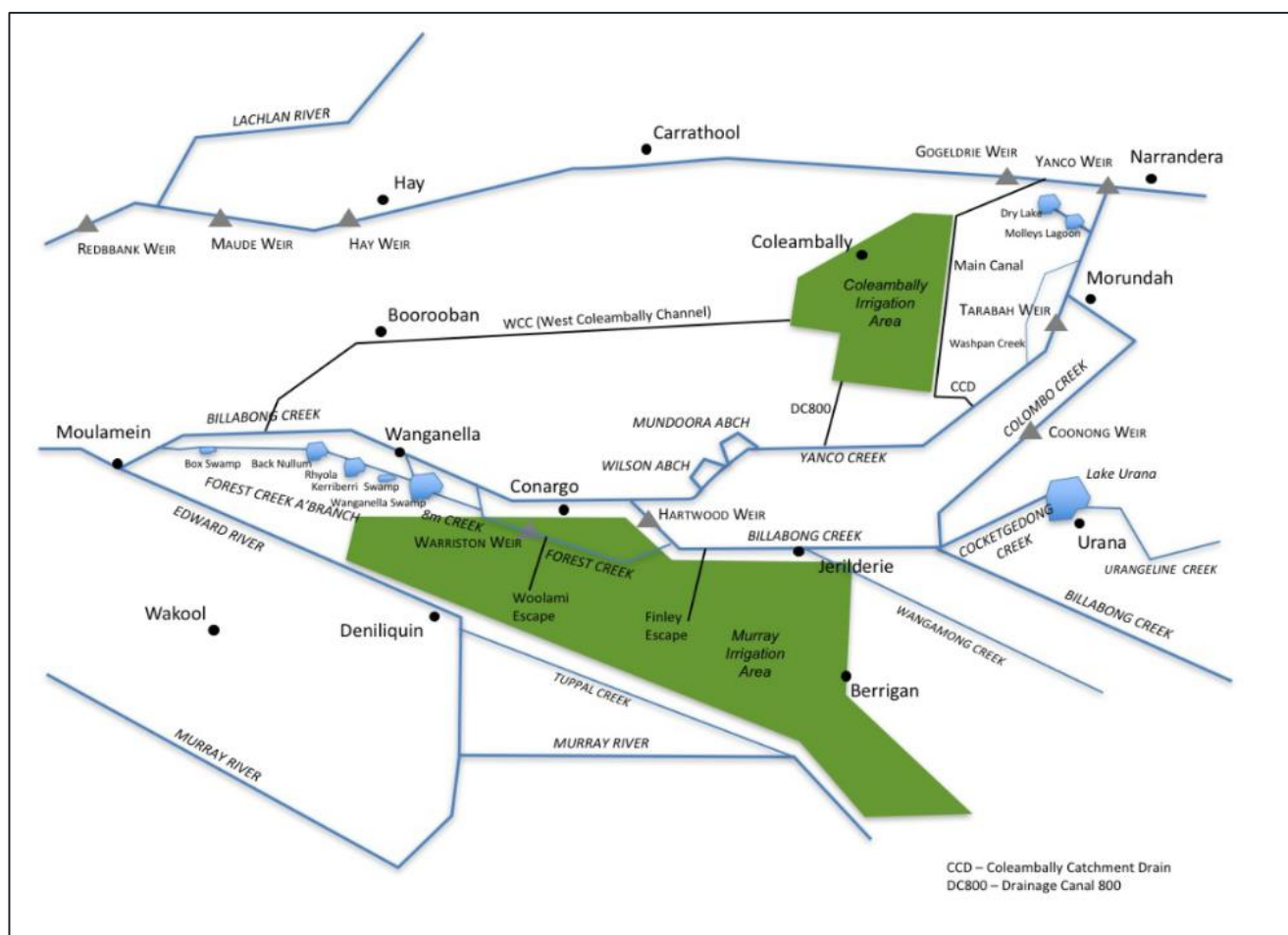
6.2. Existing environment

6.2.1. Yanco Creek system

The creek system

Billabong Creek, within the investigation area, is part of the anabranch complex of interconnecting channels that comprises the Yanco Creek system. The Yanco Creek system receives regulated flows and flood flows from the Murrumbidgee River near Narrandera and unregulated flows from Billabong Creek which has its headwaters in the Great Dividing Range. The creeks flow in a westerly direction before entering Edward River at Moulamein.

The Yanco Creek System is extensive, with almost 800 kilometres of natural channels (creeks and streams) over a region that stretches 250 kilometres from east to west (Cooling and Gippel 2018). The main branches of the system are Yanco, Colombo, Billabong, Forest and Piccaninny creeks (Figure 6.2). There are also a number of large and important floodplain wetlands, such as the Wanganella Swamp and Rhyola Swamp.



Source: Cooling and Gippel 2018

Figure 6.2 Schematic of the Yanco Creek System

Billabong Creek has its own catchment which rises in the Great Dividing Range near Holbrook. Billabong Creek is joined by Colombo Creek west of Urana and continues to flow in a westerly direction toward Jerilderie, before converging with Yanco Creek upstream of Conargo. Billabong Creek eventually joins Edward River at Moulamein.

Flows into the Yanco Creek system are regulated by Yanco Weir on the Murrumbidgee River, diverting water through the Yanco Creek offtake. At Morundah, Tarabah Weir regulates flows downstream into Yanco Creek and also diverts water into Colombo Creek. Flows from Colombo Creek join with those in Billabong Creek to be regulated by Hartwood Weir. The Forest Creek offtake upstream of Hartwood Weir can divert water into Forest Creek. Forest Creek is part of an anabranch complex that also includes Eight Mile Creek, Forest Creek Anabranch and Wanganella Swamp.

Billabong Creek reaches

Billabong Creek can be broadly divided into three reaches on the basis of hydrology, ecology and geomorphology (Alluvium, 2013; Cooling and Gippel, 2018). The proposal study area is located within the mid (Hartwood) and lower (Wanganella) sections of Billabong Creek.

The mid Billabong Creek extends from the Colombo Creek confluence to the Yanco Creek confluence. Flow in this reach is supplemented by water from Colombo Creek and becomes part of a regulated water source receiving water diverted from the Murrumbidgee River at Yanco Weir. Mid Billabong Creek has several distributaries (also referred to as anabranches and paleochannels) that divert from the main channel and re-join it upstream of Moulamein. There are a number of weirs in mid Billabong Creek below Jerilderie, including Hartwood Weir. Hartwood Weir raises the Billabong Creek level so that water enters Forest creek via the Forest Creek offtake.

The lower Billabong Creek extends from below the Yanco Creek confluence to the Edward River confluence at Moulamein and is part of a regulated water source. There are numerous weirs along this stretch of Billabong creek including Wanganella Weir. The channel in the lower Billabong Creek is deep with steep one to two metre high banks and has deep pools connected by shallow runs.

6.2.2. Pre-development (natural) hydrological conditions

Prior to European settlement, Yanco Creek was a high-level gaining creek. Under current conditions, flows within the Yanco Creek System are highly variable at all locations, there is an absence of near no-flow years, and is a more consistently flowing system compared to pre-development. The hydrology of the Yanco Creek System, including the proposal study area, is highly altered, with a loss or considerable alteration of key hydrological flow components and processes. As such the Yanco Creek System is characterised as being highly flow modified.

Flow within the Yanco system is regulated at key locations to manage water delivery. Weirs regulate the share of water between Colombo Creek and Yanco Creek (Tarabah Weir) and between Forest Creek and Billabong Creek (Hartwood Weir and Forest Creek Regulator). In addition, there are over 30 private licenced fixed crest weirs that have been constructed to provide a local store of water. As a result of regulation, flows through the Yanco Creek System are maintained at artificially high levels during high demand periods and as such the total annual flow volume currently is much higher than the pre-development environment.

6.2.3. Current hydrological controls

WaterNSW manages the Yanco Creek System to deliver around 110 GL annually to 423 water licensees and provide town water supply to Morundah, Urana, Oaklands, Jerilderie, Conargo and Wanganella (DPI 2017, NSW DPIE 2019b). Under typical conditions, the *Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016* limits regulated flow in upper Yanco Creek to 1,400 ML/day (at offtake) to prevent excessive losses from overbank flows. A minimum daily flow of 50 ML/d plus downstream water orders at Darlot is provided to maintain connectivity with the Edward River and enable water order delivery, as per the Murrumbidgee Water Sharing Plan. Outfall drains (i.e. irrigation escapes) are used to supplement water supply and overcome capacity constraints – water may be provided from the Coleambally Irrigation Area to Yanco Creek and from the Murray Irrigation District to Billabong Creek and Forest Creek.

6.2.4. Existing hydrological conditions (modelled base case)

Modelled base case

The current hydrology (the base case) was modelled to define the baseline hydrological regime, against which the hydrological regimes under the Change Case and Cumulative Change Case scenarios would be compared to assess the potential impacts of the proposal.

Annual water balance

The modelled mean annual water balance results show that flows that enter upper Yanco Creek through the Yanco Creek Offtake are distributed throughout waterways within the Yanco Creek System at key confluence and diffidence points. Changes in modelled mean annual flow results occur throughout the system due to consumptive extractions (66.9 GL/year), irrigation escape inflows (32 GL/year) and evaporation losses (23.2 GL/year). There is approximately 131.9 GL/year of miscellaneous lateral fluxes, which includes errors in gauging, seepage, overbank flows losses etc. which are not explicitly modelled.

Flows are split relatively evenly where the Yanco Creek and Colombo Creek branch between Yanco Creek at Morundah (135.1 GL/year) and Colombo Creek at Morundah (129.1 GL/year). Colombo Creek then joins Billabong Creek resulting in an increase in flows at Billabong Creek at Jerilderie (207.6 GL/year). Only a minor portion of flows are diverted to Forest Creek, with the majority of flows continuing to Billabong Creek downstream of Hartwood Weir (149.4 GL/year). Yanco Creek then joins Billabong Creek resulting in an increase in flows at Billabong Creek at Conargo (245.9 GL/year) which then flows onto Billabong Creek at Darlot (211.5 GL/year).

Seasonality of flows

The modelled mean monthly flows display a typical temperate seasonal pattern, with generally higher flows during winter-spring and lower flows during summer-autumn periods. Under the Base Case scenario, higher flows in winter-spring are likely due to unregulated high and intermediate flows entering Upper Yanco Creek through the Yanco Offtake and possibly lower irrigation demand during wetter months.

Figure 6.3 present the modelled mean monthly flows under the Base Case scenario at key locations within mid and lower Billabong Creek, which includes the proposal study area.

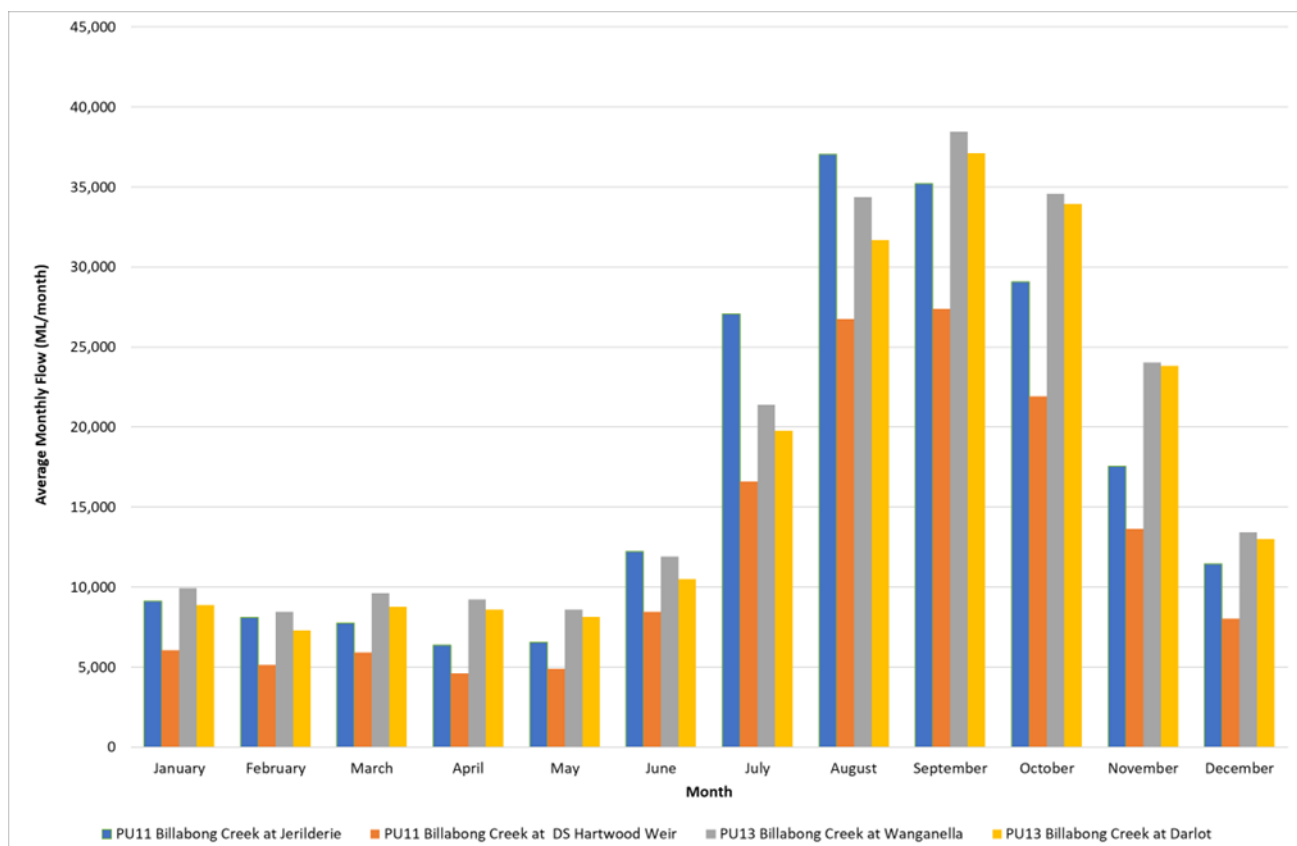


Figure 6.3 Mean monthly flows at key locations for PU reaches in the mid and lower Billabong Creek under the Base Case scenario

Flow variability

Under Base Case scenario, the total annual flow into the Upper Yanco Creek at Yanco offtake shows a high variability. due to the complex nature of its operation. The high variability is likely in response to irrigation, consumptive and environmental demands during periods of lower flow. Modelled averaged daily flow volumes are less variable during May to November, with buffer of daily flow variability in wetter months likely associated with unregulated flows from the Murrumbidgee River through Yanco Offtake and tributary streams that pass through the Yanco and Colombo creeks.

Under the Base Case scenario, the total annual flow in mid and lower Billabong Creek is highly regulated and as a result flows are modelled to be greater than 33.5 GL/year at Jerilderie, greater than 23.9 GL/year at Hartwood, greater than 42 GL/year at Wanganella and greater than 36 GL/year at Darlot, a cross the time series. These modelled total annual flows are artificially higher than the pre-development environment during dry periods as a result of regulated flows to supplying irrigation and consumptive demands and the provision of environmental flow requirements (Alluvium 2013).

Flow sizes

Cease-to-flow no longer occurs throughout Yanco and Colombo Creeks under the modelled Base Case scenario. Cease-to-flow is the level at which a creek stops flowing.

Flows downstream of Hartwood Weir are generally smaller than at other locations within mid and lower Billabong Creek. This also suggests that downstream of Hartwood Weir, base case flows occur more frequently (approximately 65 per cent of the time) whereas small freshes are modelled to occur less frequently (approximately 5 per cent of the time) compared to other locations in mid and lower Billabong Creek. This prevalence of baseflows and proportionate reduction on small freshes is considered the result of flow diversion to Forest Creek through the Forest Creek Offtake which occurs upstream of the Hartwood Weir.

Environmental Water Requirements

The modelled Environmental Water Requirement (EWR) results for Billabong Creek at Jerilderie to downstream of Hartwood Weir (PU 11 downstream of Jerilderie and PU 13), indicate the frequency with which all of the specified EWR categories are achieved. The results show these represent effectively no degree of hydrological alteration compared to “natural” pre-development conditions, ie. flow or inundation regime needed to support key ecological values of the Murrumbidgee Long-Term Water Plan objectives (DPIE 2020c).

The modelled EWR results for Lower Billabong and Intersecting creeks, downstream to Moulamein (PU13) indicate the frequency the specified EWR categories are achieved. These results show these represent a low degree of hydrological alteration compared to “natural” pre-development conditions. The main exceptions are the Nesting Support EWRs for Murray Cod and Trout Cod /Murray Cod, for each of which there is a moderate degree of hydrological alteration to the specific flow or inundation regime needed to support these species in this reach.

Although the modelled attainment for Wetland connection flow ‘preferred seasonal timing’ and ‘any time that is considered satisfactory’ and Floodplain connection flow also indicate a medium degree of hydrological change, it should be noted that, large fresh that connect wetlands in this zone are currently difficult, and small (and large) over bank flows that connect the floodplain cannot be delivered, due to potential impacts on third parties or the flows occur due to tributary rainfall events or dam spills respectively. Deliveries large freshes may only be possible with pumping or where other infrastructure exists to divert water to the floodplain.

6.3. Impact assessment

6.3.1. Construction

Construction overview

During construction of the proposed new Hartwood and Wanganella regulators, the existing weirs will remain in place for the majority of the construction timeframe, only being demolished once the new regulator is fully installed and commissioned. It will therefore continue to have a similar influence on hydrology during the construction period compared to current conditions. In addition, partial cofferdamming of Billabong Creek within the construction timeframes for each respective regulator construction site will allow for passing flows to meet irrigation and consumptive demands and environmental water provisions.

Therefore, it is considered unlikely that construction of the proposal would have a material adverse effect on the hydrology of Billabong Creek, either upstream or downstream. If there were to be any potential changes in the hydrology of Billabong Creek, either upstream or downstream, it is considered they would be short-term (i.e. within the construction timeframes of the proposal) and would not adversely affect irrigation and consumptive demands and environmental water provisions.

NSW River flow objectives

Given the above findings, it is also considered unlikely that construction of the proposal would adversely impact the relevant River Flow Objectives applicable to the proposal study area (mid and lower Billabong Creek) during the proposal construction period.

Given the construction methods, components and phasing allows for the need to provide passing flows. The existing weirs (i.e. Hartwood and Wanganella weirs) will remain in place for majority of the construction timeframe to retain the water and not allow the creek to become unregulated. An assessment of potential River Flow Objectives impacts of the proposal during construction, to the extent of proposal influence up and down stream, has been undertaken in Table 6.4.

Table 6.4 Potential impacts to River Flow Objectives with construction of the proposal

NSW river flow objective	Description	River Flow Objectives impacts during operation
Protect natural low flows	Protect natural low flows	Based on these construction methods the proposal is not expected to result in adverse impacts to low flows (i.e. unnatural prolonged drying) within the proposal study area and the broader Yanco Creek System.
Protect important rises in water levels	Protect or restore a proportion of moderate flows ('freshes') and high flows	Based on these construction methods, construction of the proposal is not expected to result in adverse impacts to moderate flows ('freshes') and high flows.
Maintain wetland and floodplain inundation	Maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems	Based on these construction methods, the construction of the proposal is not expected to result in adverse impacts to the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems.
Mimic natural drying in temporary waterways	Mimic the natural frequency, duration and seasonal nature of drying periods in naturally temporary waterways	Based on these construction methods, the construction of the proposal is not expected to result in adverse impacts to the natural frequency, duration and seasonal nature of drying periods in naturally temporary waterways.
Maintain natural flow variability	Maintain or mimic natural flow variability in all streams	Based on these construction methods, construction of the proposal is not expected to result in adverse impacts to mean daily flow volumes within lower Billabong Creek, including the proposal study area.
Maintain natural rates of change in water levels	Maintain rates of rise and fall of river heights within natural bounds	Based on these construction methods construction of the proposal is not expected to result in adverse impacts to rates of rise and fall of river heights.
Manage groundwater for ecosystems	Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems	Dewatering will not be required at Hartwood based on the design from February 2024 and the groundwater elevation recorded at the site, hence, construction is not expected to result in adverse impacts to groundwater ecosystems or surface flows. Minor dewatering is expected at Wanganella. It is likely that the extent of the effect of dewatering will be restricted to 250 m. Due to the ongoing influence of recharge from the creek to groundwater, the drawdown experienced within the radius of influence will be less than 0.5 m and occur only during the period of dewatering which will be shorter than the full construction program. Billabong Creek is partially disconnected and losing to groundwater hence, the proposal is not expected to result in reduced surface flows during construction.
Minimise effect of weirs and other structures	Minimise the impact of instream structures	Based on these construction methods construction of the proposal is not expected to result in adverse impacts to existing river extents with unimpeded fish passage.

6.3.2. Operation

Operation of the proposed regulators

The proposed regulators are designed to be operated to retain the current uses of water within the weir pools and improve the efficiency of the delivery of irrigation and environmental water to the creeks downstream. Additional storage of water behind the regulators provides the opportunity to reduce the quantity of irrigation water needing to be diverted into Yanco Creek from the Murrumbidgee River by capturing and storing part of high flows that enter the regulator pools. The regulators will be operated to optimise the capture of a portion of high flows and use this water to meet downstream demand.

Similar to existing delivery of water through the Yanco Creek system, the regulators will be operated in response to prevailing climatic conditions, requirement and orders for water (including town and environmental water) and regulatory requirements. These factors provide the broad framework within which water is delivered. The eWater Source modelling, in the base case, illustrates the outcomes of past and current water management operations and provides predictions of how creek hydrology has responded. For the change case, it incorporates the proposed operations of the new regulators and indicates how they might improve the delivery of water in similar varied management responses and the potential impact to creek hydrology in the future.

Further details of the regulator operating principles are provided in section 3.5.

Hydrological impacts during operation

The Change Case scenario results indicate minor alterations in mean annual flows within the Yanco Creek System. The typical temperate seasonal pattern of flows is maintained, with minimal impact on mean monthly flow volumes throughout the Yanco Creek System, including the proposal study area (Billabong Creek from Jerilderie to Darlot). The Change Case scenario results indicate the proposal does not substantially impact annual or daily flow volume variability and there are minimal impacts on daily flow sizes.

Overall, the hydrological analysis suggests that while operation of the proposal will have some localised (within reach) effects on hydrology (i.e. water balance, seasonality, flow variability, and flow sizes) the impacts are generally minor and consistent with those expected as a result of implementing the proposal and broader system changes, and do not substantially alter the overall hydrological characteristics of Billabong Creek within the proposal study area or the broader Yanco Billabong System.

The findings of the EWR analysis suggest that there are generally either no change or improvements in achieving EWRs with operation of the proposal (i.e. the Change Case scenario). There is predicted to be improvements in the frequency of achieving baseflows, Native Fish Nesting Support, small freshes and large fresh EWRs throughout the Yanco Creek System, including the proposal study area. Therefore it is concluded that operation of the proposal will result in an overall improvement in the frequency of achieving EWRs for a number of EWR categories to support key ecological values of the system.

Effective General Security Allocations are predicted to increase marginally under the Change Case scenario, compared to Base Case, for opening allocation and summer planning decision dates. A very minor decrease is predicted for end of the year. A minor increase in water availability to meet Water Access Licenses is predicted under the Change Case scenario.

The following sections summarise the modelled hydrological regime under operation of the proposal and other systems changes specified in the Yanco Creek system operations plan.

Annual water balance

All changes in mean annual flows when comparing the Change and Base Case scenarios represent a low degree of hydrological change (range from 11.1 per cent reduction to 2.1 per cent increase) from the Base Case scenario. The low degree of changes in mean annual flows within the Yanco Creek System are considered the product of the suite of differences between the Change Case and Base Case scenario, including:

- new environmental baseflow provision for Yanco Creek at Offtake of 250 ML/day when General Security allocations exceed 15 per cent
- increase in minimum environmental flow provision for Yanco Creek at Morundah from 50 ML/day to 100 ML/day
- the ability of the new regulators to regulate flows within Billabong Creek itself to meet environmental and water supply demands
- new limits of no orders from Coleambally Catchment Drain and Drainage Channel 800 Irrigation Escapes
- new limits of no orders from Finley Escape until Colombo Creek at Morundah reaches 130 ML/day and no orders during the winter period (15 May to 15 August).

Water Extraction

The results in Table 6.5 provide a summary of modelled consumptive extractions (Irrigation and town water supply), for the Yanco Colombo Billabong System from Yanco Creek at Offtake to Forest Creek at Warriston Weir and Billabong Creek at Darlot, from the period 1895 to 2022. The Source model consumptive extractions results indicate consumptive take can increase by +0.2 GL/year based on water availability in the Yanco Creek system under the Change Case scenario. Based on these results no reduction in water availability to meet Water Access Licenses is expected with operation of the proposal.

Table 6.5 Modelled consumptive extractions (Irrigation + Town Water Supply) between Yanco Offtake and Darlot, for data from the period 1895-2022.

Water Balance Component	Base Case	Change Case
Extractions (GL/year)	66.9	67.1
Difference from Base Case (GL/year)	0	Increase of 0.2

Seasonality of flows

All changes in mean monthly flows when comparing the Change and Base Case scenarios represent a low degree of hydrological change (6.8 per cent reduction to 7.1 per cent increase for Yanco and Colombo Creeks and 17.6 per cent reduction to 5.3 per cent increase for mid and lower Billabong Creeks) from the Base Case scenario. In addition, the typical temperate seasonal pattern of higher flows during winter-spring and lower flows during summer-autumn periods which was observed under the Base Case scenario has been retained in the Change Case scenario. The low degree of changes in mean monthly flows within the Yanco Creek System could be due to the differences between the Change Case and Base Case scenario.

Flow variability

The average change in annual flow volumes over the 127 year period when comparing the Change and Base Case scenarios represent a low degree of hydrological change (1.1 per cent reduction to 3.5 per cent increase for Yanco and Colombo Creeks and 2.0 per cent to 0.9 per cent reduction for mid and lower Billabong Creeks) from the Base Case scenario.

The average change in mean daily flows and annual flow volumes when comparing the Change and Base Case scenarios represent a low degree of hydrological change (1.3 per cent reduction to 2.2 per cent increase for Yanco and Colombo Creeks and 3.9 per cent to 1.3 per cent reduction for mid and lower Billabong Creeks) from the Base Case scenario.

Flow sizes

Almost all changes in daily flow sizes when comparing the Change and Base Case scenarios represent a low degree of hydrological change (3 per cent reduction to 18 per cent increase for Yanco and Colombo Creeks and 25 per cent to 3 per cent reduction for mid and lower Billabong Creeks) from the Base Case scenario. In addition, a comparison of Change Case to Base Case flow size results indicate no material change in the proportion of flow categories.

Environmental water requirements

The EWR results for Upper Yanco Creek and Lower Yanco to Lower Billabong Creek indicate no reductions in the frequency with which EWR categories are modelled to be achieved, compared to Base Case results. The increase in the frequency with which a number of specific EWRs are also predicted to be achieved. This includes Baseflow, Native Fish Nesting Support, Small fresh and Large fresh EWRs.

The EWR results for Colombo Creek at Morundah to Billabong Creek upstream of Jerilderie indicate very minor reductions in the frequency with which Very low flow and Baseflows are achieved compared to Base Case results, but these contradict the new minimum flow targets, and therefore will not eventuate in reality.

The EWR results for Billabong Creek at Jerilderie to downstream of Hartwood Weir indicate a minor reduction in the frequency with which Cease-to-flow and Very low flow EWRs is predicted to be achieved compared to Base Case results, but these contradict the new minimum flow targets, and therefore will not eventuate in reality.

The EWR results for Lower Billabong and Intersecting Streams downstream to Moulamein indicate minor reduction in the frequency with which Cease-to-flow and the specific flow or inundation regimes for Small Overbank Floodplain Connection Flow EWRs are achieved, but these contradict the new minimum flow targets, and therefore will not eventuate in reality.

Importantly, the EWR results for Lower Billabong and Intersecting creeks downstream to Moulamein indicate there are increases in the frequency with which the specific flow or inundation regime for Floodplain Connection Flow and Large Overbank, Small Freshes and Native Fish Nesting Support EWRs are achieved compared to Base Case results.

Additional environmental flow provisions

The new regulators for the proposal and broader system changes, are not predicted to negatively affect the achievement of the new baseflow of native fish environmental provisions specified in the Yanco Creek System Operations Plan (see Appendix U). Under the Change Case scenario, the new environmental baseflow provisions for Billabong Creek downstream of Hartwood Weir and at Jerilderie and Darlot are predicted to be achieved 100 per cent of the time under the Change Case scenario, which is no change from Base Case. The additional small fresh provision at Billabong Creek at Darlot is predicted to be achieved 53.5 per cent of the time under the modelled Change Case scenario. When comparing the Change Case scenario to the Base Case, the additional small fresh provision is predicted to be achieved for an additional 6.3 per cent of the time for the specified time period.

Effective General Security Allocations

Effective General Security Allocations are predicted to increase marginally under the Change Case scenario, compared to Base Case, for opening allocation and summer planning decision dates. A very minor decrease is predicted for end of the year.

River Flow Objectives

Under the Change Case scenario, no potential adverse impacts and some minor improvements to River Flow Objectives are predicted under the operation of the proposal alongside broader system changes specified in the Yanco Creek System Operations Plan.

With operation of the proposal alongside broader system changes, no adverse effects, and in some instances positive effects, are expected to low flows (i.e. unnatural prolonged drying), moderate flows ('freshes'), high flows and wetland and floodplain inundation flows. In addition, no material change is expected in the overall annual and daily flow variability within the Yanco Creek System with operation of the proposal. No adverse impacts are expected to groundwater dependant surface flows and ecosystems. An improvement in the rates of change in water levels is expected with implementation of operational limits for 'Pool Maximum Daily Rate of Rise' for Hartwood and Wanganella regulators and 'Native fish environmental flow provisions' for maximum rate of fall at Yanco Offtake and Billabong Creek at Darlot. Additionally, the design of the Hartwood and Wanganella regulators includes fishways that will allow an increase in river extent with unimpeded fish passage.

An assessment has been undertaken of potential River Flow Objectives impacts of the proposal during operation, to the extent of proposal influence up and down stream. The findings are discussed in Table 6.6.

Table 6.6 Potential impacts to River Flow Objectives with operation of the proposal

NSW river flow objective	Description	River Flow Objectives impacts during operation
Protect natural low flows	Protect natural low flows	The flow variability and frequency and size analysis results for the Change Case scenario (see section 6.1.4) indicate operation of the proposal is not expected to result in adverse impacts to low flows (i.e. unnatural prolonged drying) within the proposal study area and the broader Yanco Creek system. Environmental baseflow provisions specified in the Yanco Creek system operations plan (provided in Appendix U) include at (among other locations) Billabong Creek at Jerilderie of 70 ML/day (when general security allocations are equal to or greater than 15 per cent), Billabong Creek downstream Hartwood Regulator of 25 ML/day (at all times) and Billabong Creek at Darlot – 50 ML/day plus downstream orders (at all times).
Protect important rises in water levels	Protect or restore a proportion of moderate flows ('freshes') and high flows	The flow frequency and size analysis for the Change Case scenario (see section 6.1.4) indicate no material change in the proportion of moderate flows ('freshes') and high flows will occur within the study area with operation of the proposal.

NSW river flow objective	Description	River Flow Objectives impacts during operation
Maintain wetland and floodplain inundation	Maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems	The analysis of EWR (Environmental Water Requirements) attainments for the Change Case scenario (see section 6.1.4) indicate, with some exceptions, mostly no change or some minor improvements in the frequency in the expected frequency of over bank wetland connection or floodplain connection flows within the study area (i.e. lower Billabong Creek) with operation of the proposal. Very minor reduction in the frequency of small overbank floodplain connection flows predicted for lower Billabong Creek.
Mimic natural drying in temporary waterways	Mimic the natural frequency, duration and seasonal nature of drying periods in naturally temporary waterways	The annual water balance results indicate no material change in the overall water balance of the Yanco Creek system with operation of the proposal that is considered likely to result in changes to the current frequency, duration and seasonal nature of drying periods in naturally temporary waterways within the Yanco Creek system.
Maintain natural flow variability	Maintain or mimic natural flow variability in all streams	The flow variability analysis results indicate no material change in the overall annual flow variability within the Yanco Creek system with operation of the proposal. Operation of the proposal is also not expected to seriously impact mean daily flow volumes within lower Billabong Creek, including the proposal study area.
Maintain natural rates of change in water levels	Maintain rates of rise and fall of river heights within natural bounds	Operation of the proposal is expected to result in an improvement in the rates of change in water levels within the proposal study area and the broader Yanco Creek system. The Yanco Creek system operations plan includes normal regulated flow operational limits for 'Pool Maximum Daily Rate of Rise' of 0.30 metres for Hartwood and Wanganella regulators. The operations plan also includes 'Native fish environmental flow provisions' of a maximum rate of fall of nine per cent (by volume) between 14 September and 16 November inclusive for Yanco Creek at Yanco Offtake and Billabong Creek at Darlot, to better align with the EWR for fish nesting in the long-term watering plan.
Manage groundwater for ecosystems	Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems	During operation minor water table change is expected at Hartwood and Wanganella. The operation of the proposal is not expected to result in adverse impacts to water dependent ecosystems as the change in groundwater level expected from the proposal is minor. Billabong Creek is partially disconnected and losing to groundwater hence, the proposal is not expected to result in reduced surface flows during operation.
Minimise effect of weirs and other structures	Minimise the impact of instream structures	Operation of the proposal will not have a significant adverse impact on the occurrence of high quality flowing habitat or water quality within the proposal study area. The design of the Hartwood and Wanganella regulators includes fishways that will allow an increase in river extent with unimpeded fish passage.

River running heights and weir pool extents

At Hartwood the hydraulic modelling indicates there is no material change in water surface downstream of the proposed Hartwood Regulator for either the Maximum Operating Flow or Minimum Operational Flow scenarios. In particular, the township of Conargo does not experience any change outside of Billabong Creek and only changes of increase/decrease of 10 millimetres within the channel. In addition, there is a predicted increase in water surface levels to just below 100 millimetres within weir pool upstream of Warriston Weir and in Piccaninny Creek upstream of Conargo Road in all operational scenarios

The modelled results indicate minor changes to the existing Hartwood weir pool are expected, as shown in Figures Figure 3.13 and Figure 3.14. It is evident that there is an increase in lateral inundation and an increase in longitudinal inundation of 73 metres, which is due to the proposed regulator being located approximately 70 metres downstream of the existing Hartwood weir. As a result, under this particular operating scenario, there is an increase of around 51,000 square metres or about 7.7 per cent in overall inundation extent compared to existing conditions, which considered a low degree of change.

At Wanganella there is no material change in water surface levels downstream of the proposed Wanganella Regulator for the Maximum Operating Flow and proposed operating level scenarios. At the Minimum Operating Level of the regulator there is a minor reduction in predicted water surface levels (approximately five to 20 millimetres) to a distance of around 600 metres downstream, from which in become consistent with existing conditions. For Full Supply Level, a minor (approximately 10 millimetres) reduction in downstream surface water levels is predicted to a distance of around 700 metres downstream of the proposed Wanganella Regulator.

The modelled results indicate minor changes to the existing Wanganella weir pool are expected, as shown in Figure 3.15. It is evident that there is an increase in lateral inundation but no change in longitudinal inundation. As a result, under the Full Supply Level operating scenario, there is an increase of around 110,000 square metres or 30 per cent in overall inundation extent compared to existing conditions, which corresponds to a medium degree of change. However, Wanganella Regulator is not intended to operate the weir pool at Full Supply Level for a substantial period of time, as this will only occur to capture a portion of unregulated flow events which are uncommon. As such, over the long term, there is likely to be only low degree of change in the Wanganella weir pool extent.

6.3.3. Cumulative impacts

A summary of the cumulative assessment is provided in section 23.3.3 and section 4.3 in Appendix G (Hydrology assessment report).

6.4. Mitigation measures

6.4.1. Approach to mitigation and management

NSW DCCEEW is committed to minimising the environmental impact of the proposal and is investigating opportunities to reduce impacts where practicable. As prescribed by the SEARs, opportunities would also be implemented, where possible, to improve the overall outcome of the proposal.

The approach to mitigation and management of impacts is guided by the operating principles and objectives specified in the Yanco Creek system operations plan (provided in Appendix U). There are no additional mitigation and management measures beyond those provisions. The operations plan outlines general operating principles that include, among others, adaptive management adopting the lessons learnt from trialling new approaches and historic operational events that also includes adapting to seasonal conditions and variability.

The operations plan (provided in Appendix U) includes environmental baseflow provisions for the Yanco Creek system which will be met by the overall management of flows through the system and subject to the provisions of the water sharing plan and water licensing. The implementation of these flows are proposed to commence concurrent with the operations of the new regulators. The plan is to form part of the requirements of the water supply work approval issued to WaterNSW for the Murrumbidgee regulated river water source.

The Yanco Creek system operations plan is aligned with water management regulations and plans that will direct the operations of the proposed regulators and any future changes. These plans include the following:

- Murrumbidgee Water Resource Plan (Surface Water) (DPIE 2020a)
- Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016
- Murrumbidgee Long Term Water Plan (DPIE 2020b).

Water resource plans are required by the Murray-Darling Basin Plan 2012. They must comply with a number of requirements which include describing water rights, compliance with sustainable diversion limits and the provision of environmental water. The Murrumbidgee Water Resource Plan (DPIE 2020a) reflects the arrangements in the water sharing plan and the guidance for environmental watering provided by the long term water plan. The water sharing plan manages access to water resources and river operations, and regulates how water is shared between the environment, instream uses and extractive water use. The long term water plan informs annual decision-making for the environmental watering requirements of priority environmental assets and ecosystem functions.

The general approach to management of the proposal during construction and operation is outlined in chapter 24.

7. Flooding

This chapter summarises the flooding assessment report, providing the key findings of the flood impact assessment and highlighting key areas of change from existing conditions. The assessment considered the potential for areas to be directly or indirectly affected by the construction and operation of the proposal. Full details of the flood impact assessment, including the modelling and impact mapping completed for this assessment, is contained in Appendix H.

7.1. Methodology

7.1.1. Approach to assessment

Flood inundation modelling was completed to assess the impacts of the proposed structures which was a combination of a hydrological assessment and hydraulic modelling. The findings have been compared to the existing case to determine if there are increases or decreases in the potential for flooding as a result of the proposal. Results presented include flow, afflux (or change in water surface level) and flood hazard. Full details of the flood impact assessment, including the modelling and impact mapping completed for this assessment, is contained in Appendix H.

The assessment has been undertaken in accordance with the following key plans, policies and guidelines:

- Flood Risk Management Manual (DPE 2023d)
- Conargo Local Environmental Plan 2013 (Edward River Council 2013).
- Conargo Floodplain Risk Management Study and Plan (Lyall & Associates 2010)
- Billabong Creek Floodplain Management Plan (NSW DNR 2006)
- Edward and Wakool Rivers Stage 1 Floodplain Management Plan (DECCW 2011a)
- Flood Risk Management Manual (DPE 2023))
- Australian Rainfall and Runoff: A Guide to Flood Estimation (Ball et al 2019a).

7.1.2. Study area

The study area used in the assessment includes the footprint of the proposal and the surrounding area with the potential to be directly or indirectly affected by the operation of the proposal. The areas of investigation covered by this flood study comprised floodplains and surrounding land that may potentially be affected by flooding surrounding the proposed works of each regulator, as shown in Figure 7.1 and Figure 7.2. The main areas of focus within each study area are the weir pools upstream of each regulator, as flood impact is largely controlled by the respective upstream and downstream weirs and/or other creek controls.

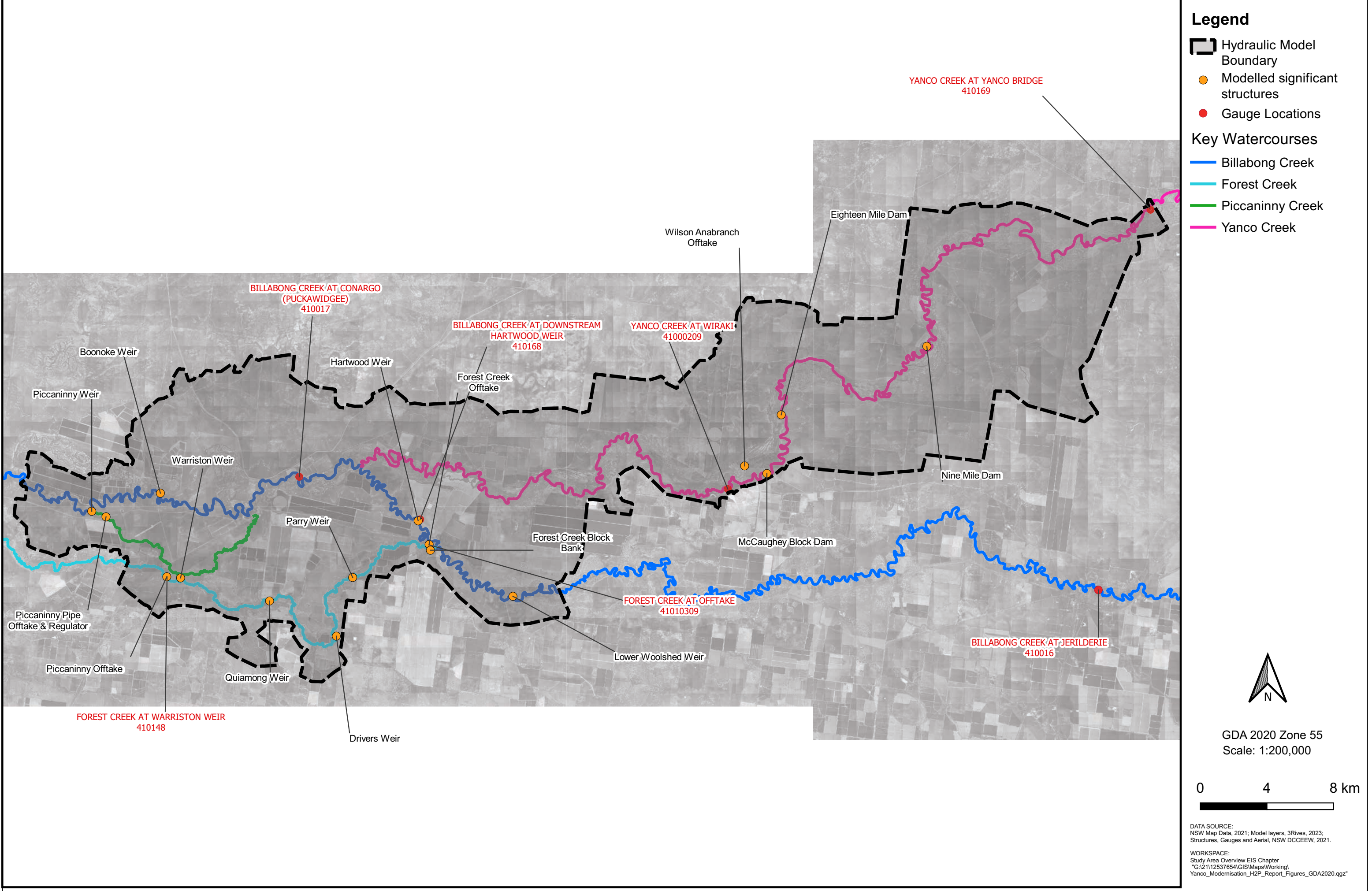


Figure 7.1: Study Area Overview



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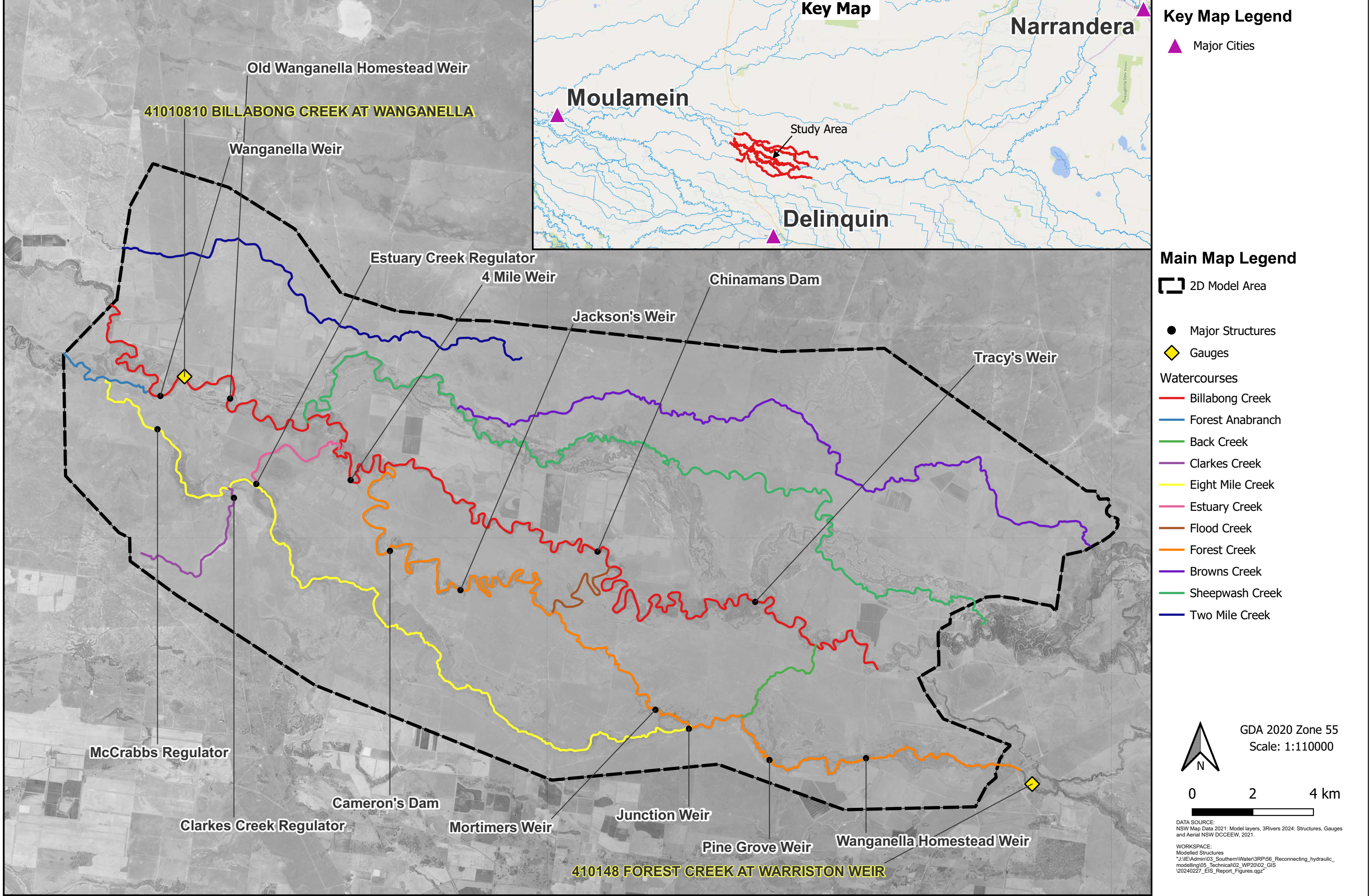


Figure 7.2: WP20 Study Area Overview



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7.1.3. Inundation modelling methodology

Inundation modelling was completed to assess the impacts of the proposed structures which was a combination of a hydrological assessment and hydraulic modelling.

The modelling at Hartwood and Wanganella has included the assessment of several flow conditions and flood events ranging from operational flow to flood flows (20 per cent (1 in 5 year average recurrence interval event) annual exceedance probability (AEP), 5.0 per cent (1 in 20 year) AEP, 1.0 per cent (1 in 100 year) AEP to the probable maximum flood (PMF)) for both existing and proposed conditions.

There are three main sources of inundation in the Yanco Creek system considered in the assessment:

- flow originating from the Murrumbidgee River through the Yanco Offtake into Yanco Creek, as well as any breakout flows
- unregulated flows in the Billabong Creek system
- the combination of flows from the Yanco Creek and Billabong Creek.

Runoff from the local catchment was considered insignificant compared to the flows from the Murrumbidgee River or Billabong Creek. Therefore flows from the Murrumbidgee River or Billabong Creek was the primary focus of the assessment.

7.1.4. Uncertainties and tolerances

To assess the flood impact of proposed structures, flood impact maps were prepared that compare the existing case flood levels to the proposed case flood level (i.e. the difference between two flood levels). They have been calculated such that:

- Increases in flood levels from existing to proposed are positive.
- Decreases in flood levels from existing to proposed are negative.

As there are a number of uncertainties in flood models it is necessary to select a modelling tolerance and for sensitive areas this has been selected to be plus or minus 10 millimetres. This is based on the outcomes of the research project that informed the development of the National Guidelines for undertaking flood modelling: Australian Rainfall and Runoff (Ball et al 2019a).

The criteria for flood impacts for this assessment are:

- plus or minus 10 millimetres for sensitive land uses such as residential homes
- plus or minus 50 millimetres for waterways, cropping and natural bushland.

Also considered is whether or not the area was previously inundated.

7.2. Existing environment

7.2.1. Hartwood

There is minimal existing flood risk at Hartwood Weir and in the surrounding areas. Faster and deeper flooding is generally contained to the creeks and defined flow paths and/or their associated floodplain corridor and other areas only engaged by ponding and/or flood fringe flows. Given the nature of Billabong Creek and the large surrounding catchments, high flow events are typically slow rising with surrounding floodplains and agricultural land gradually becoming inundated during flood events for extended periods. The existing Hartwood Weir operates as a fixed crest weir with manual drop boards that are typically removed during high-flow conditions. The upstream extent of the weir pool varies with inflows but can stretch up to around 16.5 kilometres where it is restricted by Lower Woolshed Weir, and to Parry's Weir on Forest Creek if Forest Creek Offtake is open.

The most recent flood study for the area, the Conargo Floodplain Risk Management Study and Plan (Lyll & Associates 2010), conducted modelling for sections of Billabong Creek and Piccaninny Creek around the township of Conargo. That modelling of the 1 in 100 year event (19,500 Megalitres per day. (ML/day)) indicated that only two residential properties in Conargo would be affected by shallow flood levels from Billabong Creek. Flooding mainly occurs around the banks of Billabong Creek and along or adjacent to local access roads that cross the floodplain in these areas.

The Yanco Creek System Environmental Flows Study (Alluvium 2013) provided findings and recommendations for the use of environmental water throughout the Yanco Creek system. The study included modelling for some reaches in the study area and selected cross sections used for this study have been considered throughout the development of current hydraulic models. No council flood studies exist for the Hartwood area.

Modelling of existing inundation for the current assessment shows the following outcomes for different flow events:

- 20 per cent (1 in 5 year) Annual Exceedance Probability (AEP) flood event is largely confined to the watercourse channels of Billabong Creek, Yanco Creek, Forest Creek, Piccaninny Creek, Wilsons Anabranh, Box Creek, Browns Creek and Sheepwash Creek with some breakout flow paths around Lower Woolshed Weir and in a few places along Forest Creek
- five per cent (1 in 20 year) AEP flood event inundates a wider corridor along the same watercourses, engages Back Creek and has larger breakout areas, including new ones between Yanco Creek and Billabong Creek, Forest Creek and Piccaninny Creek
- one per cent (1 in 100 year) AEP flood event inundates a wider corridor along the same watercourses and breakout areas, with Wilsons Anabranh being engaged from further upstream on Yanco Creek
- Probable Maximum Flood (PMF) event covers the majority of the area with only minor areas between waterways being outside of the extents due to having naturally high terrain or protection from an embankment or levee.

7.2.2. Wanganella

There are two major waterway systems flowing eastwards near the downstream part of the Wanganella study area, including the Billabong Creek on the north and the Forest Creek / Eight Mile Creek system on the south. The existing Wanganella Weir is located on Billabong Creek approximately one kilometre downstream of the Cobb Highway and the Wanganella village. In a similar manner to Billabong Creek at Hartwood Weir, with a large surrounding catchment at Wanganella Regulator, high-flow events are typically slow rising. The surrounding floodplains, such as Wanganella Swamp, and agricultural land gradually becoming inundated during flood events for extended periods.

Estuary Creek, Forest Creek, Eight Mile Creek and the Wanganella Swamp are generally higher than Billabong Creek. Forest Creek / Eight Mile Creek is linked with Billabong Creek through Estuary Creek. The Forest Creek / Eight Mile Creek system also slightly interacts with Billabong Creek around the existing Wanganella Weir through breakout flows from Forest Anabranh in large flood events.

Some cross-sections of channels provided in the Yanco Creek System Environmental Flows Study (Alluvium, May 2013) have been considered throughout the development of hydraulic models for the existing Wanganella Weir. Other studies that were used to inform the existing condition for the existing Hartwood Weir, have not been used to inform the existing conditions or model development for Wanganella Weir as the available information does not cover the appropriate areas of Billabong Creek and the surrounding floodplains.

Modelling of existing inundation for the current assessment shows the following outcomes for different flow events:

- 20 per cent (1 in 5 year) AEP flood event is largely confined to the watercourse channels of Billabong Creek, Eight Mile Creek, Forest Creek, Estuary Creek and Sheepwash Creek with some breakout flow paths around the Wanganella Swamp along Eight Mile Creek. Wanganella village between Billabong Creek and Lang Street is subject to minor inundation.
- Five per cent (1 in 20 year) AEP flood event inundates a wider corridor along the same watercourses, with larger breakout areas, including new ones along Billabong Creek downstream of Cobb Highway, which return flows to itself downstream. The inundation in Wanganella village between Billabong Creek and Lang Street also increases to some extent.
- One per cent (1 in 100 year) AEP flood event inundates a wider corridor along the same watercourses and breakout areas, with Forest Anabranh being engaged between Billabong Creek and Eight Mile Creek. The flood water along Eight Mile Creek is also detained upstream of Cobb Highway to some extent. The area north of Billabong Creek and south of Lang Street is mostly under water although residential properties are above these flood levels, with inundation generally confined to public open space and backyards.
- PMF event covers the majority of the area with only minor areas between waterways being outside of the extents due to having naturally high terrain or protection from an embankment or levee.

7.3. Impact assessment

7.3.1. Construction

Decommissioning and construction for each weir and regulator would involve the following elements:

- construction of the new proposed regulator downstream of the existing weir, likely in two parts with a coffer dam providing a dry work area for the portion being constructed, while flow is allowed to pass through on the other side

- decommissioning of the existing weir, likely in two parts with a coffer dam providing a dry work area for the portion of the weir and abutments being removed, while flow is allowed to pass through on the other side
- works would cease during periods of high flow to ensure the safety of site staff and manage environmental risks. During these periods, where needed, equipment would be moved to locations outside of the creek channels (further details are provided in chapter Public health and safety).

The effects of the construction on flooding would be short-term for the period of construction, and a risk assessment was completed for the construction of the proposed regulators.

The chance of a flood event of a given magnitude or larger occurring during the construction period can be determined by considering the magnitude or average recurrence interval of an event and the length of the construction period. These chances or probabilities have been calculated for the construction periods together with different standard timeframes for context.

Hartwood

The information in Table 7.1 shows the timeframe over which the chance or probability of a flood event is calculated.

Over a construction period of two years (which is longer than the construction period for the proposal), there is about an 89 per cent chance that a flow rate of 2,900 ML/day at the “Billabong Creek at Jerilderie (410016)” gauge would be equalled or exceeded.

It is assumed that the coffer dams are constructed to meet the 1 in 5 year event and the provision of adequate diversions to maintain normal flows. It is therefore unlikely that there would be significant adverse impacts as flows are generally contained in the creek channel at this event or a more common event, resulting in no significant consequences. Construction activity zones outside of the channel would not be impacted in these events.

Table 7.1 Chance of a flood event being equalled or exceeded for a given period.

Construction Period	Flood Event (average recurrence interval)									
	1.5-year	2-year	2.5-year ¹	3-year	4-year	5-year	10-year ²	20-year	50-year	100-year
2-year period	89%	75%	64%	56%	44%	36%	19%	10%	4%	2%
5-year period	100%	97%	92%	87%	76%	67%	41%	23%	10%	5%
10-year period	100%	100%	99%	98%	94%	89%	65%	40%	18%	10%
30-year period	100%	100%	100%	100%	100%	100%	96%	79%	45%	26%
50-year period	100%	100%	100%	100%	100%	100%	99%	92%	64%	39%
100-year period	100%	100%	100%	100%	100%	100%	100%	99%	87%	63%

Notes:

1. indicates this is equivalent to the 2,900 ML/d event at the “Billabong Creek @ Jerilderie (410016)” gauge over the long term.

2. indicates this is equivalent to the 5,500 ML/d event at the “Billabong Creek @ Jerilderie (410016)” gauge over the long term.

Wanganella

As for Hartwood, an appropriate level of service for the assessment of construction impacts at Wanganella would be the 1 in 5 year event. This assumes a construction period of up to two years which equates to around 3,750 ML/day at the Billabong Creek/Wanganella gauge.

The inundation modelling has demonstrated that the five year average recurrence interval event impacts are contained within the creek. There are some small breakouts into the floodplain including the low-lying areas to the rear of Lang Street in Wanganella Village, when compared to existing conditions. Therefore, there are no significant construction phase flood impacts or consequences identified. Construction activity zones outside of the channel would not be impacted in these events.

7.3.2. Operation

A full outline of the flood impacts of the proposed works during their operation phase are presented in Appendix I. A summary of results are presented for flow, afflux (or change in water surface level) and flood hazard represented by flood vulnerability categories for both the operational and flood flow scenarios. Results for the relevant events show the following general impacts.

Hartwood

Operational flow scenarios

There would be no expected change to operational flows given the regulators would continue to be operated to achieve a fixed flow split between Billabong Creek and Forest Creek from the weir pool in both existing and proposed scenarios.

There would be no change in water surface levels downstream of the proposed works or outside of Billabong Creek for all flow and proposed operating level scenarios. The water levels within Hartwood weir pool increased and decreased as expected with the change in the height of the regulator gate operations, that is, if the gate were operated to achieve a higher water level the weir pool was consequently higher and vice versa.

Upstream of the regulator water levels responded as follows, which resulted in the same directional change in the size of the overall flood extent within the weir pool:

- For the proposed scenario where the regulator was set to its minimum operating level there were decreased levels of up to around 40 millimetres for the minimum operational flow and 300 millimetres for the maximum operational flow scenarios. In these scenarios there was a 2.5 per cent and 10 per cent decrease, respectively, in overall weir pool extent over existing conditions. Overall, these changes were contained within the watercourse and bounded by Lower Woolshed Weir on Billabong Creek and the Forest Creek Offtake (and associated infrastructure such as the Forest Creek block bank) on Forest Creek.
- For the proposed scenario where the regulator was set to maximum operating level there were increased levels of around 100 millimetres for the minimum operational flow scenario and decreased levels of up to 150 millimetres for the maximum operational flow scenario. In these scenarios, there was a 3.0 per cent decrease and 10 per cent increase, respectively, in overall inundation extent over existing conditions. Overall, these changes were contained within the watercourse and bounded by Lower Woolshed Weir on Billabong Creek and the Forest Creek Offtake (and associated infrastructure such as the Forest Creek block bank) on Forest Creek.

- For the proposed scenario where the regulator was set to full supply level there were increased levels of up to 200 millimetres for the maximum operational flow and around 400 millimetres for the minimum operational flow scenarios. In these scenarios, there was a 5.0 per cent and 31 per cent increase, respectively, in overall inundation extent above existing conditions. Overall, these changes were contained within the watercourse and bounded by Lower Woolshed Weir on Billabong Creek and the Forest Creek Offtake (and associated infrastructure such as the Forest Creek block bank) on Forest Creek.

Flood flow scenarios:

There are only minor changes and redistribution of flows from the Hartwood weir pool as a result of the proposed Hartwood Regulator. These changes relate to events more frequent than 1 in 100 year events with flows increasing on Billabong Creek and decreasing on Forest Creek. For the 1 in 5 year and 1 in 20 year events, the proposed scenario has an impact of up to 1.0 per cent increase on Billabong Creek flows and 2.0 per cent decrease on Forest Creek flows.

The magnitude of these changes increases from 1 in 100 year event to PMF event, which shows the following changes:

- up to 1.4 per cent decrease on Billabong Creek flows and 1.6 per cent increase on Forest Creek flows
- changes of up to 2.0 per cent increase of flow on Yanco Creek due to altered tailwater levels on Billabong Creek.

Hydraulic modelling results also present minor changes in water surface levels as a result of proposed Hartwood Regulator works. Changes between existing and proposed conditions are reflective of the altered operation and control levels at the Hartwood Regulator, as follows:

- For flood flows more frequent than the 1 in 20 year event, the water surface levels in the Hartwood weir pool decreases, and the water surface levels downstream of the proposed regulator increases. The most significant changes in water surface levels are seen directly downstream and upstream of the Hartwood Regulator as expected. There are also minor changes to water surface levels along the lower parts of Yanco Creek for these smaller flood flow events, generally in the order of plus or minus 10 millimetres and less than plus or minus 50 millimetres.
- For flood flows greater than or equal to the 1 in 20 year event there is minimal impact on water surface levels along Billabong and Yanco creeks downstream of Hartwood Regulator. There are minor upstream impacts of increasing levels and extents on Billabong Creek within the area between the existing weir and proposed regulator, Conargo Road, and the first access track across Billabong Creek (with changes ranging from just over a 10 millimetre increase in 1 in 20 year event to up to around a 20 millimetre increase in the 1 in 100 year event and greater) as a result of Hartwood Regulator works.
- In events greater than 1 in 100 year events and less than the probable maximum flood (PMF) there are some minor impacts to the west of the regulator due to a levee/irrigation channel just being overtopped, but these are changes of less than a 25 millimetre increase. It is understood that the purpose of this levee/irrigation channel is for irrigation purposes and not flood protection. These changes in water surface levels have meant there is minimal to no change in flood extent within the study area, as a result of the Hartwood Regulator across the range of flood flow events that were modelled.

Flood hazard

The flood flow scenario results show that there has been minimal change in hazard category distribution identified across all modelled scenarios. The changes are around 0.6 per cent increase to 1.7 per cent decrease within the area of interest and a short distance downstream of the proposed Hartwood Regulator weir pool.

The township of Conargo is the closest populated area. There is little to no change in flow and water surface levels across all operational and flood flow events, including the PMF event, within and around the township. In terms of flood flows, it was found that in all events changes were generally all minor (less than plus or minus 50 millimetres). As a result of this, it can be concluded that the current flood risk in Conargo is not impacted by the operation of the proposed Hartwood Regulator and hence the existing community flood management is likely to be sufficient for proposed conditions.

The NSW Flood Risk Management Manual states there are a number of techniques to define the flood function or hydraulic categorisation of the waterway and given the minimal impact of proposed works on other variables, particularly hazard categories, and the in-stream nature of the structure it was concluded that this will not have changed between scenarios and a detailed assessment was not undertaken.

Considering all of the above, the changes and impacts that have been identified through hydraulic modelling as a direct result of the Hartwood Regulator do not have a significant impact on the flood characteristics and floodplain behaviour of the study area, with changes experienced being as expected due to altering the location and level of the weir pool control. Directly upstream and downstream of the Hartwood Regulator experience the largest changes as expected, however, the overall flood risk in this area is not significantly altered as a result of the proposed works.

It is important to note that some impacts are the result of proposed operational rules, particularly in more frequent flood events when the gates are assumed fully opened as this allows the flow to pass through at lower levels than previously.

The flood impact assessment also identified that the originally proposed access track to the Hartwood Regulator crossed a flood runner. If this flood runner is blocked this would lead to a minor increase in flood levels upstream. In larger (less frequent) flood events, where some flow bypasses the new regulator, this situation could occur. The design of the access track was modified therefore to incorporate a floodway (a ford crossing) through this section to design out this potential impact.

Climate change considerations

Climate change will lead to increased rainfall intensity and larger flood events. For this assessment, the increase in flood events has been represented by factoring the peak flows determined at gauges through the flood frequency analysis (see Appendix H). Additionally, the 1 in 200 year average recurrence interval event (0.5 per cent AEP events) and 1 in 500 year average recurrence interval event (0.2 per cent AEP events) have also been considered as indicated in the SEARs to assess the sensitivity of the factoring method.

The use of the factoring of flows approach was considered appropriate given the regional nature of flows in the Billabong Creek system, together with the complex floodplain characteristics. This approach was developed in consultation with NSW DCCEEW. Further, the traditional means of altering hydrologic inputs to ascertain altered flows as a result of climate change cannot be used for this study.

The climate change assessment has considered the impact to flooding will result in increased peak flows for a given flood event and the percentage increase in these peak flows will increase with time, as climate change increases. Consequently, the largest increase in peak flows will occur at the end of the proposal design life (100 years). The assessment has therefore compared current conditions and climate change conditions at 2100. By modelling these two scenarios it is possible to understand the potential impact of climate change throughout the design life of the regulators.

Given that there is only a minor impact in the current conditions and at 2100, only minor impacts due to climate change are predicted. These changes are outlined below.

- Using the 1 in 100 year event flows for the study area the modelled outcomes of this are summarised in Table 7.2. This table also includes the 1 in 200 and 1 in 500 year event flow estimates, which shows that the estimated 1 in 100 year event with climate change flows are between the existing flow levels for the 1 in 200 and 1 in 500 year events.
- The potential flood impacts for the 1 in 100, 1 in 200 and 1 in 500 year events with climate change are all minor. There are no changes to flood levels within a tolerance of plus or minus 50 millimetres except for small areas which are generally pasture land or waterways. Potential impacts decrease with the increasing rarity (and flow) of the events i.e. there are smaller areas of impact in the 1 in 100 year event compared to the 1 in 200 event. Therefore under climate change conditions, potential impacts would decrease in the future although these would still be minor.

Table 7.2 Modelled flow rates and climate change estimate for Billabong Creek Inflow – just upstream of Hartwood Regulator

Event	Current peak discharge in (ML/day)	Climate change assessment at 2090 (ML/day)	Climate change assessment at 2100 (ML/day)
1 in 100	10,900	13,600	16,400
1 in 200	13,100	-	-
1 in 500	16,500	-	-

Wanganella

Operational flow scenarios:

There would be no expected change to operational flows when the regulator is set to either the minimum or maximum operating levels. When the regulator is set to full supply level, there is a reduction in flow of 5 to 6 ML/day, most likely due to attenuation as a result of the increase in the inundation area. This is not considered a significant change as the flow in the fishway is at 20 ML/day under all scenarios, and the change of flow rate does not cause an inundation impact.

There would be no change or a reduction in water surface levels downstream of Wanganella Weir or outside of Billabong Creek for all operational flows and proposed operating level scenarios. There would be an increase in water surface levels upstream of the proposed regulator (i.e. within the weir pool area), as summarised below:

- When the regulator level was set to full supply level, the water surface levels in the weir pool upstream of the Wanganella Weir reached 82.1 m AHD. This means an increase in water surface levels of 1.28 metres upstream of the Wanganella Regulator under the minimum operational flow scenario and an increase in water surface levels of 1.05 metres under the maximum operational flow scenario. Figure 7.3 illustrates the changes from the minimum operational flow scenario at the creek close to Wanganella Village.
- When the regulator was set to maximum operating level, the water surface levels increased by up to 0.19 metres upstream of the Wanganella Weir compared to the existing for minimum operational flows. No change of water surface levels was identified under the existing maximum operational flows.
- When the regulator was set to minimum operating level, no change of water surface levels upstream of the Wanganella Weir was identified under all flow scenarios.
- The increase in water level and slight increase of inundation extent in scenarios mentioned above were fully contained within the Billabong Creek channel and no impact extends outside of the watercourse.

