Submissions Report

Warragamba Dam Raising

Application Number SSI-8441
EPBC ID Number 2017/794

Executive Summary

Project overview

Warragamba Dam is located within the Wollondilly local government area and is approximately 17 kilometres south-south-west of Penrith and 65 kilometres west of the Sydney CBD. To the west are the Blue Mountains, various national parks and state conservation areas, and the Greater Blue Mountains World Heritage Area (GBMWHA), which make up part of the catchment of Lake Burragorang – the water storage formed by Warragamba Dam.

It is proposed to raise the existing wall of Warragamba Dam (the Project) to provide an area above the full supply level to temporarily hold floodwaters in the upstream catchment, and then release them gradually reducing downstream flood peak levels and flood extents. There would be no change to the full supply level and therefore no change to existing maximum volume of water that can be stored for water supply.

The Project comprises the following main activities and elements:

- Demolition or removal of parts of the existing Warragamba Dam, including the existing drum and radial gates
- Thickening and raising of the dam abutments
- Thickening and raising of the central spillway
- New gates to control discharge of water from the flood mitigation zone
- Modifications to the auxiliary spillway
- Operation of the dam for flood mitigation
- Installation of environmental flows infrastructure.

The need for the Project was identified through the work of the Hawkesbury – Nepean Valley Flood Management Task Force which was established to investigate feasible flood options to reduce overall flood risks to the valley. The resulting Flood Strategy, adopted by the NSW Government in June 2016, identified nine outcomes, each supported by actions, a number of which are interrelated. The raising of the Warragamba Dam wall to reduce the flood risk downstream was one of the identified outcomes.

The objective of the Project is to provide flood mitigation in order to reduce the significant existing risk to life and property in the Hawkesbury-Nepean Valley downstream of the dam.

Statutory context

Approval for the Project is sought under Part 5, Division 5.2 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The Project is designated state significant infrastructure (SSI) and requires approval from the Minister for Planning. The Project was designated as Critical SSI by way of an Order published on the NSW legislation website on 14 October 2022.

The Project has been deemed to be a controlled action as it has the potential to impact on Matters of National Environmental Significance (MNES) and requires assessment under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). In accordance with the bilateral agreement reached between the NSW and Commonwealth governments, the Project will be assessed by relevant NSW agencies in the first instance followed by a decision by the Commonwealth Minister for the Environment.

Submission received

The EIS was placed on public exhibition from 29 September 2021 to 19 December 2021 inclusive. A summary of submissions received is provided in the following table.

Table 1 Summary of submissions received

	Object	Support	Comment	Total
Public	2,424	58	44	2,526
Organisation	47	1	5	53
Public authority	4	1	2	7
Total	2,475	60	51	2,586

The following table lists the key issues as identified through the public exhibition process.

Table 2 Key issues raised in submissions

Key issue	Frequency	Proportion (%)
Biodiversity	2034	78.65%
UNESCO World Heritage Area	1296	50.12%
Aboriginal cultural heritage	1182	45.71%
Project justification and alternatives	1152	44.55%
Flooding impacts and risks	849	32.83%
Development in floodplain (including the project enabling more development)	635	24.56%
Social impacts e.g. bushwalking and tourism	247	9.55%
Economic – Cost of proposal	249	9.63%
Engineering feasibility	99	3.83%
Water quality and security management	63	2.44%
Construction traffic	30	1.16%
Construction air	22	0.85%
Construction noise	18	0.70%
Construction impacts on water supply and quality	12	0.46%
Construction social impacts	11	0.43%
European heritage	9	0.35%
Carbon emissions	9	0.35%
Construction blasting	6	0.23%
Impact on soils	3	0.12%

Actions taken since exhibition

The following NSW Government agencies provided advice to DPE in response to the public exhibition of the EIS:

- Department of Planning, Industry and Environment; Environment, Energy and Science Group
- Department of Planning, Industry and Environment; Water/Natural Resources Access Regulator
- Heritage NSW
- Department of Primary Industries (Agriculture)
- Department of Primary Industries (Fisheries)
- Environment Protection Authority
- Sydney Water Corporation
- NSW Health
- Transport for NSW.

Due to the size of the study areas and the complexity of the Project, particularly with regard to the hydrology and the behaviour of flooding and potential effects on the environmental values, WaterNSW engaged with the agencies during the post-EIS exhibition stage. The advice from agencies was to undertake further studies and analysis to provide further detail to specific issues raised in submissions.

WaterNSW has continued to respond to community requests for information received via the Project website. Infrastructure NSW is leading further investigations into flood behaviour of the Hawkesbury-Nepean Valley building on the 2019 *Hawkesbury-Nepean Valley Regional Flood Study*, including further analysis of the 2020 and 2021 flood events that affected the valley. This also included consultation with affected downstream communities from recent flood events.

Purpose of this report

This Submissions Report provides an analysis of the submissions received through the public exhibition of the EIS and responds to all matters raised in submissions received from government agencies and the community. The report also identifies actions taken since the exhibition of the EIS and reviews the justification of the Project considering the issues raised in submissions.

Amendments

Responses to the submissions received have not required a need to change the dam raising configuration to achieve a 14 metre flood mitigation zone, this being the basis of the Project objective to lower the flood risk downstream. A number of submissions proposed alternative solutions for flood mitigation. The responses to these suggestions have outlined their consideration as flood mitigation solutions already considered through the extensive options assessment work undertaken by the Taskforce since 2013 and reassessed for the EIS.

The Project design outlined in the EIS proposed the use of gates or slots to control the release of water. Flood modelling that forms the basis of the design and the flood extents in the EIS was based on the use of gates positioned well below the sill of the central spillway crest. A slot option for discharging the flood mitigation zone has been removed from the project description as it was not considered in the flood modelling

The EIS offset strategy is amended to deliver biodiversity offsets management actions that will deliver a biodiversity benefit on-park equivalent to the biodiversity credits to be retired on national parks estate and areas within Greater Blue Mountains World Heritage Area or an adjacent or proximate national park or reserve

Supplementary investigations

As part of preparation of the Submissions Report and Preferred Infrastructure Report, further work has been carried out to build upon the findings of the assessment presented in the EIS and to clarify aspects of the environmental assessment in response to issues raised in submissions. These are listed in the following table.

Table 3 Supplementary investigations

Aspect	Description	Where provided
Groundwater	Expert technical review of issues raised by DPIE Water	SR: Appendix E
Socioeconomic	Assessment of property buyback options	SR: Appendix F
Geomorphology	Downstream bank stability Downstream erosion and sediment movement Sediment movement through upstream waterways	SR: Appendix G
Contaminated land	Supplementary contaminated land assessment for construction area	SR: Appendix H
Aboriginal heritage	Supplementary assessment to Aboriginal cultural heritage assessment report (Appendix K to the EIS) Includes additional assessment of potential impacts of temporary inundation on the physical values of heritage sites using Longneck Lagoon as a case study	PIR: Appendix F
Flooding and hydrology	Supplementary assessment incorporating additional information including March 2021 flood	PIR: Appendix D
Biodiversity	Additional assessment of potential impacts of temporary inundation on biodiversity values using Longneck Lagoon as a case study	PIR: Appendix E
Non-Aboriginal heritage	Supplementary assessment for State-listed item Megarritys Bridge and for four NPWS section 170 sites in the upstream area	SR: Appendix I PIR: Appendix G
	Archaeological research design	PIR: Appendix H
Sustainability	Revised infrastructure sustainability rating assessment	PIR: Appendix I

Conclusion

There has been an extensive objective, comprehensive, technically robust process for the identification and evaluation of all practicable options and alternatives that has led to the preferred option of raising Warragamba Dam to achieve the objective of reducing risk to life and property in the Hawkesbury-Nepean Valley. This has considered a wide range of factors including socio-economic, environmental and cultural heritage issues which have informed evaluation and refinement of options, and informed decision-making with regard to discarding options and further consideration of options through the evaluation and assessment process.

The principal benefits of the Project are:

- A significant reduction in flood heights and extents for the critical range of major floods events. For example, for the 1 in 100 chance in a year flood, a reduction of flood heights of about 5.2 metres at Penrith, 3.1 metres at Richmond and 4.1 metres at Windsor
- A significant reduction in the number of residential properties impacted by flooding in the critical range of major floods events. For example, for the 1 in 100 chance in a year flood there would an estimated reduction of 5,180 properties (68 percent reduction)
- Flood damage estimates would typically be reduced by approximately 74 to 80 percent for floods up to about the 1 in 200 chance in a year event, reducing to approximately 50 percent for a 1 in 2,000 year chance in a year event
- Increased opportunities for evacuation as evacuation routes would experience less flooding and a longer period before closure due to flooding. For example, for the 1 in 100 chance in a year flood the Windsor Bridge crossing would remain open for an additional 18 hours
- A reduction in the risk to life due to reduced flooding extents and greater evacuation opportunities
- Potentially lower flood insurance premiums for some residential and commercial premises.

The Project is considered to be consistent with the principles of ecologically sustainable development. Additional investigations carried out during preparation of the Submissions Report and the Preferred Infrastructure Report have clarified some aspects of the assessment presented in the EIS. These further investigations suggest the precautionary approach adopted for some aspects of the assessment may have been overly conservative, and that some assumed impacts, such as the total loss of environmental values in the upstream impact area, may not actually be realised. Regardless of this inherent conservatism, the mitigation strategies proposed and offset strategies for biodiversity and protected lands provide a robust framework to safeguard against potential environmental impacts associated with the Project.

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Glossary

Acronym/term	Definition
ACH	Aboriginal cultural heritage
ACHA	Aboriginal cultural heritage assessment
ACHMP	Aboriginal Cultural Heritage Management Plan
AHIMS	Aboriginal Heritage Information Management System
AIP	NSW Aquifer Interference Policy
BAR	Biodiversity assessment report
BC Act	*Biodiversity Conservation Act 2016* (NSW)
BOM	Bureau of Meteorology
BOS	Biodiversity offset strategy
BP	Before present
CEMP	Construction environmental management plan
CLM Act	*Contaminated Land Management Act 1997*
CNVMP	Construction Noise and Vibration Management Plan
CVA	Cultural values assessment (as part of the ACHA)
DAWE	Department of Agriculture, Water and the Environment (Commonwealth); this became DCCEEW on 1 July 2022
DCCEEW	Department of Climate Change, Energy, the Environment and Water (Commonwealth)
DoEE	Department of the Environment and Energy (Commonwealth); this became DAWE on 1 February 2020
DPE	Department of Planning and Environment (NSW) (formerly DPIE)
DPI	Department of Primary Industries
DPIE	Department of Planning, Industry and Environment (NSW)
EEC	Endangered ecological community
EES	Environment, Energy and Science Group, DPE
EIS	Environmental impact statement
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EPL	Environment protection licence
EUIA	Existing upstream impact area
FBA	Framework for biodiversity assessment
FESM	Fire Extent and Severity Mapping
FMZ	Flood mitigation zone
FSL	Full supply level
GBMWHA	Greater Blue Mountains World Heritage Area

Acronym/term	Definition
GILUA	Gundungurra Indigenous Land Use Agreement
GL/d	gigalitres per day
HHMS	Historic Heritage Management System
ICOMOS	International Council on Monuments and Sites
ILUA	Indigenous Land Use Agreement
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
LOS	Level of Service
LSC	Lapstone Structural Complex
mAHD	metres Australian Height Datum
mbgl	metres below ground level
ML/d	megalitres per day
MNES	Matter(s) of National Environmental Significance
NPW Act	*National Parks and Wildlife Act 1974* (NSW)
NPWS	National Parks and Wildlife Service
NVIA	Noise and Vibration Impact Assessment
OEH	Office of Environment and Heritage
OUV	Outstanding Universal Value
PCT	Plant community type
PIR	Preferred Infrastructure Report
PMF	Probable maximum flood
POEO Act	*Protection of the Environment Operations Act 1997* (NSW)
PSI	Preliminary Site Investigation
PUIA	Project upstream impact area
RAP	Registered Aboriginal Party
RSA	Road safety audit
SAQP	Sampling, Analysis and Quality Plan
SCARISS	Sydney Catchment Aquatic Real-time Information Support System
SCARMS	Sydney Catchment Aquatic Real-time Management System
SEARs	Secretary's environmental assessment requirements
SEPP	State Environmental Planning Policy
SSI	State Significant Infrastructure
SSTF	Shale Sandstone Transition Forest
TEC	Threatened ecological community
TMP	Traffic Management Plan

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Introduction

1 Introduction

1.1 Project overview

An Environmental Impact Statement (EIS) was prepared to assess the Impacts, and identify measures responding to those impacts, of the raising of Warragamba Dam (the Project). The dam is located within the Wollondilly local government area and is approximately 17 kilometres south-south-west of Penrith and 65 kilometres west of the Sydney CBD. To the west of the Project site are the Blue Mountains, various national parks and state conservation areas, and the Greater Blue Mountains World Heritage Area (GBMWHA), which make up part of the catchment of Lake Burragorang – the water storage formed by Warragamba Dam. To the east of the Project site are the Warragamba and Silverdale townships and surrounding rural residential areas. Warragamba River flows from the dam and enters the Nepean River approximately 3.5 kilometres downstream of the dam wall.

The need for the Project was identified through the work of the Hawkesbury – Nepean Valley Flood Management Task Force which was established to investigate feasible flood options to reduce overall risks to the valley. It came out of a long history of awareness of a flood risk in the valley, with more knowledge and understanding gained in recent decades from further investigations and flood experiences elsewhere. The resulting Flood Strategy, adopted by the NSW Government in June 2016, identified nine outcomes, each supported by actions, a number of which are interrelated. The raising of the Warragamba Dam wall to reduce the flood risk downstream was one of the identified outcomes.

Raising the wall would provide an area above the full supply level (FSL) to temporarily hold floodwaters from the upstream catchment, and then release them gradually reducing downstream flood peak levels and flood extents. There would be no change to the FSL and therefore no change to existing maximum volume of water that can be stored for water supply.

The objective of the Warragamba Dam Raising Project is to provide flood mitigation in order to reduce the significant existing risk to life and property in the Hawkesbury-Nepean Valley downstream of the dam. This would be achieved through raising the dam structure. Specifically, the proposal comprises raising:

1	2	3
The level of the central spillway crest by around 12 metres above the existing FSL	**The auxiliary spillway crest by around 14 metres above the existing FSL**	**The dam side walls (abutments) and roadway by 17 metres**

The opportunity would also be taken to install the physical infrastructure to allow for management of environmental flows as outlined in the NSW Government's 2017 *Metropolitan Water Plan*. However, the actual environmental flow releases do not form part of the Project (and in any case such releases would not occur during flood operations) and are subject to administration under the *Water Management Act 2000* (WM Act).

The Project comprises the following main activities and elements:

- Demolition or removal of parts of the existing Warragamba Dam, including the existing drum and radial gates
- Thickening and raising of the dam abutments
- Thickening and raising of the central spillway
- New gates to control discharge of water from the flood mitigation zone (FMZ)
- Modifications to the auxiliary spillway
- Operation of the dam for flood mitigation
- Environmental flows infrastructure.

The proposed works in the EIS have not altered in response to submissions other than the addition of one row of concrete baffles blocks on the floor of the dissipator. These are required to further reduce the amount of energy in the discharged water after it is released from the dam but do not influence the amount of water discharged as controlled by the outlet gates.

A layout of the proposed works is shown in the design drawings provided as Appendix A to the Preferred Infrastructure Report (PIR).

The Secretary's Environmental Assessment Requirements (SEARs), prepared in response to the preliminary environmental assessment (December 2016) directed that the Project consider and be responsive to the implications of climate change. Peer-reviewed climate change research found that by 2090 it is likely an additional three metres of spillway height would be required to provide similar flood mitigation outcomes to the current proposed flood mitigation proposal. Raising the dam side walls and roadway by an additional three metres may not be feasible in the future, both in terms of engineering constraints and cost. As a result, some elements of the design are proposed with a 17 metre height increase to enable adaptation to projected climate change. Any consideration of raising spillway heights above the currently proposed height is unlikely before the mid to late 21st century and would be subject to a separate planning approval process

WaterNSW undertook specific further studies, investigations and analysis in response to agency advice and issues raised from the exhibition of the EIS. This further work has enabled further detail and evidence to be included for consideration by agencies in their assessment of impacts as described in the EIS and included in the report or the PIR.

1.2 History of options development and assessment

Investigation of options to mitigate downstream flood risk dates from the 1990s with the proposal to raise Warragamba Dam by 23 metres (which was subsequently abandoned). Further work was done between 1997 and 2004 with the implementation of the Hawkesbury-Nepean Floodplain Management Strategy.

The options assessment for reducing the risk to life and property in the Hawkesbury-Nepean Valley presented in Chapter 4 of the EIS is a continuation of work undertaken by NSW Government since 2012. The Hawkesbury-Nepean Valley Flood Management Review concluded that no single mitigation option can address the flood risk precent in the valley with raising Warragamba Dam to temporarily capture flood waters being the only infrastructure option that significantly reduces flood risk.

In 2014, further work was undertaken by the Hawkesbury-Nepean Flood Management Taskforce with its recommendations incorporated into the Flood Strategy released in 2017. The Flood Strategy included nine infrastructure and non-infrastructure measures with raising Warragamba Dam being the recommended Outcome 2 to be led by WaterNSW.

A general chronology of the identification and assessment of options since 2012 is presented in the timeline on the following page.

A RANGE OF FLOOD MITIGATION OPTIONS ARE INVESTIGATED

2012

DECEMBER 2012
NSW Government accepts the State Infrastructure Strategy 2012-2032 recommendation to review flood mitigation options for the Valley, including raising Warragamba Dam

MARCH 2012
Warragamba Dam spills for the first time since 1998

2013

2013
The Hawkesbury-Nepean Valley Flood Management Review is conducted. It finds there is no single solution to managing the flood risk but that raising Warragamba Dam is the only viable infrastructure solution

2014

2014
The Hawkesbury-Nepean Valley Flood Management Taskforce is formed to advance the work of the 2013 Review, including developing key elements of the Hawkesbury-Nepean Valley Flood Risk Management Strategy

2016

2016
NSW Government adopts the Taskforce's recommendations, including its preferred infrastructure solution of raising Warragamba Dam

2017

MAY 2017
Hawkesbury-Nepean Valley Flood Risk Management Strategy is released, delivering nine outcomes for flood risk mitigation. Outcome 2 is to reduce flood risk in the Valley by raising Warragamba Dam

2017 – 2021
Environmental impact assessment and detailed concept design undertaken for proposal to raise Warragamba Dam

2019

2019
Options Assessment Report produced, detailing investigation of project alternatives

2021

29 SEPTEMBER 2021 – 19 DECEMBER 2021
The Environmental Impact Statement for the proposed Warragamba Dam Raising Project is publicly exhibited

MARCH 2021
Damaging flood event in the Hawkesbury-Nepean Valley

2022

NOVEMBER 2022
Submissions Report and Preferred Infrastructure Report submitted to NSW Department of Planning and Environment for assessment

MARCH 2022
Damaging flood event in the Hawkesbury-Nepean Valley

JULY 2022
Damaging flood event in the Hawkesbury-Nepean Valley

Project delivery

1.3 Statutory context and planning approval process

The Project is subject to NSW and Commonwealth legislation.

WaterNSW is a New South Wales state-owned corporation and is the owner and operator of Warragamba Dam. WaterNSW was requested by the NSW Government to seek project planning approval for the Warragamba Dam Raising Project (the Project), including the installation of the infrastructure to provide for improved management of environmental flow releases.

The approval for the Project is sought under Part 5, Division 5.2 of the NSW EP&A Act. The Project is designated state significant infrastructure (SSI) and requires approval from the Minister for Planning. Any SSI project may also be declared to be Critical State Significant Infrastructure (CSSI) under section 5.13 of the EP&A Act if it is of a category that, in the opinion of the Minister for Planning, is essential to NSW for economic, environmental or social reasons. The Project was designated as CSSI by way of an Order published on the NSW legislation website on 14 October 2022[1].

The Project has been deemed to be a controlled action (ref 2017/7940) as it has the potential to impact on Matters of National Environmental Significance (MNES), and as such requires assessment under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). In accordance with the bilateral agreement reached between the NSW and Commonwealth governments, an EIS under the EP&A Act for SSI can also be used for an EIS under the EPBC Act for a controlled action where directed by the Commonwealth Minister for the Environment. The direction was given for the Project to be assessed under the bilateral agreement on 17 July 2017. The Project will be assessed by relevant NSW agencies in the first instance followed by a decision by the Commonwealth Minister for the Environment.

A preliminary environment assessment was provided to the Secretary of the then Department of Planning, Industry and Environment[2] (DPIE) and Secretary's Environmental Assessment Requirements (SEARs) were issued on 30 June 2017. The SEARs were reissued on 13 March 2018 and included clarifications relating to the EPBC Act assessment requirements and detailed downstream assessment requirements. The SEARs are provided in the EIS at Appendix A. The EIS was placed on public exhibition from 29 September 2021 to 19 December 2021 inclusive.

Provisions within the following NSW State legislation and statutory instruments are also relevant to the Project and are addressed in the EIS:

- *Dams Safety Act 2015*
- *Fisheries Management Act 1994*
- *National Parks and Wildlife Act 1974* (NPW Act)
- *Protection of the Environment Operations Act 1997* (POEO Act)
- *Threatened Species Conservation Act 1995*[3] (TSC Act)
- *Water Management Act 2000*
- *Wilderness Act 1987*

1 https://legislation.nsw.gov.au/view/pdf/asmade/sl-2022-617

2 DPIE was renamed the Department of Planning and Environment (DPE) in December 2021.

3 The TSC Act was repealed when the *Biodiversity Conservation Act 2016* commenced on 25 August 2017. However, the provisions of the Biodiversity Conservation (Savings and Transitional) Regulation 2017 provide for SSI projects to be assessed under the provisions of the TSC Act if the application for the SEARs was made prior to this date. The SEARs for the Project were initially issued on 30 June 2017 meeting this requirement.

- State Environmental Planning Policy (State and Regional Development) 2011[4]
- State Environmental Planning Policy (infrastructure) 2007[5] (Infrastructure SEPP)
- State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011[6]
- Sydney Regional Environmental Plan No. 20 – Hawkesbury – Nepean River (No. 2 – 1997)[7]
- Wollondilly Local Environmental Plan 2011.

The Commonwealth *Native Title Act 1993* is also relevant to the Project.

The Project would require the following statutory approvals, consents and licences to proceed:

Assessment and approval by the NSW Minister for Planning under Part 5, Division 5.2 of the EP&A Act	**Assessment and approval by the Commonwealth Environment Minister under the EPBC Act**	**An Environment Protection Licence (EPL) for construction of the Project issued under section 43 of the POEO Act for regulating water pollution**	**Changes to the existing water supply works and water use approval under the *Water Management Act 2000* for the modified operation of the dam**

Details of these, and the application of State and Commonwealth legislation, are provided in Chapter 2 *Statutory and planning framework* of the EIS.

State Environmental Planning Policy (Infrastructure) 2011

In its advice to WaterNSW, DPE requested that clarification be provided regarding the applicability of clause 125(2)(b) of State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP) to the Project, as the clause refers to water storage facilities, while the Project relates to flood mitigation.

Chapter 2 *Statutory and planning framework* of the EIS identifies more than one pathway for the Project under the Infrastructure SEPP. Although the primary purpose is for flood mitigation there is modification to the water storage structure to enable the purpose. Chapter 2 identifies that the proposal can be characterised as 'development for the purposes of a water storage facility' or for 'flood mitigation' as possible pathways.

Clause 125(2)(b) of the Infrastructure SEPP provides

> *(2) Development for the purpose of water storage facilities may be carried out without consent if it is carried out by or on behalf of—*

4 State Environmental Planning Policy (State and Regional Development) 2011 was repealed on 1 March 2022 with the relevant provisions pertinent to the Project transferred to State Environmental Planning Policy (Planning Systems) 2021.

5 State Environmental Planning Policy (infrastructure) 2007 was repealed on 1 March 2022 with the relevant provisions pertinent to the Project transferred to State Environmental Planning Policy (Transport and Infrastructure) 2021.

6 State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 was repealed on 1 March 2022 with the relevant provisions pertinent to the Project transferred to State Environmental Planning Policy (Biodiversity and Conservation) 2021.

7 Sydney Regional Environmental Plan No. 20 – Hawkesbury – Nepean River (No. 2 – 1997) was repealed on 1 March 2022 with the relevant provisions pertinent to the Project transferred to State Environmental Planning Policy (Biodiversity and Conservation) 2021.

(b) *Water NSW on land within the Sydney catchment area within the meaning of the Water NSW Act 2014.*

Clause 124 of the Infrastructure SEPP provides

In this Division—

water storage facility, ***water supply system*** *and* ***water treatment facility*** *have the same meanings as in the Standard Instrument.*

The Standard Instrument provides that a 'water storage facility' is a type of water supply system.

Clause 49 of the Infrastructure SEPP provides that flood mitigation work has the same meaning as it has in the Standard Instrument namely

…work designed and constructed for the express purpose of mitigating flood impacts. It involves changing the characteristics of flood behaviour to alter the level, location, volume, speed or timing of flood waters to mitigate flood impacts. Types of works may include excavation, construction or enlargement of any fill, wall or levee that will alter riverine flood behaviour, local overland flooding, or tidal action so as to mitigate flood impacts.

The Project involves raising the wall of Warragamba Dam to mitigate downstream flooding so more appropriately sits under this clause. As per clause 50(1), development for the purpose of flood mitigation work may be carried out by or on behalf of a public authority without consent on any land. The equivalent provisions under State Environmental Planning Policy (Transport and Infrastructure) 2021 sit in Part 2.3 Development controls, Division 7 Flood mitigation work.

WaterNSW confirms that clause 49(1) is the more appropriate clause with regard to the Project.

1.4 Purpose and structure of the Submissions Report

This Submissions Report provides an analysis of the submissions received through the public exhibition of the EIS and responds to matters raised in submissions received from government agencies and the community. This Submissions Report also identifies actions taken since the exhibition of the EIS and reviews the justification of the Project in light of consideration of the issues raised in submissions.

The following table describes the structure and content of this report.

Table 1-1 Structure of the Submissions Report

Chapter/Appendix	Description
1 Introduction	Provides an overview of the Project, and the statutory context and planning approval process.
2 Analysis of submissions	Provides a summary of the submissions received from the public exhibition of the EIS including the number of submissions, types of submitters, and the issues raised.
3 Actions taken since exhibition	Describes actions taken by WaterNSW following exhibition of the EIS, including further consultation.
4 Response to Government submissions	Detailed consideration of advice provided by NSW Government agencies.
5 Response to public authority submissions	Detailed consideration of issues raised by public authorities (as categorised on the Major Projects website).
6 Response to community submissions	Detailed consideration of issues raised by individuals, businesses, community groups and business groups.
7 Clarification and corrections	Clarifications and corrections identified by WaterNSW subsequent to the exhibition of the EIS, and in submissions.
8 Project justification	Provides further consideration of justification of the Project with reference to consideration of issues raised in submissions.
9 References	List of references cited in the Submissions Report.
Appendix A: Submissions register	List of submissions received in response to exhibition of the EIS organised as follows: • NSW government agencies and other public authorities • Community submissions Individual community submissions are identified by the submission number assigned by DPE together with issues raised in the submission which are separately cross-referenced to where each issue is addressed in the Submissions Report.
Appendix B: Revised environmental management measures	Updated set of environmental management measures identifying changes made through clarifications, minor changes or responses to submissions.
Appendix C: Australia ICOMOS and IUCN submissions	Consideration of issues raised in Australia ICOMOS and IUCN submissions, and supplementary assessment of World Heritage matters.
Appendix D: Outline Construction Environmental Management Plan	Draft Table of Contents for CEMP
Appendix E: Expert Groundwater Technical Report Memorandum	Expert technical review of DPE Water comments related to groundwater assessment
Appendix F: Assessment of buyback options	Assessment of buyback options for flood-affected downstream properties.

Chapter/Appendix	Description
Appendix G: Supplementary geomorphology assessment	Additional investigations for downstream bank stability, downstream sediment movement and upstream sediment movement
Appendix H: Supplementary contaminated land assessment	Preliminary Site Investigation report and Sampling and Analysis Quality Plan
Appendix I: Supplementary non-Ab original heritage assessment	Assessment of four sites on NPWS Section 170 heritage register and additional assessment of potential impacts on Megarrity's Bridge.

Attachment A to DPE's letter of 17 January 2022 identified specific matters to be addressed in the Submissions Report and/or PIR as appropriate. These are identified in Table 1-2 together with a response to the respective matter.

Table 1-2 DPE requirements for Submissions Report and PIR

DPE requirement	Response
Documentation	
Review for consistency required. Different figures have been used in different sections of the document. For example, inconsistent figures for number of evacuations required in different scenarios.	Clarifications and corrections are provided in Section 7 of this report.
Data is marked as being sourced from the *Hawkesbury-Nepean Valley Flood Risk Management Strategy* (2017), but the figures differ from those presented in the strategy. The source of the data needs to be clarified.	Other key information sources: • Hawkesbury-Nepean Valley Flood Risk Management Strategy Taskforce Options Assessment Report (Infrastructure NSW 2019a) • Hawkesbury-Nepean Valley Regional Flood Study Final Report (Infrastructure NSW 2019b)
The SR and PIR must assess the upstream and downstream impacts of the proposal equally to provide a clear understanding of the balance between the positive and negative impacts of the proposal for purposes of assessment.	SR: Section 8 PR: Section 6
Review for accuracy of citations used through the document to ensure citation has occurred where required, and that citations are correct.	Review of citations has been undertaken.
Statements that suggest field surveys, or methodological approaches were not feasible should include a supporting justification stating reasons why.	Provided as appropriate in responses.
Statutory and Planning Framework	
The SR and PIR must clarify the applicability of Clause 125(2)(b) of the State Environmental Planning Policy (Infrastructure) 2011 to the proposal, as the clause refers to water storage facilities, while the proposal relates to flood mitigation.	SR: Section 1.3 PIR: Section 4

DPE requirement	Response
Project Need	
Large sections of Chapter 3 of the EIS appear to be copied from the Hawkesbury-Nepean Valley Flood Risk Management Strategy (2017), but this is not attributed in the document. The source of this section should be clarified.	The Flood Strategy is the primary strategic planning document as identified in Section 3.1.1 in Chapter 3 of the EIS and forms the basis of the discussion in this chapter. The Warragamba Dam Raising is one of nine outcomes identified in the Strategy. Other key information sources: • Hawkesbury-Nepean Valley Flood Risk Management Strategy Taskforce Options Assessment Report (Infrastructure NSW 2019a) • Hawkesbury-Nepean Valley Regional Flood Study Final Report (Infrastructure NSW 2019b)
Project Development and Alternatives	
The options presented are based on a proposal CIV of approximately $600 million, however the project CIV has been updated in the Department's system to show a CIV of more than $1.3 billion. The complete options analysis presented must be reviewed and updated to reflect the revised project costings.	As described in Chapter 4 of the EIS, the detail of options analysis presented had already been reviewed, reassessed and updated to align with the project costings in the EIS.
Are all possible variables considered and included within the chosen dam option? For example, a 'plunge pool' is identified as potentially being required which would increase spoil to be removed for "Erosion Protection" from 30,000m3 to 670,000m3. The SR and PIR must address all impacts of the increase of spoil removal if this option is to be progressed.	PIR: Section 3
Project Description	
The Project Description should be reviewed and updated including, where required, relevant figures. For example, Figure 5-4 of the EIS shows a bridge below the lower dissipater slab of the dam. Figure C-5 of Appendix L does not appear to show a bridge in the same location, but further down the river.	PIR: Section 3 and Appendix A

2

Analysis of submissions

2 Analysis of submissions

2.1 Submissions received

A summary of submissions received is provided in the following table.

Table 2-1 Summary of submissions received

	Object	Support	Comment	Total
Public	2,424	58	44	2,526
Organisation	47	1	5	53
Public authority	4	1	2	7
Total	2,475	60	51	2,586

As noted in the clarification by DPE (dated 18 February 2022) regarding submissions received:

> *This report on submissions previously contained an inaccuracy which has been amended.*
>
> *Five hundred and nineteen (519) emails or hard copy submissions were referred to as 'feedback'. The Department is treating all issues raised during exhibition as submissions and the summary of submissions contained within the amended Submissions Summary below dated 15 February 2022 has been updated to clarify this.*

DPE has advised WaterNSW that the issues raised in these submissions have been captured in the summary provided in Attachment B (Amended Warragamba Submissions Summary – Key Issues) to DPE's letter of 17 January 2022. Copies of these submissions have not been provided to WaterNSW.

2.2 Analysis of submissions

The following table lists the key issues as identified in Attachment B (Warragamba Dam – Submissions Summary) to DPE's letter of 17 January 2022[8].These are also presented graphically in Figure 2-1. These issues have been considered in

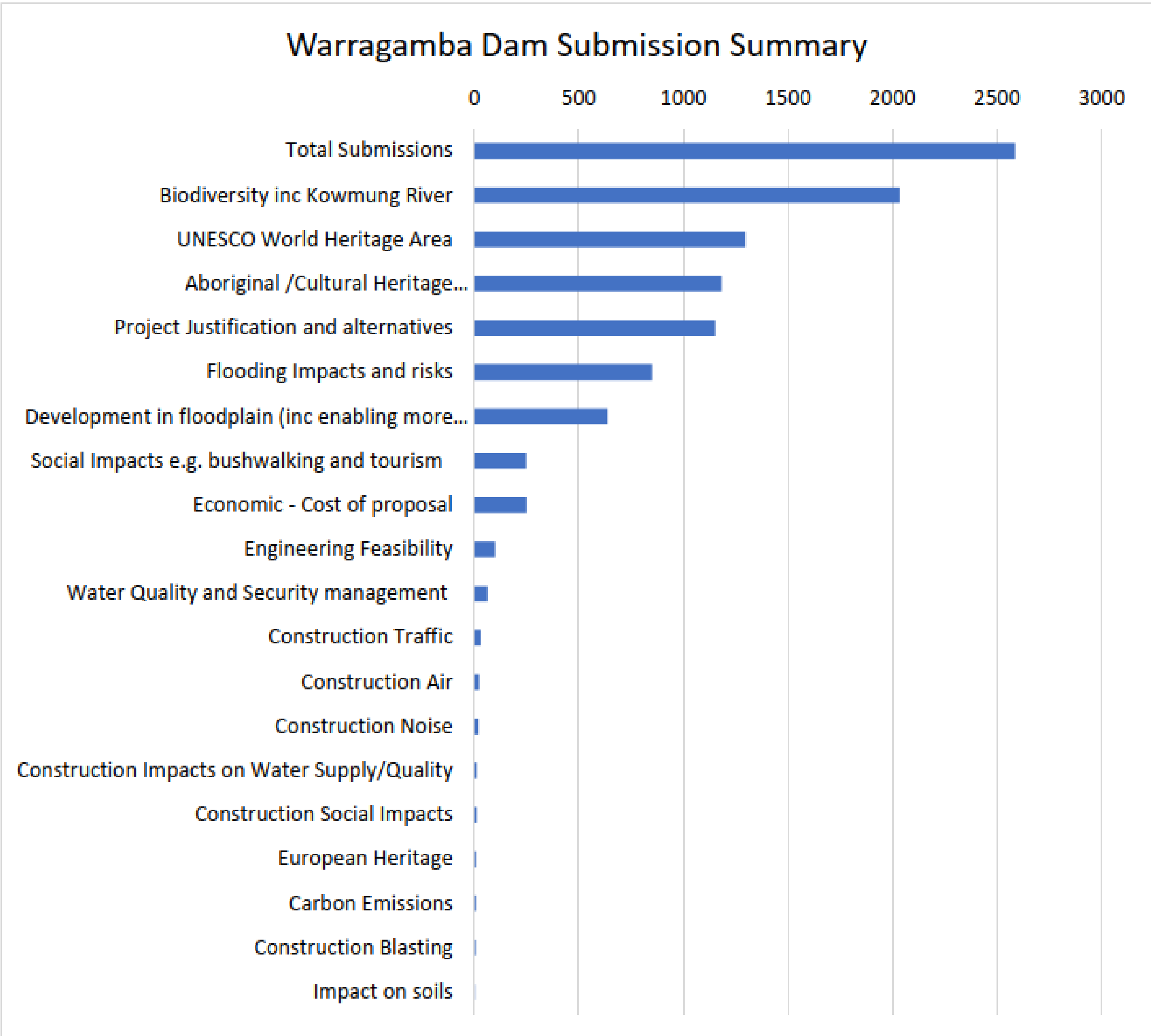
Table 2-2 Key issues raised in submissions

Key issue	Frequency	Proportion (%)
Biodiversity	2034	78.65%
UNESCO World Heritage Area	1296	50.12%
Aboriginal cultural heritage	1182	45.71%
Project justification and alternatives	1152	44.55%
Flooding impacts and risks	849	32.83%
Development in floodplain (including the project enabling more development)	635	24.56%
Social impacts e.g. bushwalking and tourism	247	9.55%

8 An amendment to the Submissions Summary was issued by DPE on 18 February 2022. The list of key issues was unchanged in this amendment.