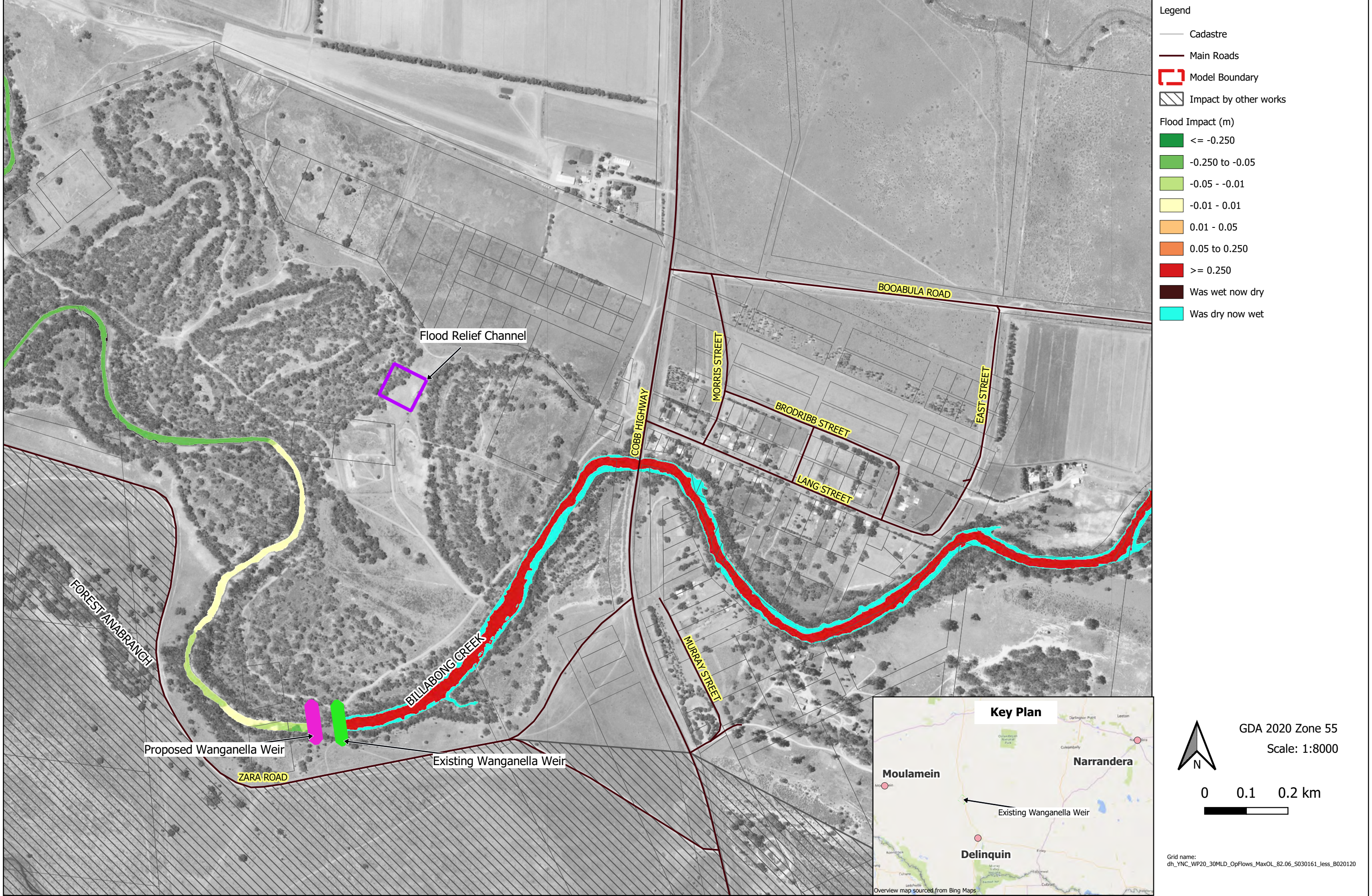


Figure 7.3 Minimum Operating Flow (30 ML/day) Flood Level Impact
"Proposed Full Supply Operational Level vs Existing"

Flood flow scenarios:

Flows in Billabong Creek exhibit minor to moderate variations during different flood events. For 1 in 5 and 1 in 20 year events, the change in flows in Billabong Creek both upstream and downstream of Wanganella Weir are very minor (i.e. change up to 0.03 per cent or 2 ML/Day).

For events greater than or equal to the 1 in 100 year events, a decrease in flows in Billabong Creek has been identified immediately upstream and immediately downstream of the weir, up to 15.3 per cent. This would be due to some flow bypassing part of the main Billabong Creek channel with the engagement of the proposed flood relief channel.

Hydraulic modelling results also present minor to moderate changes in water surface levels as a result of the proposed Wanganella Regulator. Changes between existing and proposed conditions are reflective of the effect of the proposed regulator. The following changes were identified:

- For 1 in 5 and 1 in 20 year events, increases are predicted in water surface levels upstream due to the proposed regulator. Increases of up to around 0.86 metres for the 1 in 5 year event are predicted, as shown in Figure 7.4. An increase of around 0.21 metres during a 1 in 20 year events is predicted, as shown in Figure 7.5. The increases of the water surface levels (afflux) are mostly restricted within the Wanganella weir pool, i.e., not causing impact in the neighbouring sites in the floodplain, except for a small riparian zone area in Wanganella village on the north bank of Billabong Creek and rear of Lang Street.
- For events greater than or equal to 1 in 100 year events, the upstream and immediately downstream of Wanganella Regulator experience minor decreases in water surface levels, The reduction in these larger events is the result of the engagement of the new flood relief channel, which is designed to activate in those less frequent events. The outcome for the 1 in 100 year event is shown in Figure 7.6.

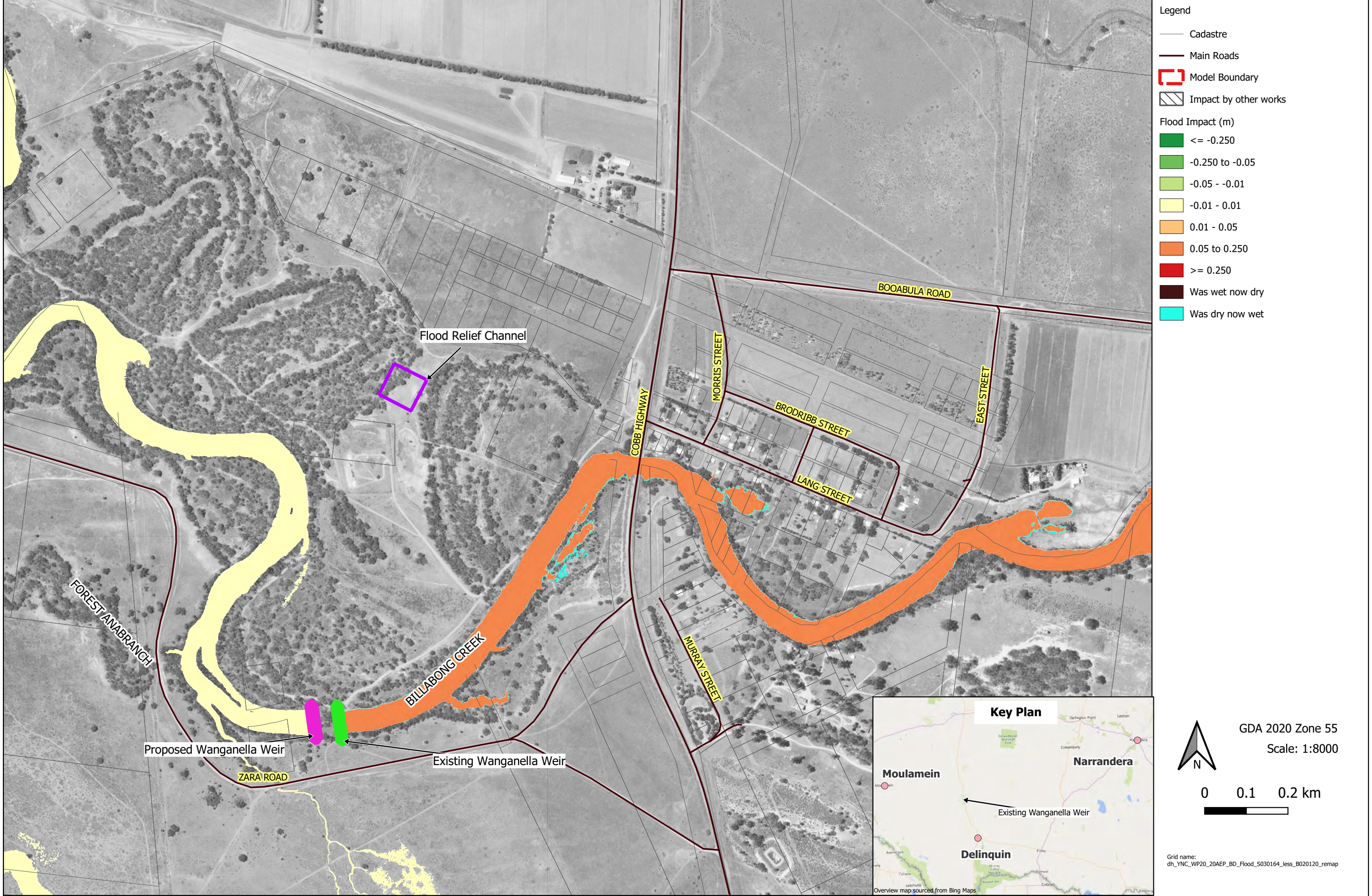


Figure 7.4 20% AEP Flood Level Impact
"Proposed vs Existing"



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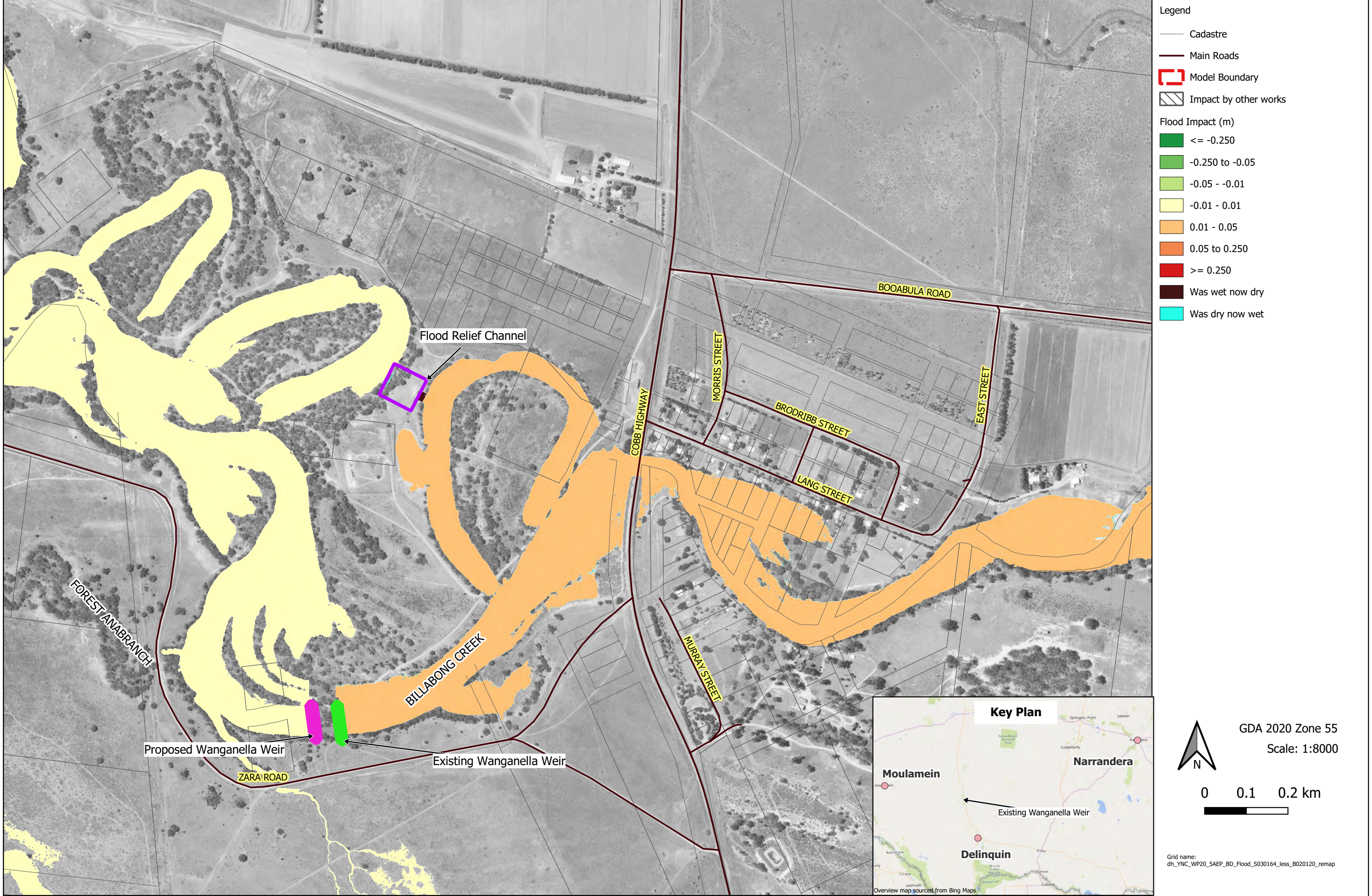
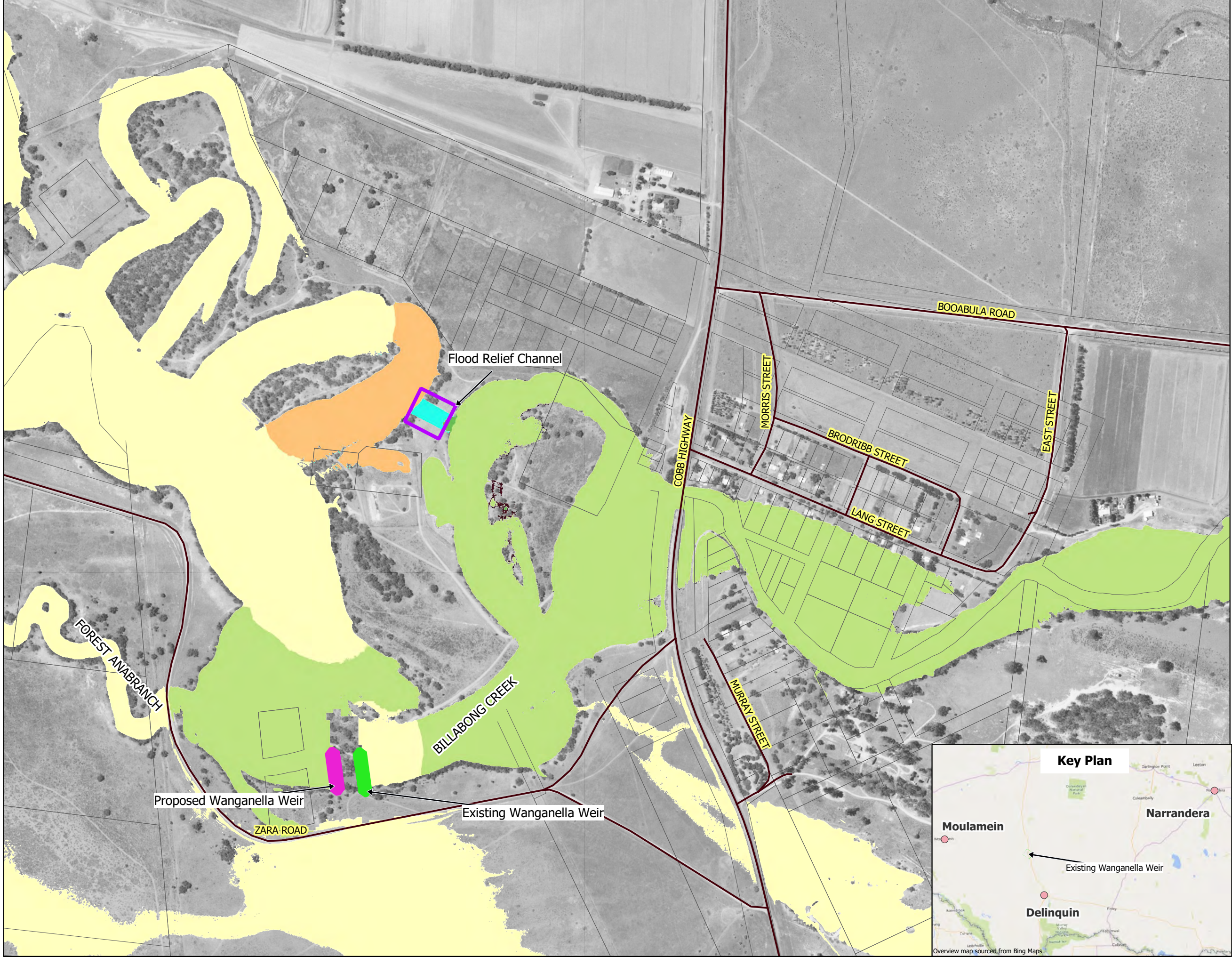


Figure 7.5 5% AEP Flood Level Impact "Proposed vs Existing"



Legend

- Cadastre
- Main Roads
- Model Boundary
- Impact by other works

Flood Impact (m)

- <= -0.250
- 0.250 to -0.05
- 0.05 - -0.01
- 0.01 - 0.01
- 0.01 - 0.05
- 0.05 to 0.250
- >= 0.250
- Was wet now dry
- Was dry now wet



GDA 2020 Zone 55
Scale: 1:8000

0 0.1 0.2 km

Grid name:
dh_YNC_WP20_1AEP_BD_Flood_S030164_less_B020120_remap

Figure 7.6 1% AEP Flood Level Impact
"Proposed vs Existing"

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Flood hazard

The flood flow scenario results show that there has been minimal change in hazard category distribution with noted changes across all scenarios of around 0.12 per cent reduction to 0.07 per cent increase. These changes largely relate to the altered position of the control and the operating rules that allow more flow through the structure in smaller events and/or due to the activation of the flood relief channel in larger, less frequent floods.

The flood impact results show that the area between Billabong Creek and Lang Street in Wanganella village, including the rear yards of several private properties, could experience moderate increase in flood levels during 1 in 5 year event, and minor flood level increases during 1 in 20 year events. These increases do not affect buildings due to the steep slope from Lang Street to Billabong Creek. The impact was not found during 1 in 100 year event or above with the flood relief channel in place.

The change in flood characteristics in this area are unlikely to result in an increase of flood risk, because of the following reasons:

- There are no flood level increases to the existing dwellings.
- The evacuation (emergency) route through Lang Street is not affected.

Based on the results presented, the proposed Wanganella Regulator does not have a significant impact on the flood characteristics of the study area.

Climate change considerations

The same approach adopted for the Hartwood Regulator was applied to the Wanganella Regulator.

The 1 in 200 and 1 in 500 year events exhibit similar patterns as those for the 1 in 100 year event. Specifically, a general decrease of water levels is achieved in the area upstream and immediately downstream of the Wanganella Regulator due to the implementation of the flood relief channel, while a localised impact. Table 7.3 shows that the estimated 1 in 100 year event with climate change flows are between the existing flow levels for the 1 in 200 and 1 in 500 year events.

Based on the results presented, the proposed works at Wanganella Regulator would not have a significant impact on the flood characteristics of the study area under climate change scenarios.

Table 7.3 Modelled flow rates and climate change estimate for flows at “Billabong Creek/Wanganella gauge.

Event	Current peak discharge in (ML/day)	Climate change assessment at 2090 (ML/day)	Climate change assessment at 2100 (ML/day)
1 in 100	15,552	19,674	23,653
1 in 200	19,852	-	-
1 in 500	24,867	-	-

24.1.1 Consistency with any Rural Floodplain Management Plans

The sites are not within an area subject of a rural floodplain management plan. The sites are downstream of the area covered by the Billabong Creek Floodplain Management Plan and upstream of the area covered by the Edward and Wakool Rivers Stage 1 Floodplain Management Plan. The sites are also outside the areas proposed to be covered by replacement floodplain management plans for the Murrumbidgee River Valley and the Murray River Valley.

There is fundamentally no change in the flood characteristics due to the proposal. It can be concluded that the flood hazard and hydraulic functions of flow conveyance in floodways and flood storage characteristics remain consistent with current conditions.

7.3.3. Cumulative impacts

A summary of the cumulative assessment is provided in section 23.3.3 and section 4.1 and 4.2 in Appendix H (Flood assessment report).

7.4. Mitigation measures

7.4.1. Approach to mitigation and management

NSW DCCEEW is committed to minimising the environmental impact of the proposal and is investigating opportunities to reduce impacts where practicable. As prescribed by the SEARs, opportunities would also be implemented, where possible, to improve the overall outcome of the proposal.

The inundation modelling discussed in section 7.1.3 demonstrates that there are no significant flood impacts resulting from the proposal. Potential impacts identified during earlier stages of the proposal have been design out and do not therefore require additional mitigation measures. This includes the following design features include specifically to manage potential flood impacts:

- The proposal identified potential flood impacts near Wanganella Township. This impact has been mitigated through the inclusion of the Wanganella flood bypass channel.
- The flood impact assessment identified that the originally proposed access track to the Hartwood Regulator crossed a flood runner. If this flood runner is blocked this would lead to a minor increase in flood levels upstream. The access track was modified to incorporate a floodway (a ford crossing) through this section to design out this potential impact.

During detailed design, modelling results would continue to be reviewed to identify if additional refinement of the proposal could result in further benefits to the environment or communities.

The general approach to management of the proposal during construction and operation is outlined in chapter 24.

8. Groundwater

This chapter summarises the groundwater impact assessment for the construction and operation of the proposal. This outlines the potential for groundwater resources to be directly or indirectly affected by the proposal and recommends mitigation measures to address potential impacts. The Groundwater Report is provided in Appendix I.

8.1. Methodology

8.1.1. Study area

The study area for the groundwater assessment includes the proposal site and surrounding area, with the potential to be directly or indirectly affected by the proposal. The area of investigation covered by this groundwater assessment comprised the shallow and intermediate aquifers surrounding Billabong Creek. The study areas are shown on Figure 8.1 and Figure 8.2.

The study area was determined based upon the likely limits of any change in groundwater level that may result from the construction and operation of the proposal and controls on groundwater level, such as creeks, waterways, wetlands and rivers. Consideration was also given to land use, including irrigation and dryland areas and published groundwater contour and occurrence information.

8.1.2. Key assessment tasks

Potential groundwater related impacts which may occur due to the proposal have been assessed by:

- Characterising the existing environmental setting including climate, topography, geology, and groundwater occurrence, quality and use, including groundwater dependent ecosystems (GDEs).
- Installation of three monitoring wells (two at Wanganella and one at Hartwood) to characterise the hydrogeological conditions near the existing weirs. Water level monitoring, hydraulic testing and groundwater quality sampling were undertaken. The location of the wells are shown on Figure 8.1 and Figure 8.2.
- Developing a conceptual groundwater model, which then provided the basis for a numerical model. The numerical groundwater modelling has been undertaken using MODFLOW-USG to quantify potential changes to groundwater levels and water balance.
- Assessing the potential for the proposal to interact with the water-table and underlying groundwater systems. This was undertaken by assessing the proposal's activities which could potentially intersect the water-table and comparing the likely depth of these activities to inferred groundwater elevations. The inferred groundwater elevations were assessed using groundwater levels from December 2023 from monitoring wells installed as part of this assessment.
- Assessing the impacts from operation by developing a numerical groundwater model and simulating the existing Hartwood and Wanganella weirs and the proposed operation of the regulators. Model boundary conditions were derived from an interpreted water-table surface developed from groundwater level data from public domain online databases and project wells. The tested scenario was based on the outputs of the Yanco Modernisation – Murrumbidgee Source Model Runs (DPE, 2023f).

- Qualitative assessment of the potential for the proposal to impact on other groundwater users, baseflow to surface water drainage systems, and GDEs using the results from the numerical groundwater models.
- Providing recommendations for monitoring and management of identified potential impacts and risks, including management measures as appropriate.

8.1.3. Key policy and legislation

Key legislation, guidelines and/or policies driving the approach to the assessment:

- *Water Act 2007*
- *Water Management Act 2000*
- *Water Management Regulation 2018*
- Water Sharing Plan for the Murray Alluvial Groundwater Sources Order 2020 (under the *Water Management Act 2000*)
- Water Sharing Plan for the Murrumbidgee Alluvial Groundwater Sources Order 2020 (under the *Water Management Act 2000*)
- Murray-Darling Basin Plan (2012)
- NSW Aquifer Interference Policy (DPE 2012)
- Murrumbidgee Alluvium Water Resource Plan (DPE 2022d)
- Murray Alluvium Water Resource Plan (DPE 2022e)
- Australian and New Zealand Environment and Conservation Council (ANZECC) Guidelines and Water Quality Objectives in NSW (DECCW 2006)
- Australian and New Zealand Guidelines (ANZG) for Fresh and Marine Water Quality (Australian Government 2018).

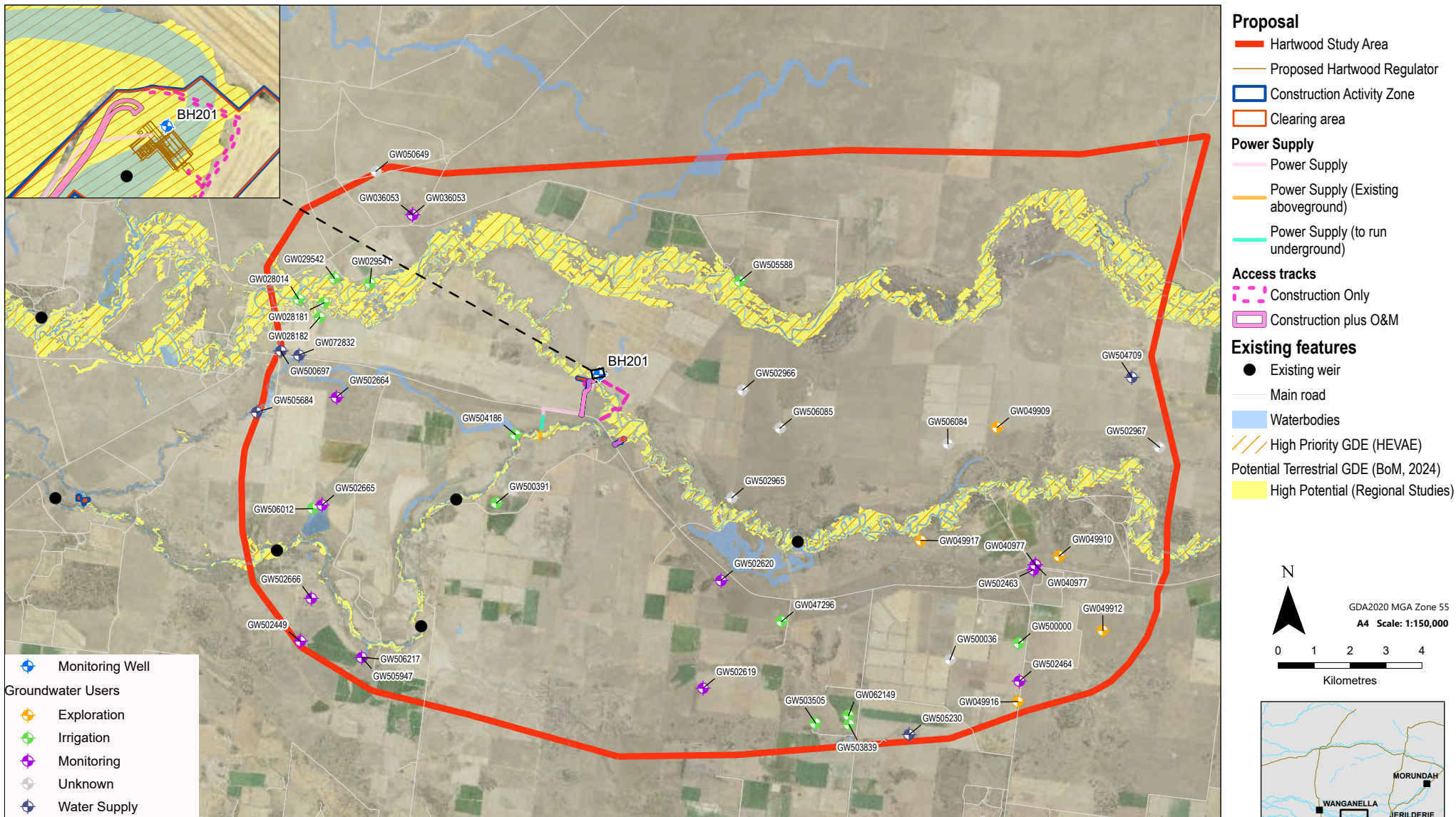
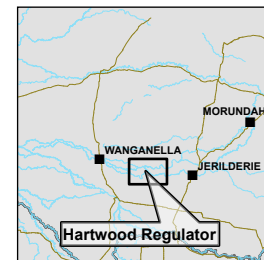


Figure 8.1 Hartwood Groundwater Study Area and Bores



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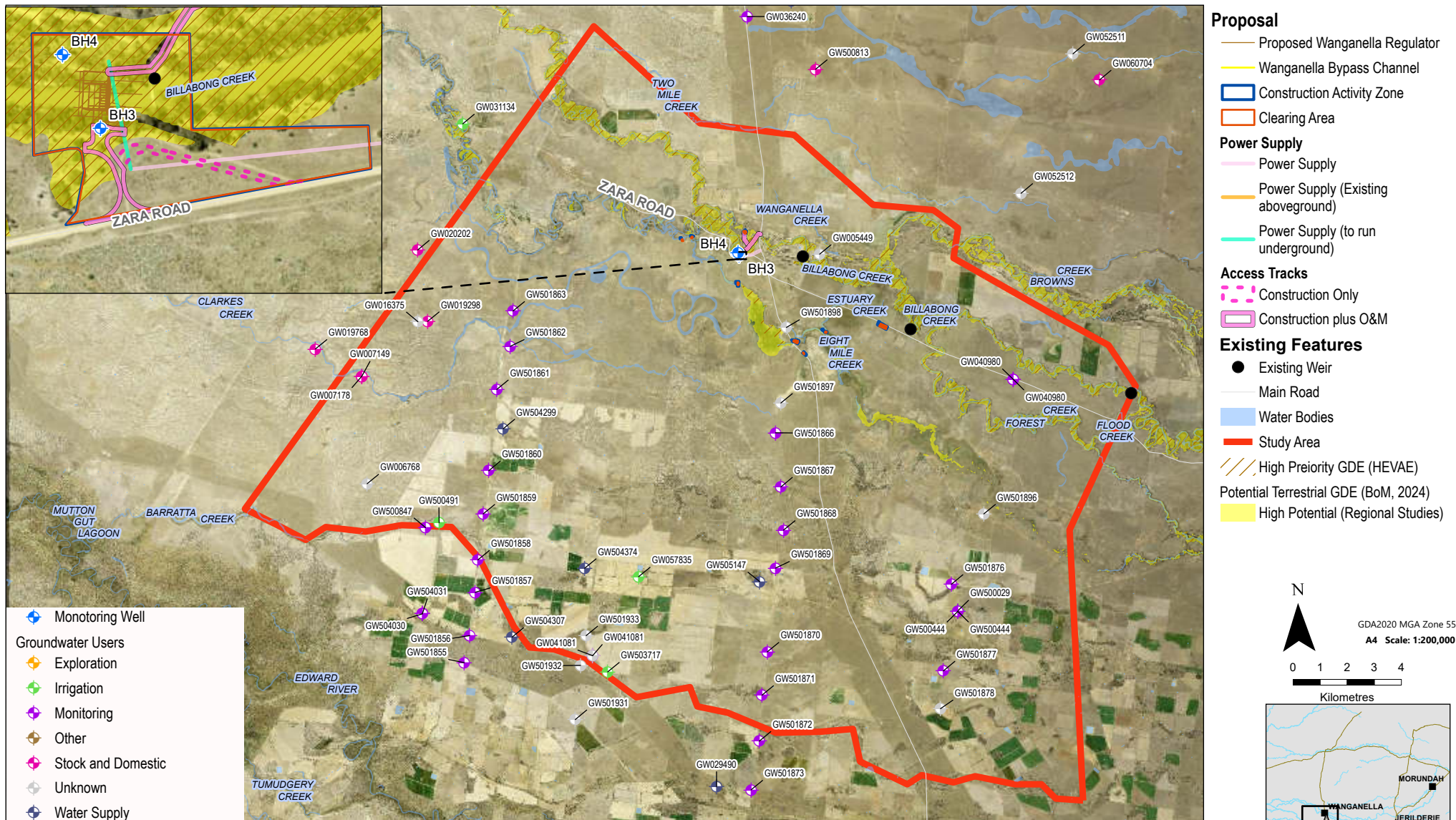
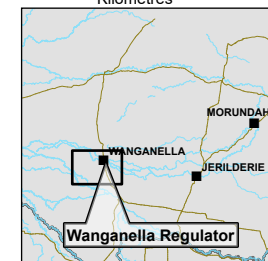


Figure 8-2 Wanganella Groundwater Study Area and Bores



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8.2. Existing environment

8.2.1. Groundwater catchment

The existing Hartwood and Wanganella Weirs are located on the common boundary of the water sharing plans for the Murray and the Murrumbidgee alluvial groundwater sources and on the boundary of the Lower Murray Alluvium and Lower Murrumbidgee Alluvium groundwater sustainable diversion limit resources units.

Groundwater in the vicinity of the proposed regulators is managed in accordance with Murray Alluvium Water Resource Plan (DPE 2022e) and the Murrumbidgee Alluvium Water Resource Plan (DPE 2022d) which outline how NSW will meet its obligations under the Basin Plan and the *Water Act 2007*. The water sharing plans are the primary regulatory instruments for the groundwater sources.

As defined in the water resource plans, the lower Murray and lower Murrumbidgee shallow alluvium and deep alluvium resource units underlay the proposal. The shallow alluvium in the Murrumbidgee Alluvium water resource plans (DPE 2022d) is described as approximately 40 metres deep within the yellow/brown sands and clays of the Shepparton formation. The deep groundwater source includes the older sediments of the Calivil Formation and the Renmark Group and is comprised of white sands and white/grey clays (DPE, 2022d). For this groundwater assessment, the approach of the Murrumbidgee Alluvium water resource plans presents the best reflection of the alluvium in the vicinity of the proposal. The shallow alluvium is limited to the upper most units of the Shepparton Formation, which are predominantly clay and silt with minor sand. In the vicinity of the proposal (see also later in this section) the shallow alluvium overlies a deeper more clay rich unit at about 40 metres depth.

8.2.2. Topography

Billabong Creek in the vicinity of the proposal is in a topographic area characterised by relatively low elevation and relatively flat and low slope. This tends to emphasise small variations in topography, which can have an effect on groundwater level and depth. The gentle and flat topography is reflected in groundwater elevation patterns.

The topography in the vicinity of the Hartwood site is generally flat with an elevation of approximately 96 metres above Australian height datum (m AHD) to 101 m AHD. The topography within the vicinity of the existing Wanganella Weir is generally flat with an elevation of approximately 87 to 91 m AHD.

8.2.3. Climate

Climate data was reviewed from the Bureau of Meteorology Deniliquin Airport automatic weather station (#074258). The average total rainfall for each calendar month from 1997 to 2024 (27 years) was analysed. This indicates there is only a moderate level of seasonality within the study area, and that rainfall is typically low in most months. Lowest average rainfall was recorded in the summer months and highest in spring. Between April and August there is very little variation between monthly rainfalls.

Average monthly maximum and minimum temperature ranges between 1971 to 2024, indicates that the proposal areas are positioned within a temperate climatic region characterised by warm summers and cool winters.

8.2.4. Registered groundwater boreholes

A review of registered groundwater bores records from the Bureau of Meteorology within the study area identified 155 within 20 kilometres and four registered bore within 5.0 kilometres of the existing Hartwood Weir. At Wanganella Weir, 73 registered bores were identified within 20 kilometres and two registered bores within 5.0 kilometres. The location of bores within the study area are shown on Figure 8.1 and Figure 8.2.

To assess the potential impact to registered bore holes within close proximity to the existing Hartwood and Wanganella weirs, the bores within 2.0 kilometres have been assessed further. This comprises:

- four at Hartwood Weir – two irrigation bores, one monitoring well and one bore with unknown use
- two at Wanganella Weir – unknown use.

8.2.5. Groundwater dependent ecosystems

Groundwater dependent ecosystems (GDEs) are ecological communities that are dependent, either entirely or in part, on the presence of groundwater for their health or survival.

A review of the Bureau of Meteorology's GDE Atlas (BOM, 2024) identified the following in the study area:

- Hartwood Weir – 13 terrestrial GDEs are identified within 500 metres of the existing Weir with two within 100 metres. Two aquatic GDEs are identified within 100 metres from the weir. Potential terrestrial GDEs with a high potential for groundwater interaction and listed as High Priority in the High Ecological Value Aquatic Ecosystems are shown on Figure 8.1.
- Wanganella Weir – 26 potential terrestrial GDEs are identified within 500 metres of the existing Weir with six within 100 metres. Four potential aquatic GDEs are identified within 500 metres of existing Wanganella Weir with two of these within 100 metres. Potential terrestrial GDEs with a high potential for groundwater interaction and listed as High Priority in the High Ecological Value Aquatic Ecosystems are shown on Figure 8.2.

8.2.6. Hydrogeology

The proposal area comprises localised deposits of Quaternary aged alluvial sediments which contain interbedded sands, clays and silts. The water-table lies within Quaternary Alluvium at around five metres below ground level, near the existing Wanganella and Hartwood weirs. The alluvium is incised into and underlain by the Shepparton Formation.

The Shepparton Formation contains the shallow regional aquifer system. The Quaternary Alluvium is incised into the Shepparton Formation in the near vicinity of Billabong Creek and other significant watercourses. The Shepparton Formation is around 40 to 50 metres thick and consists of variegated clay, silty clay with lenses of poly mictic, coarse to fine sand and gravel. The basal part of the Shepparton Formation is typically finer grained sediments than the upper part, although this is variable regionally. The deeper more clay rich units form a barrier to (downward) vertical groundwater flow and help to maintain the water elevation separation between units (see below)

The Calivil Formation underlies the Shepparton Formation and consists of poorly consolidated, poorly sorted, coarse to granular quartz sand conglomerate with thin lenses of carbonaceous clay. Based on regional hydrostratigraphy data the Calivil Formation is present at a depth of about 50 metres below surface with a thickness of approximately 80 to 100 metres.

The regional water table elevation has been affected by land use change and particularly irrigation activities from the early 1970s. Altered surface water flow regimes (e.g. at Wanganella Swamp and Eight Mile Creek) and water reform implementation in the 1990s to 2000s and flooding in more recent years have all had an influence on the water table depth. These influences have had only minor or localised effects on groundwater quality.

The water table elevation near the existing Hartwood Weir is around 90 m AHD with the average water level in the weir around 94.9 m AHD. Groundwater flow is generally from north east to south west, supplemented by minor recharge out of the creek. Flow in the shallow aquifer system is mildly affected by recharge from the creek but is overall to the south and west, with a component to the north west. As the hydraulic conductivity of the Shepparton Formation is typically low and gradients are low, the regional flow rate is small.

Water table elevations at Wanganella range from 85 m AHD in the east to 73 m AHD in the west. The water table elevation near the existing Wanganella Weir is around 78.5 to 80 m AHD with the average weir pool elevation around 80.9 m AHD. Elevated groundwater level (around 80 to 83 m AHD), with groundwater closer to the surface than is typical for the region has been identified to the south, likely associated with recharge from surface water at Wanganella Swamp / Eight Mile Creek.

Billabong Creek is a mostly disconnected creek and is losing to groundwater at both Hartwood and Wanganella. Whilst creek seepage contributes to recharge to groundwater, groundwater does not affect surface water levels nor contribute to flow in the Creek. Accordingly, groundwater variation has no effect on Billabong Creek flow or quality.

Hydraulic conductivity in the aquifer surrounding the Creek is anticipated to be low for clay dominant alluvium and moderate to high for the lenses of sandy alluvial material. Slug testing has been undertaken at three monitoring wells installed at Hartwood and Wanganella. The hydraulic conductivity ranges from 0.002 metres per day (at BH3) to 0.5 metres per day (at BH201). This indicates that although there is a moderate to high proportion of sand and coarser material, that this is combined with clays and silts and that a low to moderate overall permeability is expected. Whilst there will be sand seams present, especially in the quaternary alluvium, these are variable in extent and thickness and do not appear to constitute a widespread sand seam that extends over the study area. Accordingly higher permeability zones are expected in the immediate vicinity of the creek, but these are not expected to create zones of connection to the surrounding area, outside of the immediate floodplain of the creek.

Recharge occurs via direct rainfall infiltration, seepage from rivers/creeks (localised recharge) and from anthropogenic sources such as irrigation and environmental watering. The recharge rate is expected to be higher in irrigation areas compared to areas without irrigation.

Groundwater discharge occurs via extraction from deep bores and rare shallow extraction wells for irrigation. Through-flow to the west is likely to be the main discharge mechanism for the shallow aquifer, along with base flow into the Wakool River downstream of Deniliquin and evaporation occurring near the surface water table.

Potential terrestrial groundwater dependent ecosystems with a high potential for groundwater interaction and listed as High Priority in the High Ecological Value Aquatic Ecosystems framework (NSW DCCEW, 2018) are mapped adjacent to Billabong Creek. Whilst these areas are mapped as potential groundwater dependent ecosystems, the methodology used to define this is based on recognising enhanced evapotranspiration. It is not clear that the dominant source of water for evapotranspiration in the vicinity of the two weir pools is actually groundwater. This is because the groundwater is relatively deep and nearing the limit of accessibility by deep rooted vegetation. Immediately adjacent to the creek bank seepage and soil water could provide a significant water source, one that is not strictly from groundwater. It is considered likely that vegetation water use is dominated by river leakage and flood recharge rather than direct groundwater use.

Groundwater in the proposal area is generally fresh to slightly brackish. From the limited bore records it is interpreted that the groundwater immediately adjacent to the creek is slightly fresher than the surrounding groundwater. This is expected to be a result of long term creek and flood recharge over decades or longer.

The conceptual groundwater model for the study area has been based on the catchment attributes as outlined above.

8.3. Impact assessment

8.3.1. Construction

Hartwood

The groundwater elevation at Hartwood is around 89.6 m AHD. The base of fixed crest weir structure is 91.26 m AHD with sheet piles expected to extend to 84.9 m AHD. Based on concept design constructability, the groundwater elevation is well below the base of Hartwood Regulator structure by around 1.6 metres. Therefore it is not anticipated that groundwater dewatering would be required.

Water removal from inside of the sheet pile wall is expected to control seepage through the sheet pile wall, but this will not be groundwater.

Wanganella

The groundwater elevation at Wanganella is around 78.4 m AHD based on monitoring well data. The base of the fixed crest weir structure is 78.6 m AHD with sheet piles expected to extend to 72.7 m AHD. The assumed excavation depth is 0.5 metres below the base of structure. Based on the concept design constructability and the assumed excavation depth, the groundwater elevation is above the base of Wanganella Regulator structure by around 0.3 metres. Therefore minor dewatering is expected to be required during construction.

To estimate the groundwater inflow rate an aquifer thickness of 20 metres and a regulator length of 40 metres and width of 20 metres was assumed. A hydraulic conductivity of 0.15 metres per day was adopted based on the slug test result for one of the monitoring wells. It is estimated therefore that the groundwater inflow rate will be around 0.16 litres per second.

Groundwater drawdown in the vicinity of the construction area would be limited to a maximum of approximately 0.5 metres in depth. At the expected rate of less than 0.2 litres per second the groundwater level can be controlled by a surface mounted pump utilising a sump in the base of the excavation. No groundwater well is required and drawdown will be achieved by infiltration through the floor of the excavation.

Groundwater drawdown will be restricted to a distance to a maximum 250 metres from the in-creek excavations. This maximum distance has been calculated on the basis of an infinite aquifer without allowance for the seepage from the surrounding creek and over the full period of construction. It is anticipated that the limit of effect will be no more than 50 metres in extent because:

- Seepage into the bank and bed of the creek immediately around the construction area would mitigate drawdown.
- Construction dewatering would only be required for short periods within construction of the two halves of the regulator, once the structure is above groundwater level, dewatering will not be required. The floor of the regulator is just above groundwater level.

8.3.2. Operation

The numerical groundwater model simulated the existing environment scenario based on data for the period 2000 to 2022 and compared this to a scenario with the new regulators. The outcomes of the numerical groundwater model on the groundwater catchment detailed in this assessment are:

- No discernible change in groundwater elevation or flow direction over the study area:
- Watertable drawdown and mounding:
 - Hartwood – Very minor, ranging from 0.005 metres to 0.01 metres, limited to 1.0 kilometre from the weir pool and for periods of a few weeks associated with peak difference periods and insignificant changes on average. Whilst the effect will extend to this distance, the scale at this distance is very small, as other groundwater effects damp the changes in the watertable and reduce the effects with distance from the creek.
 - Wanganella – Minor, associated with peak difference periods limited to two kilometres from the weir pool and insignificant changes on average. The greatest effect is close to the Creek, with the scale of the effect reducing rapidly with increasing distance for the Creek. Other effects on the watertable provide a damping effect on the watertable response that considerably reduces the overall effect with distance.
- Groundwater dependent ecosystems:
 - Hartwood – Insignificant impact (high priority GDEs)
 - Wanganella – Very minor to insignificant increase in evapotranspiration, therefore and insignificant impact on water dependent ecosystems (high priority GDEs).
- Leakage from the weir pool to groundwater:
 - Hartwood – Negligible increase of less than 0.1 per cent of the estimated current seepage, amounting to around 4.0 cubic metres per day
 - Wanganella – Minor to insignificant change as the overall leakage to groundwater and disconnected system remains.
- The likelihood of irrigation or stock bores and the Lower Murray or Lower Murrumbidgee groundwater sources being adversely impacted by operation is considered negligible due to the lack of bores identified in the area and the negligible change in groundwater elevation.
- Land salinisation
 - Hartwood – is not expected to occur given that the predicted change is a lowering in groundwater level. The watertable is around 5.0 metres below ground level and groundwater levels remain within the observed range of variability.
 - Wanganella – is not expected to occur given the watertable is around 5.0 metres below ground level and groundwater levels remain within the expected range of natural variability.
- The risk of saline groundwater discharging to Billabong Creek is considered nil as the creek is predicted to remain always losing to groundwater.
- Under the NSW Aquifer Interference Assessment Policy the impacts fall within the Level 1 category and the assessment is considered “Level 1 – Acceptable”.

8.3.3. Cumulative impacts

The other projects planned in the study area were reviewed to determine if the proposal has the potential to result in significant cumulative impacts. Given the limit of the predicted drawdown no interaction between the regulators in the proposal has been identified and so no cumulative drawdown effect is expected.

No potential cumulative impacts relevant to groundwater were identified.

8.4. Mitigation measures

8.4.1. Approach to mitigation and management

The general approach to management of the proposal during construction and operation is outlined in chapter 24.

NSW DCCEEW is committed to minimising the environmental impact of the proposal and is investigating opportunities to reduce impacts where practicable. As prescribed by the SEARs, opportunities would also be implemented, where possible, to improve the overall outcome of the proposal.

As the groundwater effects are at worst only localised, short term and minor and in most cases negligible, there is no specific mitigation measures that should be applied. It is expected that the proposed construction mitigation measures to minimise contamination risks of soils and water outlined in Chapter 10 (Surface water quality and aquatic ecology) and Chapter 20 (Soils and contamination) will also protect groundwaters during construction. Therefore no similar measures are proposed here. The need for construction dewatering should be reviewed if the construction methodology changes substantially and deeper excavations are proposed.

Ongoing monitoring to confirm the scale of the changes in response to operation is recommended, however given the small scale of expected impacts only limited groundwater monitoring is required.

Groundwater level monitoring utilising the existing monitoring wells should be undertaken on a monthly basis at wells BH201 (Hartwood) and BH3 (Wanganella) for five years. Given the small change in groundwater levels expected and the absence of any threatening process for water quality, only limited water quality monitoring is required. Annual salinity (as electrical conductivity) and pH is recommended in the above mentioned monitoring wells.

Groundwater monitoring should be reviewed after five years of operation to determine whether there is a requirement for ongoing monitoring. If consistent level and water quality is observed after five years, then the monitoring could be ceased, subject to environmental regulator approval.

8.4.2. Summary of mitigation measures

Table 8.1 lists the safeguards and management measures that would be implemented to account for the potential impacts identified in section 8.4.

Table 8.1 Groundwater safeguards and management measures

ID	Impact	Environmental safeguards	Responsibility	Timing
GW01	Construction Dewatering	The need for construction dewatering will be reviewed if the construction methodology changes substantially from that assessed in the Groundwater Assessment Report and deeper excavations are proposed.	NSW DCCEEW / Contractor	Detailed design / Construction
GW02	Groundwater drawdown	Groundwater level monitoring utilising the existing monitoring wells should be undertaken on a monthly basis at wells BH201 (Hartwood) and BH3 (Wanganella) for five years.	WaterNSW	Operation
GW03	Groundwater quality	Annual water quality monitoring for salinity (as electrical conductivity) and pH. at wells BH201 (Hartwood) and BH3 (Wanganella) for five years.	WaterNSW	Operation
GW04	Groundwater quality	Site environmental management, inclusive of spill response measures, will be in accordance with broader WaterNSW existing environmental management procedures and policies.	WaterNSW	Operation

9. Geomorphology

This chapter summarises the geomorphology impact assessment for the construction and operation of the proposal. This outlines the existing geomorphological environment of Billabong Creek, potential impacts to this and recommends mitigation measures to address negative impacts. The Geomorphology Assessment Report is provided in Appendix J.

9.1. Methodology

The geomorphology impact assessment has been prepared based on a review and analysis of relevant literature and database searches, management plans and background reports, concept and detailed design documentation, applicable legislation, policies and guidelines and a site visit. The outcomes of the hydraulic (or flood) modelling for existing and proposed conditions were used to assess geomorphic effects. The assessment focused on changes in velocity, shear stress, water depth and inundation extents across the channel and floodplain areas.

The study area for this assessment includes the proposal footprint and surrounding area, with the potential to be directly or indirectly affected by the proposal. The assessment has been undertaken with reference to the geomorphic characteristics of the existing environment of Billabong Creek within weir pool backwater areas, and downstream for an appropriate distance that is within the realm of significant influence of the proposal.

Key aspects of the assessment included:

- Desk study of literature, reports and designs of the proposal.
- Bathymetric survey data which recorded the creek bed levels above Australian Height Datum (AHD).
- Site visits were undertaken by a geomorphologist on 27 April 2022 and 4 May 2022. These visits checked current geomorphic conditions and processes at the study area and geomorphic condition of the channel banks and structures at these locations, and any obvious instabilities (i.e. undercutting, slumping, evidence of ongoing erosion) were identified. Hartwood and Wanganella Wiers were observed as well as two other weirs within Billabong creek to provide broader understanding of the existing environment.
- A risk-based approach was adopted to understand the key risks and impact pathways with the potential to lead to significant geomorphological impacts. The risk assessment included:
 - assessing impact pathways identified as relevant to the proposal
 - evaluating the significance of any potential adverse effects
 - developing measures to avoid, minimise or manage adverse effects to acceptable levels.
- Review of channel hydraulics based upon velocity and shear stress values to inform an assessment of potential geomorphic effects.
- With an understanding of the existing conditions and the proposed works and potential operational scenarios, an assessment of potential geomorphology effects associated with construction and operation was undertaken based on an understanding of potential impact pathways.

9.2. Existing environment

9.2.1. Billabong Creek overview

Billabong Creek is essentially a series of weir pools, the channel is largely considered to be stable, with some localised erosion noted within the immediate vicinity of in-creek structures, generally extending a distance of around 25 to 50 metres downstream of existing weirs. This is accentuated in instances where there has been structural deterioration/failure of concrete wingwalls. High flows are outflanking these areas and there are also some seepage/flows through cracks.

A review of creek bed survey levels upstream and downstream of existing weirs reveals very little difference in bed levels which suggests there is unlikely to be significant sedimentation upstream of existing weirs, or erosion of bed downstream of the existing weirs. Existing concrete sill levels are also generally 2.0 metres higher than bed levels upstream. Bank slumping/erosion with current operations is considered a low risk. The banks themselves are comprised of cohesive clays, and combined with vegetation this provides strength to bank materials.

9.2.2. Hartwood Weir

The majority of Hartwood Weir is intact with one concrete wingwall failure on left hand side of channel (Figure 9.1). The channel upstream appears to be stable. There has been some erosion of channel banks evident downstream of weir over distance of about 50 metres (see Figure 9.3 and Figure 9.4). The channel banks upstream of the weir are stable and have vegetation cover (see Figure 9.2).

The results of the bathymetric survey show there is little difference in level of the creek bed upstream and downstream of weir (Table 9.1). It is considered unlikely that there is significant sedimentation in channel upstream of the weir. It is considered possible that with erosion of the banks downstream and associated channel widening, there has been some build-up of sediments on the channel bed downstream of the weir.

Table 9.1 Hartwood Weir – Comparison of weir height (sill level) with creek bed levels

Top of weir (sill Level) (m AHD)	Creek bed Level Upstream (m AHD)	Creek bed level downstream (m AHD)
94.69 to 94.96	92.48	92.95 to 93.30



Figure 9.1 Looking upstream at Hartwood Weir at failure of concrete side wall on left hand side of channel



Figure 9.2 Looking at channel upstream of existing weir. Stable channel banks with reeds at margins



Figure 9.3 Looking downstream at erosion of channel bank on left hand side of channel



Figure 9.4 Looking downstream of weir, evidence of ongoing erosion of banks and channel widening

9.2.3. Wanganella Weir

The structure of Wanganella Weir appears generally intact, although some cracking of concrete is noted (see Figure 9.5).

The channel upstream of the weir appears to be stable, with some minor erosion/notching of banks (see Figure 9.6). Some erosion of the banks is evident downstream of the weir over a distance of about 50 metres. This is particularly noted on the right hand side of the channel (see Figure 9.7). Around 100 metres downstream of the weir the channel banks appear stable and a high water mark can clearly be seen (see Figure 9.8).

The results of the bathymetric survey show there is little difference in creek bed levels upstream and downstream of weir (Table 9.2). It is considered unlikely that there is significant sedimentation in channel upstream of weir.

Table 9.2 Wanganella Weir – Comparison of weir height (sill level) with creek bed levels

Top of weir (sill Level) (m AHD)	Creek bed level upstream (m AHD)	Creek bed level downstream (m AHD)
Unknown	78.73	78.84 to 79.41



Figure 9.5 Looking across channel at Wanganella Weir from right hand bank



Figure 9.6 Upstream of Wanganella Weir. Minor erosion/notching of banks in weir pool



Figure 9.7 Bank erosion downstream of Wanganella Weir



Figure 9.8 100 metres downstream of Wanganella Weir showing stable channel banks, and clear high water mark

9.3. Impact assessment

9.3.1. Construction

A number of potential impact pathways have been identified as risks to creek geomorphology during the construction phase. Each of these risks are considered as part of the assessment of impacts for the proposal. The impact pathways identified for each risk is provided below.

- Risk A: Potential changes to fluvial processes leading to adverse impacts on environmental values:
 - construction works and structures potentially result in bed and bank erosion or instability
 - potential effects to important wetlands and wetland habitat as a result of changes in fluvial processes during construction.

- Risk B: Potential changes to water quality leading to adverse impacts on environmental values:
 - erosion and loss of topsoil during construction causing water quality degradation (e.g. due to clearing of vegetation and ground disturbance, inundation during construction activities)
 - discharging/dewatering poor quality water into receiving environments results in reduction in water quality.

Potential fluvial and water quality impact pathways are assessed together as these two impact pathways would not occur in isolation. For the impacts to surface water quality to occur, there must be a fluvial process to complete the impact pathway, i.e. the fluvial process connects the source of the water quality impact to the receptor or environmental value affected.

Prior to implementation of mitigation and management measures both risks are rated Medium as shown in Table 9.3.

Table 9.3 Key construction risks and ratings

Risk no.	Activity	Impact pathway	Initial risk rating	Proposed mitigation and management measures	Residual risk rating
A	Construction Surface water Flow	Potential changes to fluvial processes leading to adverse impacts on environmental values	Medium	GEO1, GEO2, GEO3, GEO4	Low
B	Construction Surface water Quality	Potential changes to water quality leading to adverse impacts on environmental values	Medium	GEO1, GEO2, GEO3, GEO4	Low

The assessment has identified mitigation and management measures which can specifically target these risks, which are listed in Table 9.4. Appropriate construction methodology, would minimise erosion and sediment risks, including upstream and downstream during both demolition of existing weirs and construction of the new replacement regulators.

Construction would avoid the disturbance to areas of the channel and in-stream or riparian vegetation/habitat where possible beyond the construction activity zone. Rehabilitation of disturbed areas directly upon completion of works would aid the recovery of disturbed areas reducing the potential for ongoing erosion of areas.

Measures to contain and monitor sediment and erosion during construction including instream and riparian areas would be carried out. In the event of erosion occurring, measures to treat surface water runoff would be carried out. Contingency measures would be established for managing construction sites during a high flow event to minimise any adverse effects. This would include pausing in-creek works during high flow.

Effective implementation of the mitigation and management measures minimises changes in flow or water quality during construction, which in turn results in insignificant or low effects. Specifically, any residual effects are expected to be temporary and localised in nature, are common to similar types of construction activities and standard control mechanisms for these types of impacts are well established.

There is high confidence that construction related impacts to surface waters would be mitigated by the controls proposed in the relevant mitigation and management measures. The residual effect after implementation of mitigation and management measures is assessed as low, as shown in Table 9.3.

9.3.2. Operation

Overview of the creek condition during operation

The new regulators would be located immediately downstream of the existing weirs and would effectively maintain the existing weir pools. It is therefore not expected that there will be any significant change in potential for scour/erosion or sedimentation of the weir pools.

There may be an increase in sedimentation in the channel immediately upstream of the new regulator structures. However as this does not appear to be happening currently at the existing weirs, it is unlikely to be significant in the future. It may be that higher flows are effective in flushing suspended sediments through the existing weir pools or there is not much sediment moving through the system as the creek banks are observed as generally stable.

Bank slumping and/or erosion as a result of operation of the proposed regulators is considered a low risk. The banks themselves are comprised of cohesive clays, and combined with vegetation this provides strength to bank materials.

The assessment indicates that the zone of the creek likely to be most prone to channel instability and higher erosion risk (relative to existing conditions) are the sections of creek immediately downstream from the proposed regulators. The regulator structures have been designed however, to include energy dissipation of flows immediately downstream through provision of concrete aprons and rock armouring of bed and channel banks.

The assessment has selected two rainfall event scenarios to model the potential change in velocity and shear stress values between existing and proposed conditions for the majority of Billabong Creek:

- The 50 per cent annual exceedance probability (AEP) event approximates bank-full discharge, the maximum discharge that the channel can convey without overflowing onto the floodplain. This discharge is considered to have morphological significance because it represents the breakpoint between the processes of channel formation and floodplain formation (Bridge, 2003).
- The 2 per cent AEP event represents a much larger flow that exceed the capacity of the channel, inundates the broader floodplain and engages network of connecting anabranches and paleochannels.

A review of modelling results shows that there is generally no appreciable change in velocity and shear stress values between existing and proposed conditions for the majority of Billabong Creek. Sections of the river exceed the low erosion risk shear stress range for both the existing and proposed conditions. Potential erosion predicted is within the natural geomorphic response of the river channel, where some localised erosion and deposition is part of the natural adjustment of the river channel in response to medium and high flood flow events.

The hydrological modelling results presented in chapter 6 and Appendix G, show that there would be very little change to the hydrological nature of the study area. Furthermore, hydraulic modelling in the Hartwood and Wanganella weir pool presented in the hydrology assessment indicated very minor increases in the area flooded by the pool under any of the operating scenarios and as such no significant geomorphological impacts are expected. The mapped area of newly wetted channel areas during normal operating levels at maximum and minimum operating flows are presented in Figure 3.13, Figure 3.14 and Figure 3.15.

Hartwood regulator

Based on a review of channel hydraulics there are no significant changes from existing and proposed flow conditions that would result in a change to the geomorphology of the creek. The section of creek downstream of the proposed Hartwood Regulator for around one kilometre will experience higher shear stresses and erosion risk. However, the range of shear stresses experienced in this section would not be dissimilar to areas upstream of the proposed regulator under existing conditions.

In response to the hydraulics modelling the regulator structure has been designed to include energy dissipation of flows immediately downstream including concrete aprons and rock armouring of bed and channel banks.

Wanganella regulator

The channel hydraulic review indicates that there are no significant changes from existing and proposed flow conditions that would result in a change to the geomorphology of the creek. The section of creek immediately downstream of the proposed Wanganella regulator would experience higher shear stress relative to existing conditions.

In response to the hydraulics modelling the regulator structure has been designed to include energy dissipation of flows immediately downstream including concrete aprons and rock armouring of bed and channel banks.

9.3.3. Cumulative impacts

The other projects planned in the study area were reviewed to determine if the proposal has the potential to result in significant cumulative impacts. No potential cumulative impacts relevant to geomorphology were identified. As such, no further cumulative assessment was conducted.

9.4. Mitigation measures

9.4.1. Approach to mitigation and management

The general approach to management of the proposal during construction and operation is outlined in chapter 24.

NSW DCCEEW is committed to minimising the environmental impact of the proposal and is investigating opportunities to reduce impacts where practicable. As prescribed by the SEARs, opportunities would also be implemented, where possible, to improve the overall outcome of the proposal.

The majority of measures to protect the creek from geomorphology changes during operation would be designed into the regulator structures. Standard controls would be utilised during construction to manage potential short term impacts.

9.4.2. Summary of mitigation measures

Table 9.4 lists the geomorphology safeguards and management measures that would be implemented to account for the potential impacts identified in section 9.3.

Table 9.4 Geomorphology safeguards and management measures

ID	Impact	Environmental safeguards	Responsibility	Timing
GE01	Erosion and sedimentation	Regulator structures designed to avoid erosion around and downstream of structures through erosion protection. Regulator structure include energy dissipation measures to manage erosion immediately downstream including concrete aprons and rock armouring of bed and channel banks.	NSW DCCEEW	Detailed design
GE02	General	A Construction Environment Management Plan (CEMP) will be prepared to include site specific control measures to manage potential erosion or sedimentation impacts from instream works as set out below.	Construction contractor	Pre-construction
GE03	Erosion and sediment	A construction Erosion and Sediment Control Plan (ESCP) will be prepared as part of the construction soil and water management plan (CSWMP) and will detail the specific erosion and sediment control measures to be implemented within the proposal area, in accordance with the principles and requirements of Managing Urban Stormwater – Soils and Construction, Volumes 1 (Landcom 2004) and 2C (DECC, 2008) (known as the Blue Book). Controls should include but not be limited to: • Instream control measures – Floating silt fences for instream works. – Undertaking work when flows are low/dry and minimise the duration of works within the watercourse as far as practicable. – Weir removal and new regulator construction to be undertaken in two phases; half of the creek needs to remain unobstructed to maintain continuous flow of water while construction is undertaken on the other side. Cofferdams, sumps and pumps would be used to separate and dewater the half of the creek undergoing construction. – Minimise clearance of vegetation and retain existing vegetation as much as possible. – Contingencies are in place for moderate to high flows, particularly during instream construction works. – Wherever possible, prefabricate instream structural elements prior to instream installation. • Terrestrial control measures – Install sediment controls around stockpiles and borrow areas to contain coarse soil and sediment, as applicable to prevent sedimentation of watercourses.	Construction contractor	Pre-construction

ID	Impact	Environmental safeguards	Responsibility	Timing
		– Placement of stockpiles away from the watercourse (at least 20 metres of creek channels) and be covered when not in use to prevent sediment runoff, and consider whether covering of stockpiles containing coarse soil and sediment is also required. – Stabilise exposed soil where applicable with the appropriate structural materials and media for the construction activities (e.g. stabilisation matting, rock armour or vegetation). – Regular, at least daily, visual water quality monitoring of waterways adjacent to the project area during construction, to assess the effectiveness of silt fences, so they can be fixed if necessary. – Erosion and sediment controls established prior to commencement of vegetation clearing or earthworks where practical.		
GE04	Reinstatement	Disturbed areas will be revegetated as soon as practical, progressively. Rehabilitation at construction sites to include replacing topsoil.	Construction contractor	Construction
GE05	Erosion and sediment	Erosion and sediment controls, will be maintained post construction until disturbed areas are stabilised. Undertake two post-construction visual assessments of the regulator over two years to identify and assess any erosion, so it can be addressed if required.	WaterNSW	Operation

10. Surface water quality and aquatic ecology

This chapter summarises the surface water quality and aquatic ecology impact assessment for the construction and operation of the proposal. This outlines the existing aquatic environment of Billabong Creek, potential impacts to this and recommends mitigation measures to address negative impacts. The surface water quality and aquatic ecology impact assessment report is provided in Appendix K.

10.1. Methodology

10.1.1. Approach to assessment

The surface water quality and aquatic ecology impact assessment for the construction and operation of the proposal has been prepared based on a review and analysis of the following:

- available aquatic fauna and water quality data
- relevant literature and database searches
- management plans and background reports
- concept and detailed design
- applicable legislation, policies and guidelines
- a site visit.

The report builds on findings from the Billabong Creek Regulators Hydrology Assessment (Appendix G) and the Billabong Creek Regulators Geomorphology Assessment (Appendix J) prepared for the proposal.

The following databases were used, with the search being carried out with a buffer of 10 kilometres around the proposal study area:

- Protected Matters Search Tool for species and communities listed under the EPBC Act, maintained by Commonwealth DCCEEW
- NSW DPI threatened species distribution maps
- Atlas of Living Australia
- The Australian Platypus Monitoring Network, an initiative of the Australian Platypus Conservancy
- TurtleSAT, a community-focused freshwater turtle mapping initiative.

The database and literature review were used to identify rare or threatened species and threatened communities potentially occurring with the study area. Potential effects on these species were considered for both construction and operation stages. The likelihood of occurrence assessment was used to determine the likelihood of each species' presence within the study area based on the dates and number of previous records of each species and consideration of the habitat present.

Site investigations of the study area were undertaken between 5 March 2023 and 8 March 2023 which comprised a visual assessment of aquatic habitat and waterway conditions and an eDNA survey targeting fish communities.

Aquatic habitat condition was assessed in accordance with sampling design and methods as detailed in the *Aquatic Ecology in Environmental Impact Assessment – EIA Guideline* (DoP, 2003). An aquatic habitat assessment to characterise the aquatic environment, was undertaken at 12 sites, starting at around 47 kilometres downstream of Wanganella Weir and ending near the top of the Hartwood Weir pool.

10.1.2. Study area

The study area that was subject to environmental impact assessment includes the proposal footprint and the reach of Billabong Creek, with the potential to be impacted by the proposal. This extended from Jerilderie to the Darlot flow gauge (near the town of Moulamein).

The area of investigation covered by this assessment is the entire Yanco Creek System starting from Yanco Weir and finishing at the Darlot flow gauge. This encompasses a broader area than that anticipated to be impacted by the new regulators, because the impacts of the new regulators have been assessed within the context of associated system wide operational changes as per the Yanco Creek System Operations Plan (Appendix U).

10.1.3. Risk assessment

The information collated during the desktop review and field surveys was used to develop a risk assessment to evaluate key risk associated with the construction and operation of the proposal.

Risk assessments were conducted to:

- identify and describe the key risks and effect pathways, resulting from the construction and operation of the proposal, that have the potential to negatively impact on the environment and/or local communities
- evaluate the significance of potential adverse effects
- develop measures to avoid or limit the adverse effects to acceptable levels.

The level of effort directed at investigating and managing potential adverse effects has been based on the evaluated risk ratings, with greater effort directed to matters that pose a higher risk. The environmental performance objective adopted for the risk assessment is to avoid and minimise impacts on State and Commonwealth listed aquatic species and communities, and aquatic ecosystem health.

10.1.4. Legislative and policy context

The following legislation has driven the approach to the surface water quality and aquatic ecology assessment:

- EPBC Act – under this Act, an action requires approval from the Minister for the Environment and Water if the action has, will have, or is likely to have, a significant impact on MNES. The MNES categories applicable to this assessment are aquatic threatened species and ecological communities, Ramsar-listed wetlands and Nationally Important Wetlands.
- *Water Act 2007* provides the legislative framework for ensuring that the Murray-Darling Basin is managed in the national interest.
- *Fisheries Management Act 1994* (FM Act) provides for the conservation, protection and management of fisheries, aquatic systems and habitats in NSW. Threatened aquatic species, populations and ecological communities relevant to this proposal are listed under Schedule 4, 4A and 5 of the FM Act.
- *Water Management Act 2000* (WM Act) is the primary legislation for the management of water in NSW. The WM Act contains provisions for water management plans and the allocation of water.

The following guidelines and/or policies have driven the approach to the surface water quality and aquatic ecology assessment:

- NSW Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013)
- NSW DPI guideline Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (Fairfull and Witheridge, 2003)
- National Water Quality Management Strategy (Australian Government, 2018b)
- Australian and New Zealand Environment and Conservation Council (ANZECC/ARMCANZ) published the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000)
- NSW Water Quality Objectives (WQOs) (DECCW, 2006)
- Guidelines for Managing Risks in Recreational Water (NHMRC, 2008)
- Murray-Darling Basin Plan (MDBA, 2012) including the Murrumbidgee Surface Water Resource Plan, the Murrumbidgee Long-Term Water Plan) Part A and Part B, and the Water Quality Management Plan for the Murrumbidgee Surface Water Resource Plan
- Water (Accredited Water Resource Plan – Murrumbidgee) Instrument 2024 and Murrumbidgee Water Resource Plan, 2024
- Approved Methods for Sampling and Analysis of Water Pollutants in NSW (NSW EPA, 2022)
- Managing Urban Stormwater, Soils and Construction, Volume 1 (Landcom, 2004)
- Guidelines for Controlled Activities on Waterfront Land, riparian corridors (Natural Resources Access Regulator 2018)
- Survey Guidelines for Australia's Threatened Fish (DSEWPAC, 2011)
- NSW Weirs Policy (NSW Government 1995).

10.2. Existing environment

10.2.1. Catchment overview

The proposal is located on Billabong Creek, which is part of the Yanco Creek System in south-west New South Wales and forms part of the Murray-Darling Basin. The Yanco Creek System is a complex braided systems of interconnecting creeks and anabranches with the main branches of the system included Yanco, Colombo, Billabong and Forest Creeks.