Key issue	Frequency	Proportion (%)
Economic – Cost of proposal	249	9.63%
Engineering feasibility	99	3.83%
Water quality and security management	63	2.44%
Construction traffic	30	1.16%
Construction air	22	0.85%
Construction noise	18	0.70%
Construction impacts on water supply and quality	12	0.46%
Construction social impacts	11	0.43%
European heritage	9	0.35%
Carbon emissions	9	0.35%
Construction blasting	6	0.23%
Impact on soils	3	0.12%

Figure 2-1 Key issues raised in submissions



2.3 Summary of key issues raised

2.3.1 Project need and justification

Key issues raised with regard to Project need and justification related to:

- Modelling of stated flooding and economic benefits: This modelling was not provided in the EIS to confirm those benefits
- Downstream development: The Project is being progressed to enable planned future development in the floodplain that will provide economic outcomes
- Purpose of dam: The dam was designed as a water supply infrastructure and was not designed to provide flood mitigation, as well as the additional water storage provided by the Project will in future be used for water supply and not for flood mitigation
- Justification: The overall justification for the Project being to enable and support urban development in a known flood prone area, that dam wall raising is an outdated response to flood risk, and that the decision to raise the dam had already been made.
- Project cost: The Project has a high stated cost that will increase as the Project progresses but will cause environmental harm, with limited targeted benefit
- Historical proposal for dam wall raising: The previous proposal to raise the dam wall, with associated EIS, was subsequently abandoned.

2.3.2 Alternatives to the Project

Key issues raised with regard to alternatives to the Project related to:

- Adequacy of assessment of alternatives: Alternatives to the Project were not adequately assessed, individually or as a combination of actions, nor was the cost-benefit analysis of alternatives including environmental benefits compared to the Project, fully considered
- Property buybacks: Properties at risk of flooding should be acquired, with land re-used for recreational open space and/or agricultural uses
- Evacuation routes: Existing roads providing evacuation routes should be upgraded
- Lower the full supply level: The full supply level should be lowered to provide capacity for temporary storage of flood waters. The reduced water supply capacity could be addressed through other water sources such as desalination plants
- Limit development in floodplains: To amend planning controls in floodplains to limit new development that can be undertaken in those areas and so manage the future quantum of people and property at risk of flood events
- Water diversion: To divert flood waters to avoid urban areas or bottlenecks formed by downstream topography
- Dam operation: To alter the operation of the existing dam to manage potential flood events, such as by early controlled releases
- Flood forecasting and preparedness: To upgrade capabilities for flood forecasting, warning systems, preparedness, and response measures.

2.3.3 Flooding impacts and risks

Key issues raised with regard to flooding impacts and risks related to:

- Contribution of the Warragamba catchment to downstream flooding: Over 45 percent of floodwaters are derived from outside of the Warragamba catchment

- Flood modelling: The Rubicon model used for flood modelling has been superseded and there are limitations with the Monte Carlo modelling that will affect the modelled downstream flood risk
- Nepean catchment: The Nepean catchment can make a significant contribution to flooding in the Hawkesbury-Nepean Valley and this flood risk should be considered separately to the Warragamba catchment
- Downstream river systems and environmental flows: Floodplains are important components of river systems and flood events are important to them. Downstream river systems will be impacted by reduced water flows in the rivers, and the subsequent release of stored flood waters to flood affected areas will extend inundation periods and affect river ecosystems
- Upstream inundation: Inundation of the upstream area will detrimentally impact vegetation, ecosystems, hydrology and landscape. There is no formal mechanism on the time limit on upstream inundation and impacts of extended inundation (beyond two-weeks) have not been assessed
- Groundwater systems: Detrimental impacts to groundwater systems including soil infiltration, aquifer recharge opportunities, water table changes affecting dam structure stability and contribute to surface water runoff from urban areas.

2.3.4 Development on the Hawkesbury-Nepean floodplain

Key issues raised with regard to development on the Hawkesbury-Nepean floodplain related to:

- Downstream development: Being the existing development and the planned future development, as justification for the Project
- Existing downstream development: Development of housing in the flood prone areas should not have been permitted and is not appropriate. The Project will give residents a false sense of security of future flood risk.

2.3.5 World Heritage

Key issues raised with regard to World Heritage related to:

- World Heritage listing: The Project will impact the Outstanding Universal Value of the World Heritage Area that may affect its listing, and damage to the World Heritage area is unacceptable
- Reputation and precedent: The World Heritage area is protected however the Project goes against those protections, the expectations of the Australian and international community, and the principles of managing a World Heritage property. If the Project proceeds it establishes a precedent for other projects that would impact protected land.

2.3.6 Biodiversity

Key issues raised with regard to biodiversity related to:

- Impacts on biodiversity and loss of habitat: The assessment undertaken was insufficient to fully assess impacts of the Project on biodiversity and habitats
- Threatened and endangered species and ecological communities: The impact will impact on threatened and endangered species and ecological communities, with surveys and assessments undertaken being inadequate
- Impacts on specified species: The impact on various specified species of fauna, and the adequacy of the assessment undertaken on those species

- Regent Honeyeater: The impact on the individuals and habitat, including breeding habitat, of the Regent Honeyeater, and the contradiction given the investment though the National Recovery Plan by Government to support the species
- Aquatic species and riparian habitats: The impacts on fish and other aquatic species, and on riparian habitats
- Additional surveys following the 2019-2020 bushfires: No survey was undertaken following the 2019-20 bushfires to assess the impacts of that fire event on biodiversity
- Invasive or introduced species: The potential for weed and exotic plants and introduced animals to intrude into areas disturbed through the Project.

2.3.7 Biodiversity offset strategy

Key issues raised with regard to the biodiversity offset strategy related to:

- Offsets for the Regent Honeyeater: the adequacy of offsets for the Regent Honeyeater
- Offsets for the World Heritage area: the adequacy of offsets for World Heritage areas given the international significance and value of these areas
- Offsets for biodiversity impacts generally: the adequacy and ability to offset for biodiversity impacts, the cost of providing offsets and the calculation method for offsets.

2.3.8 Aboriginal cultural heritage

Key issues raised with regard to Aboriginal cultural heritage related to:

- Survey extent: Only 27% of the impact area was assessed for Aboriginal cultural heritage
- Consultation: Traditional owners have not been adequately consulted in the assessment of potential impacts to Aboriginal cultural heritage
- Consent for the Project: Traditional owners have not given consent for the Project
- Potential impacts to cultural sites and places and the number of sites: The Project will detrimentally impact on, resulting in the loss of, Aboriginal sites, places and cultural values.

2.3.9 Non-Aboriginal heritage

Key issues raised with regard to non-Aboriginal heritage related to:

- Identification of heritage places and values: the inadequate consideration of non-Aboriginal heritage in the impact assessment and lack of recognition of some social and built heritage values.

2.3.10 Water quality and water supply security

Key issues raised with regard to water quality and water supply security related to:

- Water quality: The quality of water in the river systems due to pollution, contamination, erosion and siltation, turbidity and eutrophication effects
- Water supply security: To utilise alternative water supply sources to provide water supply needs instead of raising the dam wall and enabling the full supply level to be reduced to provide the flood storage capacity.

2.3.11 Construction impacts

Key issues raised with regard to construction impacts related to:

- Construction traffic: The impact of heavy construction vehicles on local roads, affecting noise congestion, safety, access, safety and amenity for residents and causing damage to local roads
- Other construction impacts: The impact of construction activities on air quality, noise, and enjoyment of the area by residents, as well as increased risk of crime and reduced tourism as a result of construction works.

3

Actions taken since exhibition

3 Actions taken since exhibition

3.1 Consultation with agencies during preparation of the Submissions Report

The following NSW Government agencies made submissions to the public exhibition of the EIS:

- Department of Planning, Industry and Environment; Environment, Energy and Science Group[9]
- Department of Planning, Industry and Environment; Water/Natural Resources Access Regulator
- Heritage NSW
- Department of Primary Industries (Agriculture)
- Department of Primary Industries (Fisheries)
- Environment Protection Authority (EPA)
- Sydney Water Corporation
- NSW Health
- Transport for NSW (TfNSW).

The submissions provided advice on a range of matters. Subsequently, WaterNSW engaged with a number of these agencies (or groups within them) to discuss specific issues raised in submissions, to advise further work being undertaken in response to various issues, and the outcomes of this work. The following is a summary of this consultation.

DPE Planning was invited to all agency meetings to attend as observers and to understand the process behind the development of responses to issues raised in submissions.

3.1.1 DPE Environment and Heritage Group

WaterNSW met with representatives of the Environment and Heritage Group (EHG) between April and October 2022 to discuss and resolve matters relating to:

- Proposed responses to submissions
- Upstream environmental management
- Additional studies
- Biodiversity offsets
- World Heritage area
- Climate change and sustainability.

The meetings provided clarification and agreement for a way forward with regard to biodiversity and the protected lands values offset, and the application of the FBA calculator for determination of credit requirements.

9 Subsequent to exhibition of the EIS and receipt of the EES Group submission, EES became part of the Environment and Heritage Group within DPE.

3.1.2 National Parks and Wildlife Service

WaterNSW met with representatives of NPWS to discuss the proposed upstream management approach and issues relating to the protected lands values offset. These meetings confirmed the approach to be taken to offset impacts to protected lands. Additionally, NPWS representatives were involved in discussions regarding biodiversity offsets held with DPE EHG and provided information and advice regarding the process to identify and implement an on-park management program that would match the biodiversity offsetting requirements associated with the Project.

3.1.3 DPE Water/Natural Resources Access Regulator

Groundwater

WaterNSW met with DPE Water in March 2022 to discuss issues raised in its submission related to potential impacts of the Project on groundwater, and to further assessment to address the issues. The additional assessment was provided to DPE Water on 11 April 2022. On 2 May 2022, DPE Water advised (via DPE Planning) that the evidence presented in the report indicated the Project would result in no more than minimal harm in accordance with the NSW Aquifer interference Policy, and that this would be confirmed following review of the final Submissions Report.

Geomorphology

An initial meeting with DPE Water was held on 11 March 2022 to discuss issues raised in its submission related to potential impacts of the Project on geomorphology including sediment movement, erosion risk and downstream bank stability. This informed further investigation into these issues. The findings of these additional investigations were provided to DPE Water ahead of a further meeting held on 18 August 2022.

3.1.4 Heritage NSW

An initial workshop was held with Heritage NSW on 30 March 2022 to discuss the matters raised in the submissions report and a way forward. A follow up meeting was held on 7 April 2022 with a focus on World Heritage matters.

A meeting to discuss the draft responses to issues raised by Heritage NSW was held on 16 August 2022. The key purpose of this meeting was for Heritage NSW to provide initial feedback on the draft responses and the supplementary Aboriginal cultural heritage assessment. Further meetings were held on 8 and 19 September 2022. Heritage NSW provided feedback regarding the proposed approach to responding to submissions and provided additional guidance with regard to the supplementary Aboriginal cultural heritage assessment, including further RAP consultation.

3.1.5 DPI Fisheries

A meeting was held with DPE Fisheries on 12 April 2022 regarding issues related to aquatic ecology. The advice provided has been used in developing responses and providing clarification on a range of matters.

3.1.6 Environment Protection Authority

EPA was offered the opportunity to meet with WaterNSW to discuss the matters raised in its submission. EPA advised that as there were no outstanding issues, a meeting would not be necessary.

3.1.7 Transport for NSW

A meeting was held with TfNSW on 14 April 2022 to discuss issues raised relating to evacuation routes and traffic and access suitability. During August, TfNSW provided additional information for consideration and advised that as there were no further outstanding issues, a follow up meeting would not be necessary.

3.1.8 Department of Agriculture, Water and the Environment

An initial meeting with DAWE[10] was held on 7 April 2022 on World Heritage-related submissions. Follow up meetings were held in conjunction with NPWS and Heritage NSW.

3.2 Stakeholder and community engagement

Infrastructure NSW is leading further investigations into flood behaviour of the Hawkesbury-Nepean Valley building on the 2019 *Hawkesbury-Nepean Valley Regional Flood Study*, and including further analysis of the 2020 and 2021 flood events that affected the valley. This included consultation with affected downstream communities. The final report into the March 2021 flood event was released in December 2021 and has informed preparation of this Submissions Report.

In September 2022, WaterNSW provided the draft supplementary assessment to the ACHA report to RAPs to update them on further work carried out with regard to Aboriginal cultural heritage. This was supported by a presentation to the RAPs on 11 October 2022.

3.3 Revised offset strategy

The offset strategy presented in the EIS comprises two main components:

- A biodiversity offset, as described in Chapter 13 of the EIS and Appendix F6 to the EIS
- A protected lands values offset, comprising the Warragamba Offset Program, as described in Section 20.7 in Chapter 20 of the EIS.

The protected lands values offset, which included purchasing and managing new lands, was to target offset sites that meet both biodiversity and protected lands offset goals.

This revised offset strategy provides the details of these two components as described in the EIS together with changes to the delivery of offsets arising from submissions and further consultation with DPE and other agencies during preparation of the Submissions Report and PIR.

3.3.1 Biodiversity offset

WaterNSW consulted extensively with DPE and relevant agencies to resolve how the FBA can be applied to the upstream area that would be subject to temporary inundation from the Project, particularly as the impacts would be infrequent, cumulative and difficult to measure over time.

For the purposes of completing an FBA assessment and calculation of offsets an upstream impact area has been identified where it is precautionarily assumed a 100 percent loss of biodiversity values within the area.

The calculation of impact to be offset as described in the EIS remains unchanged and is based on the assumed total loss of all biodiversity values from temporary inundation associated with

[10] DAWE became the Department of Climate Change, Energy, the Environment and Water (DCCEEW) on 1 July 2022.

operation of the FMZ within the Project Upstream Impact Area (PUIA). The EIS has described this as the area between 2.8 metres above FSL (RL 119.5 mAHD) and 10.27 metres above FSL (RL 126.97 mAHD), equating to an area of about 1,400 hectares. The rationale for this area is described in Section 3.2 of Appendix F6 *Biodiversity Offset Strategy* to the EIS. This defined area is representative of the likely inundation in a given 20-year period analysed by selecting the peak inundation level for each 20-year period of modelling of around 20,000 flood events. The area is not related to any particular flood frequency which is a common misunderstanding that has been identified in submissions.

The extent of biodiversity loss in the PUIA is quantified through the Framework for Biodiversity Assessment (FBA) as described in Appendix F1 *Biodiversity Assessment Report – Upstream* (Upstream BAR) to the EIS. The Upstream BAR identifies the extent of loss of relevant species and ecosystems and the corresponding number/type of credits required to offset the impact of the Project. In response to comments made by DPE EHG, the number of credits has been updated and a revised credit report will be lodged with DPE.

As described in Section 5 of Appendix F6, the *NSW Biodiversity Offsets Policy for Major Projects* (NSW Government 2014) prescribes four types of strategies that can be used to fulfil the offset requirements:

- Purchasing credits on the open market and retiring these credits
- Offsetting through a site-secured stewardship agreement where a proponent establishes its own Biodiversity Stewardship Agreement (BSA) site(s), generates its own credits and then retires the credits
- A monetary contribution into the Biodiversity Conservation Fund through which the proponent transfers the credit liability to the Biodiversity Conservation Trust, with the amount currently calculated through the Biodiversity Offset Payment Calculator
- Supplementary measures following the rules prescribed in Appendix B to the policy.

Section 6 of Appendix F6 discusses the implementation of the biodiversity offset for the Project for both the construction and operation phases, reflecting the potential need to offset impacts through more than one strategy.

The Warragamba Offset Program approach presented in the EIS was to target the purchase of land suitable for inclusion in the National Park estate and meet both biodiversity and protected land values offset goals.

Change to offset delivery

Further to the biodiversity offset approach in Appendix F6 to the EIS, the priority approach for the delivery of biodiversity offsets to meet the retirement of biodiversity credits would broadly involve Identification and costing of a series of on-park management actions that would deliver a biodiversity benefit on-park equivalent to the biodiversity credits to be retired. The areas that would receive offset actions apply to national park lands and expanded to areas within the GBMWHA or in adjacent or proximate national park or reserve lands. Additionally:

- Management actions will be proposed for each impacted species and ecosystem, i.e. each species/ecosystem that generates a credit liability will be the subject of targeted management actions
- Management actions will be costed and a Net Present Value determined on the basis of delivery/management in perpetuity

- Management actions will be designed, based on the best available science, to deliver a biodiversity benefit on park for the relevant species/ecosystem that is at least equal to the assumed loss in the PUIA.

The following key principles will apply to this component of the offset strategy:

- Management actions will go beyond 'business as usual' in terms of park management and must be based on the best available science
- Management actions will be on the national park estate, ideally on one of the reserves impacted by or adjacent to the Project; however, where it is not possible to generate a biodiversity benefit on the national park estate, or where it relates to an impact that is outside the national park estate, then the offset would be delivered on alternative land.

The Upstream BAR assumed the presence of several threatened species for the purpose of calculating required species credits. This is likely to overstate the magnitude of potential impacts and the required number of species credits. Should the Project be approved, WaterNSW would seek to have the option to conduct further surveys prior to operation of the Project for species where presence has been assumed, and to review the credit calculations for the relevant species accordingly.

As a second-tier priority approach for delivering biodiversity offsets, land purchased for the protected lands values offset would also target offset sites that, where possible, could also meet biodiversity values to contribute to the retirement of biodiversity credits. It is noted that biodiversity values that exist on land acquired for a protected land offset and subject to 'business as usual' park management cannot be counted towards the biodiversity offset requirements as there is no additional biodiversity benefit provided. It is further noted that additional actions on such land over and above 'business as usual' and core park management, and which deliver an increase or uplift in biodiversity values may potentially be counted as a biodiversity offset.

3.3.2 Protected lands values offset

As indicated in the EIS, potential impacts on protected lands values were proposed to be addressed through the Warragamba Offset Program. In addition to biodiversity, this encompassed non-biodiversity matters such as:

- Geodiversity
- Water catchment protection
- Cultural heritage
- Landscape, natural beauty and aesthetic values
- Recreation and visitor use
- Social and economic benefits derived from visitation to these areas.

The Warragamba Offset Program will prioritise land suitable for inclusion in the national park estate containing suitable biodiversity, cultural heritage, landscape and park visitor values and opportunities. Any land containing suitable offsets must also be appropriate for the national park estate. The offset would also include on-park management costs for the newly acquired lands to be included in the national parks estate.

The NSW Government's *Revocation, recategorisation and road adjustment policy*[11] states that

> *18. When negotiating compensation, NPWS will be guided by the following considerations:*
>
> - *the proposed revocation and associated compensation must result in an overall public good outcome having regard to all of the conservation, cultural heritage and other values of the land being revoked and the values of any land provided as compensation*
> - *compensatory land should preferably be of greater size than the area of land being revoked, and must at least be of equal size*
> - *it is desirable to match the area, type and quality of habitat, and cultural heritage values on land being revoked with the area of land proposed as compensation where possible. Exceptions to this may include:*
>   - *compensation that includes a higher conservation priority habitat type (e.g. that is poorly reserved) where the habitat to be impacted is commonly represented within the relevant park*
>   - *compensation lands that have unique and particularly significant conservation values*
>   - *it is desirable that land to be transferred as compensation is close to the area being revoked and preferably adjacent to the affected reserve.*

It is intended that as a minimum the quantum of land required to compensate for impact on national parks (including the affected part of the GBMWHA) will be equivalent to or greater than the affected area of national parks estate in the upstream impact area (1,303 hectares) and containing equivalent or superior values noting that there is 304 hectares of GBMWHA to offset. The protected lands values offset will also provide for separate on-park management costs over a 20-year period with funding secured prior to commencement of Project construction.

With regard to prioritising land that improves or supports the OUV for the GBMWHA (and National Heritage values), this will include consideration of, as appropriate:

- Wilderness areas
- Aboriginal cultural heritage
- Plant communities identified in the OUV statement
- Threatened flora species
- Habitat of threatened fauna species
- Other biodiversity-related matters such as scleromorphic species, ant-adapted plants, diversity and characteristics of the flora as a whole, species diversity, vertebrates and invertebrates identified in the OUV statement
- Visual amenity
- Users of the GBMWHA
- Geological structure, geomorphology and water systems.

3.3.3 Summary

The offset strategy is largely as proposed in the EIS except that in delivering biodiversity offsets, the priority to retire credits will involve Identification and costing of a series of on-park management actions that will deliver an on-park biodiversity benefit equivalent to the biodiversity credits to be retired. The protected lands values offset will prioritise land suitable for inclusion in the national park

[11] https://www.environment.nsw.gov.au/topics/parks-reserves-and-protected-areas/park-policies/revocation-recategorisation-and-road-adjustment

estate. Should any of these lands also include similar biodiversity values to those being sought for retirement of biodiversity credits then they could be considered for contribution to those offsets as a second priority. The protected lands values offset will also include on park management costs for the new lands for a 20-year period at commencement of operation of the Project.

3.4 Review of biodiversity credit calculations

In response to advice and detailed reviews provided by the Biodiversity Conservation Division of DPE (refer Sections 4.1.1 and 4.1.4 of this report), the biodiversity credit calculations for the upstream area and construction area have been revised. These will be lodged concurrently with or prior to submission of the Submissions Report and PIR to DPE. Revision of the biodiversity credit calculations has been managed by an accredited person under the *Biodiversity Conservation Act 2016*.

3.5 Supplementary investigations

As part of preparation of the Submissions Report and PIR, further work has been carried out to build upon the findings of the assessment presented in the EIS and to clarify aspects of the environmental assessment in response to issues raised in submissions. These are listed in the following table.

Table 3-1 Supplementary investigations

Aspect	Description	Where provided
Groundwater	Expert technical review of issues raised by DPIE Water	SR: Appendix E
Socioeconomic	Assessment of property buyback options	SR: Appendix F
Geomorphology	Downstream bank stability Downstream erosion and sediment movement Sediment movement through upstream waterways	SR: Appendix G
Contaminated land	Supplementary contaminated land assessment for construction area	SR: Appendix H
Aboriginal heritage	Supplementary assessment to Aboriginal cultural heritage assessment report (Appendix K to the EIS) Includes additional assessment of potential impacts of temporary inundation on the physical values of heritage sites using Longneck Lagoon as a case study	PIR: Appendix F
Flooding and hydrology	Supplementary assessment incorporating additional information including March 2021 flood	PIR: Appendix D
Biodiversity	Additional assessment of potential impacts of temporary inundation on biodiversity values using Longneck Lagoon as a case study	PIR: Appendix E
Non-Aboriginal heritage	Supplementary assessment for State-listed item Megarritys Bridge and for four NPWS section 170 sites in the upstream area	SR: Appendix I PIR: Appendix G
	Archaeological research design	PIR: Appendix H
Sustainability	Revised infrastructure sustainability rating assessment	PIR: Appendix I

4

Response to Government agency submissions

4 Response to Government agency submissions

This section of the report provides responses to advice provided in submissions made by the following NSW Government agencies:

- Department of Planning, Industry and Environment; Environment, Energy and Science Group
- Department of Planning, Industry and Environment; Water/Natural Resources Access Regulator
- Heritage NSW
- Department of Primary Industries (Agriculture)
- Department of Primary Industries (Fisheries)
- Environment Protection Authority
- Sydney Water Corporation
- NSW Health
- Transport for NSW.

Where the agency advice includes a statement or comment without a specific question or issue being raised WaterNSW considers no further response is required to the issue.

For each agency, the response to issues raised has been structured to reflect, as far as practicable, the structure of the individual submissions. As part of preparation of the Submissions Report, WaterNSW has consulted with DPE and agencies to (refer Section 3.1) clarify issues raised.

4.1 Department of Planning, Industry and Environment: Environment, Energy and Science

4.1.1 Biodiversity – upstream

4.1.1.1 General

Issue 1

The assessment of avoid and minimise leans heavily on the *Hawkesbury-Nepean Valley Flood Risk Management Strategy - Taskforce Options Assessment Report 2019*. The Biodiversity Assessment Report (BAR) has correctly identified that once a decision has been made that a dam wall of a particular height is required to mitigate downstream flooding, the options of how to build and operate the proposal are limited. EES is not able to review the assessment and decision-making undertaken by the Taskforce that led to the current proposal being selected.

Response

The Environment Energy and Science (EES) group established in July 2019 was formerly included within the Office of Environment and Heritage (OEH). OEH was a member of the Interagency Committee set up to undertake Stage One of the Hawkesbury-Nepean Valley Flood Management Review in early 2013 in response to the NSW Government's adoption of the *State Infrastructure Strategy 2012-2032* and community concerns about flood risk. In early 2014, the NSW Government established the Hawkesbury-Nepean Valley Flood Management Taskforce to advance the work carried out by Infrastructure NSW and the 2013 Review. The Taskforce include representatives from 11 agencies including OEH (Infrastructure NSW 2017).

The methodologies used by the Taskforce to evaluate infrastructure and non-infrastructure options are described in Section 3 of the Taskforce report *Resilient Valley, Resilient Communities* (Infrastructure NSW 2017). As noted in the report, an environmental, cultural, and social impact assessment was undertaken for the shortlisted flood mitigation infrastructure options investigated by the Taskforce. The Taskforce report concludes with the presentation of the Flood Strategy identifying the Strategy vision, Strategy objective, and guiding principles to deliver the nine identified outcomes including Outcome 2 *Reduced flood risk in the Valley by raising Warragamba Dam wall*.

Issue 2

The BAR for the upstream assessment has generally implemented the Framework for Biodiversity Assessment (FBA) as agreed in meetings between EES, PAG and WaterNSW in 2020. EES notes:

- The Biodiversity Assessment Method (BAM) has been applied to an agreed 'upstream impact area' based on a modelled likely maximum inundation level within a 20-year period, beyond that which would be likely to receive flooding in a 20-year period with the current dam wall.
- Total loss of biodiversity within the upstream impact area has been assumed.
- Species polygons have generally been identified by using the PCTs and IBRA subregions with which the species are associated and assuming the species was present in that entire area. This was required because surveys could not be conducted that would meet FBA survey requirements.
- Comments on species assessments and polygons were sought from Accountable Officers in EES for each of the species assessed in the BAR. Those for which an Accountable Officer was not able to assist have been reviewed by other EES officers. There are several comments recommending modifications to the relevant species polygon. These are detailed in the threatened species comments below.
- Vegetation survey plots have been undertaken across the entire flooding zone between full supply level and the PMF. As a result, plots are outside the upstream impact area being used to calculate credits. This was previously agreed as it was considered that the vegetation in the study area was generally similar in condition.
- Due to inaccessible terrain, some surrogate plots have been used. These have included data at benchmark, which can only have resulted in an increased requirement for credits compared to completing all plots as required by the FBA. This has previously been agreed.
- The vegetation plot data has been reviewed and comments are provided below.
- Data entry has not been reviewed for any of the FBA calculators given the likely need to alter species and PCT polygons.
- Matters for further consideration have been identified correctly. The additional information required for these matters has been provided in accordance with the FBA. Generally, it is noted that, although an arbitrary method for calculating credit requirements has been used, the ability to determine actual impacts on native vegetation and threatened entities, and thus provide definitive answers to many of the questions regarding further consideration, is limited. Some notes on the possible significance of impacts to these species are included below. EES will need to undertake further assessment of this aspect of the BAR to provide recommendations on additional or complementary offsets that may be required.

Response

The above issue raised in EES advice provides a summary of the upstream and construction area BARs methods used being consistent with the FBA and the further assessment to be undertaken by EES. WaterNSW considers no further response is required to this issue.

Issue 3

The Biodiversity Offset Strategy (BOS) has not identified offset sites and consequently has not determined whether the credit requirements will be met. EES notes the very large numbers of credits that will need to be retired. EES notes:

- The BOS correctly identifies the process for seeking credits, identifying supplementary measures and, where necessary, making a payment into the Biodiversity Conservation Fund for the construction impacts. It is proposed that this be undertaken prior to construction commencing. This is consistent with the *NSW Biodiversity Offsets Policy for Major Projects*, for which the FBA was developed.
- The BOS discussion of the offsets for the upstream impacts is complicated by the need to also offset impacts to the national park estate, World Heritage and Aboriginal cultural heritage. The primary mechanism is purchase and dedication of land to the national park estate. This is consistent with the biodiversity offsetting principles of both NSW and Commonwealth legislation. While the process described in the BOS is logical there are two possible obstacles:
  - The proposal discusses obtaining and transferring land equivalent to or greater than the area being impacted. The likely biodiversity offset ratios mean that the area of land required could be several times that figure.
  - The proposal is to implement the BOS prior to project operation (i.e., prior to a flooding event occurring). The timing of this will, however, be subject to weather variabilities.

Response

WaterNSW is aware of potential obstacles that exists for any major state significant infrastructure project. However, as noted in the BOS, the retirement of credits for biodiversity includes several measures. The obligation of WaterNSW is to retire credits through these measures to whatever share each measure contributes to the total credit retirement.

The comment notes that large numbers of credits will need to be retired and that the process proposed is consistent with the *NSW Biodiversity Offsets Policy for Major Projects.*

Following discussions and agreement with DPE, a revised approach to implementing the offset strategy has been developed and is described in Section 3.3 of this report.

4.1.1.2 Threatened species

The following advice details required changes to species polygons. Where the species is a matter for further consideration (discussed in Appendix K of the BAR) under the FBA, some comments is provided on the possible local and regional significance of any impacts that may occur.

EES notes that while the information provided in Appendix K of the BAR is generally in accordance with the FBA, the lack of comprehensive surveys, both in the study area and in the surrounding region, mean that much of the consideration comments are uncertain.

Species with an asterisk are those identified as a matter for further consideration in Appendix K of the upstream biodiversity assessment (Appendix F1 to the EIS).

*Anthochaera phrygia**

Plant Community Types (PCTs) HN553 and HN607 are not associated with this species in the Threatened Biodiversity Data Collection (TBDC). The credit requirements may have been over-estimated. The biodiversity offset strategy could include funding of actions from the national recovery plan for the species, such as the captive breeding program.

While possible, there is little evidence that large areas of alternative or additional habitat is available elsewhere locally. The large species polygon shown in Appendix B (Map B.82) is based on PCT associations and other habitat requirements may be absent from parts of this polygon.

The Project will cause temporary inundation of an area of habitat known to be used by 5-7 percent of the total known population of this critically endangered species. If this inundation does cause changes to the habitat that make it less suitable for Regent Honeyeaters, this could cause the loss of one of only a small number of breeding areas.

Response

The comments regarding PCTs associated with this species have been noted and the upstream biodiversity credit calculation has been updated to reflect this. The comment regarding the significance of habitat for this species is noted.

*Ancistrachne maidenii**

This is one of the matters for further consideration species not detected during surveys. An area of habitat within the upstream impact area has been estimated to calculate credit requirements.

There is one record approximately five kilometres from the dam wall (in Wollemi subregion), but no others locally. On that basis, if any impacts were to occur, then they would be significant in a local and regional context.

Response

It is noted that the species was not identified in surveys but suitable habitat occurs within the area.

*Bossiaea oligosperma**

PCTs HN527, HN536 and HN557 are not associated with this species in the TBDC but it is noted that records were found within HN536 and HN557 polygons during the surveys for the Project.

This vulnerable species is still a matter for further consideration as the Project has the potential to make it extinct in the Burragorang IBRA subregion. While a conservative estimate of 483 hectares of habitat is to be impacted, it is noted that most of the local records are outside the upstream impact area and the PMF.

Response

The comments regarding PCTs associated with this species have been noted and the upstream biodiversity credit calculation has been updated to reflect this. The comment regarding the significance of habitat for this species should it be present and impacted is noted.

*Callistemon linearifolius**

Offsets for this species have been calculated by assuming the presence of 1968 individuals, based on the PCTs it was found in during surveys. It is not clear how the number of individuals was calculated as no assumed density is given. The Proponent should provide the assumptions used to estimate the number of individuals for the credit calculations. It may be more appropriate to use an area-based calculation of credits.

This vulnerable species is still a matter for further consideration as the Project has the potential to make it extinct in the Burragorang IBRA subregion. While surveys have been limited, all six of the records for this species in the Burragorang IBRA subregion were found as a result of the surveys for this assessment. While only one of those records is within the upstream impact area, the BAR still estimates that many individuals are present in that area. The lack of surveys elsewhere in the catchment make it difficult to determine what proportion of the of the local population is likely to be inundated.

Response

The comments regarding the method of calculating assumed presence has been noted and the upstream biodiversity credit calculation has been updated to reflect this. The comment regarding the significance of habitat for this species is noted.

Callistemon megalongensis

Species polygon should include HN574. This species has also been recorded on 1st and 2nd order streams. The species polygon should include habitat associated with those streams.

Response

The comments regarding PCTs and stream order associated with this species have been noted and the upstream biodiversity credit calculation has been updated to reflect this.

Callistemon purpurascens

This species has been excluded on incorrect habitat assumptions. Additional records have been recently made. It is now known to occur on plateaus, as well as valleys. The habitats recorded include within streams on sedimentary rock; on alluvium/flood terraces; and sometimes on higher or wider terraces or on the toe of adjoining slopes. The recent discovery and potential for misidentification may contribute to lack of records in the study area. It co-occurs with *Callistemon megalongensis* and a reasonable interpretation would be that it be presumed present in the same species polygon as *C. megalongensis*.

Response

The upstream biodiversity credit calculation has been updated to reflect this new information.

Darwinia biflora

Table 7-3 should probably read 8.0 hectares for this species, rather than 80.

Response

It is confirmed that the correct area for this species in Table 7-3 is 8.0 hectares.

*Dillwynia tenuifolia**

The species polygon should include HN564 and HN566 in both the Wollemi and Burragorang subregions.

There are no records of this species from the upstream impact area and the nearest record is 6.5 kilometres east of Warragamba Dam. While impacts are unlikely, they would be noteworthy as they would be impacting some of the few individuals that occur in the subregions.

Response

The species polygon has been updated in the upstream biodiversity credit calculation.

*Epacris purpurascens subsp. purpurascens**

Are the credits calculated using individuals (p.209) or hectares (p.242)? The use of individuals would require an explanation of the assumptions used to arrive at the number used. As none were found, it may be more appropriate to use an area-based calculation of credits.

No specimens were found during surveys and the only record near the impact zone is from 1965 and within the area currently flooded when the current dam is at full supply level.

There are few other records near the study area. While impacts are unlikely, they would be noteworthy as they would be impacting some of the few individuals that occur in the subregions.

Response

The comments regarding the method of calculating assumed presence has been noted and included in the upstream biodiversity credit calculation.

Epacris sparsa

There appears to be some confusion with the unit of impact used to calculate credits. Table 7-3 says two individuals, but Table 8-5 indicates two hectares. This needs to be clarified. If individuals are used to calculate credits, then an explanation on how the number was derived is required.

Response

The comments regarding the method of calculating assumed presence has been noted and the upstream biodiversity credit calculation has been updated to reflect this.

*Eucalyptus benthamii**

Significant records of this species occur within the upstream impact area, particularly in the Kedumba Valley. Inundation of individuals is not the only concern; recruitment of the species is also likely to be affected by the Project as recruitment is particularly susceptible to changes in the flooding regime. As noted in the BAR, the CSIRO study of the effects of temporary inundation has only partial application to the Project.

The analysis in the Table K-4 (Appendix K – Matters for Further Consideration) states that impacts 'may occur' and are 'possible'. Such statements are not supported. Given the large proportion of the species population in the Project area, and the habitat in which the species occurs, it is considered that impacts will be likely.

Approximately 33 percent of the records in the Kedumba Valley are within the upstream impact area and over two thirds are within the PMF. If the species proves sensitive to temporary inundation, impacts are likely to be significant and important in terms of local and regional conservation of the species.

Response

The comments regarding recruitment and the significance of the population in the upstream impact area are noted. The calculation of credits for this species has assumed a total loss within the impact area.

*Eucalyptus glaucina**

This vulnerable species is a matter for further consideration as the records found during the surveys for this Project are a significant range extension. It has not been previously found south of the Hunter Valley. It is noted that the new records now place it in the Kanangra, Bungonia and

Burragorang subregions. Based on those currently known records, the Project has the potential to make it extinct, in all those subregions.

Most of the local records are within the upstream impact area, but this is an artefact of the area subject to limited targeted survey.

Response

The extension of range of this species as a result of surveys for the Project is noted. The calculation of credits for this species has assumed a total loss within the impact area.

Euphrasia bowdeniae

There is a valid, though no longer extant, record for this species in the Burragorang sub-region (Mt Solitary). Consideration should be given to including the relevant PCTs from that sub-region in the species polygon.

Response

The upstream biodiversity credit calculation has been updated to include consideration of this species in the relevant PCTs in the sub-region.