Billabong Creek is a significant waterway that travels over 300 kilometres in a westerly direction and drains a catchment of approximately 791 square kilometres. Billabong Creek can be divided into three reaches based on its hydrology, ecology and geomorphology. The upper reach of Billabong Creek is unregulated and flows most of the time due to catchment rainfall. The mid Billabong Creek extends from the Colombo Creek confluence to the Yanco Creek confluence and is free-flowing upstream of Jerilderie Town Weir. Mid Billabong Creek is regulated downstream of Jerilderie by numerous weirs. The Lower Billabong Creek extends from the Yanco Creek confluence to where Billabong Creek discharges into the Edward River at Moulamein and is heavily regulated due to numerous weirs. Hartwood Weir is located on the mid Billabong Creek and Wanganella Weir is located on the lower Billabong Creek.

The proposal lies wholly within the bounds of the 'aquatic ecological community in the natural drainage system of the lower Murray River catchment', also known as the 'Lower Murray River aquatic ecological community'.

10.2.2. Water quality

Analysis of existing water quality data and samples collected during the site visit assessed the key indicators of pH, electrical conductivity, dissolved oxygen, turbidity and nutrients. Generally, pH and electrical conductivity were below the Basin Plan guidelines and recommended values for the protection of nominated water quality objectives in the Australian and New Zealand Guidelines (ANZG 2018). The water quality in the broader catchment and within the vicinity of the study area is generally characterised as having elevated turbidity, nutrients and, at times, conductivity. The elevated turbidity (sediments) appears to be a result of erosion which increases were recorded following high rainfall events. In addition to elevated nutrients and turbidity, monitoring at the weir sites also shows elevated concentrations metals but no evidence of pesticide and herbicides.

The water quality indicators of turbidity, dissolved oxygen, nutrients and some heavy metals did not meet the recommended targets limits at the time of sampling in the proposal area, and nutrients and turbidity appear to be elevated throughout the catchment.

In accordance with SEAR 5 (D), an assessment of the impacts of the construction of the proposal has been undertaken in accordance with relevant guidelines for nominated water quality objectives. A brief summary of the current water quality with respect to each water quality objective is provided in Table 10.1.

Table 10.1 Surface water quality objectives – current quality

Water quality objective (WQO)	Indicators	Current water quality
Aquatic ecosystems <i>Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term</i>	• Total phosphorus • Total nitrogen • Chlorophyll-a • Turbidity • Electrical conductivity • Dissolved oxygen • pH • Chemical contaminants or toxicants	Current water quality data for Billabong Creek at various locations does not achieve this WQO due to elevated nutrients and turbidity, occasional low dissolved oxygen and elevated electrical conductivity that were outside acceptable ranges.
Visual amenity <i>To maintain the aesthetic quality of water</i>	• Visual clarity and colour • Surface films and debris • Nuisance organisms	Whilst data is limited, the WQO 'visual amenity' is likely not being met in Billabong Creek due to elevated turbidity levels and occasions of algal blooms/blackwater events.
Secondary contact recreation <i>Maintaining or improving water quality of activities such as boating and wading, where there is a low probability of water being swallowed</i>	• Enterococci • Algae and blue-green algae • Chemical contaminants	Based on existing literature regarding algal alerts in Billabong Creek, harmful algal numbers appear to be low and therefore it is assumed that the WQO secondary contact recreation is currently being achieved.
Primary contact recreation <i>Maintaining or improving water quality of activities such as swimming in which there is high probability of water being swallowed</i>	• Cyanobacterial biovolume • Toxic cyanobacterial biovolume • Potentially toxic cyanobacteria • Enterococci • Protozoan	Based on existing literature regarding algal alerts in Billabong Creek, harmful algal numbers appear to be low and therefore it is assumed that the WQO primary contact recreation is currently being achieved.

Water quality objective (WQO)	Indicators	Current water quality
Livestock water supply <i>Protecting water quality to maximise the production of healthy livestock.</i>	- Algae and blue-green algae - Salinity (electrical conductivity) - Thermotolerant coliforms (faecal coliforms) - Chemical contaminants	Data for a limited number of indicators infer that the WQO 'Livestock water supply' is currently being achieved with limited algal alerts and salinity that is generally within acceptable ranges for protection of the WQO.
Irrigation water supply <i>Protecting the quality of waters applied to crops and pastures.</i>	- Algae and blue-green algae - Salinity (electrical conductivity) - Thermotolerant coliforms (faecal coliforms) - Heavy metals and metalloids	Data for a limited number of indicators infer that the WQO 'Irrigation water supply' is generally being achieved as salinity and algal counts are generally within acceptable ranges.
Homestead water supply <i>Protecting water quality for domestic use in homesteads, including drinking, cooking and bathing</i>	- Blue-green algae - Turbidity - Total dissolved solids - Faecal coliforms - pH - Chemical contaminants	Based on existing water quality, protection of the WQO 'homestead water supply' is only partially met due to variable turbidity which exceeds the limit of five Nephelometric Turbidity Units. Other indicators where data were available fell within the recommended limits.
Aquatic foods (cooked) <i>Protection of water quality so that is suitable for the production of aquatic foods for human consumption and aquaculture activities</i>	- Algae and Blue-green algae - Faecal coliforms - Toxicants - Physio-chemical indicators	Lack of water quality data for key indicators required for the protection of aquatic foods (cooked) cannot confirm if this WQO is currently being met.

10.2.3. Aquatic habitat

Surveys have shown that Murray Cod (Vulnerable under the EPBC Act) and Silver Perch (Critically Endangered under the EPBC Act) are widespread in the middle and lower reaches of Billabong Creek, so both proposal areas have been classified 'Type 1 – Highly Sensitive KFH' (DPI, 2013).

DPI Fisheries has undertaken a detailed aquatic habitat mapping of the Billabong Creek upstream and downstream of the proposed Hartwood and Wanganella regulators. The results of the DPI Fisheries detailed aquatic habitat mapping identified aquatic habitat condition (within the study area for the survey) is in reasonable condition. Habitat mapping identified positive habitat value features included:

- 9,250 large woody habitat (LWH) features
- 679 rootballs
- 103 wetland entry/exit points
- 88 potential drought refuges covering 11.1 hectares
- 847 benches covering 1,375.8 hectares
- 10 macrophyte species covering 15.9 hectares of which Broadleaf Cumbungi was the most prevalent macrophyte species particularly at Hartwood Weir and Sedges (*Juncus* spp.) in the vicinity of Wanganella Weir.

There is a moderate to high abundance of instream structural habitat (large woody habitat and rootballs) throughout mid and lower Billabong Creek. Furthermore, refuge habitat (i.e. deep, permanent pools) is relatively common, particularly in the weir pools and rarely elsewhere. Benching along the riverbank is also common, providing variability in water depth and substrate for plant growth, amongst other important functions.

There is very little submerged aquatic vegetation in the Billabong Creek system. Floating species are sparsely distributed and occupy shallow margins or islands. A priority weed species, *Sagittaria* (*Sagittaria platyphylla*), has also been recorded near Hartwood Weir, although in very low abundance.

Emergent species, rushes, common reed and Broadleaf Cumbungi are present along the riverbanks and on benches or in shallow water in the stream margins. Common reed and Cumbungi are relatively common, although the others appear to have restricted distributions. This is probably as a result of relatively unchanging water levels in many of the waterways. Billabong Creek supports a band of riparian vegetation along its banks and higher benches.

10.2.4. Aquatic fauna

Threatened aquatic fauna

The desktop review identified that Billabong Creek was predicted habitat for a number of listed threatened species and populations. However, upon further review of literature and assessment of the waterway conditions in the field surrounding the proposal areas, it was determined that only the following species are predicted to occur in the vicinity of the study area:

- Silver Perch (Critically Endangered (EPBC Act), Vulnerable (FM Act))
- Murray Cod (Vulnerable) (EPBC Act).

Other threatened species and populations that either occur in the broader Yanco Creek System or have species distribution models indicating they are likely or possible to occur:

- Freshwater Catfish (*Tandanus tandanus*) – Endangered population (FM Act)
- Murray Crayfish (*Euastacus armatus*) – Vulnerable. (FM Act).

Threatened ecological communities

The study area is situated wholly within the 'Lower Murray River aquatic ecological community'. This effectively means that the whole fish community and its habitat is listed as Endangered under the FM Act.

The Lower Murray River aquatic ecological community encompasses all natural creeks, rivers and associated lagoons, billabongs and lakes of the regulated portions of the Murray, Murrumbidgee and Tumut Rivers. The Lower Murray River aquatic ecological community is characterised by meandering channels and wide floodplains where flows are often heavily regulated.

The aquatic habitats present in the Yanco Creek System are representative of the Lower Murray River aquatic ecological community, including permanent and intermittent river channels, and intermittent to permanent wetlands. The modification of natural river flows because of river regulation such as dams and weirs, was identified as the main threat to the ecological community. The changed river flow regimes lead to reduced habitat quality, loss of spawning areas, and reduced opportunities for dispersal and migration.

Other species

Other ecologically, commercially, and culturally important aquatic and semi-aquatic species that have been recorded in the Yanco-Billabong System in the vicinity of the study area include native fish (Golden Perch), turtles (Eastern Long-necked Turtle, Broad-shelled Turtle and Murray River Turtle), Platypus, and Rakali. While they are not listed as threatened by Commonwealth or state legislation (FM Act or EPBC Act), their general importance to the community and environment means that their presence in the study area has been considered to ensure a robust assessment of impacts.

10.3. Impact assessment

10.3.1. Construction

Overview of potential construction impacts

Construction of the proposal would involve a range of activities including vegetation clearing, earthworks, concrete works, establishment of construction compound and instream works including construction and dewatering of cofferdams, streambed excavation and demolition of existing structures. During construction, flow would be maintained throughout the creek and scour protection measures would be implemented. Construction works would not impact on the bankful level (i.e. water level, or stage, at which a waterway is at the top of its banks and any further rise would result in water moving into the floodplain).

Potential adverse effects of the proposal during construction of the proposed regulators relate to loss of connectivity and impeded passage for native aquatic species, degradation of aquatic habitat through water quality or water regime changes, spread of weeds, pest species or pathogens, impacts to Groundwater Dependent Ecosystems and direct impacts to aquatic habitat or species.

Billabong Creek a ninth order Strahler stream, is classified as waterfront land under the WM Act. Whilst a controlled activity approval is not required, the design and construction activities within the watercourse and waterfront land has considered the need to maintain flow and protect water quality, stream ecology and existing riparian vegetation.

With the implementation of safeguards and management measures discussed in section 10.4, it was determined that the risk of these impacts occurring changed from possible and likely to unlikely and rare for works in the study area. As such it is expected that the water quality objectives and aquatic ecosystem values in the study area (including threatened species and key fish habitat) would be protected during construction. The findings of the risk assessment are shown in Table 10.2.

Table 10.2 Risk assessment to the aquatic community during construction

Impact pathway	Proposal activity and potential impact	Assessed outcome	Risk rating
Loss of connectivity and impeded passage for native and other aquatic species	Construction of infrastructure within a waterway requires construction of cofferdams, which results in a temporary loss of connectivity and impeded passage impacting aquatic species	Passage for aquatic fauna would remain relatively unchanged during construction given the weir already presents a barrier to movement.	Very Low
Degradation of aquatic habitat through water quality or water regime changes	Disturbance of soil during construction of infrastructure in or adjacent to waterway corridor could lead to increased erosion/sedimentation, leading to aquatic habitat degradation and reduced water quality due to input of sediment and/or contaminants	Erosion and sedimentation would be managed via various standard water quality control measures including installation of floating silt curtains downstream of work area, sumps would be installed to manage residual water and silt fences and jute matting at the toe of batters to minimise the transport of silt into the creek.	Medium
Degradation of aquatic habitat through water quality or water regime changes	Removal of vegetation could lead to a decline in aquatic habitat (e.g. increased light levels and stream temperature) that negatively impacts on aquatic fauna.	The proposal has been designed to avoid and minimise impacts to vegetation by utilising existing cleared/disturbed areas to build the necessary infrastructure. Clearing of vegetation could result in the release of tannin leachate which would be managed via various standard water quality control measures.	Low
Degradation of aquatic habitat through water quality or water regime changes	Construction works could result in the release of oils and fuels, accidental release of concrete waste and dust and litter into downstream waterbodies, leading to water quality unsuitable for aquatic species	Spills and leaks would be managed by various standard water quality control measures.	Low
Degradation of aquatic habitat through water quality or water regime changes	Dewatering of the area could impact on surface water quality	Water pumped out of the construction areas would be discharged downstream of the construction area but upstream of the silt curtain to manage sedimentation.	Low
Degradation of aquatic habitat through water quality or water regime changes	Construction works could result in the disturbance of saline soils	Saline soils could be disturbed as a result of earthworks and piling. To be managed by various standard water quality control measures.	Very low
Degradation of aquatic habitat through water quality or water regime changes	Potential mobilisation of sediment deposited behind the existing weir walls.	These works would occur within the dry work area within the cofferdam. It is therefore unlikely that the removal of the weir will lead to the suspension and transport of sediment deposited behind the existing weirs during their removal.	Very low

Impact pathway	Proposal activity and potential impact	Assessed outcome	Risk rating
Spread of weeds, pest species or pathogens	Construction activities could lead to introduction of weeds or noxious species that become established in aquatic habitats, leading to conditions unsuitable for existing species	To be managed by various standard weed control measures.	Low
Spread of weeds, pest species or pathogens	Construction activities could lead to introduction of pathogens which directly impact existing species.	To be managed by various standard biosecurity control measures.	Low
Impacts to Groundwater Dependent Ecosystems	Groundwater drawdown may occur during dewatering of instream work areas.	Hartwood regulator – there will be no effect on groundwater as the base of the structure and likely excavation depths are above the recorded groundwater level at the site. Wanganella regulator – will be limited to a maximum of around 0.5 m with a peak possible radius of influence of 250 m and a likely maximum discernible radius of effect of less than 50 m. The expected rate of dewatering is less than 0.2 L/s.	Very low
Direct impacts to aquatic habitat or species	Construction of infrastructure within a waterway requires a cofferdam and pumping of water, which could result in accidental mortality of aquatic species within the construction site during initial construction of the cofferdam.	It is unlikely turtles, rakali, platypus and large fish such as Murray Cod, Silver Perch, and Freshwater Catfish would become trapped as they are highly mobile and would be expected to avoid the construction area. Smaller fish species and juveniles are more likely to become entrapped.	Very low
Direct impacts to aquatic habitat or species	Construction of infrastructure could cause bank disturbance resulting in loss of habitat.	Destruction of existing nest sites during construction poses a risk. The construction footprint is however small relative to the accessible nesting and burrowing habitat available more broadly throughout the Yanco Creek System.	Very low
Direct impacts to aquatic habitat or species	Construction of infrastructure in or adjacent to waterway corridor could lead to removal of large woody habitat due to adjacent land or in-channel disturbance, leading to a loss of structural habitat for aquatic species.	The instream footprint is small and many large snags were observed in each of the weir pools outside of the impact area.	Very low
Direct impacts to aquatic habitat or species	Potential injury or death of fauna through construction activities on the river bank and vehicle strikes.	There is a risk that construction activities, within a few hundred meters of the river, may directly impact on freshwater turtles nests by crushing nests and burrows. The small construction footprints and controlled slow vehicle speed, allow mobile individuals to avoid the area and vehicles.	Very low

Impact pathway	Proposal activity and potential impact	Assessed outcome	Risk rating
Direct impacts to aquatic habitat or species	Construction could increase terrestrial predator abundance (e.g. feral cat, wild dog, and Red Fox) leading to greater predation pressure on freshwater turtles and Rakali.	There is potential for the abundance of these terrestrial predators to increase as litter around the construction sites may increase food availability. To be managed by standard control measures.	Very low

Matters of national environmental significance

Based upon the construction impacts identified in the section above, an assessment of how these could impact matters of national environmental significance (MNES) under the EPBC Act was carried out. The Significant Impact Assessment for MNES and State listed species and communities was considered for species identified as 'present' or 'likely to occur' in the study area and carried out in accordance with *Matters of National Environmental Significance – Significant impact guidelines 1.1* (Australian Government DoE 2013).

Table 10.3 Summary of the Significant Impact Assessment during construction

MNES name	Expected or Potential Impact	Significant Impact Assessment
Murray Cod Silver Perch Freshwater Catfish Murray Crayfish Lowland Murray River Drainage System Endangered Ecological Community	Minor impacts are possible (risk ratings are Medium or lower) through some impact pathways (e.g. temporary changes in water quality and loss of small areas of potential habitat), but they are not considered significant under the EPBC Act.	Significant impacts are considered unlikely.

Impact on NSW water quality objectives

In accordance with SEAR 5 (D), an assessment of the impacts of the construction of the proposal has been undertaken in accordance with relevant guidelines for nominated water quality objectives. A brief summary of the current water quality and key indicators with respect to each water quality objective is provided in Table 10.1. A qualitative assessment of the potential impacts that the proposal may have on meeting these objectives during construction is provided in Table 10.4.

Table 10.4 Surface water quality objectives and potential impacts during construction

Water quality objective	Proposal related impacts during construction
Aquatic ecosystems <i>Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term</i>	Key indicators that have the potential to be impacted would be turbidity and suspended solids which could temporarily exceed background concentrations and/or the trigger value. Nutrient concentrations in soils in the area are influenced by land use, soil disturbance and human activity upstream and mobilisation of sediments in the waterways could result in increased concentrations of nutrients and toxicants if bound to the soil particles. Further increases in nutrient concentrations which are already elevated in Billabong Creek and increase with distance downstream could result in increased risk of algal blooms and eutrophication and in turn impact on dissolved oxygen levels. Currently, electrical conductivity generally complies with the Water Resource Plan target although construction presents a temporary risk of further increases due to disturbance of saline soils which could alter the salinity of water. Changes in salinity could alter instream biodiversity and ecosystem function. In order to manage risks to water quality and protect this water quality objective, a variety of management measures will be applied including silt curtains, sediment fences, sumps and regular water quality monitoring to manage sediment and saline water. Whilst this water quality objective is currently not being met the implementation of management measures would ensure that construction of the proposal would not impact on achieving the water quality objective “protection of aquatic ecosystems” of Billabong Creek in the future.
Visual amenity <i>To maintain the aesthetic quality of water</i>	Construction of the proposal could impact on achieving the water quality objective visual amenity if turbidity levels increased which in turn would result in poor water clarity. Increases in turbidity could result from release of highly turbid water during dewatering of the cofferdams, or from erosion and sedimentation. Visual amenity may also be impacted if dust or litter is mobilised during construction. Environmental management measures will be implemented to manage sediment, dust and litter and accidental spills to ensure that the aesthetic quality of Billabong Creek at each site would not be reduced and that there would be no impact to achieving this water quality objective during construction of the proposal.
Secondary contact recreation <i>Maintaining or improving water quality of activities such as boating and wading, where there is a low probability of water being swallowed</i> Primary contact recreation <i>Maintaining or improving water quality of activities such as swimming in which there is high probability of water being swallowed</i>	If construction of the proposal increases sediment and nutrients, this may result in an increased risk of algal blooms which can impact on suitability for recreation. Additionally, increased sediment may contain elevated concentrations of metals and toxicants that are hazardous to human health. Whilst not routinely monitored, enterococci and other pathogens may be present in Billabong Creek in elevated numbers from upstream sources (e.g. agricultural runoff) and may pose a risk to recreational suitability. However, construction of the proposal is not expected to introduce pathogens into Billabong Creek. Whilst there may be occasions of poor water quality during construction (eg following rainfall) with the implementation of management measures, the quality of water is not expected to deteriorate such that the existing water quality would not meet the National Health and Medical Research Council (NHMRC 2008) guidelines. Therefore, construction of the proposal would ensure that secondary and primary contact recreation in Billabong Creek continues to be achieved.
Livestock water supply <i>Protecting water quality to maximise the production of healthy livestock.</i> Irrigation water supply: <i>Protecting the quality of waters applied to crops and pastures.</i>	The construction of the proposal has the potential to increase salinity due to disturbance of saline soils. Construction also presents a risk of algal blooms if nutrient concentrations increase as a result of increased sediments. Contaminants may also be introduced via accidental spills or bound to sediment laden runoff. Construction is not expected to introduce thermotolerant coliforms. Appropriate mitigation measures will be implemented to manage these risks such that concentrations of key water quality indicators continue to meet relevant guideline criteria and that this water quality objective continues to be met.

Water quality objective	Proposal related impacts during construction
Homestead water supply <i>Protecting water quality for domestic use in homesteads, including drinking, cooking and bathing</i>	Construction of the proposal could impact on achieving the water quality if turbidity levels increased which could occur from the release of highly turbid water during dewatering of the cofferdams, from instream works or from erosion and sedimentation. The construction of the proposal has the potential to increase salinity due to disturbance of saline soils. Construction also presents a risk of algal blooms if nutrient concentrations increase as a result of increased sediments. Contaminants may also be introduced via accidental spills or bound to sediment laden runoff. Construction is not expected to introduce thermotolerant coliforms. Appropriate mitigation measures will be implemented to manage these risks such that concentrations of key water quality indicators continue to meet relevant guideline criteria and that the water quality objective continues to be met for those indicators currently being achieved and works towards achieving the guidelines for those indicators not currently meeting the required limits.
Aquatic foods (cooked) <i>Protection of water quality so that is suitable for the production of aquatic foods for human consumption and aquaculture activities</i>	The construction of the proposal has the potential to temporarily increase concentrations of physio-chemical indicators including suspended solids such that they may exceed guidelines for protection of the water quality objective. Increases in suspended solids may result in increased nutrients which present a risk for an increase in the occurrence of algal blooms or toxicants which can increase the toxicity of water. This can then result in water quality that is unsuitable for the production of aquatic foods that are safe to consume. Installation of silt curtains, sediment fences and sumps and other mitigation measures will reduce this risk of increased sediments. Therefore, with implementation of management measures, the construction of the proposal is unlikely to have a significant impact on aquatic food values.

Threatening processes

With regards to aquatic ecology values, four potentially threatening processes listed under the EPBC Act may apply to the study area. Of these the three threatening processes below have been assessed as resulting in a low risk rating:

- land clearance
- novel biota and their impact on biodiversity
- predation by European Red Fox and feral cats.

The fourth threatening processes comprises 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants'. This was assessed as having a medium risk, however during construction, strict measures would be put in place to mitigate the spread of weeds to the study area. As such, the residual likelihood of an impact during construction is considered unlikely.

10.3.2. Operation

Overview of potential operational impacts

Potential effects to ecological values during the operation phase are expected to be associated with the following broad effect pathways.

- loss of connectivity and impeded passage for native aquatic species
- degradation of aquatic habitat through water quality or water regime changes
- spread of weeds, pest species or pathogens
- direct impacts to aquatic habitat or species.

During operation, the proposal is expected to benefit native fish populations and the delivery of environmental water. This would be achieved by reestablishing river connectivity and fish passage so that fish can complete their life cycles and avoid predation, which is a common occurrence below weirs and barriers to fish passage. Although the proposal would result in considerable benefits to the native aquatic fauna communities within Billabong Creek, there are also some potential adverse impacts associated with the new regulators and proposed Yanco Creek System Operations Plan.

Potential adverse effects of the proposal during operation are discussed in Table 10.5. With respect to the potential adverse impacts identified, it is important to note that these impacts are already evident at the existing Hartwood and Wanganella Weirs.

The design of the replacement new regulators for the proposal would provide for improved flow and fish passage that would result in improved connectivity for native fish, compared to current conditions. Operation of the new regulators would result in minor changes to flow and velocity which is dependent on the operating flow (maximum or minimum). This has the potential to result in changes to aquatic habitat, such as quality and size of lentic and lotic habitat. Any potential changes are expected to be short term and managed via regulator settings. As such with the implementation of safeguards and management measures, the likelihood of these impacts occurring are expected to be unlikely during operation.

Table 10.5 Risk assessment to the aquatic community during operation

Impact pathway	Proposal activity and potential impact	Assessed outcome	Risk rating
Loss of connectivity and impeded passage for native aquatic species	The new regulator does not allow for fish passage in an upstream or downstream direction.	Fish passage design has been addressed in the design phase.	Very low
Loss of connectivity and impeded passage for native aquatic species	Fish passage through the regulator declines over time due to environmental impacts.	Once the regulator structures have been in operation through an appropriate operational cycle, the Yanco Creek System Operations Plan will be updated taking into account system monitoring results, identified operating risks and ecological response.	Very low
Loss of connectivity and impeded passage for native aquatic species	Operation of the proposal leads to fragmentation of terrestrial habitat for turtles and Rakali.	These species will be no worse than under current conditions and these species can travel short distances overland to navigate around the structures.	Very low
Degradation of aquatic habitat through water quality or water regime changes	Operation of the proposal leads to alteration of the natural flow regimes of the creek, leading to conditions unsuitable for native aquatic species.	The changes to the hydrological regime and the subsequent impact on aquatic communities has been addressed in the operations plan and changed conditions are not expected to negatively impact aquatic communities.	Low
Degradation of aquatic habitat through water quality or water regime changes	Spillage or leaks of toxic substances or litter during maintenance of infrastructure enter waterbodies, leading to water quality unsuitable for aquatic species.	This will be in accordance with broader WaterNSW operation and maintenance system.	Very low

Impact pathway	Proposal activity and potential impact	Assessed outcome	Risk rating
Degradation of aquatic habitat through water quality or water regime changes	Operation and maintenance of the regulator leads to increased erosion and sedimentation that impacts on water quality and subsequently, aquatic communities.	This will be managed in accordance with broader WaterNSW operation and maintenance system.	Very low
Degradation of aquatic habitat through water quality or water regime changes	The regulator and semi-permanent sediment control measures degrade leading to increase erosion and sediment input into the stream network.	The risk of erosion from these structures has been addressed in the design phase. Damage and degradation may lead to increased erosion risk and will be managed in accordance with broader WaterNSW operation and maintenance system.	Very low
Spread of weeds, pest species or pathogens	Operation of the proposal alters hydraulic and hydrological conditions in a way that benefits exotic fishes (e.g. European Carp).	The subsequent impact on aquatic habitat and communities has been addressed in the operations plan. The changed conditions are expected to benefit native fish over invasive species.	Low
Spread of weeds, pest species or pathogens	Operation of the proposal alters habitat conditions in a way that benefits invasive aquatic plant species in Billabong Creek and receiving waterways.	The hydraulic modelling suggested some improved conditions for aquatic plant species, but the changes were not considered significant enough to have a negative implication for the aquatic community.	Low
Direct impacts to aquatic habitat or species	Vehicle collisions lead to mortality of turtles and Rakali during operation of proposal.	The volume of maintenance vehicles would be low and on tracks with low speed limits.	Very low

Matters of national environmental significance

Based upon the operational impacts identified in the section above, an assessment of how these could impact MNES under the EPBC Act was carried out. The Significant Impact Assessment for MNES and State listed species and communities was considered for species identified as 'present' or 'likely to occur' in the Billabong Creek Regulators study area and carried out in accordance with *Matters of National Environmental Significance – Significant impact guidelines 1.1* (Australian Government DoE 2013).

As the proposal works are confined to small areas and due to the distance from Ramsar Sites, activities are not expected to have significant or long last impact on Ramsar Sites within the meaning of the EPBC Act.

Table 10.6 Summary of the Significant Impact Assessment during operation

MNES name	Expected or Potential Impact	Significant Impact Assessment
Murray Cod Silver Perch Freshwater Catfish Murray Crayfish Lowland Murray River Drainage System Endangered Ecological Community	Safeguards, in addition to the proposal operation plans, are expected to effectively minimise the risk likelihood of any potential impacts during operation (no identified risks had residual risk likelihoods greater than Unlikely or risk ratings greater than Medium). As such adhering to these plans and safeguards would adequately minimise the risk of any impact on conservation listed fishes within the proposal area and in downstream reaches.	Significant impacts are considered unlikely.

Impact on NSW water quality objectives

In accordance with SEAR 5 (D), an assessment of the impacts of the operation of the proposal has been undertaken in accordance with relevant guidelines for nominated water quality objectives. A brief summary of the current water quality and key indicators with respect to each objective is provided in Table 10.1. A qualitative assessment of the potential impacts that the proposal may have on meeting these objectives during operation is provided in Table 10.7.

Table 10.7 Surface water quality objectives and potential impacts during operation

Water quality objective	Proposal related impacts during operation
Aquatic ecosystems <i>Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term</i>	Operation of the proposal presents a risk to surface water quality of Billabong Creek including mobilisation of sediment and additional source of pollution from accidental spills. When the regulators become operational, there is a risk of scour which can contribute sediment to the waterway. Sediment may also enter the waterways from runoff from unsealed access tracks used to access the structures for maintenance and operation. Mobilisation of sediment may result in increased turbidity and nutrients such that they do not meet recommended guideline trigger values for protection of aquatic ecosystems. Additionally, there is a risk of toxicants entering the water from accidental leaks and spills which may also exceed recommended guideline values. The design has provided sedimentation controls such as rock beaching and geotextile layers to prevent scouring of Billabong Creek upstream and downstream of the regulators. Additionally spills and leaks will be managed in accordance with the operation and management procedures. As such, the operation of the new Hartwood and Wanganella Regulators is not expected to impact on achieving the water quality objective for the protection of aquatic ecosystems.
Visual amenity <i>To maintain the aesthetic quality of water</i>	Visual amenity may be impacted due to sedimentation (due to runoff from unsealed access tracks and scour of the new structure) which may result in poor visual clarity. Increased sediment loads downstream of the new structure will be mitigated via scour protection. Other water quality risks associated with maintenance activities will be managed via the operation and management procedures. Therefore, it is not expected that the operation of the proposal would impact on the long-term achievement of the water quality objective of visual amenity for Billabong Creek.

Water quality objective	Proposal related impacts during operation
Secondary contact recreation <i>Maintaining or improving water quality of activities such as boating and wading, where there is a low probability of water being swallowed</i> Primary contact recreation <i>Maintaining or improving water quality of activities such as swimming in which there is high probability of water being swallowed</i>	The operation of the regulators is not expected to contribute pathogens to Billabong Creek. Additionally accidental leaks and spills if they occur can also contribute contaminants to the waterway. With the implementation of appropriate operational management measures to manage accident spills, it is not expected that the operation of the new structures would impact on secondary or primary contact recreation and these water quality objectives would continue to be protected.
Livestock water supply <i>Protecting water quality to maximise the production of healthy livestock.</i> Irrigation water supply <i>Protecting the quality of waters applied to crops and pastures.</i>	The operation of the new regulators would not result in an increase in pathogens. With the implemented of operational management measures to manage accidental spills and leaks, an increase in chemical contaminants is also unlikely. Therefore, the operation of the new regulators is not expected to impact on achieving these water quality objectives.
Homestead water supply <i>Protecting water quality for domestic use in homesteads, including drinking, cooking and bathing</i>	The operation of the new regulators is not expected to introduce key toxicants or pathogens into Billabong Creek nor is it likely to increase the occurrence of algal blooms. Therefore, the operation of the proposal would not impact on achieving the objective homestead water supply.
Aquatic foods (cooked) <i>Protection of water quality so that is suitable for the production of aquatic foods for human consumption and aquaculture activities</i>	The operation of the new regulators is not expected to introduce key toxicants or pathogens into Billabong Creek such that they would impact on the suitability for consumption of aquatic foods (cooked).

Threatening processes

With regards to aquatic ecology values, four potentially threatening processes listed under the EPBC Act may apply to the study area during operation of the proposal. Of these, all four threatening processes have been assessed as resulting in a low risk rating:

- land clearance
- novel biota and their impact on biodiversity
- predation by European Red Fox and feral cats
- loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.

10.3.3. Cumulative impacts

A summary of the cumulative assessment is provided in section 23.3.3 and section 5.3 in Appendix K (Surface water quality and aquatic ecology assessment report).

10.4. Mitigation measures

10.4.1. Approach to mitigation and management

The general approach to management of the proposal during construction and operation is outlined in chapter 24.

Impacts to aquatic ecology due to construction are largely related to entrapment of animals due to cofferdam construction, mobilisation of poor-quality runoff and erosion/sedimentation, and the spread of aquatic weeds/pest species. The contractor will include control measures within the CEMP that describes how activities undertaken during the construction phase of the proposal will be managed to avoid or mitigate environmental impacts, and how those environmental management requirements will be implemented. A biodiversity management plan would be prepared as a sub-plan to the CEMP and would:

- identify aquatic habitat that needs to be protected
- outline a procedure for salvaging any aquatic fauna species that are at risk from dewatering
- outline all other biodiversity focused safeguards related to the establishment of instream construction work sites or other aspects of the works
- erosion and sediment controls would be identified and developed for the new regulator and existing weir sites, which would be detailed in a construction soil and water management plan (CSWMP) as part of the CEMP.

Some of the most prominent risks during operation of the proposal relate to fish passage through the new regulators and changes to instream hydraulics and hydrology. However, these risks have been accounted for in the proposal design phase, so they don't require specific safeguards given that no significant risk was identified in the risk assessment.

10.4.2. Summary of mitigation measures

Table 10.8 lists the surface water quality and aquatic ecology safeguards and management measures that would be implemented to account for the potential impacts identified in section 10.4.

Table 10.8 Surface water quality and aquatic ecology safeguards and management measures

ID	Impact	Environmental safeguards	Responsibility	Timing
SWQ01	General – CEMP	Preparation of a CEMP to outline the measures to manage water quality impacts associated the construction works is recommended. If risks are to be minimised, it is recommended the CEMP include, but not be limited to, the following: • Measures to minimise/manage erosion and sediment transport within the disturbance area and off site with consideration of contingencies for moderate to high rainfall events. • Measures to manage stockpiles, including locations and sediment controls and stabilisation. • Detail procedures to capture, contain and dispose of concrete waste. • Measures to manage saline soils.	Contractor	Pre-construction

ID	Impact	Environmental safeguards	Responsibility	Timing
		- Measures to manage water (including dewatering) and groundwater ingress from construction, including water collection protocols, and water quality standards to be achieved for release to downstream environment. This should be included in a dewatering management plan that would be prepared as a subplan to the CEMP. - Staging of works to consider and respond to forecast high flows and heavy rainfall events. - Management of the spread of weeds and pests. - Management of spills and leaks.		
SWQ02	General – CEMP	Measures to ensure all waterway crossings will be constructed in accordance with the Guidelines for Controlled Activities on Waterfront Land – riparian corridors (NRAR, 2018), Guidelines for watercourse crossings on waterfront land (DPI, 2012), Guidelines for riparian corridors on waterfront land (DPI, 2012) and Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (DPI, 2003).	Contractor	Pre-construction
SWQ03	Erosion and sediment management during construction	A construction Erosion and Sediment Control Plan (ESCP) will be prepared as part of the construction soil and water management plan (CSWMP) and will detail the specific erosion and sediment control measures to be implemented within the proposal area, in accordance with the principles and requirements of Managing Urban Stormwater – Soils and Construction, Volumes 1 (Landcom 2004) and 2C (DECC, 2008) (known as the Blue Book). Controls should include but not be limited to: - Instream control measures - Floating silt fences for instream works. - Undertaking work when flows are low/dry and minimise the duration of works within the watercourse as far as practicable - Weir removal and new regulator construction to be undertaken in two phases; half of the creek needs to remain unobstructed to maintain continuous flow of water while construction is undertaken on the other side. Cofferdams, sumps and pumps would be used to separate and dewater the half of the creek undergoing construction. - Minimise clearance of vegetation and retain existing vegetation as much as possible.	Contractor	Pre-construction

ID	Impact	Environmental safeguards	Responsibility	Timing
		- Contingencies are in place for moderate to high flows, particularly during instream construction works. - Wherever possible, prefabricate instream structural elements prior to instream installation.		
SWQ04	Spills or leaks during construction	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. These controls are to be documented in the CEMP and would include: - emergency spill response procedure in accordance with NSW DCCEEW incident management protocols - site specific controls to reduce the risk of the release of potentially harmful chemicals from spills or leaks entering waterways - storage of hazardous materials such as oils, chemical and refuelling activities in bunded areas within contractor's temporary work areas - bunded receptacles for concrete waste including concrete slurries and washout water provided at the work sites to capture, contain and appropriately dispose of any concrete waste at a suitably licenced waste facility. These will be located as far from waterways as feasible.	Contractor	Pre-construction
SWQ05	Concrete works management	To avoid ingress of concrete waste material into downstream watercourse, the CEMP would outline procedures to capture, contain and appropriately dispose of any concrete waste. Concrete structures would be pre-fabricated prior to installation instream, where practicable.	Contractor	Construction
SWQ06	Water quality monitoring	To detect and manage the degradation of water quality due to construction activities, a water quality monitoring program will be designed and implemented and appended to the CSWMP. As a minimum water quality monitoring would include: Water quality monitoring upstream and downstream of the proposal site prior to and during construction. In particular, monitoring of dissolved oxygen to ensure suitable saturation levels and turbidity to determine effectiveness of erosion and sediment controls.	Contractor	Construction

ID	Impact	Environmental safeguards	Responsibility	Timing
		Any groundwater that enters excavations within the works sites will be tested and, if suitable, pumped into nearby waterways or otherwise transferred into a treatment pond and treated before being discharged into nearby waterways. The CEMP will include water quality criteria for any water to be discharged into nearby waterways.		
SWQ07	Fish passage management during construction	Minimise the duration of fish passage restrictions (e.g. cofferdams).	Contractor	Construction
SWQ08	Weed and pathogen management	Develop and implement a weed and pathogen control plan that includes the following requirements and measures to mitigate spread: - Vehicle, personnel, material and equipment hygiene protocols (including measures required to prevent the spread or transmission of Chytrid Fungus as per Hygiene protocols for the control of diseases in Australian frogs (Murray et al. 2011). - Weed, pest animal and pathogen management and monitoring and reporting requirements during the construction period. - Weed and pathogen management and monitoring and reporting requirements should be documented. Measures must be auditable and linked to management outcomes. - Identify any listed weeds (identified in NSW WeedWise) that have been found in the construction area as part of the ecological assessment and assess the risk of additional spread prior to relocating topsoil. Implement measures to manage this risk when clearing, grading, and reinstatement activities. - To a reasonable extent when conducting clearing and grading activities, check that vehicles and plant equipment are free of soil (dust/clods) and vegetation prior to entry and exit from the construction area. - Evaluate disturbed areas post-construction and implement rehabilitation in accordance with the appropriate safeguards. - To avoid and minimise spread of weeds and pathogens, all vehicles and plant undertaking construction works directly in the watercourse must be cleaned and free of debris prior to entering a waterway, and on exit if working between multiple waterways.	Contractor	Construction

ID	Impact	Environmental safeguards	Responsibility	Timing
SWQ09	Aquatic habitat disturbance minimisation	- Limit disturbance to riparian vegetation and snags to the assessed clearing areas and avoid complete removal wherever possible. - Any large woody debris and snags (>3 m long or 30 cm wide) that have to be removed from the construction footprint should be moved to a suitable location upstream or downstream of the site in consultation with a qualified ecologist and WaterNSW.	Contractor	Construction
SWQ10	Reinstatement	- Disturbed areas will be revegetated with endemic riparian and floodplain species (replacing like for like) to be undertaken as soon as practical, progressive reinstatement. - Rehabilitation at construction sites to include replacing topsoil from the site stockpile.	Contractor	Construction
SWQ11	Pest control	Food waste accumulated on site will be stored in inaccessible bins and disposed off-site regularly so that the waste doesn't attract predatory pests such as cats and foxes.	Contractor	Construction
SWQ12	Fauna Management	Implement the following fauna management procedures during construction including: - Prepare a dewatering plan for coffer dams to avoid potential impacts to aquatic fauna such as fish stranding. - As a requirement of the dewatering plan, native aquatic fauna entrained within the coffer dams will be captured and relocated to a nearby suitable habitat by qualified aquatic ecologists. - Development and implementation of handling and salvage protocols for terrestrial and aquatic fauna during construction, including requirements for legislative permits and authorisation requirements of wildlife handlers. This will include procedures for pre-clearing, clearing surveys and procedures should fauna or nests/burrows be found during these surveys and removal is required. The protocols will include details of requirements, including wildlife handler/ecologist/NSW DPI permits.	Contractor	Construction

ID	Impact	Environmental safeguards	Responsibility	Timing
SWQ13	Fauna Management	All fencing must be fauna friendly to minimise risk of injury from collision and include provision of egress points, for example: • Temporary to exclude construction: High visibility string of bunting or plastic mesh (not transparent) attached to star pickets with plastic caps (or weighted posts that avoid ground penetration in culturally sensitive areas). • Temporary to exclude wildlife (e.g. from open trenches): Fencing stays located inside the exclusion area, or with high visibility mesh to guide wildlife away from obstructions and potential traps. Shade cloth or other suitable deterrent attached to the lower 50 cm of the outside of the exclusion zone and weighted to the ground. • No barbed or razor wire will be used. Trench management, including avoiding open trenches overnight where practicable. Where trenches cannot be closed, check trenches at the start and end of each day (i.e. dawn/dusk), and consider feasibility of measures (e.g. ramps) to aid animal escape.	Contractor	Construction
SWQ14	Fauna Management	Implement measures to minimise noise, vibration and lighting impacts on known threatened fauna species and habitat, including: • Avoid unnecessary light spill across a broader area than required to avoid attracting insects and subsequently their predators (bats and birds). • Avoiding night works during periods of high insect/bird/bat activity (October to March) as far as reasonably practical, so as to minimise disturbance to fauna communication, foraging and other behaviours that depend on sound and darkness.	Contractor	Construction
SWQ15	Hydrology	Once the proposal structures have been in operation through an appropriate operational cycle, the Yanco Creek System Operations Plan will be updated taking into account system monitoring results, identified operating risks and ecological response.	NSW DCCEEW WaterNSW	Operation
SWQ16	Erosion and sediment control during operation	• 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. • Undertake two post-construction visual assessments of regulators over two years to identify and assess any erosion caused by the structures, so it can be addressed if required.	WaterNSW	Operation

ID	Impact	Environmental safeguards	Responsibility	Timing
SWQ17	Spills or leaks during operation	Site environmental management, inclusive of spill response measures, will be in accordance with broader WaterNSW operation and maintenance and environmental management procedures for operations.	WaterNSW	Operation
SWQ18	Fish passage management during operation	- Develop and adhere to fishway maintenance protocols in line with NSW DPI – Fisheries advice - Conduct fishway monitoring in line with advice from NSW DPI - Fisheries at each regulator once the construction is complete to ensure they are operating as anticipated.	WaterNSW	Operation
SWQ19	Water quality management downstream of the new regulators	To assess changes in water quality following the construction of the proposal and implementation of the Yanco Creek System Operations Plan, develop and conduct a water quality monitoring program for Billabong Creek, downstream of Wanganella and Hartwood Regulators. This may be incorporated into existing catchment-based monitoring programs at long-term monitoring locations, if not already covered.	WaterNSW	Operation
SWQ20	Fauna management during operation	- All operation personnel would be informed of environmental responsibility with respect to the protection of aquatic and terrestrial fauna and their habitat. - All vehicles driven by operation personnel would be required to remain on designated tracks and not drive through water.	WaterNSW	Operation

10.4.3. Aquatic biodiversity offset strategy

The SEARS include a requirement that an Aquatic Biodiversity Offsets Strategy is adequately funded to mitigate and manage impacts of the proposal during construction and subsequent operation. This strategy should focus on protecting and improving the biodiversity and conservation values of Billabong Creek, its biota, and associated riparian zones in the medium to long term.

As the project area is classified as 'Type 1 – Highly Sensitive Key Fish Habitat' it requires an aquatic habitat offset strategy including monetary offsets to be proposed in accordance with the NSW policy and guidelines (DPI, 2013). To help achieve this requirement NSW DPI Fisheries has recently completed an aquatic habitat mapping investigation of Billabong Creek, upstream and downstream of the proposed Hartwood and Wanganella regulators. The aim was to better quantify the Key Fish Habitat features and potential impacts or changes to them due to the proposal to aid in offset calculations. Predominantly these findings will be used to develop an appropriate aquatic biodiversity strategy for the proposal.

A project specific offset strategy appropriate with the risk and impact to Key Fish Habitat features is subject to ongoing negotiations between DCCEEW and NSW DPI Fisheries. Further detail is provided in Section 8 of Appendix L.

11. Terrestrial flora and fauna

This chapter is a summary of the terrestrial flora and fauna impact assessment. It describes the existing environment, assesses the impacts of construction and operation of the proposal, and provides recommended mitigation and management measures. The full assessment is provided in the Biodiversity development assessment report (BDAR) in Appendix L.

11.1. Methodology

11.1.1. Study area

The study area is the area investigated which includes the proposal footprint and surrounding area, with the potential to be directly or indirectly affected by the proposal. The area of investigation covered by this biodiversity assessment comprised the parcels of land that were considered for construction of the proposal and the associated area that may be affected (directly or indirectly) by the proposal nominally comprising a 200 metre buffer area around the proposal footprint as shown in Figure 11.1 and Figure 11.2. Key parts of the study area comprise:

- **Locality** – the area within a 10 kilometre radius of the proposal footprint.
- **Assessment area** – is the area investigated in accordance with the BAM, encompassing the construction footprint and study area plus the 1,500 metre buffer area surrounding the construction footprint, patch size polygon and surrounding land included in the assessment of site context as shown in Figure 11.1 and Figure 11.2.
- **Avoidance footprint** – is the portion of the study area that has not been included in the construction footprint and would not be directly affected or subject to notable indirect impacts arising from the proposal. Includes plant communities, habitat resources and other features of the natural environment that have been specifically avoided in the design of the proposal within and around the Hartwood and Wanganella sites. The avoidance footprint also includes two other sites (Caroonboon and Piccaninny weirs), which have been removed from the final proposal design.

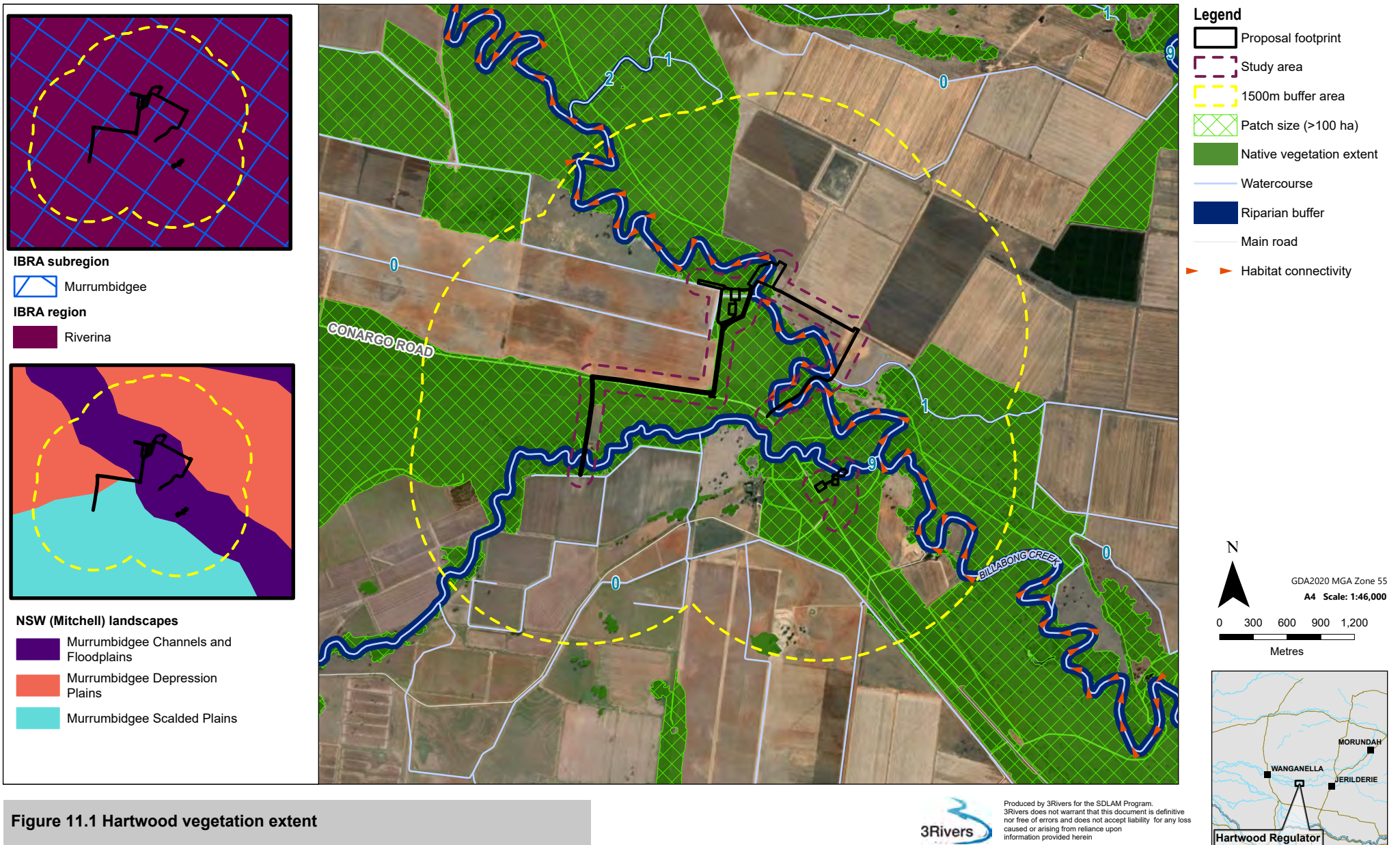


Figure 11.1 Hartwood vegetation extent



Figure 11.2 Wanganella vegetation extent

11.1.2. Desktop Study

A desktop database review was undertaken to identify threatened flora and fauna species, populations and ecological communities (threatened biota) listed under the BC Act and EPBC Act, that could be expected to occur in the locality, based on previous records, known distribution ranges, and habitats present. These were also used to obtain the necessary site data to perform BAM calculations.

Information sources used in the preparation of this report include:

- NSW DCCEEW BioNet Atlas for records of threatened biota previously recorded in a 10 kilometre radius around the proposal footprint (NSW DCCEEW 2024b) and Threatened Biodiversity Data Collection profiles of threatened species listed under the BC Act (NSW DCCEEW 2024c)
- The NSW State Vegetation Type Map (SVTM) (DPE 2023e) to identify candidate plant community types (PCTs) in the study area and to map native vegetation extent
- NSW BioNet Vegetation Classification (NSW DCCEEW 2024d) descriptions and characteristic plant species lists to identify and map PCTs at fine scale in the study area
- The BAM – Important Areas viewer spatial database of identified important habitat for threatened species (NSW DCCEEW 2024d)
- DPE Threatened biodiversity profile search online database for threatened ecological communities and species listed under the BC Act (NSW DCCEEW 2024b)
- EPBC Act Protected Matters Search Tool – for a 10 kilometre radius around the proposal footprint (searched July 2023) (Cth DCCEEW 2024a)
- EPBC Act Species profile and threats database, online profiles (Cth DCCEEW 2024b) and Register of Critical Habitat (Cth DCCEEW 2024c)
- The list of candidate species credit-type species and predicted species identified by the BAM-C.

The threatened biota and migratory species identified in the desktop assessment are presented in full in Appendix L. Following collation of database records and threatened species and community profiles, a list of threatened species requiring assessment was compiled according to the ‘steps for identifying habitat suitability for threatened species’ in the BAM. This was further refined following field surveys and identification and assessment of habitat present within the proposal footprint. A likelihood of occurrence ranking was attributed to biota based on this information and used to compile lists of ‘predicted threatened species’ (that is, ecosystem credit species) and ‘candidate threatened species’ (that is, species credit entities requiring targeted survey) according to Step 2 ‘assessment of habitat constraints’ of the BAM.

11.1.3. Terrestrial Field Surveys

Survey Overview

Seasonal surveys within the study area were conducted with reference to the BAM and appropriate threatened species survey guidelines for targeted species. Flora and fauna surveys were conducted under the Department of Planning and Environment Scientific License SL100146.

Section 11.2.7 provides a summary of the candidate threatened species (i.e. species credit matters) that were considered during field surveys and presents targeted survey effort and results. Survey techniques and timings are detailed in Appendix L.

Survey methodology

The terrestrial surveys were carried out through a number of site activities. The following key methods were used for the vegetation and flora surveys:

- vegetation mapping
- vegetation integrity survey plots (assessing site condition)
- threatened flora searches.

Fauna survey methods are described below.

- habitat constraints assessment
- diurnal bird surveys
- nest tree census
- Spot Assessment Technique
- spotlight surveys
- call playback
- Microchiropteran bat survey
- AudioMoth survey
- opportunistic observations.

Credit calculations

BAM credit calculations were completed by Ben Harrington (accredited assessor number BAAS17023) in accordance with the BAM and using the Credit calculator Version 1.4.0.00 and version 1.2 benchmark data.

The credit calculations Parent case ID for the proposal is 00033952. Assessment cases were created as follows:

- Wanganella – 00033952/BAAS23017/23/00044378 Version 1
- Hartwood – 00033952/BAAS23017/23/00044379 Version 1.

Two cases were created to allow for staging of construction at the two sites if necessary. The biodiversity credit report and predicted and candidate threatened species reports are included in Appendix L.

11.1.4. Key Legislative and policy context

The key pieces of legislation and guidelines relevant to the assessment of terrestrial biodiversity impacts for this proposal are:

- **Biodiversity Conservation Act 2016 (NSW)** – The NSW *Biodiversity Conservation Act 2016* (BC Act) provides legal protection for biota of conservation significance in NSW. It provides for the listing of threatened species and communities, establishes a framework to avoid, minimise and offset the impacts of proposed development (the Biodiversity Offsets Scheme, or BOS), and establishes a scientific method for assessing the likely impacts on biodiversity values and calculating measures to offset those impacts (the Biodiversity Assessment Method, (BAM)).
- **Biodiversity Assessment Method** – The BAM underpins the BOS and establishes a standard method to address the loss of biodiversity and threatened species

- **Biodiversity Assessment Method Calculator (BAM-C)** – The credit calculator specifies the type and extent of surveys required for a Biodiversity assessment and then processes survey data to calculate the number and type of biodiversity credits that are either required at a proposal footprint or will be generated at a stewardship site. The BAM must be applied by a person accredited under the BC Act.
- **The Biosecurity Act 2015** – provides for risk-based management of biosecurity in NSW. It provides a statutory framework to protect the NSW economy, environment and community from the negative impact of pests, diseases and weeds. It provides the legal requirements if priority weeds are recorded in a study area.
- **Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)** – this Act requires that actions likely to cause a significant impact on ‘matters of national environmental significance’(MNES) undergo an assessment and approval process. An action that ‘has, will have or is likely to have a significant impact on a MNES’ is deemed to be a ‘controlled action’ and may not be undertaken without prior approval from the Australian Minister for the Environment.

11.2. Existing environment

11.2.1. Overview of proposal footprints

The proposal footprint at Wanganella occurs adjacent to the Cobb Highway and contains moderate condition riparian woodland along Billabong Creek and native grasslands within the Wanganella Recreation Reserve. The northern bank of Billabong Creek is used by recreational campers, and is routinely subject to human disturbance. Up to 5.29 hectares of native vegetation is present at Wanganella weir.

The proposal footprint at Hartwood occurs adjacent to Conargo Road and also contains riparian woodland associated with Billabong Creek. The Hartwood site also contains both native and non-native grasslands and occurs in close proximity to cropped lands. Instream vegetation along sections of Billabong Creek in the Hartwood site is dense in cover. The weir site is not publicly accessible by the public. Up to 10.98 hectares of native vegetation is present at Hartwood weir, including 0.32 hectares of a local occurrence of ‘Natural Grasslands of the Murray Valley Plains’ critically endangered ecological community (CEEC) listed under the EPBC Act.

The proposal footprint contains large areas of cleared and degraded land that support agricultural production and cattle grazing areas as well as areas of native vegetation. Native vegetation is predominantly associated with the riparian corridor of Billabong Creek and Forest Anabran Creek which intersect the regulator sites.

Guidance provided by NSW DCCEEW (2024d), defines areas that are comprised of less than 15 per cent native vegetation are to be mapped as 100 per cent exotic and excluded from the calculation of native vegetation extent; and overall the VI plots showed the total cover of native vegetation ranged between 0.1 and 5.3 per cent. These areas are heavily degraded and disturbed as a result of ongoing agricultural production.

11.2.2. Landscape features

The assessment areas are defined as the area of land within the 1500 metre buffer area surrounding the proposal footprint for each site-based development. A summary of the landscape features associated with the study area is provided in Table 11.1. Individual landscape features are described in more detail throughout the sections below including justifications for the use of data entered in the BAM-C. No additional or specific landscape features are identified in the SEARs.

Table 11.1 Summary of landscape features present within the proposal footprint

Landscape features	Hartwood	Wanganella
Method applied for site context components	Site-based	Site-based
Interim Biogeographic regionalisation of Australia (IBRA) bioregion	Riverina	Riverina
IBRA subregion	Murrumbidgee	Murrumbidgee
LGA	Edward River	Edward River
Mitchell landscape	Murrumbidgee Channels and Floodplains	Murrumbidgee Channels and Floodplains
% native vegetation extent within buffer area	40 % (872 ha of the 2185 ha buffer area)	82 % (1011 ha of the 1240 ha buffer area)
Rivers, streams and estuaries	Billabong Creek, Forest Creek	Billabong Creek, Forest Anabranh
Wetlands	No significant named wetlands, however, a small ephemeral wetland occurs in the centre of one of the CAZs in the south-eastern section of the site.	No significant named wetlands, however, a small ephemeral wetland occurs the north-western section of the study area (adjacent to the northernmost CAZ).
Connectivity features	Riparian vegetation associated with Yanco Creek, Billabong Creek and Forest Creek provide the key habitat connectivity in the locality. These generally provide east-west connectivity, with anabranches providing connections between the two creeks. In the proposal site itself, canopied vegetation along Billabong Creek runs in a north-westerly direction. Remaining land in the proposal footprint is a combination of cropped land and native grassland and shrubland vegetation.	Riparian vegetation associated with Billabong Creek and the Forest Anabranh provide the key habitat connectivity in the locality. These generally provide east-west connectivity. Canopied vegetation extends away from the creek on the northern bank and is part of a larger area of Crown Land associated with Wanganella weir. Remaining land in the proposal footprint is a combination of cropped land and native grassland and shrubland vegetation.

11.2.3. Plant community types

The plant community types (PCTs) identified in the proposal footprint are summarised in Table 11.2 and mapped on Figure 11.3 and Figure 11.4. Further discussion of threatened ecological communities listed under the BC Act and EPBC Act is provided in section 11.2.6.

Table 11.2 Plant community types in the proposal footprint

Plant community type	BC Act status	EPBC Act status	Extent in proposal footprint at Wanganella site (ha)	Extent in proposal footprint at Hartwood site (ha)	Total extent of PCT in proposal footprint (ha)
PCT 7: River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion	Not listed	Not listed	0.61	0.84	1.45
PCT 10: River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Not listed	Not listed	0.93	0.79	1.72
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)	Not listed	Not listed	1.68	4.26	5.93
PCT 44: Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion	Not listed	Natural Grasslands of the Murray Valley Plains (CEEC)	0	0.32	0.32
PCT 46: Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion	Not listed	Listed in part - Natural Grasslands of the Murray Valley Plains (CEEC). The mapped extent of PCT 46 at the study area does not comprise part of an occurrence of this CEEC.	1.89	4.78	6.67

Plant community type	BC Act status	EPBC Act status	Extent in proposal footprint at Wanganella site (ha)	Extent in proposal footprint at Hartwood site (ha)	Total extent of PCT in proposal footprint (ha)
PCT 160: Nitre Goosefoot shrubland wetland on clays of the inland floodplains	Listed in part – Artesian Springs Ecological Community in the Great Artesian Basin (CEEC). The mapped extent of PCT 160 at the study area does not comprise part of an occurrence of this CEEC.	Not listed	0.19	0	0.19

Notes: CEEC – critically endangered ecological community.

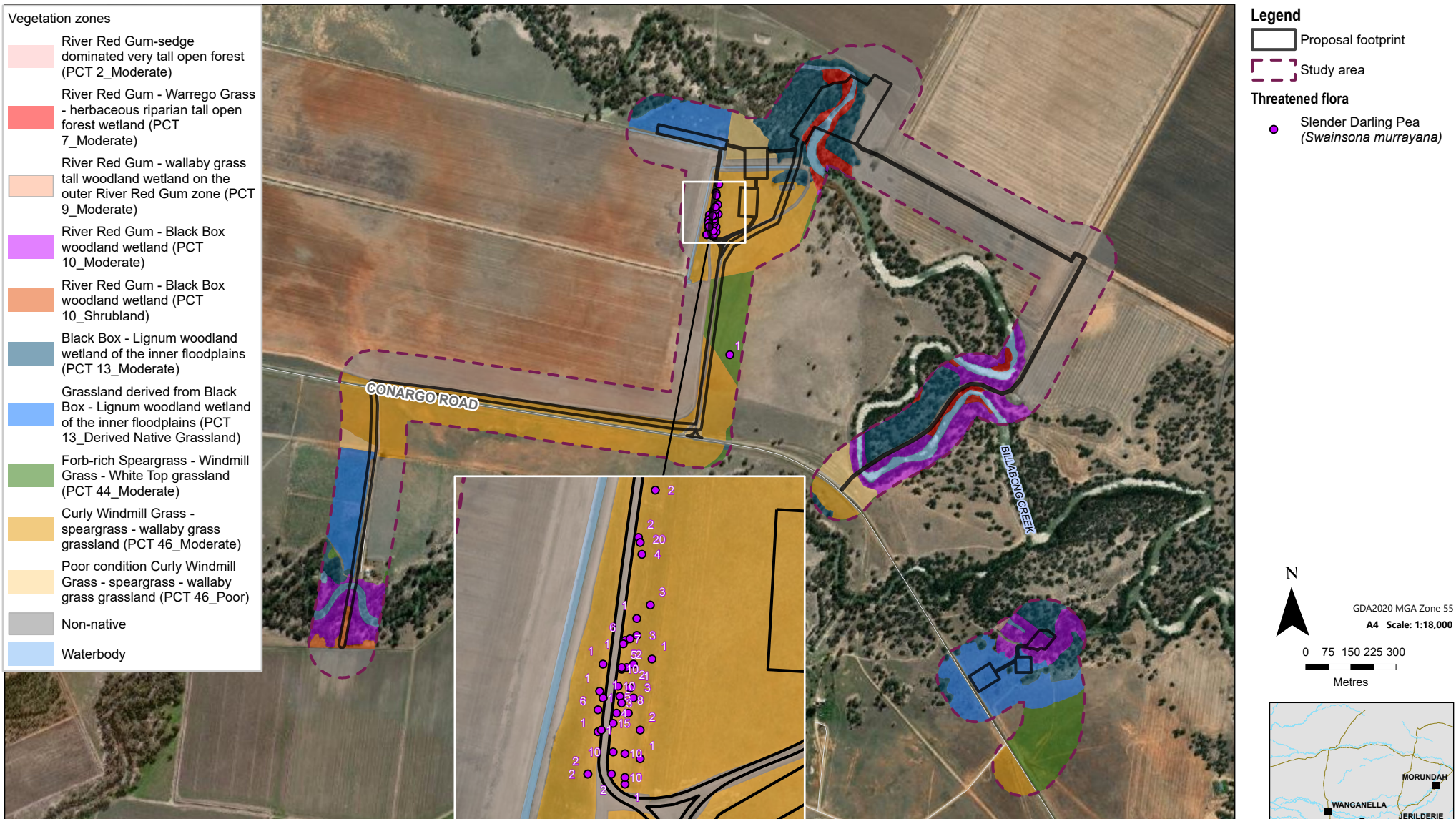


Figure 11.3 Hartwood vegetation zones and threatened flora

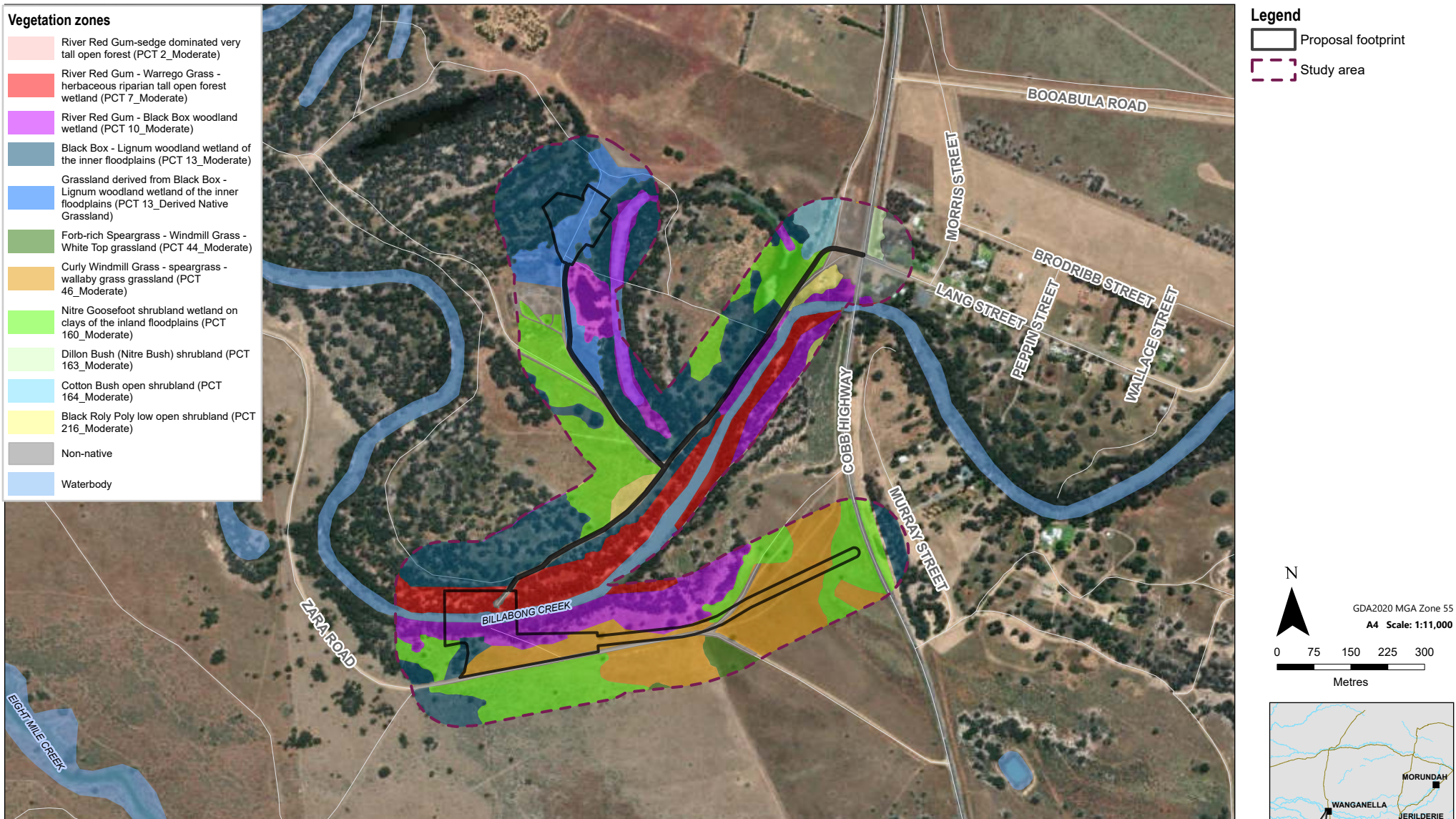


Figure 11.4 Wanganella vegetation zones



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11.2.4. Native vegetation

Native vegetation extent was initially mapped across the proposal footprint using existing mapping and high-resolution aerial photographs and then ground-truthed and adjusted based on the site surveys. Native vegetation cover is shown on Figure 11.1 and Figure 11.2.

The proposal footprint contains large areas of cleared and degraded land that support agricultural production and cattle grazing areas as well as areas of native vegetation. Native vegetation is predominantly associated with the riparian corridor of Billabong Creek and Forest Anabran Creek which is close to the proposal sites.

Areas that are not native vegetation do not require assessment according to Chapter 4 of the BAM. Areas that have been mapped as not native vegetation include cropped agricultural land, formed tracks, hard stand areas and compacted bare earth.

Areas that are comprised of less than 15 per cent native vegetation are mapped as 100 per cent exotic and excluded from the calculation of native vegetation extent:

- At Hartwood agricultural land does not meet the definition of native vegetation requiring further assessment under the BAM. The site survey showed the total cover of native vegetation ranged between 0.1 and 5.3 per cent. These areas are heavily degraded and disturbed as a result of ongoing agricultural production. Given the small area of non-native vegetation in the proposal footprint, a land categorisation assessment was not considered necessary for this BDAR.
- At Wanganella non-native vegetation is restricted to formed tracks, hard stand areas and compacted bare earth that are clearly free of any native vegetation cover and as such were not sampled with plots or described in detail.

11.2.5. Vegetation zones

Vegetation zones were mapped and sampled separately at the Hartwood and Wanganella parts of the proposal footprint to support a separate BAM-C case for each regulator site. The structure, species composition and condition of the vegetation zones within the study area are described below. All references to condition are relative to version 1.2 'wet year' benchmark data.

Vegetation integrity (VI) scores calculated for the vegetation zones in the proposal footprint are presented in Table 11.3 below. Vegetation zones for the proposal sites shown on Figure 11.3 and Figure 11.4.

Table 11.3 Vegetation integrity scores

Zone ID	Vegetation zone	Composition condition score	Structure condition score	Function condition score (where relevant) ¹	Vegetation integrity score	Hollow bearing trees present?
Hartwood						
1	7_Moderate	72.3	81.3	96.3	82.7	Yes
2	10_Moderate	92.5	45.2	97.9	74.3	Yes
3	10_Shrubland	60	67.8	20.6	43.8	No
4	13_DNG	37.4	43	12.7	27.3	No
5	13_Moderate	73.9	44.6	81.9	64.6	Yes
6	44_Moderate	87.4	65.8	n/a	75.9	n/a
7	46_Moderate	85.4	83.4	n/a	85.4	n/a
8	46_Poor	23	85.7	n/a	44.4	n/a
n/a	Non-native (PCT 10_exotic for VI estimation purposes)	0	0	1.5	0.1	No
n/a	Non-native (PCT 13_exotic for VI estimation purposes)	39.8	12.8	0.3	5	No
Wanganella						
1	7_Moderate	62.1	27.2	63.8	47.6	Yes
2	10_Moderate	80.9	30.3	59.5	52.7	Yes ²
3	13_DNG	78.3	63.3	0.3	11.5	No
4	13_Moderate	78.4	100	85.7	87.6	Yes
5	46_Moderate	92.2	86.0	n/a	89.1	n/a
6	160_Moderate	94.7	100	n/a	97.3	n/a

Notes: 1. Function score is not calculated for PCTs 44 and 46 in the Riverine Plain Grasslands vegetation formation and PCT 160 in the Inland Floodplain Shrublands vegetation formation (DPE 2023e).

2. No hollow-bearing trees were recorded in the plots sampled however hollow-bearing trees are present in the broader vegetation zone and so a hollow bearing tree record was added to plots F8 and F6 to ensure that Wanganella Zone 1 (PCT 7_moderate) and Zone 2 (PCT 10_Moderate) credits were recognised as containing hollow bearing trees.

11.2.6. Threatened ecological communities

There are no threatened ecological communities (TECs) at the Wanganella proposal site. No TECs were recorded in the proposal footprint or surrounding study area. There is no risk of direct or indirect impacts to any TECs from the construction or operation of the Wanganella regulator.

There is a local occurrence of 'Natural Grasslands of the Murray Valley Plains' critically endangered ecological community (CEEC) listed under the EPBC Act, at the Hartwood proposal site as summarised in Table 11.4. There is not an equivalent or related TEC listed under the BC Act. An assessment of the vegetation zones that are floristically similar to the community against the diagnostic and condition criteria specified in the listing advice for the EPBC Act-listed CEEC (TSSC 2012) is provided in Appendix L.

Table 11.4 TECs within the proposal footprint

TEC name	Profile ID (from TBDC, DPE 2023c)	BC Act status	EPBC Act status	Associated vegetation zones within the proposal footprint	Area within proposal footprint (ha)
Natural Grasslands of the Murray Valley Plains	20371	-	CEEC	Hartwood zone 6 – PCT44_Moderate	0.32 ha

11.2.7. Predicted threatened species (Ecosystem credit species)

Based on the bioregional context for the assessment and the PCTs, patch size, vegetation cover and habitat resources present at the proposal footprint, the BAM-C generates a list of threatened fauna species that are predicted to utilise the proposal footprint (that is, potential ‘predicted threatened species’, or potential ‘ecosystem credit entities’). Appendix L lists all ecosystem credit species that are considered likely to occur on or use the proposal footprint, separated into lists of species for each site.

The potential for these predicted threatened species to occur within the proposal footprint was further refined based on the desktop assessment, habitat resources observed during field surveys, records during the surveys, and the knowledge and experience of the assessor. Targeted surveys are not required under the BAM for these species as they are assumed to be present in the PCTs at the proposal footprint.

Figure 11.5 and Figure 11.6 present the habitat identified on site and which threatened fauna species these may support

11.2.8. Candidate threatened species (Species credit species)

Threatened species that cannot reliably be predicted to occur on a proposal footprint based on PCT, distribution and habitat criteria are identified by the Threatened Biodiversity Data Collection as ‘species credit’ entities. In some circumstances, the particular habitat components of species assessed for ecosystem credit species, such as the breeding habitat of a cave roosting bat or forest owls, are also assessed for species credits.

The likelihood of occurrence of potential candidate threatened species were reviewed, giving consideration to the habitats available in the study area (refer to threatened species for assessment tables in Appendix L).

The list of potential candidate threatened species that could occur are assessed based on the habitat resources observed during field surveys. ‘Confirmed’ candidate threatened species require further assessment of species presence and the extent of occupied habitat in accordance with the BAM. The list of confirmed candidate threatened species is presented in Appendix L.

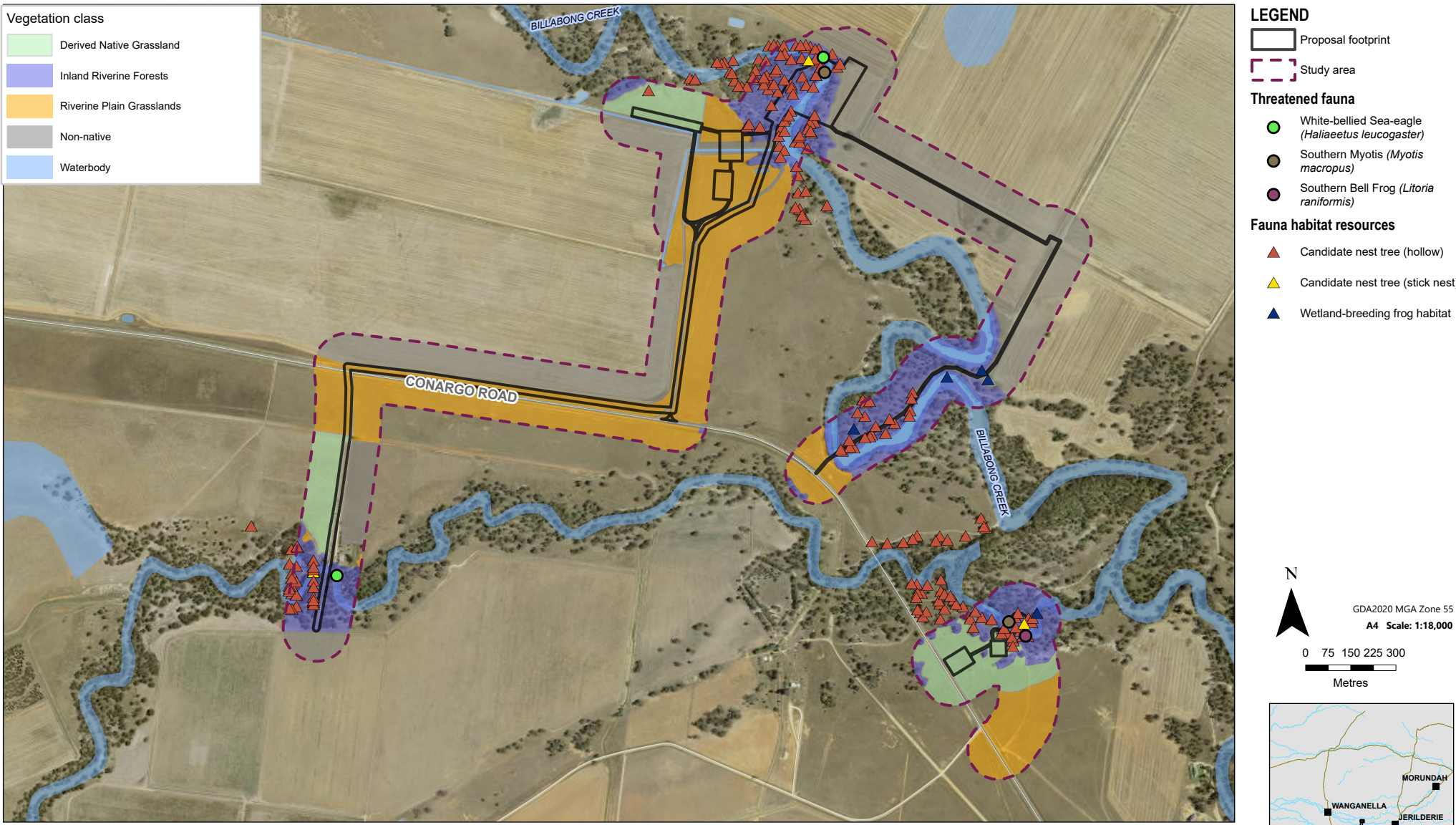
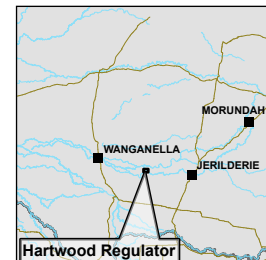


Figure 11.5 Hartwood threatened fauna and habitat resources



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High-resolution map of the Hartwood Regulator area. The map shows the location of the Hartwood Regulator and the surrounding area. The map is a vector map and is not a photograph.





11.2.9. Matters of National Environmental Significance (MNES)

TECs

The Hartwood proposal footprint comprises a local occurrence of ‘Natural Grasslands of the Murray Valley Plains’ CEEC listed under the EPBC Act. While the CEEC is associated with both PCT 44 and PCT 46 which are present in the study area, it is subject to location and condition criteria specified in the listing advice (TSSC 2012). An analysis of these location and condition criteria has confirmed the presence of the PCT associated with moderate condition PCT 44 at the Hartwood site.

No TECs listed under the EPBC Act are present within the Wanganella site study area. The local occurrence of this TEC is shown in Figure 11.3.

Threatened Species

The woodland bird species Southern Whiteface was recorded at the proposal footprint on several occasions in the August 2022 and February 2023 surveys. The Southern Whiteface is listed as a vulnerable species under the EPBC Act. One Pink Cockatoo was observed foraging at Wanganella in September 2023. A population of *Swainsona murrayana* was recorded within and adjacent to access track and power supply footprints at Hartwood in September 2022.

No other threatened species listed under the EPBC Act were recorded at the proposal footprint. Based on the results of the site surveys and habitat assessments, there is potential habitat for several threatened species as summarised in Appendix L.

The study area does not comprise any Critical Habitat for any species as defined under section 207A of the EPBC Act included in the Register of Critical Habitat (Cth DCCEEW 2024c).

Migratory shorebird species

The proposal footprint does not intersect with any important habitat for any migratory shorebird species. However potential habitat is present for the migratory species listed in Table 11.5.

Table 11.5 Migratory shorebird species listed under the EPBC Act that may occur at the proposal footprint

Common name	Scientific name	EPBC Act status	Likelihood of occurrence
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	C, J, K	Possible
Pectoral Sandpiper	<i>Calidris melanotos</i>	J, K	Possible
Latham’s Snipe	<i>Gallinago hardwickii</i>	J, K	Possible
Common Greenshank	<i>Tringa nebularia</i>	C, J, K	Possible

Notes: C=listed as a migratory species under the China-Australia Migratory Bird Agreement (CAMBA), J= listed as a migratory species under the Japan-Australia Migratory Bird Agreement (JAMBA), K= listed as a migratory species under the Korea-Australia Migratory Bird Agreement (KAMBA)

Migratory terrestrial species

There is potential foraging or resting habitat at the proposal footprint for migratory bird species that may occur in, or fly over, woodland and grassland habitats listed in Table 11.6 below. None of these species would be reliant upon habitats within the proposal footprint for any part of their life cycle. They would be most likely to fly over the proposal footprint, if occurring in the locality at all.

Habitat in the proposal footprint is not likely to support an ecologically significant proportion of the population of any of these species, be of critical importance to the species at particular life-cycle stages, is not located at the limit of any of the species' range, and/or located within an area where the species is declining. As such, potential habitat in the study area is not 'important habitat' for any of these species, as defined in the guidelines (DoE 2015).

Table 11.6 Migratory terrestrial species listed under the EPBC Act that may occur at the proposal footprint

Common name	Scientific name	EPBC Act status	Likelihood of occurrence
Fork-tailed Swift	<i>Apus pacificus</i>	Migratory (terrestrial)	Possible
White-throated Needletail	<i>Hirundapus caudacutus</i>	Migratory (terrestrial)	Possible
Yellow Wagtail	<i>Motacilla flava</i>	Migratory (terrestrial)	Possible

11.3. Impact assessment

11.3.1. Avoid and minimise impacts

The proposal would result in direct impacts on native vegetation and threatened species habitats as shown in Figure 11.1 and Figure 11.2. There is also the potential for indirect impacts on areas of native vegetation adjacent to the proposal footprint, both during construction and from the operation of the regulators. The proposal would result in impacts on non-native vegetation during construction and impacts from changes in hydrology during construction and operation.

The BAM requires that measures are undertaken to avoid and minimise impacts. Key measures for this proposal are listed in Table 11.7.

Table 11.7 Avoidance and minimisation measures for direct, indirect and prescribed impacts

Action	Outcome	Timing	Responsibility
Identification of a site with minimal biodiversity value	Not possible to fully avoid impacts noting the location of the regulators and power easement is in an area of native vegetation.	Site selection	Proponent
Avoidance of impacts to vegetation through the use of existing access to the proposal footprint.	Avoiding and minimising the amount of native vegetation clearing required.	Site selection	Proponent
Minimisation of impacts to biodiversity values by avoiding higher value habitat features and resources.	Avoidance of impacts to any candidate nest trees and minimisation of impacts on PCT 44 (Natural Grasslands of the Murray Valley Plains CEEC).	Preliminary design	Proponent
Reducing the proposal footprint and concentrating development in non-native or poor condition vegetation.	Avoiding and minimising the amount of native vegetation clearing required.	Design	Construction contractor
Providing an adequate buffer between the proposal footprint and mature trees, and water courses adjoining the proposal footprint.	Avoiding indirect impacts to retained native vegetation and water courses.	Design	Construction contractor
Preparation and implementation of a construction environmental management plan.	Minimising and managing direct and indirect impacts during construction.	Construction	Construction contractor
Preparation and implementation of an operation environmental management plan.	Minimising and managing direct and indirect impacts during operation and maintenance activities.	Operation	Proponent contractor

11.3.2. Direct Impacts

The proposal would remove up to 16.27 hectares of native vegetation across the proposal footprint. Direct impacts on native vegetation as a result of the proposal comprise:

- removal of 1.45 hectares of River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion (PCT 7)
- removal of 1.72 hectares of River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion) (PCT 10)
- removal of 5.93 hectares of Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion) (PCT 13)
- removal of 0.32 hectares of Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion (PCT 44) including a local occurrence of 'Natural Grasslands of the Murray Valley Plains' critically endangered ecological community (CEEC) listed under the EPBC Act
- removal of 6.67 hectares of Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion (PCT 46)
- removal of 0.19 hectares of Nitre Goosefoot shrubland wetland on clays of the inland floodplains (PCT 160).

Direct impacts on candidate species credit species listed under the BAM comprise:

- removal of 1.25 hectares of occupied habitat for the Little Eagle (*Hieraaetus morphnoides*) listed as a vulnerable species under the BC Act
- removal of 2.12 hectares of occupied habitat for the Bush Stone-curlew (*Burhinus grallarius*) listed as an endangered species under the BC Act
- removal of 8.57 hectares of occupied habitat for the Southern Bell Frog (*Litoria raniformis*) listed as a vulnerable species under the BC Act and endangered species under the EPBC Act
- removal of 4.03 hectares of occupied habitat for the Southern Myotis (*Myotis macropus*) listed as a vulnerable species under the BC Act
- removal of 1.96 hectares of mapped important habitat for the Plains-wanderer (*Pedionomus torquatus*) listed as an endangered species under the BC Act and critically endangered species under the EPBC Act
- removal of 0.009 hectares of occupied habitat for Slender Darling-pea (*Swainsona murrayana*) listed as a vulnerable species under the BC Act and EPBC Act.

Additional direct impacts are likely for the following ecosystem credit species recorded within the proposal footprint:

- Dusky Woodswallow (*Artamus cyanopterus cyanopterus*)
- Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*)
- White-bellied Sea-eagle (*Haliaeetus leucogaster*)
- Pink Cockatoo (*Lophochroa leadbeateri*)
- Southern Whiteface (*Aphelocephala leucopsis*)
- Inland Forest Bat (*Vespadelus baverstocki*)
- Little Pied Bat (*Chalinolobus picatus*).

11.3.3. Indirect Impacts

The proposal may result in residual indirect impacts through light spill and noise and vibration generation causing displacement of threatened species and other native fauna from habitat adjoining the proposal footprint. The proposal would result in residual prescribed impacts through the removal or modification of vegetation within habitat corridors, minor changes to surface water flows and a moderate risk of vehicle strike causing harm to threatened fauna species and other native fauna using habitats in the vicinity of the proposal footprint. These residual impacts are likely to be minor in intensity and consequence and so no offsets are proposed.

An assessment of serious and irreversible impacts has prepared for the Plains-wanderer due to the removal of 1.96 hectares of mapped important habitat for this species.

The study area does not contain important habitat for any migratory species listed under the EPBC Act nor any Critical Habitat for any species as defined under section 207A of the EPBC Act included in the Register of Critical Habitat (Cth DCCEEW 2024c).

Assessments of significance have been prepared for threatened ecological communities and threatened species listed under the EPBC Act that are likely to be impacted by the proposal.

11.3.4. Prescribed impacts

A summary of residual impacts resulting from prescribed impacts is provided in Table 11.8. The potential for significant residual impacts is unlikely.

Table 11.8 Summary of prescribed impacts

Prescribed impact	Comment	Residual impacts
Human-made structures	The proposal would remove some human-made structures that may provide foraging and breeding habitat for certain threatened fauna.	No significant residual impacts are likely.
Non-native vegetation	The proposal would remove areas of non-native vegetation that may provide some foraging and breeding habitat for some threatened fauna.	No significant residual impacts are likely.
Habitat connectivity	The proposal would remove small areas of native vegetation, in particular riparian vegetation associated with the construction of the regulators. Removal of vegetation and construction of regulator infrastructure would only result in a minor increase in the degree of fragmentation between retained areas of habitat for the species. The proposal would not isolate any areas of habitat or sever any connecting links. Threatened biota are expected to continue to be able to move along the riparian corridor. Overall, the proposal is predicted to present an improvement in fish passage (60.7 km and 50.5 km respectively) within the Yanco-Billabong System and general improvements to the hydrological and hydraulic conditions within the proposal study area. Noting that wetland and floodplain communities would also benefit from improved fish passage and hydrological and hydraulic conditions, the proposal would improve aquatic habitat connectivity in the longer term.	No significant residual impacts are likely.
Water bodies, water and hydrological processes	Potential impacts on water quality would occur during construction (around 18 months). These impacts would likely comprise increases in sediment load and turbidity over this period. Given the small scale and duration of proposed works there is a minor risk of impacts to water quality that is likely to be substantially mitigated through use of coffer dams and standard environmental management measures on floodplain work areas. Changes to hydrology would occur during operation of the proposal through replacement of existing fixed crest weirs with automatic remote controlled regulated weirs at Hartwood and Wanganella. The proposal would affect hydrological processes through contribution to the regulation of the system in accordance with the Operations Plan. Operation of the proposal result in minor overall changes to the hydrology of the system, improved delivery of EWRs (Refer to see Chapter 6) and improved connectivity of aquatic habitat (see Chapter 10). Operation of the proposal would not have an adverse effect on wetland dependent species or their habitats.	No significant residual impacts are likely.
Vehicle strike	The proposal would increase the risk of vehicle strike to a small degree.	No significant residual impacts are likely.

11.3.5. Serious and irreversible impacts on biodiversity values

Section 6.7 of the BC regulation sets out principles for determining whether an impact on a specific threatened species or ecological community is serious and irreversible.

One potential serious and irreversible impact (SAIL) entity could be affected by the proposal as outlined in Table 11.9.

None of the other threatened biota of relevance to this assessment are candidate SAIL entities.

Table 11.9 Entities at risk of a SAIL

Common name	Scientific name	Reason for inclusion in assessment
Plains-wanderer	<i>Pedionomus torquatus</i>	Included in current list of entities at risk of an SAIL and is likely to be impacted by the proposal

11.3.6. Cumulative impacts

A summary of the cumulative assessment is provided in section 23.3.3 and section 8.4 in Appendix L (Biodiversity development assessment report).

11.4. Mitigation measures

11.4.1. Approach to mitigation and management

The general approach to management of the proposal during construction and operation is outlined in chapter 24. The Biodiversity Development Assessment Report safeguards and management measures that would be implemented to account for the potential impacts identified in section 11.4.

Specific mitigation measures are recommended to minimise likely impacts on biodiversity values. These measures are presented according to the hierarchy of avoidance and mitigation of impacts, and the identification of residual impacts of the proposal that cannot be avoided or mitigated. The proposal will include, as a minimum, industry-standard measures for the management of soil, surface water, weeds and pollutants, as well as site-specific measures for the management of flora and fauna.

The proposal will include implementation of measures to mitigate residual impacts, specified in a Construction Environmental Management Plan (CEMP). The CEMP will provide detailed environmental controls to manage key environmental issues. The CEMP will be reviewed and updated as necessary throughout the relevant phases of the proposal.

The CEMP will include, as a minimum, industry-standard measures for the management of soil, surface water, weeds and pollutants, as well as site-specific measures for the management of flora and fauna.

The study area contains local populations of several threatened species as confirmed through targeted surveys and the preparation of the terrestrial biodiversity assessment. Of these species *Swainsona murrayana* and the Southern Bell Frog are notable in that they are, in general, susceptible to direct harm from construction impacts and aspects of their ecology mean that the risk of impact would vary significantly with seasonal conditions. Pre-construction assessment requirements for *Swainsona murrayana* and the Southern Bell Frog are detailed in Table 11.10.

Residual direct impacts require further assessment for SAI (refer to section 11.3.4). Residual indirect or prescribed impacts for which no mitigation measures are proposed require an adaptive management strategy in accordance with BAM guidelines. Other indirect and prescribed impacts that remain after avoid, minimise and mitigate have been applied, may be offset using additional biodiversity credits (above the credit requirement generated by the BAM-C for direct impacts) and/or other conservation measures.

11.4.2. Summary of mitigation measures

Mitigation measures to manage potential impacts to biodiversity would also be implemented as part of those identified for hydrology and flooding, water quality, soils and contamination. A summary of mitigation measures relating to biodiversity assessment is provided in Table 11.10 and Chapter 24.

Table 11.10 Terrestrial flora and fauna safeguards and management measures

ID	Impact	Mitigation measures	Responsibility	Timing
B01	General biodiversity impacts	Flora and fauna management controls will be included within the CEMP. This will include measures, processes, and responsibilities to minimise the potential for biodiversity impacts during construction and use of the camps incorporating recommendations below and expanding on specific details where necessary.	Proposal ecologist	Pre-construction
B02	General biodiversity impacts	Flora and fauna management controls will be included within the WaterNSW operational management procedures. This will include measures, processes, and responsibilities to minimise the potential for biodiversity impacts during operation of the proposal incorporating recommendations below and expanding on specific details where necessary.	WaterNSW	Operation
B03	General	All workers will be provided with an environmental induction prior to starting work on site. This will include information on the biodiversity values of the site, protection measures to be implemented to protect native biota and penalties for breaches.	Construction contractor and Proposal ecologist	Construction
B04	Removal of vegetation and habitat resources	Plans will be prepared showing areas to be cleared and areas to be protected, including exclusion zones and protected habitat features in the vicinity of work areas.	Proposal ecologist	Pre-construction
B05	Removal of vegetation and habitat resources	A pre-construction assessment of the local <i>Swainsona murrayana</i> population will be conducted including: - consideration of whether the construction period coincides with the August to November flowering period for the species (Cth. DCCEEW 2024b) - consideration of prevailing rainfall conditions in the preceding cool season and assessment of the likely health and extent of the local population - supplementary survey as appropriate to confirm the extent of above-ground plants in the local population - definition and implementation of additional impact and avoidance measures as appropriate potentially including delayed construction activity, adjustment of CAZs, exclusion fencing and/or translocation.	Proposal ecologist	Pre-construction

ID	Impact	Mitigation measures	Responsibility	Timing
B06	Removal of vegetation and habitat resources	A pre-construction assessment of the local Southern Bell Frog population will be conducted including: - consideration of whether the construction period coincides with the Spring-Summer breeding and higher adult frog activity period for the species - consideration of prevailing rainfall and river conditions and assessment of the likely presence and extent of potential breeding habitat in ephemeral wetlands - supplementary survey as appropriate to confirm the extent of occupied breeding habitat and/or mobile adult frogs in the local population - definition and implementation of additional impact and avoidance measures as appropriate potentially including delayed construction activity, adjustment of CAZs, exclusion fencing, procedures for dewatering of wetlands and/or translocation.	Proposal ecologist	Pre-construction and construction
B07	Removal of vegetation and habitat resources	Prior to the commencement of any work in or adjoining areas of native vegetation, a survey will be carried out to mark the construction impact boundary. The perimeter of this area would be fenced using high visibility fencing and clearly marked as the limits of clearing. All vegetation outside this fence line will be clearly delineated as an exclusion zone to avoid unnecessary vegetation and habitat removal and the transmission of weeds or disease. Fencing and signage will be maintained for the duration of the construction period. Fencing will be designed to allow fauna to exit the site during clearing activities.	Proposal ecologist	Pre-construction and construction
B08	Unexpected direct impacts to threatened flora and fauna	An unexpected finds protocol will be prepared to detail measures to be undertaken if threatened flora and fauna not previously recorded on site are detected during clearing or construction activities.	Proposal ecologist	Construction
B09	Harm to resident fauna	Protocols for the management of fauna and habitats would be included in the CEMP. These will include (if required): - a procedure for the felling of hollow-bearing trees to prevent or minimise mortality of fauna - salvage of hollows and logs where practicable - management of any trenches or drill sites to prevent fauna from becoming trapped or injured - any additional measures for the management of frog breeding habitat as appropriate to seasonal conditions and the outcomes of pre-construction surveys.	Construction contractor and Proposal ecologist	Construction

ID	Impact	Mitigation measures	Responsibility	Timing
B10	Harm to resident fauna	Pre-clearing surveys will be undertaken prior to and during construction by a suitably qualified ecologist. The surveys and inspections, and any subsequent relocation of species, will be undertaken in accordance with the CEMP. Specific surveys include: - an initial pre-clearance survey of the proposal footprint, undertaken by a suitably qualified ecologist prior to the commencement of any clearing activities including: - surveys for roosting microbats in any man-made structures to be removed - searches for nests in vegetation to be removed - identification of fauna refuge sites potentially requiring fauna management during removal, including hollow-bearing trees, woody debris as well as human made material such as metal sheets - a daily pre-clearance fauna survey of the day's work area, undertaken by a suitably qualified ecologist prior to the clearing of native vegetation - monitoring of clearing activities and observation, rescue, treatment and/or relocation of any resident fauna as appropriate.	Construction contractor and Proposal ecologist	Construction
B11	Harm to resident fauna	Monitoring of clearing activities would include particular focus on habitat features that may harbour threatened species that are vulnerable to direct harm including during: - felling of habitat trees that may contain roosting threatened birds or microbats - earthworks in or near floodplain depressions that may contain breeding habitat for the Southern Bell Frog - earthworks affecting cracking clay soils or woody debris that may harbour Grey Snakes or Southern Bell Frogs.		
B12	Harm to resident fauna	A post-clearing report will be prepared documenting all animals that are handled, or otherwise managed, within the site. Data to be recorded includes: - date and time of the sighting and details of the observer - species - number of individuals recorded - adult/juvenile - condition of the animal (living/dead/injured/sick) - management action undertaken (e.g. captured, handled, taken to vet) - results of any management actions (e.g. released, placed in a nest box, euthanised, placed with carer). An inventory of hollows and fallen timber salvaged and relocated will be maintained.	Construction contractor and Proposal ecologist	Construction

ID	Impact	Mitigation measures	Responsibility	Timing
B13	Pathogen spread and establishment	All machinery entering the site will be appropriately washed down and disinfected prior to work on site to prevent the potential spread of weeds and disease in accordance with the NSW best practice Protocols to protect priority biodiversity areas (DPIE 2020f). Protocols to prevent introduction or spread of chytrid fungus will be implemented following the NSW hygiene guidelines for wildlife (DPIE 2020f).	Contractor	Construction
B14	Spread of weeds	Declared priority weeds will be managed according to requirements of the NSW <i>Biosecurity Act</i> . Soil material and stripped groundcover vegetation with the potential to contain priority weeds will not be removed from the proposal footprint. Soil disturbance would be avoided as much as possible to minimise the potential for spreading weeds.	Contractor	Construction
B15	Soil loss hazard – erosion of soils and sediment due to clearing during construction	A construction Erosion and Sediment Control Plan (ESCP) will be prepared as part of the construction soil and water management plan (CSWMP) and will detail the specific erosion and sediment control measures to be implemented within the proposal area, in accordance with the principles and requirements of Managing Urban Stormwater – Soils and Construction, Volumes 1 (Landcom 2004) and 2C (DECC, 2008) (known as the Blue Book).	Contractor	Pre-construction, construction
B16	Reduction in surface water quality due to sedimentation	Erosion and sediment controls throughout the proposal site will be inspected and maintained to ensure they are operating effectively.	Contractor	Construction
B17	Vehicle strike	Appropriate speeds for all construction and contractor vehicles will be enforced to limit dust generation and minimise risk of fauna mortality through vehicle strike during construction and operation.	Contractor, WaterNSW	Construction, operation
B18	Light spill. Displacement of fauna from habitat adjoining the proposal footprint	Light generated during construction will be managed in general accordance with the requirements in Australian Standard AS 4282-1997 Control of the Obtrusive Effects of Outdoor Lighting. Directional lighting will be used to minimise the effects of light spill outside the CAZ as far as possible.	Contractor, WaterNSW	Construction, operation

ID	Impact	Mitigation measures	Responsibility	Timing
B19	Noise and vibration generation Displacement of fauna from habitat adjoining the proposal footprint	All activities on site are to be undertaken as per the approved CEMP and WaterNSW operational environmental procedures, with works confined between the following hours: daytime hours of 7am to 6pm, Monday to Sunday (including public holidays), with the exception of the following activities: - the delivery of materials as requested by the NSW Police Force or other authorities for safety reasons; emergency work to avoid the loss of life or damage to property, or to prevent environmental harm - emergency work to avoid the loss of life, property and/or material harm to the environment - works as approved through the out-of-hours works protocol as approved through the CEMP. Additional, specific controls will be included within the CEMP and should consider the proposal specific management measures outlined in the Noise and Vibration Impact Assessment (GHD 2023b).	Contractor, WaterNSW	Construction, operation
B20	Water quality, chemical and fuel impacts on flora and fauna	Specific measures will be incorporated into the CEMP and WaterNSW operational environmental procedures to minimise the potential for chemical spills and associated impacts on natural environments adjacent to and downstream of the areas of impact. Spill kits will be made available to construction vehicles and operation/maintenance vehicles. A management protocol for accidental spills will be put in place. Chemicals will be stored in bunded areas.	Contractor, WaterNSW	Construction, operation

11.4.3. Offset requirement

A BAM assessment and credit calculations have been performed in accordance with the methodology (DPIE 2020a) and using credit calculator version 1.4.0.00 incorporating version 1.2 'wet year' benchmarks. Offsets are required for residual impacts on native vegetation and threatened species habitat that cannot be avoided or mitigated.

The following ecosystem and species credits would need to be retired to offset residual impacts of the proposal on threatened species habitats:

- Hartwood:
 - 26 ecosystem credits for PCT 7 River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland
 - 18 ecosystem credits for PCT 10 River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone
 - 90 ecosystem credits for PCT 13 Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone
 - 12 ecosystem credits for PCT 44 Forb-rich Speargrass - Windmill Grass - White Top grassland
 - 146 ecosystem credits for PCT 46 Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam
 - 150 species credits for the Southern Bell Frog

- 129 species credits for the Southern Myotis
- 123 species credits for the Plains-wanderer
- 94 Slender Darling-pea species credits.
- Wanganella:
 - 11 ecosystem credits for PCT 7 River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland
 - 18 ecosystem credits for PCT 10 River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone
 - 30 ecosystem credits for PCT 13 Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone
 - 63 ecosystem credits for PCT 46 Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam
 - 7 ecosystem credits for PCT 160 Nitre Goosefoot shrubland wetland on clays of the inland floodplains ecosystem credits
 - 69 species credits for the Bush Stone-curlew
 - 30 species credits for the Little Eagle
 - 82 species credits for the Southern Bell Frog.

12. Aboriginal heritage

This chapter provides a summary of the Aboriginal Cultural Heritage Assessment Report prepared by Austral Heritage. It describes existing Aboriginal heritage, identifies potential impacts, and provides measures to mitigate and manage the impacts identified. The Aboriginal Cultural Heritage Assessment Report is provided in Appendix M.

12.1. Methodology

12.1.1. Approach to assessment

The Aboriginal Cultural Heritage Assessment Report (ACHA) has been prepared in accordance with the legal requirements, guidelines and policies of Heritage NSW (formerly the Office of Environment and Heritage). The guiding document for this assessment is the Code of Practice for the Investigation of Aboriginal objects in NSW (DECCW 2010b) (Code of Practice).

The significance values provided in the Australia International Council on Monuments and Sites (ICOMOS) Charter for the Conservation of Places of Cultural Significance (the Burra Charter) are considered to be the best practice heritage management guidelines in Australia (Australia ICOMOS 2013a). The assessment of significance values has considered the Burra Charter.

The ACHA was undertaken to assess the potential harm that may occur to Aboriginal cultural heritage values for the removal of Hartwood Weir and Wanganella Weir, and for the construction of the new regulators, Wanganella flood bypass channel and associated infrastructure.

A detailed description of the legislative and policy context for the assessment is provided in section 1.4 of ACHA Report (see Appendix M). Further information on the assessment methodology is provided in section 5 and 6 of ACHA Report.

The assessment of potential impacts on Aboriginal heritage considers cultural knowledge and the results of background research and field investigations. This includes an assessment of the potential for unknown Aboriginal objects to be located where the ground surface is disturbed, for example, by excavation works. The assessment involved:

- desktop study and predictive model
- site survey
- consultation with the Aboriginal community
- Input into the concept design to avoid impacts
- assessing the potential for direct, indirect and cumulative impacts on Aboriginal heritage
- identifying measures to minimise impacts on Aboriginal heritage.

Due to the history of local Aboriginal communities within the study area and the location of registered sites identified, consideration of Aboriginal cultural heritage constraints and issues were a core component of the development of the design for the proposal and the location of construction areas and access tracks.

12.1.2. Study area

The assessment considered impacts to the land associated with Lot 1 DP707463, Lot 28 DP756330, Lot 56 DP756322, Lot 27 DP756330 and Lot 7301 DP1162488, making up the Forest Creek block bank, Hartwood Weir, Wanganella Weir and Wanganella flood bypass channel work areas and include the locations of the proposed new Hartwood and Wanganella regulators. These study areas are located within the Edward River Local Government Area, and the parish of Wodonga in the county of Townsend.

The desktop study extended to a region of 10 kilometres outside of the study area.

12.1.3. Desktop study

The desktop study carried out background research and a database search which consisted of the following key tasks:

- population and contact history
- previous archaeological work
- regional archaeological context
- heritage database search, including Aboriginal Heritage Information Management System (AHIMS) managed by Heritage NSW
- local archaeological context.

The findings of the desktop study were used to formulate a broad predictive model that identifies the type and character of Aboriginal cultural heritage sites that may be present within the study area. The findings of the predictive model indicated the likely site types to be considered during the archaeological survey.

12.1.4. Site survey

A site specific investigation methodology was developed for the archaeological survey that complied with the Code of Practice. Site surveys were conducted on 13 July and 8 December 2023 and the 23 May 2024. Representatives from local Aboriginal community groups Yarkuwa, Cummeragunja and the Deniliquin Local Aboriginal Land Council attended some of the site visits.

The objectives of the survey were to:

- complete a systematic survey that targets areas that have been identified as having the potential to contain Aboriginal heritage values
- identify and record Aboriginal archaeological sites visible on the ground surface and areas of potential archaeological deposit (PAD)
- re-identify previously identified Aboriginal archaeological sites found during prior surveys within the study area
- ground-truthing the previous consultant's survey to confirm the sites and PADs for inclusion in this ACHA.

12.1.5. Consultation

Stakeholder consultation for this proposal was carried out in line with the Consultation Requirements (DECCW 2010a). The Consultation Requirements outline a four-stage consultation process which includes:

- Stage 1 – Notification of the project proposal and registration of interest
- Stage 2 – Presentation of information about the proposed project

- Stage 3 – Gathering information about cultural significance
- Stage 4 – Review of the draft cultural heritage assessment report.

Appendix M provides details of the process, a consultation log and evidence of all correspondences that were sent and received as part of the consultation process.

12.2. Existing environment

12.2.1. Aboriginal historical and landscape context

Past land uses practices

European settlement in the area occurred in the mid-1800s at which time the land was cleared for agriculture. The pastoral station was mainly used for livestock, most notably for sheep, as well as cropping, including wheat. Water at the station was obtained from water holes and dams along the creeks and constructed water tanks and dams within the station.

In 1912, the Yanco, Colomco and Billabong Creeks Water Trust (The Water Trust) was established to secure water within Billabong and surrounding creeks (Government Gazette of the State of New South Wales, 18 March 1921, p.1805). Works conducted by the trust and other private works have greatly affected the permanency of the water within the creek and the flow of the water. The water infrastructure within the study area was constructed under the 1912 Water Act, as a “block dam and pipe regulator” as a part of an irrigation license for Gerard Harris McLaughlin and Wendy Laraine McLaughlin (Government Gazette of the State of New South Wales, 30 March 1984, p.1820).

The construction of water infrastructure, the clearing of the land and developing it for cropping has likely impacted Aboriginal sites. Scar trees would have been removed and the earth mounds and hearth been slowly flattened over the years. Grazing the land also has an impact on sites, with cattle being found to move lithic artefacts from their original locations, depending on the grazing intensity, site topography, and size of the artefacts (Schoville 2019). Hoofed animals have also exacerbated the effects of clearing and cropping through increased soil erosion, leading to subsurface cultural sites being exposed.

As a result of these previous activities, there would have been large scale land clearance that would have included land levelling and tree removal. This would have destroyed, harmed and relocated sites from their in-situ context.

Archaeological Context

The range of environments and landscapes within the Riverina region influenced on the lives of the Aboriginal people who lived there. As hunters and gatherers, Aboriginal people were reliant on their surroundings to provide food. Their transitory lifestyle affected population size, social interactions and degree of mobility, which can be confirmed in the archaeological record.

The Riverina would have been able to support large populations of Aboriginal people, due to the number of permanent watercourses and the associated food and resources. Watercourses and surrounding riparian land would have provided materials that were used for the creation of canoes, nets, stone tools, and other items for the collection and transportation of goods.

The full detailed description of Aboriginal archaeological context is included in section 4 of the ACHA Report (Appendix M).

12.2.2. Recorded Aboriginal sites and places

The background research conducted as part of this assessment identified 13 previously registered sites within 10 kilometres of the study area. Two of these AHIMS sites are located in close proximity to the study areas, consisting of modified trees.

Site survey of the study area identified eight new Aboriginal sites and re-identified two previously recorded Aboriginal sites. These consisted of five modified trees, three earth mounds, one hearth and one modified tree and PAD. One previously recorded site was not able to be relocated.

12.2.3. Archaeological potential and significance

An assessment, in accordance with the Burra Charter, of the scientific significance of the Aboriginal sites located within the study area is outlined in Table 12.1.

Based on the archaeological survey, the study area is considered to have **moderate** archaeological potential.

Table 12.1 Statements of significance for Aboriginal sites in the study area

Site / AHIMS	Assessment of significance	Grading
Forest Creek Block Bank Scarred Tree 2 AHIMS #54-30031	Forest Creek Block Bank Scarred Tree 2 (AHIMS # 54-3-0031) 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; however, scar trees are a declining cultural site since they are dependent on the life of the tree. It offers very little educational or research potential. Therefore, Forest Creek Block Bank Scarred Tree 2 (AHIMS # 54-3-0031) has a moderate scientific value at a local level.	Moderate
Forest Creek Block Bank Scarred Tree 3 AHIMS #54-30034	Forest Creek Block Bank Scarred Tree 4 (AHIMS # 54-3-0057) is a scarred tree in good condition and is not associated with any other sites. This form of scarred tree is common within the surrounding region; however, scar trees are a declining cultural site since they are dependent on the life of the tree. It offers very little educational or research potential. Therefore, Forest Creek Block Bank Scarred Tree 4 (AHIMS # 54-3-0057) has a moderate scientific value at a local level.	Moderate
Forest Creek Block Bank Scarred Tree 4 AHIMS #54-3-0057	Forest Creek Block Bank Scarred Tree 4 (AHIMS # 54-3-0057) 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; however, scar trees are a declining cultural site since they are dependent on the life of the tree. It offers very little educational or research potential. Therefore, Forest Creek Block Bank Scarred Tree 4 (AHIMS # 54-3-0057) has a moderate scientific value at a local level.	Moderate
Forest Creek Block Bank Earth Mound 1 AHIMS #54-3-0058	Forest Creek Block Bank Earth Mound 1 (AHIMS # 54-3-0058) contains high scientific value at a local level. This earth mound is isolated from other earth mounds and is uncommon within the surrounding region. Forest Creek Block Bank Earth Mound 1 (AHIMS # 54-3-0058) contains both educational and research potential as well as being a representative example of an earth mound.	High

Site / AHIMS	Assessment of significance	Grading
Hartwood Weir Scarred Tree 4 AHIMS # 54-3-0059	Hartwood Weir Scarred Tree 4 (AHIMS # 54-3-0059) is a scarred tree in good condition and is not associated with any other sites. This form of scarred tree is common within the surrounding region; however, scar trees are a declining cultural site since they are dependent on the life of the tree. It offers very little educational or research potential. Therefore, Hartwood Weir Scarred Tree 4 (AHIMS # 54-3-0059) has a moderate scientific value at a local level.	Moderate
Hartwood Weir Scarred Tree and PAD AHIMS # 54-3-0055	Hartwood Weir Scarred Tree and PAD (AHIMS # 54-3-0055) contains two components; a scarred tree in good condition, and an associated potential archaeological deposit (PAD). This type of associated site is uncommon within the surrounding region, and, although scar trees are a declining cultural site since they are dependent on the life of the tree, the associated PAD contains both educational and research potential. Therefore, Hartwood Weir Scarred Tree and PAD (AHIMS # 54-3-0055) has a high scientific value at a local level.	High
Hartwood EM Weir 1 AHIMS # 54-3-0054	Hartwood EM Weir 1 (AHIMS # 54-3-0054) contains high scientific value at a local level. This earth mound is isolated from other earth mounds and is fairly common within the surrounding region. Hartwood EM Weir 1 (AHIMS # 54-3-0054) contains both educational and research potential as well as being a representative example of an earth mound.	High
Hartwood EM Weir 2 AHIMS # 54-3-0056	Hartwood EM Weir 2 (AHIMS # 54-3-0056) contains high scientific value at a local level. This earth mound is associated with Hartwood EM Weir 1 (AHIMS # 54-3-0054) and is fairly common within the surrounding region. Hartwood EM Weir 2 (AHIMS # 54-3-0056) contains both educational and research potential as well as being a representative example of an earth mound.	High
Hartwood EM Weir 3 AHIMS # 54-3-0061	Hartwood EM Weir 3 (AHIMS # 54-3-0061) contains high scientific value at a local level. This earth mound is isolated from the other earth mounds and is very common within the surrounding region. Hartwood EM Weir 3 (AHIMS # 54-3-0061) contains limited educational and research potential and is a representative example of an earth mound.	Moderate
Wanganella Weir Scarred Tree 1 AHIMS # 54-2-0263	Wanganella Weir Scarred Tree 1 (AHIMS # 54-2-0263) is a scarred tree in good condition and is not associated with any other sites. This form of scarred tree is common within the surrounding region; however, scar trees are a declining cultural site since they are dependent on the life of the tree. It offers very little educational or research potential. Therefore, Hartwood Weir Scarred Tree 4 (AHIMS # 54-3-0059) has a moderate scientific value at a local level.	Moderate
Wanganella Weir Scarred Tree 3 AHIMS # 54-2-0264	Wanganella Weir Scarred Tree 3 (AHIMS # 54-2-0264) is a scarred tree in good condition and is not associated with any other sites. This form of scarred tree is common within the surrounding region; however, scar trees are a declining cultural site since they are dependent on the life of the tree. It offers very little educational or research potential. Therefore, Hartwood Weir Scarred Tree 4 (AHIMS # 54-3-0059) has a moderate scientific value at a local level.	Moderate

12.3. Impact assessment

12.3.1. Construction impacts

Impacts on recorded Aboriginal sites and places with archaeological potential

The 11 sites identified within the study area comprise of seven modified trees, three earth mounds and one modified tree and associated PAD. An evaluation of harm to the Aboriginal sites identified as part of the ACHAR (see Appendix M) is summarised in Table 12.2.

All sites harmed would be from direct impacts which relate to an activity such as tree trimming or works which disturbs the ground including, but not limited to, site preparation activities, installation of services and infrastructure, roadworks and changes in water flows affecting the value of a cultural site.

Constructing the proposal would involve excavation and subsurface disturbance including within and adjacent to Billabong Creek channel. The five sites identified as being directly impacted are through either minor impacts such as trimming of branches, or major impacts such as their removal and/or destruction.

As shown in Table 12.2, a total loss of three heritage sites would occur. One would be a partial loss and for one scar tree, the necessary minor trimming, would not result in a loss of value to the item.

These sites have had their surrounding landscapes impacted and disturbed by previous developments however such as pastoral practices and informal access tracks, as well as being common representations of their site types.

Table 12.2 Assessment of harm to identified Aboriginal sites

Site name / AHIMS No.	Type of harm	Degree of harm	Consequence of harm
Forest Creek Block Bank Scarred Tree 2 / AHIMS # 54-3-0031	Direct	Whole – trimming only	Partial loss of value
Forest Creek Block Bank Scarred Tree 3 / AHIMS # 54-3-0034	None	None	No loss of value
Forest Creek Block Bank Scarred Tree 4 / AHIMS # 54-3-0057	Direct	Whole	No loss of value
Forest Creek Block Bank Earth Mound 1 / AHIMS #54-3-0058	None	None	No loss of value
Hartwood Weir Scarred Tree 4 / AHIMS # 54-3-0059	Direct	Whole	Total loss of value
Hartwood Weir Scarred Tree and PAD / AHIMS # 54-3- 0055	None	None	No loss of value
Hartwood EM Weir 1 / AHIMS # 54-3-0054	None	None	No loss of value
Hartwood EM Weir 2 / AHIMS # 54-3-0056	None	None	No loss of value
Hartwood EM Weir 3 / AHIMS # 54-3-0061	Direct	Whole	Total loss of value
Wanganella Weir Scarred Tree 1 / AHIMS # 54-2-0263	None	None	No loss of value
Wanganella Weir Scarred Tree 3 / AHIMS # 54-2-0264	Direct	Whole	Total loss of value

Measure to avoid and minimise harm

Within the study area, the proposed works were revised during concept design and through consultation with local Aboriginal community groups, to avoid and minimise harm to identified Aboriginal sites, where possible. These measures included:

- The location of the construction activity zones were selected as they already have an existing creek crossing and/or are heavily disturbed. Where possible construction zones were located to avoid known heritage sites. The aim of these measures is to avoid impacting undisturbed creek banks and floodplains, as well as adjacent areas which would be required to create new accesses.
- Access to the proposal sites and borrow pits have used existing access tracks where possible, in an effort to reduce the potential for disturbance.
- A new access track for Forest Creek block bank was selected rather than the existing track, as the existing track was currently impacting a heritage feature. The new track would prevent the construction works further impacting that heritage feature.
- Consultation has occurred with Representatives from local Aboriginal community groups to discuss the potential impacts and develop mitigation and management measures to minimise impacts where possible.

12.3.2. Operational impacts

Impacts on Aboriginal heritage would be limited to the construction stage. No additional impacts are anticipated on the areas of archaeological potential or cultural values during operation. Consideration should still be given for the operational maintenance activities to ensure these are undertaken in accordance with the appropriate unanticipated discoveries management procedures.

12.3.3. Cumulative Impacts

A summary of the cumulative assessment is provided in section 23.3.3 and section 8.4 in Appendix M (Aboriginal cultural heritage assessment report).

12.4. Mitigation measures

12.4.1. Approach to mitigation and management

The Burra Charter, advocates a cautious approach to change: “do as much as necessary to care for the place and to make it useable, but otherwise change it as little as possible so that its cultural significance is retained” (Australia ICOMOS 2013a, p.1). Based on this principle, this section identifies the measures that are recommended to avoid harm.

The approach to managing impacts has been developed after considering:

- the archaeological context
- environmental information
- consultation with the local Aboriginal community
- findings of the archaeological survey
- the predicted impact of the planning proposal on archaeological resources.

The potential for impacts during construction would be managed in accordance with a proposal-specific Aboriginal cultural heritage management plan, prepared and implemented as part of the CEMP. The plan would:

- detail processes and responsibilities to minimise potential impacts on Aboriginal heritage during construction (such as the management of the associated collection of artefacts according to the requirements of the registered Aboriginal parties)
- be prepared in accordance with relevant guidelines, standards and the ACHAR
- include an unexpected finds procedure.

12.4.2. Summary of mitigation measures

The recommended Aboriginal Cultural Heritage Assessment safeguards and management measures that would be implemented to account for the potential impacts are presented below in Table 12.3.

Table 12.3 Recommended Aboriginal Heritage safeguards and management measures

ID	Impact	Environmental safeguards	Responsibility	Timing
AH1	Protecting Aboriginal heritage and minimising impacts during construction	All ground-disturbing works to earth mound and/or potential archaeological deposit (PAD) sites, including Forest Creek Block Bank Earth Mound 1 (AHIMS # 54-3-0058), Hartwood Weir Scarred Tree and PAD (AHIMS # 54-3-0055), Hartwood EM Weir 1 (AHIMS # 54-3-0054) and Hartwood EM Weir 2 (AHIMS # 54-3-0056), must be avoided. Traditional Owners must also be involved in monitoring works to ensure the protection of these sites from the proposed works. Specific conditions include: 1. The identified Aboriginal sites that are in close proximity to the access tracks, including Forest Creek Block Bank Earth Mound 1 (AHIMS # 54-3-0058), Hartwood Weir Scarred Tree and PAD (AHIMS # 54-3-0055), Hartwood EM Weir 1 (AHIMS # 54-3-0054) and Hartwood EM Weir 2 (AHIMS # 54-3-0056), must be fenced off using temporary flagging to ensure that the sites are not disturbed. All vehicles must keep to the access tracks. 2. An exclusion line using bollards is to be erected to the south of Hartwood EM Weir 1 (AHIMS # 54-3-0054) and Hartwood EM Weir 2 (AHIMS # 54-3-0056) to ensure that no vehicles drive in close proximity to sites.	NSW DCCEEW Construction contractor	Design, pre-construction, construction

ID	Impact	Environmental safeguards	Responsibility	Timing
AH2	Protecting Aboriginal heritage and minimising impacts during construction	Identified scar trees, including Hartwood Weir Scarred Tree and PAD (AHIMS # 54-3- 0055), Wanganella Weir Scarred Tree 1 (AHIMS # 54-2-0263) and Forest Creek Block Bank Scarred Tree 3 (AHIMS # 54-3-0034) are to have no ground-disturbing works within the canopy dripline, damage to their trunks or limbed removed and/or damaged. Temporary flagging must be erected to ensure the preservation of these sites and Traditional Owners must be involved in monitoring works to ensure the protection of these sites from the proposed works.	Construction contractor	Pre-construction, construction
AH3	Protecting, avoiding and minimising impacts on Aboriginal heritage & Consultation	Heritage features must be managed under the preparation of an Aboriginal Cultural Heritage Management Plan (ACHMP) that, at a minimum, includes: 1. Minimisation and managing the impacts of the project on heritage items within the disturbance area. 2. Protecting the heritage items outside the project disturbance area. 3. Managing the discovery of human remains or previously unidentified heritage items. 4. Ensuring any workers on site receive suitable heritage inductions prior to carrying out any work on site. 5. Monitoring and reporting on the effectiveness of any mitigation measures and any heritage impacts of the project. 6. Maintaining and managing reasonable access for registered Aboriginal parties (RAPs) to heritage items on site. 7. Conducting further archaeological and heritage assessments in any disturbance areas where this assessment has not already been carried out. 8. Be developed in consultation with RAPs and Heritage NSW.	NSW DCCEEW Construction contractor	Design, pre-construction, construction, operation
AH4	Unexpected finds	This assessment covers the harm to all known cultural heritage sites. In the event that unexpected finds occur during the proposed construction activities, an unexpected finds process must be followed. This process will be developed as part of the recommended ACHMP prior to the proposed works' commencement. 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.	Construction contractor	Construction

ID	Impact	Environmental safeguards	Responsibility	Timing
AH5	Consultation	It is recommended that DCCEEW continues to inform the Aboriginal stakeholders about the management of Aboriginal cultural heritage within the study area throughout the completion of the project. The consultation outlined as part of this ACHA is valid for six months and must be maintained by the proponent for it to remain continuous. If a gap of more than six months occurs, then the consultation will not be suitable to support an ACHMP for the study areas.	NSW DCCEEW	Construction
AH6	Consultation	A copy of the ACHAR should be forwarded to all Aboriginal stakeholder groups who have registered an interest in the project.	NSW DCCEEW	Design, pre-construction

13. Non-Aboriginal heritage

A Statement of Heritage Impact has been prepared for each heritage item of local or higher significance which would be impacted by the proposal, in accordance with the Department of Planning and Environment (2023) Guidelines for Preparing a Statements of Heritage Impact. This chapter summarises the heritage assessment. The full assessment report is provided in Appendix N.

13.1. Methodology

The non-Aboriginal heritage assessment was carried out according to the principles and guidelines provided in:

- Australia ICOMOS Charter for Places of Cultural Significance (Burra Charter) (Australia ICOMOS 2013a).
- *NSW Heritage Manual* (NSW Heritage Office 1996) including the following sections:
 - Investigating History. This section was used in carrying out research into historical context and history of individual heritage items.
 - Investigating Fabric. This section was used in surveying and recording individual heritage items.
- *Assessing Heritage Significance* (Heritage Council of NSW 2023). The updated guidelines, which draw on the earlier *Assessing Heritage Significance* (NSW Heritage Office 2001) as part of the 1996 NSW Heritage Manual, was used to review existing significance assessments and carry out significance assessments for new heritage items.
- *Investigating Heritage Significance* (draft guideline) (NSW Heritage Office 2004). The updated section of NSW Heritage Manual was used to carry out significance assessment for new heritage items.
- *Guidelines for preparing a statement of heritage impact DPE 2023g*.

This assessment considers the potential non-Aboriginal heritage issues resulting from the construction and operation of the proposal, and where required, identifies feasible and reasonable mitigation and management measures. This assessment:

- addresses non-Aboriginal archaeology, built heritage items and historical conservation areas, in accordance with Heritage NSW guidelines, the Australia International Council on Monuments and Sites (ICOMOS) *Charter for Places of Cultural Significance (Burra Charter)*, and relevant Commonwealth heritage guidelines
- identifies non-Aboriginal heritage items within the study area
- assesses the potential impacts on the heritage items from the proposed proposal activities
- identifies mitigation and management measures to minimise impacts to heritage.

For the purposes of the assessment, the proposal footprint, and study area have been defined as follows:

- Project footprint – the site that would be directly disturbed by construction and the location of operational infrastructure. The disturbance area would include clearing areas, construction activity zones, access tracks and power supply corridors.

- Study area – the area investigated which includes the footprint of the proposal and surrounding area with the potential to be directly or indirectly affected by the project. The study area covered by this non-Aboriginal heritage assessment comprised a 5.0 metre buffer encompassing all of the project works which may directly or indirectly impact upon non-Aboriginal heritage items, as shown in Figure 13.1 and Figure 13.2.

The assessment of non-Aboriginal heritage focusses on the history of the two portions of the study area, where each section of the study area encompasses one of the two weirs, and the history associated with the surrounding regions. The following key tasks were undertaken as part of the assessment:

- review of heritage databases to identify whether any listed items were located within, or in the vicinity of, the project site
- review of historical sources, and existing archaeological and historical reporting, to determine the historical context of the project site and assess the non-Aboriginal archaeological potential across the project site historical background research
- a review of historical mapping and aerial imagery in the region along Billabong Creek
- a site survey to identify potential heritage items and areas of archaeological potential, including:
 - a visual inspection of the heritage items within the study area
 - key features and the nature and condition of the heritage item, including photographs and notes, were recorded.

13.2. Existing environment

13.2.1. Desktop assessment

Register searches

One registered non-Aboriginal heritage item within the study area is Hartwood Weir (WaterNSW S170 4550110). This is listed on the state agency heritage register, WaterNSW Section 170 State Agency Heritage and Conservation register.

While Hartwood Station is listed on the National Trust of Australia (NSW) Register, it is approximately 10 kilometres to the east of the study area.

There are no historical heritage places within proximity to the Wanganella Weir study area.

Previous historical heritage investigations

Few historical heritage investigations have been undertaken in this region. No copy of the *Deniliquin Council Heritage Study*, completed by Inventory in 2008, is available from the Edward River Council for review, and the Edward River Heritage Study, which was noted as needing completion in 2020 (Edward River Council 2020), has not been published as of 14 August 2024. Those reports which are available have been summarised in Table 3-2 of Appendix N.

Historical site context

The study area is situated entirely in rural countryside, along Billabong Creek. The land in surrounding the region has been used for grazing sheep and cattle since the late-1830s and early-1840s. The pastoral stations with which the weirs are related have passed through numerous land owners and pastoral companies. The land use surrounding the weirs remains generally unchanged to the present day, as the surrounding stations are still being primarily used for grazing and cropping purposes.

There is a history of weir building along Billabong Creek, dating back to at least 1858, where newspaper reports noted that station holders along the creek had been constructing dams and reservoirs for years. This was in an effort to have enough water for their sheep and cattle, as well as for domestic purposes. However, this practice was not approved of by all station owners along the creek, as it deprived other station owners of water. Numerous legal proceedings ensued over the 1860s and into the 1890s. However, the introduction of the 1912 Water Act and the licensing of dams (and weirs) quieted the issue. Subsequent to the Act, the weirs within the study area were built:

- Hartwood Weir was likely licensed to John Hunter Patterson III in 1914, and built in 1915-1916
- Wanganella Weir was licensed to Windouran Shire Council in 1916 and built in 1927 after they gained the necessary special lease land.

Due to there being a low to moderate potential for previously unidentified historical heritage items to be present within the study area, a field survey of the study area was also undertaken.

13.2.2. Field survey

The field survey recorded four built heritage items identified during desktop assessment, comprising Hartwood Weir (S170 4550110), along with the potential heritage features of an old bridge, a timber structure within the study area at Hartwood Weir, and Wanganella Weir within the study area at Wanganella Weir.

There were no heritage items with known archaeological potential, so no detailed archaeological assessments were prepared for this proposal. An investigation of potential areas of archaeological potential was undertaken as part of the field survey.

13.2.3. Heritage significance assessment

Both Hartwood Weir and Wanganella Weir have been assessed as being of local significance, despite their respective poor and extremely poor conditions. Neither the old bridge nor the timber structure, both of which are in extremely poor condition, are assessed as being of heritage significance. No additional potential heritage items or areas of archaeological potential were identified during the field survey. As such, a SOHI is provided for both Hartwood Weir and Wanganella Weir in section 4 of Appendix N.

An item will be considered to be of State (or local) heritage significance if, in the opinion of the Heritage Council of NSW, it meets one or more of the following criteria (Heritage Council of NSW 2023):

- Criterion A (Historical significance): An item is important in the course, or pattern, of NSW's cultural or natural history (or the cultural or natural history of the local area).
- Criterion B (Historical association): An item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the cultural or natural history of the local area).
- Criterion C (Aesthetic/creative/technical achievement): An item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area).
- Criterion D (Social, cultural, and spiritual): An item has strong or special association with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons.
- Criterion E (Research potential): An item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area).
- Criterion F (Rare): An item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area).

- Criterion G (Representativeness): An item is important in demonstrating the principal characteristics of a class of NSW's cultural or natural places; or cultural or natural environments (or a class of the local area's cultural or natural places; or cultural or natural environments).

The significance assessment for Hartwood Weir is provided in Table 13.1 are based on the wording of the NSW Heritage Office Heritage Data Form for Hartwood Weir (WaterNSW S170 4550110) (Heritage NSW 2019). The significance assessment for Wanganella Weir is provided in Table 13.2. Both the old bridge and timber structure were assessed but did not meet any criterion (refer to Appendix M).

Table 13.1 Significance assessment of Hartwood Weir (WaterNSW S170 4550110)

Criterion	Heritage assessment
SHR criteria (A) Historical significance	Hartwood Weir is one of the oldest weirs in the area, built in 1915-1916. It was also the first to be handed over to the Yanko, Colombo and Billabong Creeks Water Trust in 1937 under the Water Conservation and Irrigation Commission in a program of asset acquisition in the late 1930s. Hartwood is one of the oldest properties in the district, dating back to the 19th century when it was a large sheep run. The weir was therefore of significance to the history both Hartwood Station and to the local region.
SHR criteria (B) Historical association	The weir is closely associated with an established family in the area (the Pattersons) and closely associated with a particularly influential and long-serving member of the relevant Trust (Mr. John Hunter Patterson). The weir was built by Arthur Churchill Fitznead, an engineer for the NSW Public Works Department (c.1891-1907), for the Murray, Windouran and Conargo Shire Councils from the inception of the local governments in 1907 until the 1940s. It also shares an indirect association with John Monash who was involved in water disputes as an expert witness in 1897 in the Riverina area, which included Hartwood Station.
SHR criteria (C) Aesthetic/creative/ technical achievement	Hartwood Weir shows little aesthetic value, and appears to be a typical concrete weir built by the Conargo Shire engineer. It does not meet Criterion C.
SHR criteria (D) Social, cultural, and spiritual	There is strong local interest in the history of Hartwood property and its associated structures (e.g. the Hartwood woolshed on Billabong Creek). While the weir is not situated within the current extent of the Hartwood property, this local interest in the Patterson family would include the weir as one of the surviving weirs demonstrating Patterson's influence (particularly relating to water management) across the district.
SHR criteria (E) Research potential	Hartwood Weir does not appear to have any potential to yield information that would contribute to an understanding of the history of the area. It does not meet Criterion E.
SHR criteria (F) Rare	Hartwood Weir does not appear to have any uncommon, rare or endangered aspects. It does not meet Criterion F.
SHR criteria (G) representative	This structure is a good example of concrete weir construction in the early twentieth century, in particular, the use of brick block as an aggregate. Crushed bricks were used at times when the gravel most commonly used – and which did not occur in the region – was unavailable. While the weir is in a poor condition, it is still an operational example of a weir of this type within the local area.

Table 13.2 Significance assessment of Wanganella Weir

Criterion	Heritage assessment
SHR criteria (A) Historical significance	Wanganella Weir was built in 1927, and is almost 100 years old. The history of Wanganella Weir is linked to that of the Windouran Shire Council and the people of Wangonilla. Requests for a dam or weir going back to at least 1898, when the Trustees of Wangonilla Commons requested that a timber overshot dam or weir to be built on Billabong Creek. Windouran Shire Council applied for a license for an overshot dam or weir in 1916, and again in 1920. The weir, which was built much later, was constructed on a special lease of two acres of land over Billabong Creek. However, the weir does not appear to have been otherwise particularly significant to the development of any particular industry, nor to any important phase or event in the history of the township. It does not meet Criterion A.
SHR criteria (B) Historical association	There is no special association between Wanganella Weir and the life or works of any individual or family, and is one of many public works by the Windouran Shire Council. It does not meet Criterion B.
SHR criteria (C) Aesthetic/creative/ technical achievement	Wanganella Weir shows little aesthetic value, and appears to be a typical overshot dam authorised by the Hay Land Board under the 1912 Water Act. It does not meet Criterion C.
SHR criteria (D) Social, cultural, and spiritual	Wanganella Weir may have some importance to the local community as a publicly available swimming area and camping spot centred around an historical weir, built for the township of Wanganella. Despite its extremely poor condition, it is still an operational weir, providing water to the township.
SHR criteria (E) Research potential	Wanganella Weir does not appear to have any potential to yield information that would contribute to an understanding of the history of the area. It does not meet Criterion E.
SHR criteria (F) Rare	Wanganella Weir does not appear to have any uncommon, rare or endangered aspects. It does not meet Criterion F.
SHR criteria (G) representative	Wanganella Weir does not appear to demonstrate any principal characteristics of NSW's historical weirs in its current state. It does not meet Criterion G.



Figure 13.1 Hartwood Weir on Billabong Creek taken by W H Johnston c.1920s (Johnston n.d.)



Figure 13.2 Hartwood Weir during low flow of the creek 2024



Figure 13.3 Wanganella Weir looking upstream



Figure 13.4 DCCEEW photograph of the Old Bridge and stone crossing during a dry period, near Hartwood Weir



Figure 13.5 Timber uprights and posts on the east bank, facing southwest

13.3. Impact assessment

13.3.1. Construction

The two existing weir structures within the creek would be substantially demolished at Hartwood Weir and Wanganella Weir, with some parts being retained. Demolition of majority of the structures has been deemed necessary due to health and safety concerns of the degraded structures and they would affect the water levels and the flows required by the new regulators.

In accordance with the principles and guidelines of Section 170A (1) of the Heritage Act, alternatives to demolition of the weir were considered by NSW DCCEEW. The two primary reasons for the demolition of the weirs are:

- The new regulators would not be able to control flows as intended if the weirs were retained.
- The weirs would remain as barriers to upstream fish movement and DPI-Fisheries have requested their removal to allow upstream fish passage.
- Partial demolition or breaching of the weirs were also considered but it was determined that these options were not viable as:
- The partially demolished weir would be a navigation hazard.

- The partial demolition of the weir would accelerate the further deterioration of the already poor condition weir structures potentially resulting in damage to the new downstream regulators in the event of a catastrophic failure of an existing partially demolished weir.
- Maintenance of the partially demolished structure would result in poor constructability outcomes as well as posing safety issues.

While the proposal would not be the best conservation solution for the weirs, and does not promote ongoing use and upkeep of the historical weirs, the impacts to the weirs are unavoidable.

Impact to non-Aboriginal heritage can be both direct and indirect. Direct harm may occur as a result of activities that directly impact identified heritage items and areas of archaeological potential. Direct impact may include demolition of existing heritage items, disturbance of the ground surface during site preparation activities, as well as impacts associated with truck haulage and use of areas of compound sites.

Indirect harm to non-Aboriginal heritage refers to impacts that occur as a result of other actions. Indirect harm may include impacts from vibration, increased visitation, increased erosion, or changing access. Indirect impact may also result from modification to the visual amenity, landscape and views to and from heritage items.

A summary of potential direct and indirect impacts to non-Aboriginal heritage during construction is provided in the following sections.

Hartwood Weir (WaterNSW S170 4550110)

Hartwood Weir is located on Billabong Creek at allotments 1/-/DP1144789, 2/-/DP1144789 and 3/-/DP181995, which is situated between two parcels of land at 4144 Conargo Road Hartwood. The heritage item is listed on the WaterNSW S170 register as ID 4550110 (Heritage NSW 2019).

The item is of local significance, and it meets criterion A (significance), B (associative), D (social) and G (representative) as described in Table 13.1.

Due to the decommissioning of the existing weir and construction of the new regulator; the proposal would directly impact upon the Hartwood Weir (WaterNSW S170 4550110) heritage item. These pre-construction and construction works would comprise:

- demolition of a substantial portion of the heritage item (the weir structures within the creek), including:
 - removal of both wingwalls (abutments) down to the level of the existing floor of the weir structure
 - removal of the drop boards, walkways, and concrete diaphragm walls down to the concrete base slab (apron level):
 - o the broken concrete surface will be roughly trimmed only
- the base slab and approximately 300 millimetres of step at the edge of the base slab on the waterway face of the wingwalls of the existing structure will be retained
- reinstatement of the wingwall removal area with placement of fill (rock) to reinstate creek banks and appropriate beaching protection of any new earthworks.

Further works that may have indirect impact upon the heritage item include site establishment activities during construction including the use of a temporary crane pad / laydown area, approximately 10 metres north of the existing weir crest.

There would be no enhancement of heritage significance due to the direct impacts to the heritage item. The proposed demolition of the structure would cause direct impact to the heritage item. This would include the removal of the original headwall, bays, and all remaining red gum drop boards that form the weir structure within the creek. Only a small step at the edge of the base slab on the waterway face of the wingwalls, along with the base slab in the creek bed, would be retained.

The remaining portions of the weir provide some representation of the heritage significance of the original weir. Their retention marks the location of the historically-significant Hartwood Weir, which was one of the oldest weirs in the area. The retained elements of the structure show that the weir was situated within the original extent of the socially-significant Hartwood property. The brick-block concrete abutment walls are of representative significance, as they retain some of the representative significance of early 20th century weirs built using brick block as an aggregate. The remaining step (approximately 300 millimetres in height) at the edge of the base slab would comprise the only remaining feature of the weir, neither of which would serve as a visible reminder of the former weir. As such, the demolition would impact upon the heritage significance and fabric of the heritage item, and result in the heritage item no longer being a weir.