*Genoplesium baueri**

This is an endangered species with only one record within the Burragorang IBRA subregion which was not found during surveys. It is difficult to determine the likely impacts to this species (re. matters for further consideration) due to the lack of targeted surveys. Any impact could be significant in terms of local and regional conservation of the species.

Response

It is noted that the species was not identified in surveys, but suitable habitat occurs within the area. The species was assumed present and considered in the upstream BAR.

*Gyrostemon thesioides**

The BAR has excluded Kanangra, Wollemi and Bungonia IBRA subregions from the species polygon based on erroneous data in the TBDC (which will be corrected). The species polygon should be expanded to include the same PCTs in all four subregions.

It is difficult to determine the likely impacts to this species (re. matters for further consideration) due to the lack of targeted surveys. Any impact could be significant in terms of local and regional conservation of the species.

Response

It is noted that the species was not identified in surveys, but suitable habitat occurs within the area. The upstream biodiversity credit calculation has been updated to reflect corrections to the TBDC by EES.

*Hakea dohertyi**

Table 5-5 of the BAR associates this species with HN525, HN535, HN536 and HN557. Table 7-3 includes HN517, HN527, HN538, HN606, HN607 and HN557. The species polygon provided in GIS format, however, uses HN527, HN538 and HN557. BioNet associates the species with HN525, HN535 and HN536. It is recommended that the species polygon for this species be reconsidered.

While the known population likely to be inundated is small in comparison to that in the Kowmung Valley to the west, it is all the records known from the Burragorang IBRA subregion (although some of the recorded locations would be inundated during a flood event without the Project proceeding). If the species is sensitive to inundation, the known population within the Burragorang subregion is likely to threatened with extinction.

As a result, conditions of approval for seed/propagule collection, ex-situ population establishment and translocation need to be considered for this species.

Response

The comment regarding the significance of the known population should it be impacted is noted. The species polygon was revised for the update of the upstream biodiversity credit calculations.

Haloragodendron lucasii

BioNet records in the Blue Mountains have been re-attributed from *H. lucasii* to *H. gibsonii*. As a result, this species need no longer be considered as likely to be present in the upstream impact area and no offsets are required.

Response

This new information is noted and has been updated in the upstream biodiversity credit calculations.

Heleioporus australiacus

Heleioporus occupies home ranges up to 500-600 m from breeding ponds. The species polygon should, therefore, be changed to: 'All native vegetation within 600 m of 2nd and 3rd order streams on sandstone – in Burragorang, Wollemi, Kanangra IBRA subregions'.

Response

The advice is noted and the upstream biodiversity credit calculations have been updated accordingly.

*Hibbertia puberula**

The impacts of the Project on the local population of this species are difficult to ascertain. The nearest local records are 15 kilometres from the study area and local habitat can only be estimated by PCT associations.

The low number of local records means that any impact could be significant in terms of the local and regional conservation of the species.

Response

It is noted that the species was not identified in surveys, but suitable habitat occurs within the area. The species was assumed present and considered in the upstream BAR.

Hygrocybe aurantipes and Hygrocybe reesiae

These species occupy similar habitat to *Hygrocybe anomala* var. *ianthinomarginata*. The species polygon should be the same as for that species.

Response

The advice is noted and the upstream biodiversity credit calculations have been updated accordingly.

Ixobrychus flavicollis

The TBDC does not list all the PCTs associated with this species. As a result, rather than PCT associations based on the TBDC, it would be more accurate to map the species polygon as all land within 40 metres of:

- freshwater wetlands or
- estuarine wetlands or
- other areas of permanent water, including permanent water courses.

Response

The advice is noted and the upstream biodiversity credit calculations have been updated accordingly.

Macropus parma

The TBDC states that this species' habitat cannot be predicted through PCTs. It is recommended that a survey or expert report is required to identify those parts of the study area that are likely to provide habitat.

Response

This advice is noted. The species has been assumed present in the upstream impact area within the PCTs in the credit calculator. EES was consulted during preparation of the Submissions Report and it was noted that no experts were able to be engaged or additional survey had been completed.

*Melaleuca deanei**

One individual of this species was detected incidentally during surveys approximately three kilometres from the upstream impact area. No other records are known from the impact area or surrounding localities. If any impacts to this species do occur, they would be significant in terms of the local and regional conservation of the species as it is otherwise unknown from the Wollemi IBRA subregion.

Response

It is noted that the species was not identified in the impact area from surveys, but suitable habitat occurs within the area. The species was assumed present and assessed in the upstream BAR and species credits calculated.

Melaleuca groveana

Should Table 7-3 read six hectares for this species, rather than six individuals? If the latter, an explanation of how the number of individuals was determined should be provided.

Response

It is confirmed that the correct value for this species in Table 7-3 is six hectares.

Petaurus norfolcensis

BioNet also associates this species with HN553. This PCT should be added to the species polygon.

Response

The advice is noted and the upstream biodiversity credit calculations have been updated accordingly.

Phascogale tapoatafa

This species, like many species credit species, cannot necessarily be predicted based on the presence of any particular PCT. The occurrence of the brush-tailed phascogale is more closely aligned with an abundance of large hollows with small entrances and sparse ground and shrub cover.

The assessor should seek the advice of an expert to assist in the drafting of the species polygon/s for the brush-tailed phascogale. In addition, the species polygons should be based on the specific habitat requirements for this species. The TBDC encourages the use of an expert to determine the presence of suitable habitat for the brush-tailed phascogale, rather than relying on a survey.

Response

This advice is noted. The species has been assumed present in the upstream impact area within the PCTs in the credit calculator. EES was consulted during preparation of the Submissions Report and it was advised that no experts were able to be engaged or additional survey had been completed. Suitable habitat was assumed to be present across six different PCTs and included in the biodiversity credit calculations

Phyllota humifusa

The inclusion of this species is based on a record on the Bimlow tablelands. This has recently been determined to be incorrectly identified – so the species could justifiably be excluded.

Response

The advice is noted and the upstream biodiversity credit calculations have been updated accordingly.

*Pomaderris brunnea**

The report estimates the population within the Warragamba Special Area as possibly over 1000, which is a signification proportion of the total population of the species (most other populations are less than 100). Of the 51 records within the Special Area, 13 (approximately 25 percent) are within the upstream impact area and 50 are within the PMF.

With such a large proportion of the population subject to impacts, sourcing credits will be very difficult. If the species proves sensitive to temporary inundation, the known local population will be more vulnerable to extinction.

Response

The comment regarding the significance of the population of this species should it be impacted is noted. The species has been assumed present across 1,146 hectares of the impact area and resulted in large credit requirements to be delivered in the offset strategy.

Rhizanthella slateri

Within sandstone derived habitats, *Rhizanthella slateri* has been recorded within dry woodlands at the bases of species including (but not limited to) *Corymbia gummifera*, *Eucalyptus piperita* and *Angophora costata*. The co-occurrence of *Allocasuarina* species can often benefit *Rhizanthella* by adding leaf litter and supressing ground and shrub cover competition.

It is recommended that HN566 and HN568 be included in the species polygon, as well as all four IBRA subregions - Bungonia, Burragorang, Kanangra and Wollemi.

Areas with high shrub and ground cover densities could be excluded from the species polygons, where these can be reliably mapped.

Response

The comments regarding PCTs associated with this species have been noted and the upstream biodiversity credit calculations have been updated to reflect this.

*Rhodamnia rubescens**

The Scrub Turpentine is a 'count' species as opposed to an 'area' species. The impact to this species is referred to within the report as being 78 hectares. It is not clear how the 78-hectare impact area has been converted to a number of individuals for the purposes of calculating the species credit requirement. The current credit requirement is 3,878 species credits.

Scrub Turpentine is not included in the Biobanking Credit Calculator as this species has only recently been listed. To determine the credits for the Scrub Turpentine, *Acronychia littoralis* (Scented Acronychia) has been used as a surrogate in the calculations. The latter species has the highest offset multiplier that could be chosen under FBA, maximising the credit requirements. This is, therefore, acceptable.

Again, with no known local records, any impacts that do occur would be significant in a local and regional context.

It is likely that complementary offsets will be required for this species. Credits are difficult to generate on Biodiversity Stewardship sites due to the difficulty in controlling myrtle rust.

Response

The method of calculation has been updated in the upstream biodiversity credit calculations. The comments supporting the use of *Acronychia littoralis* as a surrogate are noted.

*Solanum armourense**

The Project will impact on known records in the Bungonia IBRA subregion. There are 101 records in this subregion, of which 26 are within or near the upstream impact area. Nearly 50 percent of the records in the Bungonia IBRA subregion are outside the PMF. However, if the species is sensitive to temporary inundation, then the Project will reduce the local population substantially and increase its risk of extinction in the subregion.

Response

The comment regarding the significance of the population of this species should it be impacted is noted.

*Tetratheca glandulosa**

A vulnerable species that is a matter for further consideration as there are few records in the Wollemi and Burragorang subregions.

Like other undetected species, determining the significance of the impact of the Project on this species is difficult. With so few records in these two subregions, any loss due to the Project will have substantial implications for the conservation of the species at local and regional scales.

Response

The comment regarding the significance of this species should it be present and be impacted is noted.

Zieria involucrata

The species polygon should also include HN517, HN536, HN537 and HN538.

Response

The advice is noted and the upstream biodiversity credit calculations have been updated accordingly.

Zieria murphyi

There are records for this species near Penrose in the Burragorang sub-region. Consideration should be given to including the relevant PCTs from that sub-region in the species polygon.

Response

The advice is noted and the upstream biodiversity credit calculations have been updated accordingly.

4.1.1.3 Vegetation plot analysis

DPE obtained data from 93 BAR plots and applied it to a new DPE on-line tool[12] that compares new plot data against new Eastern NSW PCTs. The resulting Eastern NSW PCTs were then traced to identify current PCT relationships. PCT assignments were reviewed against an additional 105 plots located within the 550 m buffer area that are available in BioNet.

The analysis found:

- there was a high level of agreement between the PCTs identified in the BAR survey data and the plot data stored in BioNet and classified in the PCT classification source (Tozer *et al*. 2010)
- 24 of the 93 BAR plots did not have strong matches to any PCT; this does not preclude the assignment of these plots to a PCT but may suggest a less certain relationship
- the BAR data did not present evidence for the presence of PCTs 1292 (HN607) or 1083 (HN566)
- the analysis suggests that PCT 1181 is present within the study area but not assessed in the BAR
- the results of the PCT assignment evaluation found disagreement with the PCT assignments in the BAR for 20 plots
- PCTs 1401 and 840 have a higher proportion of plots unassigned or in disagreement
- there were a further seven plots for which the data did not support a PCT assignment using DPE methods - plots US15, US60, US61, US71, US72, US76, US88. This was primarily due to low species numbers in these plots. Plots assigned by the BAR to PCT 840 were most problematic as there are few other BioNet plots assigned to this PCT in the buffer area to provide additional supporting evidence. Resurvey of these plots would assist in clarifying the PCT mapping for the study area.

[12] https://BioNet.shinyapps.io/vegplot/

Table 4-1 Recommended amended PCT assignments for BAR plots

BAR site label	BAR assigned PCT	Recommended amended PCT
US1	1083	1081
US10	1083	1181
US11	1081	1181
US12	1081	1181
US2	1081	1181
US25	860	1401
US35	870	832
US49	870	832
US50	870	832
US6	1083	1081
US74	1401	832
US75	860	832
US79	877	871
US8	1083	1081
US80	1292	1105
US81	1292	941
US82	871	1246
US83	1292	941
US92	871	1284
US93	871	860

Response

The identification of PCTs was undertaken by the survey team using the professional judgement, guidelines, databases and tools available to the team. The methodology for PCT assignment is provided in detail in Section 4 of Appendix F1.

The suggested changes are based on new tools that were not available to the survey team at the time of survey. We have reviewed the suggested changes with field assessment data and information and accept that the suggested PCTs are reasonable (noting that PCT assignment depends on a range of factors including site location and local environmental elements). As the suggested assignments are based on more recent information the credit calculations for the upstream area have been updated accordingly.

With regard to resurvey of plots with plot data unable to be confirmed using the EES tool, the changes to the current PCT determination have not been made unless there was a logical relationship to the adjusted PCTs. As part of the management plan, it is proposed to resurvey all accessible plots. Access for resurvey to the catchment area is currently not feasible.

4.1.1.4 PCT mapping

Fourteen BioNet plots intersect the vegetation mapping for the upstream impact area. Agreement between these plots and BAR PCT mapping suggests a map accuracy of above 80 percent. It provisionally suggests that the map forms a foundation for revisions to PCT assignments outlined in this review.

The BAR PCT map requires revision to include PCT 1181 and to review the amended PCTs assigned to both BAR and BioNet plots. For example, the extent of PCT 1401 is likely to be over-estimated and more likely encompass habitats occupied by PCTs 840, 871 or 832. A set of BioNet plots and their PCT assignments to assist with map revisions is provided in Table 2.

Response

Table 2 has not been reproduced in this report due to its length. Consistent with the response for Section 4.1.1.3, the upstream BAR PCT map has been revised and biodiversity credit calculations revised accordingly.

4.1.1.5 TEC identification and mapping

Plot data was evaluated to determine the presence of PCTs in the study area. It is agreed that there are two threatened ecological communities present:

1. River-Flat Eucalypt Forest on Coastal Floodplains (RFEF) listed as Endangered under the BC Act and Critically Endangered under the EPBC Act
    - DPE agrees with areas mapped as RFEF in large areas of alluvium where the plot data, existing mapping and substrate mapping agree.
    - BioNet plot data (BML78, BML75, BML87, BUR66 and NTT57) indicates that RFEF also occurs where there a small, unmapped, alluvial deposits.
    - Plots assigned to PCT 1292 and situated on alluvial soils should be included in this TEC.
2. White Box Yellow Box Blakely's Red Gum Woodland listed as Critically Endangered under the BC Act and Critically Endangered under the EPBC Act
    - The BAR interpretation of the distribution of this TEC is likely to be precautionary.
    - Not all areas assigned to PCT 840 may meet the definition of the TEC (Paragraph 4.11 Final Determination).
    - There is a low likelihood that PCT 1401 is related to the TEC. This appears to be an error in the BioNet vegetation classification database.

Response

The advice is noted and both TEC identification and mapping have been updated.

4.1.1.6 Further consideration of White Box Yellow Box Blakely's Red Gum Woodland

Table 7-11 provides the information required by Section 9.2.4.2 of the FBA (Matters for further consideration) for this critically endangered ecological community (CEEC). It is noted that the requirement under Section 9.2.4.2(b) was unable to be provided due to the large size of the study area and a modification has been implemented. This modification is acceptable.

With that modification and noting that the area of the CEEC in the upstream impact area may have been over-estimated, it is considered that the information has been provided in accordance with the FBA.

No recommendations on additional or supplementary offsets can be formulated at this stage.

Response

Confirmation that the provision of information is in accordance with the FBA is noted.

4.1.2 Biodiversity – downstream

4.1.2.1 Field survey

Issue 1

No surveys were carried out for amphibians, despite three species in likelihood of occurrence table listed as being high or recorded (i.e. Giant Burrowing Frog, Green and Golden Bell Frog (GGBF), Red-Crowned Toadlet). However, EES considers this is of low concern as no GGBF have been recorded since 1977 and the other threatened frogs are unlikely to be impacted.

Response

EES' comments with regard to the Green and Golden Bell Frog and other threatened frogs are noted.

Issue 2

Surveys for bats were 'at least two nights' at sites. As such, surveys for bats were not in accordance with the threatened bat survey guidelines, which state a minimum four nights is required for acoustic detection for all species where ultrasonic call detection is being used.

Response

The survey methodology was discussed with EES during both development of the methodology and during the consistency review of the draft EIS by DPE and other agencies. The EES comments recognised that because of the potential for impacts on all species including bats the species needed to be included in the EIS. The downstream BAR considered the likely presence of bats based on the outcomes of survey and literature review. The potential impact on threatened bats was considered further as part of the risk assessment of the proposal.

Issue 3

Survey locations were very limited and not randomly distributed across the subject area. Also, many of the flora plot locations and fauna survey locations were not within the survey area. This creates a risk that threatened species and their habitats will be impacted without adequate assessment.

Response

The focus of survey was on areas of public or protected lands likely to contain higher biodiversity values. This was discussed with EES during development of the methodology and during agency review of the draft EIS. EES noted that while it was understood that surveys could not be comprehensive given the scope of the Project, acknowledgement of this limitation in the assessment was recommended.

Section 4.5 of Appendix 2 to the EIS acknowledged the limitations of the field survey and outlined how the assessment had undertaken a conservative approach such that all the biodiversity and conservation values of the assessed vegetation and habitat were captured.

Issue 4

Much of the plot data in Appendix C of Appendix F2 does not include dates or recorders.

Response

The plots were performed by Niche Environment and Heritage between 20 November 2017 and 13 February 2018 by two botanists, in a report authored by C. Forrest and L. Baker in April 2018.

Issue 5

The method used for the preparation of the likelihood of occurrence table is not a standard method. Typically, all species recorded or known within a five- or 10-kilometre radius of the site are recorded in the table. However, for the EIS, firstly all entities within a two-kilometre buffer were selected, then entities were removed if no suitable habitat was present, then entities were removed if there were no nearby records, and finally the table was developed for the remaining species. This may have resulted in species not being adequately assessed.

Response

The study area included all land within the existing PMF from Warragamba Dam to the confluence of the Colo River and the Hawkesbury River. This is shown in Figure 1.2 in Appendix F2 and includes landforms varying from Cumberland lowlands, foot slopes of the Hornsby Plateau and Blue Mountains Plateau and the Macdonald Ranges. For the purposes of likelihood of occurrence table an additional two-kilometre buffer was added to this very large area. This represents an area that covers much of the Hawkesbury and Nepean floodplain, significantly greater than a 10-kilometre buffer surrounding the Warragamba Dam site.

Issue 6

As noted in Appendix F2, surveys were not carried out in the recommended survey period for *Dillwynia tenuifolia* or *Epacris purpurascens var. purpurascens*.

Response

Section 4.5 in Appendix F2 acknowledged the limitations of the field survey. These primarily related to field accessibility and verification. Section 4.5 outlined how the assessment had undertaken a conservative approach such that all the biodiversity and conservation values of the assessed vegetation and habitat was captured. The limitations for these two species were clearly identified in the assessment.

Issue 7

The likelihood of occurrence table lists 40 flora species as having a high or moderate likelihood of occurrence, but only two species were targeted during surveys. All species with a high or moderate likelihood should have been targeted. This may result in threatened species being impacted without adequate assessment.

Response

The focus of survey was on areas of public or protected lands likely to contain higher biodiversity values. This was discussed with EES during development of the methodology and during agency review of the draft EIS. EES noted that while it was understood that surveys could not be comprehensive given the scale of the Project, acknowledgement of this limitation in the assessment was recommended.

Section 4.5 of Appendix F2 acknowledges the limitations of the field survey and outlines how the assessment took a conservative approach such that all the biodiversity and conservation values of the assessed vegetation and habitat were captured.

Issue 8

Appendix F2 is inconsistent in stating how many flora species were targeted during surveys. Section 5.4.2 states targeted surveys were carried out for two flora species, but Section 4.2.5 states targeted surveys were carried out for 10 species.

Response

Section 4.2.5 in Appendix F2 provides the details of the survey effort while Section 5.4.2 outlines the outcomes of the survey but incorrectly identifies the targeted species. It is agreed that the wording is inconsistent around the term 'targeting'. A known population of *Acacia pubescens* was targeted for detailed recording of specimens. Occurrences of *Dillwynia tenuifolia* were also recorded. The other eight targeted species are those which could reasonably be expected to have been detected if present within the *Acacia pubescens* survey area. Efforts to target and map populations was restricted to the two species, *Acacia pubescens* and *Dillwynia tenuifolia*. Reference to all other threatened flora are considered to be opportunistic survey, through which an additional five species where found.

4.1.2.2 Potential threatened species

Issue 1

Several fauna species were not considered despite recent records in the locality (e.g. Eastern Osprey, Ruff, Red-necked Stint, Pacific Golden Plover, Wood Sandpiper and Marsh Sandpiper).

Response

A new search was undertaken on 28 June 2022 that confirmed that the Ruff, Red-necked Stint, Pacific Golden Plover, Wood Sandpiper and Marsh Sandpiper have been recorded within the search area. The search area comprised the PMF flood extent plus a two-kilometre buffer. These species are not listed as threatened under either the BC Act or the EPBC Act. They are however listed as migratory species under the EPBC Act.

Accordingly, as noted in Section 6.4.3 of Appendix F2, these species were not subject to the assessment provisions of the BC Act and were therefore not included in the likelihood of occurrence table. The Eastern Osprey is listed under the BC Act as a vulnerable species. The new search identified one record of an Eastern Osprey but this record was greater than 10 kilometres from the study area and hence was not included in the likelihood of occurrence table.

Migratory species were not identified as a controlling provision in Attachment A to the SEARs. As noted in Section 12.12.3 of Chapter 12 of the EIS

> *While the Project may impact on areas of vegetation utilised by some migratory species, overall it would likely not have a significant impact on migratory species listed under the EPBC Act.*

This conclusion is considered to apply to the additional migratory species noted.

Issue 2

There are a number of species with many records, which should have been listed as 'recorded' but were not (though it is acknowledged that amending them to 'recorded' would not change their assessment): *Marsdenia viridiflora*, *Micromyrtus blakelyi*, *M. minutiflora*, *Persoonia hirsuta*, *Pimelea spicata,* Pectoral Sandpiper.

Response

This has been checked. All of the species recorded within the study area have been included in Appendix A to Appendix F2. Within this Table there is a column indicating the source of the record, whether it is within the study area and whether it is within the 1 in 10 chance in a year flood extent. An additional column identifies whether there is a likelihood of occurrence of a species within the 1 in 10 chance in a year flood extent. The categories used are 'None', 'Low', 'Moderate' and 'Recorded' with definitions for these also provided in Appendix A.

As an example, *Marsdenia viridiflora* is identified as a NSW Atlas record, so therefore Yes for the study area, no for the 1 in10 chance in a year flood extent but is considered by the assessor as having a high likelihood of occurrence within the latter area. The Pectoral Sandpiper was identified as potentially present from the PMST results but no records were identified and the likelihood of occurrence for this species within the 1 in 10 chance in a year flood extent was assessed as low.

4.1.2.3 Minimum information requirements

Issue 1

Section 1.6 of Appendix F2 advises it was agreed with the OEH that the 10% AEP event downstream extent would comprise the targeted survey area for the downstream assessment. EES considers no such agreement was made.

Section 1.6 also advises it was agreed with the OEH that the survey and assessment of the downstream area would be truncated to the confluence of the Hawkesbury and Colo Rivers. EES considers no such agreement was made.

Response

The two matters noted above were agreed to in a meeting attended by representatives from OEH, DoEE, DPE and WaterNSW on 19 September 2017. This is documented in minutes of the meeting that were distributed to all attendees. OEH subsequently advised WaterNSW, via email dated 28 September 2017, that no additions or amendments to the minutes were required.

Issue 2

Except for PCT 725, none of the other vegetation condition classes in Appendix B of Appendix F2 for the PCT match the condition classes listed in Table 5-1 for that PCT e.g. for PCT 1106, Table 5-1 states there are four condition zones: moderate/good, moderate/good_good, moderate/good_med and moderate/good_low, but Appendix B states the condition classes are moderate/good_good, moderate/good_med, moderate/good_low and moderate/good_derived.

Response

The comment is noted. Appendix B to Appendix F2 provides the details of PCT types within the study area. The information summarised in Table 5-1 and Table 5-2 identifies PCT types with the survey area. The study area includes land within the existing PMF which is much larger than the survey area (land within the existing 1 in 10 chance in a year flood event). It is likely that the differences in condition classes relate to the differences in the areas.

Issue 3

Table 5-2 in Appendix F2 indicates some large areas of PCTs were not surveyed (e.g. all of PCT 1067 [despite 3.62 hectares occurring in the survey area] and over 200 hectares of the critically endangered ecological community (CEEC) Cumberland Plain Woodland (PCT 849) [i.e. all of PCT 849 apart from the 'Moderate/good low' vegetation zone area]). This creates a risk that some PCTs have been misidentified.

Response

This issue is noted in Section 4.5 (Survey limitations) of Appendix F2. It was recognised that not all of the survey area could be ground-truthed, and as a result aerial photographic interpretation coupled with the interpretation of soil profiles and existing vegetation mapping products was used to extrapolate the final vegetation mapping and understanding of fauna habitat. Using aerial photography to determine the condition classes of each PCT was restricted due to the inability to determine the weed coverage. For such vegetation, a conservative approach was taken to capture all potential floristic and structural value with the potential to occur with or without the presence of weeds, with such vegetation assigned to the 'Moderate/good' condition class. In assessing the extent of TECs and threatened fauna habitat, this approach was used to ensure all the biodiversity and conservation value of the assessed vegetation and habitat was captured. This represents a precautionary approach to identification of PCTs and TECs using available information.

Issue 4

The description of weather conditions during surveys is too broad to be instructive i.e. 'temperatures higher than average'. No specific detail is provided about the weather conditions on the days of survey.

Response

Figures 4-3 and 4-4 in Appendix F2 present the temperature and rainfall records graphically for the period covering the downstream field surveys between 20 November 2017 and 13 February 2018.

Issue 5

The SEARs include the requirement for a 'description of the likely impacts on biodiversity' and Section 6.1 of Appendix F2 contains an 'impact and risk assessment methodology'. It is noted that an impact risk assessment has been done as well as an assessment of significance for many species. But there is no 'impact assessment' as such.

Response

For the assessment of downstream impacts, a risk-based approach was used. This is because the nature of impact depends on changes to the risk of flood events having an impact on species or communities. Further information has been included in the assessment to justify this approach which is supported by additional information undertaken post exhibition on downstream impacts on groundwater, geomorphology and ecology presented in this report and the PIR.

Issue 6

Section 6 only discusses 'impacts', there is no distinction made between which are direct or indirect. The SEARs specifically require assessments of direct and indirect impacts.

Response

All of the impacts downstream are considered indirect impacts as per the definition provided in the glossary of Appendix F2.

Issue 7

The SEARs also require that 'where possible', impacts are quantified, but this has not been done and there is no justification provided on why it could not be done (although it is noted there is some quantification of impacts for some species in the assessments of significance).

Response

Quantification of impacts in Appendix F2 is limited to identifying the area of the endangered ecological community or species habitat potentially affected by the Project. The matter of an actual impact will be dependent on a range of factors including apportioning the potential impact of the Project relative to other influences in the downstream catchment. This is noted at the beginning of Section 6 of Appendix F2.

Issue 8

Section 6.4.1 advises PCTs listed as CEECs under the *Biodiversity Conservation Act 2016* were assigned a high-risk rating (in Table 6-4). This rating should also have been applied to PCTs listed as CEECs under the *Environment Protection and Biodiversity Conservation Act 1999*.

Response

It is agreed that this rating should also have been applied to PCTs listed as CEECs under the EPBC Act. The risk rating was used to identify which communities required further assessment through an Assessment of Significance which is provided in Appendices F2 and F5. All of the EPBC Act CEECs were subject to an Assessment of Significance regardless of the risk rating applied in Table 6-4.

Issue 9

The SEARs require an assessment of the likely impacts on wildlife corridors. This is addressed in a few paragraphs in Section 6.8, but the discussion is very broad and is mostly a general discussion of how corridors can be affected rather than any assessment of the impacts of the Project. There is no identification of biodiversity links and corridors in the study area. There is no assessment of whether any specific areas are at higher risk, or any assessment of the degree to which corridors will be affected.

Response

Drawing on the spatial data set Cumberland Subregion BIO Map Biodiversity Corridors of Regional Significance[13], it is noted that there are two areas (Regional Corridor 32, Regional Corridor 33) that occur along the Hawkesbury River in proximity to the FMZ discharge zone. Other corridors in proximity to the FMZ discharge zone are:

- Regional Corridor 5 which occurs along South Creek
- Regional Corridor 22 which occurs along Rickabys Creek.

For the above two corridors, only parts of the corridor are in in proximity to the FMZ discharge zone.

All of the above corridors are riparian corridors. Flooding is an existing risk to movement along these biodiversity corridors. Operation of the FMZ discharge zone would increase the duration of low-level flooding for up to 14 days depending on the magnitude of the inflow flood event. This would have minimal effect on fauna movements along the corridor. Vegetation in riparian corridors is typically tolerant of temporary inundation and it is not anticipated that there would be a material impact from the Project.

Issue 10

There is inadequate justification for the assigned consequences of impacts. Table 6-3 states, for example, advises in relation to the potential impacts of a reduced flooding extent in wetland and

13 https://datasets.seed.nsw.gov.au/dataset/cumberland-subregion-bio-map-biodiversity-corridors-of-regional-significance38691/resource/d79d8ff5-7d49-4b6a-9f78-b788f26799d3

floodplain vegetation communities and habitats that: The gradual nature of change would be difficult to measure and to accurately differentiate the impact of the Project from broader changes within the catchment. However, it does not follow that if changes are difficult to measure, they are therefore not significant. EES also disagrees with other comments in this table such as:

- That the consequences of bank erosion, which the EIS lists as likely, would be minor
- That the consequences of displacement of habitat for fauna dependent on riparian or wetland habitats would be only moderate
- That the reduction in flooding extent in wetland and floodplain vegetation communities and habitats would only be of medium consequence
- That the consequences of the increased duration of inundation in wetland and floodplain vegetation communities and habitats would be insignificant, as these areas are currently subject to wet periods and flooding events. However, the Project will result in changes to the frequency and duration of these flood events.

Response

Section 4.2.2 of this report provides further information related to potential impacts on groundwater and bank erosion (and related matters such as GDEs) based on the expert technical reviews provided as Appendix E and Appendix G respectively to this report.

Issue 11

Table 6-5 lists that the impact risk to threatened flora species are all medium or low, except for critically endangered species. However, EES considers the impacts on some riparian species are likely to be high particularly *Eucalyptus benthamii* and *Pomaderris brunnea*.

Response

Table 6-5 in Appendix F2 provides justification for the assigned impact risk for each species. With regard to *Eucalyptus benthamii* and *Pomaderris brunnea*. The respective justifications for these two species are

> *Requires deep alluvial soils and a flooding regime that permits seedling establishment (OEH website). Based on current known records and habitat requirements, this species may be sensitive to changes to the downstream flooding regime. The likelihood of significant changes to the downstream flooding regime due to the Project is considered low, and noting the contributions from other downstream catchments.*

and

> *A single record of this species occurs adjacent to the Colo River. It is known to occur in moist woodland or forest on floodplains and creek lines. This species may be sensitive to flooding regime changes as a result of the Project.*

No specific details have been provided by EES with regard to the different view for justification of the assigned risk ratings for these two species which limits providing a meaningful response.

The NPWS environmental assessment guidelines for *Eucalyptus benthamii*[14] note that the life cycle of this species may be affected by prevention of major flood events which reduces broadscale silt deposition, in turn reducing germination opportunities. The Project would reduce the extent of

[14] https://www.environment.nsw.gov.au/resources/nature/EbenthamiiEia0500.pdf

flooding downstream but there would still be overbank flooding contributing to deposition of silt on the floodplain.

Further information on the significance of impacts for these species has been prepared based on additional information developed following the EIS exhibition (refer Section 6.2 in the PIR).

Issue 12

The outcomes of all the assessments of significance in Table 6-7 are that a significant impact is only ‘unlikely’ or ‘potential’. No species are assessed as being likely to be significantly impacted. It is not adequate to conclude that a ‘potential’ significant impact is likely: the assessment should be definitive on this matter. It is noted that for a number of threatened communities listed in Table 6-7, the result for four out of five of the applicable assessment criteria is that a negative impact is likely for that criterion, however the overall conclusion is only ‘potential’. Such outcomes are not adequately justified.

Response

The Assessments of Significance where it was concluded there could be a potential impact due to the Project have been reviewed considering the findings of the additional investigations relating to temporary inundation of vegetation and downstream geomorphology. The reviews concluded that, taking a precautionary position, it was likely that the Project would have a significant impact on *Pomaderris brunnea* and *Rhodamnia rubescens*. Further details regarding the revised conclusions are provided in Section 6.2.3 of the PIR.

Issue 13

For the assessment of impacts on GDEs, the EIS argues that while the frequency of overbank flooding would be reduced in some areas, during flood mitigation zone (FMZ) discharge there would be higher levels and an increased flow, which would replenish aquifers, mitigating impacts. There are many assumptions in this statements that are not adequately justified.

Response

Further detailed consideration of potential impacts on groundwater is presented in the expert technical review provided as Appendix E to this report. This provides evidence to support the impact assessment in the EIS that there is a low risk of potential impacts to groundwater systems and GDEs because of the Project.

The additional analysis provided in the expert technical review supports the conclusions of the assessment in the EIS with regard to the likely limited impact on the recharge of the downstream alluvial aquifer. As the review notes, the alluvial aquifers are recharged predominantly via direct rainfall recharge, along with stormwater from ephemeral creeks and urban areas. Occasional overbank flooding surcharges groundwater levels for short periods but this water then drains back to the Nepean/Hawkesbury River.

As noted in Section 9.5.1 of the EIS, the four high priority GDEs identified in the *Greater Metropolitan Region Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources* (NSW Office of Water 2011), these being Pitt Town Lagoon, Long Swamp, Longneck Lagoon, and O’Hares Creek, would not be affected by the Project. The location of each GDE relative to selected flood events was reviewed using GIS and all would continue to be inundated by the 1 in 5 chance in a year event and larger events with the Project.

Issue 14

The mitigation measures proposed are inadequate. Only one is proposed, as described in Table 7-1: that an operational protocol for FMZ be developed to minimise potential impacts on downstream native vegetation from inundation. The objectives of the protocol also include reducing impacts on life and property. Therefore, EES considers the protocol is unlikely to provide much mitigation for biodiversity impacts as the protocol objectives for reducing impacts on life and property are always likely to be more important than objectives around biodiversity impact.

Response

The Project would reduce the depth, duration, and general extent of flooding downstream of Warragamba Dam (with the exception of low-lying areas affected by operation of the FMZ which would experience an extended period of temporary inundation), equating to a reduced risk of impact from flooding. Sections 4.2.2 and 4.2.4of this report provide further information related to potential impacts on groundwater and bank erosion (and related matters such as GDEs) based on the expert technical review provided as Appendix E and the technical note provided in Appendix G respectively to this report. This supports the conclusions of the impact assessment in the EIS, i.e. that there is a low risk of potential impacts to groundwater systems and users (both human and environmental) or to erosion and slumping of streambanks because of the Project. Given this reduced risk of impact, no specific mitigation measures are proposed for a reduction in flooding extent.

Issue 15

There are no mitigation measures proposed for a reduction in flooding extent.

Response

Section 7.1 of Appendix F2 discusses measure to avoid impacts while Section 7.3 identifies that development of the operational protocol for the FMZ would seek to minimise potential impacts on downstream vegetation from temporary inundation subject to meeting operational priorities for protection of life and property.

It is not considered practicable to consider potential mitigation measures to modify downstream flood extent through a revision of the design of the dam wall height.

Further detailed consideration of potential impacts on groundwater is presented in the expert technical review provided as Appendix E to this report. This provides evidence to support the impact assessment in the EIS that there is a low risk of potential impacts to groundwater systems and GDEs from a reduced flooding extent. As such no mitigation measures are considered necessary in this regard.

4.1.2.4 Offsets

Issue 1

An offsets package is not proposed. Section 7.2 of Appendix F2 under *Requirement to offset* states

> *As outlined in Section 2(h) of Attachment B (of the SEARs), where the Project cannot adequately avoid or mitigate impacts on downstream biodiversity, such that there are no residual impacts from the Project, then a biodiversity offset package should be considered.*

However, this wording is incorrect. The SEARs state that a biodiversity offset package is expected.

Section 7.2 states

> *For the purposes of this assessment, residual impacts are those which will likely have a 'significant impact' on threatened biota as determined by the assessment of significance.*

However, this is inconsistent with the SEARs, which state that any residual impacts must be offset not just the significant ones.

Response

WaterNSW confirms that an offsets package with regard to downstream biodiversity is not proposed. The justification for this is provided in Section 7.2 of Appendix F2 which notes that

> *The primary purpose of offsetting is to facilitate development in an environmentally sustainable manner, and to ensure development does not have unacceptable impacts on native ecosystems and species.*[15]

The outcome of a groundwater assessment determined that the Warragamba Dam Raising Project was not an aquifer interference activity and therefore will not impact on groundwater dependant ecosystems through a reduction in out of bank flooding. There is a positive impact on other riparian vegetation through the reduction in extent of out-of-bank flooding through operation of the FMZ.

Existing flooding already results in banks reaching their saturation limit causing slumping, therefore the consequence of releasing the FMZ within bank over a longer period will not have an incremental impact.

It is noted that that residual impacts to be considered relate to impacts on downstream biodiversity. Section 2(h) of Attachment B to the SEARs states:

> *Description of the residual impacts of the proposal. If the proposal cannot adequately avoid or mitigate impacts on downstream biodiversity, then a biodiversity offset package is expected (see the requirements for this at point 6 below).*

Based on the assessment and consideration of the additional studies undertaken that it is unlikely that there will be residual impacts from the Project.

It is noted that there is no 'point 6 below' included in Attachment B to the SEARs

Issue 2

Section 7.2 does not recommend any monitoring as 'it is unlikely that monitoring would be able to differentiate between potential impacts resulting from the Project and from other downstream factors.' EES does not agree with this statement and considers monitoring an important tool to inform ongoing management of the dam to reduce impacts.

Response

WaterNSW notes the advice and confirms that no monitoring is being proposed and considers no further response is required for this issue based on the reasoning in the EIS.

4.1.2.5 Likely impacts (both direct and indirect) on downstream land reserved under the National Parks and Wildlife Act 1974

Section 6.9 advises that Scheyville and Cattai National Parks would experience the greatest reductions in flooding extents but would experience a longer duration of low-level flooding due to

[15] https://www.environment.nsw.gov.au/topics/animals-and-plants/biodiversity-offsets-scheme/about-the-biodiversity-offsets-scheme/how-the-biodiversity-offsets-scheme-works

the discharge of water from the FMZ. Section 6.9 also states that the actual areas affected relative to the overall areas of these national parks would be very small but there are no figures provided to quantify this. This section also advises the reduction in flood extent, depth and duration will not cause significant biodiversity impacts but there is nothing further to justify this claim. These national parks contain regionally significant remnants of CEECs, endangered ecological communities and threatened species. The guidelines for developments adjoining national parks estate, which were supposed to be referenced but were not, make it clear that developments should seek to avoid (and then minimise and mitigate) any direct or indirect adverse impacts on reserved lands.

Response

The guideline *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft)* (DEC 2004) is included in the list of references provided in Section 9 of Appendix F2 and is referenced variously throughout the report.

Section 7.1 of Appendix F2 discusses measure to avoid impacts while Section 7.3 identifies that development of the operational protocol for the FMZ would seek to minimise potential impacts on downstream vegetation from temporary inundation subject to meeting operational priorities for protection of life and property.

With regard to Scheyville National Park and Cattai National Park, these two areas would experience a reduction in the frequency, extent and depth of temporary inundation (like the entire downstream area). Between 19 February 1992 and 2 March 2012 there were no flood flows from Warragamba Dam apart from a minor spill between 24-28 August 1998. This strongly suggests that the ecosystems in these areas are not reliant on flood releases from Warragamba Dam for them to be sustained.

Additional investigation, including field observations and reference to historical data, has been carried out for Longneck Lagoon which is located just to the north of Scheyville National Park and would have broadly similar environmental conditions. The outcomes of this investigation are provided in Section 6.6 of the PIR.

4.1.3 Biodiversity – downstream (bilateral assessment)

The following issues relate to the assessment of downstream impacts only and are in relation to Appendix F5 *Matters of National Environmental Significance – Biodiversity* of the EIS unless stated otherwise.

4.1.3.1 Identification of MNES – Biodiversity

Issue 1

There are a number of records in BioNet of the following migratory species in the Project area, but they have not been considered in Appendix F5: Red-necked Stint, Ruff, Pacific Golden Plover, Wood Sandpiper; Marsh Sandpiper. It is noted that none of these species are listed in Attachment 1 to the SEARs (that lists which EPBC Act-listed species must be considered).

Attachment 1 of the SEARs lists a number of species to be considered in the EIS. All species and TECs listed as downstream only have been considered in the EIS. The species and TECs not listed as downstream only are considered in the upstream bilateral assessment.

Response

A new search was undertaken on 28 June 2022 that confirmed that the Ruff, Red-necked Stint, Pacific Golden Plover, Wood Sandpiper and Marsh Sandpiper have been recorded within the search area. The search area comprised the PMF flood extent plus a two-kilometre buffer. These species are not listed as threatened under either the BC Act or the EPBC Act. They are however listed as migratory species under the EPBC Act.

Migratory species were not identified as a controlling provision in Attachment A to the SEARs. As noted in Section 12.12.3 of Chapter 12 of the EIS

> *While the Project may impact on areas of vegetation utilised by some migratory species, overall it would likely not have a significant impact on migratory species listed under the EPBC Act.*

This conclusion is considered to apply to the additional migratory species noted.

Issue 2

The FBA has not been applied in relation to this EIS as the FBA cannot adequately assess overland flow impacts. In the absence of a methodology, the adequacy of the EIS has been assessed against the survey and assessment requirements in the SEARs. The EIS has addressed all EPBC Act-listed species except those identified above.

Response

WaterNSW notes the advice and considers no further response is required for this issue.

Issue 3

The species listed above have not been addressed in the EIS. The SEARs require that the EIS determine the list of potential threatened species for the site using databases such as BioNet. Given that there are records for the species listed in BioNet, then it can be concluded these species have not been addressed in accordance with the SEARs.

Table 7-3 lists EPBC Act-listed fauna species identified as potentially occurring in the Project area. Table 7-13 lists EPBC Act-listed fauna species recorded within the downstream study area or identified from database searches. Table 8-3 provides a likelihood of occurrence of threatened species.

Response

WaterNSW refers to the above response noting a new search was undertaken on 28 June 2022 which confirmed that the Ruff, Red-necked Stint, Pacific Golden Plover, Wood Sandpiper and Marsh Sandpiper have been recorded within the search area. The search area comprised the PMF flood extent plus a two-kilometre buffer. These species are not listed as threatened under either the BC Act or the EPBC Act. They are however listed as migratory species under the EPBC Act.

Issue 4

The EIS makes no mention of the species listed above. Table 10-1 lists the results of the assessments of significant impact for 94 species and communities. Of these, 63 species/TECs are considered likely to be significantly impacted (i.e. six percent), and 31 are considered unlikely to be significantly impacted. It is noted there is no determination on whether it is the upstream, downstream or construction site impacts that are causing the significant impact.

Threatened species and TECs recorded in the study area or identified from database searches are detailed in Tables 7-12, 7-13 and 7-15. An assessment of significance has been completed for all of these, except *Lasiopetalum joyceae*. There are two records of this species in the affected downstream area in BioNet, so an assessment of significance should have been completed.

Response

The EIS noted that one record of this species (*Lasiopetalum joycae*) is located near the downstream study area boundary. This species is known to occur on ridgetops on the Hornsby Plateau[16]. This species is unlikely to occur in the area subject to flooding regime changes. In view of this, an assessment of significance was not undertaken.

Issue 5

EES considers further information from the proponent is critical to the assessment on MNES. The inadequacies regarding the analysis of impacts, avoidance, mitigation and offsetting are outlined elsewhere in this document, along with the further information required.

The adequacy of vegetation mapping has been separately assessed.

Response

Further information regarding the impact on MNES species has been prepared based on new information provided after the EIS was placed on exhibition and is provided in Section 6.2.3 of the PIR.

4.1.3.2 Assessment of the relevant impacts

Issue 1

There are no measures proposed to mitigate impacts, except for a statement that environmental management plans will be prepared.

There are no offsets proposed for downstream impacts. The EIS states that development of the operational protocol for the FMZ would seek to minimise potential impacts on downstream vegetation from temporary inundation subject to meeting operational priorities for protection of life and property.

Response

WaterNSW notes the advice and considers no further response is required for this issue but also refers to earlier responses related to no downstream offsets.

Issue 2

Turpentine-Ironbark Forest of the Sydney Basin Bioregion: In response to the criterion *will the action cause a substantial change in species composition of an occurrence of an ecological community*, the EIS identifies that gradual alterations to the structure of the community may occur over an extended dry period. However, the EIS then states that this would not result in complete loss of the TEC, and therefore, the Project is unlikely to have an adverse effect on the composition of the ecological community. However, the complete loss of the TEC is not relevant to this criterion. Given the critically endangered status of this TEC, EES considers the Project may have a significant impact on this TEC, given potential changes in species composition.

Response

The EIS noted that there is a practical challenge in applying the significant impact assessment guidelines for the Project, particularly for TECs and threatened flora, as the nature and magnitude of potential impacts area uncertain and will be dependent greatly on the frequency of the flood event, the depth and duration of temporary inundation, and the associated tolerance of vegetation to temporary inundation. The EIS considered the potential impacts that could result

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[16] https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10451

from changes to hydrology. These include the potential for gradual alterations to the structure of the community that may occur over an extended dry period. The assessors concluded that this was unlikely to occur as a result of the Project and therefore was unlikely to be a significant impact. The conclusion was drawn considering a range of factors. WaterNSW agrees that complete loss is not relevant to this criterion.

Issue 3

Swift Parrot: The EIS states the Project will likely modify, destroy, remove or decrease the availability or quality of habitat of an estimated 761 hectares of suitable or potential foraging habitat. However, it says that given the nature of the predicted impact of the Project, it is unlikely the action will lead to a long-term decrease in population size. EES does not consider this to be adequate justification. Given the large scale of the predicted impact to foraging habitat, EES considers that there may be a significant impact on this critically endangered species.

Response

An assessment of significance for downstream concluded significant impact is not likely. The assessment discussed potential impact to 761 hectares of suitable or potential foraging habitat. As noted above this was based on a precautionary approach. It is unlikely that this downstream habitat would be altered as a result of the Project such that it reduced suitable or potential foraging habitat.

Issue 4

Grey-headed Flying-fox (GHFF): The EIS states that three GHFF camps are known from the downstream impact area, none of which are listed as Nationally Important camps. The EIS acknowledges the Project would require removal of critical foraging habitat, which may result in a long-term decrease of the size of an important population. The Project may remove or modify an estimated 3,827 hectares of foraging habitat. The EIS also acknowledges the Project could affect habitat critical to the survival of the species and that the species may decline as a result of the Project. However, the EIS argues that because significant areas of foraging habitat would remain at the local and regional scale, the impacts are not significant. EES considers this argument is unconvincing given the proposed removal or modification to a large area of foraging habitat and given the acknowledgement that the Project is likely to affect critical habitats and lead to species declines.

Response

An assessment of significance for downstream concluded significant impact is not likely. The assessment discussed potential impacts to 3,827 hectares of foraging habitat. As noted above, this was based on a precautionary approach. It is unlikely that this downstream habitat would be altered such that the foraging habitat for the GHFF would be reduced.

4.1.3.3 Avoid, mitigate and offset

Issue 1

The measures to avoid and minimise impacts have been described in Chapter 4 of the EIS. They are also discussed in Section 13.1 and Table 13-1 of Appendix F5. There are no specific gaps in relation to the discussion on Commonwealth matters compared to state-listed entities.

Response

WaterNSW notes the advice and considers no further response is required for this issue.

Issue 2

The SEARs require the EIS includes discussion of how long-term management arrangements will be guaranteed. There is only one mitigation measure proposed, that an 'operational protocol for the FMZ' would be developed, which would 'seek to minimise potential impacts on downstream vegetation from temporary inundation subject to meeting operational priorities for protection of life and property'. The main EIS volume (Chapter 29, Section 29.3) states that this operational protocol would need to be developed during the detailed design of the Project and in consultation with relevant stakeholders up and downstream of the dam. There is no more detail provided in the EIS on the operational protocol.

Table 29-17 of the EIS states that the operational protocol will 'need to balance the multiple objectives from the FMZ, upstream inundation, environmental flows and downstream riverine requirements. The outcome will be to minimise as much as possible the inundation durations in upstream areas and reduce downstream flooding'. Therefore, it appears that while the aim of the operational protocol may be partly to reduce biodiversity impacts downstream, there are also other priorities that will be taken into account in the operational protocol, which may mean biodiversity is given a lower priority compared to these other factors. As such, EES does not consider the EIS provides any tangible mitigation measures for biodiversity. In addition, EES considers the EIS does not provide detail on how long-term management arrangements will be guaranteed, as required by the SEARs.

Response

Long term management arrangements already exist for current flood operations and are anticipated to be maintained albeit possibly modified where identified from the EIS assessment outcomes. WaterNSW, SES and the Bureau of Meteorology (BOM) are the key agencies that are identified under the NSW State Flood Plan for flood incident management.

WaterNSW must apply appropriate due diligence in relation to its operations. In relation to the operations of its dams and other structures it must operate the structures to minimise risk to other stakeholders as far as reasonably possible.

The objective of flood operations is therefore to operate the dam:

- To protect the structure from failure
- To leave the storage full at the end of the flood
- Where it does not impede the first two objectives and where feasible and practicable, seek to mitigate the impact of the flood on downstream communities.

WaterNSW has established a flood operations framework in accordance with the NSW State Flood Sub Plan and to meet other key legislative requirements. The purpose of the framework is to outline the WaterNSW roles and responsibilities in relation to flood management and the process and procedures in place to meet these requirements.

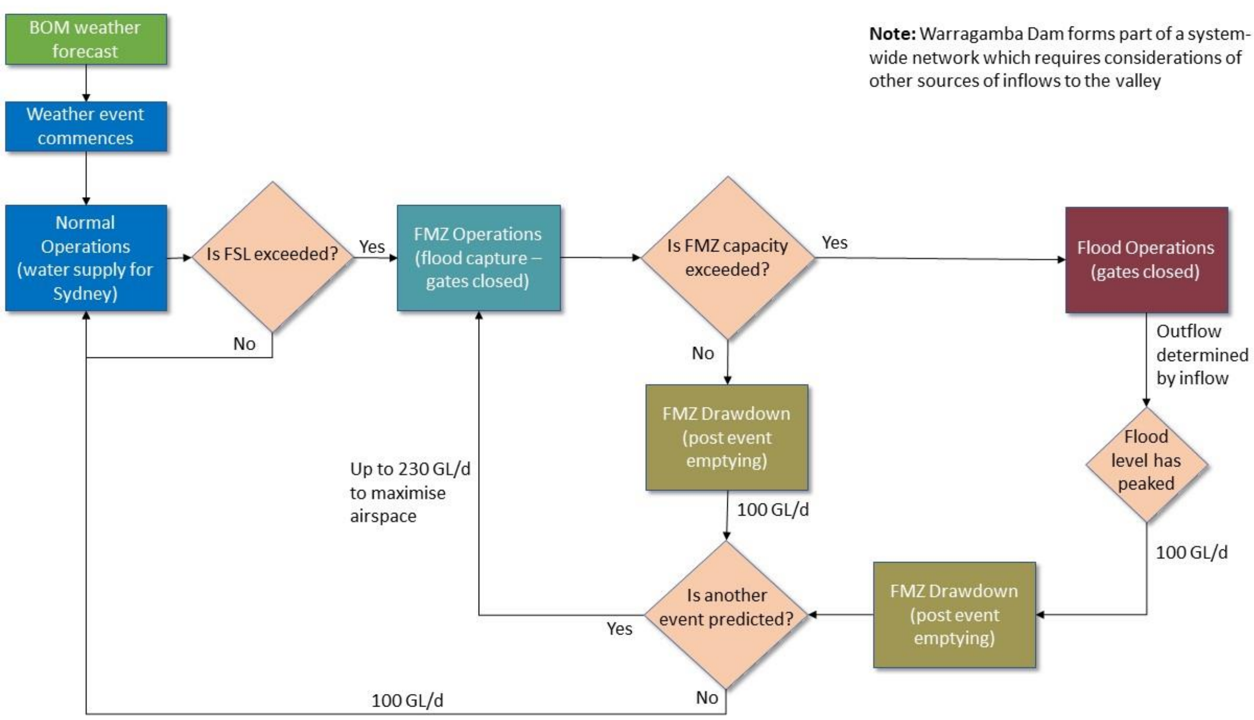
The EIS flood extents downstream were modelled using the operating objectives noted in the EIS and an FMZ drawdown framework that used a targeted duration to drawdown the FMZ back to FSL within 14 days.

The outflow modelling for the EIS takes into account the sizing of the FMZ gated outlets which have a designed maximum discharge rate of 230 GL/d which can be initiated for about 2-3 days if required should there may be another subsequent flood event due prior to the FMZ being emptied. Thereafter this rate is reduced to 100 GL/d in a constant flow until the FMZ is discharged and the lake level returns to the existing FSL. If there is no forecast subsequent event, a lower constant discharge of around 100 GL/d is modelled to draw down the water level to FSL again and limit further downstream flooding.

Therefore, during the constant discharge flow, water in the FMZ will be released in a controlled manner through the gated outlets and discharged at a rate that does not cause further impacts that exceed the previous flood level peak as the level recedes gradually back to normal river levels. The constant discharge to draw down the FMZ can also be varied below the constant rate should the Warragamba catchment contribution be required to ramp down in response to other sources of flooding impacts as part of the current flood incident management operations for the valley.

For flood events that exceed the FMZ capacity, the operator would not initiate the new gates until the flood peak has passed and therefore has no ability to control water discharging over the crests.

Figure 4-1 Flood operations flow chart



For the EIS modelling, the drawdown is based on the lake level and operators would use the Minimum Discharge Lookup Table that would be included in the operating rules verified in the modelling to identify the release rates based on the maximum lake level (peak level). The table identifies the flow rates that need to be released and the time it will take at that rate to empty the full FMZ. The flood would need to be in recession before the gates start any opening sequence.

Further details on flood incident management, dam operations and the drawdown framework are provided in Appendix B to the PIR.

4.1.3.4 Offsetting

The SEARs (Attachment A – guidelines for EPBC Act assessment) require that 'where a significant residual adverse impact to a relevant protected matter is considered likely, the EIS must provide information on the proposed offset strategy'. Appendix F5 lists 63 species that the EIS considers are likely to be significantly impacted by the Project, however, no offsets are proposed. This includes a number of the species that listed in the referral documents as impacted downstream only. There are also no comments on why offsets are not proposed.

Response

WaterNSW confirms that an offsets package with regard to downstream biodiversity is not proposed. The justification for this is provided in Section 7.2 of Appendix F2 and in the above responses.

4.1.3.5 Referencing of information and data used for the assessment

The data sources used in the EIS are listed in Table 6-1 and included the PMST, SPRAT profiles, NSW BioNet threatened species records and profiles, BioNet vegetation classification, Biodiversity Values Map, Atlas of Groundwater Dependent Ecosystems, Directory of Important Wetlands and Mitchell Landscapes layer. EES supports the use of all these data sources as being the most accurate and reliable data sources available.

Response

WaterNSW notes the advice and considers no further response is required for this issue.

4.1.4 Biodiversity – construction area

4.1.4.1 Agreed modifications to the Framework for Biodiversity Assessment (FBA)

Under the Secretary's Environmental Assessment Requirements, EES can agree to approaches for assessing biodiversity impacts different to the FBA. In pre-exhibition discussions between Planning and Assessment Group, EES, the Commonwealth Department of Agriculture, Water and the Environment, and WaterNSW, the following modifications to the FBA were agreed:

- Surrogate plots could be used where insufficient plots were not able to be surveyed on the construction area site. Except where noted below, this has been implemented acceptably
- Plots outside of the construction area site could be used. Except where noted below, this has been implemented acceptably
- Assumed presence be used, based on PCT associations, to develop species polygons for the purposes of calculating species credit requirements for offsets.

Response

WaterNSW notes the advice and considers no further response is required for this issue.

4.1.4.2 PCT and TEC mapping

Issue

Nine of the 12 plots conducted for this assessment (not including surrogate plots but including those off site) were provided to Vegetation Classification and Ecology as part of the assessment for the upstream BAR (the plots were in the same dataset). These were analysed as part of that work and it is recommended the following plots have their PCT assignments amended.

Table 4-2 Recommended amended PCTs for construction area assessment

BAR Site label	BAR assigned PCT	Recommended amended PCT
US1	1083	1081
US10	1083	1181
US11	1081	1181
US12	1081	1181
US2	1081	1181
US6	1083	1081
US8	1083	1081

These re-assignments would also mean that Vegetation Zones 1 and 2 are now assessed using plots from more than one PCT.

It is also recommended that:

- Data from Plots US3-5 be analysed using the Plot to PCT Assignment Tool to determine if alternative PCTs should be assigned to these plots.
- Mapping of PCTs be revised based on the recommended plot PCT assignments.
- Where vegetation zones no longer have sufficient plot data to meet FBA requirements, additional plot surveys be undertaken.

Only surrogate plots have been used for Vegetation Zone 5 due to site access limitations. This was discussed in meetings with WaterNSW and is considered appropriate. However, the revision of the PCT identification and mapping may mean that surrogate data for an alternative PCT needs to be used.

Figure 4-2 of the BAR shows apparent vegetation within the development site that is not mapped as native vegetation nor as a PCT. It is recommended the assessor clarify whether the vegetation is native, whether it will be cleared as part of the development and, if so, assign PCTs and include it in the assessment of impacts.

EES notes the BAR advice that 'WaterNSW has recently carried out approved vegetation clearing around built structures for the purposes of asset protection in relation to bushfire risk. This clearing has reduced the area of vegetation mapped by SMEC by 0.15 hectares' (Section 3.6, page 25). It is recommended this area be identified on a map to assist in clarifying the assessment.

Response

The recommendations have been reviewed by an ecologist including through a site visit. The suggested alternative PCT assignments have been agreed.

The apparent vegetation has been reviewed by the assessor. These areas were not classified as PCTs because they comprised parkland and an area of land within the auxiliary spillway. The assessor has investigated the site and mapped the area in detail identified vegetation within the parkland that contains elements of PCT and classified it as such. This area is not subject to clearing for the project. The second area within the spillway contains no vegetation; the apparent vegetation appears to be a shadow created by the spillway walls.

The area of land already cleared has been identified.

4.1.4.3 Threatened species assessment

Large-eared Pied Bat is only a species credit species when caves and other suitable habitat is present. These have been determined to not be present. There is, therefore, no need to provide a species polygon and calculated species credits for this species.

The Common Planigale has previously been recorded from the site. Because the species was not recaptured with additional survey effort, this species is now considered by the assessor to be absent. The species is known to be notoriously difficult to detect, even when known to be present. In addition, the assessor has used Elliott trapping to target the species planigale which is considered an ineffective technique for detecting. Given some of the survey methods employed are unsuitable and the species has been recorded on site previously, the Common Planigale should be included within the list of the species assumed to be present within the development site. A species polygon should therefore be provided and credits calculated.

Vegetation Zone 5 has not had any threatened species polygons associated with it. Further detail on past disturbance is required before this can be accepted, especially for fauna. Indirect impacts on retained Shale Sandstone Transition Forest (SSTF) through temporary inundation or flooding are not discussed. Further information should be provided to demonstrate whether such impacts are likely and, if so, whether that could alter abiotic factors critical to the long-term survival of the retained SSTF vegetation.

Targeted surveys would increase the certainty around the assessment of threatened species that are matters for further consideration. Offsets calculated by the FBA are not necessarily a measure that contributes to the recovery of a species or a Threatened Ecological Community. As these entities are matters for consideration that are of particular concern, additional offsets or other measures will need to be considered in any conditions of approval. These include implementing actions from the Save Our Species database both on site (as part of the Construction Environmental Management Plan and ongoing management) and funding those actions at other sites.

Response

The FBA assessment calculation has been redone noting the advice on the Common Planigale and the Large-eared Pied Bat.

Vegetation Zone 5 is the area below the dam wall adjacent to the waterway. It is an area that is highly disturbed due to its location and it was difficult to assign a PCT. Access for plots was not possible due to the location. The assessor reviewed the classification and discussed the original assessment with the ecologist at the time. A site visit indicate that there was minimal habitat present – primarily bare rock. It is considered that the inclusion of Vegetation Zone 5 in the assessment and ecosystem credit calculation reflects a precautionary approach.

4.1.4.4 Other matters

The development footprint in Figure 7-1, Appendix F3 is a series of disconnected vegetation patches within the larger development site. There has been no reference to access roads on the plan of the development footprint. The assessor should clarify whether these are connected by an existing road network. If not, any additional clearing for roads should be assessed as part of the BAR.

Response

It is confirmed that access roads are not included within the retained vegetation areas. No additional clearing for roads will be required.

4.1.5 Biodiversity – upstream and construction area (preliminary bilateral assessment)

4.1.5.1 Identification of MNES – Biodiversity

Table 6-1 of the MNES - Biodiversity report specifies the databases that have been used to identify potential biodiversity MNES. The Project Assessment Notes supplied by the Department of Agriculture, Water and the Environment (then DEE) list the upstream and construction area impacts:

- two threatened flora species (*Eucalyptus benthamii* and *Hakea dohertyi*) are considered likely to be significantly affected by the proposal
- 13 other threatened flora species may also be impacted
- three threatened fauna species (Regent Honeyeater (*Anthochaera phrygia*), Grey-headed Flying-fox (*Pteropus poliocephalus*) and Large-eared Pied Bat (*Chalinolobus dwyeri*)) are considered likely to be significantly affected by the proposal
- 14 other threatened fauna species may also be impacted
- two threatened ecological communities (White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (WBYBBRGGW) and Shale Sandstone Transition Forest of the Sydney Basin Bioregion (SSTF)) are considered likely to be significantly affected by the proposal
- seven other threatened ecological communities may also be impacted.

The MNES – Biodiversity report (Tables 8-2, 8-3 and, 8-4)1 has assessed the likelihood of occurrence of:

- 20 threatened ecological communities (TECs)
- 100 threatened flora species
- 37 threatened fauna species.

The report has used all primary data sources to identify likely species. These include:

- DAWE Protected Matters Search Tool
- DAWE Directory of Important Wetlands in Australia
- DAWE Species Profiles and Threats Database
- DPE BioNet
- DPE Threatened Biodiversity Profile Search
- DPE BioNet Vegetation Classification

Persoonia mollis subsp. revoluta (EPBC – vulnerable) was found in the construction area during the surveys for the proposal. It was listed on the EPBC Act in June 2021 and is not assessed. Under section 158A of the EPBC Act, new listings that happen after a controlled action decision do not apply to the assessment or further approval process decisions. The controlled action decision for this proposal predates the listing of this species so it is not required to be assessed.

DPE is not aware of any other EPBC-listed species that should have been considered in the assessment.

Response

WaterNSW notes the advice and considers no further response is required for this issue.

4.1.5.2 Assessment of the relevant impacts

The FBA, as modified by agreement, has been applied to all species and TECs that occur, or are assumed to occur, in the upstream and construction assessment areas. BARs for these assessments have been reviewed separately. There are several recommendations for changes to the assessment as a result of that review. These relate primarily to mapping of PCTs (and, consequently, TECs) and species polygons.

The SEARs Attachment A, the Commonwealth requirements, address migratory species that are not NSW threatened species and SEARs Attachment B, the assessment requirements for the Downstream EIS. No migratory species (that aren't also threatened species) are noted in the referral documents.

Migratory species are addressed in 7.7, 8.3, 10, 11.2 and 12.2.4 of the MNES Report. It is concluded that the proposal is not likely to have a significant impact on any migratory species. It is considered that the assessment of migratory species is in accordance with the SEARs.

As the biodiversity assessment reports (BARs) have assumed species presence for most threatened species reviewed (for the purposes of credit calculations), the definitive assessment of impacts has been difficult. The MNES report has described the types of potential impacts and their extents.

Response

WaterNSW notes the advice and considers no further response is required for this issue.

4.1.5.3 Avoid, mitigate and offset

A review of avoidance and mitigation for the two BARs has been conducted separately. In summary, once the decision to raise the dam wall to reduce downstream flooding was made, there is little scope for avoiding impacts, apart from avoiding direct impacts in the construction area.

Response

WaterNSW notes the advice and considers no further response is required for this issue.

4.1.5.4 Offsetting

The credit requirements for offsets have been identified in accordance with the FBA with the following caveats:

- there are several recommendations for modifications to those BARs, including identification and mapping of PCTs and consequently mapping of species polygons. These modifications will necessarily alter the amount of credits required
- no review of the FBA calculator files has been possible, so data entry has not been reviewed.

No offset sites have been identified. The BOS has recommended a process for their future identification. EES notes that given the quantum of credit requirements identified in the BARs, sourcing the necessary credits may be difficult.

Response

WaterNSW notes the advice and considers no further response is required for this issue.

4.1.6 Hydrology and aquatic biodiversity

4.1.6.1 General comments

Issue 1

If the Project is approved, approximately 284 kilometres of upstream rivers, streams and creek will potentially be inundated in a PMF event. Very little attention has been paid to the aquatic ecology in these inundation areas, despite them containing known locations of threatened/endangered or protected species. The likely impacts to these streams are not minor. These areas may become similar to the current FSL for Warragamba Dam.

Response

From discussion with DPE and agencies following exhibition of the EIS, it is understood that the distance of approximately 284 kilometres was derived from measuring channel length of upstream streams and creeks from FSL up to the Project PMF. However, this distance measurement approach does not take into account the existing risk of temporary inundation between FSL to the existing dam PMF.

With reference to Section 15.2.3 in Chapter 15 of the EIS, flood events were truncated to separate out local catchment inflows from temporary inundation associated with the effect of backwater from Lake Burragorang. The result of this is that the upstream extent of the existing PMF and the Project PMF are similar.

While the measurenment of approximately 284 kilometres of upstream rivers, streams and creeks will potentially be inundated in a Project PMF event can be derived, it is also the existing PMF and therefore not an incremental impact from the Project. Temporary inundation is an existing impact in these upstream waterways. As summarised in Section 15.6.5 in Chapter 15 of the EIS, the Project will affect upstream hydrology and flooding through:

- Increases in the depth and duration of temporary inundation, this being greatest at Warragamba Dam and in Lake Burragorang, and decreasing moving up the tributaries
- An increase in frequency of flood events of resulting in events of a specified depth occurring more frequently than currently occurs; this would be most pronounced at the dam wall and in Lake Burragorang, and will decrease moving up the tributaries
- An increase in the lateral extent of temporary inundation (which will be influenced by the surrounding topography).

Issue 2

Assessing and predicting the actual downstream impacts specific to the changed flow regime because of raising the dam wall will be difficult if not an impossible task. The installation of infrastructure to enable the release of downstream environmental flows is included in the Project. However, the exact nature of these environmental flows remains ambiguous and is not clearly articulated in the EIS.

Response

The Project would take the opportunity during the construction period for the dam raising to install the physical infrastructure to allow for management of environmental flows as outlined in the NSW Government's 2017 Metropolitan Water Plan. However, the actual environmental flow releases do not form part of the Project as they are subject to administration under the *Water Management Act 2000*. WaterNSW advises that water releases under an environmental flow regime would not operate in the event that the dam is in flood operation mode).

4.1.6.2 Upstream hydrological impacts

While the EIS suggests that some inundation areas will be temporary and this will be dependent on individual flood events and dam levels, temporary inundation effects and their consequences could be long-lasting if not permanent. This is most easily demonstrated using satellite imagery, aerial photographs, and location specific photographs at the upper end of the current FSL for Warragamba Dam. This occurs due to several important physical processes:

- Temporary inundation floods riffle, pool and glide morphologies, rendering such areas unsuitable for many habitat specialists (e.g. riffle dwelling insects; fish that use riffles for spawning/egg laying such as the Macquarie Perch)
- Temporary inundation can kill vegetation not adapted to inundation (i.e. most Australian terrestrial species, including most eucalypt species)
- Wave action scours and erodes unconsolidated sediment in the upper reaches and on the banks
- At high storage levels, sediment washing in from the upstream catchment settles out and smothers the bottom substrate (potentially causing large detrital layers and sand slugs in the river in the upper most reaches where inundation occurs).

All these effects are readily apparent at the upstream end of the current FSL but have not been appropriately recognised or assessed in the EIS. The succession of shoreline communities on previous river margins depends not only on the interplay between erosion and sedimentation of substrates and invasion and extinction of organisms, but also on the duration, timing, and frequency of regulated water levels.

Response

WaterNSW notes that the above issue uses the terminology ‘current FSL’. The EIS clearly states that the FSL will not change with the Project, being 116.72 mAHD.

All the physical processes noted already occur within the upstream area. The EIS has assessed whether the Project would have an effect on these existing processes.

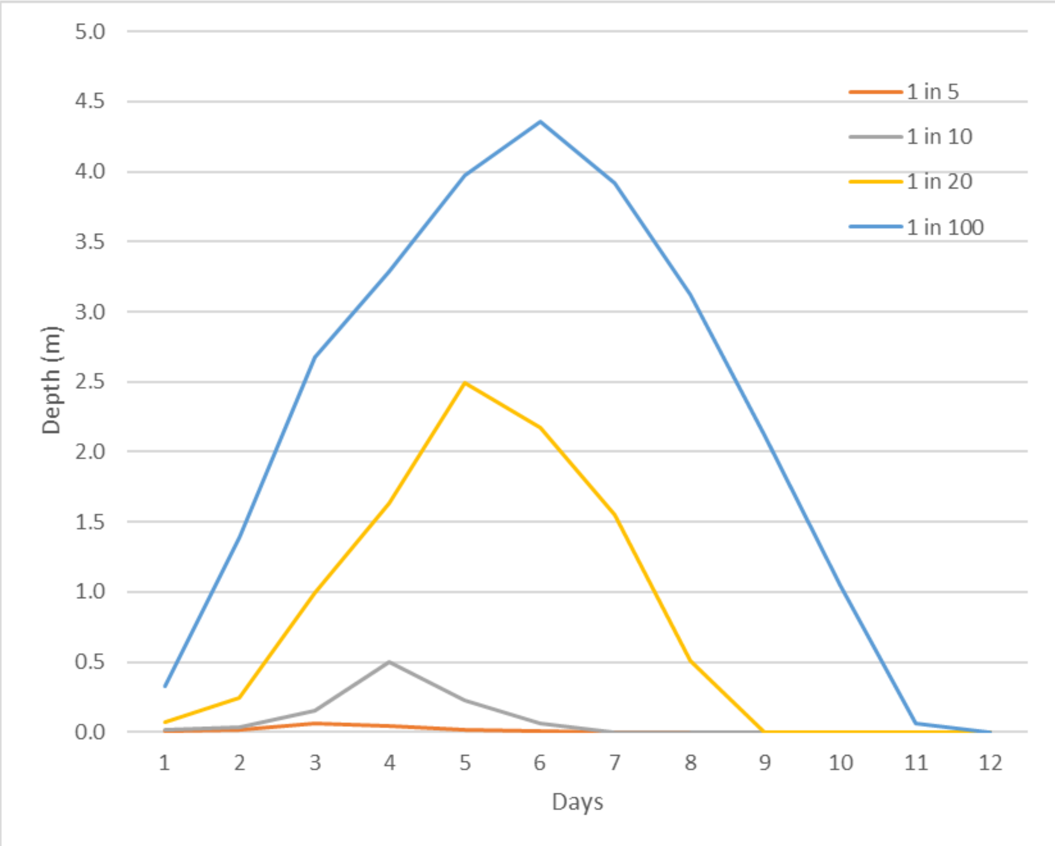
With regard to the temporary inundation of riffle, pool and glide morphologies, this has been examined through:

- a review of aerial imagery for the main tributaries for which cross-section data is a available to identify locations of these features
- identification of cross sections in proximity to these locations
- review of depth-duration curves for selected cross-sections to identify the depths of existing temporary inundation for selected flood events (e.g. 1 in 5 chance in a year flood, etc)
- review of depth-duration curves for the same cross-section(s) with the Project to identify the incremental depth of temporary inundation for the same flood events.

Brumley *et al*. (1987) cited in the *National Recovery Plan for the Macquarie Perch (Macquaria australica)* (CoA 2018) found that Macquarie Perch habitat sites in rivers consisted of a rubble substrate of small boulders, pebbles and gravel with water depth being between 0.2–0.9 m but usually 0.4–0.6 m. The species requires fast-flowing water with gravel-cobble substrates to breed (Cadwallader & Rogan 1977; Appleford *et al*., 1998; Lintermans 2007; 2013, cited in CoA 2018). The breeding season for the Macquarie Perch extends from October to mid January (DSEWPC 2011).

As an example, Figure 4-2 shows the depths and durations of temporary inundation for the 1 in 5, 1 in 10, 1 in 20 and 1 in 100 chance in a year flood events at cross-section Wollondilly 3380 which is approximately 80 metres upstream from a riffle feature in the Wollondilly River.

Figure 4-2 Depths and durations of additional temporary inundation with the Project at cross-section Wollondilly 3380



The following points are noted with regard to the Macquarie Perch:

- The maximum duration of temporary inundation is 10 days for the 1 in 100 event (and which is a relatively rare event); this is unlikely to be a significant constraint to breeding in the context of the length of the breeding season
- There is a negligible increase in the depth of temporary inundation for the relatively more frequent 1 in 5 chance in a year flood event
- With reference to the water depths noted in the National Recovery Plan, the maximum incremental depths for the 1 in 5 and 1 in 10 chance in a year events would be unlikely to be a material constraint to breeding.

With regard to other fauna that may utilise riffle habitat, given the relatively short durations of temporary inundation associated with the Project and noting that this already occurs, no material impacts are anticipated.