In accordance with the principles and guidelines of Section 170A (1) of the Heritage Act, alternatives to demolition of Hartwood Weir were considered by NSW DCCEEW but it was determined that these options were not viable. As this impact to the heritage fabric of the weir cannot be avoided, further assessment and archival recording would be completed.

There are no known or suspected areas of archaeological potential within the boundary of the heritage item at Hartwood Weir, that could be impacted by the proposal. Therefore no further archaeological investigations are proposed at this site.

While the base slab, which comprises the main subsurface portion of the weir situated within the creek bed, and a small step at the edge of the base slab on the waterway face of the wingwalls in both creek banks would remain, the proposed works would still be of medium – large scale and of moderate – high intensity. This would cause permanent and irreversible changes to the heritage item. There would not be any remaining features above the waterline to serve as a visual reminder of the location of the historical weir. As such, the overall level of impact on Hartwood Weir (WaterNSW S170 4550110) would be **major**.

Wanganella Weir

Wanganella Weir is located on Billabong Creek within part of allotment 7005/-/DP1024202. However, allotments 7015/-/DP1053753 and 7006/-/DP1055647, which is situated off the Cobb Highway, Wanganella.

The heritage item is not currently listed, but has been assessed as being of local significance as it meets criterion D (social) as described in Table 13.2.

The proposal would directly impact upon the Wanganella Weir heritage item. These pre-construction and construction works would comprise:

- demolition of a substantial portion of the heritage item (the weir structures within the creek), including:
 - removal of the northern wingwall (abutment) only down to the level of the existing floor of the structure
 - removal of drop boards, any steelwork and concrete diaphragm walls down to the concrete base slab (apron level):
 - o this will involve the removal and trimming of the concrete wall at the face of the southern wingwall
 - o the broken concrete surface will be roughly trimmed only
- the base slab, the southern wingwall (due to bank stability issues), and approximately 300 millimetres of a step at the edge of the base slab on the waterway face of the northern wingwall, of the existing structure will be retained
- reinstatement of the wingwall removal area with placement of fill (rock) to reinstate northern creek bank and appropriate beaching protection of any new earthworks.

Further works which may have indirect impact upon the Wanganella Weir heritage item include construction and use of an access track on the northern bank adjacent to the concrete ramp and abutment walls.

There would be no enhancement of heritage significance due to the direct impacts to the heritage item. The proposed demolition of the structure would comprise direct impact to the heritage item. This would include the removal of the original headwall, and the remaining piers of the original 11 bays that form the weir structures within the creek. The southern abutment wall, timber formwork, and apron base block would be retained. Construction of the new regulator may impact upon any remaining timber formwork on the south bank of the weir.

The remaining portions of the weir provide some representation of the heritage significance of the original weir. Their retention marks the location of the socially-significant Wanganella Weir, around which a publicly available swimming area and camping spot have evolved. The southern wingwall, timber formwork, small step (approximately 300 millimetres in height) at the edge of the base slab, along with the base slab in the creek bed, would comprise the only remaining feature of the weir. Of these, the southern wingwall and timber formwork may be damaged by heavy vehicle operation during the demolition of the main body of the weir. Despite the visible presence of these two weir features, the demolition would impact upon the heritage significance and fabric of the heritage item, and result in the heritage item no longer comprising a weir.

In accordance with the principles and guidelines of Section 170A (1) of the Heritage Act, alternatives to demolition of Wanganella Weir were considered by NSW DCCEEW, but it was determined that these options were not viable. As this impact to the heritage fabric of the weir cannot be avoided, further assessment and archival recording would be completed.

Additionally, the use of the access track adjacent to the north bank of the heritage item may have indirect impact to the heritage item, while the construction of the new regulator may impact upon any remaining timber formwork. These impacts may occur prior to demolition of the weir structures, due to the use of construction machinery and vehicles within close proximity to the heritage feature.

There are no known or suspected areas of archaeological potential within the boundary of the heritage item at Hartwood Weir, that could be impacted by the proposal. Therefore no further archaeological investigations are proposed at this site.

While the base slab, which comprises the main subsurface portion of the weir situated within the creek bed, and the wingwall and ramp in both creek banks would remain, the proposed works would still be of medium – large scale and of moderate – high intensity. This would cause permanent and irreversible changes to the heritage item. The retention of the southern wingwall and timber formwork would serve as a visual reminder of the location of the historical weir. Despite this, the overall level of impact on Wanganella Weir would be **major**.

13.3.2. Operation

As construction works would comprise the demolition of the majority of the Hartwood Weir (WaterNSW S170 4550110) and Wanganella Weir heritage items, there would be no operational impacts as the heritage items would already be removed prior to operation. Additionally, any previously unidentified historical heritage items and archaeological sites would already be discovered during the construction phase. As such, there would be no operational impacts to non-Aboriginal heritage due to the proposal.

Operation of the proposal would result in a change to the upstream extent of the hydraulic influence of the existing weirs. Preliminary modelling shows that there will be small changes to the existing weir pool extents and the areas providing slow, moderate, fast, and very fast water velocity.

There would also be small changes to the areas providing slow, moderate, fast, and very fast water velocity downstream of the new regulators. The remaining features of the weirs comprise a small step at the edge of the base slab and the apron base block at Hartwood Weir and the southern wingwall, timber formwork, small step at the edge of the base slab and the apron base block at Wanganella Weir. As these features were

constructed to be subject to water flows of various levels and speeds, they would not be subject to any additional hydrological impacts from changes to the water flow by the construction of the new regulators.

Therefore, no heritage features would be subject to operational impacts from the two new regulators.

13.3.3. Cumulative impacts

A summary of the cumulative assessment is provided in section 23.3.3 and section 8.4 in Appendix N (Non-Aboriginal heritage assessment report).

13.4. Mitigation measures

13.4.1. Approach to mitigation and management

The general approach to management of the proposal during construction and operation is outlined in chapter 24.

NSW DCCEEW is committed to minimising the impact of the project and is investigating opportunities to reduce impacts where practicable. As prescribed by the SEARs, opportunities would also be implemented, where possible, to improve the overall outcome of the project.

The overall guiding principle for heritage management is that impacts to non-Aboriginal heritage should be avoided as far as reasonably practicable. If avoidance is not possible or practicable, measures should be taken to minimise and mitigate impacts to non-Aboriginal heritage. Mitigation measures have been developed based on the type and significance of the site, as assessed by a suitably qualified heritage consultant and/or historical archaeologist. The mitigation measures, below, outline the actions required to mitigate and/or manage each potential impact, as well as any other actions and commitments that arise, as necessary.

Table 16.6 lists the non-Aboriginal Heritage safeguards and management measures that would be implemented to account for the potential impacts identified in section 16.3. These mitigation and management measures include general management measures that will be undertaken for the pre-construction and construction phases (HH1). They also cover site-specific measures for the S170-listed Hartwood Weir (HH2) and locally significant Wanganella Weir (HH3).

13.4.2. Summary of mitigation measures

Table 16.6 lists the non-Aboriginal heritage safeguards and management measures that would be implemented to account for the potential impacts identified in section 16.3.

Table 13.3 Non Aboriginal Heritage safeguards and management measures

ID	Impact	Environmental safeguards	Responsibility	Timing
HH1	Impacts to registered and previously unidentified historical heritage items or archaeological sites	Management of historical heritage during pre-construction and construction - Prior to construction commencing, all personnel working on site will be provided a site-specific cultural heritage induction (e.g. Project induction toolbox talks and staff inductions). This will include the heritage sensitivities of work sites and the procedures for the management of non-Aboriginal cultural heritage during construction, such as the discovery of historical artefacts, features or deposits, or the discovery of human remains. - An unexpected finds protocol that specifies measures to avoid and minimise impacts on any previously unidentified historical archaeological sites and values discovered during pre-construction and construction will be prepared. If unexpected items are discovered during construction, all work will cease in the area. The Contractor will inform the site supervisor and Project Manager, and an Historical Archaeologist will be engaged to assess the item's significance. The Project Manager must advise a WaterNSW heritage officer of any unexpected finds on WaterNSW land or in relation to a WaterNSW asset, as per Section 146 of the Heritage Act.	NSW DCCEEW, Contractor	Pre-construction, Construction
HH2	Impacts to Hartwood Weir (WaterNSW S170 4550110)	Management of Hartwood Weir (WaterNSW S170 4550110) during pre-construction - NSW DCCEEW will record the asset prior to demolition in accordance with Heritage NSW's How to Prepare Archives Records of Heritage Items, Guidelines for Photographic Recording of Heritage Sites, Buildings and Structures, and the updates to technology and practice which have occurred since the 2006 guidelines were issued. The archival recording should result in three sets of a digital photographic report, along with digital materials. DCCEEW will provide WaterNSW with a draft copy for review, prior to lodging this recording with the Heritage NSW library, State Library of NSW and the local council library (Guideline 3.57). NSW DCCEEW and WaterNSW will also retain a copy of the final report for their own records. - Explore options in conjunction with WaterNSW for the installation of interpretation of Hartwood Weir to provide information about the heritage significance of the site, fabric, value and history of the site, supported by digital content, including consideration of expenditure and ongoing maintenance. The interpretation display should include the engraving (from the right bank abutment), which is proposed to be removed as part of demolition. For example, interpretation options may include (but are not limited to): - signage	WaterNSW, NSW DCCEEW, Contractor	Pre-construction

ID	Impact	Environmental safeguards	Responsibility	Timing
		– embedded interpretation – artworks – interpretive display. • Places for interpretive display/s may include location/s determined by WaterNSW and/or NSW DCCEEW. Recommendations from the Edward River Council and/or other local stakeholders may be taken into consideration in the determination of the preferred location/s. • Provision of 14 days prior written notification of the proposed demolition of the heritage item will be made to the Heritage Council of NSW by NSW DCCEEW and WaterNSW.		
HH3	Impacts to Wanganella Weir	Management of Wanganella Weir during pre-construction • The asset will be recorded prior to demolition in accordance with Heritage NSW's preferred method of archival recording, as described in HH2. A draft version of the report should be provided to WaterNSW for review. NSW DCCEEW will provide WaterNSW with a draft copy for review, prior to lodging this recording with the Heritage NSW library, State Library of NSW and the local council library. NSW DCCEEW and WaterNSW will also retain a copy of the final report for their own records. • Explore options in conjunction with WaterNSW for the installation of interpretation (for example but not limited to signage, embedded interpretation, artworks, interpretive display) at the portion of Wanganella Weir which is being retained (near the southern wingwall and timber formwork) to provide information about the heritage significance of the site, fabric, value and history of the site, supported by digital content, including consideration of expenditure and ongoing maintenance. • Prior to its demolition, measures to manage indirect historical heritage impacts to the remaining elements of the weir (the southern wingwall and timber formwork) will be implemented, including physical barrier protection and/or exclusion zones, until the works in the vicinity of the remaining weir features have been completed.	NSW DCCEEW, Contractor	Pre-construction

14. Land use, property and agriculture

This chapter provides a summary of the potential impacts of the proposal on land use and property. It describes existing land uses and agricultural capability in and around the proposal site, assesses the impacts of construction and operation, and provides measures to mitigate and manage the impacts identified. The full assessment report is provided in Appendix O.

14.1. Methodology

The land use, property and agricultural impact assessment has been undertaken in accordance with the following key legislation and policy guidelines:

- *Infrastructure proposals on rural land* (DPI 2013b)
- *Land use conflict risk assessment guide* (DPI 2011)
- *Managing biosecurity risks in land use planning and development guide* (DPI 2020).

A desktop assessment of the impacts of the proposal during both construction and operations stages on the current land use (including specific agricultural land use impacts). Consultation with agencies and adjacent landholders to inform this assessment was undertaken by other specialists. This chapter includes summaries of the results of other studies, reported within the EIS.

The study area for the land use, property and agricultural impact assessment consists of the two study areas which are defined as follows:

- **Proposal footprint** – includes all locations, terrestrial and in-stream, where the proposal directly impacts the land surface or water body. This includes clearing areas, construction activity zones, access tracks and power supply routes. This includes the operational footprint which comprises the regulators, power cables and permanent access tracks.
- **Regional study area** – the area investigated which includes the footprint of the proposal and surrounding area, with the potential to be directly or indirectly affected by the proposal. The area of investigation covered by this land use assessment comprises the Edward River LGA which encompasses the proposal area.

14.2. Existing environment

14.2.1. Land use

General land use description

Almost 95 per cent of the regional study area consists of agricultural land or associated land uses. The majority of this (about 68 per cent) is used for the grazing livestock in areas of native vegetation. The next highest agricultural land use is irrigated crops which represents about 22 per cent of the regional study area. Further information about agricultural land uses are outlined in section 14.2.2.

The proposal footprint at both Hartwood and Wanganella, like the regional study area, are dominated by agricultural land consisting of the grazing of livestock in area of native vegetation. The percentage of this type of agricultural use is greater at Wanganella where 80 per cent of the proposal footprint is mapped as grazing of native vegetation. The Hartwood site also includes some areas mapped for cropping and irrigated cropping representing about 16 per cent of the proposal footprint at this regulator. About 20 per cent of both the proposal footprints are represented by land forming part of the Billabong Creek.

Land use zoning

While there are three local environmental plans in the Edward River Council as a result of mergers of three separate council areas, only the *Conargo Local Environmental Plan 2013* is relevant to the proposal. All land at both proposal footprints is zoned RU1 Primary Production. The objectives of the zone are:

- 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 allow the development of non-agricultural land uses that are compatible with the character of the zone.

14.2.2. Agricultural land uses

Land and soil capability

In NSW, rural land is classified under the land capability classification system. This system aims to delineate classes of rural land based on inherent physical capacity to sustain a range of land uses and management practices in the long term without degradation to soil, land, air and water resources. The land capability classes range from 1 (highest capability land) to 8 (lowest capability land). Classes 1 to 3 are considered the best and most versatile for cropping, while higher numbers are capable of pasture or forestry.

Land and soil capability of land within the regional study area is generally classed as either Class 4 or 5 with 77 per cent of land in the regional study area identified within these two classes. Some Class 3 land is present within the regional study area however this only represents 11 per cent of the study area. As outlined in the below section, the land at the two proposal footprints for the regulators is considered to be consistent with the regional characteristics in terms of land and soil capability.

At Hartwood 70 per cent of the proposal footprint is Class 4 land, meaning the land is considered to be of moderate capability and is not overly suitable for cropping and high intensive grazing. The remainder of the land is considered to be either Class 5 or 6.

At Wanganella 97 per cent of the proposal footprint is Class 5 land, meaning that the land is considered to be of moderate to low capability and is largely suitable for grazing only. The remainder of the land is considered to be Class 4 land.

Strategic agricultural land

The NSW Strategic Regional Land Use Policy (DPIE 2012) identifies highly productive land for special consideration when proposed for land use change. There are three types: “critical industry clusters” and “biophysical strategic agricultural land” are established while a third category, “state strategic agricultural land” has recently been publicly exhibited.

The proposal footprint does not include any critical industry clusters or biophysical strategic agricultural land. While not within the proposal footprint there is some state strategic agricultural land located adjacent to both proposed regulators, as shown in Figure 14.1. Some construction elements of the proposals (that is, construction access) is however located within this state strategic agricultural land.



Source: NSW DPI (2022) Draft State Significant Agricultural Land Map

Figure 14.1 Draft SSAL mapping adjacent to Hartwood (left) and Wanganella (right) regulators

Agricultural production and value

As mentioned above, the dominant land use in broader area is grazing. Over 200 businesses control 550,000 sheep and lamb, with a further 150 running 40,000 beef or dairy cattle. A small amount of pork and poultry is also produced, although this is unlikely to be a “grazing” land use.

Cropping is predominantly wheat and barley with sizeable minorities in canola, oats and even rice. Five per cent of the land is divided among other experimental, high-value or heirloom-type crops.

The total of all agriculture types contributes \$326 million to the local economy every year.

14.2.3. Non-agricultural land use

While agriculture is the overwhelmingly dominant land use, there are other incidental or potentially relevant land uses near the proposal footprints for the two regulators.

Residential land uses

There are limited residential land uses in close proximity to both of the regulators. Any residential land uses are generally associated with residential dwellings on agricultural properties.

The nearest dwelling to the Hartwood Regulator is located about 1.8 kilometres from the regulator or 1.2 kilometres from the Forest Creek block bank. The nearest urban centre is Conargo which is about eight kilometres to the west of the proposed regulator.

The Wanganella regulator is located in a predominantly agricultural area, however it is located about 1.0 kilometre south-west of Wanganella Village. The proposed flood bypass channel is located about 500 metres west of the main street of Wanganella. The nearest residential dwellings are located about 500 metres from the flood bypass channel and about 870 metres west of the nearest residential dwelling which is positioned on an agricultural property.

Other land uses

The Wanganella Landfill is located on land adjacent to the flood mitigation drainage channel proposed at Wanganella. The access for this is proposed to form part of the access to the regulator. This facility is small and has a limited range of waste which can be accepted including: bricks, concrete, garden waste; general household waste; oil; steel and tyres.

Crown land and travelling stock reserves

The proposal is positioned on Crown land at both regulators, with those lots located within the proposal footprint outlined in Table 14.1. Four of the impacted Crown land lots are reserved for travelling stock reserves. All travelling stock reserves outlined in Table 14.1 are Category 2 reserves which are used for travelling stock, emergency management or biosecurity purposes. They could also be used for other reasons such as biodiversity conservation, First Nations People's cultural heritage or recreational purposes. Zara Road is Crown land but is managed by Edward River Council.

Table 14.1 Crown land and travelling stock reserves

Regulator	Lot/DP	Reserve number	Reserve purpose	Existing licences
Hartwood	Lot 28 DP756330	R92577	Future public requirements	Grazing
	Lot 27 DP 756330	R30139	Travelling stock reserves	None
	Lot 7301 DP1162488	R30139	Travelling stock reserves	None
	Lot 7304 DP1165043	R987	Travelling stock reserves	None
Wanganella	Lot 7004 DP1024203	R88408	Preservation of Fauna/Public Recreation	None
	Lot 92 DP 756336	R88408	Not specified	None
	Lot 7009 DP 1024201	R58165	Travelling stock reserves	None

Aboriginal Land Claims and Native Title

There are no existing Native Title Claims at Hartwood.

There is an active Native Title Claim at Wanganella, but it is not registered and therefore for the purposes of this report not active.

Both sites include land subject to a number of Aboriginal Land Claims under the *Aboriginal Land Rights Act 1983 (NSW)*. All claims are currently under investigation with no known determination date. It is not clear what impact these claims would have.

14.3. Impact assessment

14.3.1. Construction

General land use impacts

Direct impacts on land use during construction would result from the permanent and temporary land requirements for the proposal and the short-term presence of construction equipment, plant, vehicles, compounds and work sites within the construction footprint. During construction, the use of this land would change from those uses described in section 14.2 to a construction site. Public access to this land (where it is currently available) would be restricted.

During the construction phase, approximately 21.46 hectares of land would be affected across the two sites. The land that would be affected is currently used for:

- grazing native vegetation (14.69 hectares)
- cropping (1.02 hectares)
- irrigated cropping (1.29 hectares) – access tracks located on mapped irrigated cropping land, however utilise existing access tracks
- rivers (4.36 hectares) – this accounts for the new regulators and associated works located within the watercourses.

Agricultural land use impacts

Although mapped as agricultural land in the zoning and land use maps, the actual use of the land required by the proposal largely has no specific land use with most of the land consisting of Crown land.

The construction of the proposal would impact about 15 hectares of land mapped as being for grazing purposes. This reduction would be temporary and is expected to have negligible impact on the value of production across the regional study area.

In addition to the direct impact on agricultural land the proposal has the potential to result in the following key impacts which are described in greater detail (along with other potential, less key, impacts) in Table 4.3 of Appendix O:

- impacts on access to agricultural land uses due to damage of internal roads, blockage of access
- impacts resulting from cutting of fences including mixing of livestock leading to disruptions to planned breeding programs
- impacts due to settlement of dust on adjacent crops and pastures

- impacts from the introduction of weeds and other pests
- impacts due to the reduction in the availability of water from agriculture with Billabong Creek the likely source of water.

The proposal may result in some land being subject to additional inundation by the proposed works, however these areas are relatively minor and localised. The effects of these inundation areas are considered to be negligible.

Non-agricultural land use impacts

Impacts on residential land uses

The proposal would have no direct impact on any urban land, including residential properties on farmland. Due to the proximity to the Wanganella settlement, amenity impacts, including traffic and access, noise and vibration, and visual impacts may be affected. These are outlined in Chapter 15/Appendix P, Chapter 16/Appendix Q and Chapter 17 respectively.

Works may affect the shared access to the Wanganella Landfill but would be managed to ensure the community's access to this facility is maintained at all times.

Although the proximity of the landfill makes it an attractive potential disposal site for waste from the construction, it is considered that the magnitude of the proposed works would likely have a significant impact on the potential capacity and expected life of the small community facility. No disposal of any materials would occur here without previous approval from Edward River Council.

Crown land and travelling stock reserves

Impacts on Crown land (not reserved as travelling stock reserves) are considered minimal as any land to be impacted either has no specific use or the proposed use of land during construction is not considered to impact upon any existing land uses.

Where Crown land is reserved as a travelling stock reserve, there is a potential for construction activities to limit the movement of stock movement along the travelling stock reserves. Any impacts on the use of travelling stock reserves would be minimised through the implementation of mitigation measures outlined in section 14.4.

Aboriginal land claims and Native Title

The proposal would result in works located within lots with Aboriginal land claims. These claims are currently under investigation by DPHI - Crown Lands and are yet to be determined.

Works at Wanganella are located within an active claim area (VC2021/001) referred to as Wamba Wemba. While this application is active, it was not accepted for registration on two occasions in April 2022 and October 2022. As this has not been registered for the purposes of this assessment this claim has not been considered active, however mitigation is proposed to ensure further consideration is made in the event the claim is registered. No native title claims apply to the land at Hartwood.

14.3.2. Operation

General land use impacts

Direct impacts on land use during operation would result from the permanent land requirements for any permanent infrastructure required for the proposal.

About 10 hectares of land would be permanently affected by the proposal, comprising land that is mainly used for the following proposal elements:

- operational footprint of the new regulators
- operational footprint of the Wanganella flood bypass channel
- power supply corridor (above and underground)
- access tracks for operations and maintenance purposes.

The majority of the land impacted is associated with the power supply corridor and this number likely overinflates the area of land required as the power supply corridor would be a combination of above and below ground and alignment has been carefully selected to follow boundary alignments. Operationally, the footprint also includes the new regulators which would be primarily located within Billabong Creek.

The proposal may result in some land being subject to additional inundation by the proposed works, however these areas are relatively minor and localised. The flood impact assessment (see chapter 7) concluded that there is fundamentally no change in the flood characteristics due to the proposals, and flood storage characteristics remain consistent with current conditions. Further, as there is no fundamental change to the flooding conditions the existing emergency management, evacuation and access. Similarly, as there are no changes to the existing flooding there are no impacts to social and economic costs to the community as a consequence of the proposals. The effects of these inundation areas are considered to be negligible.

Agricultural land use impacts

Where possible, land taken out of agricultural use during the construction phase would be returned to the previous condition and therefore the proposal would have virtually no impact once operational. Access tracks and fencing would be constructed and managed in accordance with lease agreements to control stock movement.

Spread and control of weeds and other biosecurity protocols have the potential to impact agricultural use. These impacts would be managed in accordance with relevant legislation as with any agricultural operations on the impacted land.

Land use conflicts can occur when one land use is perceived to infringe upon a neighbouring land use. In rural areas, land use conflicts commonly occur between agricultural and non-agricultural land uses. Given the remote location of the new regulators and the mitigation measures proposed, the land use conflict is considered to be low.

Non-agricultural land use impacts

Urban land use

The proposal is not expected to result in any impacts on any urban land uses including the Wanganella Landfill.

Crown land and travelling stock reserves

Operation is not expected to have any additional impacts beyond those identified during construction. In most cases the operation of the proposal would result in reduced impacts on Crown land.

Impacts on travelling stock reserves during operation are considered to be limited with the only a small number of proposal elements proposed to be permanent within the reserves. This additional infrastructure is likely to only consist of access tracks and isolated power poles which are both unlikely to result in a noticeable reduction in capacity of the travelling stock reserve.

Aboriginal land claims and Native Title

Impacts on Aboriginal land claims and Native Title would be as described during construction, however the amount of land would be reduced with impacts only expected where there is permanent infrastructure present.

14.3.3. Cumulative impacts

Other proposals in the area were reviewed and no cumulative impact risks were identified from a land use viewpoint.

14.4. Mitigation measures

14.4.1. Approach to mitigation and management

The general approach to management of the proposal during construction and operation is outlined in chapter 24.

NSW DCCEEW is committed to minimising the impact of the proposal on property and land use around the sites and is investigating opportunities to reduce impacts where practicable. As prescribed by the SEARs, opportunities would also be implemented, where possible, to improve the overall outcome of the proposal.

The ongoing consultation and engagement programme would involve the local community and land owners. Further details are provided in the consultation report in Appendix E. The potential impacts identified and assessed will be managed and mitigated through a range of measures and strategies recommended in Table 14.2. These will also be supported by the mitigation measure proposed for other topics, notably chapter 15 (traffic and access) and chapter 19 (social).

14.4.2. Summary of management measures

Table 14.2 lists the land use, property and agriculture safeguards and management measures that would be implemented to account for the potential impacts identified in section 14.3.

Table 14.2 Land use, property and agriculture safeguards and management measures

ID	Impact	Environmental safeguards	Responsibility	Timing
LU1	Biosecurity (Weeds and pathogen management)	As part of the CEMP document weed and pathogen management should be documented. Measures must be auditable and linked to management outcomes such as: • identify listed weeds (identified in NSW WeedWise) in the construction area and assess the risk of additional spread prior to relocating topsoil. Implement measures to manage this risk during clear and grade, and reinstatement • to a reasonable extent practicable during the clear and grade phase, check that vehicles and plant equipment are free of soil (dust/clods) and vegetation prior to entry and exit from the construction area • evaluate disturbed areas post-construction and implement rehabilitation in accordance with the appropriate safeguards. To avoid and minimise spread of weeds and pathogens, all vehicles and plant undertaking construction works must be cleaned and free of debris prior to entrance to the site. Plant used within waterways must be cleaned before exiting the site if working between multiple waterways.	Contractor	Pre-construction, construction and operation
LU2	Land use and property impacts, including severance and other impacts on operations	The design and construction planning would continue to be refined to minimise potential impacts on land uses and properties as far as reasonably practicable. Consultation with landholders would be ongoing to identify opportunities to minimise impacts on farming operations where practicable. Property owners and occupants would be consulted in accordance with the communication management plan for the proposal, to ensure that owners/occupants are informed about: • the timing and scope of activities in their area • any potential property impacts/changes, particularly in relation to potential impacts on access, services, or farm operational arrangements • activities that have the potential to impact on livestock. Feasible and reasonable property-specific measures would be identified in consultation with landholders, and implemented during construction, where construction is located on or immediately adjacent to private properties and has the potential to affect farm operational arrangements.	Contractor	Pre-construction and construction

ID	Impact	Environmental safeguards	Responsibility	Timing
LU3	Native Title	Consultation with the claimants of Native Title Claim VC2021/001 would be undertaken to confirm any further plans to get the claim registered. In the event further attempts to register the claim are proposed consultation with the claimant would occur with regards to the proposed works within the claim area.	Contractor	Pre-construction
LU4	Property acquisition and easements	All property acquisition and easements will be carried out in accordance with the <i>Land Acquisition (Just Terms Compensation) Act 1991</i> and in consultation with WaterNSW.	DCCEEW	Pre-construction
LU5	Traffic and access	Landowners will be consulted about access arrangements.	Contractor	Pre-construction / construction
LU6	Reinstatement	Disturbed areas will be revegetated with endemic riparian and floodplain species (replacing like for like) to be undertaken as soon as practical, progressively. Rehabilitation at construction sites to include replacing topsoil. Mature trees removed from the construction footprint will be cut into appropriate sections and relocated adjacent to waterways. Existing woody debris will also be relocated. Any reinstatement plans in proximity to the proposal will be reviewed and approved by WaterNSW beforehand.	Contractor	Construction
LU7	Wanganella Landfill	Access to the Wanganella Landfill is to be maintained at all times. Any loss of public access is to be notified to the community in advance with an alternate access to be provide where possible.	Contractor	Construction
LU8	Wanganella Landfill	Wanganella Landfill is not to be used for the disposal of waste without the prior approval from Edward River Council. It should also only be used for the disposal of materials agreed upon with Council.	Contractor	Construction
LU9	Travelling Stock Reserves	Access along the Travelling Stock Reserves is to be maintained at all times. Where access cannot be maintained, consultation with Local Land Services would be undertaken to confirm any requirements during any full closures of the reserve.	Contractor	Construction
LU10	Travelling Stock Reserves	Consultation with Local Land Services would be undertaken to confirm any specific requirements for works within a travelling stock reserve in relation to their use and any fencing or similar required during construction.	Contractor	Construction

15. Traffic and access

This chapter provides a summary of the transport and traffic impacts of the proposal. It describes the existing transport environment, identifies potential impacts during construction and operation, and provides measures to mitigate and manage the impacts identified. The full assessment report is provided in Appendix P.

15.1. Methodology

The Traffic Impact Assessment was undertaken in accordance with the Guide to Traffic Generating Development (TfNSW 2002). By comparing estimated traffic generation to existing traffic volumes, it is possible to consider the functions and hierarchy of roads. This chapter:

- describes the existing conditions in the transport network
- assesses the impacts of construction and operation of the two proposed new weirs (at Hartwood and Wanganella) using their likely traffic generation, access and other requirements
- includes mitigation measures to address identified issues.

The methodology was as follows:

- review of the proposed or expected routes for construction and operations traffic
- review of public and active transport options in the area
- review of traffic count data from Edward River Council
- review of five-year (2018-2022) crash history for the road network in the study area
- identification of likely traffic generation for construction and operations of the proposal
- assessment of potential additional conflicts attributable to the construction or operation
- assessment of travel time impacts on road users
- identification of any cumulative impacts from other planned works
- identification of mitigation measures for identified impacts.

This assessment was prepared with regard to the following legislative and policy context:

- Austroads Guide to Traffic Management Part 12: Traffic Impacts of Development (Austroads, 2020)
- Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections (Austroads, 2021)
- Guide to Traffic Generating Developments Updated Traffic Surveys (Roads and Maritime, 2013)
- Transport for NSW Traffic Modelling Guidelines (TfNSW 2013)
- Traffic Control and Work Sites Technical Manual (Transport for NSW, 2020).

15.2. Existing environment

This section describes the pre-development situation for the three roads of greatest importance. The private tracks to be used are counted within the site impact assessment and not considered further for impacts on traffic on the public road.

Road network

The two sites are remote and isolated locations accessed along private tracks and local roads. For the purposes of this assessment, the local area has been defined to include surrounding main roads likely also to form part of the immediate route of construction or operational traffic. These are:

- the Cobb Highway, a State Road
- Conargo Road, a Regional Road
- Zara Road (Crown land, managed by Edward River Council).

Cobb Highway is a state road (B75) and is a key route connecting NSW far west communities between Victoria and the Queensland Border. Cobb Highway also connects the Barrier, Mid-Western, Sturt, and Riverina Highways. The majority of Cobb Highway is a sealed single carriageway approximately 6.5 metres wide, refer to Figure 15.1. This road is approved for heavy freight up to B-double length vehicles. The speed limit is 100 kilometres per hour, and there are no dedicated parking, pedestrian, cycle or public transport facilities along most of its route including within the study area. It passes the Wanganella site but due to its local significance may carry some traffic for the Hartwood site also.

Conargo Road is a regional road which connects Deniliquin and Jerilderie via Wandook, Conargo, Hartwood and Coree. It is a sealed single carriageway approximately 6.5 metres wide, refer to Figure 15.2. It is approved for heavy freight up to B-double length vehicles. The speed limit is 70 kilometres per hour. There are no dedicated parking, pedestrian, cycle or public transport facilities along most of its length including within the study area. It passes the Hartwood site but may carry traffic to the Wanganella site also.

Zara Road is an unsealed track local road that runs an east-west alignment, refer to Figure 15.1. Zara Road is Crown land but is managed by Edward River Council. The road's eastern terminus is near Wanganella and its western terminus at the Forest Anabranche. It is not approved for heavy freight use. There are no dedicated parking, pedestrian, cycle or public transport facilities along its length including the study area.

It provides access to the Wanganella site only and would not be expected to take any traffic for the Hartwood site.



Figure 15.1 Cobb Highway View facing north, approaching intersection with Zara Road near Wanganella



Figure 15.2 Conargo Road near Hartwood

Source: Google maps

Existing traffic

Edward River Council supplied traffic counts for four roads, including a western connection to the Cobb Highway, Pretty Pine Road. It is observed that the remote area with disparate land use does not have a defined “peak hour” as with urban commuter situations. While the busiest hour is recorded as “peak” it may not necessarily be the same hour for different roads. This is not considered a concern because construction traffic will also vary depending on the construction phase.

Table 15.1 shows estimated vehicle volume to capacity ratio (vcr) for the passenger car units (pcu) on each road for annual average daily traffic (AADT).

Table 15.1 Existing mid-block volume to capacity ratio – key roads (2022)

Regulator	Road Name	Direction	AADT (pcu)	Existing traffic		Carriageway capacity ¹ (pcu / direction)	vcr (2022)	
				AM Peak (pcu)	PM Peak (pcu)		AM Peak	PM Peak
Wanganella Regulator	Cobb Highway	Southbound	205	21	21	1225	0.017	0.017
		Northbound	205	21	21	1225	0.017	0.017
	Zara Road	Eastbound	8	1	1	200	0.004	0.004
		Westbound	8	1	1	200	0.004	0.004
Hartwood Regulator	Conargo Road	Southbound	441	44	44	1,225	0.036	0.036
		Northbound	441	44	44	1,225	0.036	0.036

Note: AADT = Annual Average Daily Traffic pcu = passenger car units (1 LV = 1 pcu, 1 HV = 2 pcu)

1. It is noted that the original source indicates carriageway capacity using vph. For the purposes of this assessment, the capacity has been assumed to be equivalent to passenger car units (pcu).

Table 15.1 shows that all roads are operating well below capacity, with a maximum use of under four per cent. This is well under the target maximum of 85 per cent, and suggests there is sufficient additional capacity to support traffic associated with construction and ongoing use without additional management.

Road safety

Between the three roads, nineteen crash incidents were reported by the NSW Centre for Road Safety in the previous five years (2018-2022). None were fatal. Most were vehicles leaving the road around a bend or collision with an animal.

Active and public transport

There are no dedicated pedestrian or cycle facilities anywhere in the study area. A short stretch of separated bikeway within the settlement of Conargo is over 15 kilometres from the Hartwood site.

Within the study area only one weekly bus trip (route 999) was identified, using the Cobb Highway, but with all stops within settlements.

15.3. Impact assessment

15.3.1. Construction

Road network

No direct changes to the road network are anticipated such as temporary closures or diversions.

Upgrades to some site access tracks are expected. This would include locations where access tracks connect to Zara Road and the Cobb Highway at Wanganella and Conargo Road at Hartwood. A new site access is proposed at Hartwood to access the Forest Creek block bank site. This would require a new access from Conargo Road to be constructed. Disruption to the road network is expected to be very minor and take only a few days at most at these intersections.

Parking of all vehicles would be within the proposal sites and have no effect on the road network.

No dangerous or hazardous goods are proposed to be transported for this proposal. If dangerous or hazardous goods are transported, it must be in accordance with relevant standards and codes and measures included within the traffic management sub-plan, outlined in Table 15.3.

Traffic generation

Various vehicle types are required for the construction stage. This will include light vehicles, trucks in various sizes and purposes with the larger vehicles potentially including 31 tonne concrete mixers, 45 tonne quarry trucks, and up to 100 tonne cranes.

The number of people on site will vary over time as different phases of construction occur – some requiring more labour than others. Most of the discrete tasks are sequential and cannot be completed concurrently or in any other order. The total construction period is expected to be around 18 months, with the majority of works taking place in the dry season.

At Hartwood, the peak workforce is estimated at 26 personnel for a period of 80 days. At Wanganella, an estimated eight additional workers are required to construct the flood mitigation channel. This is conservatively assumed to coincide with the likewise 26 personnel for 80 days for the main regulator and fishway construction. This gives a peak workforce of 34 at the Wanganella site.

The existing road traffic volumes presented in Table 15.1 are compared to the construction traffic predicted to be generated by the proposal in Table 15.2.

Table 15.2 Forecast increase in peak hour two-way traffic volumes – 2025 with construction

Regulator	Road Name	Direction	Capacity ¹ (pcu / direction)	Existing traffic (2022)		2025 during Construction			
				vcr		Traffic Volume		vcr	
				AM Peak	PM Peak	AM Peak (pcu)	PM Peak (pcu)	AM Peak	PM Peak
Wanganella Regulator	Cobb Highway	South-bound	1225	0.017	0.017	69	69	0.056	0.056
		Northbound	1225	0.017	0.017	69	69	0.056	0.056
	Zara Road	Eastbound	200	0.004	0.004	49	49	0.244	0.244
		Westbound	200	0.004	0.004	49	49	0.244	0.244
Hartwood Regulator	Conargo Road	South-bound	1225	0.036	0.036	83	83	0.068	0.068
		Northbound	1225	0.036	0.036	83	83	0.068	0.068

LEGEND  Free flow Congested

Note: AADT = Annual Average Daily Traffic pcu = passenger car units (1 LV = 1 pcu, 1 HV = 2 pcu)

1. It is noted that the original source indicates carriageway capacity using vph. For the purposes of this assessment, the capacity has been assumed to be equivalent to passenger car units (pcu).

Traffic generation during construction will be a mix of light and heavy vehicles and expected to be evenly split between the north and south directions of travel from the two sites. As shown in Table 15.2, the surrounding road network has ample existing capacity therefore the traffic level of service will not be substantially affected by the additional traffic from the proposal.

Road safety

A desktop assessment of sight distances at key intersections in the journey plan of construction traffic shows that most have adequate view to maintain safety. However, the southbound view of drivers using the Cobb Highway access to the Wanganella Regulator site is obstructed and does not meet the standard distance for cars or trucks. This is not generally considered a problem due to the low number of vehicles projected to use this access, so signage to warn regular users of the road of the potential for unusual activity is considered sufficient. It is recommended to install signage as the traffic management strategy for this access.

Active and public transport

The nature of the proposal and the operation, as well as the remote location of the site means active is not likely to form any significant part of construction traffic.

Bus route 999 is not considered to impact or be impacted by construction or traffic in any significant way.

15.3.2. Operation

A limited range of activities would be required to operate the proposal as it would be operated from a remote control centre. Traffic generation during operations is therefore expected to be minimal. After the construction phase, normal operations would require around one trip per week. For the first two years, commissioning of the fishway would require an additional trip per week. These are not fixed numbers and will fluctuate throughout the year. Operation would involve monthly monitoring and tours as well as regular maintenance on the structure and machinery. In summary, on average the operation and maintenance of the proposal would generate up to one inbound and outbound vehicle movement per day.

Operation of the proposal therefore is not anticipated to have an impact on the capacity of the road network or active and public transport.

15.3.3. Cumulative Impacts

The other projects planned in the study area were reviewed to determine if the proposal has the potential to result in significant cumulative impacts. No potential cumulative impacts relevant to traffic were identified. As such, no further cumulative assessment was conducted.

15.4. Mitigation measures

15.4.1. Approach to mitigation and management

The general approach to management of the proposal during construction and operation is outlined in chapter 24.

As outlined in section 3.6 the alignment of access tracks will be refined during detailed design, in agreement with landowners, Edward River Council and Crown Lands, where appropriate. Refinements could include minor changes to access track alignments to improve sight distances onto public road.

Construction impacts would be managed through development of the construction traffic management sub-plan, prior to construction. This would be carried out as the construction methodology and agreements with land owners are finalised.

15.4.2. Summary of management measures

Table 16.6 lists the traffic and transport safeguards and management measures that would be implemented to account for the potential impacts identified in section 16.3.

Table 15.3 Traffic impact mitigation measures

ID	Impact	Environmental safeguards	Responsibility	Timing
TA1	Impacts to traffic and transport networks	Develop a construction traffic management sub-plan, prior to construction. The plan shall detail: - the potential impacts/delays associated with the development. - the works required to the existing road infrastructure. - the measures to be implemented to maintain the standard and safety of the network. - the procedures to monitor and ensure compliance. The plan will include, at a minimum, the following management measures: - preparation of a Traffic Guidance Scheme, detailing adequate road signage at construction work sites to inform motorists and pedestrians of the work site ahead to ensure that the risk of road accidents and disruption to surrounding land uses is minimised - maintain accessibility for pedestrians and cyclists - indicate routes to be used by heavy construction-related vehicles to minimise impacts on sensitive land uses and businesses - implement measures to manage traffic flows around the area affected by the construction of the proposal, including, as required, regulatory and direction signposting, line marking, and variable message signs and all other traffic control devices necessary for the implementation of the construction traffic management sub-plan - undertake consultation with the relevant road authorities during preparation of the sub-plan. Ensure the performance of proposal traffic arrangements is monitored during construction.	Contractor	Pre-construction
TA2	Safety implications arising from the general increase in traffic volumes	Protection shall be provided through advanced warning of roadworks, speed changes, safety barriers with adequate offsets and deflection allowance, where necessary. The construction TMP shall cover strategies to manage vehicular flow to facilitate the safe movement of road users (i.e. workers and staff, and the general public – pedestrians, cyclists, and other non-proposal vehicles) within, around, and to/from the proposal footprint.	Contractor	Construction and operation

ID	Impact	Environmental safeguards	Responsibility	Timing
TA3	Increase in heavy vehicles	All deliveries shall be scheduled and coordinated to facilitate the organised arrival of trucks. Ample space and time shall be allotted for the safe loading and unloading of materials. All parking and queueing (if any) shall be contained within the proposal footprint.	Contractor	Construction and operation
TA4	Damage on roads along haulage and access routes resulting from the movement of proposal vehicles	The conditions of the access roads to the proposal's footprint, and of the roads linking the proposal sites to the existing freight network used for freight transport shall be assessed by a Road Dilapidation Report prior to construction commencing and following completion of construction. Any defects attributable to construction activities shall be rectified or compensated in consultation with the relevant road authorities.	NSW DCCEEW / Contractor	Construction
TA5	Environmental impacts associated with the movement of vehicles	Monitor the roads leading to and from the proposal footprint and take necessary steps to rectify any road deposits caused by site vehicles as soon as reasonably practicable, to maintain the safety of road users. Where possible, offset the construction vehicle activity from peak periods of road network activity.	Contractor	Construction
TA6	Environmental impacts associated with the movement of vehicles	Induct employees and contractors to raise awareness and understanding of traffic and transport mitigation measures to be implemented during construction via the CEMP.	Contractor	Construction
TA7	Impacts to road infrastructure	Undertake the necessary upgrades and construction of vehicular access tracks to provide safe and efficient movement of light and heavy vehicles to the proposal sites.	Contractor	Pre-construction

16. Noise and vibration

This chapter provides a summary of the noise and vibration impact assessment. It describes the applicable noise and vibration criteria and the existing noise environment, identifies potential impacts during construction and operation, and provides measures to mitigate and manage the impacts identified. The full assessment report is provided in Appendix Q.

16.1. Methodology

The noise and vibration impact assessment was undertaken in accordance with the key assessment guidelines listed below. Other assessment guidelines relevant to the noise and vibration impact assessment are referenced in Appendix Q

- *Assessing Vibration: a technical guideline* (DEC 2006), for assessment of vibration impacts on human comfort during construction
- *Interim Construction Noise Guideline* (ICNG) (DECC 2009), for assessment of construction noise
- *Noise Policy for Industry* (NPfI) (NSW EPA 2017), for assessment of operational noise.

This chapter assesses the impacts of noise and vibration during the construction and operation of the proposal, and includes mitigation measures to address identified issues. The study area for the noise and vibration impact assessment comprises the area approximately 1.5 kilometres from all elements of the proposal (including work areas). Noise and vibration sensitive receivers were identified within this study area and classified based on their type (see section 16.2.1).

The construction noise and vibration assessment was undertaken using the following methodology:

- review the proposed construction activities, equipment, work areas and construction hours for the proposal
- establish the noise management levels (NMLs) for each receiver type in accordance with the ICNG
- based on the worst-case construction activities for each work area, undertake a screening assessment to identify where NMLs have the potential to be exceeded
- identify whether NMLs can be exceeded at any sensitive receivers near access tracks and the power lines (short-term works)
- where the NMLs have the potential to be exceeded at sensitive receivers near each main work site (long-term works), undertake detailed noise modelling to predict noise levels based on indicative construction scenarios and likely equipment to be used for each scenario
- establish safe working distances for vibration intensive equipment and identify any sensitive receivers that fall within these distances.

The operational noise and vibration assessment was undertaken using the following methodology

- establish the operational noise criteria in accordance with the NPfI
- identify sound power levels of noise-generating equipment that would be installed as part of the proposal
- undertake qualitative assessment of potential operational impacts based on identified sound power levels (see above dot point).

A construction road traffic noise assessment was undertaken in accordance with the *NSW Road Noise Policy* (DECCW 2011b). An operational road traffic noise assessment was not undertaken as additional traffic generation during the operation of the project is anticipated to be negligible (refer to Chapter 15 – Traffic and access).

16.2. Existing environment

16.2.1. Sensitive receivers

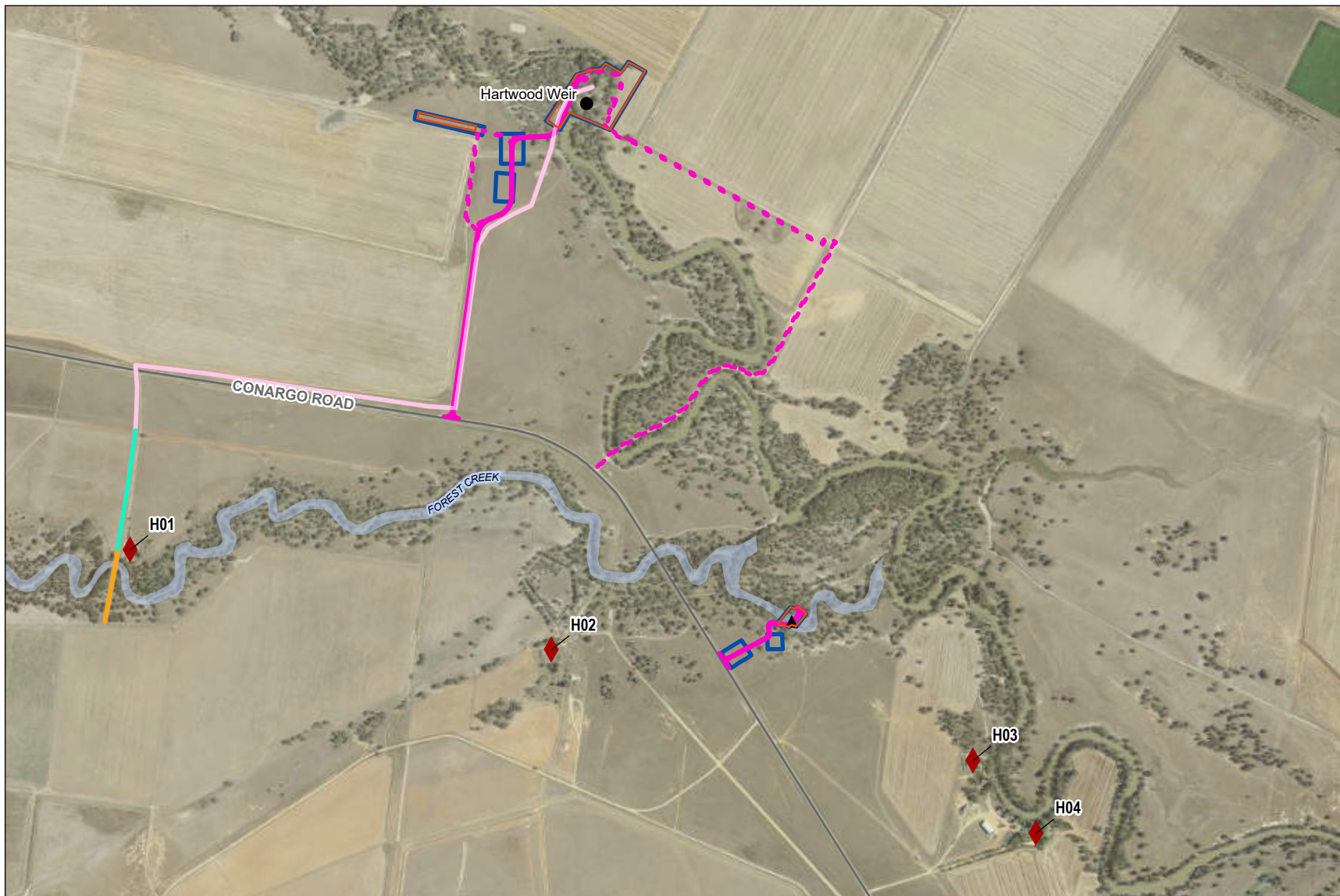
Receivers sensitive to noise and vibration can be categorised as residential and non-residential land uses (for example schools or hospitals). All identified receivers have been assumed to be residential land uses based on a desktop review using aerial imagery. This is a conservative approach as the noise criteria for residential land uses is more stringent than for non-residential land uses.

Twenty-six sensitive receivers have been identified within the study area; four in Hartwood and 22 in Wanganella. The location of the proposal and identified sensitive receivers is shown in Figure 16.1 (Hartwood) and Figure 16.2 (Wanganella).

16.2.2. Existing noise environment

The proposal site is located in a rural setting at both Hartwood and Wanganella with limited development in close proximity which has the potential to impact the background noise levels. The acoustic environment is dominated by natural sounds with the occasional vehicle on nearby roads or on adjacent rural properties.

Noise monitoring has not been undertaken to determine the rating background levels for the assessment as it is expected that the existing background noise levels would be below the minimum rating background levels prescribed in the NPfI. These minimum rating background levels are 35 L_{A90} dBA for the day (7am – 6pm), 30 L_{A90} dBA for evening (6pm – 10pm), and 30 L_{A90} dBA for night (10pm – 7am).



Proposal

Construction Activity Zone

Clearing Area

Power Supply

Power Supply

Power Supply (Existing aboveground)

Power Supply (to run underground)

Power Supply Buffer

Access Tracks

Construction Only

Construction plus O&M

Existing Features

Existing weir

Existing Block Bank

Water bodies

Roads

Receivers

N

GDA2020 MGA Zone 55

A4 Scale: 1:20,000

0 200 400 600

Metres

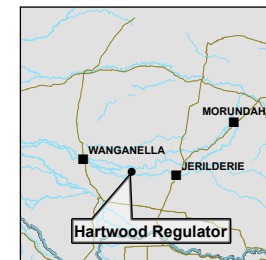


Figure 16.1 Hartwood proposal site and sensitive receivers



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Figure 16.2 Wanganella proposal site and sensitive receivers

16.3. Criteria

16.3.1. Construction noise

Construction NMLs vary based on the time of day. The NMLs at sensitive receivers in the study area are summarised in Table 16.1 and are based on the use of the minimum rating background levels having been adopted for all residential receiver locations. Note should be made that all works for the proposal are currently proposed to be undertaken during standard hours only, with the outside of standard hours NMLs been provided for reference purposes only.

Table 16.1 Construction noise management levels

Sensitive receiver type	Construction Noise Management Levels, $L_{Aeq(15min)}$, dBA				
	Standard construction hours		Outside standard construction hours		
	Noise affected	Highly noise affected	Day	Evening	Night
All residential receivers	45	75	40	35	35

16.3.2. Construction vibration

The assessment of construction vibration was undertaken though identifying safe working distances of different construction equipment.

Table 16.2 outlines the safe working distance for vibration intensive equipment in accordance with Transport for NSW's *Construction Noise and Vibration Strategy* (TfNSW 2019) as outlined in the SEARs.

Table 16.2 Vibration safe working distances

Equipment	Human comfort (OH&E Vibration guideline)	Cosmetic damage (BS 7385)
Piling rig – Bored <800 mm	N/A	2 m (nominal)
Piling rig–Hammer (12 t down force)	50 m	15 m
Piling rig – Vibratory (sheet piles)	20 m	2 m to 20 m
Vibratory roller (>18 tonnes)	100 m	25 m
Vibratory roller (13-18 tonnes)	100 m	20 m
Vibratory roller (7-13 tonnes)	100 m	15 m
Vibratory roller (4-6 tonnes)	40 m	12 m
Vibratory roller (2-4 tonnes)	20 m	6 m
Vibratory roller (1-2 tonnes)	15 m	5 m
Small hydraulic hammer 300 kg (5-12t excavator)	7 m	2 m
Medium hydraulic hammer 900 kg (12-18t excavator)	23 m	7 m
Large hydraulic hammer 1600 kg (18-34t excavator)	73 m	22 m
Jackhammer (handheld)	Avoid contact with structure	1 m (nominal)

16.3.3. Road traffic noise

The NSW Road Noise Policy (DECCW 2011b) provides road traffic noise criteria for residential land uses affected by additional traffic on the public road network. Section 3.4.1 of the NSW Road Noise Policy states that any increase in the total noise level at existing residences and other sensitive land uses affected by traffic generation on existing roads should be limited to 2 dBA above current levels.

16.3.4. Operational noise

The NPfI provides guidance on the assessment of operational noise impacts. The intrusiveness noise level controls the relative audibility of operational noise compared to the background level at residential receivers. The amenity noise level limits the total level of external noise for all receiver types. Both levels are calculated and the lower of the two in each time period is set as the project noise trigger level.

For residential receivers, the project noise trigger levels are provided in Table 16.3.

Table 16.3 Project noise trigger levels – residential noise receivers, dBA

PNTL $L_{Aeq(15min)}$ at residential receivers	Assessment period		
	Day	Evening	Night
Intrusive noise level	40	35	35
Project amenity noise level	48	43	38
Project noise trigger level	40	35	35

16.4. Impact assessment

16.4.1. Construction

Construction noise impacts

Hartwood Regulator

The predicted construction noise levels at each sensitive receiver within the Hartwood Regulator study area are presented in Table 16.4. Works at the Hartwood Regulator would not result in the exceedance of criteria for the majority of receivers. The exception to this is at receiver H01 where the criteria would be exceeded for construction scenario S4. This impact is not expected to result in an exceedance of the criteria for any prolonged period of time as the construction of the power supply route moves along the alignment to a distance where exceedances are not expected.

No receivers are predicted to experience noise levels above the highly noise affected level of 75 dBA.

Table 16.4 Predicted construction noise levels at sensitive receivers at Hartwood, $L_{Aeq(15min)}$ dBA

Receiver ID	Regulator piling works	Regulator works (non-piling)	Site access (clearing/upgrade works)	Power supply route
	S1	S2	S3	S4
H01	35	30	35	47
H02	35	40	44	38
H03	30	41	40	28
H04	28	36	36	26

Wanganella Regulator

The predicted construction noise levels at each sensitive receiver within the Wanganella Regulator study area are presented in Table 16.5. Where the standard hours NML of 45 dBA is predicted to be exceeded, the cell has been shaded in grey.

Exceedance of the criteria is only expected at five receivers, W02 to W06. All other receivers are not expected to experience construction noise impacts. Exceedances at W02, W03, W04 and W06 would be a result of construction scenario S3 (site access works) due to the proposed access works located just west of Wanganella. This exceedance is for works at their closest point and as the works move west away from the receivers the noise levels would decrease. Additionally, the noise intensive duration of these works is

expected to be approximately one week in length, therefore, the predicted exceedances are expected to be very temporary in nature.

Predicted exceedances at receiver W05 would occur as a result of construction scenarios S1 (regulatory piling works) and S4 (power supply route). These expected exceedances are linked to works which would be short term in nature (construction scenario S1) or would occur in a linear fashion (construction scenario S4) meaning the exceedances are expected to reduce as the works move away from the receiver.

No receivers are predicted to experience noise levels above the highly noise affected level of 75 dBA.

Table 16.5 Predicted construction noise levels at sensitive receivers at Wanganella, $L_{Aeq}(15min)$ dBA

Receiver ID	Regulator piling works	Regulator works (non-piling)	Site access (clearing/upgrade works)	Power supply route	Flood relief channel clearing works	Flood relief channel earthworks
	S1	S2	S3	S4	S5	S6
W01	39	33	40	32	41	41
W02	44	38	52	40	40	40
W03	40	35	53	38	42	42
W04	44	38	49	40	39	39
W05	47	41	44	46	39	39
W06	39	34	48	37	39	39
W07	43	37	45	39	38	38
W08	43	37	45	38	38	38
W09	42	36	43	37	38	38
W10	42	37	43	38	37	37
W11	43	37	43	39	37	37
W12	44	38	38	41	35	34
W13	42	36	40	38	36	35
W14	44	38	37	41	34	33
W15	41	36	39	37	35	35
W16	38	34	38	36	35	35
W17	40	35	38	36	34	34
W18	42	36	35	38	32	32
W19	41	35	37	37	34	34
W20	40	35	36	36	33	33
W21	40	34	36	35	33	32
W22	36	31	33	32	30	30

Construction vibration impacts

Human comfort

The most vibration intensive activity associated with the construction works are anticipated to be vibratory rolling works with a roller up to 18 tonnes. Rolling activities have the potential to exceed the human comfort vibration criteria should these works occur within 100 metres of residences. No residences have been identified within 100 metres of the main work sites at Hartwood or Wanganella, therefore no adverse human comfort vibration impacts are anticipated.

However, two receivers in Wanganella (W02 and W03) have been identified to be within 100 metres of the site access tracks. These receivers may experience human comfort impacts should vibratory rolling work occur within 100 metres of these dwellings. This would be a temporary impact as the works are linear in nature and vibration levels would decrease as the construction equipment moves away from the receiver.

Structural damage

Rolling activities (vibratory roller up to 18 tonnes) have the potential to exceed the structural damage vibration criteria should these works occur within 20 metres of any buildings. No buildings have been identified within 20 metres of any elements of the proposal (at both Hartwood or Wanganella), and as such no adverse structural damage vibration impacts are anticipated.

Road traffic noise impacts

During construction, two receivers are located within the distance where exceedance of the 55 dBA criteria is exceeded, however they would not be subject to a relative increase of greater than 2 dBA and therefore impacts are not expected.

16.4.2. Operational noise impacts

Operational noise

Based on the expected operation of the Hartwood and Wanganella Regulators, noise emissions from the sites are expected to be minimal and comparable to the existing weirs. Therefore, qualitative assessment has been undertaken.

The nearest receiver to each regulator is approximately 750 metres away. The primary operational noise would be hydraulics adjusting the Regulators to change the flow rate. A noise-generating source would need to have a minimum sound power level of 101 dBA to exceed the 35 dBA operational trigger level at a distance of 750 metres. Based on the distance between nearby noise sensitive receivers, and the expected operational equipment on site, it is expected that operational equipment can be designed to comply with the operational noise criteria.

Road traffic noise impacts

During operation, the proposals would have low vehicle movements which would not result in relative increase in noise levels of greater than 2 dBA.

16.4.3. Cumulative impacts

NSW DCCEEW are undertaking the Yanco Creek Modernisation Project (Part1b: Wanganella Swamp) which is located four kilometres south east of the Wanganella Regulator. The construction of both projects is expected to be at a similar time however due to the distance between the projects, cumulative impacts are not expected as a result of no shared receivers between the projects.

16.5. Mitigation measures

16.5.1. Approach to mitigation and management

NSW DCCEEW is committed to minimising the environmental impact of the proposal and is investigating opportunities to reduce impacts where practicable. As prescribed by the SEARs, opportunities would also be implemented, where possible, to improve the overall outcome of the proposal.

The approach to mitigation and management would also be guided by the following:

- The Interim Construction Noise Guideline identifies that, due to the nature of construction, it is inevitable that impacts arise where construction occurs near sensitive receivers. During construction there would be noise impacts on some receivers during certain times and during certain construction activities.
- Where noise is above the construction noise management levels, all feasible and reasonable work practices to minimise noise would be implemented, and all potentially affected receivers would be informed.
- Operational noise generating equipment should be selected or designed to comply with the operational noise criteria identified in this assessment.

16.5.2. Summary of mitigation measures

Table 16.6 lists the noise and vibration safeguards and management measures that would be implemented to account for the potential impacts identified in section 16.3.

Table 16.6 Noise and vibration safeguards and management measures

ID	Impact	Environmental safeguards	Responsibility	Timing
NV1	Construction hours and scheduling	Where feasible and reasonable, construction would be carried out during the ICNG standard daytime working hours. Work generating high noise and/or vibration levels would be scheduled during less sensitive time periods.	NSW DCCEEW / Construction contractor	During construction
NV2	Construction noise	The use of quieter and less vibration emitting construction methods would be considered and implemented, where feasible and reasonable.	NSW DCCEEW / Construction contractor	Before and during construction
NV3	Construction noise	As much distance as possible would be placed between the plant or equipment and residences and other sensitive land uses, where possible.	NSW DCCEEW / Construction contractor	Before and during construction
NV4	Construction noise	Reduce throttle setting and turn off equipment when not being used.	Construction contractor	During construction
NV5	Construction noise	Selection of equipment which is of an appropriate size and power for the task would be undertaken where possible.	NSW DCCEEW / Construction contractor	Before and during construction
NV6	Impacts from deliveries	Loading and unloading of materials/deliveries would occur as far as possible from sensitive receivers.	NSW DCCEEW / Construction contractor	During construction

ID	Impact	Environmental safeguards	Responsibility	Timing
NV7	Impacts from deliveries	Delivery vehicles would be fitted with straps rather than chains for unloading, wherever possible.	NSW DCCEEW / Construction contractor	During construction
NV8	Impacts from deliveries	Out of hours movements would be avoided or minimised where possible.	NSW DCCEEW / Construction contractor	During construction
NV9	Vibration impacts	Where required, limit the size of the vibratory compactor to maintain the safe work buffer distances.	NSW DCCEEW / Construction contractor	During construction
NV10	Notification to affected residences	Where site establishment works at site access tracks (vegetation clearing or upgrade of tracks) would occur within 700 metres of residences, the affected residences would be notified a minimum of 7 days prior to work including: - a description of the works to be undertaken including its timing and duration - the expected noise levels during the works - a contact number for further information or for complaints.	NSW DCCEEW / Construction contractor	Pre-construction
NV11	Construction traffic noise	Reduce the speed of vehicles when approaching sensitive receivers.	Construction contractor	Construction
NV12	Construction traffic noise	With the exception of delivery of oversized plant or structures, schedule deliveries to nominated hours only.	Construction contractor	Construction
NV13	Construction traffic noise	Optimise the number of vehicle trips to and from site – movements can be organised to amalgamate loads rather than using a number of vehicles with smaller loads.	Construction contractor	Construction
NV14	Construction traffic noise	Limit access routes to the site to the designated routes.	Construction contractor	Construction
NV15	Construction traffic noise	Manage driver behaviour and avoidance of the use of engine compression brakes.	Construction contractor	Construction
NV16	Operational noise	Mechanical plant should be designed to meet the Noise Policy for Industry project noise trigger levels.	NSW DCCEEW / Contractor	Detailed design
NV17	Operational noise	Mechanical plant should be well maintained and operate in an efficient manner. This is to limit any excess noise generation that may arise when plant is not functioning correctly.	NSW DCCEEW / Contractor	Detailed design

17. Visual amenity

This chapter describes the existing visual amenity in the study area, and potential impacts associated with the proposal. It qualitatively assesses the potential impacts of construction and operation of the proposal on visual amenity for sensitive receivers, and provides recommended mitigation and management measures.

17.1. Methodology

This assessment considers the effects of the proposal on visual amenity for sensitive receivers.

A qualitative assessment was carried out to provide an understanding the relative physical differences between the current visual environment and that of the environment with the new regulators.

The methodology for this visual amenity assessment involved:

- site inspections and desktop analysis to:
 - assess the study area’s visual amenity
 - identify sensitive receivers
 - identify sensitive viewpoints
 - undertake site photography
- qualitative assessment of potential visual amenity impacts, including impacts to:
 - key views
 - the existing weirs
 - heritage places
- provision of mitigation measures to manage potential visual impacts of the proposal.

For further discussion on Aboriginal places, non-Aboriginal heritage, and community impacts refer to chapter 12 (Aboriginal heritage), chapter 13 (non-Aboriginal heritage) and chapter 19 (Social), respectively.

17.2. Existing environment

17.2.1. Landscape

The proposal is located on Billabong Creek, which is part of the Yanco Creek system in south-west NSW. The Yanco Creek system forms a part of the Murray-Darling Basin. The Yanco Creek System is located in the NSW Riverina and comprises a creek and floodplain system that commences at the Murrumbidgee River. The landform is generally floodplain with some sandhills adjoining the creek. Extensive vegetation clearing has historically occurred for agriculture and infrastructure across the landscape.

The gradient across the study area is gentle, falling about 19 metres over some 70 kilometres (as a straight line from the Hartwood to Wanganella Weir).

Vegetation in the study area generally consists of River Red Gum forest fringing along the waterways, transitioning to Black Box woodland upslope of the creeks. Areas at higher elevations support flood tolerant woodland, native grassland, and chenopod shrublands located on rarely flooded terraces that grade into shrubland and native grasslands on surrounding alluvial plains. Pockets of remnant Cypress Pine woodland also exist on sandy soils and elevated dunes. For further discussion of vegetation at the proposal site refer to chapter 11 (Terrestrial ecology).

Wanganella

The area immediately surrounding the Wanganella proposal area are shown in photos below. Figure 17.1 shows the landscape around Billabong Creek looking south from the location of the existing weir. This shows flat pasture land, with scattered shrubs, with trees located along the creek line. Figure 17.2 is looking east from the weir on the northern side of the creek from within the Wanganella Camping Reserve. Figure 17.3 provides an aerial view of the proposal site at Wanganella showing the riparian vegetation bounding the creek, and the existing access track to the camping reserve on the north side of the creek.



Figure 17.1 Looking south from Wanganella Weir



Figure 17.2 North side of Billabong Creek at the Wanganella Camping Reserve



Figure 17.3 Aerial view of Wanganella Weir

Hartwood

The Hartwood proposal site is surrounded by a thin strip of riparian habitat along Billabong Creek. Beyond the creek is mainly primary production land and pasture. A few settlements and farms are scattered across the landscape, including properties at 4483 Conargo Road and 4253 Conargo Road which are the closest to the proposal site. The surrounding area is traversed by a number of minor roads and overhead power lines.

Figure 17.4 illustrates the riparian landscape surrounding the existing weir. Figure 17.5 show a typical view to the east of the surrounding flat agricultural land and agricultural infrastructure. Figure 17.6 provides an aerial view of the riparian habitat surrounding the proposal site.



Figure 17.4 Looking south to Hartwood Weir

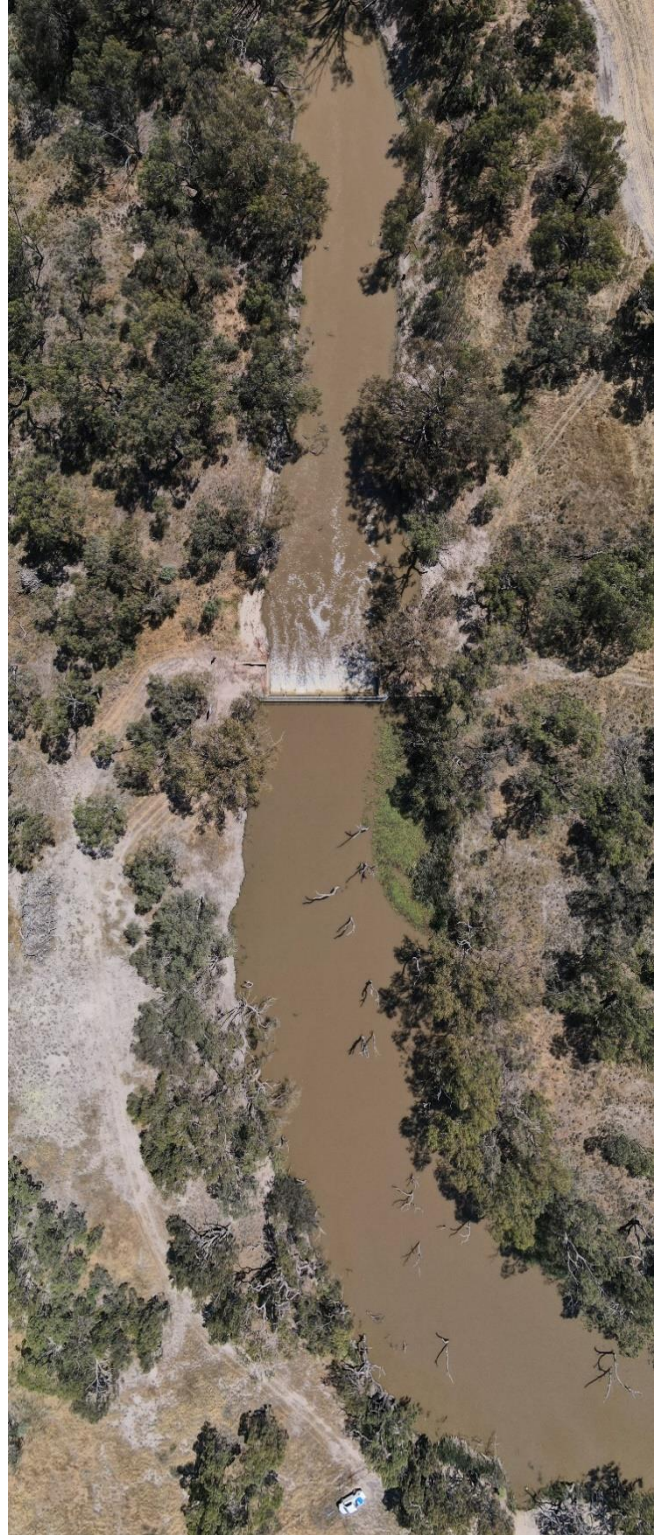


Figure 17.6 Aerial view of Harwood Weir and adjacent area



Figure 17.5 Pastureland and irrigation channel south-west of proposal site, looking east

17.2.2. Local community, public amenity and key sites

The land use surrounding the proposal site comprises mainly agricultural fields with a corridor of intact riparian vegetation along Billabong Creek. The agricultural areas include irrigation infrastructure, pumpstations, borrow pits, access tracks, power lines and fencing. Further details on agricultural land use are provided in chapter 14.