An analysis of vegetation condition has been carried out using survey plots in the upstream study area to assess resilience to temporary inundation. This examined vegetation condition for a riparian vegetation community and a eucalypt woodland community, respectively:

- HN574/PCT 1105 River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion

- HN527/PCT 840 Forest Red Gum–Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion

All plots used in the analysis were classed as Moderate/good condition.

The analysis benchmarked the number of native species against the Sydney Basin IBRA Region and the South Eastern Highlands IBRA Region. The analysis distinguished between plots within the area of existing impact (from the existing dam) and above this area (which would be affected by the Project).

The results for the riparian vegetation community are shown in Figure 4-3 to Figure 4-6 inclusive. These show that vegetation in the area of existing impact is broadly consistent with the community condition benchmarks suggesting that this community has a significant degree of resilience to temporary inundation – which would not be unexpected for a riparian vegetation community.

Figure 4-3 Number of native species in HN574/PCT 1105 plots

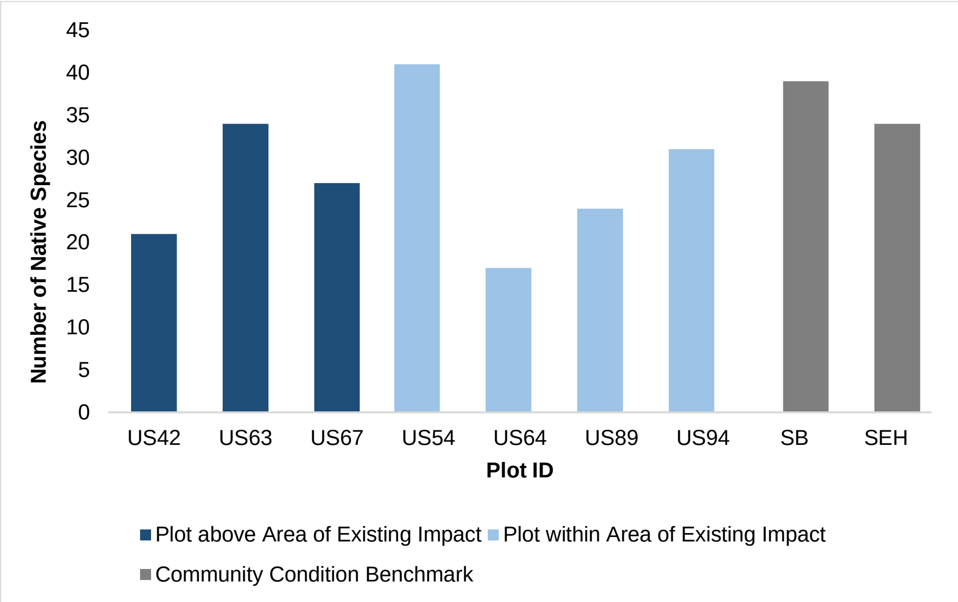


Figure 4-4 Native ground cover (grasses) in HN574/PCT 1105 plots

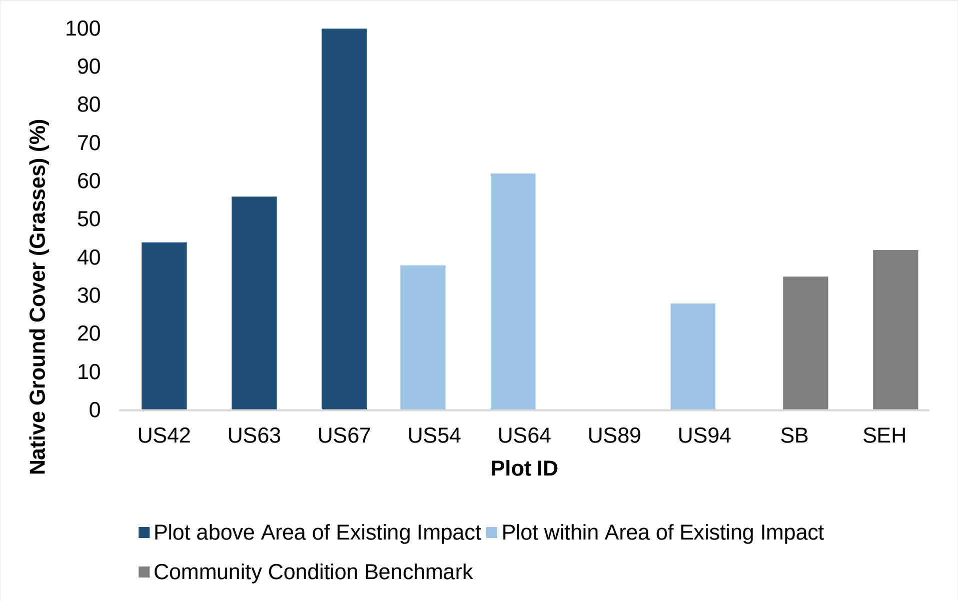


Figure 4-5 Native ground cover (shrubs) in HN574/PCT 1105 plots

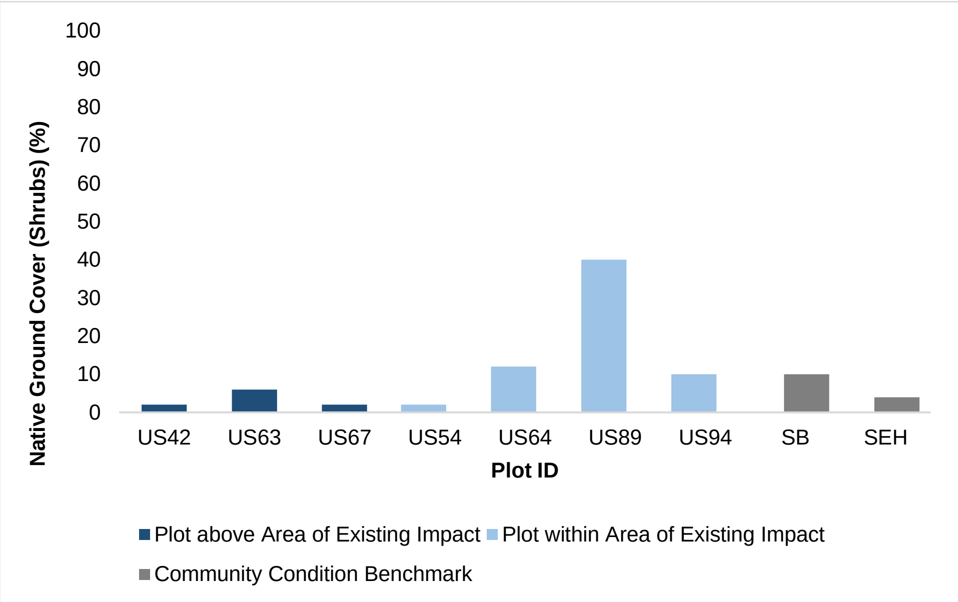
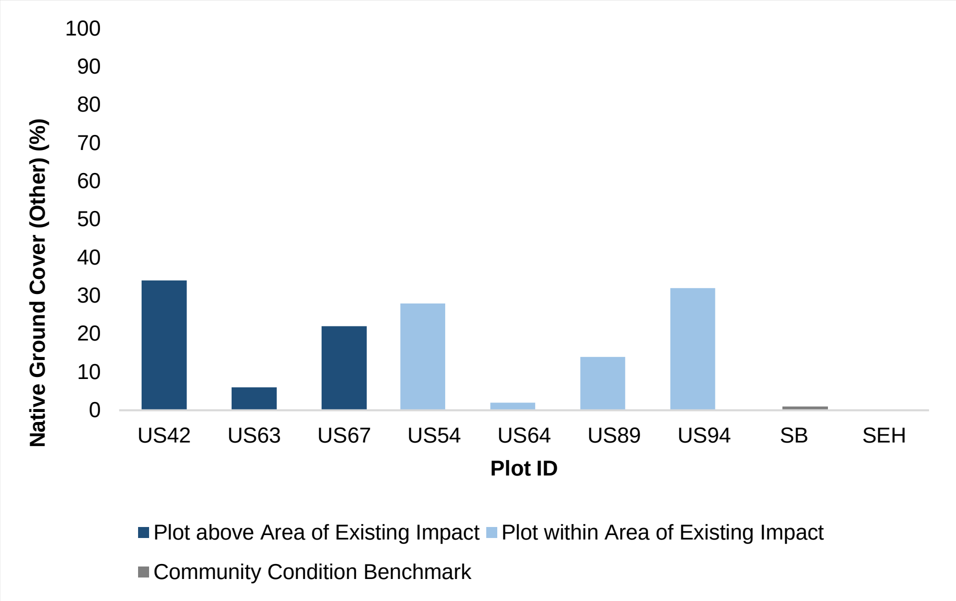


Figure 4-6 Native ground cover (other) in HN574/PCT 1105 plots



Erosion risk due to wave action would generally be restricted to the shoreline around Lake Burragorang. The incremental impact of the Project with regard to this issue is considered in Sections 5.1 and 5.2 of Appendix N2 *Geomorphology Technical Assessment*.

As noted, settlement of suspended sediment delivered from the upper catchment is an existing process. This issue is also considered in Sections 5.1 and 5.2 of Appendix N2.

4.1.6.3 Wollondilly River

Issue 1

There is approximately 9.15 kilometres of river length mapped above Murphys Crossing to the new PMF level for the Wollondilly River. Flooding to this level will submerge Murphys Crossing (the major eastern access point to Yerranderie) and much of the road that leads to it. Flooding could also submerge the gauge on the Wollondilly River at Joorilands. The historic Joorilands Shearing Shed would also be inundated under the new PMF.

Response

As noted in the response provided in Section 4.1.6.1, the EES estimate of affected river length does not take into account temporary inundation that does and can occur in flood events with the existing dam nor the truncation of the flood events considered in the assessment.

However, specifically for Murphys Crossing, this location is already affected by temporary inundation from the existing dam and will similarly be affected by temporary inundation from the Project which would be of an increased depth and duration in the order of half a day and up to half a metre. With regard to the issue of access, this is affected by existing flooding and the Project would increase the duration of temporary inundation similar to that anticipated for the dam wall and for within Lake Burragorang (refer Table 15-14 in Chapter 15 of the EIS).

The gauge on the Wollondilly River at Joorilands is already impacted by the existing PMF event (should one ever occur which is unlikely) and more frequent flood events. The depth and duration of temporary inundation will increase with the Project. Given this location is only a short distance upstream of Lake Burragorang this increase would be similar to that anticipated for the dam wall and for within Lake Burragorang (refer Table 15-14 in Chapter 15 of the EIS).Further discussion with regard to the Joorilands Homestead is provided in Section 6.4 of the PIR.

Issue 2

There is approximately 4.75 kilometres of river length above Murphys Crossing to the 'impact' level mapped for the Wollondilly River. Flooding to this level will still submerge Murphys Crossing (the major eastern access point to Yerranderie) and much of the road that leads to it.

Response

As noted in the response to the previous issue, Murphys Crossing is already affected by temporary inundation from the existing dam and will similarly be affected by temporary inundation from the Project from an increase in depth and duration.

Issue 3

It is noted that the FSL is mapped as extending well above Murphys Crossing, but it is more likely that it is downstream of the crossing based on anecdotal and on-ground observations.

Response

The mapping of FSL (116.72 mAHD) in EIS figures has been carried out using GIS. A spot check was carried out with reference to Nattai 8929-IS GeoPDF topographic map through an examination of the map contours for this locality. This identified that the map is consistent with the mapping of FSL as presented in the EIS.

Issue 4

Depth-duration curves in Chapter 15 *Flooding and hydrology* were examined for four cross-sections on the Wollondilly River:

- Location 2 (WOLLONDILLY_US_6720) approximate location of the Project PMF event
- Location 3 (WOLLONDILLY_US_8933) represents the approximate location of the Project for the 1% AEP event (upstream of the Jooriland gauge)
- Location 4 (WOLLONDILLY_3380) upstream of Murphys Crossing
- Location 5 (WOLLONDILLY_15000) located within Lake Burragorang.

The EIS findings were:

- Increases in the depth and duration of temporary inundation were suggested to be less than half a metre and half a day respectively for the two upstream most cross-sections, the exception being the PMF event for Location 3 (WOLLONDILLY_US_8993) where the increase in depth was about 1.1 metres
- At Location 4 (WOLLONDILLY_3380) increases in depth were less than half a metre for all events up to the 1% AEP; for the PMF event the increase in depth is about 4.3 metres
- At Location 4 (WOLLONDILLY_3380) increases in inundation was less than half a day up to the 1% AEP event, then increasing up to 3.6 days for the 1% AEP event
- At Location 5 (WOLLONDILLY_15000) there was a clear increase in depths and durations for inundation, broadly mirroring those at the dam wall for respective flood events.

On 1 November 2021 WaterNSW sought to reduce the levels in Warragamba Dam to one metre below full supply. It was stated that this would take approximately five days assuming 'no further rain'. Under extreme flooding events with large flows continuing to enter Warragamba Dam from the catchments, it would likely take much longer. It is difficult to reconcile the suggested inundation levels and durations above (e.g. 0.5 metres height and half day duration) with the practicalities and timing of drawdown stated for Warragamba Dam for the November 2021 release.

Unexplained assumptions are likely driving predictions of the extent and duration of inundation in the EIS and these model predictions need validation.

Flood impacts like the current FSL impacts may occur up to the full PMF level in the Wollondilly River - an extension of flood effects to about 9.15 kilometres of river length.

Response

References in the EIS to incremental depths and durations of temporary inundation of about 0.5 metres and half a day are referring to upstream locations in the tributaries that flow into Lake Burragorang. Refer for example to the summary provided in Section 15.6.5 of Chapter 15 of the EIS. The increase in the depth and duration of temporary inundation would be greater at the dam wall and in Lake Burragorang (refer Table 15-14 in the EIS).

Validation of the hydrological model used for the Project is described in Chapter 6 of Volume 1 of the *Hawkesbury-Nepean Valley Regional Flood Study Final Report* (Infrastructure NSW 2019).

4.1.6.4 Jooriland River

There is approximately 3.1 kilometres of river length mapped above the Jooriland River junction with the Wollondilly River that is inside the 'new' PMF level. No details were provided in the EIS on inundation levels or duration for Jooriland River. Inundation impacts could occur up to the PMF level in the Jooriland River - an extension of inundation impacts to approximately 3.1 kilometres of river length.

Response

As noted in the response provided in Section 4.1.6.1, the EES estimate of affected river length does not take into account temporary inundation that does and can occur in flood events with the existing dam nor the truncation of the flood events considered in the assessment.

4.1.6.5 Tonalli River

Issue 1

The upper catchment of the Tonalli River drains areas around the old mining town of Yerranderie and there have been previous studies undertaken on heavy metal pollution within the Tonalli River. Very little information is provided on the ecology of the Tonalli River or how it may be impacted, particularly in the predicted inundation zone.

Response

As noted in the response provided in Section 4.1.6.1, the EES estimate of affected river length does not take into account temporary inundation that does and can occur in flood events with the existing dam nor the truncation of the flood events considered in the assessment.

The historic township of Yerranderie sits outside the upstream Project study area. Drainage from the Tonalli River catchment, and associated impacts on downstream water quality, is an existing issue and this would not change with the Project.

Further comment on potential impacts on aquatic ecology is provided in Section 4.1.6.16.

Issue 2

No details were provided in the EIS on inundation level or duration for the Tonalli River. Inundation impacts like the existing impacts of the current FSL may occur up to the full PMF level in the Tonalli River - an extension of inundation impacts to approximately 4.5 kilometres of river length.

Response

Information relating to the incremental depth and duration of temporary inundation with the Project has been derived from an analysis of depth-duration curves generated from the hydrological modelling carried out for the Project. Derivation of depth-duration curves is possible only where cross section information is available, and these were not developed for the smaller tributaries (including the Tonalli River) draining to Lake Burragorang.

As noted in the response provided in Section 4.1.6.1, the EES estimate of affected river length does not take into account temporary inundation that does and can occur in flood events with the existing dam nor the truncation of the flood events considered in the assessment. Truncation of flood events also uses depth-duration curves so could not be carried for the Tonalli River, however, it is anticipated that the pattern of flooding, in terms of extent up the Tonalli River would not differ between existing and with the Project.

4.1.6.6 Nattai River

Very little information is provided on the ecology of the Nattai River or how it may be impacted by yet further inundation.

Depth-duration curves were examined for four cross-sections on the Nattai River:

- Location 9 (NATTAI_US_8700) the approximate location of the PMF event
- Location 10 (NATTAI_US_11066) about 2.4 kilometres downstream of NATTAI_US_8700 and the approximate location of the Project 1% AEP event
- Location 11 (NATTAI_1880) about 2.6 kilometres downstream of cross-section NATTAI_US_11066
- Location 12 (NATTAI_5680) a further 3.8 kilometres downstream where the Nattai River broadens out into Lake Burragorang.

Predicted changes along the Nattai River include:

- Increases in the depth and duration of inundation for cross-sections NATTAI_US_8700 and NATTAI_US_11066 of less than half a metre and half a day respectively for all events with the exception of the PMF event for NATTAI_US_11066, which would increase inundation levels by about 7.8 metres.
- Increases in the depth and duration of inundation are more noticeable at cross-section NATTAI_1880, particularly for the 5% AEP and rarer events.
- At NATTAI_5680, there is also a clear increase in depths and durations for inundation for all events.

This indicates that there will be significant inundation occurring in the Nattai River. There is approximately 5.1 kilometres of river length mapped above the FSL that is inside the 'new' PMF level for the Nattai River. The upper end of the PMF appears to coincide with the Eel Hole cited as a resting place of Gurangatch in the Aboriginal creation story of the area[17]. Inundation impacts like the existing impacts of the current FSL may occur up to the PMF in the Nattai River.

Further comment on potential impacts on aquatic ecology is provided in Section 4.1.6.16.

Response

As noted in the response provided in Section 4.1.6.1, the EES estimate of affected river length does not take into account temporary inundation that does and can occur in flood events with the existing dam nor the truncation of the flood events considered in the assessment

The analysis of the Nattai River cross sections presented in the EIS is intended to show the declining influence of the Project moving up the tributaries and away from Lake Burragorang. This shows the increases in depth and duration of temporary inundation will occur principally at Warragamba Dam, and within and around the margins of Lake Burragorang.

Consideration of potential impacts of the Project on Aboriginal cultural values, including the Gurrangatch-Mirrigan Dreaming Track, is provided in the Aboriginal cultural values heritage assessment which forms Appendix 2 to the Aboriginal cultural heritage assessment (Appendix K to the EIS).

Further comment on potential impacts on aquatic ecology is provided in Section 4.1.6.16.

4.1.6.7 Little River

Issue 1

The EIS mapping appears to overestimate the exact FSL position in the Little River, but impacts are readily observable up to FSL. Very little information is provided on the ecology of the near-pristine Little River or how it may be impacted by yet further inundation.

Response

The mapping of FSL (116.72 mAHD) in EIS figures has been carried out using GIS. A spot check was carried out with reference to Nattai 8929-IS GeoPDF topographic map. This map is consistent with the mapping of FSL as presented in the EIS.

The FSL represents the existing maximum extent of lake Burragorang under normal operational conditions and represents an existing impact. The FSL will not change with the Project.

As noted previously, truncation of flood events is based on depth-duration curves where cross sections are available to derive these curves. No cross section information is available for Little River. However, based on a review of contours on Nattai 8929-IS GeoPDF topographic map, the increases in depth and duration of temporary inundation would be expected to be similar to those for cross section NATTAI_1880 (refer Table 15-17 in Chapter 15 of the EIS).

Issue 2

There is approximately 2.6 kilometres of river length mapped above the FSL that is inside the 'new' PMF level for Little River. No details were provided in the EIS on inundation level or duration for the Little River. Inundation impacts like the existing impacts of the current FSL may occur up to the full PMF level in the Little River - an extension of inundation impacts to approximately 2.6 kilometres of river length.

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[17] The Eel Hole' refers to a large waterhole just downstream of the junction of the Nattai River and Whitegum Creek (1905 Parish Map). Eel-holes were associated with the resting places of Gurangatch. Gundungurra Aboriginal Heritage Association 2018. Submission 72 to Inquiry into Water NSW Amendment (Warragamba Dam) Bill 2018 3 October 2018.

Response

As noted in the response provided in Section 4.1.6.1, the EES estimate of affected river length does not take into account temporary inundation that does and can occur in flood events with the existing dam nor the truncation of the flood events considered in the assessment.

4.1.6.8 Werriberri Creek

Very little information is provided on the ecology of Werriberri Creek or how it may be impacted, particularly in the predicted inundation zone.

There is approximately 1.4 kilometres of river length mapped above the FSL that is inside the 'new' PMF level for Werriberri Creek. No details were provided in the EIS on inundation level or duration for Werriberri Creek. Inundation impacts like the existing impacts of the current FSL may occur up to the full PMF level in Werriberri Creek, an extension of inundation impacts to approximately 1.4 kilometres of stream length.

Response

As noted in the response provided in Section 4.1.6.1, the EES estimate of affected river length does not take into account temporary inundation associated with the existing dam nor the truncation of the flood events considered in the assessment.

As also noted previously, truncation of flood events is based on depth-duration curves where cross sections are available to derive these curves. No cross section information is available for Werriberri Creek. However, noting the location, the increase in the depth and duration of temporary inundation would be similar to the dam wall (refer Table 15-14 in the EIS).

Further comment on potential impacts on aquatic ecology is provided in Section 4.1.6.16.

4.1.6.9 Green Wattle Creek

The majority of Green Wattle Creek is in a near pristine state inside the Blue Mountains National Park and part of GBMWHA. Very little information is provided on the ecology of Green Wattle Creek or how it may be impacted, particularly in the predicted inundation zone.

There is approximately 4.65 kilometres of river length mapped above the FSL that is inside the 'new' PMF level for Green Wattle Creek. No details were provided in the EIS on inundation level or duration for Green Wattle Creek. Inundation impacts like the existing impacts of the current FSL may occur up to the full PMF level in Green Wattle Creek, an extension of inundation impacts to approximately 4.65 kilometres of stream length.

Response

As noted in the response provided in Section 4.1.6.1, the EES estimate of affected river length does not take into account temporary inundation associated with the existing dam nor the truncation of the flood events considered in the assessment.

As also noted previously, truncation of flood events is based on depth-duration curves where cross sections are available to derive these curves. No cross section information is available for Green Wattle Creek. The increase in the depth and duration of temporary inundation with the Project for the lower reaches of Green Wattle Creek where it runs into Lake Burragorang (approximating FSL) would be similar to the dam wall (refer Table 15-14 in the EIS). As noted in Section 15.6.5 of the EIS, the influence of the Project decreases moving upstream away from the lake.

Further comment on potential impacts on aquatic ecology is provided in Section 4.1.6.16.

4.1.6.10 Butchers Creek

Very little information is provided on the ecology of Butchers Creek or how it may be impacted, particularly in the predicted inundation zone.

There is approximately 3.75 kilometres of river length mapped above the FSL that is inside the 'new' PMF level for Butchers Creek. No details were provided in the EIS on inundation level or duration for Butchers Creek. Inundation impacts like the existing impacts of the current FSL may occur up to the full PMF level in Butchers Creek - an extension of inundation impacts to approximately 3.75 kilometres of stream length.

Response

As noted in the response provided in Section 4.1.6.1, the EES estimate of affected river length does not take into account temporary inundation associated with the existing dam nor the truncation of the flood events considered in the assessment.

As also noted previously, truncation of flood events is based on depth-duration curves where cross sections are available to derive these curves. No cross section information is available for Butchers Creek. The increase in the depth and duration of temporary inundation with the Project for the lower reaches of Butchers Creek where it runs into Lake Burragorang (approximating FSL) would be similar to the dam wall (refer Table 15-14 in the EIS). As noted in Section 15.6.5 of the EIS, the influence of the Project decreases moving upstream away from the lake.

Further comment on potential impacts on aquatic ecology is provided in Section 4.1.6.16.

4.1.6.11 Kedumba River

Issue 1

Very little information is provided on the ecology of Kedumba River or how it may be impacted, particularly in the predicted inundation zone. The former Office of Environment and Heritage (OEH) has recorded the endangered Adams Emerald Dragonfly within the Kedumba River catchment (in Reedy Creek) but this is not identified in the EIS despite being in the published scientific literature.

Response

Further consideration of potential impacts on the Adams Emerald Dragonfly is provided in Section 4.1.6.19.

Issue 2

There is approximately 6.4 kilometres of river length mapped above the FSL that is inside the 'new' PMF level for the Kedumba River. No details were provided in the EIS on inundation level or duration for Kedumba River. Inundation impacts like the existing impacts of the current FSL may occur up to the full PMF level in Kedumba River. Only the Coxs River and Wollondilly River are likely to have a larger inundation impact zone than the Kedumba River.

Response

As noted in the response provided in Section 4.1.6.1, the EES estimate of affected river length does not take into account temporary inundation associated with the existing dam nor the truncation of the flood events considered in the assessment.

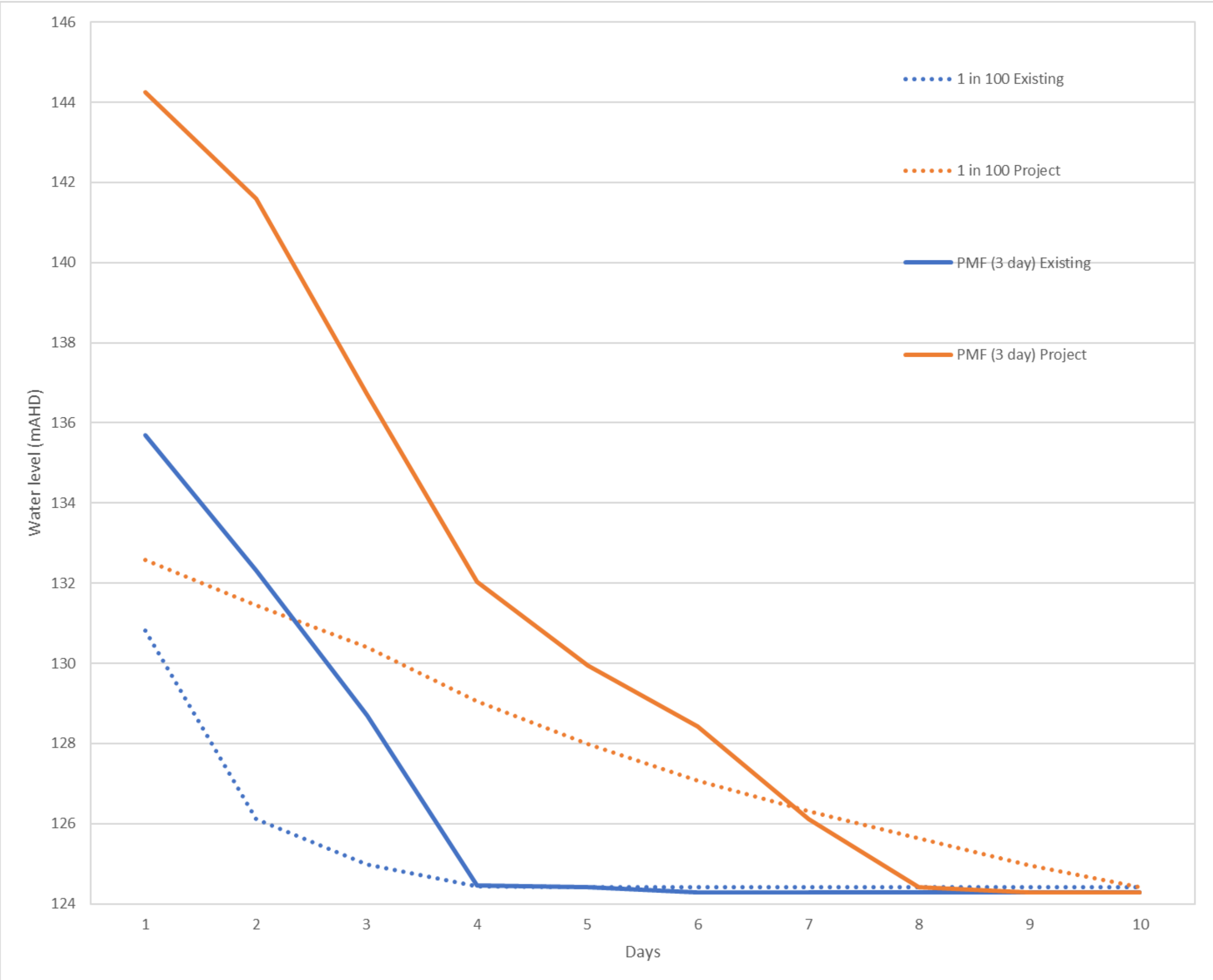
Subsequent to the hydrological analysis carried out for the EIS, the upstream hydrological model has been extended, including up the Kedumba River. Table 4-3 presents the results of an analysis of depth-duration curves for cross section Kedumba_0 which is located about 300 metres downstream of the confluence with Reedy Creek. This shows the Project would have a negligible incremental impact up to the 1 in 20 chance in a year event. For the 1 in 100 chance in a year event, the Project would increase the depth of temporary inundation by up to 1.8 metres and the duration of temporary inundation by an additional five days. For the PMF event, the Project would increase the depth of temporary inundation by up to 8.6 metres and the duration of temporary inundation by an additional three days. It should be noted that these incremental depths are maximum depths and would not be maintained for the total length of time of temporary inundation (refer Figure 4-7).

Table 4-3 Changes in temporary inundation depth and duration for cross section Kedumba_0

	Flood event (1 in x chance in a year)									
	1 in 5		1 in 10		1 in 20		1 in 100		PMF	
	E[1]	P[2]	E	P	E	P	E	P	E	P
Depth (m)	2.4	<0.5	3.3	<0.5	4.2	0.6	6.4	1.8	11.4	8.6
Duration (days)	4	<0.5	4	<0.5	4	3	4	5	5	3

Notes: 1 – E = existing; 2 – P = additional depth/duration with Project

Figure 4-7 Depth-duration curves for 1 in 100 chance in a year and PMF events for cross section Kedumba_0



4.1.6.12 Reedy Creek

Issue 1

Because of its relatively pristine nature, Reedy Creek has been used previously for studies into natural riverine processes and nutrient studies (UWS 2001). OEH recorded the endangered Adams Emerald Dragonfly within Reedy Creek; however, this is not identified in the EIS despite being in the published scientific literature (Theischinger *et al* 2011). This location may be flooded by PMF events.

Response

This location is potentially affected by the PMF associated with the existing dam. This risk will not change with the Project.

Further consideration of potential impacts on the Adams Emerald Dragonfly is provided in Section 4.1.6.19.

Issue 2

There is approximately 2.3 kilometres of river length mapped above the FSL that is inside the 'new' PMF level for Reedy Creek. No details were provided in the EIS on inundation level or duration for Reedy Creek. Inundation impacts like the existing impacts of the current FSL may occur up to the full PMF level in Reedy Creek - an extension of inundation impacts to approximately 2.3 kilometres of stream length.

Response

As noted in the response provided in Section 4.1.6.1, the EES estimate of affected river length does not take into account temporary inundation associated with the existing dam nor the truncation of the flood events considered in the assessment.

Estimates of incremental depths and durations for temporary inundation associated with the Project were derived from analysis of channel cross sections developed for the hydrological modelling. These were developed only for the main channels draining to Lake Burragorang and did not include Reedy Creek.

However, given the location of Reedy Creek and the elevation of its confluence with the Kedumba River (approximately 120-130 mAHD based on Jamison 8930-2N GeoPDF topographic map), the incremental depth and duration of temporary inundation would be similar to that for cross-section COX_US_9985 where the incremental depth and duration of temporary inundation for the PMF event would be about 3.5 metres and less than half a day (refer Table 4-6).

4.1.6.13 Cedar Creek

Very little information is provided on the ecology of Cedar Creek or how it may be impacted, particularly in the predicted inundation zone.

There is approximately 3.4 kilometres of stream length mapped above the FSL that is inside the 'new' PMF level for Cedar Creek, located approximately 900m downstream of the Berrima Inga Creek confluence. No details were provided in the EIS on inundation level or duration for Cedar Creek. Inundation impacts like the existing impacts of the current FSL may occur up to the full PMF level in Cedar Creek - an extension of inundation impacts to approximately 3.4 kilometres of stream length.

Response

As noted in the response provided in Section 4.1.6.1, the EES estimate of affected river length does not take into account temporary inundation associated with the existing dam nor the truncation of the flood events considered in the assessment.

Truncation of flood events is based on depth-duration curves where cross sections are available to derive these curves. No cross section information is available for Cedar Creek. The increase in the depth and duration of temporary inundation with the Project for the lower reaches of Cedar Creek where it runs into Lake Burragorang (approximating FSL) would be similar to the dam wall (refer Table 15-14 in the EIS). As noted in Section 15.6.5 of the EIS, the influence of the Project decreases moving away from the lake.

Further discussion on potential impacts on aquatic ecology is provided in Section 4.1.6.16.

4.1.6.14 Kowmung River

Issue 1

The FSL for Warragamba Dam extends up the Coxs River to about the confluence with the Kowmung River. The Kowmung River itself however is not impacted. There is approximately 4.7 kilometres of stream length mapped above the FSL that is inside the 'new' PMF level for the Kowmung River.

Response

As noted in the response provided in Section 4.1.6.1, the EES estimate of affected river length does not take into account temporary inundation associated with the existing dam nor the truncation of the flood events considered in the assessment.

Issue 2

Depth-duration curves were examined for two cross-sections on the Kowmung River:

- Location 15 (KOWMUNG_10130) the approximate location of the Project PMF event
- Location 14 (KOWMUNG_13130) about three kilometres further downstream and represents the approximate location of the 1% AEP event.

Predicted changes along the Kowmung River include:

- Increases in the depth and duration of inundation for cross-section Location 15 (KOWMUNG_10130) are less than half a metre and half a day respectively for all events
- Increases in the depth of inundation for Location 14 (KOWMUNG_13130) are less than half a metre up to the 1% AEP event, and about 4.3 metres for the PMF event
- Increases in the duration of inundation for Location 14 (KOWMUNG_13130) are less than half a day up to the 5% AEP event, increasing slightly – up to two days – for the rarer events.

Inundation impacts like the existing impacts of the current FSL may occur up to the full PMF level in the Kowmung River - an extension of inundation impacts to approximately 4.7 kilometres of river length.

Response

As noted in the response provided in Section 4.1.6.1, the EES estimate of affected river length does not take into account temporary inundation associated with the existing dam nor the truncation of the flood events considered in the assessment.

4.1.6.15 Coxs River

Issue 1

There is approximately 6.4 kilometres of stream length mapped above the current FSL that is inside the 'new' PMF level for the Coxs River.

Response

As noted in the response provided in Section 4.1.6.1, the EES estimate of affected river length does not take into account temporary inundation associated with the existing dam nor the truncation of the flood events considered in the assessment.

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Issue 2

Depth-duration curves were examined for three cross-sections on the Coxs River:

- Location 6 (COX_US_7335) the approximate location of the Project PMF event
- Location 7 (COX_US_9985) the approximate location of the 1% AEP event, about 2.5 kilometres downstream of COX_US_7335
- Location 8 (COXS_28800) further downstream and located within Lake Burragorang.

Predicted changes along the Coxs River are:

- Increases in the depth and duration of inundation are half a metre (for the PMF event) or less and half a day respectively for Location 6 (COX_US_7335) for all events
- Increases in the depth of inundation for Location 7 (COX_US_9985) are half a metre or less up to the 1% AEP event and about 3.5 metres for the PMF event
- Increases in the duration of temporary inundation for Location 7 (COX_US_9985) are less than half a day up to the 5% AEP event; this increases slightly to 0.7 days for the 1% AEP event and the PMF event
- At Location 8 (COXS_28800), there is a clear increase in depths and durations for inundation for all events
- An increasing influence of the Project moving downstream with the increase in depth and duration of inundation within Lake Burragorang generally reflecting that at the dam wall.

Inundation impacts like the existing impacts of the current FSL may occur up to the full PMF level in the Coxs River - an extension of inundation impacts to approximately 6.4 kilometres of river length. It is likely that the Coxs River gauge at Kelpie Point will be flooded in a PMF event.

Response

As noted in the response provided in Section 4.1.6.1, the EES estimate of affected river length does not take into account temporary inundation associated with the existing dam nor the truncation of the flood events considered in the assessment.

The Coxs River gauge at Kelpie Point is affected by the PMF associated with the existing dam. This risk will not change with the Project.

4.1.6.16 Aquatic ecology assessment

Issue 1

For the scale of this project, the aquatic ecology assessment is considered inadequate as:

- it does not identify raising of the dam wall will extend inundation impacts to about 284 kilometres of rivers/streams
- it fails to identify that current FSL areas also experience 'temporary inundation' yet demonstrate significant, likely permanent impacts (bare ground, no riparian vegetation, sand slugs in streams) in areas close to the current FSL
- there has been no targeted sampling of aquatic species in the 'new' inundation zones
- only 15 small water samples (from five sites) were sent for eDNA analysis out of the approximately 1100 plus streams that will be impacted by the 'new' inundation zone at some level/duration (the specific eDNA report was identified but not included in the appendix for the aquatic studies)
- the desktop assessment of aquatic ecology has not identified all known threatened species locations, some of which will be directly impacted by inundation
- water quality impacts are only discussed in very general terms and only considered Total Nitrogen, Total Phosphorus, Chlorophyll-a and Total Suspended Solids.

Response

As noted previously, EES's estimate of 284 kilometres of upstream waterways that would be affected by the Project is not correct and the reasons for this are provided in Section 4.1.6.1.

The FSL is, by definition, the maximum level of Lake Burragorang during normal water supply operations. The water level of Lake Burragorang fluctuates over time and the effects of this on the aquatic environment below FSL represent an existing impact associated with the existing dam. This will not change with the Project.

The term 'new inundation zone' is based on the assumption that an additional 284 kilometres of rivers and streams would be affected by the Project. As noted above, this assumption is incorrect.

The omission of some known threatened species locations does not change the conclusions of the aquatic ecology assessment as threatened species were assumed present where suitable habitat existed.

Potential upstream water quality impacts are discussed in Section 27.5.3 of Chapter 27 of the EIS. This covers increased natural organic matter which could result in disinfection by-products, increased turbidity from erosion, increased nutrient concentrations, increased pathogen concentrations and changes in pollutant ,loads.

Issue 2

The predicted inundation is also predicated on some very strong assumptions (water level at dam wall only goes to approximately 10 metres) without any clear idea/statement of how water will be released from Warragamba during extreme floods and therefore the veracity of predicted inundation levels and duration upstream.

Response

The predicted inundation is based on the extensive hydrological modelling carried out for the Project as explained in Chapter 15 of the EIS. In an extreme flood event where the water level in Lake Burragorang exceeds the new spillway crest level of 128.5 mAHD before the flood has peaked there would be uncontrolled releases. Once the flood has peaked, controlled releases will be possible through gated conduits set well below the new spillway crest level (with invert at 105.45 mAHD) until the water level returns to the existing FSL.

Issue 3

As recently as the week beginning 1 November 2021 WaterNSW was drawing Warragamba Dam down to try and decrease levels by one metre. WaterNSW suggested this would take about five days (WaterNSW 2021). Yet statements were made that the upper end of inundation would likely increase by only 0.5 metres for a duration of half a day. Assumptions underlying the model need much closer scrutiny and to be clearly articulated. The aquatic ecology assessment has failed to consider the uncertainty around inundation extent and duration and its potential impacts on the upstream environment.

Response

References in the EIS to incremental depths and durations of temporary inundation of about 0.5 metres and half day are referring to upstream locations in the tributaries that flow into Lake Warragamba. Refer for example to the summary provided in Section 15.6.5 of Chapter 15 of the EIS. The increase in the depth and duration of temporary inundation would be greater at the dam wall and in Lake Burragorang (refer Table 15-14 in the EIS).

Validation (calibration) of the hydrological model used for the Project is described in Chapter 6 of Volume 1 of the *Hawkesbury-Nepean Valley Regional Flood Study Final Report* (Infrastructure NSW 2019).

In light of the above, WaterNSW does not agree that the aquatic ecology assessment does not consider uncertainty around inundation extent and duration and its potential impacts on the upstream environment.

4.1.6.17 'New' inundation zone

The potential extent of the 'new' inundation zone created at PMF was discussed above. Approximately 284 kilometres of upstream rivers, streams and creeks may be inundated by the proposed raising of Warragamba Dam wall (based on PMF mapping which could potentially become the 'new' FSL for Warragamba Dam).Very little if any attention has been paid to the aquatic ecology in these inundation areas, despite them containing known locations of threatened/endangered or protected species.

Response

As noted in the response provided in Section 4.1.6.1, the EES estimate of affected river length does not take into account temporary inundation associated with the existing dam nor the truncation of the flood events considered in the assessment. The estimated additional 284 kilometres of upstream that would be affected by the Project is not correct.

As also previously stated, FSL relates to the maximum water level of Lake Burragorang during normal operation for water supply. This will not change with the Project.

4.1.6.18 Macquarie Perch

Issue 1

The assessment is highly subjective since no targeted surveys for Macquarie Perch were undertaken. Further, the eDNA results (Appendix B) identified Macquarie Perch at sites 9 and 13.

Caution should be placed on the assessments of presence/absence of Macquarie Perch given the inadequate survey effort and the very few sites that were considered.

Response

The Macquarie Perch was assumed present and considered within the EIS accordingly. The aquatic assessment concluded that impacts to the Macquarie Perch are not anticipated.

Issue 2

While Knight (2010) identified the Macquarie Perch was often one of the most common fish sampled at those sites found supporting the species, it had a fragmented and patchy distribution in the catchment and often occurred in low numbers. Knight (2010) also observed that all sites where Macquarie Perch occurred were in an undisturbed condition, suggesting that their distribution is limited by their sensitivity to in-stream habitat conditions.

Despite citing Knight (2010) on numerous occasions, the aquatic ecology assessment appears to not acknowledge the central theme of Knight's (2010) paper, the feasibility of excluding alien Redfin Perch from Macquarie Perch habitat in the Hawkesbury-Nepean Catchment. It is obvious that further inundation of approximately 284 kilometres of upstream rivers, streams and creeks will enhance the potential for Redfin Perch to invade Macquarie Perch habitat.

Response

As noted in the response provided in Section 4.1.6.1, the estimated 284 kilometres of affected river length(which relates to the PMF event), does not take into account temporary inundation associated with the existing dam nor the truncation of the flood events to remove the influence of local catchment inflows. The estimated additional 284 kilometres of upstream rivers, streams and creeks that would be affected by the Project is not correct.

The principal effect of the Project on Macquarie Perch habitat will be an increase in the depth and duration of temporary inundation. It will not increase the upstream limit of flooding associated with the Project. Accordingly, it is considered unlikely that the Project would represent a material change to the risk of Redfin Perch invading Macquarie Perch habitat.

Issue 3

Despite identifying nine sites for Macquarie Perch 'assessment', no targeted sampling of Macquarie Perch was undertaken for this Project. What was recorded was a range of habitat variables that did not relate directly to Macquarie perch presence or absence. Only five sites in four rivers/streams were surveyed for eDNA out of the approximately 1100 plus streams that will be impacted by the 'new' inundation zone at some level/duration. Two of these sites produced evidence of Macquarie Perch DNA.

Macquarie Perch have previously been found (Dennis Ashton, Sydney Catchment Authority catchment officer pers comm) in:

- Kowmung River, (both up and downstream of the gauging station)
- Wollondilly River, various sections above FSL up to Goodmans Ford
- Coxs River, near gauging station
- Nattai River, above FSL up to and including Alum River and Martins Creek
- Little River (Warragamba catchment), above FSL up to (west of) Buxton
- Blue Gum Creek, between Little River and Thirlmere Lakes
- Jacobs Creek, from Blue Gum Creek to near Buxton

- Lake Burragorang, near Butchers Creek camp, stored water.

It is noted that there was no habitat assessment for the Kowmung River, Butchers Creek or many of the other streams likely impacted by the Project.

The reasoning for the lack of targeted Macquarie Perch sampling was:

> *This site assessment was undertaken between September and December 2017, which coincided with the spawning period for Macquarie Perch and other threatened species, and as such extractive sampling (e.g. fishing, netting, trapping) were not feasible to undertake.*

It has been nearly four years since the site assessments in which time targeted Macquarie Perch sampling was clearly 'feasible' and could easily have occurred. The aquatic ecology assessment is considered deficient in its sampling and assessment of Macquarie Perch populations likely to be impacted by the Project.

Response

The aquatic ecology assessment has assumed the presence of this species and is the principal basis for the two Assessments of Significance provided in Appendix D to Appendix F4 *Aquatic Ecology* of the EIS. Further field sampling would not change the outcome of these Assessments of Significance as the question is not about whether the species is present or not (assumed present), but whether the Project would have a significant impact on the species and its habitat.

Section 4.1.6.2 comments on potential impacts of the Project on riffle habitat that may be utilised by the Macquarie Perch noting:

- The maximum duration of temporary inundation is 10 days for the 1 in 100 event (and which is a relatively rare event); this is unlikely to be a significant constraint to breeding in the context of the length of the breeding season
- There is a negligible increase in the depth of temporary inundation for the relatively more frequent 1 in 5 chance in a year flood event
- With reference to the water depths noted in the National Recovery Plan, the maximum incremental depths for the 1 in 5 and 1 in 10 chance in a year events would be unlikely to be a material constraint to breeding.

The assessments of significance have been reviewed considering the above points. The conclusions that the Project is unlikely to have a significant impact on this species are considered to still hold.

4.1.6.19 Adams Emerald Dragonfly

Issue 1

The aquatic ecology assessment states:

> *The Adam's emerald dragonfly (Archaeophya adamsi) is listed as endangered under the FM Act. Larvae of the Adam's emerald dragonfly generally occur in small to moderate sized creeks with gravel or sandy beds, with narrow, shaded riffle zones containing moss and abundant riparian vegetation (DPI 2013). Such habitat conditions are present in tributary streams feeding into Lake Burragorang. Construction activities for the Project would be confined to a relatively small area and would not be expected to impact on habitat utilised by this species.*

This statement fails to identify the published occurrence of Adam's Emerald Dragonfly in Reedy Creek at a location inside the potential inundation zone (Theischinger *et al*. 2011). This individual was collected by OEH in 2011 and Theischinger *et al.* (2011) provided the details: Reedy Creek at

Kedumba Valley Rd, Kings Tableland, Blue Mountains National Park (33.826335˚S/150.37164˚E), ca. 150 m asl: 1 F-?3 larva, 11-05-2011, G. Theischinger & M. Krogh.

Response

The location noted above occurs outside of the construction area and above the existing PMF (untruncated) but within the Project PMF (untruncated).This location is also above the 1 in 100 chance in a year flood event (untruncated) with the Project. This location is more likely to be affected by local catchment inflows than from backwater effects from the Project.

Issue 2

The Aquatic Ecology Assessment has failed to adequately survey the scientific literature in relation the Adam's Emerald Dragonfly. Further, no targeted sampling for the species has occurred. The Aquatic Ecology Assessment is considered deficient in its sampling and assessment of Adam's Emerald Dragonfly populations likely to be impacted by the project.

Response

The aquatic ecology assessment has assumed the presence of this species and is the basis for the Assessment of Significance provided in Appendix D to Appendix F4 *Aquatic Ecology* of the EIS. This noted that the Project is not anticipated to result in modifications to suitable habitat or reduce the availability of potential breeding habitat for the Adam's Emerald Dragonfly. The additional record at Reedy Creek does not materially alter this conclusion.

Consideration has also been given to the specific issue of the potential for longer term impacts of sediment deposition affecting gravel shoal/riffle habitat suitable for Adam's Emerald Dragonfly. It is noted that this is an existing risk that will continue to occur independent of the Project. Further work carried out on potential changes to the pattern of sediment movement through the upstream channel system (refer Appendix G) subsequent to completion of the EIS confirmed that the Project would have a limited increase in the extent and lateral width of deposition in all upstream channels but noted that this a process that currently exists.

Following consideration of the above additional matters, the conclusion of the assessment of significance is still valid, i.e. that the Project is not likely to have a significant impact on the Adam's Emerald Dragonfly.

4.1.7 Climate change and sustainability

4.1.7.1 Climate change risk

Issue 1

The Proponent must assess the risk and vulnerability of the project to climate change in accordance with the current guidelines (SEAR 7.1).

The EIS has referenced and broadly applied frameworks, standards and processes relevant for the purposes of assessing the risks and vulnerabilities of the Project to climate change. However, EES considers the engagement with community, experts and stakeholders and the scope of the risk assessment is limited. As a result, the assessment is unable to demonstrate an appropriate level of adequacy to mitigate the risks identified and potentially excludes consideration of other government objectives and outcomes.

Response

There has been extensive work on consideration of climate risk as part of development of the Project, including for the Project design to incorporate resilience to climate change as described in

Section 5.1 of the EIS. The Project is not vulnerable to climate change, but an essential aim of the Project is to reduce the impact of increased flood risk related to climate change projections.

The scope of the climate change assessment was developed in consultation with climate change experts in the former DPIE. This assessment was then subject to independent peer review facilitated by the Office of the NSW Chief Scientist and Engineer as described in the flood study report (Infrastructure NSW 2019). The peer reviewers were Professor Jason Evans (Climate Change Research Centre, University of NSW) and Professor Seth Westra (School of Civil, Environmental and Mining Engineering, University of Adelaide). The peer reviewed assessment of climate change was undertaken with extensive consultation with DPIE.

If climate change remains as projected, the need for the Project to mitigate the increased flood risk on the downstream communities will only increase as outlined in the EIS. If the impact of climate change on flood risk is below projections, whether due to inaccurate projections or reduced greenhouse emissions, the Project would mitigate less flood events.

The work undertaken is consistent with all identified government climate change objectives and outcomes. This is one of the first major infrastructure projects which has incorporated changes in flood risk due to climate change.

Additional information on the extent of climate change consideration can also be found in the Infrastructure NSW 2021 report *Climate Change and Flooding Effects on the Hawkesbury-Nepean*[18].

Issue 2

The residual risk of downstream flooding following completion of the Project will still be high (downgraded from extreme) and requires further articulation of proposed risk treatments, or consideration in the detailed project design.

Response

The current natural downstream flood risk that the project is designed to mitigate is extreme. The project reduces this risk to high. Further reductions in flood risk are possible with larger dam raising, but these would have larger upstream impacts.

Complementary measures in the Flood Strategy will still apply to manage the residual flood risk, including maintaining current flood land use planning and development controls, improved flood awareness, improved flood forecasting, improved flood emergency planning and response. The Project is just one of nine outcomes of the Flood Strategy to minimise flood risk in the valley.

The Project will provide substantial flood mitigation benefits, particularly for floods up to about the 1 in 1,000 chance in a year flood event. However, the residual risk of downstream flooding will still be high due to the potential for extended minor low-level flooding during emptying of the FMZ. Operation of the FMZ is discussed in Section 15.8 in Chapter 15 of the EIS.

Risk treatment for climate change has been addressed in the Project design which has been informed by the climate change modelling. This has included an extra three metres in the non-overflow abutment height to accommodate the future raising of the spillway crest in the future should the modelled climate change projections be realised. During detailed design the climate change modelling and projections will be reviewed and updated to meet the latest available climate change projections data.

18 https://insw.com/media/3233/climate-change-and-flooding-effects-on-the-hnv_2021.pdf

Issue 3

The scope of the risk assessment is narrow and basic focusing on construction and the operation of the dam, however there will be other values, assets and objectives that may be impacted that are within the control of the proponent and should be analysed in more detail, such as ecological and Aboriginal cultural heritage values. EES is concerned the EIS does not demonstrate a meaningful analysis of the risks identified and the associated adaptation options, or effective planning and prioritising of adaptation options. This is a significant oversight and means that the adequacy of the adaptation strategies identified cannot be assessed.

Response

The potential impacts of the Project are essentially related to changes to the pattern of hydrology and flooding in relation to the incremental depth and duration of temporary inundation, flood frequency and flooding extent both upstream and downstream of Warragamba Dam. The Project would largely reduce downstream impacts associated with flooding, particularly for overbank flows.

Changes to hydrology and flooding have been assessed using hydrological and hydraulic models as described in the *Hawkesbury-Nepean Valley Regional Flood Study Final Report* (Infrastructure NSW 2019). The hydrological modelling has allowed for climate change as per the recommended approach in the 2019 version of *Australian Rainfall and Runoff* (ARR 2019).

The environmental assessment for the EIS is based on the hydrological modelling therefore implicitly incorporates consideration of climate change risk with regard to the environmental aspects considered such as biodiversity and Aboriginal cultural heritage.

Issue 4

Loss of biodiversity has been identified as a risk and assessed with a moderate consequence, however risks to Aboriginal cultural assets do not appear to have been identified. While ecological risks have been identified, the analysis of these and the adaptation/risk mitigation responses indicate that these risks have not been analysed in any meaningful way. It is unclear how the risks responses/adaptations will effectively mitigate these risks, despite the risk being downgraded to medium with the risk treatments. EES is also concerned with the lack of proposed risk treatment options to address fire risks, and the high number of risks that have a residual risk rating of medium or high.

Response

As noted above, the environmental assessment for the EIS is based on the hydrological modelling which has allowed for climate change, and therefore implicitly incorporates consideration of climate change risk with regard to the environmental aspects considered such as biodiversity and Aboriginal cultural heritage.

Separate risk assessments have been carried for environmental aspects and are presented in the relevant EIS chapters (such as Section 18.12 for Aboriginal cultural heritage). Management of risks is presented, as appropriate, in the management and mitigation measures section of the individual assessment chapters. Management of bushfire risk during construction is addressed though management measure HS 6 (refer Appendix B to this report).

With regard to risks that have a residual risk rating of medium or high, a review of the risk assessments would be carried out during detailed design to better inform risk treatments and management measures.

Issue 5

It is unclear if the risk identification and assessment processes only involved representatives from WaterNSW and Infrastructure NSW. More detail about the engagement process is needed to determine the adequacy of the risk assessment process as limited engagement may mean there are missed risks and opportunities to meet broader government objectives and outcomes and community expectations. Given the significance of the Project, EES would expect a wide range of stakeholders and experts to be included at all key stages of the process with evidence of this engagement supplied in the EIS.

Response

In addition to representatives from Water NSW and Infrastructure NSW, a representative from WMAwater (the company carrying out the hydrological and hydraulic modelling for the Hawkesbury-Nepean Valley Regional Flood Study) also participated in the workshop. Also, as noted previously the climate change component of the hydrological modelling was peer reviewed.

Issue 6

Near future (2030) has been considered for construction phases, and far future (2070) has been considered for operation phases. Some NARCliM data has been referenced and the proponent has referenced other reputable sources as part of the assessment.

Response

As previously noted, the climate change component of the hydrological modelling was peer reviewed by Professor Jason Evans (Climate Change Research Centre, University of NSW) and Professor Seth Westra (School of Civil, Environmental and Mining Engineering, University of Adelaide).

Issue 7

The Proponent must quantify specific climate change risks with reference to the NSW Government's climate projections at 10 kilometre resolution (or lesser resolution if 10 kilometre projections are not available) and incorporate specific adaptation actions in the design (SEAR 7.2).

Given the significant nature of the Project, the risks associated with potential maladaptation and the changing pace of climate projections and modelling, EES recommends that the most up to date advice and data on climate change is used for every stage of the Project. This should include updating projection information to consider insights from Intergovernmental Panel on Climate Change Sixth Assessment Report (IPCC AR6) as useable and relevant data is made available.

Response

The climate change risk assessment was undertaken in 2018 and future climate projections for the project region were established from the best available data at that time, being the NARCliM 1.0 dataset (2014). The NARCliM 1.0 projections were supported by information from *Climate Change in Australia*[19]. It is noted that as yet these projections are not dynamically downscaled for NSW.

NARCliM 1.5 was not released until 2020, after the climate change risk assessment was complete, and was not specifically used to identify future climate trends. This notwithstanding, it is noted that NARCliM 1.5 complements NARClim1.0 and should only be used in combination with NARCliM 1.0.

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[19] https://www.climatechangeinaustralia.gov.au/en/

WaterNSW confirms that the future detailed design stage of the Project will use the latest available climate change projections from IPCC.

Issue 8

The proponent has referred to and used NARCliM (1.0) and Climate Change in Australia (CSIRO) data for projections not suitable for assessment with NARCliM data to inform the assessment of risks (Appendix G, Section 3, pages 23-27).

Response

NARCliM does not provide information on the number of East Coast Lows and the CSIRO data was used to provide this supporting information.

Issue 9

EES notes the recently published report on climate change and flooding in the Hawkesbury-Nepean which highlights the uncertainty and limitations of climate projections with determining changes to rainfall and precipitation (*Climate Change and Flooding Effects on the Hawkesbury-Nepean, Final Report*, Infrastructure NSW, September 2021). The EIS has considered increased precipitation due to climate change in line with the ARR approach and factored this into the design of the Project.

The report notes there has been a range of data sources and methods applied to assess the impacts of climate change on flooding relevant to the Project which has produced a range of rainfall increases drawing from all data and approaches including NARCliM. The EIS has applied the report and adopted a 9.5 percent increase by 2060 (considered the 'reasonable midway estimate') to model the impacts of climate change. As a result the EIS has proposed a design intervention which will involve raising the abutments by a further three metres (to a total of 17 metres above the current height) to allow for potential further raising of the spillway to this height at a future time if needed. This is to account for the potential increases in rainfall under climate change and to 'future proof' the asset if climate change results in increased rainfall.

This main design intervention demonstrates that the Project has incorporated a design measure that considers potential increases in flood producing rainfall events due to climate change; and that this is not based on the NARCliM projections due to the uncertainty and limitations of applying NARCliM precipitation projections in flood modelling.

Response

As previously noted, the climate change component of the hydrological modelling was peer reviewed by Professor Jason Evans (Climate Change Research Centre, University of NSW) and Professor Seth Westra (School of Civil, Environmental and Mining Engineering, University of Adelaide).

Issue 10

It is unclear how other potential climate change risks have been factored into the Project design and operation, particularly fire, elevated carbon emissions, and the mitigation of risks such as damage and the loss of Aboriginal cultural assets. Technical assessment of these and other climate change risks and any proposed treatment/adaptation measures should be included as part of this process to inform the Project design.

Response

Climate change risks have been assessed based on the scope of the Project and associated components. Table 5-1 in Appendix G to the EIS shows how the screening of risk was undertaken for the project components. The assessment is high level and provides appropriate assessment of risk based on the level of detail provided by the concept design. Further review and refinement of the risk ratings and treatments would be carried out during detailed design.

4.1.7.2 Sustainability

Issue 1

Priority 4 of the NSW *Net Zero Plan Stage 1: 2020-2030* is for NSW government to led by example. As a major infrastructure project, the Warragamba Dam Raising Project has the scale and opportunity to go beyond the minimum requirements set by NSW Government Resource Efficiency Policy (GREP) and be an exemplar for other major infrastructure projects to minimise emissions towards net zero for both operations and construction. EES notes, for example, an initiative in Table 23-5 proposes that construction-related greenhouse gas (GHG) emissions will be reduced by a minimum five percent from the Project baseline GHG footprint. EES does not consider a five percent reduction accords with science-based targets or the ambition of the NSW Net Zero Plan.

Response

The first stage of the Net Zero Plan is to support a range of initiatives targeting energy, electric vehicles, hydrogen, primary industries, technology, built environment, carbon financing and organic waste.

The operational carbon footprint of the Project will be low and will likely be very similar to the existing dam. There will be further opportunities during detailed design to consider the reduction of embodied emissions when the key material selections are refined during design development. It is noted that material performance is critical to dam safety so any low emission materials will need to meet strict performance criteria.

As technology for hybrid/electrical construction plant and equipment improves, more feasible holistic opportunities for alternate fuels/lower carbon plant and equipment may become available in the future. These opportunities would be considered during detailed design and development of construction methodologies.

As noted, Table 23-5 proposes that construction-related greenhouse gas (GHG) emissions will be reduced by a minimum five percent from the Project baseline GHG footprint. This provides scope for greater reductions to be achieved.

Issue 2

The Project should target a 'Leading' or 'Excellent' infrastructure sustainability (IS) rating at minimum. A project of this magnitude and with current NSW Government policy context, applying a minimum GREP or targeting a 'Commended' IS rating is not considered sufficient.

Response

The potential IS Rating score has been revised (refer Section 6.6 of the PIR). This has identified that the Project would be able to achieve an 'Excellent' score.

Issue 3

The Project should deliver a full life-cycle assessment and consider whole-of-life carbon due to the significant impact of emissions from construction.

Additional detail should be provided on how the embodied emissions in materials will be reduced. For example, the Project should actively require low-emissions building materials (recycled, repurposed, biomaterials and renewable materials). The Project will have significant procurement power and therefore an opportunity to influence supply chains towards providing low-emission building material solutions.

Response

The detailed concept design has used internationally recognised guidelines for dam design including the Dam Safety NSW guidelines. The materials selected in the design do comply with these guidelines. As part of the detailed design phase, WaterNSW can consider a full life-cycle assessment process in consultation with Dams Safety NSW.

Issue 4

The impacts of the emissions from energy generation and transportation could be further mitigated and should be given greater emphasis and consideration.

Response

WaterNSW commits to explore opportunities to further mitigate emissions energy generation and transportation will be considered during detailed design and construction planning (refer new management measure CC7 in Appendix B to this report).

Issue 5

Additional weighting and stronger outcomes should be sought for the IS Rating, particularly in emissions reduction, materials footprint and renewable energy. There should be far greater focus on:

- Renewable energy options both onsite and offsite (e.g. through procurement of renewable energy certificates)
- Opportunities for embodied emissions reduction particularly in structural materials of the dam but also in on-site buildings
- Materials footprint reduction at all stages of the Project, as well as considerations for decommissioning the construction site in the future
- The use of electric vehicles and charging infrastructure.

Response

As noted previously, the potential IS rating for the Project has been reviewed and revised (refer Section 6.6 of the PIR). This identified that an 'Excellent' rating could be achieved in a number of categories and associated credit types including 'Energy and carbon' and 'Materials' which addresses several of the points made.

The construction site would be decommissioned once all construction activities had been completed.

Opportunities to provide for the use of electric vehicles and charging infrastructure would be investigated in consultation with the delivery contractor during construction planning.

Issue 6

The Project should be developed to be as energy efficient as possible, maximising onsite renewable energy with the remainder powered by 100 percent renewables (e.g. Green Power or other renewable energy certificates).

Response

WaterNSW will look for opportunities for energy efficiencies during detailed design and construction planning (refer new management measure CC7 in Appendix B to this report).

4.1.8 Floodplain risk management

4.1.8.1 Strategic justification and Project need (Chapter 3)

Issue 1

Section 3.2.1.6, page 3-7 in the EIS states

> *Under a medium climate change projection, by 2090 the 1 in 100 chance in a year flood level is forecast to increase by around 1.1 metres at Windsor and 0.7 metres at Penrith (WMAwater 2017). For a1 in 100 chance in a year flood the Taskforce estimated only 2,500 residential properties would be impacted compared to 7,600 properties if the Project were not to proceed. In a flood similar to the largest flood since European settlement (1867 flood – 1 in 500 chance in a year flood), 5,000 residential properties would be impacted, compared to 15,500 if the Project were not to proceed.*

This section on climate change should also refer to sea level rise. The sixth paragraph seeks to justify the Project, citing reductions in evacuees. It would also be appropriate to note what sea level rise was applied to this scenario e.g. how would these numbers of properties and evacuees change with different sea level rise projections?

Response

The Hawkesbury-Nepean River is located in a drowned river valley. Sea level rise has a low influence on the depth of flooding. Although the river is tidal up to Yarramundi under normal conditions, the natural sandstone gorges cause flood levels to rise well above sea level in any significant flood event.

Table 51 in the Hawkesbury-Nepean Valley Regional Flood Study report identifies that sea level rises of 0.4 metres and 0.9 metres were adopted to assess impacts for sea level. In adopting a sea level rise of 0.9 metres for the 1 in 100 chance in a year event, the rise in flood levels was proportional to sea level rise. The influence of assuming a 0.9 metre sea level rise results in a flood level change of less than 0.1 metres at Wisemans Ferry and 0.01 metres at Ebenezer. Therefore, sea level rise would have no significant impact on the number of people to evacuate from the highly populated areas of the valley.

Issue 2

Section 3.2.1.6, page 3-9 in the EIS states

> *However, based upon additional climate change and hydrological modelling, to provide similar current flood mitigation benefit as the 14-metre FMZ, in 2090 the dam spillways may need to be raised to create an FMZ of 17 metres. For all raising options considered, the full supply level would not change.*

Consideration should be given to reviewing the planning horizon for the Project and the associated climate projections given the release of IPCC AR6.

Response

The climate change assessment considered a broad range of increased rainfall scenarios based on dynamic down scaling and temperate scaling. The range covers the projections from IPCC AR6.

The climate change and hydrological modelling was undertaken during the development of the EIS. Climate change was modelled for a medium scenario projected by around 2060. The updated projections in IPCC AR6 could mean that this level of climate change could be realised earlier than projected. As the dam raising mitigates the impact of climate change on flood risk this scenario would make the need for the dam raising stronger.

NARCliM 2.0 is scheduled for release in 2023 and will provide future climate projections for NSW using the most recent climate change model predictions from IPCC. WaterNSW confirms that the future detailed design stage of the Project will use the latest available climate change projections from IPCC.

4.1.8.2 Project development and alternatives (Chapter 4)

Section 4.8.2, page 4-53 in the EIS states

> *This proposal does not seek or provide for any increase the level of the spillways above 14 metres. It allows for the spillway crest heights to be constructed at the levels that would create an FMZ of 14 metres. This FMZ has been applied to the assessment of upstream temporary inundation impacts and the downstream flood mitigation benefits as previously discussed in this section.*

This chapter indicates that the assessment has applied a FMZ of depth 14 metres. However, Chapter 15 (page 15-63) states

> *The Project would involve raising the dam wall and spillways to create a dedicated FMZ, with a depth of around 12 metres above FSL.*

It appears the economic assessment in Chapter 4 has applied an FMZ of depth 14 metres, however, it is not clear whether an FMZ of depth 14 metres as indicated in Chapter 4 or 12 metres as indicated in Chapter 15 has been applied in all other assessments undertaken to support the EIS.

Response

The Project is described in Chapter 5 of the EIS. The Project includes raising the level of the central spillway crest by around 12 metres and the auxiliary spillway crest by around 14 metres above the existing FSL for temporary storage of inflows. The configuration of the spillway crest levels and the gated outlets control the extent and duration of the temporary upstream inundation and downstream releases. There would be no change to the existing full supply level or the maximum volume of water stored for water supply.

All EIS assessments are based on the above design configuration of the spillway crest levels. The flood modelling allows for the controlled release of stored water from the FMZ through eight gated conduits. The outflow modelling that informs the extent of downstream flooding are based on operating rules outlined in the PIR,. The discharge rates would commence after the flood has peaked and the flood is in recession and vary dependent on the lake level. For the Hawkesbury-Nepean Valley flood incident management encompasses all sources of flooding including other dam storages and non- regulated rivers. The timing and rate of discharge from Warragamba is coordinated with other sources of flooding that are influencing the downstream flood extent.

Chapter 15 and Appendix H1 contain the results of the flood modelling and extents based on the detailed concept design, spillway configuration, outlets and discharge rates as described in the Appendix H1. The PIR includes design drawings related to spillway configurations and discharge capacities and the operating regime for the raised dam

4.1.8.3 Flooding and hydrology (Chapter 15)

Note: comments relating to minor clarifications and corrections are addressed in Section 7.

Issue 1

Section 15.1.2, page 15-6 states

> *The project study area comprises:*
>
> - *upstream: area within the Project probable maximum flood (PMF) extent*
> - *downstream: area within the current PMF (note that the downstream Project PMF area would be less than that for the current PMF).*

The upstream study area should be based on the extent of PMF level under the raised dam conditions. The incremental impacts should be documented by considering the impacts under baseline and raised dam conditions.

The downstream study area should be based on the PMF flooding extent under baseline and raised dam conditions to assess the incremental impacts and benefits.

Response

The upstream study area is defined within the Project (raised dam) probable maximum flood (PMF) extent. The downstream study area is defined by the existing PMF, however the raised dam PMF area would be less than the study area, providing a lower impact than currently could be experienced.

The incremental impact assessments have been addressed against all flood events as defined under the SEARs in agreement with DPE. For flooding analysis extent, Chapter 15 of the EIS addresses PMF extents under existing and with Project PMF events.

It is important to note that both upstream and downstream Project PMF extents have been truncated. This means the modelled layers were abbreviated at cross section locations where there was no longer differences between the existing and Project flood events, and where flooding is dominated by local catchment flooding at that location. This is discussed in Chapter 15 of the EIS.

The PMF is a hypothetical flood estimate akin to a 'worst case scenario'. It represents a notional upper limit of flood magnitude and no attempt is made to assign a probability of exceedance to such an event (AR&R 2019). In other words, the PMF is so unlikely it is impossible to estimate the chance of it occurring. The PMF 'worst case scenario' flood event used for dam safety evaluation of large dams and is highly unlikely to occur in large catchments such as Lake Burragorang.

Issue 2

Section 15.3.1.4, page 15-23 states

> *Monthly flows into and out of Warragamba Dam are summarised in Figure 15-11 which shows that unregulated river flows into Warragamba Dam are notably higher than regulated river flows released downstream of the dam.*

The regulated flows need some clarification. For example:

- Additional information regarding the long-term releases from the dam into the downstream waterways and for water supply purposes
- An explanation of why the regulated flows would be highest in June when the Sydney's water demand is low during winter.

Response

The principal objective of the Project is to mitigate downstream flood risk. The operational management of regulated flows is a separate issue to the Project.

Issue 3

Section 15.3.1.4, page 15-23 states

> *Daily baseflow releases (or riparian releases) also occur from the dam, which are typically between 20 megalitres and 30 megalitres per day.*

The flow releases are possibly not related to baseflows. Clarification should be provided about the releases for the North Richmond Water Filtration Plant, which has an average demand of 20 ML/d and peak demand of 30 ML/d.

Response

Section 15.3.1.4 of the EIS provides an overview of existing dam operations and discussion regarding daily baseflow releases is provided as part of this overview. Operational releases are provided through pipelines to feed the raw water to the various treatment plants. The North Richmond WFP is operated by Sydney Water and draws water directly from the Hawkesbury-Nepean River when needed. The amount drawn by Sydney Water is similar to the amount of water released from the dam for riparian releases.

Issue 4

Section 15.4.1, page 15-32 refers to inclusion of other flood events. Refence should be made to the February–March 2012 and March 2021 flood events when the dam level was high.

Response

Historic flooding is discussed in Section 15.4.1 of the EIS with historic dam levels shown on Figure 15.8. The development of the EIS was generally completed before the results of these flood events had been evaluated, however, the recent 2021 and 2022 flood events are discussed in the Executive Summary to the EIS.

Issue 5

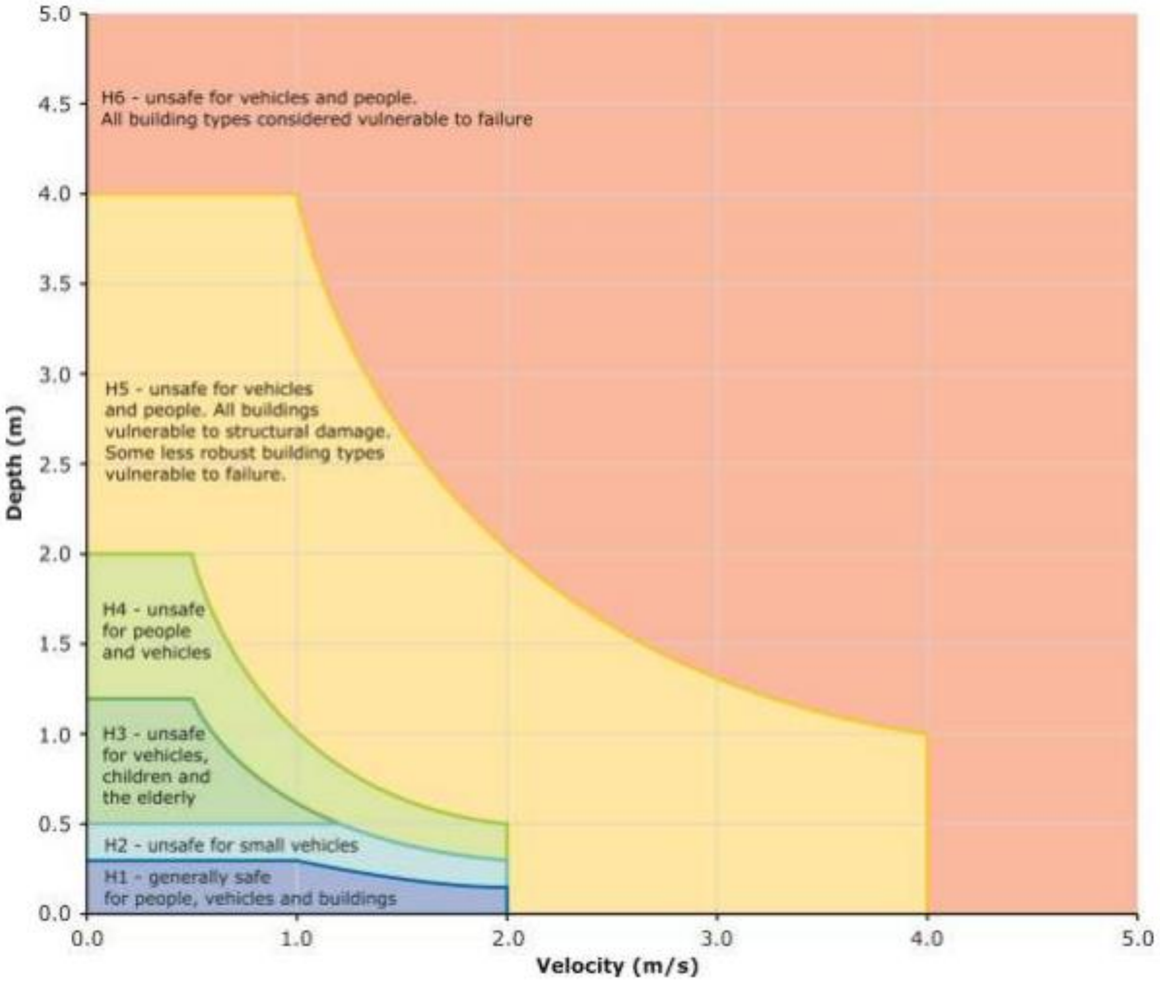
Table 15-9 in Section 15.4.5.3 (pages 15-47, 15-48) and Table 15-27 in Section 15.7.6 (pages 15-98, 15-99) of the EIS relate to hazard category linkage to building constraints.