Billabong Creek, shown in Figure 17.7 and Figure 17.8, is a key landscape feature in the study area. It attracts local and regional visitors for recreation and tourism, including creek-based activities such as walking, biking, kayaking, camping, bird watching and fishing.

Wanganella Village, see Figure 17.9 is located around one kilometre north-east of Wanganella Weir. A few settlements and farms are scattered across the wider area, the closest of which is around one kilometre to the east. The existing Wanganella Village landfill, a small rural waste tip is located around 0.5 kilometres north of the weir. The surrounding area is traversed by a number of minor roads and overhead power lines.

Wanganella Camping Reserve, shown in Figure 17.10 features an open space to camp and picnic. The camping reserve is located within the proposal site and therefore public access is available at this location currently and will be available on completion of the proposal. It features camping tables located near to the existing weir and access tracks throughout. Wanganella Weir is a distinctive feature of the Wanganella Camping Reserve. There are camping tables provide near the existing weir, as shown in Figure 17.2. A camp and caravan park including facilities such as toilets is located south of Wanganella Village, around 0.5 kilometres east of the weir.



Figure 17.7 Billabong Creek near Wanganella Weir from the left bank



Figure 17.8 Billabong Creek near Wanganella Weir looking upstream



Figure 17.9 Wanganella Village looking south from the Cobb Highway



Figure 17.10 View of Wanganella Weir from Wanganella Camping Reserve

Public access is not provided to the area of Hartwood Weir and there are no public facilities in the vicinity of the weir. Apart from Billabong Creek, there are no key sites of note in this area. Other features on the landscape include agricultural plant such as the pump station located around 50 metres south of the weir (refer to Figure 17.11), and overhead power lines (refer to Figure 17.12).



Figure 17.11 Agricultural pumpstation, south of proposal site



Figure 17.12 Agricultural drainage channel and power line

17.2.3. Existing weirs

The existing Wanganella Weir has a dilapidated appearance resulting from its degraded concrete structures, as shown in Figure 17.10. The highest point of the structure is positioned at close to ground level, with just the top of the piers protruding above the ground and the high water level.

Hartwood Weir also has a dilapidated appearance resulting from its degraded concrete structures. The majority of the weir is positioned close to ground level, however a steel walkway and signage protrudes above the ground and water level (refer to Figure 17.13).

Forest Creek block bank comprises an existing rock and soil bank with an access track across the top, as shown in Figure 17.14. The bank is integrated into the surrounding environment with no significant features detracting from the rural nature of the surrounds.



Figure 17.13 Hartwood Weir footbridge and signage



Figure 17.14 Forest Creek block bank

17.2.4. Heritage

Chapter 12 outlines the Aboriginal heritage associated with the proposal sites. A number of Aboriginal heritage features have been identified within and near the proposal sites. These sites comprise seven modified trees, three earth mounds and one modified tree and associated with a Potential Archaeological Deposit.

As discussed in chapter 13 (Non-Aboriginal heritage, Hartwood Weir is listed in WaterNSW's Heritage and Conservation Register prepared under section 170 of the *Heritage Act 1977*. Although in a degraded condition, Hartwood Weir has historical, representative, cultural and associative heritage values under the NSW heritage criteria. The words 'Feb 1916 A.C. Fitznead Engineer' are engraved in the concrete on the right bank abutment, indicating the date of construction and supervising engineer. Hartwood Weir has been assessed as being of local significance, despite its poor conditions.

Despite Wanganella Weir's poor condition, the weir has been assessed as providing tangible evidence of the social aspect of community water management infrastructure within the local region. Wanganella Weir has local heritage significance. The weir is not currently listed, but has been assessed as being of local heritage significance as it meets criterion D (social).

17.2.5. Viewpoints and sensitive receivers

In order to identify potential change of views as a result of the proposal. A number of viewpoints have been selected to appropriately represent:

- views that are in close proximity to the proposal site
- viewers that may have prolonged views of the proposal
- views of assets with high visual amenity (e.g. the creek or a heritage structure).

Other than the works proposed to take place in the Wanganella Camping Reserve, the main construction areas would be set back from nearby roads and would be generally screened from public viewpoints by trees. Works undertaken in the Wanganella Camping Reserve would be limited to a small area of the recreation reserve to limit potential visual impacts to users of the reserve.

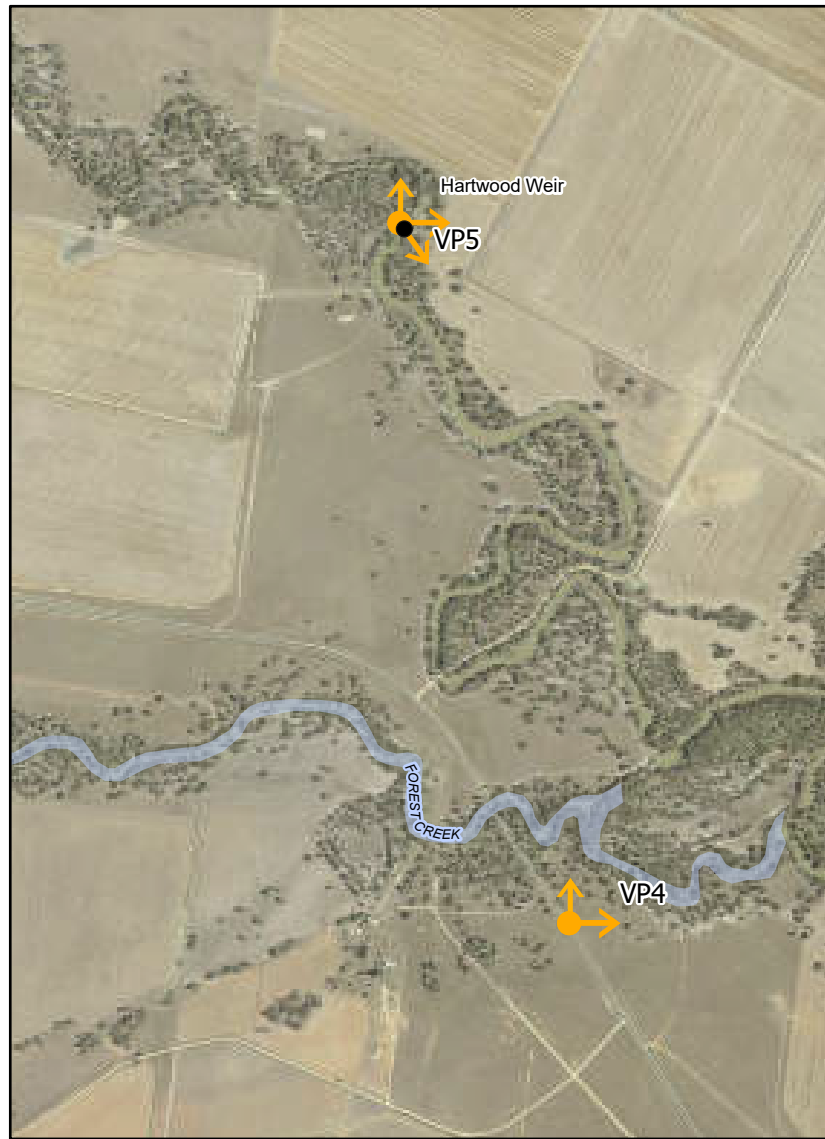
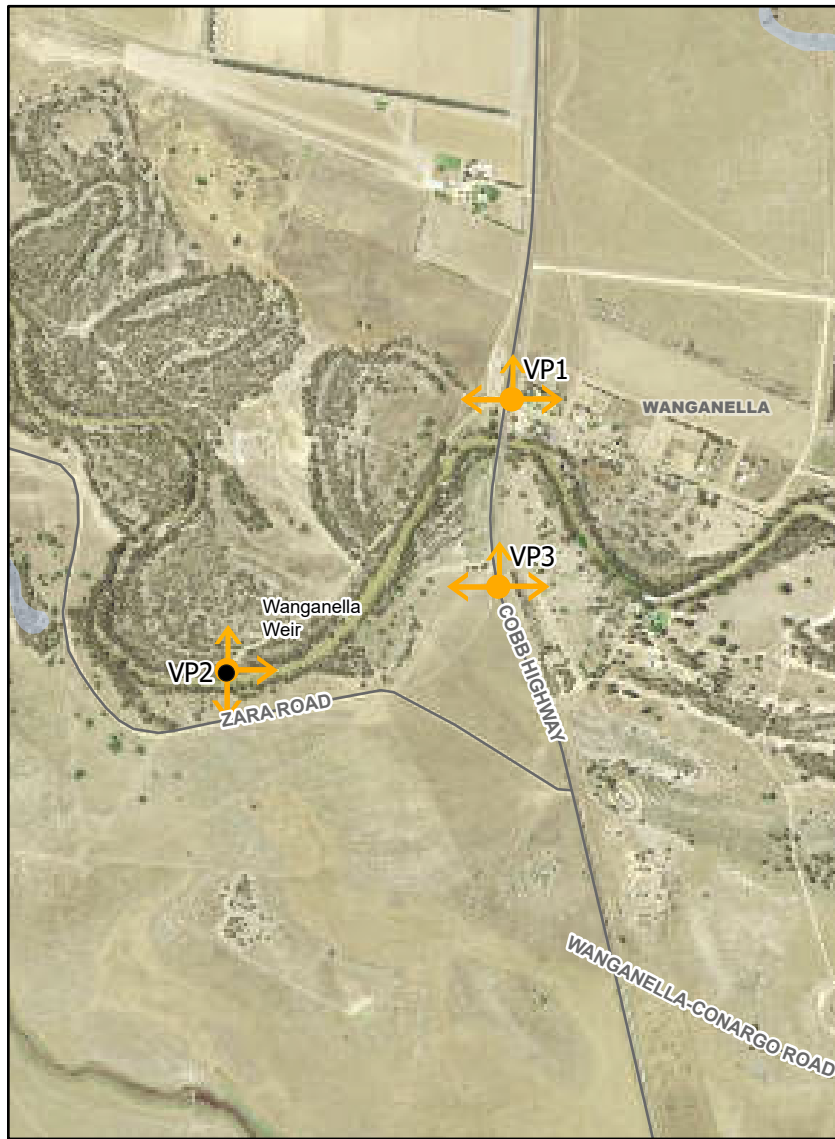
Sensitive receivers have been identified as:

- road users
- businesses at Wanganella
- recreational users at Wanganella Camping Reserve
- landowners
- residents.

The selected viewpoint locations are listed in Table 17.1 and shown on Figure 17.15. As the proposal site is in a mostly flat, rural area, there would be limited views of the proposal during construction and operation. As such, the selected viewpoints focus on views from Wanganella, the Wanganella Camping Reserve, and adjacent roads.

Table 17.1 Viewpoint locations

Viewpoint (VP)	Proposal area	Location	View direction	Description	Sensitive receiver
VP1	Wanganella	-35.211 144.816	Looking east	View from Wanganella Store and the Cobb Highway	• Business • Residences • Road users
VP2	Wanganella	-35.218, 144.807	Looking south	View from Wanganella Camping Reserve to Billabong Creek	• Recreational user • Neighbouring land owner
VP3	Wanganella	-35.216, 144.815	Looking north	View from Conargo Road along the proposed access track to Hartwood	• Road users
VP4	Hartwood	-35.327 145.292	Looking east	View from Conargo Road towards Forest Creek block bank	• Road users
VP5	Hartwood	-35.310, 145.287	Looking south-east	View towards Hartwood Weir from the left bank of Billabong Creek	• Neighbouring land owner



- Existing weir
- ↗ Viewpoint Direction
- Water bodies
- Roads

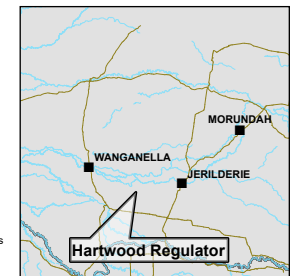
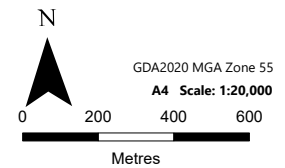


Figure 17.15 View points



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17.3. Impact assessment

17.3.1. Changes to local community, public amenity and key sites

This section describes the scale and design of the proposed development, considering the impacts upon the visual amenity of the local community, public amenity and key sites, including:

- how services and plant are integrated into the overall design of the proposed development
- any services to be relocated or rerouted to facilitate the development.

Construction

The construction process would be similar at all work areas and involve the following activities which would have most impact on the visual amenity of the proposal sites:

- construction equipment situated site
- construction vehicles accessing the sites
- use of lighting.
- vegetation clearance.

An assessment of the impact of construction activities at key view points is provided in section 17.3.2.

The construction phase would take around 18 months to complete all works. Therefore the reduction in visual amenity from construction equipment on site and vehicles accessing the work areas, would be temporary. Some work areas however, such as the Wanganella flood relief drainage channel, would only take a few weeks to complete.

Night works are not proposed, therefore use of lighting at the construction site would be minimal and limited to daytime hours, and is unlikely to cause light spill or a nuisance to sensitive receivers.

Vegetation clearance would have the most significant effect during construction. This would increase the visibility of the construction areas and works, where buffer vegetation is lost. The loss of vegetation would not be permanent and the sites would be rehabilitated on completion. However the loss of mature and semi mature trees would take several years to mitigate through the establishment of new plantings. Further details on plantings are provided in section 17.3.4.

During construction, storage areas, fencing, signage, and other ancillary structures and machinery would be visible. Some sensitive receivers would be able to see construction activities from nearby roads, particularly Zara Road, or while completing works on farms. Sensitive receivers within Wanganella village would also be able to see road works and truck movements along the access routes to Wanganella Weir during construction. However, visual impacts for these viewers would be temporary and visual amenity impacts would only occur during construction. As such, impacts to the local community and public amenity would be minor. To reduce this impact, mitigation measures have been provided in Table 17.9.

The construction works at Wanganella would be within the camping reserve. However, access to this area would be restricted to maintain public safety during construction, therefore the public would have limited visibility of this location.

An underground power line would be installed adjacent to a residential property at 4483 Conargo Road, south of the Hartwood site. The trenching works to install this and connect to the existing overhead power line would be visible for several weeks during installation, at this property.

Operation – Hartwood

Changes to structures

The proposal would result in the removal of the majority of the existing Harwood Weir structure, with just the base slab being retained. The construction of the proposed regulator close to the site of the weir is not considered to impact on the setting of the existing structure as the weir would no longer exist in its original form.

The new regulator would be constructed close to the original location of the Hartwood Weir. The regulator would be more substantial than the original weir as it would include a fishway and trafficable deck for maintenance. A concept layout of the regulator is shown in Figure 17.16. A concept image of the regulator is shown in Figure 17.17. The final designs would be similar to these images although there may be minor refinement during detailed design and following further consultation.

The height of the regulator would not be substantially higher than ground level as the trafficable deck would need to be level with the adjoining creek banks. The trafficable deck would be wider than the existing footbridge and therefore more visually intrusive.

The regulator would have a more modern appearance than the existing weirs (refer Figure 17.17). Although this would result in a visual change at these sites, agricultural infrastructure such as regulators are characteristic of the area.

By designing the regulator in the same location as the existing weir, and using the existing access track, has limited the need for new areas of development within the creek.

Limited sensitive receivers would be impacted by the proposal at Hartwood as this site would remain mostly screened by riparian vegetation, even with some vegetation clearance. The site cannot be seen from any residences, public roads or places. Neighbouring land owners are the only sensitive receivers that would be able to observe the site, most likely while carrying out farming practices on the adjacent pastures.

Forest Creek block bank would be rebuilt and raised by around 0.5 metres. Apart from the minor increase in height, it would of a similar structure and scale as the existing block bank. Access to the site is not available to the public and therefore views of the structure would be limited to land owners using the access tracks nearby.



Figure 17.16 Indicative layout of Hartwood Regulator



Figure 17.17 Indicative design of the Hartwood Regulator

Changes to utilities

The proposal would include a new utility corridor comprising overhead and underground electricity cables. (refer to Figure 3.1) The additional poles would be visible from Conargo Road. There are however, already a number of poles in this area and along the road side, and it will not be an unfamiliar feature on the landscape. The utility corridor would pass a residential property at 4483 Conargo Road. In consultation with the property owner, the cable would be installed underground, minimising impacts to visual amenity at this location.

Changes to weir pool

The modelled hydrology results (see section 6.3.2) indicate that at full supply level of the regulator, minor changes to the existing Hartwood weir pool are expected, as shown in Figure 3.14 and Figure 3.15. The results show there is a minor increase in lateral inundation, so in a small number of locations more of the existing bank is inundated. There is also an increase in the length of the weir pool due to the proposed regulator being located around 70 metres downstream of the existing Hartwood weir ie the weir pool starts behind the new regulator structure. Overall it is predicted under the full supply level operating scenario the surface area of the weir pool will be around 51,000 square metres greater in overall inundation extent compared to existing conditions. This extent is spread along the full length of the weir pool. This is considered a low degree of change and is unlikely to change the visual amenity of the area.

Operation – Wanganella

Changes to structures

The proposal would result in the removal of the majority of the existing Wanganella Weir structure, with just the base slab and one wingwall (abutment) being retained. The construction of the proposed regulator close to the site of the weir is not considered to impact on the setting of the existing structure as the weir would no longer exist in its original form.

The new regulator would be constructed close to the original location of the Wanganella Weir. The regulator would be more substantial than the original weir as it would include a fishway and maintenance walkway part way across the structure. A concept layout of the regulator is shown in Figure 17.18. The regulator design would be similar to that shown in Figure 17.17 for Hartwood Regulator, however it would be on a smaller scale as it would not include a trafficable deck for maintenance vehicles. Access across the structure would be via pedestrian access only. The final designs would be similar to these images although there may be minor refinement during detailed design and following further consultation.

The height of the regulator would not be substantially higher than ground level as access would be needed from the adjoining creek banks. The regulator would include a pedestrian walkway part way across the structure for maintenance. The existing weir does not have a walkway, therefore the regular would be more visually intrusive than the existing weir.

The regulator would have a more modern appearance than the existing weir. It would have a less rustic appearance to the weir as it would be fitted with modern steel walkways and equipment (refer Figure 17.17). Although this would result in a visual change at this site, agricultural infrastructure such as regulators are characteristic of the area.

By designing the regulator in the same location as the existing weir, and using the existing access track on the northern bank; this has limited the need for new areas of development within the creek.

Visual impacts to the local community would be more notable at the Wanganella site due to its position within the Wanganella Camping Reserve. The picnic tables in the camping reserve would have a view of Billabong Creek. The newly constructed Wanganella Regulator would be slightly downstream of the previous weir location.

The Wanganella Regulator has been designed to reduce visual amenity impacts to Wanganella Camping Reserve. The fishway and access road would be located on the southern bank of Billabong Creek out of the picnic area. The access road and fishway would largely be out of view from the picnic area as the southern bank of Billabong Creek is higher than the northern bank.

Other design choices to reduce the proposal's impact on visual amenity are provided in Table 17.9.



Figure 17.18 Indicative layout of the Wanganella Regulator

Changes to utilities

The proposal would include a new utility corridor comprising overhead and underground electricity cables. (refer to Figure 3.3) The additional poles would be visible from Zara Road and Conargo Road. There are however, already a number of poles in this area and along the road side, and it will not be an unfamiliar feature on the landscape.

Changes to weir pool

The modelled hydrology results (see section 6.3.2) indicate minor changes to the existing Wanganella weir pool are expected, as shown in Figure 3.13. It is evident that there is a small increase in lateral inundation but no change in longitudinal inundation. As a result, under the full supply level operating scenario, there is around a 110,000 square metres in overall inundation extent compared to existing conditions, which corresponds to a medium degree of change. This extent is spread along the full length of the weir pool. However, Wanganella Regulator is not intended to operate the weir pool at full supply level for a substantial period of time, as this will only occur to capture a portion of unregulated flow events which are uncommon. As such, over the long term, there is likely to be only low degree of change in the Wanganella weir pool extent and is unlikely to change the visual amenity of the area.

17.3.2. Impacts on views

The following section highlights key viewpoints (VP) of the proposal site and describes potential impacts to visual amenity at these viewpoints.

VP1: Wanganella Store

VP1, shown in Figure 17.19, is located at Cobb Highway adjacent to Wanganella Store looking east towards the access track to Wanganella Weir.



Figure 17.19 VP1: Wanganella Store – existing view

Table 17.2 VP1 assessment

Criteria	Comments
Description of existing view	The foreground shows the intersection of Cobb Highway and the access track to Wanganella Weir in a cleared, flat pasture. The background of the view contains trees and vegetation to the south-east associated with Billabong Creek. This view is representative of views from residences on the east side of Wanganella village.
Anticipated change to view	During construction, temporary visual impacts would be experienced by sensitive receivers associated with track upgrade works, and truck and machinery movement along the access track. Truck movements during construction would be temporary and not uncharacteristic of the view and therefore visual amenity impacts are expected to be minor. Demolition of the existing weir and construction of the new regulator would not be visible from this viewpoint as this would occur about 700 metres from the viewpoint and works would be screened by riparian vegetation. The operational structures would not be visible from this location.

VP2: Wanganella Camping Reserve

VP2, shown in Figure 17.20, is located in the Wanganella Camping Reserve looking south at Wanganella Weir.



Figure 17.20 VP2: Wanganella Camping Reserve – existing view

Table 17.3 VP2 assessment

Criteria	Comments
Description of existing view	The foreground shows the existing Wanganella Weir degraded concrete structure and the Billabong Creek. The weir is a central feature of the view. The background of the view contains the riparian vegetation along the right bank of Billabong Creek. This view is representative of views by recreation users within the Wanganella Camping Reserve.
Anticipated change to view	During construction, storage areas, fencing, signage, and other ancillary structures and machinery would be visible from the camping reserve. Earthworks, sediment and erosion controls, coffer dams, and concrete pouring would also be visible from the camping reserve. Construction work would cause a detrimental visual impact to this view. However, this impact would be short term. The area around the works would be restricted to ensure public safety therefore, alternative areas within the reserve would be used for camping and picnics reducing the likelihood of recreational users seeing the construction works. As part of the proposal the existing Wanganella Weir would be demolished. The new Wanganella Regulator would be slightly downstream and would be fitted with a fishway and steel settings. Some riparian vegetation would be removed on the right bank of Billabong Creek to install the fishway and access road. Demolishing Wanganella Weir would remove a central feature of the Wanganella Camping Reserve view. However, the remaining view would be a creek scape with native vegetation and as such this view would still have high amenity. The new regulator would have a modern appearance, however once the new vegetation has started to establish, the new structure would integrate into the environment. The new access road and fishway would be constructed on the south bank of Billabong Creek so they would be out of view from within the reserve. As such, visual impacts from the new regulator would be minor during construction and minor during operation developing to neutral once the vegetation has reestablished.

VP3: Conargo Road near Hartwood Weir

VP3, shown in Figure 17.21, is located at Conargo Road looking east towards Zara Road and Billabong Creek.



Source: google maps 2023

Figure 17.21 VP3: Conargo Road near Wanganella Weir – existing view

Table 17.4 VP3 assessment

Criteria	Comments
Description of existing view	The foreground shows Conargo Road and a cleared, pasture with utility poles. In the distant background there is riparian vegetation along the Billabong Creek. The view includes some existing gravel and dirt access tracks. Zara Road is a dirt track in the background of the view following the alignment of the creek.
Anticipated change to view	During construction, storage areas, fencing, signage, and other ancillary structures and machinery may be visible from Conargo Road, although at a distance, and would be visible from Zara Road. A permanent operation and maintenance gravel access road would also be constructed from Zara Road. There would be additional utility poles installed extending from the existing electricity power line. Construction vehicles would be visible from Conargo Road as they move along Zara Road. These would only be viewed from road users fleetingly and as such there would be limited visual amenity impacts. At the completion of construction, the permanent operation and maintenance access road would be visible from Zara Road, but is unlikely to be visible from Conargo Road. The new access road would not be uncharacteristic of the viewpoint and would only be viewed from road users with short term views. The track would be similar in appearance to other tracks in the area. The new Wanganella Regulator would not be visible from Conargo Road with only fleeting views of the structure, mainly the walkway, visible from Zara Road. As vegetation re-establishes this view will be hidden.

VP4: Conargo Road near Forest Creek

VP4, shown in Figure 17.22, is located at Conargo Road looking east towards Forest Creek riparian corridor.



Source: google maps 2023

Figure 17.22 VP4 Conargo Road looking east towards Forest Creek – existing view

Table 17.5 VP4 assessment

Criteria	Comments
Description of existing view	The foreground shows Conargo Road and a cleared, grassy field. The background features riparian vegetation surrounding the confluence of Forest Creek and Billabong Creek. This view is representative of road users viewing the proposed works at the Forest Creek block bank.
Anticipated change to view	During construction, storage areas, fencing, signage, and other ancillary structures and machinery would be visible from Conargo Road as a laydown area would be adjacent to the road. The main works would be about 250 metres from the road. Road upgrade works and truck movements would also be visible. These would only be viewed from road users with short term views of the works area. At the completion of construction, the upgraded Forest Creek block bank would be screened from view by vegetation and the structure would be close to ground level and similar to the existing structure. As such, there would be negligible visual impacts to the viewpoint.

VP5: Hartwood Weir

VP5, shown in Figure 17.23, is located at the existing Hartwood Weir from the north bank of Billabong Creek.



Figure 17.23 VP5: Hartwood Weir looking south– existing view

Table 17.6 VP5 assessment

Criteria	Comments
Description of existing view	The foreground shows the existing Hartwood Weir and signage. The abutments of the weir are made of concrete and have visible cracking. There is a steel walkway suspended over the weir. Each bank is lined with established riparian vegetation.
Anticipated change to view	During construction, storage areas, fencing, signage, and other ancillary structures and machinery would be visible around Hartwood Weir. However, this viewpoint is screened from road users by vegetation and is not publicly accessible. As such, viewers of Hartwood Weir are limited to neighbouring landowners and therefore visual impacts from construction would be limited. The new regulator would look similar the existing weir but would include a fishway, upgraded access, and a trafficable deck, as shown in Figure 17.17. This would be a larger scale structure but would not be uncharacteristic of the existing viewpoint.

17.3.3. Impacts on heritage items

Chapter 12 outlines the potential impacts to Aboriginal heritage. Of the eleven heritage features identified within and near the proposal sites, three scar trees would be directly impacted by the proposal, plus some scar trees would require minor trimming. As noted in chapter 12, these features and features that would be retained have had their surrounding landscapes impacted and disturbed by previous developments, pastoral practices and informal access tracks, as well as being common representations of their site types. The impact on the visual amenity of Aboriginal heritage features in the vicinity of the proposal is therefore considered to be minor.

As discussed in chapter 13, the proposal would involve demolition of the Hartwood Weir which is listed in WaterNSW's Heritage and Conservation Register prepared under section 170 of the *Heritage Act 1977*. As such, the feature would not be available to view in the future. However, it is noted that there are limited viewpoints of Hartwood Weir. As such, the visual amenity of demolishing the weir is expected to be minor. Mitigation measures have been provided in Table 17.9 to manage this impact.

Wanganella Weir is not currently listed, but has been assessed as being of local heritage significance. There would be no enhancement of heritage significance due to the direct impacts to the heritage item. The proposed demolition of the weir structures within the creek at Wanganella Weir would comprise direct impact to the heritage item. It is proposed to retain the wingwalls and base slab of the weir. The remaining portions would provide some representation of the heritage significance of the original weir. Their retention would serve as a visual reminder the location of the socially-significant Wanganella Weir, around which a publicly available swimming area and camping spot have evolved. As such, the visual amenity of demolishing the weir is expected to be a minor adverse impact on the visual amenity at this location.

For further discussion on non-Aboriginal heritage refer to chapter 13.

17.3.4. Minimising adverse impacts to visual amenity

The proposal and its construction method have been designed to minimise adverse impacts to visual amenity. Design choices that minimise adverse impacts are summarised in Table 17.7.

As discussed in section 17.3.3, the access road and fishway would be located on the right bank of Billabong Creek at Wanganella to reduce visual amenity impacts to Wanganella Camping Reserve.

The proposal laydown and compound areas would be generally set back from major roads and screened by trees and thus would have a limited visual amenity impact.

Table 17.7 Design choices which would minimise adverse visual impacts

Proposal element	Design feature	Reduced adverse visual impacts
Selecting an in-stream construction method	- Reduced construction footprint - Reduced earthworks - Reduced truck movements required to move spoil - Reduced vegetation removal	- Physically smaller area with visual impacts during construction - Fewer impacts to visual amenity caused by vegetation removal and traffic movements
Constructing access tracks on existing paths, where possible	- Reduced vegetation removal - Reduced earthworks	Fewer impacts to visual amenity caused by vegetation removal and traffic movements
Layout of the Wanganella Regulator	- Fishway and access road would not be located on the Billabong Creek bank used for picnicking and camping in the Wanganella Camping Reserve - A trafficable deck was replaced with a pedestrian walkway to decrease the scale of the structure	- Less impact to visual amenity as the topography and riparian vegetation at Wanganella would screen the fishway and access road from viewers - The reduced scale of the regulator would minimise its structure
Electricity cable alignment	The utility corridor would directly pass a residential property at 4483 Conargo Road. In consultation with the property owner, the cable will be installed underground	There will be no new above ground utility corridor adjacent to this property minimising impacts to visual amenity at this location
Demolition of existing weirs	Retention of the wingwalls and base slab	Their retention would serve as a visual reminder the location of the heritage weirs

Further mitigation measures to reduce impacts to visual amenity are provided in Table 17.9.

Visual impacts from tree removal have been reduced by minimising the disturbance footprint of the proposal, where possible (refer Table 17.7). The disturbed area would be rehabilitated to pre-existing conditions as far as possible after construction is completed. This would include some landscaping including planting of the trees. Table 17.8 outlines the upper number of trees that may require removal and the anticipate number of trees to be replanted. An aim of the construction methodology would be to minimise tree removal, where possible.

Table 17.8 Proposed tree removal and plantings

Site	Trees removed	Trees planted
Hartwood	43	43
Wanganella	20	20

17.3.5. Cumulative impacts

The closest project identified is the Yanco Creek Modernisation Part1b: Wanganella Swamp Project which is located around four kilometres south east of the proposal. The construction of both projects is expected to be at a similar time however due to the distance between the projects, cumulative impacts are not expected as a result of no shared receivers between the projects.

17.4. Mitigation measures

17.4.1. Approach to mitigation and management

The general approach to management of the proposal during construction and operation is outlined in chapter 24.

The overall guiding principle for management is that impacts to visual amenity should be minimised as far as reasonably practicable. Mitigation measures have been developed based on the nature of the site, as and its position in the landscape. A rehabilitation plan for each site will be further developed in consultation with WaterNSW who will operate the site, Edward River Council and the local community. Due to the remote location of the sites, the rehabilitation plan will include a suitable planting schedule with local endemic species which require low maintenance. An aim of the construction methodology would be to minimise tree removal, where possible. Rehabilitation principles are outlined in section 3.3.6.

The mitigation measures, below, outline the actions required to mitigate and/or manage each potential impact, as well as any other actions and commitments that arise, as necessary.

17.4.2. Summary of mitigation measures

Table 17.9 lists the visual amenity safeguards and management measures that would be implemented to account for the potential impacts identified in section 17.3.

Table 17.9 Visual amenity safeguards and management measures

ID	Impact	Environmental safeguards	Responsibility	Timing
V1	Changes to view from vegetation loss	Disturbed areas will be revegetated with endemic riparian and floodplain species (replacing like for like) to be undertaken as soon as practical, progressively. Mature trees removed from the construction footprint will be cut into appropriate sections and relocated adjacent to waterways. Existing woody debris will also be relocated.	Construction Contractor	Construction
V2	Impacts to views from construction	Work areas will be kept tidy at all times. All temporary above-ground infrastructure will be removed at the completion of construction. Reinstatement of construction activity zones will commence progressively post construction and will be undertaken as soon as practicable.	Construction Contractor	Construction
V3	Impacts from construction lighting	Lighting of work areas, compounds, and work sites will be oriented to minimise glare and light spill impact on nearby receivers.	Construction Contractor	Construction
V4	Changes to views in Wanganella Camping Reserve	The following actions will be adhered to during work within Wanganella Camping Reserve: - Picnic tables and facilities within the construction footprint will be relocated to another area in Wanganella Camping Reserve. - Construction site hoarding and fencing will be designed, erected, and maintained to minimise visual impacts. This will include: - erecting hoarding/fencing as early as possible in the site - using high quality materials suitable for parks and public spaces. - The hoarding of construction materials will be minimised as far as practicable.	Construction Contractor	Construction
V5	Rehabilitation of the site	A rehabilitation plan for the sites will be developed in consultation with WaterNSW and Edward River Council. This will include a planting schedule of endemic riparian and floodplain species (replacing like for like) appropriate to the sites and requiring low maintenance. The disturbed riverbanks will be reinstated with materials that provide stability while also presenting as natural an appearance as possible. Any rehabilitation plans in proximity to the proposal will be reviewed and approved by WaterNSW.	NSW DCCEEW Construction contractor	Pre-construction, construction and operation

18. Public health and safety

This chapter describes the potential public health and safety, and hazards associated with the construction and operation of the proposal. It assesses the potential impacts of construction and operation of the proposal, and provides recommended mitigation and management measures.

18.1. Methodology

Construction and operation of the regulators has the potential to cause hazards and risks to public health, safety and the environment. A qualitative assessment of potential hazards and risks to public safety associated with constructing and operating the proposal has been undertaken in accordance with the SEARs.

The assessment involved the following:

- identifying construction and operational activities with the potential to cause risks to receivers.
- a qualitative assessment of the potential risks of the proposal to public health and safety during both construction and operation, and proposed mitigation of any identified impacts. Including road safety and recreational use of the creek ie swimmers, dam safety, bush fire risks and identifying any dangerous goods likely to be used on site.
- review of bushfire risks.
- a dam consequence category assessment.
- identifying measures to mitigate the potential hazards and risks identified.

The assessment focused on those activities with the potential to result in hazards and risks to surrounding communities, land uses, and the environment. The assessment does not take into account potential health and safety risks to on-site workers associated with normal construction operations, as these are regulated by workplace health and safety legislation (including the *Work Health and Safety Act 2011*) and are not relevant to approval of the proposal under Division 5.2 of the EP&A Act. Site management would be the responsibility of the construction contractor, who would be required (under the Work Health and Safety Act) to manage the site in accordance with relevant regulatory requirements.

A dam consequence category assessment was carried out, as required for water storage developments. The purpose of this assessment was to present the dam-break and consequence category assessment for the regulators following the *Dams Safety NSW Regulation 2019* and associated guidelines. This assessment included a detailed assessment of the dam-break and flood inundation mapping for a several scenarios, and an assessment of both the population at risk and potential loss of life. A summary of the worst case findings of this assessment is provided in this chapter.

The *Rural Fires Act 1997* provides for the prevention, mitigation and suppression of bush fires, and aims to protect environmental, cultural and community assets from damage arising from fires. Under section 3(d) of the Act, the protection of the environment through bush fire prevention activities are required to be carried out having regard to the principles of ecologically sustainable development described in section 6(2) of the *Protection of the Environment Administration Act 1991*.

For further discussion on flooding and community impacts refer to chapter 7 (Flooding) and chapter 19 (Social), respectively.

18.2. Existing environment

18.2.1. Sensitive receivers

The proposal site is located in a rural area, with a mix of agricultural, residential and recreational land uses. Sensitive receivers include the following:

- residents and landowners living or working near the proposal site
- road users travelling past the proposal site or on routes used for construction traffic
- recreational users of Billabong Creek and Wanganella Camping Reserve
- Wanganella village residents using the public water supply provided from Billabong Creek
- residents, property and landowners in the vicinity of and down stream of the regulators.

Sensitive receivers close to the proposal are described in chapter 16 (Noise and vibration) and chapter 19 (Social). Within around 3.0 kilometres of both sites a total of 26 sensitive receivers have been identified comprising a mix of small villages and isolated farmsteads:

- 4 sensitive receivers around Hartwood
- 22 sensitive receivers around Wanganella.

18.2.2. Water resources

Water from Billabong Creek is piped from the existing weir pool, upstream of Wanganella Weir, to Wanganella Village. This is stored in a water tank in the village to provide a secondary, non-potable supply. The creek is also used for watering livestock.

It should be noted that current water quality for Billabong Creek at various locations, does not achieve water quality objective for 'aquatic ecosystems' due to elevated nutrients and turbidity, occasional low dissolved oxygen and elevated electrical conductivity that were outside acceptable ranges. Based on existing literature regarding algal alerts in Billabong Creek, harmful algal numbers appear to be low. Data for a limited number of indicators infer that the water quality objective for 'Livestock water supply' is currently being achieved with limited algal alerts and salinity that is generally within acceptable ranges for protection of the WQO. (refer to chapter 10 (Surface water quality and aquatic ecology)).

18.2.3. Bushfire categories

The Planning Portal Hazard – Bush Fire Prone Vegetation Mapping Tool is designed to identify areas of Bush Fire Prone Land based on vegetation types and their associated risks. The NSW Rural Fire Service provides a methodology for categorizing bush fire prone land (NSW Rural Fire Service 2019), which includes the following:

- Vegetation Category 1 – highest risk for bush fire. Represented as red on the bush fire prone land map and will be given a 100-metre buffer. Includes areas of forest, woodlands, heaths, forested wetlands, and timber plantations.
- Vegetation Category 3 – medium bush fire risk. Represented as dark orange on a Bush Fire Prone Land map and will be given a 30-metre buffer. Includes grasslands, freshwater wetlands, semi-arid woodlands, alpine complex and arid shrublands.
- Vegetation Category 2 – lower bush fire risk (higher than the excluded areas). Represented as light orange on a bush fire prone land map and will be given a 30-metre buffer. Includes rainforests and lower risk vegetation parcels.

Bush Fire Prone Land maps for Wanganella and Hartwood show that In both cases, the regulators are surrounded by grasslands, categorised as Category 2 vegetation, signifying lower bush fire risk.

18.3. Impact assessment

18.3.1. Potential construction impacts

Although unlikely, construction activities could result in hazards and risks to the safety of the local community and road users if improperly managed. Potential hazards and safety risks from construction of the proposal are outlined below.

Dam safety

The existing Hartwood and Wanganella Weirs are located upstream of the new regulators. This would enable the regulators to be completed and tested before the old weirs are removed. This would avoid the risk of the regulator structures failing during construction and the weir pool being released down stream in a dam-break event.

Road safety

During construction there would be additional heavy and light vehicles using the local roads and tracks around the proposal sites. This would result in a number of increased risks to road users and the local community. These include:

- Potential safety risk to pedestrians and road users from traffic movements from a traffic incident or crash.
- Items falling off or blowing off vehicles during the transportation of equipment and material to and from site, injuring people along side the roads or road users. This could include movement of hazardous materials.

Construction of the proposal would involve numerous traffic movements to transport goods and materials to and from site. This could pose a safety risk to pedestrians and road users from increased traffic incidents and crashes and material falling or blowing off vehicles. The risk to pedestrians is considered low due to the remote locations, particularly around Hartwood as this site is inaccessible to the public and set back from the road. Safety risks during construction and transportation of materials by road would be managed by implementing standard workplace health and safety requirements and traffic management controls. This would include controls to routes, speed and covering of materials during transportation. Road and traffic safety is discussed in more detail in chapter 15 (Traffic and access).

The transport of hazardous or dangerous goods is not expected to be required for the construction of the proposal. If transport of hazardous or dangerous goods is required, transportation would be undertaken in accordance with the following standards and codes:

- State Environmental Planning Policy (Resilience and Hazards) 2021
- Australian Code for the Transport of Dangerous Goods by Road & Rail (National Transport Commission 2020)
- AS/NZS 4452:1997 The storage and handling of toxic substances (Joint Standards Australia/Standards New Zealand 1997).

Public health and safety

During construction there would be additional activities occurring around the proposal sites. This could result in a number of increased risks to the local community. Health and safety issues could result from:

- swimmers or other water users in proximity to construction work areas being injured
- spillage of materials and/or wastes or mobilisation of existing, contamination, impacting quality of soil and water
- reduction in amenity due to changes to noise levels and air quality related impacts from dust generated during construction activities
- potential for risks to public safety resulting from unauthorised access to construction work areas, including where these areas are located with the Wanganella Camping Reserve.

Health and safety risks during construction would be managed by the implementation of standard workplace health and safety requirements to manage public and staff safety. A work health and safety management plan and safe work method statements would be developed in accordance with regulatory requirements. This would include measures to protect against flood inundation, such as:

- Consideration of the impacts of both riverine flooding and flash flooding in the emergency management planning on the workers and the ability to quickly and safely evacuate from construction activity zones.
- Ensure workers and people on site are aware of the flood risk, for example through site inductions and by using signage.
- Emergency planning which outlines when and how the worksite would be closed and all materials and equipment secured prior to the start of the working day if there is a risk of flooding, on receipt of advice from the Bureau of Meteorology (BoM), or when other evidence leads to an expectation of flooding. During site works, the BoM website would be checked prior to start of the workday for any Flood Warnings.

A creek exclusion zone would be set up to indicate safe distances that must be kept between other water users and construction activities. The creek exclusion zone would be of a sufficient size so to remove the risk of vessels or swimmers colliding with construction equipment and to reduce the risk of injury from underwater noise during piling.

Potential contamination impacts from spillage of material such as vehicle fuels, would be mitigated through the appropriate management of the storage of such materials, and inclusion of spill kits (refer to chapter 20 (soils and contamination)).

During construction of the flood bypass channel, hazards from landfill gas could arise due the nearby Wanganella rural landfill. Excavation works could cause migration of vapours or gases from the landfill. Risks would relate mainly to construction staff and would be managed through the work health and safety management plan. Mitigation and management measures are outlined in 20.4 (soils and contamination) and could include a ground gas management plan and monitoring. Measures would be reviewed by the construction contractor as construction methodology is finalised for the bypass works.

It is unlikely that there would be a risk to human health from changes to water quality. An assessment of the impacts of the construction of the proposal has been undertaken in accordance with relevant guidelines for nominated water quality objectives (refer to chapter 10 Surface water quality and aquatic ecology). A brief summary of the current water quality with respect to each water quality objective and a qualitative assessment of the potential impacts is provided in Table 18.1.

Table 18.1 Water quality objectives – construction.

Water quality objective (WQO)	Indicators	Proposal related impacts during construction
Secondary contact recreation Maintaining or improving water quality of activities such as boating and wading, where there is a low probability of water being swallowed	Enterococci Algae and blue-green algae Chemical contaminants	Based on existing literature regarding algal alerts in Billabong Creek, harmful algal numbers appear to be low and therefore it is assumed that the WQO secondary contact recreation is currently being achieved. Construction of the proposal if it increases sediment and nutrients may result in an increased risk of algal blooms which can impact on suitability for recreation. Additionally, increased sediment may contain elevated concentrations of metals and toxicants that are hazardous to human health. Whilst not routinely monitored, enterococci and other pathogens may be present in Billabong Creek in elevated numbers from upstream sources (e.g. agricultural runoff) and may pose a risk to recreational suitability. However, construction of the proposal is not expected to introduce pathogens into Billabong Creek. Whilst there may be occasions of poor water quality during construction (eg following rainfall) with the implementation of management measures, the quality of water is not expected to deteriorate such that the existing water quality would not meet the NHMRC (2008) guidelines. Therefore, construction of the proposal would ensure that secondary contact recreation in Billabong Creek continues to be achieved.
Primary contact recreation Maintaining or improving water quality of activities such as swimming in which there is high probability of water being swallowed	Cyanobacterial biovolume Toxic cyanobacterial biovolume Potentially toxic cyanobacteria Enterococci Protozoan	Based on existing literature regarding algal alerts in Billabong Creek, harmful algal numbers appear to be low and therefore it is assumed that the WQO primary contact recreation is currently being achieved. Construction of the proposal if it increases sediment and nutrients may result in an increased risk of algal blooms which can impact on suitability for recreation. Additionally, increased sediment may contain elevated concentrations of metals and toxicants that are hazardous to human health. Whilst not routinely monitored, enterococci and other pathogens may be present in Billabong Creek in elevated numbers from upstream sources (eg agricultural runoff) and may pose a risk to recreational suitability. However, construction of the proposal is not expected to introduce pathogens into Billabong Creek. Whilst there may be occasions of poor water quality during construction (e.g. following rainfall) with the implementation of management measures, the quality of water is not expected to deteriorate such that the existing water quality would not meet the National Health and Medical Research Council guidelines (NHMRC (2008)). Therefore, construction of the proposal would ensure that primary contact recreation in Billabong Creek continues to be achieved.

Health impacts, such as anxiety or loss of sleep, from noise and air quality impacts are anticipated to be negligible due to the distance from sensitive receivers or the short duration times for works close to receivers such as installing new power lines. Annoyance could be caused to recreational users at Wanganella Reserve campsite, however users are able to find other recreation sites to use during the 18 month construction period. Noise and air quality would be managed by the mitigation measures identified in sections 16.4.1 and section 21.4, respectively. The majority of works would take place during the day time and therefore impacts to sleep are not anticipated. Therefore the risk of health impacts are considered very low.

The potential for unauthorised public access resulting in safety risks is considered to be low, assuming the implementation of appropriate safety controls in accordance with NSW workplace safety laws. NSW workplace safety laws require construction sites to have adequate site security, which includes appropriate fencing and securing of equipment. The construction contractor would ensure that construction sites are safe and secure at all times, and take all possible actions to prevent entry by unauthorised persons. Where the works are located within or adjacent to publicly accessible areas, such as the Wanganella Camping Reserve, alternative access arrangements would be provided to ensure safe access around the proposal site. Signage would be placed within the Wanganella Camping Reserve to warn pedestrians of potential hazards from vehicles movements and areas close to the construction works would have restricted public access.

Bushfire risks

The proposal site and surrounded by grasslands are categorised as Category 2 vegetation, signifying lower bush fire risk.

The Planning for Bush Fire Protection – A Guide for Councils, Planners, Fire Authorities and Developers (NSW Rural Fire Service, 2019) provides standards and guides for land use planning and development on bush fire prone land. The guide sets out principles to reduce the impact of bush fires and protect development and occupants from bush fire risks.

Construction works can pose risks of causing a bush fire due to on site ignition sources such as hot works, or accidental bush fires due to poor management. Risks are associated with sparks from hot works, vegetation clearing and the use of vehicles and equipment on site. Storage of small amounts of flammable materials such as fuels or leaks and spills from plant and equipment could also provide a fuel source for bush fires if ignited.

The isolated nature of the proposed worksites, surrounded by grassland, presents a low safety risk of sensitive receivers. This risk would be managed through the implementation of mitigation and management measures in the construction environmental management plan.

18.3.2. Potential operation impacts

The key potential for hazards and risks during operation of the proposal would be associated with:

- dam safety and potential inundation and flooding
- public safety and security issues (unauthorised access), including potential for safety risks to swimmers and users of Wanganella Camping Reserve
- operation of new electricity lines.

The proposal has been designed to comply with relevant standards thus minimising risk to nearby communities and the environment.

Dam Safety

A Consequence Category Assessment has been carried out to consider the impact downstream of the regulators in the event that a regulator breaks and the water stored behind it in the weir pool is released.

This assessment considered the *Dams Safety NSW Regulation 2019* and associated guidelines. This study considered flood inundation modelling and mapping, and an assessment of both the Population at Risk and Potential Loss of Life. The assessment was limited to the assumed Sunny Day and flood breach scenarios documented, under the assumed upstream versus downstream water level conditions. A more severe flood breach was not considered since the regulator would be drowned and the breach flood wave would be marginal. The Consequence Category Assessment was based on assumed estimates of patronage for Billabong Creek downstream of the regulator and considered itinerant and non-itinerant populations.

The severity of damage and loss has been assessed in accordance with the *Declared Dams Consequence Category Assessment and Determination Methodology for Dams Safety Act 2015*. It is acknowledged that the assessment of severity is subjective.

Since both structures have been assessed as having a low consequence category they will not need to be declared structures under the *NSW Dams Safety NSW Regulation 2019*.

Dam safety would be managed for the life of the regulator through continual maintenance activities and asset checking. This would include:

- occasional checking of regulator gates for operability
- monthly: after significant flooding events and key checking of fishway gates
- annually: after significant flooding events, checking and clearing of bulkhead isolation slots, checking and clearing of trash rack each gate operation and post flooding events
- any repair works identified by the inspections listed above
- routine maintenance and inspection as developed by WaterNSW for the assets
- following wet commissioning, frequent checking of the structure would be scheduled until a consistent level of performance and functionality is established and understood.

Hartwood

Given the potential flood wave impact during a dam break is primarily limited to the Billabong Creek channel and immediate flood plain, no non-itinerant population at risk were identified as potentially impacted from Hartwood Regulator.

There is limited access to the creek at this location and recreational users, would be unlikely. However to provide a conservative assessment it was assumed that there may be an itinerant population of fishermen on the creek banks in the Sunny Day case. It has been assumed that five recreational fishermen would access Billabong Creek for eight hours each day over two weekend days.

The conclusion of the assessment, where it relates to the environment and community was:

- Environmental impacts are considered whether the discharge from a dam-break event would contaminate waters, impact ecosystems and whether these can recover within 1 year. The magnitude of the flood wave would be expected to cause some erosion and damage along Billabong Creek which would take up to 1 year to recover. The risk is considered as being **Minor**.
- Health and Social impacts are considered as being **Minor** with less than 100 people affected by the loss of water services from the regulator.
- Based on the Potential Loss of Life range, the Sunny Day Consequence Category is assessed as **Low**, and the Flood Consequence Category is assessed as **Low**.

Wanganella

Given the breach flood wave impact is primarily limited to the Billabong Creek channel and immediate flood plain, no non-itinerant population at risk were identified.

Based upon knowledge of the catchment around Wanganella Reserve campground, it is assumed that during times of catchment flooding, there is sufficient flood warning and it is unlikely that there would be campers on the banks of Billabong Creek. Even in the event of regulator structural failure, the hazard and vulnerability rating of this overflow would be expected to be low, which is generally safe for vehicles and people. It has therefore been assumed that there is negligible risk to campers at the Wanganella Reserve campground.

Other recreational users could also potentially be swimmers and fishermen in a Sunny Day case, since under the flood condition it was considered that swimmers and fishermen would not be at the creek due to undesirable weather conditions. For swimmers and fishermen, the population at risk has been assumed to be 10 recreational swimmers and fishermen accessing Billabong Creek for 8 hours each day over two weekend days. These assumptions were used to calculate the area at risk and Population at Risk. The increase in flood velocity and increase in flood depth are not considered significant at this location. Recreational swimmers and fishermen would therefore, have time to take evasive action from rising flood water by moving up the bank. Also should swimmers and fishermen be swept away, it was assumed that the probability of an accident was neutral and the vulnerability was neutral given the low flow velocities at this site.

For itinerants in watercraft, such as “tinnies”, it has been assumed the low flow velocities and rise in water level would not put the craft at risk.

The conclusion of the assessment, where it relates to the environment and community was:

- Environmental impacts are considered whether the discharge from a dam-break event would contaminate waters, impact ecosystems and whether these can recover within one year. The magnitude of the flood wave would be expected to cause some erosion and damage along Billabong Creek which would take up to one year to recover. The risk is considered as being **Minor**.
- Health and Social impacts are considered as being **Minor** with less than 100 people affected by the loss of water services from the regulator.
- Based on the Potential Loss of Life range, the Sunny Day Consequence Category is assessed as **Low**, and the Flood Consequence Category is assessed as **Low**.

Roads safety

There would be very few vehicle movements associated with the operation and maintenance of the proposal. Therefore additional risk to road users from traffic movements is considered unlikely. Maintenance vehicles on site would be restricted to very low speeds minimising risks to the public.

Public health and safety

During operation and maintenance of the proposal there are limited activities occurring around the proposal sites and therefore risks to the public would be limited. Risks could result from the following activities however:

- swimmers or other water users in proximity to the new regulators being injured
- spillage of materials and/or wastes from maintenance activities, impacting quality of soil and water
- potential for risks to public safety resulting from unauthorised access on the regulator structures.

The proposal’s design has included consideration security, safety, and risk issues. To restrict unauthorised access to the proposal and manage safety risks fencing would be installed along the trafficable deck and at the maintenance access. The fishway would be covered with a grate that would prevent people or fauna from falling into the fishway. The pedestrian walkway on the Wanganella Regulator would have a locked gate to restrict access and would have safety features such as hand rails meeting relevant design standards. The location of the Hartwood Regulator does not have public access. Signage would be provided in an appropriate location, communicating this.

Safety risks could be posed to people swimming too close to the new regulators. Warning signs would be placed adjacent to the new regulators to inform community members of this risk and communicate that swimming near or jumping off the regulators is prohibited. A creek exclusion zone would be indicated with buoys in Billabong Creek around the new regulators to demarcate the area where swimming is prohibited.

Risks and management of spillages and wastes during operation of the regulators would be managed in accordance with WaterNSW standard management and maintenance requirements.

It is unlikely that there would be a risk to human health from changes to water quality during operation of the proposal. An assessment of the impacts of the operation of the proposal has been undertaken in accordance with relevant guidelines for nominated water quality objectives. A brief summary of the current water quality with respect to each objective is provided in Table 18.2. Further detail is provided in chapter 10 (surface water quality and aquatic ecology).

Table 18.2 Water quality objectives - operation.

Water quality objective	Indicators	Proposal related impacts during operation
Secondary contact recreation Maintaining or improving water quality of activities such as boating and wading, where there is a low probability of water being swallowed	Enterococci Algae and blue-green algae Chemical contaminants	Based on existing literature regarding algal alerts in Billabong Creek, harmful algal numbers appear to be low and therefore it is assumed that the WQO secondary contact recreation is currently being achieved. The operation of the regulators is not expected to contribute pathogens to Billabong Creek. Additionally accidental leaks and spills if they occur can also contribute contaminants to the waterway. With the implementation of appropriate operational management measures to manage accident spills, it is not expected that the operation of the new structures would impact on secondary contact recreation and this WQO would continue to be protected.
Primary contact recreation Maintaining or improving water quality of activities such as swimming in which there is high probability of water being swallowed	Cyanobacterial biovolume Toxic cyanobacterial biovolume Potentially toxic cyanobacteria Enterococci Protozoan	Based on existing literature regarding algal alerts in Billabong Creek, harmful algal numbers appear to be low and therefore it is assumed that the WQO primary contact recreation is currently being achieved. The operation of the regulators is not expected to contribute pathogens to Billabong Creek. Additionally accidental leaks and spills if they occur can also contribute contaminants to the waterway. With the implementation of appropriate operational management measures to manage accident spills, it is not expected that the operation of the new structures would impact on primary contact recreation and this WQO would continue to be protected.

Bushfire risks

The design and operation of the proposal's power supply would be undertaken in accordance with standard industry guidelines and codes of practice. The proposed powerline connection to new regulators would be established with an appropriate easement to meet Essential Energy clearance requirements.

Essential Energy would own the power infrastructure from the regulators control hut, including all overhead lines, poles, power supply cables and underground cables. Essential Energy would maintain these in accordance with its own standards and procedures. This would include maintaining the powerline easement to manage bushfire risk.

The upgraded access tracks to both regulators would provide safe access for firefighting, if required.

Risks and management of bushfire potential during operation of the regulators would be managed in accordance with WaterNSW standard management and maintenance requirements and emergency management plans.

18.3.3. Cumulative impacts

The closest project identified is the Yanco Creek Modernisation Part1b: Wanganella Swamp Project which is located around four kilometres south east of the proposal. The construction of both projects is expected to be at a similar time however due to the distance between the projects, cumulative impacts are not expected as a result of no shared receivers between the projects.

18.4. Mitigation measures

18.4.1. Approach to mitigation and management

The general approach to management of the proposal during construction and operation is outlined in chapter 24. Construction risks would be management through standard industry control measures and emergency planning. This would include a bush fire emergency management controls prepared in accordance with Planning for Bush Fire Protection (NSW Rural Fire Service, 2019) and in consultation with the NSW Rural Fire Service.

Dam safety would be managed for the life of the regulators through routine maintenance activities and asset upkeep.

18.4.2. Summary of management measures

Table 18.3 lists the public safety and hazard safeguards and management measures that would be implemented to account for the potential impacts identified in section 18.3.

Table 18.3 Public safety and hazard safeguards and management measures

ID	Impact	Environmental safeguards	Responsibility	Timing
HR1	Managing the potential for hazards during construction	The CEMP will detail processes, responsibilities, and measures to manage hazards, and incident and emergency situations during construction.	Contractor	Pre-construction, construction
HR2	Managing the potential for hazards during construction	The soil and water management plan will include a spill response procedure. The procedure will detail measures to manage hazardous substances and dangerous goods, including storage, handling, and spill response, in accordance with legislative requirements.	Contractor	Pre-construction, construction
HR3	Signage to warn of safety risks from traffic	Where required, signs will be installed during construction of the proposal to communicate risks from traffic to the community.	Contractor	Pre-construction, construction

ID	Impact	Environmental safeguards	Responsibility	Timing
HR4	Managing risks to users of Billabong Creek	A creek exclusion zone will be demarcated using buoys during construction and operation of the proposal. During construction, the creek exclusion zone will be of a sufficient size to remove the risk of vessels or swimmers colliding with construction equipment and to reduce the risk of injury from underwater noise during piling. During operation, the creek exclusion sign will be of a sufficient size to manage the safety risk to swimmers from the regulators. Signs will be installed during operation of the proposal to communicate that swimming near or jumping of the new regulators is prohibited.	Contractor	Construction, operation
HR5	Bushfire risk	A bush fire emergency management plan will be prepared in accordance with Planning for Bush Fire Protection (NSW Rural Fire Service, 2019) and in consultation with the NSW Rural Fire Service. The bush fire emergency management plan will include responsibilities associated with and details of: • site specific hazards and risks for the proposal area • hot works procedures • procedures to maintain bush fire awareness • bush fire mitigation measures • fire preparedness actions including evacuation triggers, evacuation routes, mustering points, neighbourhood safe places • instructions for sheltering in-vehicle if there are no other options. Construction staff attendance on site will be suspended on days with severe or greater forecast fire danger ratings, and construction/maintenance hours will be reduced or moved to an earlier time on hot days (days above 40 degrees) to avoid work being undertaken during the hottest time of the day.	Contractor	Construction
HR6	Bushfire risk	WaterNSW will implement procedures relating to bushfire hazards for maintenance activities.	WaterNSW	Operation

19. Social

This chapter assesses the potential social impacts of the of the proposal. Both positive and negative impacts are identified and mitigation measures outlined to address these impacts. This chapter summarises social impact assessment and is informed by the proposal's estimated development cost. The full social impact assessment report is provided in Appendix R.

19.1. Methodology

19.1.1. Approach to assessment

This section describes the methodology followed to prepare a Social Impact Assessment (SIA) of the construction and operation of the proposal. Overall, the methodology has been prepared to respond to the SEARs, with the SIA process considering by the following guidelines:

- *Social Impact Assessment Guideline* DPE, 2023b (the SIA Guideline)
- *Technical Supplement – Social Impact Assessment Guideline for State Significant Projects* – hereafter referred to as the ‘SIA Technical Supplement’ DPE, 2023c
- International Association for Impact Assessment *International Principles for Social Impact Assessment* Vanclay et al., 2003
- *Social Impact Assessment: Guidance for assessing and managing the social impacts of projects* Vanclay et al., 2015.

In addition, the report responds to the following legislation and strategies for the area:

- EP&A Act 1979
- Riverina Murray Regional Plan 2041 (DPE 2023a)
- Community Strategic Plan 2022-2050 (Edward River Council, 2022)
- Edward River Council Advocacy Strategy (Edward River Council, 2019a)

In the context of this SIA, social impacts are understood as the consequences that people and communities experience as a result of project-induced changes that affect the way they “live, work, play, relate to one another, organise to meet their needs and generally cope as members of society” Burdge & Vanclay, 1996.

19.1.2. Social values and baseline

As outlined in the SIA Guideline, social impacts can involve changes to one or more of the following social values:

- **Way of life**, including how people live, how they get around, how they work, how they play, and how they interact each day
- **Community**, including composition, cohesion, character, how the community functions, resilience, and people’s sense of place
- **Accessibility**, including how people access and use infrastructure, services and facilities, whether provided by a public, private or not-for-profit organisation

- **Culture**, both Aboriginal and non-Aboriginal, including shared beliefs, customs, practices, obligations, values and stories, and connections to Country, land, waterways, places and buildings
- **Health and wellbeing**, including physical and mental health especially for people vulnerable to social exclusion or substantial change, psychological stress resulting from financial or other pressures, access to open space and effects on public health
- **Surroundings**, including ecosystem services such as shade, pollution control, erosion control, public safety and security, access to and use of the natural and built environment, and aesthetic value and amenity
- **Livelihoods**, including people's capacity to sustain themselves through employment or business
- **Decision-making systems**, including the extent to which people can have a say in decisions that affect their lives, and have access to complaint, remedy and grievance mechanisms.

Data to inform the social baseline has been gathered from the following sources:

- Australian Bureau of Statistics (ABS) Census, 2021 and 2016
- NSW Department of Planning and Environment Population Projections
- economic data (e.g. economy.id)
- local, regional and state government websites and publications
- Google maps
- academic literature on water projects and their potential social impacts.

This SIA has identified potential direct, indirect or cumulative impact with both negative or positive outcomes. It has considered the individual, community, or segment of a community by whom it is experienced. Issues raised by the community and stakeholders during consultation have also been considered in this assessment.

19.1.3. Consultation

The SIA has been informed by the outcomes of various stakeholder and community consultation activities, including:

- stakeholder interviews by the SIA team
- stakeholder and community engagement activities by NSW DCCEEW – detailed in Consultation report: Yanco Creek Modernisation Project (see chapter 5 and Appendix E (Consultation Report)).

SIA specific stakeholder consultation was undertaken in accordance with the requirements of the SIA Guideline (DPE, 2023a). The purpose of SIA consultation was to validate and gather information to inform the development of the social baseline, the identification and assessment of potential social benefits and impacts, and development of mitigation and management measures. The stakeholders targeted for SIA consultation were identified on the basis they would experience positive or negative social impacts as a result of the proposal, and/or they represent communities and stakeholders who would experience impacts.

SIA consultation was undertaken between September and October 2022 by the SIA team via attendance at a NSW DCCEEW run community information sessions and a Registered Aboriginal Party (RAP) session, face-to-face interviews, and videoconference interviews.

19.1.4. Estimated development cost

The estimated development cost (formerly known as the capital investment value) of the proposal has been developed in accordance with Planning circular PS 24-002 and amended Sections 6 and 251, and Schedule 7 of the EP&A Regulation method for calculating costs. The estimation has been carried out by a Australian Institute of Quantity Surveyors Certified Quantity Surveyor / Royal Institution of Chartered Surveyors quantity surveyor providing:

- a detailed estimated development cost of the proposal (as defined in Schedule 7 of the EP&A Regulation)
- an estimate of jobs that will be created during the construction and operational phases of the proposed development.

19.2. Existing environment

The existing environment provides the social baseline against which impacts and benefits can be assessed. The local study for each site's area baseline describes:

- key features, local amenity and character of the proposal site and surrounding area
- select demographic and economic indicators for the suburbs of Conargo and Wanganella.

The regional study area baseline describes:

- demographic indicators
- indigenous values and interests
- economy and industry
- community values and wellbeing.

19.2.1. Hartwood

The existing weir to be demolished, adjacent to the proposal site, is owned and operated by WaterNSW on land owned by that body. It is heritage listed.

The new regulator at Hartwood would be on isolated RU1 – Primary Production-zoned land, with no residential or social infrastructure within 2.0 kilometres. The nearest village is Conargo, some 10 kilometres away in the west. Crown land and land on existing travelling stock routes would be acquired in accordance with applicable legislation to facilitate the construction of the regulator and its power supply and access. There would be access from both sides of the water during construction. There is no public access via road to the location of Hartwood Weir.

19.2.2. Wanganella

The existing weir to be demolished, adjacent to the proposal site, was constructed to provide town water supply and is owned by Edward River Council. The weir pool provides incidental recreational opportunities such as kayaking and fishing.

The new regulator It would be on RU1 – Primary Production zoned land but would be only about 1.0 kilometres southwest of Wanganella village. The site forms part of Wanganella Recreational Reserve. Acquisition of Crown land and land on travelling stock routes would be acquired in accordance with relevant legislation. There would be access from both sides of the water.

The Recreational Reserve is large and along with waterways and vehicle tracks, includes informal camping areas, a cemetery, and the town landfill.

19.2.3. Local communities

Wanganella village is around one kilometre north of the Wanganella Weir proposal site. It has a slowly falling population currently around 60 people with a community hall, play facilities, church, and post office/general store. There are also formal tourist facilities and the Recreation Area is cited as an important attractor to the town. Due to falling water availability and increased mechanisation of farm work, demand for labour in the region is falling.

Conargo and Jerilderie are two nearby settlements which are also dependent on Billabong Creek for domestic and agricultural water. Conargo is larger than Wanganella and contains a number of rural services such as a rural fire brigade and school. Conargo is around 10 kilometres west of the Hartwood proposal site.

Jerilderie is further away, but a town of over 900 people. Billabong Creek supplies domestic and agricultural water as well as Lake Jerilderie, a recreational lake for water skiing. Jerilderie is around 40 kilometres east of the Hartwood proposal site.

19.2.4. Regional study area

The sites are part of the Southern Riverina region of New South Wales. The Edward River Council includes several towns in a predominantly agricultural setting featuring wool (especially the famous Peppin Merino sheep), rice, and timber. The Billabong Creek meanders through the flat landscape providing water for towns and irrigation, specifically general security, stock and domestic, and supplementary licences for seasonal crops.

Indigenous values

The Riverina region would have been able to support large populations of Aboriginal people due to the number of permanent watercourses and associated food and material resources. Resources would have included materials used for the creation of canoes, nets, and tools.

Cultural flows can be described as the care for surface and ground water resources as an aspect of caring for Country. Maintaining cultural flows include various outcomes for Indigenous people, including identity, capacity building, spiritual, cultural, social, environmental, and economic outcomes. Community engagement carried out by NSW DCCEEW also identified the importance of maintaining river flows for various cultural, environmental, community, and economic purposes, in particular for local Aboriginal communities.

Community values

The *Edward River Community Strategic Plan 2022-2050* (Edward River Council 2022) describes the following values of relevance to the proposal:

- healthy, socially connected and resilient
- economic diversity
- vibrant and creative
- sustainable, quality Infrastructure
- a health and attractive natural environment
- a good place to visit for nature, food and fun.

The community describes itself in consultation events as “friendly”, “resilient” and “self-reliant”. There is an interdependency on the availability of water which feeds the agricultural production which is central to the region’s identity. This supports the attractive lifestyle which also benefits from the recreational opportunities the water can offer.

Natural resources stemming from the water include freshwater fish, birds, as well as other wildlife. This setting and abundance form the basis of recreation, tourism and economic investment in the region outside of agriculture. There is a strong culture of volunteerism in the Edward River Council area, which is linked to community support for resource management groups. However the intensity of political interest in water rights has begun to fatigue the community. The Council has committed to advocating for the following basic principles:

- no further productive water acquisition through buy-backs
- greater detail on the benefits, uses and regulation of environmental water
- all basin regions to have the same standard of compliance, metering and measurement as the Murray system
- no further water removed.

The Council has an interest in maintaining biosecurity with resource management to protect local native species and waterways from introduced weeds and pests.

Demographics

The Edward River LGA has a slowly declining population currently around 8,450. First Nations people represent 4.8 per cent compared to a state-wide 3.4 per cent. The population is also older than the state-wide average with a quarter aged over 65 years old, compared to 18 per cent for New South Wales. Reflecting this, almost half of families have no children, more than the NSW rate of 38 per cent. Although the settlements of Conargo and Wanganella achieved socio-economic advantage scores as moderate to high level of advantage, the Edward River LGA as a whole ranked lower, representing a moderate level of disadvantage.