As is, the tables suggest no building constraints unless the hazard level is H5 or above. This is incorrect as it depends on the event (i.e. if the land is below the flood planning level, minimum floor levels will apply, which is a building constraint). The title 'building constraints' should be 'no additional building constraints needed to address flood hazard'.

Response

As noted in Chapter15, Tables 15-9 and 15-27 are drawn from Appendix H2 *Flood Risk Analysis* which includes the following figure defining hazard categories as a function of water depth and flow velocity. The reference to no building constraints in the tables is in the context of these two parameters. It is acknowledged that there may be an alternate title such as the one suggested.

Figure 4-8 General flood hazard vulnerability curves



Source: Australian Institute for Disaster Resilience (2014)

Issue 6

Section 15.4.6, page 15-55 of the EIS states

> *Currently the Bureau of Meteorology can provide up to 15-hour flood level predictions for large flood events. However, the SES requires more than 15 hours to evacuate some flood islands in the Hawkesbury-Nepean Valley during large flood events.*

The flood prediction and forecasting system recently developed and evaluated for the Hawkesbury-Nepean Valley by the Bureau of Meteorology would be able to increase the forecast time to 24 hours to 36 hours. The predictive capability is expected to be increased in the future beyond the current 15 hours.

Response

There are two parts to a flood forecast: the forecast lookahead time and the accuracy of that forecast. The current BoM flood forecast target in the NSW Service Level Specification is a flood peak forecast of eight hours at Penrith and 15 hours at Windsor, ±0.3 metres with 70 percent accuracy. However, forecasting the flood peak is relatively easy as by definition the rainfall event driving the flood must be easing.

What is critical for emergency services is forecasts of rising flood levels early in the flood event when evacuation orders are being progressively issued. These flood forecasts are less accurate as the rainfall event is still evolving and the catchment rainfall/runoff response is still being determined.

The pilot probabilistic forecast product provides an envelope of flood levels to emergency services for planning purposes out to 36 hours. These probabilistic forecasts can have a very large variation early in the flood event, with up to four metres being observed. This large range in forecast flood levels means that they cannot be reliably used to trigger evacuations, but rather are used by the SES to consider what range of flood events it needs to prepare for.

The predictive capacity is not expected to significantly increase in the future. Despite significant advances in high-resolution satellite and radar observations and greatly increased computer modelling capability, increases in flood forecast accuracy are declining and in some cases going backwards, probably due to more irregular weather due to climate change.

The dam raising does delay the downstream flood peaks by 10 or more hours for most flood events. This means that the flood peak will occur later in the weather event with more rain on the ground. It is expected that the dam raising could therefore increase the flood forecast time and accuracy. However, the flood evacuation modelling for the raised dam was undertaken with people being triggered to evacuate according to the current BoM flood peak forecast target time. This means that the risk to life benefits from the dam raising are conservative.

Projected climate change was modelled to accelerate flood peaks by up to five hours. It is uncertain if this acceleration will make floods harder to forecast in the future.

Issue 7

Table 15-10, page 15-56 in Chapter 15 relates to the number of people requiring evacuation.

The assessment regarding the number of people requiring evacuation appears to be based on the evacuation of all the residential and non-residential populations in flood affected areas. This may be conservative. The actual number of people requiring evacuation is likely to be less.

Response

The SES flood plan requires that all people in flood affected areas need to be evacuated. This is done progressively on a subsector basis, and if an area is not forecast to be flood-impacted or isolated, it will not be ordered to evacuate. A conservative approach is preferred given leaving people at risk during flood events is not acceptable.

Issue 8

The title of the sixth column in Table 15-14 (page 15-64) should be 'Increase in Depth (m)' as it shows only the increase in water depth above the existing scenario not the actual Project depth. It is recommended an additional column be added showing the total inundation depth (i.e. 3.6, 6.4, 10.1, 15.3 and 27.2 metres for 1 in 5, 10, 20, 100 and PMF respectively) as shown in Figure 15-30.

Response

WaterNSW confirms that that Table 15-14 (Column 6) should read 'Increase in depth', which when added to the existing depth gives the total depth.

Issue 9

Tables 15-15, 15-16, 15-17 and 15-18 (pages 15-67, 15-70, 15-73 and 15-76) provide depth and duration information.

The tables only present the depth and duration impacts of the Project as changes from the existing and not as totals. It is recommended 'P= Project' be redefined as 'P = increase in Project impact'. Alternatively, the total impacts of the Project should be included.

Response

WaterNSW notes that the tables show incremental changes to the Project which is how the Project should be assessed, not on the total impacts of Project that would incorrectly include existing impacts.

Issue 10

Additional information (incorporating information like Tables 15- 14 and 15-15, the depth-duration curves in Figures 15-31 to 15- 34 and the flood frequency distributions in Figures 15-35) should be provided showing likely changes on the following services under the raised dam conditions:

- Bridge closures along the Hawkesbury River
- Duration of traffic interruption at road bridges for prolonged release of the floodwater from the FMZ
- Bank full conditions of the river (baseline conditions and the raised dam conditions) and the potential risk for erosion. The main reach of the river would carry the major loading in transferring the flood flow from the FMZ and would be subject to stress and risk
- Risk for water supply interruption within the North Richmond Delivery Zone. A high level of turbidity would exist during the controlled release of floodwater from the FMZ and the water filtration plant may not be functional. As a result, residents and businesses may not have access to potable water which could incur significant risks.

If these impacts are significant, they should be included in the socioeconomic assessment. The benefits of the reduction of flood damage to people and properties are likely to be compensated to some extent by the disbenefits of the interruption of services in some areas, whereas services in other areas may be improved.

Response

Bridge closures:

There are two components related to the impacts of the Project on bridge closures:

- The time before a bridge is closed
- The duration for which a bridge is closed.

Table 15.26 in Chapter 15 of EIS shows the number of hours before a river crossing (bridge) is closed for existing conditions and the Project. The table shows that for all but one modelled event at one location, there are positive benefits for all bridges, i.e. there is a delay in the time before the bridge is closed during a flood event. The main benefits would occur for bridges at Cattai Creek, Yarramundi Road, Windsor, North Richmond and Wallacia (Blaxland crossing), and to a lesser extent Richmond (Blacktown road) and Mulgrave (Jim Anderson).

Table 24-13 shows changes in the closure duration associated with the project for various flood probabilities. While this data indicates that there is an increase in the closure duration for most affected bridges, these calculations were based on assumed levels prepared in 2019 (during the 28-year gap in moderate and major flooding) and prior to recent lived experiences of these moderate and major floods. Work is currently underway to update these figures based on observations from the 2021 and 2022 floods. The Project's impacts on bridge closures is already considered in the socioeconomic assessment and summarised in Table 21-15 in Chapter 21 of the EIS.

FMZ discharge and bank erosion:

Chapter 22 *Soils* of the EIS assesses Project FMZ flows on the downstream river system and potential cumulative erosion impacts. A 'low' to 'medium' residual risk was predicted for river channel sections downstream of the dam. Further information about river bank stability and FMZ flows are discussed in Section 4.2.4 of this report.

Risk for water supply interruption within the North Richmond Delivery Zone:

FMZ discharge and water quality is assessed in Section 27.5.4 of the EIS. This included modelling various water quality parameters including nitrogen, phosphorus, chlorophyll-a and turbidity. It was concluded that compared to existing conditions the FMZ discharges would have negligible impact on downstream water quality. There would be minimal operational impacts on the Richmond water filtration plant.

Issue 11

Section 15.6.5, page 15-80 of the EIS states

> *For upstream locations, approximating the limit of the Project PMF event, the analysis shows:*

Locations at the upper end of the PMF extent should be identified (i.e. Location 2 – Wollondilly River, Location 6 – Cox River, Location 9 – Nattai River and Location 15 – Kowmung River).

Response

Chapter 15 of the EIS discusses truncation of flood extents. Depth-duration curves for modelled cross sections were used to identify tributary cross-sections at which there were no differences between the existing and Project PMF flood events. Chapter 15 of the EIS presents modelled depth/duration data for a range of flood frequencies including the PMF, up to the truncated level for major tributaries. Various flood extents are also shown on flood maps provided in Chapter 15 of the EIS.

Issue 12

Section 15.6.5, page 15-80 of the EIS states

> *For locations approximating the limit of the 1 in 100 chance in a year event, the analysis shows:*

Locations at the upper end of the 1 in 100 chance in a year event should be identified (i.e. Location 3 – Wollondilly River, Location 7 – Cox River, Location 10 – Nattai River and Location 14 – Kowmung River).

Response

Chapter 15 of the EIS provides information on Project changes to temporary inundation levels and durations for the 1 in 100 chance in a year event at the dam wall and major tributaries, including the Wollondilly River, Coxs River, Nattai River and Kowmung River. The 1 in 100 chance in a year Project flood extent is also shown on the flood map provided in Chapter 15 of the EIS.

Issue 13

Section 15.6.5, page 15-80 of the EIS states

> *There would be an overall decrease in flood velocities, both in the tributaries and within Lake Burragorang.*

This does not seem to be correct. The velocities along the tributaries and within the reservoir are expected to be decreased due to containment of flood storage within the FMZ. There would not be any changes in velocities under baseline and raised dam conditions for floodwater level up to the FSL of the dam.

Would the reduction of velocities in raised dam conditions when the FMZ is in use increase the potential for sedimentation within the tributaries and reservoir, mainly the upstream side of the dam wall than under the existing conditions and if so, would this have water supply implications?

Response

WaterNSW periodically assesses the level of sediment deposition in the reservoir and has found that like most reservoirs there is some deposition in the area of the lake immediately adjoining tributaries where velocities suddenly drop significantly. The raising will not affect the amount of sediment but will change the behaviour. The location of sediment deposited during smaller events and during the rising limb of a larger events flood will not change significantly. During the recession of large events when the dam is at higher levels some of the existing deposition will change from the lake proper to the very bottom reaches of the major tributaries. A lot of this deposition will be remobilised in the early part of the next event and subsequently be deposited in the normal part of the existing lake.

Issue 14

Section 15.7.1, page 15-81 of the EIS states

> *However, there are potential negative impacts that need to be considered including:*
>
> - *the impacts of water discharge from the FMZ after a rainfall event. This may result in environmental, social, and economic impacts as water levels and velocities downstream of the dam would be higher for a longer period than the existing situation*
> - *environmental impacts from the reduction in flooding extents and peak water velocities, especially for sensitive features such as wetlands.*

There are significant benefits from the Project for the downstream communities which extend to Wiseman Ferry, in relation to the reduction in the frequency of flooding (Section 15.7.2.2), substantial reduction in flood depth (Table 15-20) and reduction in flood extents (Section 15.7.2.3). However, additional information should be provided on the impacts of longer periods of inundation on properties in low-lying areas (more likely properties impacted by the 1 in 5-year chance in a year flood). It is noted from Table 15-21, for example, the duration of flooding increases by around 100 hours to 200 hours. Acknowledging the overall reduction in Annual Average Damage (AAD) due to the Project, adequate data on the properties impacted by longer duration flooding including changes in AAD, loss of access, isolation period, income loss and extended recovery period should be provided.

A negative environmental impact that also needs to be considered is the potential reduction in fertility of the Hawkesbury-Nepean floodplains downstream of the dam due to changes in the deposition of sediments and nutrients from floodplain inundation. Consideration should be given to whether these impacts are significant.

Response

There are a limited number of properties at the 1 in 5 chance in a year flood level that would be impacted by a prolonged flooding from the FMZ discharge. Flood property damages are predominantly flood peak related and not driven by flood duration. Figure 15.9 in Chapter 15 of the

EIS shows how the Project would reduce peak dam outflows for all flood scenarios, including the 1 in 5 chance in a year flood. The evaluation of the Annual Average Damage has included sufficient data on the properties impacted including loss of access, isolation, income loss and other related factors.

The agricultural productivity in the lowlands is due to the rich alluvial soils. Extended inundation duration will impact plantings but there is no direct evidence to show that deposition of sediments and nutrients will impact fertility in the long term.

Issue 15

Table 15-20, page 15- 83 relates to consideration of sea level rise due to climate change.

The impacts of sea level rise if adopting the parameters in the recent IPCC report may reduce the Project benefit shown in Table 15-20 from M1 Motorway to Lower Portland the limit of tide effect. However, these impacts are unlikely to apply to the areas of concern for this Project i.e. Penrith and Windsor for the target scale of events this Project aims to address.

Response

The climate change and hydrological modelling was undertaken during the development of the EIS. Climate change was modelled for a medium scenario projected by around 2060. The updated projections in IPCC AR6 could mean that this level of climate change could be realised a few years earlier. As the dam raising mitigates the impact of climate change on flood risk this scenario would make the need for the dam raising stronger.

WaterNSW confirms that the future detailed design stage of the Project will use the latest available climate change projections from the IPCC.

Issue 16

Section 15.7.2.3, Figures 15-38 to 15-41 and Tables 15-22 to 15- 25, pages 15-89 to 15- 92 could include additional information such as the following.

Longitudinal profiles of flood extents in terms of reduction of peak water levels under baseline conditions and the raised dam conditions would be useful to visualise the extent of river reach, where improvement would be possible.

Consideration should also be given to including similar figures and tables on changes to service interruption, under the current and Project scenarios. This would provide additional information on the Project benefits and disbenefits.

Response

WaterNSW has considered the above suggestions, however, the EIS already includes an exhaustive amount of figures and tables for flood events as required by the SEARs and supporting documentation that provides sufficient information to address SEARs requirements. Chapter 15 of the EIS presents flood maps for the SEARs range of flood events which show existing and Project changes to flood extents. Flood function and flood hazard mapping is also proved in Appendix H2 to the EIS. These maps show primary and secondary floodway characteristics, as well as flood hazards. Similarly, various tables in Chapter 15 of the EIS show expected Project changes within the river system, including at major bridge crossings.

Project benefits and potential negative impacts are discussed throughout the EIS and summarised in Chapter 29 *EIS Synthesis, Project justification and conclusion*.

Issue 17

Section 15.7.9.1, page 15-106 relates to changes to the morphology of the downstream river, bank erosion sedimentation and services.

Consideration should be given to the potential for changes to the morphology of the downstream river system altering bank erosion (as occurred in the March 21 flood) due to prolonged discharge of the stored floodwater within the FMZ relative to higher flows over a shorter timespan without the Project. If differences are significant, consideration should be given to incorporating these in the economic assessment (i.e. in terms of any changes to the cost of restoration of riverbanks and managing change in morphological conditions).

Consideration should also be given to whether the project significantly alters the potential for sedimentation within the reservoir and any potential loss of water supply storage. If these issues are significant the impacts should be considered based on the life cycle performance of the water supply infrastructure and the related impacts in the downstream waterways.

The significance of the benefits/disbenefits of the project on services (water supply and transport), should be also considered. If significant, consideration should be given to incorporating these in the economic assessment (Appendix M (SEIA).

Response

The matter of changes to morphology in the river system downstream are addressed in the geomorphology responses in Section 4.2.4 of this report.

WaterNSW has undertaken bathymetric surveys that indicate that there has been minimal loss of storage due to sedimentation despite the lake being of sufficient size. The potential for sedimentation would not be increased when the dam is raised. While there will be some localised slowing of delivery of sediment from the lower reaches of the tributaries into the lake, there will not be an increase in total sediment load from the tributary catchments.

Issue 18

Section 15.7.10, page 15-106 of the EIS states

Potential negative impacts include:

- *discharge of the FMZ would result in longer periods of low level flooding and flood hazard, disruption to transport and businesses as well as an increase in the risk of bank erosion: see Chapter 21 (Socio-economic, land use and property), Chapter 24 (Transport and traffic) and Chapter 22 (Soils)*
- *existing wetland and floodplain habitats that are dependent on a specific long-term flooding regime may be impacted due to the reduction in frequency of flooding: see Chapter 9 (Downstream biodiversity assessment report)*
- *agricultural land uses that currently benefit from the nutrients and sediments deposited on the floodplain may be impacted by reduced periods of inundation; see Chapter 21 (Socio-economic, land use and property)*

Where there are likely to be significant changes to riverbank degradation, riverbank erosion and morphological changes due to prolonged bank full discharge of floodwater from the FMZ due to the project, relative to the existing shorter duration higher flows, their inclusion in the summary of downstream impacts should be considered. The Hawkesbury-Nepean River will be running full for a prolonged period following a flood event. The water level will then drop to the normal level (or baseflow level). Consideration should be given to whether this would create an increased risk for slip failure of saturated banks along with the potential changes of riverbank conditions and cross-sectional patterns of the river. A finer scale geotechnical analysis would be required for the long-term assessment of these changes.

The potential changes associated with the sedimentation patterns in the upstream reach of the dam and the erosion and morphological changes of the downstream reach of the dam do not appear to have been considered in sufficient detail. The erosion rates and potential morphological changes in the downstream reach may be limited by emptying the FMZ at a rate lower than 100 GL/d. This may be possible considering the joint probability of two consecutive flood producing rainfall events in the dam's catchment.

While acknowledging the potential impacts of reduced inundation on agricultural land uses with regard to the deposition of nutrients and sediments, an assessment of impacts cannot be found in Chapter 21.

Response

The matter of changes to morphology in the river system downstream are addressed in the geomorphology responses in Section 4.2.4 of this report.

Issue 19

Section 15.8.4, page 15-109 of the EIS states

> *The timing and rate of discharge during flood events would be determined on a case-by-case basis.*

Clarification is required regarding the timing and rate of the releases of the piggyback discharges used in the assessment.

Response

With inflows to Warragamba Dam being temporarily stored in the FMZ, an approach that draws down part of the storage by 'piggy-backing' the discharge after the flood has peaked. A piggy-back approach is better able to meet the competing objectives of drawing the dam down to restore the availability of the FMZ back to the FSL in a reasonable period and enabling the bridges downstream to be opened in the shortest timeframe after the flood has peaked.

The EIS stated that the maximum discharge rate through the new FMZ gated outlets is around 230 GL per day for about 2-3 days as a 'piggy-back' approach behind the flood peak and thereafter reduced to 100 GL per day until the FMZ is discharged down the FSL.

FMZ releases would be made after the downstream flood has peaked at a rate that aims to avoid the river exceeding the previous flood level peak. The rate of release also aims to avoid breaching river banks depending on the size of the event. The flow would be gradually reduced in stages. Therefore, the FMZ releases would be targeted to not impact anywhere that had not already been affected by the preceding flood in coordination with the existing flood operation protocols with SES and the BOM.

In the event of a second forecast significant flood inflow, it would be possible to empty the whole of the FMZ within 10 days. This would allow FMZ capacity to mitigate further downstream flooding.

Issue 20

Section 15.8.5.1, page 15-109 of the EIS states

> *Flood mitigation zone releases are made after the flood at the downstream location has peaked; with a slight delay and a temporary fall in river levels while downstream peak is confirmed. The FMZ is then discharged at a rate that does not cause the river to exceed the previous flood level peak and is gradually reduced in stages …*
>
> *The maximum discharge rate through the new outlet conduits would be 230 gigalitres per day ...*
>
> *In the event of a second forecast significant flood inflow, it would be possible to empty the whole of the FMZ with piggybacking within 3-4 days. This would allow FMZ capacity to mitigate further downstream flooding.*

The assessment indicates that the FMZ releases are made after the flood at the downstream location has peaked, however, it is not clear whether the assessment has considered events with multiple peaks. If the maximum discharge rate of 230 GL/d is released and it coincides with a second peak of the event, the impact on the downstream areas, particularly Richmond-Windsor floodplain, would be significant.

The report indicates that, in the event of a second forecast significant flood inflow, it would be possible to empty the whole of the FMZ with piggybacking within 3-4 days. The assessment should undertake a sensitivity testing for this scenario to estimate the impacts on the downstream community.

It would be prudent to run various scenarios selected from the Monte Carlo approach to provide a better understanding of the potential impacts of the piggyback discharge. It would be useful to present the outcomes of the impacts of the piggyback discharge in figures like that provided for the constant discharge in Section 15.8.5.2, Table 16-29 and Section 15.8.6.

Response

Monte Carlo simulation performs risk analysis by building models of possible results by substituting a range of values – a probability distribution – for any factor that has inherent uncertainty. It then calculates results over and over, each time using a different set of random values from the probability functions.

Monte Carlo modelling incorporates the simulation of a large number of flood events using combinations of various input parameters. Input parameter values are randomly selected from predefined probability distributions for each variable to provide a combination representing a single possible event. The Monte Carlo framework was established to model flood events based on randomly sampling each variable from within the range of possible inputs:

- Rainfall intensity and frequency – catchment average rainfall
- Spatial pattern of rainfall – where in the catchment rain falls
- Temporal pattern of rainfall – when in the event rain falls
- Initial loss – rain 'lost' at the beginning of an event through infiltration into the soil
- Pre-burst rainfall – rain that occurs before the most intense burst of the storm
- Dam drawdown – the level of Warragamba Dam before the start of an event
- Relative timings of tributary inflows
- Tides.

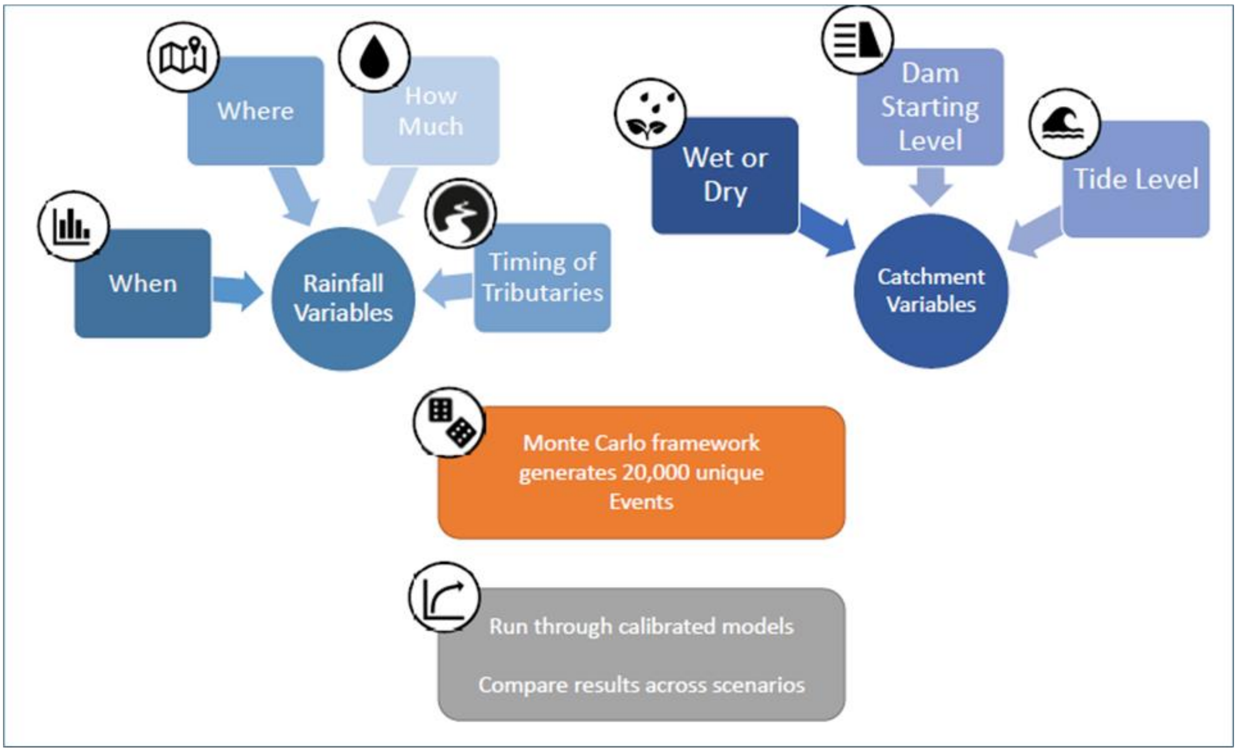
The Monte Carlo approach recognises that any design flood characteristic (e.g. peak flow) could result from a variety of combinations of flood-producing factors rather than from a single combination. The approach mimics 'Mother Nature' in that the influence of all probability distributed inputs are explicitly considered thereby providing a more realistic representation of the flood generation processes.

The model outputs for a particular flood in the EIS are represented by an 'envelope' of events, which cover a wide range of flood durations and affected areas. The EIS has conservatively adopted the 90th percentile modelled event and the actual impacts are likely to be less.

The Monte Carlo modelling has included multiple peak events. Piggybacking means that the releases do not exceed the initial peak. The accelerated releases of 230 GL/d, if a subsequent event is forecast, will therefore seek to not exceed the initial peak and create additional downstream impacts. The whole aim of an accelerated discharge through a 'piggy back' discharge is to minimise impacts by recovering the mitigation storage for the close subsequent event. When the second event starts, the dam would mitigate the second flood event by capturing water again and releasing following the second peak.

The process for Monte Carlo modelling for the Project is summarised in the following figure.

Figure 4-9 Monte Carlo modelling process



Issue 21

Section 15.8.5.2, page 15-109 of the EIS states

> *A constant FMZ discharge rate of around 100 gigalitres per day was assessed against a range of environmental, social, and economic factors (Table 15-29).*

It is unclear if the proposed constant discharge would proceed after the Hawkesbury-Nepean recedes to its normal level or while it is receding (i.e. during the falling limp of the hydrograph).

Details of the assumptions made to assess the potential impacts from a prolonged 100 GL/d discharge rate (as presented in Table 15-29) should be provided.

Response

Previous responses should be noted, however, in summary the FMZ gated outlets are based on a maximum discharge rate of 230 GL/d which can be initiated for about 2-3 days if required. Thereafter this rate is reduced to 100 GL/d in a constant flow until the FMZ is discharged and the lake level returns to the existing FSL. If there is no forecast subsequent event a lower constant discharge of around 100 GL/d is modelled to draw down the water level to FSL again and limit further downstream flooding.

The operating objectives and principles include a requirement to minimise downstream impact of flooding to properties the principle being to release the floodwaters at times and rates to reduce the flood peak downstream and therefore limit the impact to property.

Therefore, during the constant discharge flow, the FMZ will be released in a controlled manner through the gated outlets and discharged at a rate that does not cause further impacts that exceed the previous flood level peak as the level recedes gradually back to normal river levels. The constant discharge to drawdown the FMZ can also be varied below the constant rate should the Warragamba contribution be required to ramp down in response to other sources of flooding impacts as part of the flood incident management for the valley.

Issue 22

Section 15.8.5.2, page 15-109 of the EIS states

> *However, water quality of the FMZ would be higher than typical wet weather water quality in the Hawkesbury- Nepean River. This is because at Richmond the flood water would also contain runoff from urban and agricultural areas within the downstream catchment, which would be more polluted than the runoff from the heavily vegetated Warragamba catchment.*

Water quality within Lake Burragorang may also be impacted when intercepting floodwater following bushfires due to sediments and debris which may accumulate in the FMZ and reservoir. Additional water treatment and/or supply restrictions may therefore be required following major wet weather events.

The long-term risks to water supply because of climate change should also be considered by an assessment of the projected multi-hazards (e.g. drought, extreme hot days, heatwaves, bushfires, air quality, flooding and water quality).

Response

The potential impact of bushfire events on water quality in Lake Burragorang is an existing risk and will not change with the Project. WaterNSW has existing processes and strategies for dealing with water quality risk, including impacts from bushfires.

Longer term risks to water supply security due to climate change and other factors that influence demand are not a separate issue to the Project.

Issue 23

Table 15-29, page 15-111 of the EIS states

> *River water quality – It is expected that the higher FMZ releases would generally have a positive effect on water quality due to their 'flushing' of the river and destratification of the deeper pools, particularly in the upper reaches…*

> *Riverbank erosion and protection – Medium flows are likely to result in some erosion. Older structures may degrade or collapse.*

It is also possible that river water quality may not improve by releasing the water from the FMZ at a rate of 100 GL/d and further details should be provided comparing existing with raised dam conditions. It is recommended further details be provided on the impacts from the controlled release of 100 GL/d on riverbank erosion.

Response

FMZ discharge and water quality are assessed in Section 27.5.4 of the EIS. This included modelling various water quality parameters including nitrogen, phosphorus, chlorophyll-a and turbidity. It was concluded that compared to existing conditions the FMZ discharges would have negligible impact on downstream water quality.

Further analysis of the downstream erosion risk has shown that the erosion risk of the FMZ discharge release rate is likely increased from North Richmond to just beyond Cattai Creek, but the change upstream of Windsor is small. The discharge release rate was governed by the requirement to reduce the level of the FMZ back to the full supply level as soon as practical without causing further flooding and limiting the potential impacts on the upstream environment. Further details of erosion risk are provided in Appendix G.

Issue 24

Table 15-30 provides the change in probability of a 1 in 100 chance in a year event by 2090. The text indicates this information for the Project is without an additional allowance of three metres for climate change. It would be prudent to add another row to show the probability with the additional three metres in the abutment height.

Response

The information in Table 15-30 is demonstrating the change in chance per year event, in terms of years, between now and 2090 when applying climate change projections. If the projections are realised this will require a further increase of three metres in spillway height in the future. The design has included the extra three metres in the non-overflow abutment height to accommodate the future raising of the spillway crest in the future. The raising of the abutment height now will only be required to accommodate for a future spillway raising of three metres.

Issue 25

Table 15-31, page 15-117 states

> *A detailed operational protocol for the operation of the FMZ will be developed in consultation with relevant downstream and upstream stakeholders.*

To prepare a detailed protocol, a full assessment of the impacts of FMZ discharges, including the piggy-back discharges, on downstream areas is required.

Response

Previous responses should be noted, however, in summary the FMZ gated outlets are based on a maximum discharge rate of 230 GL/d which can be initiated for about 2-3 days if required. Thereafter this rate is reduced to 100 GL/d in a constant flow until the FMZ is discharged and the lake level returns to the existing full supply level. If there is no forecast subsequent event a lower constant discharge of around 100 GL/d is modelled to draw down the water level to FSL again and limit further downstream flooding.

The EIS outflow modelling was also guided by the operating objectives included in the EIS. The detailed operational protocol to be developed prior to operating the FMZ will be based on the assumptions contained in the modelling that forms the basis of the EIS assessments and the relevant impacts extents both upstream and downstream of the dam.

Issue 26

The risk matrix table (Figure 15-49, page 15-119) may need to be elaborated by capturing a range of risk factors (such as water quality issues due to flooding after bushfire) currently not considered in the operational stage of the raised dam.

Response

The potential impact of bushfire events on water quality in Lake Burragorang is an existing risk and will not change with the Project. WaterNSW has existing processes and strategies for dealing with water quality risk, including impacts from bushfires.

Issue 27

Regarding Section 15.14.2, pages 15-131 onwards, additional maps should be included showing changes in bank full discharge in terms of duration under existing conditions and with the project to provide an indication of the risks of prolonged bank full discharges. This would vary depending on the cross-sectional size of the downstream reaches, which could also be included on maps.

Response

Consideration of the potential impacts of a constant discharge of 100 ML/d is provided in Table 15-29 of the EIS which shows that main access bridges would remain open and no residential, businesses or critical infrastructure would be adversely affected.

Maps showing the extent of FMZ discharges (bankfull and some overbank flows) are provided in Section 15.8.6 of the EIS.

4.1.8.4 Flooding and Hydrology Assessment Report (Appendix H1)

Issue 1

Section 1.3.3, page 8 of Appendix H1 to the EIS states

> *There will be two different emptying protocols:*
>
> *(1) Minor flood releases – releases of inflows captured from a 5% to 2.5% AEP event or at the tail end of larger floods. The rate of discharge of these releases will be identified based on potential flooding risks downstream, … the subsequent release from the dam will need to be restricted to avoid increases in these reduced downstream flooding extents. Typically, discharges would be at 1,150 m^3/s (around 100 GL/d) but would not occur until after the peak of the flooding downstream has passed.*
>
> *(2) Major flood releases – releases for significant flood events. As the FMZ is designed to contain a 5% to 2.5% AEP event above FSL, any event above this will cause spilling to downstream areas, albeit at a lower level. During this scenario there is an opportunity to increase the rate of discharge from the FMZ at a higher rate than for minor flood releases without increasing the extent of downstream flooding (that is, piggyback releases). This can typically occur for the first two days before the FMZ discharge rate would then be reduced to the same rate as for minor flood releases (that is, 1,150 m^3/s).*

There is some inconsistency regarding the emptying protocol and the prolonged duration of flooding:

- For minor flood releases it indicates the rate of the discharge will be determined subject to the risk downstream. However, it also indicates the rate of discharge would be typically 100 GL/d. How has the 100 GL/d discharge rate been calculated?
- For major flood releases it indicates that piggyback releases will apply to events greater than 5% AEP (i.e. 1 in 20 chance in a year) to a 2.5% AEP (approximately 1 in 40 chance in a year). However, this is inconsistent with section 15.8.5.1 which states, *piggybacking at this rate would be suitable for any downstream flood greater than a 1 in 5 chance in a year flood event*. Section 15.8.5.1 also states *piggybacking of discharges would generally occur for two to three days after the peak of a flood event, after which a constant discharge rate of around 100 gigalitres per day (1,160 cubic metres per second) would be implemented*, however, Figure 4-26 of Appendix H1 (and Figure 15-36 of Chapter 15) show the drawdown release for the 1% AEP extends to around 115 hrs ~4.7 days before the discharge reduced to a constant of 100 GL/d.

Response

Operation of the FMZ is discussed in the response above. The rate of 100 GL/d discharge was selected based on:

- Optimising downstream flows to within the river channel as much as possible
- Not causing the river to exceed the previous flood level peak
- Maintaining bridge access on primary evacuation routes
- Emptying the FMZ as fast as possible to ensure sufficient capacity for a recurring flood event.

The modelling shows that a discharge flow of 100 GL/d will be within bank for most of the Nepean and Hawkesbury River downstream of the Warragamba Dam. In some low areas this flow could exceed the banks, including the Richmond Lowlands and Pitt Town Bottoms. The EIS outflow modelling was also guided by the operating objectives included in the EIS. The detailed operational protocol to be developed prior to operating the FMZ will be based on the assumptions contained in the modelling that forms the basis of the EIS assessments and the relevant impacts extents both upstream and downstream of the dam.

Section 15.8.5.1 of the EIS discusses 'piggy back' discharges from the FMZ. These discharges may be higher than the constant discharge rate, but would only occur at a rate that does not cause the river to exceed the previous flood level peak. The higher rate is reduced in stages to the constant discharge rate. Further, piggy back discharges would likely only be necessary if there was a prediction of recurring flooding within a short time-period to enable further temporary storage in the FMZ.

For example, Figure 15-36 in Chapter 15 in the EIS shows the maximum rate of discharge from the FMZ for a 1 in 100 chance in a year event. In this instance 'piggy back' discharges would occur for up to about five days. However, for smaller floods or when another major rainfall event is not expected, then typically piggy back discharges would occur for around 3-4 days.

Issue 2

Section 1.3.3, page 8 of Appendix H1 to the EIS states

> *The extent and duration of inundation is important to defining potential impacts on environmental values. The approximate change to upstream lake surface area based on recent*

hydro survey data of Lake Burragorang (data provided by INSW, 19 February 2015) is summarised in Table 1-1.

Table 1-1 is based on a raised dam wall of 12 metres; it is assumed this is the level of the central spillway crest as described on page 5-1 and that it accords with the current proposal.

Response

WaterNSW confirms that the levels referred in Table 1-1 for the central spillway are correct and accords with the current proposal. For further clarity the new auxiliary spillway crest level is 130.6 mAHD, about 14 metres above the current auxiliary spillway crest level.

Issue 3

Table 3-12, page 75 of Appendix H1 to the EIS regarding consistency with data in Table 8-15 in Appendix M.

The data in the tables for residential properties affected by events greater than 1% AEP is different.