The situation appears to be localised as adjoining and nearby Local Government Areas have managed stable or growing populations (Berrigan, Murrumbidgee and Murray River Councils). Attracting and retaining younger residents is a challenge for the Council.

Economics

Between 2003 and 2008, the Edward River Council LGA’s Gross Regional Product fell from \$629 million to \$517 million. Figure 19.1 indicates that it has since held roughly steady around this level, with a high of \$550 million in 2013 and a low of \$503 million in 2020.

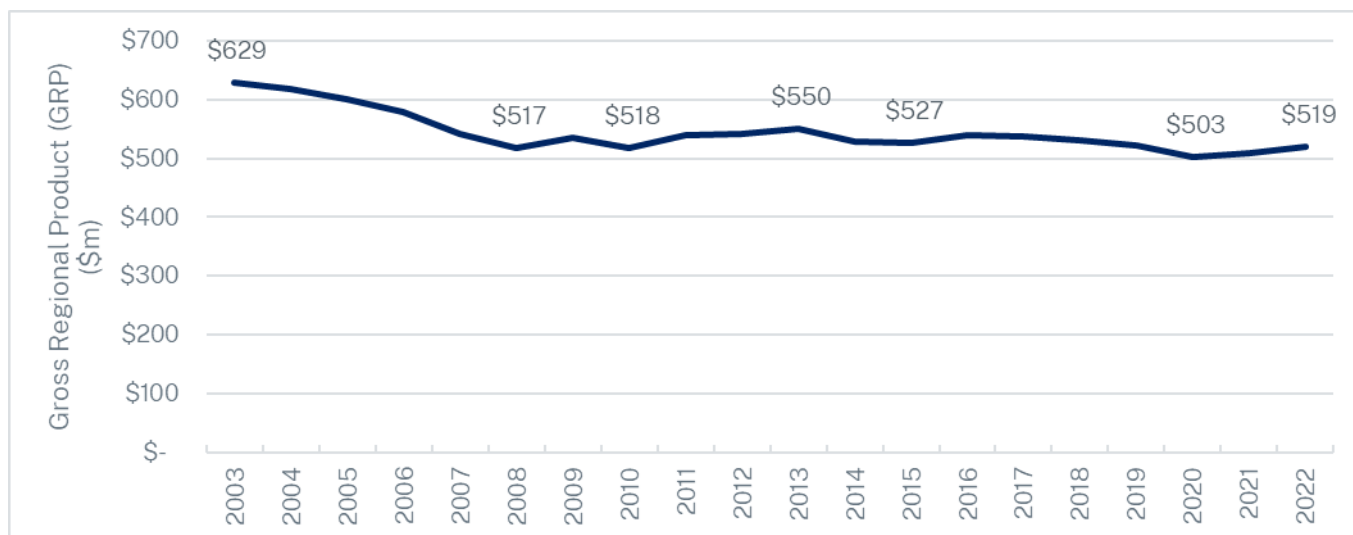


Figure 19.1 Edward River Council LGA Gross Regional Product

Figure 19.2 shows that the biggest contributors were agriculture, forestry and fishing, with over \$100 million in financial year 2022. Health care & social assistance and construction were the next two with just under \$50 million each. Utilities contributed \$29 million while Education was \$25 million.

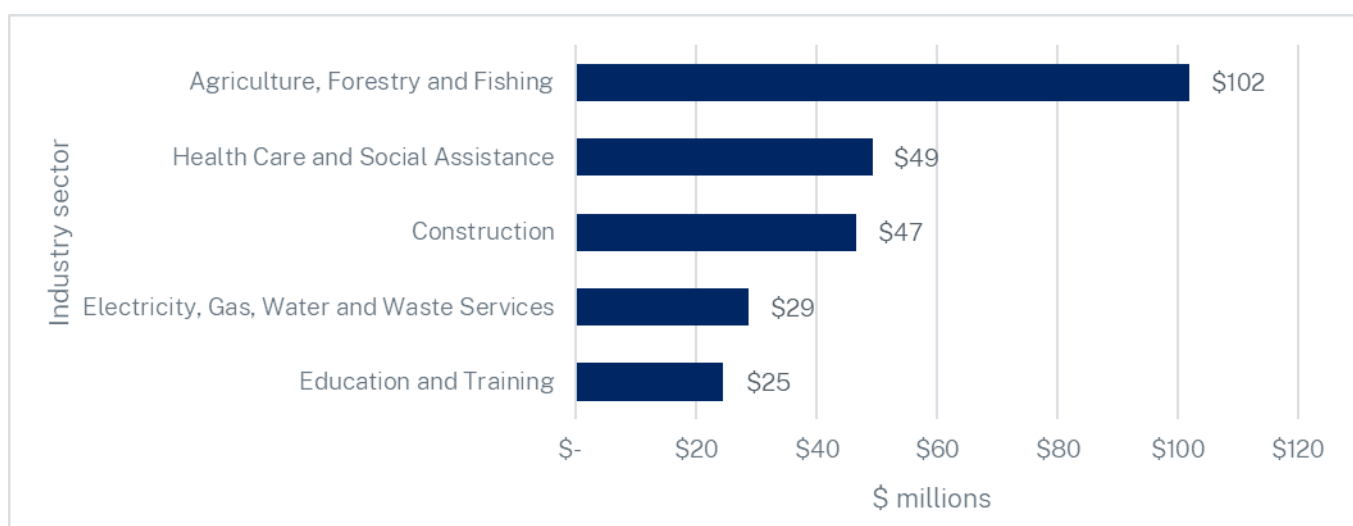


Figure 19.2 Edward River Council LGA industry sectors

Thirty-five per cent of the just over 1,000 businesses in the LGA are related to agriculture, fishing and forestry. Most of these did not have permanent employees and many have seasonal workforces mainly in the late spring and autumn periods.

Despite the relatively older population, labour force participation in the LGA is comparable to the state as a whole, at 56 per cent compared to 59 per cent. The unemployment rate, currently 3.6 per cent, is typically higher than NSW and with larger fluctuations.

Housing and accommodation

Perhaps reflecting the older demographic, 70 per cent of homes are owned or being paid off compared to 64 per cent for NSW as a whole. Of these 90 per cent of homes are detached dwellings. Weekly rent is almost half the state average at \$220 per week compared to \$420 for New South Wales as a whole. The area has a higher proportion of unoccupied dwellings (14 per cent compared to 9.4 per cent). These may be used as holiday homes or could be abandoned due to lack of employment opportunities in the area. Most of the 26 per cent accommodation providers in the area are located in Deniliquin. There are also eleven whole-house short term accommodation choices.

Despite the vacancy rate, tourism accommodation is tight especially around local events such as the Deni Ute Muster when normal supply is overwhelmed. This situation can also occur during harvest time where seasonal workers are accommodated in visitor accommodation or on farms.

19.2.5. Key findings

Key findings from the local and regional baseline most relevant to the SIA include:

- Billabong Creek is a culturally important body of water for traditional owners, where Aboriginal stakeholders have expressed a high interest in the appropriate management of Billabong Creek for potential cultural flows of water.
- Billabong Creek provides an important supply of domestic and commercial water for towns, villages, and irrigators in area.
- Water is the “life blood” of the region and supports the economy and thus lifestyle and wellbeing for surrounding communities.
- Most irrigation water licences in the Yanco Creek system are general security, stock and domestic, and supplementary licences used for seasonal crops.
- The regional community is highly engaged in water matters, however, some are experiencing fatigue from the ongoing need to advocate for their interests.
- Wanganella is the only site which has nearby housing, recreational use, accommodation, and other social infrastructure. It is also located within a recreation reserve.
- The regulator sites are located within or nearby to land used for agricultural operations.
- The local and regional study areas are characterised by agricultural lands, waterways, and riverine forests.
- Water recreation is common in the local and regional study areas, including fishing, kayaking, and boating.

19.3. Impact assessment

19.3.1. Construction

The potential social impacts and benefits during the construction phase are similar across Hartwood and Wanganella so have not been considered separately, although Hartwood is relatively isolated from most sensitive receivers.

The construction phase would have the following temporary impacts:

- occupation of Crown and private land
- changes to access of private land
- excavation for underground power lines
- changes of internal access of paddocks such as installation of cattle grids
- additional vehicle movements to and within property
- additional noise, vibration, dust, visual impacts (especially at Wanganella)
- changes to visual amenity from vegetation clearance
- changed water management
- potential risk to First Nations heritage
- local procurement of consumables, materials and labour for construction
- imported labour to be housed nearby (maximum one hour drive time)
- demolition of heritage-listed weir.

Property and landholders

Construction of the proposed Hartwood and Wanganella regulators and associated works, would involve temporary land requirements which may result in the temporary disruption of access to land for some private landowners. NSW DCCEEW has been consulting with affected landowners about property impacts to minimise and avoid impacts to landholders as much as possible. This includes designing an underground transmission line through one property to avoid impacts from an overhead transmission line.

Construction vehicles may also be required to move between paddocks, requiring gates to be opened/closed, or use of temporary cattle grids. Existing access tracks for site access during construction and the maintenance of new infrastructure during operation may also result in temporary disruptions and an inconvenience for some private landowners. It is expected that all properties impacted by temporary land requirements would be restored/rehabilitated following construction, to enable current land use and activities to resume. NSW DCCEEW will continue to consult with affected landholders during the pre-construction and construction phase. Consultation for the EIS noted a desire for landholders to be engaged and kept actively informed regarding where their property was likely. As outlined in the Consultation report (Appendix E) NSW DCCEEW will continue to consult with affected landholders during the pre-construction and construction phases and will be included in the decision-making process regarding new infrastructure on their property. This is expected to assist managing disruptions to affected landholders.

There is also potential for power disturbances for nearby residents and businesses as a result of upgrades to transmission lines during construction. These disturbances, however, are likely to be temporary in nature and therefore minor. It is expected that affected residents and businesses would be notified prior to work being completed.

Soil disturbance and vehicle movements have the potential to introduce and spread weeds, pests and diseases, which could impact agricultural production (livestock grazing). Further details on this are provided in chapter 14 (Land use, property and agriculture).

Access and connectivity

During construction, equipment and personnel would require daily access to the work sites via existing and some new temporary access tracks. Upgrades to the existing access tracks would be undertaken prior to construction work commencing to reduce any potential damage.

The Hartwood site would be accessed via two existing access tracks. The west bank track is located on Crown Land while access to the east bank would be via a small private creek crossing. This has the potential to temporarily impact access for surrounding private landowners who use the crossing.

The Wanganella site would be accessed via two existing tracks. Both access tracks are located on Crown Land. Access to the site via the to the camping reserve track may potentially reduce access to the area for recreational users of the creek and adjacent Wanganella Recreational Reserve.

Overall, construction activities may temporarily affect access for some property owners, users of Wanganella Recreation Reserve, and users of the creek during construction.

Economy, business and employment

The estimated development cost of the proposal is listed in section 3.1.1. This value is a direct economic benefit to the NSW, regional and local communities. This value includes investment during the construction phase which would support local economy, business and employment.

During construction, the proposal will require a wide range of consumables, goods and services. Procurement opportunities from local and regional businesses in the construction industry could generate flow on employment opportunities.

The construction workforce is expected to fluctuate depending on the phase of construction and associated activities. It is anticipated that up to 26 personnel per day would be on site over the 18-month construction period. This may provide increased employment opportunities for residents in the local and regional study area, particularly those in the construction industry. While a local workforce would be prioritised for employment opportunities during construction, some roles would likely require specialised skills and may need to be sourced from outside the local and regional study areas.

Housing and accommodation

Some construction roles may need to be sourced from outside the local and regional study area. Non-resident workers would be required to stay in accommodation facilities within a safe driving distance of one hour. Deniliquin would be the preferred option as the largest town within driving distance of the proposal sites. Other nearby towns such as Jerilderie, Finley and Echuca may also be considered if accommodation in Deniliquin is unavailable.

There are approximately 11 accommodation facilities and an additional nine short-term accommodation providers (Airbnb) available in Deniliquin. Consultation for the SIA indicated that short-term accommodation vacancy in Deniliquin is low and usually at full capacity during times of local and regional events. To manage workforce accommodation impacts and avoid reduced availability for tourists, consultation with local accommodation providers will be required in the lead up to and during construction regarding workforce accommodation requirements.

Changes to local amenity

Changes to local amenity may result from construction activities including vegetation clearance, vehicle movements, earthworks, and establishment of a construction activity zones. Given the somewhat isolated location of the proposal sites, changes to local amenity are not expected to affect most community members.

Given the Hartwood site is relatively isolated from sensitive receivers, amenity changes are not expected to affect most community members. Recreational users of the creek who access the site and surrounds may be disturbed by amenity changes during construction. However, creek users are expected to find other places along the river for recreational activities during construction.

There may be some impacts to recreational users of Wanganella Recreation Reserve and the creek at times, due to increased noise, vibration and dust, and visual impacts. There is potential for some recreational users of the reserve and creek to be deterred from using the area during construction.

Indigenous communities and values

The proposal would impact on a number of Aboriginal heritage items during construction, which is discussed in chapter 12. The Aboriginal heritage assessment recommends a range of mitigation measures which are based on consultation with RAPs during field surveys. Implementation of these mitigation measures is expected to support avoiding impacts to tangible Aboriginal cultural heritage values for local Aboriginal stakeholders.

NSW DCCEEW implemented a comprehensive Aboriginal Community Engagement Strategy to identify and engage appropriate Aboriginal stakeholders about the project. NSW DCCEEW also prepared an Aboriginal Cultural Strategy to guide active participation of First Nations people in project matters affecting their cultural heritage. This strategy has been pivotal in safeguarding cultural practices, language, knowledge, and identity throughout the project's assessment phase (see Appendix E).

Heritage values

Construction of the proposed new regulators would require demolition of the existing weir structures including the removal of the original headwall. The existing Hartwood Weir is of heritage significance and is a locally listed heritage item. Changes to the existing weir may impact local community values associated with the weir's heritage, and history of the area. The Non-Aboriginal Heritage Assessment (see chapter 13 and Appendix N) recommends a range of mitigation measures to avoid or manage heritage impacts. This includes exploring interpretation opportunities at each weir site, such as signage or interpretation to provide information about the heritage significance of the site, fabric, value and history of the site. This is also expected to support community values associated with local heritage and history.

Community wellbeing and cohesion

Disruptions and reduced amenity during construction, would be temporary and due to the relatively remote location of the proposal anticipated to be minor. Construction activities are therefore not anticipated to affect community wellbeing and cohesion.

Summary of potential construction impacts

Table 19.1 provides a summary of the assessed the social impacts identified for the construction phase of the proposal. The significance rating shown has been applied to each social impact based on the outcome of this assessment and the assumption that mitigation and management measures have been carried out.

Table 19.1 Social impact assessment – summary of potential construction impacts

Potential impact description	Stakeholders affected	Mitigation measures	Residual significance
Property and landholders			
Temporary land use changes due to the requirement for new transmission lines and upgrading and use of access tracks may lead to disruptions in usual activities and be an inconvenience for some landowners.	Private landowners providing access to Hartwood and Wanganella proposal sites	Consultation with affected land owners Communication and Engagement Plan	Negative Low
Construction activities and the associated movement of vehicles and machinery between properties could potentially lead to the introduction and spread of pests, weeds and diseases. The introduction of pests, weeds and diseases poses a potential biosecurity risk for adjacent and other nearby agricultural properties if not managed properly.	Landowners at all proposal sites Adjacent landowners to all proposal sites	Weeds and pathogen management outlined in the CEMP Communication and Engagement Plan	Negative Low
Potential power disturbances for nearby residents and businesses due to upgrades of transmission lines may lead to temporary power disturbances and outages.	Nearby residents and businesses	Communication and Engagement Plan	Negative Low
Changes to local amenity			
Local amenity in close proximity to construction works may be reduced including for recreational users of Wanganella Recreation Reserve and the creek temporarily. While this may deter some users from visiting these areas at times during construction, most users are expected to find other places along the creek to use during construction. Removal of vegetation may reduce visual amenity for a longer period, however most people are expected to adapt to this as replanted vegetation grows.	Users of Wanganella Recreation Reserve and users of the creek around the sites	Communication and Engagement Plan Revegetation of disturbed sites	Negative Low
Access and connectivity			
Construction activities may temporarily affect access for some property owners, users of Wanganella Recreation Reserve, and users of the creek during construction.	Property owners adjacent to sites and access tracks Users of Wanganella Recreation Reserve and the creek surrounding the sites	Traffic Management Plan (TMP) Communication and Engagement Plan	Negative Low
Community wellbeing and cohesion			
Improved water management contributing to community wellbeing and increased water delivery for drinking water and domestic supply.	Towns / villages dependent on Billabong Creek for stock and domestic water Irrigators on Billabong Creek	Water management measures Communication and Engagement Plan	Positive High

Potential impact description	Stakeholders affected	Mitigation measures	Residual significance
Aboriginal communities and values			
If inadequately managed there is potential for the proposal to disturb or damage both registered and non-registered Aboriginal heritage sites. This has the potential to impact both tangible or intangible cultural values associated with these areas, which has the potential to impact wellbeing for Aboriginal communities.	Local and regional Aboriginal stakeholders	Aboriginal Cultural Heritage Management Plan (ACHMP) Continued engagement with local Aboriginal stakeholders	Negative Low
The proposal has the potential to contribute to cultural values for local and regional Aboriginal communities through improving environmental and potential cultural flows of Billabong creek. This may contribute to enhanced spiritual, cultural and wellbeing outcomes for Aboriginal people.	Local and regional Aboriginal stakeholders	Water management measures Continued engagement with local Aboriginal stakeholders	Positive High
Economy, business and employment			
Procurement opportunities for local and regional businesses may contribute to the local and regional economy, and provide employment opportunities for local residents.	Businesses and workforce in the local regional study area	Maximise opportunities for local and First Nation employment and business participation	Positive Medium
Housing and accommodation			
Potential for reduced availability of short term accommodation for non-resident workers in nearby towns.	Accommodation facilities and tourism industry in the regional study area	Consult with local accommodation providers	Negative Low
Heritage – Non-Aboriginal			
Removal of the existing Hartwood weir would impact the locally listed heritage item. This change may impact local community values associated with the weir's heritage, and history of the area.	Local and regional communities	Non-Aboriginal heritage management measures including interpretation	Negative Low

19.3.2. Operation

This section outlines the social impacts and benefits once construction is complete, during the normal operation phase of the project. These are similar across the two sites so have not been considered separately, although note that Hartwood is relatively isolated from most sensitive receivers.

Operation would change the existing situation in the following ways:

- The new, larger infrastructure and loss of vegetation would affect visual amenity for users of the creek nearby. This affect will reduce over time as vegetation regrows but would never return to pre-construction levels.
- Better access via improved tracks may benefit landowners and recreational users of the creek at Wanganella, or impact private land owners newly vulnerable to trespass.
- Better water regulation is a key purpose of the proposal. The works would result in improved water security for drinking and domestic supply.

- The additional fish ladders will improve fishing in the creeks.
- Generally higher water levels will improve vegetation health which would benefit local ecosystems and thus passive users of the land like bushwalkers, birdwatchers and kayakers.
- Improved capacity for environmental and potential cultural flows for First Nations peoples.
- Improved water security and better dosing and timing of water deliveries.
- Improved stock safety in times of low rainfall.
- Sustained improvement in tourism offering through reliable water sports would lead to higher and more stable visitor numbers, stimulating the accommodation industry.
- Some aspect of the existing Hartwood Weir is proposed to be retained and relocated as a heritage monument, maintaining a link to the past.

Property and landholders, access and connectivity

During operation, impact to property and landowners is expected to be negligible as required easements and access agreement would have been established.

Economy, business and employment

As a key objective of the proposal, improved water management in Billabong Creek is expected to improve water delivery, reliability and timing, as well as reduce the need for water buy backs. Improved environmental outcomes and water availability in the study area is expected to benefit a range of industries and businesses in the region. In particular, agricultural operations which are dependent on the reliable supply of water to operate their businesses, and have experienced periods of lost revenue during times of extended drought. During NSW DCCEEW consultation, concerns were raised about potential impacts to water quality of the creek. It was identified in SIA consultation that the health of the creek systems has a direct impact on the quality of output from agricultural operations. For example, when water levels in the creek systems are too low, stock can get stuck in mud and often do not survive. Minimum flow rates established for the operation of the new regulators would mean stock bogging would be less likely.

Improved environmental conditions and recreational experience for river users may also attract more visitors to the area. The local visitor economy predominantly relates to water-based activities. This may benefit nearby accommodation providers and potentially increase visitation to small businesses in the local and regional area, as well as businesses which rely on Billabong Creek.

Housing and accommodation

The operational workforce would be very low and there is unlikely to impact the availability of local housing and accommodation.

Changes to local amenity

The natural environment and ambience were cited during SIA consultation as an important aspect of the recreational experience in the area around Wanganella and along Billabong Creek. There is potential for changed views due to vegetation clearance and the installation of the new structures to decrease some recreational user's enjoyment of the areas. However, most people are expected to adapt to visual changes over time, particularly as new vegetation establishes.

Indigenous communities and values

The proposal has the potential to contribute to cultural values for local and regional Aboriginal communities through improving environmental and potential cultural flows in Billabong Creek. The relationship between the health and wellbeing of Aboriginal people and the health of Country is well documented in literature (for example in (Salmon, et al., 2018)). The proposal, therefore, has the potential to contribute to enhanced spiritual, cultural, and wellbeing outcomes for Aboriginal people.

Heritage values

Provision of interpretation opportunities in relation to the demolished weirs, to provide information about the heritage significance of the structures, fabric, value and history of the sites is expected to support community values associated with local heritage and history.

Community wellbeing and cohesion

A key objective of the proposal is to provide more reliable and efficient delivery of water in Billabong Creek.

SIA consultation found that water security is inextricably linked to community wellbeing for local communities. Overall, improved water management would contribute to reliable water delivery for drinking water and domestic supply and reduce the need for water buybacks. This is expected to enhance community wellbeing and contribute to community values.

Some stakeholders have raised concerns about potential interruptions to water supply during construction, and changed access to water for both domestic and stock use during operation. While the management of water will be guided by an operations plan, during consultation, some stakeholders felt there should be more tangible parameters in place to ensure sufficient flows in Billabong Creek.

During operation, improved environmental flows in Billabong Creek would improve the creek and environmental conditions. This may lead to improved recreational experiences for:

- recreational fishers, through improved fish stock due to improved fish passage
- bushwalkers, birdwatchers, and kayakers, through improved quality of vegetation health.

Local and regional communities highly value the river and water-based recreation, particularly at Wanganella. Improved environmental flows are therefore, expected to contribute to community and recreational values, as well as community wellbeing.

Summary of potential operational impacts

Table 19.2 provides a summary of the assessed the social impacts identified for the operational phase of the proposal. The significance rating shown has been applied to each social impact based on the outcome of this assessment and the assumption that mitigation and management measures have been carried out.

Table 19.2 Social impact assessment - summary of potential operational impacts

Potential impact description	Stakeholders affected	Mitigation measures	Residual significance
Property and landholders			
Movement of maintenance vehicles could potentially lead to the introduction and spread of pests, weeds and diseases. The introduction of pests, weeds and diseases poses a potential biosecurity risk for adjacent and other nearby agricultural properties if not managed properly.	Landowners at all proposal sites Adjacent landowners to all proposal sites	Weeds and pathogen management outlined in operational management plan Communication and Engagement Plan	Negative Low
Access and connectivity			
Upgrades to access tracks is expected to benefit affected property owners, as well as users of Wanganella Recreation Reserve, due to increased accessibility and safety over the longer term.	Property owners adjacent to sites and access tracks Users of Wanganella Recreation Reserve	Traffic Management outlined in the operational management plan Communication and Engagement Plan	Positive Medium
Community wellbeing and cohesion			
Improved water management contributing to community wellbeing and increased water delivery for drinking water and domestic supply.	Towns / villages dependent on Billabong Creek for stock and domestic water Irrigators on Billabong Creek	Water management measures Communication and Engagement Plan	Positive High
Improved environmental flows contributing to enhanced recreational values and community wellbeing for local and regional communities who highly value the creek and water-based recreation.	Local and regional communities Wanganella Recreation Reserve users and creek users	Water management measures Communication and Engagement Plan	Positive High
Aboriginal communities and values			
If inadequately managed there is potential for the proposal to disturb or damage both registered and non-registered Aboriginal heritage sites. This has the potential to impact both tangible or intangible cultural values associated with these areas, which has the potential to impact wellbeing for Aboriginal communities.	Local and regional Aboriginal stakeholders	Aboriginal Cultural Heritage Management Plan control measures included in the operational management plan Continued engagement with local Aboriginal stakeholders	Negative Low

Potential impact description	Stakeholders affected	Mitigation measures	Residual significance
The proposal has the potential to contribute to cultural values for local and regional Aboriginal communities through improving environmental and potential cultural flows of Billabong creek. This may contribute to enhanced spiritual, cultural and wellbeing outcomes for Aboriginal people.	Local and regional Aboriginal stakeholders	Water management measures Continued engagement with local Aboriginal stakeholders	Positive High
Economy, business and employment			
Improved environmental outcomes and water availability in the study area is expected to benefit a range of industries and businesses in the region, particularly agricultural operations.	Regional businesses including agricultural operations and irrigators on Billabong Creek	Water management measures Communication and Engagement Plan	Positive High
Improved environmental conditions and recreational experience for river users may attract more visitors to the local and regional area. This may benefit nearby accommodation providers and potentially increase visitation to small businesses.	Local recreational and tourism based businesses	Water management measures Communication and Engagement Plan	Positive Medium
Heritage – Non-Aboriginal			
Removal of the existing Hartwood weir would impact the locally listed heritage item. This change may impact local community values associated with the weir's heritage, and history of the area.	Local and regional communities	Non-Aboriginal heritage management measures including interpretation	Negative Low

19.3.3. Cumulative impacts

A summary of the cumulative assessment is provided in section 23.3.3 and section 6.10 in Appendix R (social assessment report).

19.4. Mitigation measures

19.4.1. Approach to mitigation and management

The general approach to management of the proposal during construction and operation is outlined in chapter 24.

NSW DCCEEW is committed to minimising the environmental impact of the proposal and is investigating opportunities to reduce impacts where practicable. As prescribed by the SEARs, opportunities would also be implemented, where possible, to improve the overall outcome of the proposal.

The social impacts and benefits identified and assessed in this report will be managed and mitigated through a range of measures and strategies recommended in Table 19.3, and by those recommended in other EIS specialist studies. This will also be supported by the mitigation measure proposed for other topics, notably chapter 14 (land use, property and agriculture), chapter 15 (traffic and access), chapter 16 (noise and vibration), chapter 17 (visual amenity) and chapter 21 (air quality).

The management strategies have been developed based on industry standards, practices and guidelines, reference to the measures implemented on other comparable projects, and feedback from stakeholders during consultations.

19.4.2. Summary of management measures

Table 19.3 lists the social safeguards and management measures that would be implemented to account for the potential impacts identified in section 16.3.

Table 19.3 Social safeguards and management measures

ID	Impact	Environmental safeguards	Responsibility	Timing
S1	Impacts and benefits for local and regional communities	NSW DCCEEW will continue to manage and deliver the Communication and Engagement Plan (C&EP) in the lead up to and during construction of the proposal. This will help to ensure that: - the community and stakeholders have a high level of awareness of all processes and activities - accurate and accessible information is made available - a timely response is given to issues and concerns raised by the community - feedback from the community is encouraged - opportunities for input are provided.	NSW DCCEEW	Pre-construction / construction
S2	Amenity and access impacts for local communities and landholders	A communication management plan will be developed by the primary contractor in accordance with the C&EP and implemented to define the specific requirements for engagement during delivery of the proposal. A communication management plan will be developed to ensure that: - landowners/landholders, community members and businesses affected by construction activities (eg property impacts, cultural heritage impacts, access changes, noise, vibration, dust) are notified in a timely manner about impacts - accurate and accessible information is made available through multiple channels (eg printed fact sheets and notification letters, email, phone calls, online) - feedback from the community is encouraged - opportunities for input are provided where appropriate. The communication management plan will define the requirements for the complaints management system to be implemented throughout the duration of the proposal, including 24-hour, seven days a week phone line, postal and email address for written enquiries, and publication of contact details.	NSW DCCEEW, construction contractor	Pre-construction / construction

ID	Impact	Environmental safeguards	Responsibility	Timing
S3	Impacts to and benefits for Aboriginal communities	NSW DCCEEW will continue to engage with local Aboriginal stakeholders about the proposal. NSW DCCEEW will continue to manage and deliver tailored and targeted engagement with Traditional Owners and Aboriginal communities and stakeholders in accordance with the C&EP. This will: • provide mechanisms for Aboriginal people and communities to provide input to the proposal • draw upon perspectives, knowledge, relationships, cultural practices, and wisdoms of Aboriginal stakeholders to minimise potential disruptions from the proposal • demonstrate how input provided is incorporated into decision making and planning for the proposal • identify employment, training, and procurement opportunities associated with the proposal • protect and mitigate harm of Aboriginal cultural heritage and spiritual values within the influence of the proposal scope.	NSW DCCEEW	Pre-construction / construction
S4	Local and First Nation employment and business opportunities	NSW DCCEEW will maximise the participation of local, regional and First Nation businesses in the proposal, such as: • preferential local and First Nation participation inclusions in tender documents which outline the sub-contracting and local employment goals that construction contractors would need to deliver • promotion of supply and employment opportunities through local industry channels, employment organisations and local Aboriginal organisations.	NSW DCCEEW	Pre-construction / construction
S5	Non-resident workforce accommodation requirements	The construction contractor will share information with local accommodation providers about any non-resident workforce accommodation requirements in a timely manner.	Construction contractor	Pre-construction / construction

20. Soils and Contamination

This chapter provides the soils and contamination assessment for the proposal. It describes the existing soils environment, including potential areas of contamination, assesses the potential impacts during construction and operation, and provides measures to mitigate and manage the impacts identified. The contamination assessment report is provided in Appendix T.

20.1. Methodology

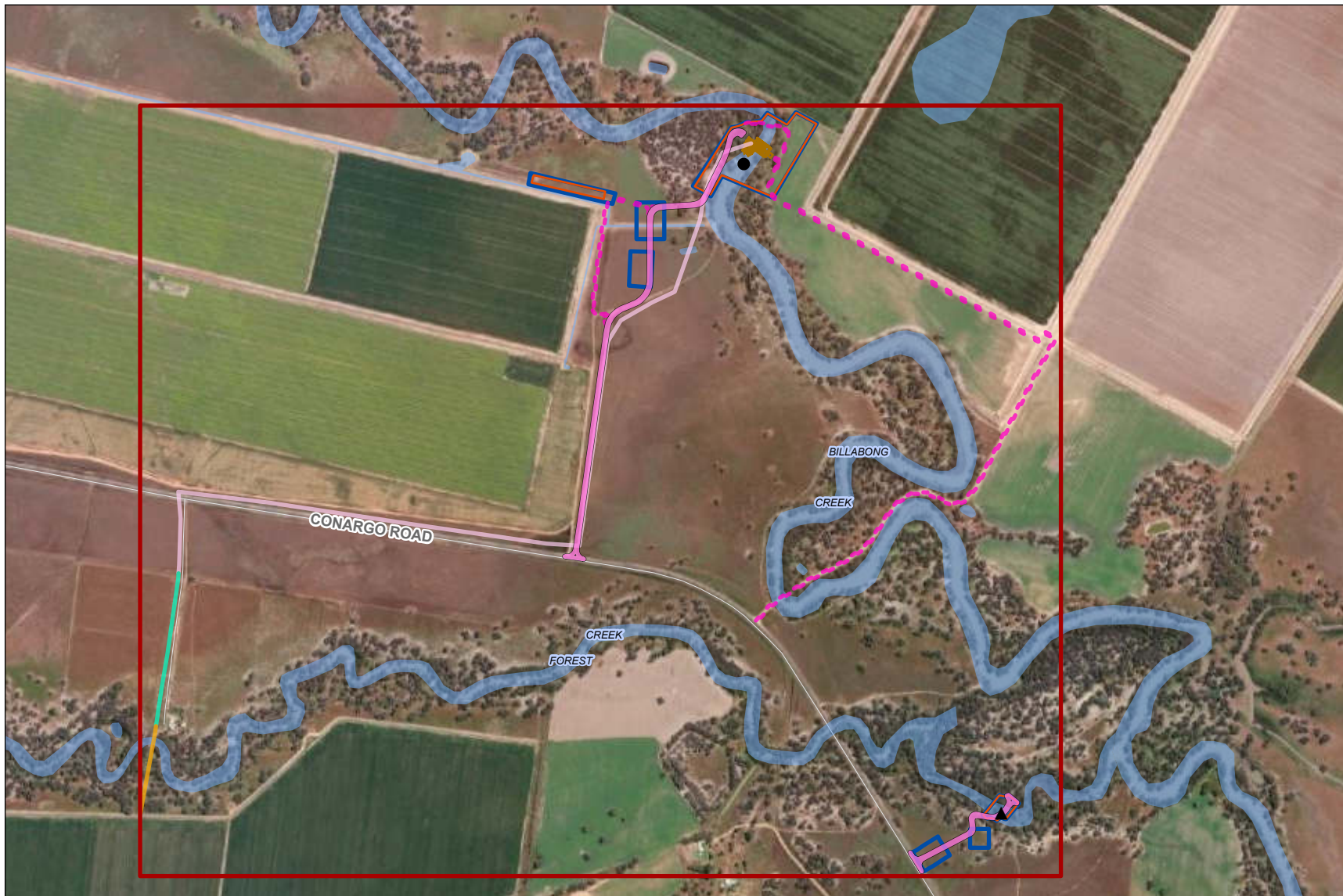
The assessment was carried out with reference to the following:

- applicable legislation and planning instruments (including the *NSW Contaminated Land Management Act 1997* (the CLM Act), the *Protection of the Environment Operations Act 1997* (POEO Act), and State Environmental Planning Policy (Resilience and Hazards) 2021
- other relevant policies and guidelines, including the *Consultants Reporting on Contaminated Land: Contaminated Land Guidelines* (NSW EPA 2020), the *Acid Sulfate Soil Manual* (Acid Sulfate Soil Management Advisory Committee 1998), and guidelines on the duty to report contamination under the CLM Act.

The study area for the soils and contamination assessment is the proposal site, as described in section 3.1.2 (Proposal description) and the surrounding area with the potential to be directly or indirectly impacted by the proposal, as shown in Figure 20.1 and Figure 20.2. Desktop searches undertaken for the contamination assessment also extended up to two kilometres around the proposal site.

The assessment involved:

- a preliminary site investigation in general accordance with the *Consultants Reporting on Contaminated Land: Contaminated Land Guidelines* (NSW EPA 2020) including:
 - identifying sites and areas of known and potential contamination in the study area, including reviewing the following NSW EPA databases:
 - o register of contaminated sites and list of notified sites under sections 58 and 60 of the CLM Act
 - o environment protection licence records under section 308 of the POEO Act
 - reviewing publicly available data and web-based information searches, background information relevant to the study area, survey data and topography, including historical aerial photographs, geological maps, soil landscape maps, acid sulfate soil risk mapping, and hydrogeological landscape mapping
 - compiling a conceptual site model to identify potential contamination sources, receptors and exposure pathways
 - providing recommendation for further contamination assessment, if required
- identifying the potential to disturb acid sulfate soils and areas of salinity
- reviewing the results of the soil assessment undertaken as part of geotechnical investigations (see below)
- assessing potential construction and operation impacts that may result from contaminated land or groundwater, and the potential impacts on soils
- identifying mitigation measures to reduce or minimise identified impacts.



Proposal

- Study Area
- Proposed Hartwood Regulator
- Construction activity zone
- Clearing area

Power Supply

- Power Supply
- Power Supply (Existing aboveground)
- Power Supply (to run underground)

Access tracks

- Construction Only
- Construction plus O&M

Existing features

- Existing weir
- Existing block bank
- Main road
- Water bodies

N



GDA2020 MGA Zone 55

A4 Scale: 1:16,000

0 100 200 300 400

Metres

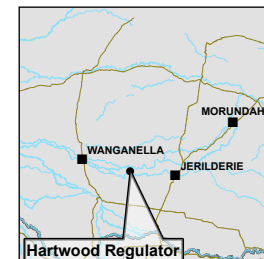


Figure 20.1 Soils and contamination study area - Hartwood Regulator



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Proposal

- Wanganella Landfill
- Study Area
- Wanganella bypass channel
- Proposed Wanganella Regulator
- Construction activity zone
- Clearing area
- Power Supply**
 - Power Supply
 - Power Supply (to run underground)
- Access tracks**
 - Construction Only
 - Construction plus O&M
- Existing features**
 - Existing weir
 - Water bodies
 - Main road

N

GDA2020 MGA Zone 55

A4 Scale: 1:8,000

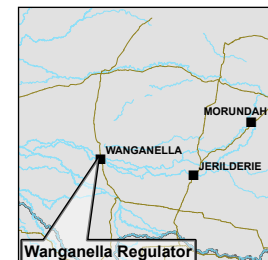
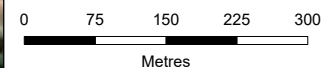


Figure 20.2 Wanganella Regulator contamination assessment study area



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20.1.1. Soil investigations

The geotechnical investigations undertaken to inform the design included assessment included:

- drilling of four boreholes at Hartwood Regulator and two boreholes at Wanganella Regulator to a maximum depth of 18 metres below ground surface.
- installing a groundwater well at Hartwood Regulator and two groundwater wells at Wanganella Regulator
- undertaking a suite of laboratory tests to classify the soils encountered, including tests for acid sulfate soil and soil dispersion.

20.2. Existing environment

20.2.1. Landform

Topography and geotechnical

The topography at the Hartwood Regulator and Wanganella Regulator sites is relatively flat and uniform at approximately 90 metres Australian height datum (AHD) and 100 metres AHD, respectively.

The study area is generally underlain by Quaternary aged alluvial channel sediment deposits associated with Billabong Creek which consist of very-fine grained sand overlaying light brown clayey silt. Additionally, Tertiary and Quaternary aged alluvial floodplain deposits occur within 100 metres to 500 metres of the study area and are characterised by silt consisting of very fine to medium grained lithic to quartz rich sand.

Seismicity

The National Seismic Hazard Assessment (Geoscience Australia 2018).defines the level of earthquake ground shaking across Australia that has a likelihood of being exceeded at a given time. This information is used to inform the design of a structure. Seismic hazard is calculated as the ground motion level, on engineering rock, that has a given probability of being exceeded within a given period: two per cent in 50-year exceedance in the Australian Standard AS1170.4 – Earthquake actions in Australia 2007.

AS 1170 requires the structural designer to consider the effects of earthquakes. The design is influenced by the classification of the site (based on the subsoil strength and thickness) and a hazard factor (based on the probability of earthquakes).

The maximum depth of soil and the soil type and description were assessed for each regulator based on existing borehole logs and the CSIRO Depth of Regolith map available at the Geoscience Australia Portal. Geotechnical assessment carried out for the proposal classified the proposal areas as deep soil sites.

Under the 2018 National Seismic Hazard Assessment, both sites are mapped as having a spectral acceleration of 0.08 to 0.1 in a 50-year period. This level is in the lower range of potential seismicity risk within Australia. Therefore, the potential for ground motion in a seismic event would be unlikely at the at the existing structures.

Naturally occurring asbestos

Naturally occurring asbestos refers to a group of fibrous minerals associated with altered ultramafic rock. 'Ultramafic' describes igneous rocks that were originally formed deep in the earth; however, by the time they are exposed at the earth's surface by erosion, the rocks have been successively metamorphosed into serpentinite rock containing minerals such as lizardite, chrysotile, and antigorite. These rocks are known to outcrop in parts of NSW and may include chrysotile asbestos or tremolite/actinolite asbestos, or sometimes no asbestos at all.

A search of the NSW Resources and Geosciences naturally occurring asbestos database indicated that there are no naturally occurring asbestos records within one kilometre of the proposal site. The potential for naturally occurring asbestos to be encountered has not been considered further.

20.2.2. Soils

Soil types

The soil landscape within the study area is described in Table 20.1.

Table 20.1 Soil landscapes

Soil landscape	Characteristics
Yancobong – alluvial channels and flood plain floodplains of the Yanco and Billabong Creek systems	Includes relict meander bends, scrolls, and flood runners with a local relief of less than 10 metres. The soil unit is predominately gilgai plains of cracking grey clays with small areas of cracking brown clays, and very small areas of hard alkaline red soils and hard alkaline brown soils on low rises. Bordering dunes are also included in the landscape and include arenic rudosols. The land has been partially cleared with native forest remaining and some localised weed infestations. Limitations include poor drainage with soils that deform easily when wet.

The geotechnical investigations undertaken to inform the design indicate that soil is moderately dispersive to not dispersive, so have the potential to be susceptible to erosion and dispersion.

Acid sulfate soils

Acid sulfate soils are naturally occurring soils containing iron sulfides. Iron sulphides, when exposed to the air due earthworks, undergo an oxidation reaction creating sulfuric acid. The creation of sulfuric acid and the subsequent mobilisation of aluminium, iron, and manganese from the soils and may pose a risk to environmental and human receptors through the acidification of soils and drainage waters, and, thereby, the deoxygenation of water bodies. This may have a detrimental effect on the receiving environment and may result in vegetation dieback, fish kills, the contamination of surface and groundwater, and the corrosion of infrastructure.

The CSIRO Atlas of Australian Acid Sulfate Soils indicates that most of the study area has a low, to extremely low probability of having naturally occurring acid sulfate soils.

The acid sulfate soil laboratory tests undertaken as part of the geotechnical investigations indicated that soils do not contain appreciable existing acidity and that soils in the proposal site do not require management under an acid sulfate soils management plan. Therefore the potential to encounter acid sulfate soils has not been considered further.

Salinity

Soils can become saline when water tables rise and bring salt to the surface. This can occur as a result of weathering of rocks containing salt, use of saline irrigation water, or proximity to marine environments. Saline soil can become sodic (high concentrations of sodium) from the leaching of salt through the soil profile, which can leave sodium behind bound to clay particles.

Areas prone to salinity are usually at low positions in the landscape, such as in valley floors and along floodplains.

Saline soils have the potential to damage concrete and metals structures, make soils unsuitable for re-use as fill, and may affect landscaping.

The hydrogeological landscape overlay on the eSPADE web map (NSW Government n.d) was viewed to understand potential salinity risks. The overlay identifies the following:

- land salinity hazard – includes areas of dryland and irrigation salinity and is determined using knowledge of salt content in geological units and other geological observations
- salt load hazard – identifies tributaries capacity to transport salt loads flowing downstream that can be distributed by flow and irrigation
- stream electrical conductivity hazard – identifies stream which high concentration peaks in stream salinity
- overall salinity hazard – combined product of land salinity, salt load, and stream electrical conductivity hazard.

Review of the overlay identified that while both the salt load hazard and instream electrical conductivity are low within Billabong Creek, land salinity is categorised as high and the overall salinity hazard is categorised as moderate.

A salinity study which categorised areas was completed by the DPE in 2023 (DPE 2023h). All Yanco Creek locations have been categorised as moderate salinity hazard apart from Wanganella Swamp, which is rated as a moderate to high salinity hazard. The risks of increased salinity in the River Murray for each project site (including the proposal) was assessed and also whether an impact pathway existed based on conceptual modelling. Only the operation of Wanganella regulator at full supply levels was rated moderate risk, the remaining risks were rated low. The assessment recommended the salinity impact estimate be reviewed should details of the projects be changed, however is unlikely to result in a significant effect (DPE 2023h).

20.2.3. Contamination

The section outlines areas of contamination concern within the proposal site. It includes any listed contaminated sites, previous contaminating activities, land uses, and associated potential contaminants of concern.

Hartwood Regulator

Available historical land use and aerial imagery data indicate that the study area around Hartwood Regulator has historically been underdeveloped with agricultural land use occurring adjacent to the regulator. Other works in the study area include road construction which intersected Billabong Creek. While former petroleum and mineral exploitation titles apply to the study area, historical aerial imagery provides no indication of earthworks associated with these activities and licences. EPA records indicate that former licensed activities occurred within one kilometre of the study area associated with the application of herbicides throughout waterways in NSW. However, it is unknown whether these herbicides were applied to the waterways in the study area.

Listed Contaminated Sites

Desktop studies revealed that there are no listed contaminated sites within 150 metres of the Hartwood Regulator study area.

Areas of Contamination Concern

Table 20.2 provides an overview of potential contamination sources and contaminants of potential concern within the study area.

Table 20.2 Potential sources of contamination – Hartwood regulator

Potential sources of contamination	Contaminants of potential concern
Hazardous materials from existing buildings and infrastructure on site	• asbestos containing materials • heavy metals
Historical agricultural activity and land uses including pesticide and herbicide use, and chemical storage	• total recoverable hydrocarbons, benzene, toluene, ethylbenzene and xylene
Potential use of uncontrolled fill during historical development of the site	• polycyclic aromatic hydrocarbons • organochlorine and organophosphorus pesticides

Wanganella Regulator study area

Available historical aerial imagery and historical land use records show that the Wanganella Regulator study area has remained undeveloped until the development and operation of a rural landfill adjacent to the Wanganella flood bypass channel, which remains operational today (see Figure 20.2). Additionally, residential developments and associated earthworks have occurred east of study area. While a number of former mining and extraction licences apply to the study area, historical aerial imagery gives no indication of earthworks associated with these activities and licences. EPA records indicate that former licensed activities occurred within 1 kilometre of the study area associated with the application of herbicides throughout waterways in NSW. However, it is unknown whether these herbicides were applied to the waterways in the study area.

Listed Contaminated Sites

Desktop studies revealed that there are no listed contaminated sites within 150 metres of the Wanganella study area.

Areas of Contamination Concern

Table 20.3 summarises potential contamination sources and associated potential contaminants of concern within the study area.

Table 20.3 Potential sources of contamination – Wanganella regulator

Potential Sources of contamination	Contaminants of potential concern
Hazardous materials from existing buildings and infrastructure on site. Historical agricultural activity and land uses including pesticide and herbicide use, and chemical storage. Potential use of uncontrolled fill during historical development of the site. Landfilling activities associated with Wanganella Landfill	• asbestos containing materials • heavy metals • total recoverable hydrocarbons, benzene, toluene, ethylbenzene and xylene • organochlorine and organophosphorus pesticides • semi-volatile organic compounds • volatile organic compounds • phenols • polychlorinated biphenyls • per- and poly-fluoroalkyl substances (PFAS) • landfill gases including methane, carbon monoxide, carbon dioxide, hydrogen sulphide, and VOCs

20.3. Impact assessment

20.3.1. Construction

Potential to encounter contamination

As described in section 20.2.3, potentially contaminating land uses are present in the vicinity of the proposal site. Preliminary conceptual site models were compiled for each regulator site as part of the contamination assessment. The models identified that if inadequately managed, disturbance of contaminated areas has the potential to:

- mobilise contaminants, affecting nearby soils, surface water and groundwater
- increase the migration of contaminants into surrounding areas via leaching, overland flow and/or subsurface flow (water and/or vapour) or dust, with the potential to impact on receiving environments, such as Billabong Creek and the surrounding community
- increase the risk of exposure to contaminants (direct contact and/or inhalation) by site workers, visitors and the local community.

The findings of the desktop assessment indicated that at Hartwood Regulator the potential for widespread and elevated contamination in soils, groundwater and surface water within the proposal site is considered **Low**.

At Wanganella Regulator the potential for widespread and elevated contamination in soils, groundwater and surface water within the proposal site is considered **Low**. A **Moderate** risk is identified in the area of the Wanganella Landfill directly south-west of a proposed construction activity zone. A review of the risk from the landfill and establishment of controls if necessary, is required by the contractor as the construction methodology for the flood bypass channel is finalised.

The potential for impacts due to the potential disturbance of contamination would be minimised by implementing the measures provided in section 20.4.

Potential to generate contamination

If inadequately managed, construction activities have the potential to result in the contamination of soils due to:

- accidental spills and leaks of fuel, oils, and other potentially contaminating substances, from plant and equipment or mishandling of dangerous goods stored on site
- inadequate handling of contaminated materials and excavated waste
- mobilisation of contaminants during demolition of structures, including services, which contain potentially contaminating substances such as asbestos and leaded paint.

The potential contamination of surface soils due to the above activities could affect groundwater through leaching, and/or surface water due to mobilisation of contaminated run-off.

These potential impacts would be mitigated by implementing the measures provided in section 20.4.

Hazardous materials surveys would be undertaken prior to the stripping and demolition of any structures.

Hazardous materials would be removed and disposed of in accordance with relevant legislation, codes of practice, and Australian Standards.

Soil impacts

Soil erosion and sediment transport

Construction would temporarily expose the natural ground surface and sub-surface through the removal of vegetation, general excavation and soil disturbance.

Excavation and ground disturbance activities would expose and disturb soils, which if not managed adequately, could result in:

- erosion of exposed soil and stockpiled materials, particularly where construction activities are undertaken in soil landscapes characterised by dispersive soils, given their susceptibility to erosion
- increases in salinity levels in soil
- potential for localised changes to landform such as earth embankments and cut or fill areas which could impact local hydrology
- dust generation resulting in air quality impacts
- mobilisation of contaminated sediments and contamination of surface water runoff, with resultant potential for environmental and human health impacts.

The potential for dust impacts is considered in chapter 21 (Air quality). The potential for soil erosion impacts would be minimised by implementing a soil and water management plan, which would be prepared and implemented as part of the CEMP in accordance with the Blue Book (Landcom 2004) or the Best Practice Erosion & Sediment Control (International Erosion Control Association 2008) (IECA Manual), as relevant (see section 20.4).

Salinity

Excavation would be undertaken in areas with moderate salinity hazard. In addition, construction may disturb soils in areas with unidentified salinity potential.

High salinity soil can reduce or preclude vegetation growth and produce aggressive soil conditions, which may be detrimental to concrete and steel. Impacts may also occur as a result of the erosion and off-site transport of saline sediments, resulting in impacts on the receiving environment.

The potential for impacts due to the presence of saline soils is considered low. Any potential impacts would be temporary and managed by implementing standard best-practice erosion and sediment control measures.

20.3.2. Operation

Potential to encounter contamination

Day-to-day operation of the proposal would be unlikely to expose site users to potentially contaminated soil (or groundwater).

Potential to generate contamination

Operation has the potential to contaminate soil and groundwater from leaks and spills of fuel, oils and other hazardous materials during maintenance activities. However, the potential is considered to be low, given the likely scale and duration of maintenance activities.

This potential impact would be minimised by implementing procedures to handle dangerous goods and hazardous materials and manage spills similar to those used for other Water NSW infrastructure.

Landform

The proposed design has considered the stability and seismic risk of the location. Both regulators would be constructed in accordance with the design, therefore seismic risks are not expected to impact the stability of the soils at the proposal sites once operational.

Soils

Soil erosion and sediment transport

There is potential for recently disturbed soils to be susceptible to erosion, particularly during initial periods of landscaping and re-establishment of vegetation. This may occur in areas where planting is proposed, including adjacent to disturbed areas, along embankments, and in the reinstatement of temporary ancillary facilities where topsoil is settling and vegetation is establishing.

Temporary soil stabilisation may be required immediately following construction to prevent potential erosion, topsoil loss or soil migration. This is particularly likely to be required following severe storms. A rehabilitation strategy would be prepared to guide the approach to rehabilitation of disturbed areas (see section 3.3.6). The strategy would include requirements for monitoring during the establishment of these areas.

Operation is not likely to result in any significant impacts on soils, topography or geology. The risk of soil erosion during operation would be minimal, as all areas impacted during construction would be sealed or rehabilitated and landscaped to prevent soil erosion from occurring. Maintenance activities involving ground disturbance would be undertaken in accordance with Water NSW's standard operating procedures.

Salinity

Operation is not expected to impact the salinity levels of the proposal site. Maintenance activities would be unlikely to involve ground disturbance activities of sufficient magnitude to increase water infiltration resulting in erosion and off-site transport of saline sediments, particularly with the implementation of standard erosion and sediment control measures.

20.3.3. Cumulative impacts

The potential for erosion and sedimentation impacts as a result of the proposal is mainly associated with construction. These potential impacts would be readily managed with the implementation of standard erosion and sedimentation control measures. As such, it is not expected that the proposal would have a material impact on erosion and sedimentation at the scale that cumulative impacts could occur.

Potential impacts associated with contamination for the proposal are considered low during construction, with further assessment required to confirm the potential for any localised contamination associated with the Wanganella Landfill. During operation there is the potential for minor leaks and spills potentially resulting in highly localised contamination. There are no cumulative impacts considered likely when taking in to account other identified projects. In addition, the overall risk of encountering land contamination is low, and the proposal would be unlikely to generate impacts at a scale that would interact with other projects.

20.4. Mitigation and management

20.4.1. Approach to mitigation and management

Approach to managing the key potential impacts identified

To confirm the risk of contamination and associated management requirements, targeted site investigation would be undertaken of the proposal site and area directly adjacent to the Wanganella Landfill.

The potential for contamination impacts would also be managed by preparing and implementing a soils and water management plan which would detail how potential and actual contaminated soils and materials would be managed to minimise the potential for on and off-site impacts.

The key approach to managing soils during construction would also involve preparing a soil and water management plan as part of the CEMP as described in chapter 24. The plan would define the processes, responsibilities and erosion and sediment control measures that would be implemented during construction (in accordance with the Blue Book or the IECA Manual, as relevant).

As described in section 3.3.6, a rehabilitation strategy would be prepared to guide rehabilitation planning, implementation, monitoring and maintenance of disturbed areas. The strategy would include measures to immediately stabilise and provide for the long-term rehabilitation of areas disturbed by construction. This would assist in minimising the potential for soil and erosion impacts.

Approach to managing other impacts

An unexpected finds protocol would be developed as part of the soil and water management plan to ensure that any unexpected contamination encountered during construction does not expose workers, site users, and/or the environment to contamination in excess of regulatory guideline levels. The unexpected finds protocol would outline the activities to be undertaken in the event that previously undetected contamination is identified, which would include making the site safe, carrying out an assessment of the finds, and managing the finds based on the results of the assessment.

Hazardous material surveys would be undertaken for structures to be removed.

Other impacts would be managed by implementing the measures provided in section 20.4.2.

Measures to control impacts associated with soil and contamination may overlap with measures proposed for the control of potential air quality, water quality, and waste management impacts. All measures for the proposal would be consolidated and described in the CEMP. The plan would identify measures that are common between different aspects. Common impacts and common mitigation measures would be consolidated to ensure consistency and implementation.

20.4.2. Summary of management measures

Measures that will be implemented to address potential soils and contamination impacts risk are listed in Table 20.4.

Table 20.4 Mitigation measures to address contamination and soil impacts.

ID	Impact	Environmental safeguards	Responsibility	Timing
CS1	Wanganella flood bypass channel area – Development of a leachate and ground gas management plan as part of construction management documents	• Development of a leachate and ground gas management plan and assessment of potential for runoff from the Landfill into receiving water bodies as part of construction management documents (e.g. CEMP). Consideration should be given to targeted site investigations to inform the development of the leachate and ground gas management plan. • Implementation of a monitoring during construction works in this area to address human health risks from potential gas/vapour migration. • Implementation of a groundwater monitoring program to assess the potential for leachate migration into excavations and during operation. • Management/Monitoring plans should be prepared in accordance with relevant NSW EPA Guidance including, but not limited to: – consultants reporting on contaminated land, Contaminated Land Guidelines, NSW EPA 2020 – Environmental Guidelines, Solid Waste Landfills (2nd Edition), NSW EPA 2016.	Contractor	Pre-construction
CS2	Construction environmental management plan (CEMP)	• Odour and dust/fibre control procedures and monitoring to minimise the release of dust/fibres to the surrounding environment. • Erosion and sediment control procedures and management measures. • Procedures to minimise the potential for construction spills and contamination releases. • Protocols to minimise the potential for offsite migration of impact in surface water and groundwater. • Emergency response procedures in the event of a release of contamination, whether it be via surface water, groundwater, or air. • A soil management plan detailing the high-risk areas of the site, exposure risk management protocols, materials storage procedures (including stockpile management and reuse protocols), waste transport procedures, waste tracking and disposal plans to ensure all material is appropriately managed.	Contractor	Pre-construction, construction

ID	Impact	Environmental safeguards	Responsibility	Timing
		- An unexpected finds protocol, particularly with regard to asbestos, which is linked to additional site investigations and the development of a remedial action plan, where required, to effectively manage contamination. - Management/Monitoring plans should be prepared in accordance with relevant NSW EPA Guidance including, but not limited to: - Consultants reporting on contaminated land, Contaminated Land Guidelines, NSW EPA 2020. - Environmental Guidelines, Solid Waste Landfills (2nd Edition), NSW EPA 2016. - The NSW Waste Classification Guidelines and relevant NSW reuse/waste orders and exemptions (E.g. the Excavated Natural Material Order / Exemption).		
CS3	Environmental monitoring program	- Surface water, groundwater and dust monitoring should be implemented to monitor for and respond to the emergence of contamination impacts during construction of the proposal. - Monitoring plans should be prepared in accordance with relevant NSW EPA Guidance including, but not limited to: - consultants reporting on contaminated land, Contaminated Land Guidelines, NSW EPA 2020.	NSW DCCEEW / Contractor	Pre-construction, construction and operational
CS4	Operational management	An operational management plan will include controls to minimise contamination from plant and equipment usage during maintenance activities.	WaterNSW	Operation

21. Air Quality

This chapter provides a qualitative review of potential air quality impacts which could arise during the construction and operation of the proposal, focusing on dust. This chapter provides measures to mitigate and manage the impacts identified.

21.1. Methodology

A qualitative review of potential air quality impacts from particulate matter (dust) has been prepared to identify measures to manage and mitigate the risks. The methodology for the air quality impact assessment involved:

- characterising key features of the surrounding environment, including the location of surrounding receivers and sensitive land use areas and background air quality
- identifying key air quality issues during construction and operation phases, as well as suitable criteria for the evaluation of these risks
- identifying the potential for impacts to occur during construction and operation
- recommending mitigation measures to effectively manage any risks to air quality based on the outcomes of the air quality impact assessment.

21.2. Existing environment

21.2.1. Rainfall

The closest BoM monitoring station to the proposal with rainfall data is located at Deniliquin (Airport AWS) (station number 074258).

As shown in Table 21.1, the mean rainfall per year was 374.9 millimetres from 1997 to 2022, with the highest average monthly rainfall experienced in November (43.6 millimetres).

Table 21.1 Mean rainfall data for Deniliquin (Airport AWS) from 1997 to 2022 (BoM, 2023)

Rainfall	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Rainfall (mm)	24.5	27.5	27.2	27.7	27.5	29.8	28.3	33.9	34.7	40.3	43.6	28.8	374.9

21.2.2. Wind

The closest Bureau of Meteorology (BoM) monitoring station to the proposal with wind data is also located at Deniliquin (Airport AWS) (station number 074258).

Afternoon winds tend to be stronger than morning winds at Deniliquin (Airport AWS) weather station. Winds are fairly constant through the year, tending towards 17.5 to 19.5 kilometres per hour (BoM, 2023).

Table 21.2 Mean rainfall data for Deniliquin Visitor Information Centre from 1997 to 2010 (BoM, 2023)

Wind speed	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean 9am wind speed (km/h)	19.5	19.3	17.9	16.4	13.8	14	13.7	15.9	17.9	19.6	19.2	19.6	17.2
Mean 3pm wind speed (km/h)	20.5	19.2	18.4	17.4	17.7	17.9	18.6	20.3	21.3	21.3	20.3	21.1	19.5

21.2.3. Existing air quality

The nearest NSW Air Quality Monitoring Network monitoring station is at Albury approximately 170 kilometres east of the proposal (station number 9731).

Table 21.3 shows that PM₁₀ annual average concentrations have been below the air quality goals (as per the *National Environment Protection (Ambient Air Quality) Measure (the Air NEPM)* (NEPC 1998) and any relevant updates), for the past 10 years.

Table 21.4 show that PM_{2.5} annual average concentrations have been below the air quality goals (as per Air NEPM) for the past six years, except for in 2019 and 2020 likely due to the impacts of bushfires in these years (Annual air quality statements DPE 2022).

Table 21.3 Annual average PM10 concentrations in Albury

Year	Annual average PM10 at Albury (µg/m³)	EPA assessment criterion (µg/m³)
2013	15.8	25
2014	15.9	
2015	14.6	
2016	15.1	
2017	15.8	
2018	19.8	
2019	23.4	
2020	20.1	
2021	14.3	
2022	11.7	

Table 21.4 Annual average PM2.5 concentrations in Albury

Year	Annual average PM12.5 at Albury (µg/m³)	EPA assessment criterion (µg/m³)
2017	7.3	8
2018	7.3	
2019	10.1	
2020	11.1	
2021	7.3	
2022	5.6	

21.2.4. Regional and local context

The proposal is located in a rural setting with agriculture as the primary land use (refer chapter 14 Land use, property and agriculture). Local air quality would likely be influenced by drought conditions and bushfire activity (Virya Energy, 2022a).

Edward River LGA had a relatively low population density of 0.9 people per square kilometre in 2021 (ABS, 2022a). Wanganella village, located about one kilometre from Wanganella Weir, had a population 61 people in 2021 (ABS, 2022b).

A total of 26 sensitive receivers have been identified in the vicinity of the proposal:

- 4 sensitive receivers in Hartwood
- 22 sensitive receivers in Wanganella.

These sensitive receivers are the same as assessment for the noise and vibration impact assessment and are shown in Figure 16.1 and Figure 16.2. All of these sensitive receivers are assumed to be rural residential receivers for the purpose of this assessment.

21.3. Impact assessment

21.3.1. Potential construction impacts

The main impacts to air quality as a result of the proposal are likely to come from dust generated during construction activities, use of access tracks and vehicle and equipment.

Construction of the proposal would potentially result in emissions from:

- dust generated from vegetation removal and ground disturbance activities
- dust generation from wind blowing dust off stockpiles and disturbed surfaces
- dust generated by construction vehicles travelling on disturbed/unsealed access routes
- exhausts from machinery, equipment, and vehicles used during construction.

Emissions and dust during construction of the proposal would be minor and adequately managed by the safeguards provided in Table 21.5.

There are negligible impacts to sensitive receivers anticipated due to (IAQM, 2014):

- the distance of the works from the sensitive receivers
- the scale of works.

21.3.2. Potential operations impacts

During operation, the new regulators would have no impact on air quality for the surrounding environment.

Some dust could be generated during dry periods when the regulators are operational but Billabong Creek is in low flow. When the water levels are low larger areas of the river channel would be exposed to wind erosion, however this impact is would not be difference from existing conditions and are not expected to be significant.

The level of dust emissions generated by maintenance vehicles would be comparable to existing conditions. Numbers of vehicles would be low and since the unsealed roads and access tracks to the regulators would be upgraded as part of the proposal to provide a better road condition that is less prone to erosion or generation of fine particles.

21.3.3. Cumulative impacts

NSW DCCEEW are undertaken the Yanco Creek Modernisation Project (Part1b: Wanganella Swamp) which is located four kilometres south east of the Wanganella Regulator. The construction of both projects is expected to be at a similar time however due to the distance between the projects, cumulative impacts are not expected as a result of no shared receivers between the projects.

21.4. Mitigation measures

21.4.1. Approach to mitigation and management

The general approach to management of the proposal during construction and operation is outlined in chapter 24.

The key approach to managing dust during construction would also involve preparing a soil and water management plan as part of the CEMP as described in section 24.2. The plan would define the processes, responsibilities and erosion and sediment control measures that would be implemented during construction (in accordance with the Blue Book or the IECA Manual, as relevant).

21.4.2. Summary of management measures

Table 21.5 lists the air quality safeguards and management measures that would be implemented to account for the potential impacts identified in section 21.3.

Table 21.5 Air quality safeguards and management measures

ID	Impact	Environmental safeguards	Responsibility	Timing
AQ1	Air quality	Dust during construction will be considered and addressed within the CEMP and will include methods to manage work during strong winds or other adverse weather conditions as required. As a minimum, the following measures will be included: • covering all loaded trucks and vessels • machinery to be turned off rather than left to idle when not in use • maintenance of all vehicles, including trucks and vessels entering and leaving the site in accordance with the manufacturers specifications to comply with all relevant legislation • maintenance of all plant and equipment to ensure good operating conditions and exhaust emissions comply with the <i>Protection of the Environment Operations Act 1997</i> • stockpiled materials will be covered, stabilised, or stored in areas not subject to high wind • maintaining the work site in a condition that minimises fugitive emissions of dust.	Contractor	Pre-construction, construction
AQ2	Impacts on sensitive receivers	Local residents will be advised of hours of operation and duration of work and supplied with a contact name and number for queries regarding air quality.	Contractor	Pre-construction

22. Waste management and resource use

This chapter describes the potential resource use and waste impacts associated with the proposal. This includes a preliminary assessment of waste streams generated as a result of the proposal, and the mitigation measures to manage and minimise the wastes identified.

22.1. Methodology

The different types of waste and materials generated during construction and operation of the proposal must be identified early in the development process to provide for their management, where waste cannot otherwise be avoided or minimised. Wastes must be managed to avoid any potential environmental, health and safety impacts associated with the contamination of soils and water, and the generation of leachate, odours, or dust. Furthermore, resources must be managed carefully to ensure they are used effectively and sustainably.

The basis of this assessment was to consider the hierarchy of avoiding waste generation and primary resource use in favour of reduction, reuse, and recycling, consistent with the *Waste Avoidance and Resource Recovery Act 2001* (WARR Act). This hierarchy is considered in all stages of design development, construction, and operational planning.

The assessment has been carried out with consideration with the following relevant legislation, policies, and guidelines:

- *Protection of the Environment Operations Act 1997* (POEO Act) and the *Protection of the Environment Operation (Waste) Regulation 2014* and the *Work Health and Safety Regulation 2011*.
- Waste Classification Guidelines (NSW EPA, 2014b)
- NSW Sustainable Design Guidelines Version 4.0 (TfNSW 2017)
- NSW Waste and Sustainable Materials Strategy 2041 (DPIE, 2021c)
- NSW Circular Economy Policy Statement: Too Good to Waste (NSW EPA, 2019).

The assessment considered the impacts associated with:

- resource use and materials management during construction and operational maintenance works
- waste generation, management and disposal during construction, operation and decommission
- the proposal's ability to respond to waste management and resource conservation plans, policies, and guidelines.

The assessment involved:

- Reviewing the indicative demolition and construction methodologies to identify any waste generating and resource consumption activities.
- Identifying potential waste types, and classifications according with relevant legislation and guidelines. A summary of waste types, quantities, and classifications under the POEO Act is provided in Table 22.1.

- Identifying potential environmental, health and safety impacts if wastes are not managed appropriately. These impacts are summarised in Table 22.2.
- Identifying waste management options including which waste management facilities may take waste generated because of construction and operation of the proposal. The proposed methods for managing different types of waste are summarised in Table 22.3. Licenced waste management facilities near the proposal are summarised in Table 22.4.
- Providing measures to manage and mitigate waste where it cannot be avoided, reduced, or reused. Management measures for the mitigation of impacts associated with waste and resource use are summarised in Table 22.5.

The estimated waste and material types (including spoil quantities) are indicative and have been identified for the purpose of determining potential waste management options. Although the actual quantities of waste generated by the proposal may differ from the estimates made, the identified waste management options would remain appropriate based on the waste stream identified and are scalable.

22.2. Impact assessment

22.2.1. Assessment of construction and operation impacts

Waste generation

Construction and decommissioning of the proposal would require the management or disposal of excess spoil, general construction waste, demolition waste, and green waste. Table 22.1 provides an indicative list of the waste types that may be generated by the proposal. The table characterises and classifies waste types of accordance with the *Waste Classification Guidelines Part 1: Classifying Waste* (NSW EPA 2014a).

The largest waste type associated with the proposal is spoil generated as result of shallow earthworks, reshaping of the creek bed, and reprofiling of the land. Spoil is any material (such as soil, rock, or dirt) excavated and removed from its original location. Where material would be re-used within the proposal, where possible. Further details are provided in section 3.3.9.

The proposal would involve the generation of metal and concrete waste associated with the demolishing of Hartwood Weir and Wanganella Weir. A consideration of impacts associated with the mobilisation of debris, silt, and potentially contaminated materials downstream is considered in chapter 6 (hydrology and surface water resources) and chapter 20 (soils and contamination).

Green waste would be generated through the removal of vegetation for permanent and temporary infrastructure and facilities including borrow pits, access tracks, crane pads, and crane slew zones.

The main waste-generating activity during operation would be associated with:

- maintenance of the regulator, replacement of equipment as parts comes to their end of life
- generation of small quantities of green waste because of vegetation control to maintain electricity easements
- other small volumes of waste from staff carrying out maintenance activities such as food waste, plant and vehicle hydrocarbons.

Table 22.1 Waste generation

Waste type	Description / source	POEO Act Classification	Project stage
Paper and cardboard	General office/staff wastes, packaging materials	General solid waste (non-putrescible)	Construction Decommissioning
Green waste	Cleared vegetation	General solid waste (non-putrescible)	Construction Operation
Soil	Surplus spoil from excavation and earthworks	General solid waste (non-putrescible)	Construction Decommissioning
Hydrocarbons	Used lubricants, oils and fuels, contaminated water from equipment washing.	Liquid waste	Construction Decommissioning Operation
General domestic	Food scraps, aluminium cans, glass bottles, plastic and paper containers	General solid waste (putrescible and non-putrescible)	Construction Decommissioning Operation
Commercial waste	Empty fuel/lubricant, filters and oily rag drums and storage containers (non-volatile), herbicide and pesticide storage containers	General solid waste (non-putrescible)	Construction Decommissioning Operation
Demolition waste from existing weirs	Concrete and metal structures	General solid waste (non-putrescible)	Construction Decommissioning
Sewage	Biological wastes from on-site septic systems, portable ablutions facilities pump-out	Liquid waste	Construction Decommissioning

Potential impacts if waste is not managed appropriately

The potential impacts associated with aspects of waste generation during construction and operation are summarised in Table 22.2.

Impacts associated with the excavation and disturbance of soil and their potential to generate, and mobilise contamination is considered in chapter 20. Other impacts relating to surface water and groundwater, aquatic ecology, and air quality associated with the transport of waste are detailed in their respective chapters. Construction waste management activities would not have a significant impact on the environment or human health given that the mitigation and management measures detailed in section 22.3 are implemented. It is assumed that these aspects of waste management would not have a significant impact on the environmental or human health if:

- wastes are managed according to the measures described in Table 22.3
- all pre-construction, construction, and operation mitigation and management measures described in section 22.3 are followed.

Table 22.2 Potential impacts associated with waste generation and management

Aspect of waste management	Potential impacts
Generation of waste including, demolition, excavation, and handling	• generation of dust from excavation, handling, and removal of waste • soil and sediment transport and runoff from exposed surfaces • contaminated leachate generation and sediment runoff which may impact receiving waterbodies such as Billabong Creek and impact water quality and ecosystem integrity
Storage of and segregation of waste (including stockpiling of spoil)	• odours and dust from stockpiling/storage of wastes • contaminated leachate generation and sediment runoff which may impact receiving waterbodies such as Billabong Creek and impact water quality and ecosystem integrity • cross contamination of soils due to improper segregation and storage • attracting illegal dumping from third parties on stockpile sites or other waste storage areas
Waste Transportation	• dust from loading waste onto vehicles and movement of waste on haul roads • road traffic noise from waste collection vehicles and movement of waste • traffic generated by haulage of spoil to reuse/disposal facilities • odours from loading waste onto vehicles and movement of waste collection vehicles to disposal or recycling facilities • unlawful transport and disposal
Non-classified or incorrectly classified waste transport and disposal	• contamination of soils, groundwater and/or surface water • contamination of recycling facilities/landfills • regulatory non-compliance
Unlicensed waste contractors transporting waste	• potential illegal dumping of waste • regulatory non-compliance

Waste Management

The proposal would be designed and constructed to ensure the responsible management of unavoidable waste and promote the reuse of such waste in accordance with the resource management hierarchy principles outlined in the WARR Act and NSW Waste Avoidance and Resource Recovery Strategy 2014-2021 (NSW EPA, 2014b). Where possible, materials would be reused either on or off site. Excavated spoil would be reused on site for backfilling, landscaping, and other uses. If spoil cannot be reused on-site, opportunities for off-site reuse would be investigated.

Materials that cannot be reused would be classified in accordance with the Waste Classification Guidelines (NSW EPA, 2014a) and disposed of at an approved materials recycling or waste disposal facility. The construction contractor would be responsible for ensuring waste generated by construction is disposed of at an appropriately licenced facility. The roles, responsibilities, and measures for managing wastes generated during construction will be detailed in the CEMP.

The proposed approach to managing the different types of waste identified (see Table 22.1) to be generated during construction in accordance with the waste management hierarchy, is presented in Table 22.3. This also includes methods for storing and stockpiling of waste materials to prevent the cross-contamination.

Table 22.3 Waste Management Measures

Waste	Hierarchy	Management
Spoil	Avoid	The proposal is designed to avoid spoil generation as far as practicable.
	Reuse	Reused on site for backfilling, landscaping, and other uses.
	Resue	If spoil is unable to be reused on-site, opportunities for off-site reuse would be investigated.
	Dispose	Excess spoil that cannot be reused would be disposed of appropriately at a licenced facility.
	Dispose	Any contaminated soils including creek silt (if encountered) would be tested and treated on-site and disposed of at a suitably licensed facility.
Demolition waste from existing weirs	Reuse	Metal components would be disassembled and sold as scrap metal where possible.
	Recycle	Where recycling is considered feasible, rubbish and debris would be stored for collection by an authorised contractor, for offsite recycling.
	Dispose	Materials that cannot be reused would be disposed of at a licenced facility.
Green waste	Avoid	Clearing would be minimised by prioritising placement temporary ancillary infrastructure in areas that have been previously cleared or avoiding areas with trees.
	Reuse	Green waste will be used for beneficial on-site or off-site reuse, such as mulching, or habitat creation where feasible.
	Dispose	Excess green waste that cannot be reused would be disposed of at an appropriately at a licenced facility. Weeds would be separated, sprayed, and bagged, and disposed of at an appropriately at a licenced facility.
Paper and cardboard	Recycle	Separated for recycling and sent to the appropriate facility.
Hydrocarbons	Dispose	Disposed of at a licenced facility.
General Domestic	Dispose	Disposed of at a licenced facility.
Commercial Waste	Dispose	Disposed of at a licenced facility. During storage on site, commercial waste would be stored in an appropriately bunded hardstand area.
Sewage	Dispose	Waste would be collected by a contractor and disposed off-site at a suitably licensed facility.

Table 22.4 details licenced waste disposal facilities near the proposal that could receive waste that could not otherwise be avoided, mitigated, or reused. Materials for disposal would likely to go to either Deniliquin Landfill Depot, Pretty Pine Landfill or Blighty Waste Disposal Depot. Alternatively, demolition waste may be provided to landowners for their use in negotiation with them.

It should be noted that the Wanganella Village rural landfill would not be used by the proposal, as agreed with Edward River Council.

Table 22.4 Licenced waste disposal facilities near to the proposal (Edward River Council, n.d.; RAMJO Riverina Waste Group, n.d.)

Name	Address	Additional waste services provided		
		Metal recycling	Disposal of triple rinsed plastic and steel drums	Motor oil
Deniliquin Landfill Depot	Tip Road, Deniliquin NSW 2710	✓	✓	-
Blighty Waste Disposal Depot	Riverina Highway, Blighty NSW 2713	✓	-	✓
Conargo Landfill	McKenzie Street, Conargo NSW 2710	-	-	✓
Pretty Pine Landfill	Gibbs Road, Pretty Pine NSW 2710	✓	-	✓
Booroorban Landfill	Cobb Highway, Booroorban NSW 2710	-	-	✓
Coleambally Waste Depot	Martin Bell Road, Coleambally NSW 2707	-	✓	-
Darlington Point Waste Depot	Address not provided.	-	✓	-
Jerilderie Waste Depot	Rifle Range Road, Jerilderie NSW 2716	-	✓	-

Nearby sewage treatment plants that may receive sewage from portable ablutions facilities are located at (Virya Jacobs, 2022b):

- Deniliquin Sewage Treatment Plant at Calimo Street, Deniliquin (Licence No. 1694)
- Jerilderie Sewage Treatment Plant at Wilson Road, Jerilderie (Licence No. 1692)
- Murrumbidgee Council Sewage Plant at Boyd Street, Darlington Point (Licence. No. 6260).

Resource use

The proposal would be designed and constructed to ensure the responsible management of unavoidable waste and promote the reuse of such waste in accordance with the resource management hierarchy principles outlined in the *WARR Act*. The resource management hierarchy principles, in order of priority are:

- avoidance of unnecessary resource consumption
- resource recovery including reuse, reprocessing, recycling, and energy recovery
- disposal.

By adopting the above principles, the proposal would include aims to efficiently reduce resource use, reduce costs, and reduce environmental harm in accordance with the principles of ecologically sustainable development.

Construction of the proposal would require the use of resources, including:

- resources associated with the operation of construction machinery and motor vehicles, including the use of diesel and petrol
- material required for road surface and pavements, such as gravel
- material required for regulator and fishway construction, such as concrete, steel etc.
- fill required to meet design levels
- construction water, such as for concrete mixing and dust suppression.

The materials required for construction of the proposal are not currently limited in availability. However, materials such as metal and fuel are non-renewable and would be used conservatively. Excess spoil, not suitable for reuse, would be disposed of in accordance with safeguards and mitigation measures outlined in section 22.3. The management measures outlined in section 22.3 to reuse waste on-site would assist in minimising the number of resources required for construction.

22.3. Mitigation and management measures

22.3.1. Approach to mitigation and management

The general approach to management of the proposal during construction and operation is outlined in chapter 24.

Waste management would be guided by the waste management hierarchy consistent with the methodology outlined in section 22.1, ensuring that wastes are only disposed of after all options for reducing resources use and minimising waste are exhausted. Wastes that are generated during construction will be reused and recycled where possible. Appropriate waste management protocols and procedures will be followed to ensure that any remaining waste is transported and disposed of at appropriately licenced facilities.

Prior to the commencement of construction or demolition of existing weir infrastructure, waste and resource controls will be developed as part of the CEMP. These will outline the processes, responsibilities as well as the management and mitigation measures to be followed during construction to manage any potential impacts associated with resource use or waste generation, transport, and management. The controls would be prepared consistent with the *NSW Waste and Sustainable Materials Strategy (DPIE, 2021c)* and would apply the circular economy principles to waste management.

There is a potential for the unexpected encounter of contamination during demolition and construction of weir infrastructure. Any previously unidentified contaminated material would be managed in accordance with the unexpected finds procedure which forms part of the CEMP (see section 20.4.2).

22.3.2. Summary of management measures

Table 22.5 lists the waste management and natural resources safeguards and management measures that would be implemented to account for the potential impacts identified in section 22.2

Table 22.5 Waste management and resources use safeguards and management measures

ID	Impact	Environmental safeguards	Responsibility	Timing
WR1	Waste management	Resource and waste management controls will be prepared and included in the CEMP. These will include the following (as a minimum): - the type, classification, and volume of all materials to be generated and used on-site including identification of recyclable and non-recyclable waste in accordance with <i>NSW EPA Waste Classification Guidelines</i> (2014) - quantity and classification of excavated material generated as a result of the proposal - interface strategies for excavated spoil on-site to ensure reuse where possible - strategies to 'avoid', 'reduce', 'reuse' and 'recycle' materials - classification and disposal strategies for each type of material - destinations for each resource/waste type either for on-site reuse or recycling, offsite reuse or recycling, or disposal at a licensed waste facility - details of how material will be stored and treated on-site - identification of available recycling facilities on and off-site - identification of suitable methods and routes to transport waste - procedures and disposal arrangements for unsuitable excavated material or contaminated material - the types of waste collected, amounts, date/time and details of disposal are to be recorded in a waste register - site clean-up for each construction stage.	Contractor	Pre-construction
WR2	Waste management	Waste receptacles will be provided, and recycling of materials encouraged. Rubbish will be transported to an appropriate waste disposal facility.	Contractor	Construction
WR3	Waste management	All wastes will be managed in accordance with the POEO Act.	Contractor	Construction
WR4	Waste management	Portable toilets will be provided for construction workers and will be managed by the service provider to ensure the appropriate disposal of sewage.	Contractor	Construction

ID	Impact	Environmental safeguards	Responsibility	Timing
WR5	Waste management	Weeds removed during work will be managed in accordance with the <i>Biosecurity Act 2015</i> requirements that relate to their classification status.	Contractor	Construction
WR6	Waste management	Site inductions will occur and be recorded by a Site Supervisor to ensure staff are aware of waste disposal protocols.	Contractor	Construction
WR7	Demand on resources	Procurement will endeavour to use materials and products with a recycled content where that material or product is cost and performance effective.	NSW DCCEEW Contractor	Pre-construction

23. Cumulative

A cumulative impact assessment was undertaken for the proposal with reference to the Cumulative Impact Assessment Guidelines for State Significant Projects guidelines (DPIE, 2021a). The assessment has considered relevant present, and reasonably foreseeable future projects that could result in a material impact on key environmental matters. This chapter provides a summary of the assessments prepared in the technical reports of this EIS for specific key matters and considers whether the combined effect of these different impacts would be acceptable.

23.1. Methodology

Cumulative impacts are defined as an impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. The overall effect of cumulative impacts could be positive or negative, depending on the nature of the proposal and its surroundings, other relevant projects within proximity of the proposal (or hydrologically linked), as well as the nearby communities and environment.

This cumulative impact assessment was undertaken for the proposal with reference to the Cumulative Impact Assessment Guidelines for State Significant Projects guidelines (DPIE, 2021a).

The technical reports provided in Appendices G to T and summarised in the technical chapters in Part C of this EIS, have considered cumulative impacts for specific key matters. The study area for the cumulative impact assessment was selected based on the likely extent of direct and indirect cumulative impact and is variable across each matter specific assessment.

This section integrates the findings of the matter specific assessments and determines whether the combined effect of these different impacts would be acceptable.

Future projects were considered if they were in the study area, and were:

- related to the proposal
- other State significant development and State significant infrastructure projects
- projects that are classified as designated development and require an EIS
- projects that require assessment under Division 5.1 of the EP&A Act that are likely to significantly affect the environment and require an EIS
- projects that have been declared to be controlled actions under the EPBC Act
- any major greenfield and urban renewal developments that are scheduled for the area (e.g. new areas zoned for urban development).

The scoping process was then used to determine if a project may result in a significant impact and thus warranted further detailed assessment for each key matter.

23.2. Scoping of future projects

Nine projects were identified as potentially having a significant cumulative impact due to location or timing of the project. These were considered for the technical matter assessed. A summary of these projects is provided in Table 23.1 and the potential cumulative impacts for each project.

Detailed assessment of these future projects is provided in section 23.3. Several additional project specific to the non-Aboriginal heritage assessment are listed in Table 23.3.

Table 23.1 Cumulative impact scoping summary

Project	Approx. distance to proposal (km)	Definition	Project status / Indicative timing / overlap	Potential cumulative impact
Yanco Creek Modernisation Project Part 1b: Wanganella Swamp Upgrades and construction of a series of structures that would act to raise and control inundation of the swamp to facilitate more successful bird breeding events and other environmental outcomes.	4 km to Wanganella Regulator	Related to the proposal	Construction anticipated to commence in 2025.	Flooding
Yanco Creek Modernisation Project Part 3: Wilsons Anabranch Upgrade and construction of a structure that would act to facilitate more successful bird breeding events and other environmental outcomes.	21 km to Hartwood Regulator	Related to the proposal	Construction anticipated to commence in mid 2025. Two months to complete.	Terrestrial flora and fauna
Yanco Creek Modernisation Project Part 4: Forest Creek Return Flows via Piccaninny Creek. Upgrade the existing Piccaninny Creek Block Bank in the connecting channel and install a new regulator so that excess Forest Creek flows can be diverted to Billabong Creek via Piccaninny Creek. A block bank or control structure on Piccaninny Creek upstream of the Forest Creek-Piccaninny Creek connecting channel may also be required. Flow measurement would also be installed.	15 km to Hartwood Regulator	Related to the proposal	Construction anticipated to commence in mid 2025. Two months to complete.	Hydrology Terrestrial flora and fauna
Yanco Creek Modernisation Project Part 5b: Cheverells Creek Offtake Remove the existing pipe culvert and construct a new pipe offtake and flow rate control works at the existing Cheverells Creek Offtake location with a Layflat gate regulator, including remote flow control, level and flow monitoring capability.	101 km to Hartwood Regulator	Related to the proposal	Construction anticipated to commence in mid 2025. Take three months to complete.	Terrestrial flora and fauna

Project	Approx. distance to proposal (km)	Definition	Project status / Indicative timing / overlap	Potential cumulative impact
Reconnecting River Country Program The program focuses on relaxing or removing some of the constraints or physical barriers impacting the delivery of water for the environment. The program area includes the Murrumbidgee River.	Not known	Not known	No specific timeline, projects or locations were available at the time of assessment. These could be located throughout the Murrumbidgee River area	
Yanco Delta Wind Farm Construction and operation of a wind farm 10 north-west of Jerilderie in NSW. The proposed wind farm will include approximately 210 turbines, a battery energy storage system, solar panels and associated electrical infrastructure.	39 km to Hartwood Regulator	Project under assessment	Construction of the project is targeted to begin in late-2024 subject to planning approval, with an expected duration of 36 months. Operation is expected to begin in 2025 with an operation life of at least 30 years.	Terrestrial flora and fauna
Yanco Solar Farm Construction and operation of a ground-mounted photovoltaic solar array generating around 60 megawatts alternating current.	129 km to Hartwood Regulator	Approved project	Construction phase of the project is expected to begin in 2023 and take approximately 10 months. Facility would be expected to operate for around 30 years.	
SDLAM program Murrumbidgee and Murray National Park Project	120 km to Wanganella Regulator	Approved project	Construction of the project is targeted to begin in late-2025 subject to planning approval.	Non-Aboriginal heritage
Bullawah Wind Farm Installation, operation, maintenance and decommissioning of up to 170 wind turbines, Battery Energy Storage System (BESS) facilities, ancillary infrastructure and temporary facilities associated with the construction of the wind farm.	55 km to Wanganella Regulator	Project under assessment	Construction phase of the project is expected to begin in mid to late 2025 and take approximately 24 months.	

Key

Detailed quantitative assessment

The project may result in significant impacts on the matter, including cumulative impacts. Detailed assessment is characterised by:

- potential overlap in impacts between a future project and the proposed project
- potential for significant cumulative impacts as a result of the overlap, requiring detailed technical studies to assess the impacts
- sufficient data is available on the future project to allow a detailed assessment of cumulative impacts with the proposed project for the relevant matter.

Uncertainties exist with respect to data, mitigation, assessment methods and criteria.

Project	Approx. distance to proposal (km)	Definition	Project status / Indicative timing / overlap	Potential cumulative impact
Standard qualitative assessment	The project is unlikely to result in significant impacts on the matter, including cumulative impacts. Standard assessments are characterised by: • impacts are well understood • impacts are relatively easy to predict using standard methods • impacts are capable of being mitigated to comply with relevant standards or performance measures • the assessment is unlikely to involve any significant uncertainties or require any detailed cumulative impact assessment.			

23.3. Cumulative impact assessment

The proposal is part of the regional SDLAM program which combined is being developed to improve the efficiency of water management across the Yanco Creek System. Cumulatively the projects would benefit Billabong Creek by improving the ability to deliver the right amount of environmental and consumptive (town and irrigation) water to the right place at the right time and to improve the passage of native fish through the system. The proposal would assist delivery of improved environmental outcomes compared to current conditions. This is further discussed in section 2.1.

The construction and operation of the proposal with other projects, has the potential for some adverse cumulative impacts however, which are discussed in the sections below. The areas where potential impacts have been identified are surface water quality, biodiversity, social and heritage impacts. Due to the distance to other projects, cumulative impacts are not expected for other environmental matters.

23.3.1. Hydrology

Given the general consistency of Cumulative Change Case mean annual flows, mean monthly flows, annual and daily flow variability, flow size, EWR results, Effective General Security Allocations and Water Extractions to those for the modelled Change Case scenario, there are not anticipated to be any major additional cumulative effects within Yanco and Colombo Creeks beyond those observed under the Change Case when assessing the proposal in the context of implementation of the Part 4 Forest Creek Return Flows Project.

In summary, the generally low degree of changes are potentially modelling artifacts resulting from the limitations of the eWater Source model and/or the product of the following differences between the Cumulative Change and Base Case scenarios:

- new environmental baseflow provision for Yanco Creek at Offtake of 250 ML/day when General Security allocations exceed 15 per cent
- increase in minimum environmental flow provision for Yanco Creek at Morundah from 50 ML/day to 100 ML/day
- the ability of the new regulators to regulate flows within Billabong Creek itself to meet environmental and water supply demands
- new limits of no orders from Coleambally Catchment Drain and Drainage Channel 800 Irrigation Escapes
- new limits of no orders from Finley Escape until Colombo Creek at Morundah reaches 130 ML/day and no orders during the winter period (15 May to 15 August)

- new environmental flow provision for Forest Creek at Offtake of 10 ML/day
- new operational principle to divert unplanned flows down Piccaninny Creek to assist in preventing unplanned flows in Forest Creek downstream of Warriston Weir during normal regulated periods.

For Yanco and Colombo creeks, all components of the Cumulative Change Case Source model remain unchanged from the Base Case scenario. For mid and lower Billabong Creeks, applicable components of the Forest Creek return flows project have been applied, but otherwise all elements of the Cumulative Change Case scenario remain unchanged from the Change Case scenario.

23.3.2. Flooding

Hartwood

The detailed hydraulic modelling has demonstrated that the proposed infrastructure for the other parts of the Yanco Creek Modernisation Project within the study area, comprising of proposed regulators on Forest Creek and Wilson Anabranh, are hydraulically independent. Therefore, there are no cumulative flood impacts of these works when combined with the proposal.

Wanganella

There are several proposed structures in the Wanganella Swamp area as part of the Yanco Creek Modernisation Project which are proposed to improve ecological outcomes, including from environmental watering, for the swamp.

The key features of the works proposed for Wanganella Swamp are the renewal of existing regulators and the construction of new regulators to enable water to be held within the swamp to enhance the ecological outcomes of natural floods and environmental watering. The hydraulic modelling of these structures has considered those options that locally have the largest flood impact. The result of this is that the cumulative assessment can be considered conservative.

As there is fundamentally no change in the flood characteristics due to the proposal, it can be concluded that the flood hazard and hydraulic functions of flow conveyance in floodways and flood storage characteristics remain consistent with current conditions. The impact from the proposed Wanganella Regulator is restricted to within the Billabong Creek area and does not extend to the area of other projects.

The Wanganella Swamp project is closest to the proposal, therefore the cumulative impacts were analysed through the modelling of a proposed scenario with the Wanganella Regulator and Wanganella Swamp Regulators, for 1 in 5 year, 1 in 20 year and 1 in 100 year events. The cumulative flood impact assessment, including the Wanganella Regulator and the Wanganella Swamp project, collectively show that:

- The introduction of the Wanganella Swamp project could potentially cause an increase of local flood water levels in smaller floods.
- An increase in levels upstream of the Wanganella Regulator to approximately +128 millimetres (1 in 5 year) and +43 millimetres (1 in 20 year) under the cumulative scenario caused by the inclusion of the Wanganella Swamp project.

The above results show that the Wanganella Regulator will not affect the Wanganella Swamp area while the Wanganella Swamp works can impact the Billabong Creek area in certain locations for the cumulative case (i.e., through flows entering from the Estuary Creek). This result was determined as the only connectivity between the Forest Creek / Eight Mile Creek (Wanganella Regulator area) system is Estuary Creek (Wanganella Swamp area) in the 1 in 5 year and 1 in 20 year events. Therefore it was concluded that this is the source of the flood level increase. The modelling of the proposed Estuary Creek Regulator as part of the cumulative proposed case identified the contribution that Estuary Creek makes to flood levels in Billabong Creek.

This result is anticipated for the following reasons:

- The southern waterways (i.e. Estuary Creek, Eight Mile Creek, and Forest Anabranh) are generally higher than the northern waterway and flow towards Billabong Creek.
- The modelling of the proposed Estuary Creek Regulator being open releases more water into Estuary Creek, resulting in afflux in Estuary Creek and part of Billabong Creek.

It was identified that closing the proposed Estuary Creek regulator gate during floods could reduce these flood levels for smaller floods (less than 1 in 10 year).

Further details of the cumulative flooding assessment, including flood mapping, is provided in chapter 4 of Appendix H.

23.3.3. Terrestrial flora and fauna

Cumulative impacts for terrestrial biodiversity were assessed with reference to the *Cumulative Impact Assessment Guidelines for State Significant Projects* guidelines (DPIE 2021a). In accordance with the guidelines, this cumulative impact assessment has considered relevant future and current projects that could result in a material impact on biodiversity values. Project identified as potentially having a cumulative terrestrial biodiversity impact are summarised in Table 23.2.

Table 23.2 Projects identified as potentially contributing to a terrestrial biodiversity cumulative impact

Future project	Potential cumulative impact Yes / No	Impacts on native vegetation	Impacts on relevant threatened ecological communities	Impacts on relevant threatened species
Yanco Creek Modernisation Project Part 1b: Wanganella Swamp	Yes	Impacts not yet quantified. Likely to include a small area of native vegetation removal.	Impacts not yet quantified.	Impacts not yet quantified
Yanco Creek Modernisation Project Part 3: Wilsons Anabranch	Yes	Direct impacts to ~0.19 ha of native vegetation	N/A	Slender Darling-pea: 3.53 ha of potential habitat Southern Bell Frog: 0.19 ha of potential habitat
Yanco Creek Modernisation Project Part 4: Forest Creek Return Flows via Piccaninny Creek	Yes	Direct impacts to ~2.08 ha of native vegetation	N/A	Slender Darling-pea: 1.84 ha of potential habitat Southern Bell Frog: 0.35 ha of potential habitat
Yanco Creek Modernisation Project Part 5b: Cheverells Creek Offtake	Yes	Direct impacts to ~1.38 ha of native vegetation	N/A	Slender Darling-pea: 0.61 ha of potential habitat Southern Bell Frog: 0.16 ha of potential habitat
Reconnecting River Country Program	N/A	Impacts not yet quantified.	Impacts not yet quantified.	Impacts not yet quantified
Yanco Delta Wind Farm	Yes	Direct impacts to ~175 ha of native vegetation	Natural Grasslands of the Murray Valley Plains: ~130 ha	Southern Myotis: 0.20 ha of potential habitat Plains-wanderer: 1.78 ha of mapped important habitat Slender Darling-pea: 3.53 ha of potential habitat
Yanco Solar Farm	Yes	Direct impacts to 0.54 ha of native vegetation	N/A	N/A
Bullawah Wind Farm	N/A	Impacts not yet quantified.	Impacts not yet quantified.	Impacts not yet quantified

23.3.4. Surface water quality and aquatic ecology

Of the projects considered in Table 23.1, the following were considered as having potential cumulative impacts and further assessment was carried out

- Part 1b: Wanganella Swamp
- Part 3: Wilsons Anabranh
- Part 4: Forest Creek Return Flows via Piccaninny Creek.

No other projects were identified as having a potential cumulative impact.

Construction Phase

All threat pathways identified for the construction phases were rated as having 'Rare' or 'Unlikely' likelihood of occurrence following implementation of the proposed management measures and safeguards outlined in Appendix F. As such, the threat pathways identified are unlikely to contribute significantly to negative cumulative effects in the system. This finding is based upon the following assumptions:

- The clearance areas where trees would be removed are small.
- Any impacts on water quality and physical habitat are likely to be largely confined to an area close to the construction footprint and be temporary in nature (i.e. less than a year).
- Direct impacts to threatened species are very unlikely if the proposed safeguards are followed.
- The spread of weeds into the area is a constant risk, but should be adequately mitigated by the safeguards implemented.

Operation Phase

The effects of the modelled hydrological and hydraulic outcomes (see chapter 6 and Appendix G were assessed in combination with a number of other projects to identify if there were cumulative impacts. These scenarios comprised:

- Hartwood Regulator with and without the works related to the Forest Creek Return Regulator and Wilsons Anabranh Offtake
- Wanganella Regulator with and without the works related to the Wanganella Swamp Regulators.

The results found that the works related to this proposal are effectively independent of Wilsons Anabranh Offtake and Wanganella Swamp Regulators, with no significant changes expected.

The hydrological cumulative impacts (adverse and beneficial) with Forest Creek Return Flows project identified the most relevant results were related to the achievement of Environmental Watering Requirements within the study area for native fishes.

The key Environmental Watering Requirements results for Mid Billabong Creek (Jerilderie to downstream of Hartwood Weir) are as follows:

- no reduction in the frequency with which the specific flow or inundation regime EWRs are achieved in the cumulative case compared to the base case, while some minor increases are predicted (less than or equal to four per cent).
- the frequency with which all of the specified EWR categories are modelled to be achieved represents no or a low degree of hydrological alteration to the specific flow or inundation regime needed to support key ecological values and related Murrumbidgee Long-Term Watering Plan objectives in this reach.

The key Environmental Watering Requirements results for lower Billabong and Intersecting Streams (downstream of Hartwood Weir to Moulamein) are as follows:

- no or negligible (less than or equal to one per cent) reduction in the frequency with which the specific flow or inundation regime EWRs are achieved in the cumulative case compared to the base case
- small increases in the frequency of large overbank floodplain connection, wetland connection flow EWRs, small freshes and native fish nesting support
- the predicted frequency of attaining native fish nesting support would still represent a medium degree of hydrological alteration for these flow categories following implementation of the SDLAM projects.

A potential cumulative benefit of the proposal is an increase in fish passage due to the construction of fishways in the Hartwood and Wanganella Regulator and fishway structures. While these structures are expected to facilitate upstream fish movement, the potential benefits for fish communities are lessened by the presence of other existing instream structures (e.g. farm dams and weirs) that also present barriers to fish movement further up and down stream.

The results indicate that that with the new fishway the following fish habitat would be connected:

- Approximately 47 kilometres of unimpeded riverine habitat between Caroonboon Weir and the existing Wanganella Weir would be extended by around 14 kilometres, up to 4 Mile Dam.
- Approximately 34 kilometres of unimpeded riverine habitat between Boonoke Homestead Weir and the existing Hartwood Weir would be extended by around 16 kilometres of stream habitat up to Lower Woolshed Weir.

The construction of the fishways would provide a considerable improvement, although the broader benefits of the increased habitat connectivity would be localised and are expected to have little overall benefit to populations at the level of the Billabong-Yanco system which are still fragmented by several other barriers.

It is noted that while 4 Mile Dam, Chinamans Dam, and Tracey's Weir, which are located between Wanganella Weir and Hartwood Weir, pose barriers to fish movement, they are smaller structures. It is likely that they would be drowned out occasionally during high flows, allowing for a greater degree of upstream and downstream fish movement. This may result in connectivity being improved further under certain flow conditions. However, the fish populations between these structures are still considered fragmented.

We note that there would also be an increase in high-quality, fast flow habitat above Hartwood Regulator that would provide important habitat for flow-sensitive species such as Silver Perch. Again, this would mark a considerable improvement, but the benefits would be localised and are expected to have modest overall benefit to populations at the level of the Billabong-Yanco system.

23.3.5. Aboriginal heritage

The townships and suburbs surrounding Forest and Billabong Creeks have been subject to progressive and continuing agricultural and pastoral practices, which have and will continue to place pressure on the archaeological resources within the region. To assess whether the predicted impacts from the proposal would have a broader impact on the cultural resources of the region, an analysis of AHIMS sites associated with a current or previous Aboriginal Heritage Impact Permit (AHIP) was completed for this proposal.

The results demonstrate that none of the sites within the designated local search area have been subject to AHIPs. This data indicates that all the sites have an extremely high conservation rate along Billabong and Forest Creeks.

The Riverina is a region that will be subject to progressive urbanisation over time, and this will place pressure on the archaeological resources within the region. To qualify whether the potential impacts from the proposal would have a broader impact on the cultural resources of the region, an analysis of AHIMS sites in relation to

their current or future zoned use was carried out. The purpose behind this analysis is to determine the volume of AHIMS sites that are located within zonings that have or are likely to be subject to progressive development. This assumes that sites that are located within land zoned for residential (R1 – R5), business (B1 – B5) and industrial (IN1 – IN4) purposes are more likely to be under threat of harm. Conversely, sites that are zoned for environmental (E1 – E5), recreational (RE1 – RE2) and rural (RU1 – RU6) purposes are more likely to be subject to conservation.

This analysis identified 13 other AHIMS all of which are located within zonings (RU1 Rural) which are likely to facilitate conservation outcomes and therefore have minimal threats to the conservation of sites.

This analysis indicates that locally, 100 per cent of the AHIMS sites identified are being conserved rather than destroyed. Therefore a cumulative impact of harm to known sites, between the proposal and other projects is not predicted.

23.3.6. Non-Aboriginal heritage

In 2003, Austral Archaeology (Austral Archaeology, 2003) undertook a heritage assessment of 304 river structures within southern NSW and 36 across northern NSW. The aim of this study was to identify the for potential registering items on the s170 heritage register, on behalf of State Water (a predecessor agency to WaterNSW). In summary, of the total number of water structures that were assessed, there were 24 weirs or regulators considered to be of significance in the southern region, which includes the current proposal area and the broader SDLAM program region. This provides a baseline of data for heritage weirs and other river structures within NSW by which cumulative impact can be assessed.

The other projects planned in the region were reviewed to determine if the proposal has the potential to result in significant cumulative impacts. The projects reviewed are listed in Table 23.3. Of these projects a total of four heritage-listed weirs, and one non-listed weir assessed as being of local significance, have been identified for demolition across the region.

Table 23.3 Projects and potential historical weir demolitions

Project	Historical weirs to be removed
Yanco Creek Modernisation Projects, see Table 23.1 and the proposal	One s170-listed weir of local significance in poor condition, and one non-listed weir of local significance in extremely poor condition, will be demolished on Billabong Creek (the proposal).
Lower Murray – Locks 8 & 9 Project	Two non-listed weirs, which were assessed as not holding local or state heritage significance, will be demolished along Carrs, Capitts and Bunberoo Creeks.
Murrumbidgee and Murray National Park Project	Two s170-listed weirs of local significance in poor operational condition, noting that the heritage fabric of both are in very good condition, will be demolished at Yanga National Park. Four non-listed regulators and one non-listed culvert, none of which were assessed by Austral Archaeology as having any heritage significance, will be demolished at Millewa National Park.
Koondrook-Perricoota Flow Enabling Works Project	One s170-listed regulator which had undergone substantial change since its 2003 assessment, two non-listed regulators, and a non-listed offtake, none of which meet the threshold for local or state heritage significance, will be demolished.
Mid-Murray Anabranches Constraints Demonstration Reach Project	No known weirs will be demolished; two culverts and a block bank will be removed, and one bridge and one culvert replaced, along Native Dog Creek, none of which were assessed by Austral Archaeology as having heritage values. No known weirs will be demolished; four bridges and a penstock gate will be removed, and five bridges and a rock crossing replaced, along Bullatale Creek. Five timber and composite timber bridges were assessed as having local heritage values.

The four s170-listed weirs and one of local heritage significance being demolished as part of the SDLAM program, comprise 20.83 per cent of state or local significant heritage weirs or regulators in the southern region.

This is mitigated in a limited fashion by one of the s170-listed weirs having subsequently been assessed as not being of heritage significance and the other four heritage weirs only being of local significance, rather than state level significance. Additionally, two of these weirs were shown to be substantially altered, or in a poor condition, while the other two were in poor operational condition although their heritage fabric was in very good condition.

The proposal is therefore likely to result in a moderate cumulative impact to heritage water infrastructure assets.

23.3.7. Social

The proposal is not considered to contribute significantly to cumulative impacts with other projects to social impacts, with the implementation of the mitigation measures proposed in section 19.4.

However, from a social perspective, there is some potential for competition for skilled labour if there are other projects being constructed in the region at the same time. This could result in more roles being filled by non-residents, leading to increased demand for housing and accommodation in the region. As an existing issue, competition for skilled labour can be challenging to manage for individual proponents. However, it is expected that demand for accommodation can be managed through early consultation with local accommodation providers.

23.3.8. Summary of results

The potential for cumulative impacts has been included as part of relevant technical assessments of the EIS. The cumulative assessment has considered the *Cumulative Impact Assessment Guidelines for State Significant Projects* (DPIE, 2021a).

The proposal is part of the regional SDLAM program which combined is being developed to improve the efficiency of water management across the Yanco Creek System. Cumulatively the SDLAM projects would benefit Billabong Creek by improving the ability to deliver the right amount of environmental and consumptive (town and irrigation) water to the right place at the right time and to improve the passage of native fish through the system. The proposal would assist delivery of improved environmental outcomes compared to current conditions. This is further discussed in section 2.1.

The proposal has been developed to minimise the potential for adverse cumulative impacts through hydrological modelling which has enabled the design of the proposal to design out impacts where possible. The proposal also included mitigation and management measures to avoid or minimise potential adverse cumulative impacts (refer to Appendix F).

There is some potential for adverse cumulative impacts even after mitigation and management measures have been incorporated, which relate principally to biodiversity and heritage.

24. Approach to environmental management and mitigation

This chapter provides a summary of the proposed approach to environmental management and mitigation for the proposal. The chapter also provides a summary of key project and assessment uncertainties, and the proposed approach to design refinements.

24.1. Approach to environmental management

NSW DCCEEW, WaterNSW and its responsible contractors, will manage their environmental responsibilities and environmental performance consistent with the principles contained within the ISO 14000 (environmental management) series and standards. This includes establishing a corporate environmental policy, setting environmental direction through objectives and targets, integrating these into work systems, and providing measures for continuous improvement.

The Environment Management System outlines the agency's commitment to effectively manage any risks that may lead to an impact on the environment. Should the proposal be approved, NSW DCCEEW would manage the environmental performance of the proposal in accordance with these policies and standards.

The approach to environmental management and mitigation for the proposal, building on the measures incorporated in the design, involves:

- environmental management system, which would provide the framework for implementing environmental management during construction and operation (described below), and any conditions of other approvals, licences, or permits
- mitigation measures – measures provided in the chapters in Part C of the EIS (and compiled within Appendix F (Consolidated mitigation measures)) have been developed as an outcome of the environmental impact assessment
- conditions of approval – the proposal would be undertaken and managed in accordance with the conditions of approval
- project-specific CEMP – to guide the approach to environmental management during construction as described in section 24.2
- environmental management during operation – as described in section 24.3.

24.2. Construction environmental management

Key construction environmental management documentation, which would be prepared in accordance with the planning approval and mitigation measures (see Appendix F), is described below.

24.2.1. Construction environmental management approach

The general approach to environmental management during construction would include developing the CEMP as the primary proposal-specific environmental management plan (described below). The CEMP would include sub-plans that would outline the mitigation, management and monitoring requirements for specific environmental and community aspects. Some sub-plans may be combined where there are synergies in the impacts or requirements.

In addition to the CEMP, and its sub-plans, a number of other strategies and plans would be developed and implemented during construction to manage environmental and community impacts in accordance with the mitigation measures (see Appendix F).

24.2.2. Construction environmental management plan

The management of environmental impacts during construction would be documented in a CEMP, which would provide a centralised mechanism through which all potential construction-related environmental impacts would be managed. The CEMP would be prepared in accordance with Environmental Management Plan Guideline for Infrastructure Projects (DPIE, 2020g) and Independent Audit Post Approval Requirements (DPIE, 2020h).

The CEMP would provide the system and procedures to ensure that environmental impacts are minimised, and that legislative and approval requirements are fulfilled. The CEMP would include:

- the environmental policy, objectives, and performance targets for construction
- description of activities to be undertaken during construction
- reference to relevant statutory and other obligations, including consents, licences, approvals, permits and voluntary agreements required
- issue-specific sub plans that detail how construction activities would be managed and monitored to avoid or minimise impacts, including the type, location and timing of environmental controls
- processes for managing non-conformances, including identifying and implementing corrective and preventative actions to rectify the non-conformance and prevent recurrence (described below)
- processes for demonstrating compliance with the commitments made in the EIS and relevant approval conditions
- responsibilities for planning, implementing, maintaining and monitoring environmental controls including the responsibilities of sub-contractors
- procedures for the control of environmental records
- a compliance tracking and auditing program.

Staff inductions and training will include the following:

- instructions on project specific environment requirements

- staff and public safety, for example:
 - consideration of the impacts of both riverine flooding and flash flooding in the emergency management planning on the workers and the ability to quickly and safely evacuate them from the site
 - ensure workers and people on site are aware of the flood risk, for example through site inductions and by using signage
 - emergency planning which outlines when and how the worksite would be closed and all materials and equipment secured prior to the start of the working day if there is a risk of flooding, on receipt of advice from the BoM, or when other evidence leads to an expectation of flooding. During site works, the BoM website would be checked prior to start of the workday for any Flood Warnings.

24.2.3. Outline of CEMP sub-plans

The CEMP would comprise a main CEMP document, issue-specific sub-plans and procedures. An outline of the indicative construction sub-plans are as follows:

- Flora and Fauna Management Plan
- Aboriginal Heritage Management Plan
- Soil and Water Management Plan
- Emergency Management Plan
- Construction Traffic Management Plan.

The requirement to prepare these sub-plans is specified by the mitigation measures in relevant chapters, which have been compiled in Appendix F (Consolidated mitigation measures). It is noted that the conditions of approval may require different and/or additional matters to be addressed in the CEMP or sub-plans.

24.2.4. Environmental performance

The management measures detailed in the CEMP would be monitored during construction to confirm their effectiveness and whether any additional measures are required. Site inspections would be regularly undertaken to check and update measures as necessary. Environmental site monitoring would also be undertaken to confirm proposal impacts and existing environmental values in accordance with monitoring commitments made in this document.

The CEMP would provide for an internal compliance monitoring program where the construction contractor(s) would periodically monitor and report on performance against relevant statutory and other obligations, including the conditions of approval. Independent external audits would also be carried out in accordance with Independent Audit Post-Approval Requirements (DPIE, 2020h) and Australian/New Zealand Standard AS/NZS ISO 19011:2003 – Guidelines for quality and/or environmental management systems auditing.

Environmental inspections and audits would be undertaken by NSW DCCEEW.

24.2.5. Non-conformance and corrective action

For any environmental issues that arise, corrective and preventative actions must be implemented. Corrective and preventative actions may be developed to address issues or initiate environmental management improvement opportunities identified as a result of incidents, inspections and monitoring, audit findings and other reviews.

Incidents would be managed in accordance with NSW DCCEEW Environmental Management System.

The CEMP would document the development and implementation of corrective and preventative actions during construction.

24.2.6. Continual improvement

The CEMP and sub plans would be reviewed and updated as required, including in response to audit findings, compliance monitoring results, and incidents and inspections that identify corrective and preventative actions. This would include an annual review conducted by the contractor(s) as part of the continual improvement process.

24.3. Operational environment management

It is intended that the regulators would be owned and operated by WaterNSW. Essential Energy would own and operate the electricity infrastructure from the control hut outwards from the regulators.

WaterNSW has existing environmental management procedures and policies which would cover environmental management of the regulators. Anything that is specific to these regulators will be added to the standard procedures.

Measure would include an Operational Management Plan which would detail how the performance outcomes, issues identified through ongoing risk analysis, commitments and mitigation measures would be applied. The Operational Management Plan would include approaches to managing operations during special events, compliance auditing and incident management.

24.4. Project uncertainties and approach to design refinements

24.4.1. Project uncertainties

The design presented in this EIS has been developed to a level where potential impacts can be appropriately identified and assessed. Some design elements and construction methodologies would continue to be refined as part of the design development and construction planning process.

Aspects of the design, and the associated potential impacts, that may be subject to further refinement are summarised in section 3.6.

24.4.2. Approach to design refinements

The design and indicative construction method presented in the EIS (see chapter 3 (Proposal description)) defines a proposal that provides a sound basis for assessing the potential impacts of the proposal (as described in this EIS) and future design development to the standard required to support project delivery.

Sufficient flexibility has been provided to allow for the design to be refined during design development, where relevant, to improve environmental performance, minimise impacts on the community and the environment, respond to feedback from the community and stakeholders, provide value for money, and respond to innovations in design, construction method and/or environmental management. As a result, the final design may vary from the design described in the EIS.

The proposal design as described in the EIS would be subject to ongoing refinements during design development, as described in section 3.6 and in accordance with the:

- mitigation measures (see Appendix F)
- the conditions of approval.

Refinements may be made to further:

- avoid areas of environmental sensitivity identified following approval
- reduce the construction timeframe
- reduce impacts and increase benefits to the community
- respond to community and stakeholder feedback
- promote innovative outcomes and technological improvements
- provide improved value for money outcomes
- improve operation without increasing the potential environmental impacts.

Such refinements may include (for example) minor changes to:

- bridge design
- confirmation of gate configuration, number and specification
- structural design
- height of sill for Wanganella flood bypass channel
- safety in design requirements
- access track alignment and pavement design
- geotechnical design
- computational fluid dynamics (hydraulic modelling) and physical creation and testing of the fishway
- electrical design (mains power and site electrical).

Refinements would not include significant changes to the project.

A consistency review would be undertaken for design refinements to consider whether the refinements would:

- comply with the conditions of approval
- be consistent with the objectives and operation of the project as described in the EIS
- result in a change to the approved project that is not considered significant
- result in potential environmental or social impacts of a similar scale and nature as those considered by this document.

If the proposed refinement is significantly inconsistent with the above, it would be considered a project modification. Approval for any modifications would be sought in accordance with the requirements of Division 5.2 of the EP&A Act.

Part D

Justification and
conclusion

25. Justification of the project

This section provides a justification and evaluation of the proposal as a whole, having regard to its economic, environmental and social impacts and the principles of ecologically sustainable development. The justification, incorporates an evaluation of the overall findings of the EIS, considers the requirements of the EP&A Regulation and the strategic need for the proposal.

25.1. Justification and evaluation

This EIS has been prepared having regard to the NSW State Significant Infrastructure Guidelines – including the Preparing an Environmental Impact Statement Guideline. During development of the proposal and the preparation of the EIS, NSW DCCEEW has consulted with various parties, including DPHI, relevant agencies and stakeholders, in accordance with the *Undertaking Engagement Guidelines for State Significant Projects* (DPHI, 2024).

A Registered Environmental Assessment Practitioner declares that this EIS meets certain standards in relation to its completeness, accuracy, quality and clarity, as per Part 8 Division 5 of the EP&A Regulation. The declaration is provided in at the front of this EIS.

25.1.1. Biophysical, economic and social considerations

The environmental assessment requirements of the Secretary of the Department of Planning and Environment (the SEARs) requires the EIS to be prepared in accordance with Part 8 of the EP&A Regulation (see Appendix A (SEARs compliance table)). Clause 192(1)(f) requires an EIS to provide ‘the reasons justifying the carrying out of the development, activity or infrastructure in the manner proposed, having regard to biophysical, economic and social considerations, including the principles of ecologically sustainable development set out in Section 193.

Detailed environmental investigations have been carried out as described in chapters 6 to 23 of the EIS to:

- understand the existing environment
- inform design development
- assess the potential impacts of the project
- identify appropriate measures to avoid and minimise potential impacts.

The following sections provides a summary of the biophysical, economic and social considerations of the project justification, including consideration of the project’s consistency with the principles of ecologically sustainable development.

25.1.2. Biophysical considerations

Investigations, site survey, risk assessment and studies were undertaken by technical specialists experienced in impact assessment to provide a high level of certainty in understanding the environment and identifying potential impacts.

Specialists used best practice methodologies in accordance with relevant statutory requirements and guidelines. These included methodologies identified in the SEARs and the requirements of the EP&A Act and the EP&A Regulation. Assessments and standard industry best practice. This assessment included considering the potential for cumulative impacts during construction and operation. Details of the investigations undertaken, methodologies applied, and results in relation to the key biophysical considerations, are described chapters 6 to 23.

Key potential biophysical impacts of the proposal are discussed in the sections below.

Hydrology

- It is considered unlikely that construction of the proposal would have a material adverse effect on the hydrology of Billabong Creek, either upstream or downstream. This is principally due to the existing weir remaining in place until the new regulator is installed and a construction methodology that would maintain a constant creek flow.
- The hydrological analysis indicates that operation of the proposal would have some localised minor impacts on hydrology (i.e. water balance, seasonality, flow variability, and flow sizes) but do not significantly alter the overall hydrological characteristics of Billabong Creek within the proposal study area or the broader Yanco Billabong System.
- Operation of the proposal would result in an overall improvement in the frequency of achieving environmental water requirement for a number of categories to support key ecological values of the system.
- The proposal is also not anticipated to negatively impact the key hydrological aspects of the Yanco Creek System, when taking into consideration potential cumulative effects associated with the Forest Creek Return Flows Project.

Flooding

- There are no significant construction phase flood impacts or consequences predicted at Hartwood or Wanganella.
- There would be no significant detrimental flooding increases to properties, assets, and infrastructure. As there is fundamentally no change in the flood characteristics due to the proposal, it can be concluded that the flood hazard and hydraulic functions of flow conveyance in floodways and flood storage characteristics remain consistent with existing conditions and the Conargo Local Environment Plan (Edward River Council 2013).
- As there is no fundamental change to the existing flooding conditions the existing emergency management, evacuation and access, and contingency measures remain current and relevant where they exist and no new community emergency management arrangements for flooding are required.
- As there is no fundamental change to the existing flooding conditions there are no impacts to social and economic costs to the community as a consequence of the proposals.
- The assessment of climate change at 2100 from the proposal shows no significant impacts. A minor improvement is predicted at the Wanganella Regulator due to the introduction of a flood bypass channel.

Groundwater

- During construction no significant impacts are predicted at Hartwood. At Wanganella, limited drawdown with an expected rate of dewatering is less than 0.2 L/s is predicted.
- During operation of the proposal no discernible change in groundwater elevation or flow direction is predicted over the study area at Hartwood. At Wanganella a slight lowering of groundwater levels by 0.01 to 0.02 metres is predicted over 20 years.

Geomorphology

- With the implementation of safeguards and management measures during construction it is determined that the risk of bed and bank erosion or instability impacts occurring is low risk in the study area. As such it is expected that geomorphology values in the study area would be protected during construction.
- During operation it is predicted that there would not be any significant change in potential for scour/erosion or sedimentation of the weir pools. The bed and banks could undergo some minor geomorphic adjustment due to the new flow regime. Localised erosion risks are expected in association with the regulator structures, but erosion effects would be localised and manageable.
- Small changes in velocity and shear stress values between the existing and proposed levels are predicted but show that values are below thresholds considered to represent a geomorphic risk.

Surface water and aquatic flora and fauna

- With the implementation of construction safeguards and management measures it was determined that the risk rating for identified impact pathways was between 'medium' and 'very low', but mostly 'low' and 'very low'. As such it is expected that the water quality objectives and aquatic ecosystem values in the study area, including threatened species and key fish habitat would be protected during construction.
- Hydraulic and hydrological modelling indicates that operation of the new regulators would result in relatively minor changes to flow and velocity regardless of the operating flow setting (maximum or minimum). These minor changes are unlikely to negatively impact the native aquatic community. With the implementation of management measures and additional safeguards, the risk rating derived for the risk pathways were 'low' and 'very low' in all instances.
- During operation, the proposal is expected to improve native fish populations and the delivery of environmental water by reestablishing river connectivity and fish passage so that fish can complete their life cycles and avoid predation. Water quality objectives and aquatic ecosystem values in the study area, including threatened species and key fish habitat would be protected during operation.

Terrestrial flora and fauna

- The proposal would remove up to 16.23 hectares of native vegetation across the proposal footprint.
- Removal of areas of habitat associated with threatened species: Little Eagle, Bush Stone-curlew, Southern Bell Frog, Southern Myotis, Plains-wanderer and the Slender Darling-pea.
- An assessment of serious and irreversible impacts has been prepared for the Plains-wanderer due to the removal of 1.96 hectares of mapped important habitat for this species.

While some negative impacts have been identified, measures have been developed to minimise the potential impacts as far as possible. These measures, and the proposed approach to environmental management during construction and operation, are described in chapter 24 (Approach to environmental management and mitigation) and Appendix F (Consolidated mitigation and management measures). Biodiversity offsetting would be required.

25.1.3. Economic and social considerations

NSW DCCEEW's Yanco Creek modernisation program is progressing the upgrade of infrastructure to enable smarter use of water in the Yanco Creek system, including Yanco, Billabong, Colombo and Forest Creeks. It encompasses a series of initiatives aiming to improve water management as part of commitments within the SDLAM program.

The modernisation focuses on delivering equivalent and/ or improved environment outcomes through infrastructure and smarter use of water. Some of the expected benefits in the Yanco, Billabong, Forest, Colombo creeks and Murrumbidgee River system include:

- more efficient delivery of environmental water
- improved fish passage (e.g. new fishways)
- improved knowledge and understanding of First Nations cultural heritage
- improved connection to Country
- an economic, training and employment boost for local communities
- improved levels of service for water users (e.g. more flexible irrigation scheduling)
- a reduced risk of further non-strategic water market purchases from the southern-connected Basin to meet Basin Plan commitments.

This proposal comprises one part of NSW DCCEEW's Yanco Creek modernisation program. The proposal is needed to improve the efficiency of water management in Billabong Creek by improving the ability to deliver the right amount of environmental and consumptive (town and irrigation) water to the right place at the right time and to improve the passage of native fish through the system. The proposal would assist delivery of improved environmental outcomes compared to current conditions. In summary, the proposal would offer the following benefits to the community and economy:

- Modernising ageing infrastructure
 - The weirs are ageing and are in different states of deteriorating condition and have very limited to no ability to control flow.
 - The proposal would replace these weirs with regulators to meet contemporary demands for water supply and efficient delivery of water.
- Improving service for water users
 - Due to existing long ordering periods for water and delivery times in the creek, WaterNSW maintains high levels of flow in the Yanco Creek system throughout the season to avoid risks of non-supply. Therefore flows within the system are greater than would be required. The proposal would shorten the ordering period improve operational flexibility and reduce over supply of consumptive water.
- Improving fish passage
 - The proposal would remove existing barriers to fish passage at two weirs associated with the proposal. This would support unimpeded fish passage for native fish species, including Murray Cod in this section of Billabong Creek.
- Improved delivery of environmental water
 - Hartwood regulator would help to improve the efficiency of the delivery of environmental water into the Forest Creek system including important environmental wetlands in the Wanganella area.
 - The proposal would improve environmental water managers' ability to achieve ecological outcomes in the Yanco Creek system.

Notwithstanding the benefits, constructing and operating the proposal would have the potential for a range of impacts on the community. Potential impacts, including a range of economic, social and cultural heritage considerations, have been assessed in accordance with the SEARs and relevant guidelines. Details of the investigations undertaken, methodologies applied, and results obtained, are described in chapters 6 to 23.

Key potential impacts of the proposal are discussed in the sections below.

Aboriginal heritage

Five sites have been identified as being directly impacted through either minor impacts such as trimming of branches, or major impacts such as their removal and/or destruction. These sites have had their surrounding landscapes impacted and disturbed by previous developments, pastoral practices and informal access tracks, as well as being common representations of their site types.

The sites comprise:

- Forest Creek Block Bank Scarred Tree 2 / AHIMS # 54-3-0031 – Partial loss of value
- Forest Creek Block Bank Scarred Tree 4 / AHIMS # 54-3-0057 – No loss of value
- Hartwood Weir Scarred Tree 4 / AHIMS # 54-3-0059 – Total loss of value
- Hartwood EM Weir 3 / AHIMS # 54-3-0061 – Total loss of value
- Wanganella Weir Scarred Tree 3 / AHIMS # 54-2-0264 – Total loss of value.

Non-Aboriginal heritage

The two existing weir structures within the creek would be substantially, with some parts being retained. Demolition of majority of the structures has been deemed necessary due to health and safety concerns of the degraded structures and they would hinder the water levels and the flows required by the new regulators. The weirs have the following heritage status:

- Hartwood Weir (S170 4550110), is registered under Section 170 of the Heritage Act for NSW government state agencies
- Wanganella Weir is assessed as having local significance although it has no listing.

Social

The key positive social impacts with the potential to occur during construction and operation are primarily related to procurement opportunities for local and regional businesses, improved water management, delivery and availability contributing to business and economic outcomes, particularly agricultural industries and improved water security of town water supply at Wanganella.

Negative impacts which could arise as a result of the proposal include:

- impacts on community infrastructure as a result of the project's temporary land requirements include access and inconveniences to Wanganella camping reserve and landowner access
- changes to local amenity from increased noise, traffic movements and visual impacts, mainly during construction
- loss of local heritage potentially impacting community values through the removal of heritage items.

Land use, property and agriculture

The proposal would have short-term impacts resulting from the temporary removal of land required for construction activities.

The land that would be affected is predominantly used for extensive livestock grazing and smaller areas of cropping land. The proposal avoids irrigated agricultural land. Following rehabilitation of the construction footprint, normal agricultural production and other existing land uses will be able to resume.

Longer-term impacts as a result of the removal of land for ongoing operations and maintenance activities would comprise:

- Small areas of land for the regulator infrastructure and access tracks mapped as agricultural land to be removed from production. This land is currently classified as Crown Land however, and it has limited agricultural use. The removal of these areas of land for operational access would have limited effect on the overall agricultural resources base of the regional study area.

25.2. Principles of ecologically sustainable development

The following sections provide reasons justifying carrying out the project with regard to the principles of ecologically sustainable development, as defined by clause 192(1)(f) of the EP&A Regulation.

25.2.1. Precautionary principle

The precautionary principle is defined as ‘...if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation’.

The EIS has been prepared using a conservative and precautionary approach, including investigating and considering potential worst-case outcomes where relevant. The purpose of this is to ensure that adequate consideration is given to avoiding, minimising and mitigating impacts that could cause temporary or permanent environmental degradation or adverse social impacts.

The assessment of potential impacts has been undertaken in a way that is consistent with the precautionary principle and with accepted scientific and assessment methodologies, taking into account statutory and agency requirements. Assessments have applied a conservative approach with regard to consideration and modelling of project construction and operational arrangements.

An environmental risk assessment was carried out which considered the likely consequence levels of impacts and how the mitigation measures can reduce the risks. The risk assessment is provided in Appendix D. The proposal has been designed to avoid impacts where possible, and to reflect the findings of the assessments undertaken. Mitigation and management measures have been proposed to minimise potential impacts, and these management measures would be implemented during construction and operation.

Lack of full scientific certainty has not been used as a reason to postpone or avoid identification and adoption of design or management measures to avoid or minimise environmental degradation.

25.2.2. Inter-generational equity

The principle of inter-generational equity is defined as ‘...the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.’

The proposal has environmental objectives to support the existing and future environment. The proposal consistency with these objectives are considered in section 2.1. While there would be some environmental and community impacts, economic expenditure and use of materials to construct the proposal, the net benefit to the community over the proposal’s design life would be positive.

Construction would be associated with some impacts to the community and environment as described in chapters 6 to 23. However, the area affected, and the extent of these impacts, are considered to be relatively small and justified by the economic and environmental benefits over the proposal’s life.

No residual or outstanding impacts have been identified that would adversely affect the health, diversity and productivity of the environment available for the enjoyment and benefit of future generations.

25.2.3. Conservation of biological diversity and ecological integrity

The principle of conservation of biological diversity and ecological integrity is defined as ‘...conservation of biological diversity and ecological integrity should be a fundamental consideration.’

The proposal is located in an agricultural environment that has widely been cleared but that still has biodiversity and ecological value. Key areas of biological significance include the riparian vegetation and waterway of Billabong Creek.

Conservation of biological diversity and ecological integrity has been an important consideration in proposal planning, design development and construction planning. The proposal design has been developed to avoid or minimise impact on areas of high ecological value as far as possible.

A biodiversity assessment was undertaken in accordance with the *Biodiversity Assessment Method* (DPIE, 2020i) as described in chapters 10 (Surface water quality and aquatic ecology) and 11 (Terrestrial flora and fauna). Detailed assessments have been carried out to identify biodiversity impacts and a range of mitigation measures have been identified for implementation.

The assessment concluded that during operation, the proposal is expected to improve native fish populations and the delivery of environmental water by reestablishing river connectivity and fish passage so that fish can complete their life cycles and avoid predation. Water quality objectives and aquatic ecosystem values in the study area, including threatened species and key fish habitat would be protected during operation.

The proposal would remove up to 16.23 hectares of native vegetation across the proposal footprint, including areas of habitat associated with threatened species. An assessment of serious and irreversible impacts has been prepared for the Plains-wanderer due to the removal of 1.96 hectares of mapped important habitat for this species. Impacts on biodiversity would be offset

25.2.4. Improved valuation and pricing of environmental resourcing

The principle of improved valuation and pricing of environmental resources is defined as ‘...*environmental factors should be included in the valuation of assets and services.*’

The value of the environment is inherently considered in the design of a development that avoids and minimises impacts.

The proposal would result in impacts to terrestrial and aquatic ecology and, as the proponent of the proposal, NSW DCCEEW would offset these impacts in accordance with the requirements of the NSW Biodiversity Offsets Scheme and the Policy and the requirements of the Department of Primary Industries- Fisheries. This is consistent with the 'polluter pays' approach to the valuation of biodiversity.

The total estimated development cost includes all costs necessary to carry out the development for the full scope that the proponent is seeking consent for. The estimated development cost includes the cost of implementing management and mitigation measures identified by the EIS. The costs of reducing overall waste generated, minimising noise, protecting air quality, biodiversity and heritage, and of ensuring sustainability in procurement and other environment protection measures, are all incorporated into the overall proposal cost.

25.3. Summary of the strategic need

As a requirement of the Water Act, the Murray-Darling Basin Authority was set up and was required to develop a plan to manage how much water could be used by industries and communities in the Basin. The Murray-Darling Basin Plan (the Basin Plan) was adopted in November 2012. 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 plan sets the amount of water that can be taken from the Basin each year.

The Basin Plan sets sustainable diversion limits for each catchment or group of catchments. The existing sustainable diversion limits were lower than the amount of water that was being used at the time. As a consequence, water has to be recovered from the Basin's already allocated water to meet the limit. To provide flexibility, the Basin Plan includes a mechanism to adjust sustainable diversion limits to achieve equivalent social, economic and environmental outcomes with less water recovery. The Sustainable Diversion Limit Adjustment Mechanism allows the sustainable diversion limits to be adjusted within defined limits to offset the remaining gap between extractions and the desired 2,750 GL water saving.

NSW DCCEEW's Yanco Creek modernisation program is progressing the upgrade of infrastructure to enable smarter use of water in the Yanco Creek system, including Yanco, Billabong, Colombo and Forest Creeks. It encompasses a series of initiatives aiming to improve water management as part of commitments within the SDLAM program.

This proposal comprises one part of NSW DCCEEW's Yanco Creek modernisation program.

The modernisation of the Yanco Creek system aims to:

- create a community and government partnership to maintain and improve flows
- keep the Yanco, Billabong, Forest and Colombo Creeks flowing
- be smart in the use of available water
- modernise ageing infrastructure
- ensure project benefits for irrigators, town water supplies, native fish, water birds, culture and heritage, and recreational use.

In summary the modernisation program focuses on delivering equivalent and/ or improved environment outcomes through infrastructure and smarter use of water. Some of the expected benefits in the Yanco, Billabong, Forest, Colombo creeks and Murrumbidgee River system include:

- more efficient delivery of environmental water
- improved fish passage (e.g. new fishways)
- improved knowledge and understanding of First Nations cultural heritage

- improved connection to Country
- an economic, training and employment boost for local communities
- improved levels of service for water users (e.g. more flexible irrigation scheduling)
- a reduced risk of further non-strategic water market purchases from the southern-connected Basin to meet Basin Plan commitments.

The proposal is needed to improve the efficiency of water management in Billabong Creek by improving the ability to deliver the right amount of environmental and consumptive (town and irrigation) water to the right place at the right time and to improve the passage of native fish through the system. The proposal would assist delivery of improved environmental outcomes compared to current conditions.

25.4. Achieving the proposal objectives

This proposal comprises one part of NSW DCCEEW's Yanco Creek modernisation program. Subject to approval, the proposal would contribute to achieving the aims of the overall modernisation program, as discussed in section 25.3.

The objectives of the Billabong Creek Regulators proposal are to:

- modernise ageing infrastructure
- provide service for water users
- improve fish passage
- improve delivery of environmental water.

The mechanisms for achieving these objectives are summarised in Table 25.1.

Table 25.1 Achieving proposal objectives

Proposal objectives	Detail
Modernising ageing infrastructure	- The weirs are ageing and are in different states of deteriorating condition and have very limited to no ability to control flow. - The proposal would replace these weirs with regulators to meet contemporary demands for water supply and efficient delivery of water.
Improving service for water users	- There are currently long ordering periods for water, of up to 26 days to the lower Billabong Creek, between releases from the headwater dams and final delivery of water to licensees (Cooling and Gippel, 2018; WaterNSW, 2015). - Long delivery times for water in the creek make it difficult to implement effective order management or control (WaterNSW, 2015). - As a result, WaterNSW maintains high levels of flow in the Yanco Creek system throughout the season to avoid risks of non-supply (WaterNSW, 2015). - Thus, flows within the system are greater than would be required to meet actual irrigation demand and so end of system flows at Darlot are generally higher than the target set in the <i>Murrumbidgee Regulated River Water Sharing Plan</i> (WaterNSW, 2015). - The proposal would improve operational flexibility and reduce over supply of consumptive water.
Improving service for water users Sustainable Diversion Limits and the Adjustment Mechanism supply projects	- The Basin Plan provides flexibility by allowing the Sustainable Diversion Limits to be offset using supply projects such as the proposal. - In early 2019, NSW signed a funding agreement with the Australian Government to undertake detailed planning for several projects, including the proposal, under the SDLAM Program. - The NSW Government has brought forward five of its remaining SDLAM projects, including the proposal, through the NSW SDLAM Acceleration Program (the Acceleration Program). - The proposal would deliver equivalent or better environmental outcomes compared to those achieved under current Basin Plan settings, using an estimated 16 GL less water when combined with the Computer Aided River Model Project.
Improving fish passage	- The native fish community is highly degraded and fragmented in the Yanco Creek system, with over 30 weirs and barriers reducing fish movement in the Yanco Creek system and only one of which has a fishway (Stuart, 2022). - The proposal would remove existing barriers to fish passage at location of the two weirs associated with the proposal. This will support unimpeded fish passage for native fish species, including Murray Cod (<i>Maccullochella peelii</i>). The existing distances of unimpeded fish passage will be increased by around 14 kilometres, at Wanganella and 16 kilometres at Hartwood.
Improved delivery of environmental water	- Hartwood regulator would help to improve the efficiency of the delivery of environmental water into the Forest Creek system including important environmental wetlands in the Wanganella area. - The proposal would improve environmental water managers' ability to achieve ecological outcomes in the Yanco Creek system.

25.5. Statutory compliance

The proposal is subject to environmental and planning approvals in accordance with the NSW Environmental Planning and Assessment Act 1979 (EP&A Act) and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The proposal is State significant infrastructure (SSI), and the Minister for Planning and Public Spaces is the approval authority. An environmental impact statement (EIS) is required to accompany the application for approval of the proposal.

This EIS has been prepared to support the application for approval of the proposal under Part 5 Division 5.2 of the EP&A Act. It addresses the Secretary's Environmental Assessment Requirements (SEARs) issued by the NSW Department of Planning, Housing and Infrastructure (DPHI) on 17 October 2024 and the form and content requirements of sections 190 and 192 of the EP&A Regulation and the State Significant infrastructure Guidelines – *Preparing an Environmental Impact Statement (Department of Planning, Industry and Environment (DPIE), 2021a)*. A summary of how the SEARs have been addressed in this EIS are provided in Appendix A.

The proposal was referred to the Commonwealth DCCEEW to determine if it is categorised as a controlled action under the EPBC Act and would require approval from the Australian Minister for the Environment and Water. The decision on the referral (024/09939) was made on 17 September 2024. This decision under section 75 of the EPBC Act was that the proposal is not a controlled action.

25.6. Concluding statement

The proposal is needed to improve the efficiency of water management in Billabong Creek by improving the ability to deliver the right amount of environmental and consumptive (town and irrigation) water to the right place at the right time and to improve the passage of native fish through the system. The proposal would assist delivery of improved environmental outcomes compared to current conditions. This would support the aim of the Murray-Darling Basin Plan (the Basin Plan) adopted in November 2012 and NSW DCCEEW's Yanco Creek modernisation program which aims to upgrade of infrastructure to enable smarter use of water in the Yanco Creek system.

In summary the proposal would contribute to the modernisation program through a focus on delivering improved environment outcomes through upgraded infrastructure and smarter use of water. The objectives of the Billabong Creek Regulators proposal are to:

- modernise ageing infrastructure
- provide service for water users
- improve fish passage
- improve delivery of environmental water.

This design of the proposal would meet the objectives listed above while avoiding and minimising impacts on the local and regional environment, and impacts on the local community and businesses, as far as possible.

Measures to minimise the identified potential impacts would be implemented through the design development, construction planning phases, and operation of the proposal, taking into account the input of stakeholders and the local community.

An environmental risk assessment was carried out which considered the likely consequence levels of impacts and how the mitigation measures can reduce the risks. The risk assessment is provided in Appendix D. The proposal has been designed to avoid impacts where possible, and to reflect the findings of the assessments undertaken.

To manage the potential impacts identified by the EIS, and in some cases remove them completely, the assessment chapters outline a range of mitigation measures that would be implemented during design, construction and operation. The majority of the potential construction related impacts would be effectively mitigated by the implementation of best practice management, including the implementation of the environmental management approaches described in chapter 24 (Approach to environmental management and mitigation) and the mitigation measures compiled in Appendix F (Consolidated mitigation measures).

The environmental performance of the project would be managed by implementing the CEMP and Operational Management Plan (see chapter 23), which would also ensure compliance with relevant legislation and any conditions of approval. With the implementation of the proposed mitigation and management measures the potential environmental impacts of the project would be adequately managed.

Lack of full scientific certainty has not been used as a reason to postpone or avoid identification and adoption of design or management measures to avoid or minimise environmental degradation.

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