Response

WaterNSW advises that Table 8-15 in Appendix M has the correct number of residential properties affected by flooding with the existing dam above the 1 in 100 chance in a year event. This data is also reflected in the socio economic impact assessment chapter (Chapter 21). The assessment of residential property impacts for flood events greater than 1in 100 year event has used the numbers from Table 8-15 in Appendix M.

Issue 4

Table 3-15, page 88 of Appendix H1 to the EIS regarding consistency with data in Table 8-18 in Appendix M.

For the same flood event, it is assumed the data for 'Number of people requiring evacuation (2018) – Total residents requiring evacuation' in the Table 3-15 of Appendix H1 should match the data for 'Existing risk (2018) – Total residents considered in evacuation planning' in Table 8-18 of Appendix M. However, this is not case for events greater than 1% AEP.

Response

WaterNSW advises that Table 8-18 in Appendix M has the correct estimate of people considered in evacuation planning by 2041 for events greater than the 1 in 100 chance in a year event. This data is also reflected in Chapter 21 (Socio economic) of the EIS.

Issue 5

Table 3-17 page 96 of Appendix H1 to the EIS regarding the *Draft South Creek Floodplain Risk Management Strategy and Plan,* Dec-2019, Penrith City Council.

Penrith City Council adopted the South Creek Floodplain Risk Management Study and Plan in February 2020 (i.e. prior to completion date of the Flooding and Hydrology Assessment report).

Response

WaterNSW notes the correction of the date from December 2019 to February 2020.

Issue 6

Table 4-7, page 123 of Appendix H1 to the EIS regarding inconsistency of project scenario discharge rate.

In Table 4-7 the Project scenario discharge rate is 1,160 m^3/s while on page 8 it is 1,150 m^3/s. Throughout the EIS (apart from Appendix H1) the constant release of 1,157 m^3/s is rounded up to 1,160 m^3/s.

Response

WaterNSW confirms that the figure has been rounded up to 1,160 m^3/s which is less than 0.5 percent for rounding up and does not materially change the EIS assessment.

4.1.8.5 Socio-economic, land use, and property (Chapter 21)

Section 21.7.3.3, page 21-60 of the EIS regarding impacts from discharge of FMZ water.

The discussion on impacts from operation of the FMZ is insufficient with no quantification of the impacts.

Response

Operation of the FMZ will result in an extended period of elevated water levels downstream as the FMZ is drawn down. Flows will be largely contained within the river channel but will also extend into some low lying areas (and noting that these areas will have already been affected by the preceding flood event). Chapter 21 notes the potential impacts of this on various matters such as transport links and access (and refers to Chapter 24 *Traffic and transport* where quantitative details are provided).

While it is appreciated that discussion on impacts from operation of the FMZ could be enhanced through additional quantitative information, it is noted that for a 1 in 100 chance in a year flood event, the Project would reduce the number of people required to be evacuated from 55,000 to 14,000, homes impacted from 7,600 to 2,500, and would reduce damages from $3 billion to $0.4 billion. For a 1 in 500 chance in a year flood (similar to the 1867 flood, the Project would reduce the number of people required to be evacuated from 90,000 to 45,000, homes impacted from 15,500 to 5,000, and would reduce damages from $8 billion to $2 billion[20].

4.1.8.6 Socio-economic, Land Use, and Property Assessment Report (Appendix M)

Issue 1

Executive Summary *Demography and community values* page ix of Appendix M to the EIS states

> *According to the 2016 ABS Census, there were an estimated 260,511 residents in the identified 74 PMF-affected suburbs in the downstream communities' study area.*

It is not clear whether this represents the total of all residents in the 74 PMF-affected suburbs or only the residents impacted by PMF flooding in those suburbs. It is noted from Table 8-18 that the 'total people considered in evacuation planning (2041)' will be 259,000 (resident and employees) in a PMF event.

Response

The 2016 ABS Census data includes all residents (260,511) within the 74 PMF-affected suburbs. This number is projected to increase to 315,218 by 2036 (Table 6-27 of Appendix M to the EIS). Of these there are currently (2018) 104,000 residents at risk and who are considered in evacuation planning.

The number of residents currently at risk and considered in evacuation planning is projected to increase to 189,000 by 2041. The total number of employees at risk and considered in evacuation

20 https://www.infrastructure.nsw.gov.au/media/3148/why-raise-warragamba-dam_sept21.pdf

planning is projected to be 69,000 by 2041. Therefore the total number of residents and employees at risk and considered in evacuation planning is projected to be 259,000 by 2041 (Table 8-18 of Appendix M to the EIS).

Issue 2

Executive Summary, Summary table of residual significance ratings in the SEIA study areas, pages xvii to xix of Appendix M to the EIS regarding the adequacy of data in table.

This table should also include: the disbenefits from the FMZ in upstream and downstream areas, what would be its impacts (environmental and economic contexts and the associated risks), what risk mitigation measures are available and the residual risks. Details on the flood affected properties (including those flood affected properties along with evacuation difficulties) should be included in this table and in the executive summary of Appendix M.

Response

The summary table of residual significance ratings has considered both positive and negative impacts for the matters as prescribed by the SEARs. The operation of the FMZ will provide a delay for water to be released that would normally contribute earlier for a given flood event under existing dam operations. This will reduce the number of flood affected properties that are currently impacted from flood events occurring from the existing dam. The details of the extent of these reductions to properties affected for each type of prescribed flood event can be found in the list of tables in Appendix M. WaterNSW does not consider it necessary to replicate this same data into the summary table of residual significance ratings for the purpose of assessment.

Issue 3

Section 8.4.1.1, pages 199 to 204 of Appendix M to the EIS regarding the population affected by flooding.

The combined populations of suburbs potentially threatened by flooding does not provide an accurate indication of the benefits of the project, as not all populations in these suburbs are affected by flooding. The population requiring evacuation is the population that should be referenced. Using the combined populations is also inconsistent with Tables 8-10, 8-11 ,8-12 and 8-14 which detail the number of properties affected by flooding.

Response

As mentioned in the first response for this section, figures used for property numbers and population are those properties currently at risk of being affected by inundation from flooding and residents included in the modelling for evacuation planning. However, it is also worth noting that although a property may not be inundated it could still be affected if there are disruptions to power, water or sewerage working as a result of flooding below the property. The assessment has assumed a directly affected residence but there would also be indirectly affected residences that may also require evacuation if services are affected. This has been apparent in recent flood events around NSW for the past two years.

Issue 4

Section 8.4.1.1 – *Flood-related land use controls*, page 207 of Appendix M to the EIS states

> *Under the current land use planning system, the 1 in 100 chance in a year event is the default planning level for local councils to set flood planning controls for residential development, unless they apply for and receive approval to impose more stringent flood controls under 'exceptional circumstances.*

A new planning circular (PS21-006 – *Considering flooding in land use planning*) has been in effect since 14 July 2021. This replaced the need for 'exceptional circumstances'.

Response

WaterNSW notes the advice on the new planning circular.

Issue 5

Section 8.4.1.1 – *Flood-related land use controls*, page 207 of Appendix M to the EIS states

> *The Hawkesbury-Nepean Valley Flood Risk Management Strategy recommended that a suitable planning instrument such as State Environmental Planning Policy (SEPP) be prepared ...*

The discussion should focus on outcome 3 of the Strategy and the regional land use planning framework. A SEPP is not specified as the planning mechanism to achieve this outcome.

Response

The proposal to raise Warragamba Dam for flood mitigation is the focus of the EIS under Outcome 2 of the *Hawkesbury-Nepean Valley Flood Risk Management Strategy*. The statement that a suitable planning instrument such as a SEPP be prepared is a suggested instrument. There may be other regulatory instruments more appropriate to ensure the desired outcomes for land use planning framework are achieved.

Issue 6

Section 8.4.1.1 – *Flood-related land use controls*, page 207 of Appendix M to the EIS states

> *The SEPP would directly amend the relevant local council Local Environmental Plans to include maps showing the flood planning area that is to be maintained. This may be supported by a direction under section 9.1 of the EP&A Act to prohibit councils subsequently amending the flood planning area.*

Flood studies are live documents that are continuously updated due to changes in topography, new information, new industry practice or a major event. Subsequently, the flood planning area may also change with modified and up-to-date modelling undertaken by local councils. The application of a SEPP would need to be limited to the area impacted by the Hawkesbury Nepean backwater as there may be local flood issues that need to be managed by local councils and will influence their flood planning areas.

Response

The final details of a SEPP and its application, if such an instrument is adopted, are yet to be concluded. The making of any such SEPP in relation to flood controls for the downstream area is outside of the scope of the Project.

Issue 7

Section 8.4.1.1 – *Flood-related land use controls*, page 207 of Appendix M to the EIS states

> *…the effectiveness of the flood planning system will be reliant upon collaboration and coordination between State driven policy and local government implementation.*

Considering flooding in land use planning is part of the established flood risk management process in NSW. Given local councils are primarily responsible for flood risk management in their local government areas, the Hawkesbury-Nepean regional land use planning framework, undertaken as part of outcome 3 of the Hawkesbury-Nepean Valley Flood Strategy aims to facilitate the effective consideration of Hawkesbury-Nepean regional flooding in local government land use planning decisions: it is not, however, a 'flood planning system' – this is incorrect terminology.

Response

WaterNSW notes the advice around careful use of terminology.

Issue 8

Item 6 in Table 8-26, page 228 of Appendix M to the EIS notes the following impact:

> *Operation – Decreased frequency but increased duration of inhibited access to and from low lying property due to longer duration of the FMZ discharge.*

Alteration of flow regime would occur due to the prolonged discharge along the river (bank full conditions) following floods. The consequences of this prolonged discharge as being 'moderate' is questioned given the potential for banks to degrade, bank instability, and long-term morphological changes. There may be environmental damage and associated costs (non-market value), which should be considered in the economic analysis.

Water quality in Lake Burragorang may be degraded at a higher propensity during flooding events associated with bushfires and this may create water supply risks, which should be addressed.

Response

The FMZ operation will not result in bankfull flow during the recession in cross-sections that are confined, as they are able to contain even the peak flows under existing conditions. This applies in broad terms to most reaches upstream of North Richmond, and downstream of Cattai Creek. The recession flow will be approaching bank full in parts of the reach from North Richmond to Cattai Creek during larger flood events. The matter of effects due to erosion and morphological change are addressed in the geomorphology responses in Section 4.2.4.The issue of water quality in Lake Burragorang being potentially affected by flood events occurring in close proximity to a bushfire event is an existing risk.

4.1.8.7 Climate change risk (Appendix G)

Issue 1

Section 5.1.1.3, page 35 of Appendix G to the EIS states

> *Sea-level rise impacts for 2100 are projected to occur as far inland as Sackville and the lower Colo River (Coastal Risk Australia 2018). While these impacts would be important to consider when modelling the potential increased flood risk to the Hawkesbury-Nepean Valley under climate change scenarios, the risk to the construction and operation of the Project was considered minor to negligible. The interaction of future sea-level rise and rainfall and the effect this may have on the flood risk to the Hawkesbury-Nepean Valley was addressed by WMAwater (2018), and the results are discussed in Chapter 15 (Flooding and hydrology) of the EIS.*

The SEARs require

> *the Proponent (to) assess and model the impacts on flood behaviour during construction and operation for a full range of flood events up to the PMF (accounting for sea level rise and storm intensity due to climate change.*

However, it is noted (from Table 14-3 in Chapter 14) that sea level rise was excluded from the risk assessment and 'justification for why (sea level rise it was) excluded is provided in Appendix G'. This justification appears to be limited to a statement that 'the risk (from sea level rise) to the construction and operation of the Project was considered minor to negligible.' Given the downstream limit of the downstream study area is Wisemans Ferry, which is well within the tidal influence of the estuary, particularly with very high sea level rise projections relevant to reasonable planning horizons, further information should be provided to demonstrate how flooding risks and impacts have been assessed and modelled.

Response

The Hawkesbury-Nepean River is drowned river valley. Sea level rise has a low influence on the depth of flooding. Although the river is tidal up to Yarramundi under normal conditions, the natural sandstone gorges cause flood levels to rise well above sea level in any significant flood event.

Table 51 in the Hawkesbury-Nepean Valley Regional Flood Study report identifies that sea level rises of 0.4 metres and 0.9 metres were adopted to assess impacts for sea level. In adopting a sea level rise of 0.9 metres for the 1 in 100 chance in a year event, the rise in flood levels was proportional to sea level rise. The influence of assuming a 0.9 metre sea level rise results in a flood level change of less than 0.1 metres at Wisemans Ferry and 0.01 metres at Ebenezer.

Given the minor impact of sea levels on flood risk, and the fact that the dam raising would reduce flood risk, the impacts from sea level rise are considered minor.

Issue 2

Section 1.3, page 7 of Appendix G to the EIS states

> *The Project timeframes assessed were:*
>
> - *construction - 2021-2025*
> - *operation (design-life) - 2025-2125.*
>
> *In relation to the climate projections referenced in this document, this corresponds to:*
>
> - *construction NSW and ACT Regional Climate Modelling (NARCliM) near-future projections, which represent 2020 to 2039, and are referred to in this assessment as 2030 projections*
> - *operation (design-life) - NARCliM far-future projections, 2060 to 2079, and are referred to in this assessment as 2070 projections.*

While the design life of the Project (operational life) has been specified to be up to 2125, climate change impacts to 2070 only have been assumed to be the 'far-future projection' planning horizon based on IPCC AR5 and NSW and ACT Regional Climate Modelling (NARClim). It should be noted that IPCC AR6 has now superseded IPCC AR5 and projections beyond 2125 are now available. It should also be noted that the NARClim Climate Change Impacts considers only increased rainfall intensity, not sea level rise. While IPCC AR6 was not available when Appendix G was prepared, it should now be considered to better understand the full range of climate change implications for the full design life of the Project.

Response

The climate change risk assessment was undertaken in 2018 and future climate projections for the project region were established from the best available data at that time, being the NARCliM 1.0 dataset (2014). The NARCliM 1.0 projections were supported by information from *Climate Change in Australia*[21]. It is noted that these projections are not dynamically downscaled for NSW. NARCliM 1.5 was not released until 2020 after the climate change risk assessment was complete,

[21] https://www.climatechangeinaustralia.gov.au/en/

and was not specifically used to identify future climate trends. This notwithstanding, it is noted that NARCliM 1.5 complements NARClim1.0 and should only be used in combination with NARCliM 1.0.

The climate change risk was modelled under a wide range of climate change scenarios. It was found to reduce flood risk under all climate change scenarios, including an extreme 24 percent increase in rainfall intensity. WaterNSW agree that the future detailed design stage of the Project will use the latest available climate change projections from the IPCC.

4.1.9 Protected lands

4.1.9.1 National park values

Issue 1

The Project impacts on all national park values from temporary inundation of up to 1,303 hectares of reserves, including up to 304 hectares of the Greater Blue Mountains World Heritage Area (GBMWHA). Those values include biodiversity, Aboriginal cultural heritage, historic heritage, World Heritage, wilderness and wild rivers, roads and fire trails, and other facilities.

The impacts on national park values of up to 1,303 ha, including 304 hectares of World Heritage Area will need to be offset.

Response

This will be addressed through the revised offset strategy (refer Section 3.3).

Issue 2

The EIS has not fully responded to recommendations provided following the review of consistency of the draft EIS with the Secretary's Environmental Assessment Requirements (SEARs).

Response

Finalisation of the EIS included consideration of all issues raised during the consistency review process and the discussion in the EIS was revised where considered appropriate.

Issue 3

The EIS proposes that offsets for impacts on protected area values be included in the proposed Warragamba Offset Program, and states that the Environmental Management Plan (EMP) required under Part 5A of the *Water NSW Act 2014* would support and complement the Warragamba Offset Program (Chapter 13 *Biodiversity Offset Strategy*).

The EMP is not the mechanism – either in part or wholly – for determining offsets for the Project impacts on protected area values. The Warragamba Offset Program must address offsets for impacts on protected area values.

The proposed Warragamba Offset Program for the upstream study area should recognise the impacts on those protected area values and detail how those impacts will be offset.

Response

This will be addressed through the revised offset strategy (refer Section 3.3).

Issue 4

WaterNSW should consult NPWS in preparing the Warragamba Offset Program in relation to offsets for impacts on protected area values; and that the determination for the Project requires that the Deputy Secretary, NPWS approve the Warragamba Offset Program.

Response

WaterNSW notes the advice and considers no further response is required for this issue.

4.1.9.2 Wilderness areas affected by the Project

Issue 1

The EIS addresses wilderness areas that fall within the World Heritage area, which includes a section of the Nattai Wilderness near the Wollondilly and Nattai Rivers and a small section of the Kanangra-Boyd Wilderness on Butchers, Laceys and Green Wattle Creeks. The EIS states that 36 hectares of declared wilderness will be impacted (Appendix J, page 72).

A section of the Kanangra- Boyd Wilderness between the Cox's River and Tonalli Cove, along the Lake Burragorang Foreshore and associated creeks falls outside of the World Heritage area but will be impacted by the proposal.

The EIS should address the impacts of inundation on all declared wilderness areas (i.e. not only the Nattai Wilderness within the World Heritage area).

Response

Table 4-4 and Table 4-5 present the areas of designated wilderness affected by temporary inundation from the existing dam for five flood events up to the PMF, and the incremental areas that would be potentially affected due to the Project for the same flood events.

Table 4-4 Changes to flood extents for Kanangra-Boyd Wilderness

Flood event (1 in x chance in a year)	Existing (ha)	With Project (ha)	Change (ha)
Blue Mountains National Park			
5	167.28	288.35	121.07
10	196.89	422.03	225.14
20	223.20	602.44	379.24
100	362.10	878.91	516.81
PMF	884.75	1,543.68	658.93
Yerranderie State Conservation Area			
5	26.83	60.69	33.85
10	33.62	98.86	65.24
20	40.25	145.09	104.84
100	77.20	206.25	129.05
PMF	194.58	326.56	131.98

Table 4-5 Changes to flood extents for Nattai Wilderness

Flood event (1 in x chance in a year)	Existing (ha)	With Project (ha)	Change (ha)
Nattai National Park			
5	2.94	5.31	2.36
10	3.99	12.86	8.87
20	5.57	32.85	27.29
100	10.50	65.89	55.39
PMF	60.36	152.04	91.68

The total areas of the Kanangra-Boyd Wilderness and the Nattai Wilderness are 123,322 hectares and 41,327 hectares respectively. For the PMF event, the existing dam potentially affects 0.88 percent of the total area of the Kanangra-Boyd Wilderness and 0.15 percent of the Nattai Wilderness. The Project would potentially affect an additional 0.64 percent of the Kanangra-Boyd Wilderness and 0.22 percent of the Nattai Wilderness.

Section 6 of the *Wilderness Act 1987* provides that

(1) An area of land shall not be identified as wilderness by the Director-General unless the Director-General is of the opinion that:

(a) the area is, together with its plant and animal communities, in a state that has not been substantially modified by humans and their works or is capable of being restored to such a state,

(b) the area is of a sufficient size to make its maintenance in such a state feasible, and

(c) the area is capable of providing opportunities for solitude and appropriate self-reliant recreation.

Section 15.6.3 of the EIS provides a discussion and assessment of changes to flood levels and durations of temporary inundation in the upstream study area. Changes in temporary inundation depth and duration for selected cross sections in general proximity to these two wilderness areas are presented in Table 4-6. The locations of these cross sections are shown in Figure 15-29 of the EIS.

Table 4-6 Changes in temporary inundation depth and duration

Location	Flood event (1 in x chance in a year)									
	1 in 5		1 in 10		1 in 20		1 in 100		PMF	
	E[1]	P[2]	E	P	E	P	E	P	E	P
COX_US_9985 (Kanangra-Boyd Wilderness)										
Depth (m)	2.4	<0.5	4.6	<0.5	5.3	<0.5	6.7	<0.5	15.2	3.5
Duration (days)	5.8	<0.5	5.4	<0.5	6.2	<0.5	5.3	<0.5	7.0	<0.5
COX_28800 (Kanangra-Boyd Wilderness)										
Depth (m)	0.7	2.5	1.3	5.1	2.2	9.1	5.1	10.8	14.0	12.2
Duration (days)	6.8	2.4	6.4	3.8	7.2	8.0	6.4	8.3	7.0	7.0
WOLLONDILLY_15000 (Kanangra-Boyd Wilderness)										
Depth (m)	0.7	2.5	1.3	5.0	2.3	9.0	5.2	10.7	14.2	12.1
Duration (days)	6.8	2.4	6.4	3.8	7.2	8.0	6.8	8.3	7.0	6.0
NATTAI_1880 (Nattai Wilderness)										
Depth (m)	2.8	0.5	3.1	3.2	4.0	7.4	5.9	10.0	14.2	12.0
Duration (days)	6.8	2.4	6.4	3.8	6.7	8.0	6.4	8.3	7.0	6.0
NATTAI_US_11066 (Nattai Wilderness)										
Depth (m)	3.8	<0.5	4.1	<0.5	4.8	<0.5	5.9	<0.5	7.7	7.8
Duration (days)	5.9	<0.5	5.4	<0.5	6.2	<0.5	5.2	<0.5	7.0	<0.5

Notes: 1 – E = existing; 2 – P = additional depth/duration with Project

Cross sections COXS_28800, WOLLONDILLY_15000 and NATTAI_1880 are located within Lake Burragorang while cross sections COX_US_9985 and NATTAI_US_11066 are located further upstream from the lake. As can be seen the incremental depth and duration of temporary inundation with the Project falls away markedly moving upstream away from the lake.

The Project will not change the size of the two designated wilderness areas.

Existing access to designated wilderness areas will be maintained and the Project will not restrict opportunities for solitude and appropriate self-reliant recreation.

Issue 2

The EIS only addresses matters of consent under section 15 of the *Wilderness Act 1987* and provides an assessment of impacts to wilderness within the World Heritage area (in Appendix J, Section 6.1.7). The EIS should address consistency with the management principles under section 9 of the *Wilderness Act 1987*.

Response

Section 9 of the *Wilderness Act 1987* addresses the management principles for wilderness areas and states:

> *A wilderness area shall be managed so as:*
>
> *(a) to restore (if applicable) and to protect the unmodified state of the area and its plant and animal communities,*

(b) to preserve the capacity of the area to evolve in the absence of significant human interference, and

(c) to permit opportunities for solitude and appropriate self-reliant recreation (whether of a commercial nature or not).

The designated wilderness areas potentially affected by the Project occur in the following protected lands areas adjoining Lake Burragorang:

- Blue Mountains National Park (Kanangra-Boyd Wilderness)
- Yerranderie State Conservation Area (Kanangra-Boyd Wilderness)
- Nattai National Park (Nattai Wilderness).

Management of the areas of the Kanangra-Boyd Wilderness that fall within Blue Mountains National Park and Yerranderie State Conservation Area is addressed through the *Blue Mountains National Park Plan of Management* (NPWS 2001a) and *Nattai Reserves Plan of Management* (NPWS 2001b) respectively. Management of the areas of the Nattai Wilderness within Nattai National Park are managed through the *Nattai Reserves Plan of Management* (NPWS 2001b).

With regard to the management principles identified in section 9 of the *Wilderness Act 1987,* WaterNSW would continue to work collaboratively with NPWS with regard to management of those parts of designated wilderness areas that fall within the Special Areas managed by WaterNSW, and where access is provided to the public.

As noted in Chapter 13 of the EIS, under Part 5A of the *Water NSW Act 2014*, WaterNSW is required to prepare an EMP before the temporary inundation of any land protected by the *National Parks and Wildlife Act 1974* can occur. NPWS would be consulted in preparing the EMP to ensure they align with and are consistent with the management of wilderness areas under these plans of management.

Existing access to designated wilderness areas will be maintained and the Project will not restrict opportunities for solitude and appropriate self-reliant recreation.

4.1.9.3 Impacts on Katoomba-Mittagong walk

The EIS states that temporary inundation will not impact on recreational access due to the area of inundation being 'Schedule 1 lands' where access is restricted.

The Katoomba to Mittagong Walk has two 'walking corridors' through the Schedule 1 Catchment, where walking is permitted. The proposed inundation will impact on access to those corridors at the Wollondilly River and Cox's River crossings.

Information is available publicly on WaterNSW's website on the walking corridors at: https://www.waternsw.com.au/__data/assets/pdf_file/0011/55946/Map1-FINAL-what-you-can-and-cant-do-in-special-areas-2016-2.pdf.

The EIS should address impacts of inundation on recreational access to the Katoomba to Mittagong Walk.

Response

In general, the Project would not affect access to either of these two sections of the Katoomba to Mittagong Walk. The existing arrangements for catchment protection will remain including where access may be temporarily restricted, such as during bushfire events, which would not change with the Project.

4.1.9.4 Assessment of risk from erosion and sedimentation

EES considers the impact of erosion and sedimentation is likely to be higher than 'low or medium', particularly if there are several inundation events occurring within an interval that is too short for vegetation to recover. This cumulative impact of multiple inundation events is not considered by the EIS.

The EIS should address the likely impacts of erosion and sedimentation and consider the cumulative impact of multiple inundation events.

Response

A detailed assessment of erosion risk in the upstream study area is provided in Sections 5.1 and 5.2 of Appendix N2 *Geomorphology Technical Assessment*. This examines out of bank erosion above Lake Burragorang and around the shoreline of Lake Burragorang respectively. Further assessment of sediment movement through the upstream system is provided in Appendix G.

The matter of recovery time for vegetation from the effects of temporary inundation is complex and subject to the influence of numerous factors, and consideration of this is provided in Appendix F1 *Biodiversity Assessment Report – Upstream* to the EIS. As acknowledged in the EIS, there is still substantial uncertainty around this.

Appendix F1 also included details of experiments into the effect of temporary inundation on Camden White Gum (*Eucalyptus benthamii*) which concluded that this species appeared to be tolerant of shallow flooding of up to six weeks in duration.

As part of additional investigation undertaken to respond to issues raised in submissions, an analysis of vegetation condition has been carried out using survey plots in the upstream study area (refer Section 6.7.3 of the PIR). This examined vegetation condition for a riparian vegetation community and a eucalypt woodland community. For the riparian community, the analysis suggested that this community has a significant degree of resilience to temporary inundation. The analysis also suggested that temporary inundation may not have a significant impact on the woodland community. It cannot therefore be assumed that temporary inundation would necessarily lead to a loss of vegetation cover.

Adopting 30 days or less as an arbitrary nominal minimum period for vegetation recovery from a temporary inundation event, since construction of Warragamba Dam in 1960, there have been 21 inflow events where the water level in Lake Burragorang has been above FSL within 30 days or less of another inflow event above FSL. With one exception(March 2022), these exceedances of FSL were less than half a metre, with the duration of the periods of water levels above FSL for these events ranging widely from two days up to 42 days. While the historical record is not an indicator of the pattern of future inflow events, it would suggest that multiple inflow events resulting in water levels in Lake Burragorang rising significantly above FSL, and occurring close together in time are rare.

Given the above, the assigned risk rating 'low or medium' presented in the EIS is considered reasonable.

4.1.9.5 Assessment of weed and pest issues

The EIS does not consider weed and pest issues resulting from increased inundation. It is considered likely that the death of vegetation, increased erosion and siltation will provide habitat for weeds and pest species such as feral pigs and deer.

The EIS should address weed and pest issues resulting from increased inundation.

The EMP should consider increased pest and weed control programs after any inundation events.

Response

Consideration of weed and pest issues is provided in Section 8.8.7 of the EIS in the context of potential key threatening processes (KTPs) of relevance to the Project. As noted in the discussion provided, these KTPs may result from changes to vegetation community and structure from temporary inundation, in turn potentially creating conditions more conducive to the operation of these KTPs.

It should be noted that vegetation die-off would not necessarily follow on from temporary inundation as noted in Section 8.8.2 of the EIS.

4.1.9.6 Bushfire impacts

Issue 1

While the post-fire mapping indicates that most of the inundation area is unburnt or low intensity, this increases the importance of this area as a post-fire refuge. This is likely to be the case in future fires.

The cumulative impact of fires followed by a flood event (as occurred in 2020) needs to be examined, particularly around post fire refuge for animals and the impact on obligate-seeding plant species.

While the EIS notes that as biodiversity survey work was undertaken prior to the fire, it would be valuable to assess any changes to species distribution within the study area. That is particularly for species which may have had their habitat severely reduced by fire and are using the inundation area as a refuge.

Post-fire surveys should be undertaken to assess any changes to species distribution within the study area.

Response

WaterNSW clarifies that that the EIS does not use the term 'inundation area' as the incremental area of temporary inundation between an existing flood event and the equivalent flood event with the Project will vary depending on the frequency of the flood event (refer Table 15-13 in the EIS).

In March 2020, the NSW Government released the *Guideline for applying the Biodiversity Assessment Method at severely burnt sites* (DPIE 2020). The intent of the guideline is to provide assessors with a reasonable, evidence-based and transparent process for identifying severely burnt native vegetation and provides a range of approaches for applying the BAM on land impacted by severe bushfire.

The guidelines state that where the Stage 1 BAM assessment has been completed prior to severe bushfire, the assessor should use this information to prepare the impact assessment. Given that Stage 1 of the FBA is broadly consistent with the objectives and outcomes of Stage 1 of the BAM, WaterNSW is of the view that further assessment is not required for the Project.

Issue 2

An assessment of the cumulative impact of fires followed by a flood event (as occurred in 2020) should be undertaken particularly around post fire refuge for animals and the impact on obligate-seeding plant species.

Response

The issue of the potential cumulative impact of a bushfire followed by a significant flood event is an existing risk. The Project would alter this risk profile through increased depth, duration, frequency and extent of temporary inundation associated with a specific flood event.

The Special Areas Strategic Plan of Management provides the strategic framework for the planning, delivery and reporting of joint land management activities (which includes bushfire) within the catchment by WaterNSW and NPWS.

Issue 3

The role of the inundation area as a post-fire refuge after the 2019/20 bushfires should be considered.

Response

A discussion of the estimated time required for the recovery of fauna species with large population losses following the 2019-2020 bushfire event is provided in Legge *et al.* (2022). This examined the distributions of 288 taxa that overlapped with the fire extent (approximately 104,000 km^2) in the bioregions of southern and eastern Australia most affected by the 2019–2020 bushfires. This includes the study area for the Project. Estimation of spatial variation in fire severity used the Australian Google Earth Engine Burnt Area Map (AUS GEEBAM; DAWE, 2020a, cited in Legge *et al*., 2022), defining 'severe' fires as those with substantial effects on the canopy (canopy is scorched or consumed), and 'mild' fires as those with no or moderate effects on the canopy.

The assessment presented in Legge *et al*. (2022) predicted that only 12 percent of the taxa examined would recover to pre-fire levels by 10 years. Recovery was considered possible for a further 34 percent of taxa meaning that over half of the taxa assessed were unlikely to recover to pre-fire levels after 10 years (or three generations). The groups with the poorest potential for recovery were spiny crayfish, fish and mammals whereas recovery was greatest for reptile and bird taxa.

Should the Project be approved, it is unlikely that construction would commence before 2024/2025. With a nominal five-year construction period (refer Section 5.4.2 of the EIS), completion of the Project would be around 2029/2030, about 10 years after the bushfire event. Based on the assessment in Legge *et al*., (2022), it is possible that a number of fauna species in the upstream area would still be recovering from the bushfire event.

It is noted that vegetation/habitat in both the upstream study area and the wider catchment has also been recovering from the bushfire event and would be expected to continue to do so (barring other significant landscape disturbance events). Accordingly, the value of relatively unburnt areas that could act as post-fire refuges, and that could be affected by temporary inundation associated with the Project would likely have changed relative to other areas outside of the upstream Project area by the time the Project is operational, and further noting that the timing of any temporary inundation associated with the Project is indeterminate.

4.1.9.7 Road and trail access

Issue 1

Chapter 20 of the EIS states that there is unlikely to be material damage to roads and fire trails. However, Section 6.1.20 of Appendix J *World Heritage Assessment Report* states: 'The Project may result in the increased extent and duration of flooding of fire trails that are used to access areas in the GBMWHA, however this is likely to be minimal in relation to the upstream impact area within the GBMWHA.'

The inundation area will impact an estimated 26 bridges and culverts, particularly along the W4 trail in Nattai National Park and Nattai State Conservation Area. The EIS does not consider the impact on these assets. EES considers there is likely to be damage either by erosion or sedimentation to road, trail, bridge and culvert assets on NPWS estate as a result of inundation.

The likely impacts to roads, trails, bridges and culverts resulting from inundation should be more fully addressed.

Response

A range of built assets are maintained within the Special Areas of the catchment. These include roads, buildings and water supply infrastructure. The Special Areas also contain built assets managed by other parties that relate to utilities, mining, transport corridors and telecommunications. The owners of these assets must maintain facilities to relevant industry standards and also respond to the hazards represented in the Special Areas, such as fie. The joint sponsors actively work with the asset owners to ensure the maintenance needs of the assets are considered.

Table 4-7 provides a list of NPWS assets affected by flooding associated with the existing dam and with the Project for the 1 in 5, 1 in 10, 1 in 20 and 1 in 100 chance in a year flood events. This is based upon data provided by NPWS.

Table 4-7 NPWS assets potentially impacted by the Project

Asset type	1 in 5		1 in 10		1 in 20		1 in 100	
	E[1]	P[1]	E	P	E	P	E	P
Bridge/Elevated walkway	0	3	0	6	0	7	4	8
Building	0	0	0	0	0	0	0	0
Crossing	14	19	15	30	17	58	29	81
Drainage point	0	0	0	1	0	2	1	2
Facility	0	0	0	0	0	0	0	0
Gate	0	0	0	0	0	0	0	0
Hydrological storage point	0	1	0	1	0	1	1	2
Other structure	0	1	0	2	0	2	2	2
Route point	2	2	2	2	2	2	2	2
Sign	1	2	2	3	2	8	3	16
Treatment disposal area	0	0	0	0	0	0	0	0
Visitor area	0	0	0	0	0	0	0	0

1. E: existing; P: with Project

The asset type potentially most affected by the Project are crossings comprising culverts, causeways, fords, cross drains, runoff drains and rollover channels. These structures are designed to convey drainage flows and therefore would be expected to be resilient to the forces of flowing water.

Flooding that currently affects NPWS assets is associated with backwater from Lake Burragorang that gradually inundates areas as the water level in the lake rises where the rate of inflow is greater than the rate of release of flood waters at Warragamba Dam. This pattern of inundation would not change with the Project. Flow velocities associated with backwater inundation would be very low and therefore the risk of damage to assets is similarly considered low.

The low velocities associated with backwater inundation would be conducive to deposition of suspended sediment. However, for drainage structures this is anticipated to be temporary with sediment likely to be re-entrained by drainage flows from up catchment as lake levels drop.

Issue 2

The EMP should address the assessment and repair of assets that are inundated including:

- An engineering assessment of bridges and culverts prior to any inundation event to identify any upgrades required to ensure that they can withstand inundation.
- Contingency planning for access by NPWS and WaterNSW (as land management agencies) and for emergency agencies such as the Rural Fire Service if trail repairs take time to complete.

Response

Temporary inundation due to the Project will comprise backwater from Lake Burragorang and would be unlikely to cause damage to bridges, roads, trails and other NPWS assets. Damage is more likely to result from local catchment inflows which have higher flow velocities, as currently occurs, and which are unrelated to the Project.

Section 64C(1) of the *Water NSW Act 2014* requires WaterNSW to consult with the Chief Executive of the Office of Environment and Heritage[22] as part of preparation of the EMP relating to the temporary inundation of national park land resulting from the Warragamba Dam project. Should the Project be approved, consultation would be initiated and would identify the matters to be addressed in the EMP. This would include consideration of the matters noted above.

4.1.9.8 World Heritage values

Issue 1

The EIS does not sufficiently consider the Project impacts on World Heritage values. The EIS makes incorrect assumptions about how to determine the World Heritage values.

Response

Further clarification has been obtained from relevant agencies through meetings convened by DPE following exhibition of the EIS. This has been use to inform responses to other related World Heritage issues in this report. This includes additional assessment against the OUV of the GBMWHA and consideration of cumulative impacts related to bushfire (refer Appendix C).

[22] This is the wording as used in section 64C, however, this role disappeared with the abolition of OEH in 2019. Most of the functions of OEH were transferred to the then Environment, Energy and Science Group within DPE. The equivalent role is now the Environment and Heritage Coordinator-General.

Issue 2

The EIS has not fully responded to recommendations provided following the review of consistency of the draft EIS with the SEARs.

Response

Finalisation of the EIS included consideration of all issues raised during the consistency review process and the discussion in the EIS was revised where considered appropriate.

Issue 3

World Heritage values should be assessed against the Statement of Outstanding Universal Value, the listing criteria and integrity and management arrangements.

Response

Further assessment against the Statement of Outstanding Universal Value, the listing criteria and integrity and management arrangements is provided in Appendix C to this report.

Issue 4

Integrity and management arrangements are set out in the Statement of Outstanding Universal Value. The integrity of the World Heritage area includes Aboriginal cultural connection, wilderness, geology, geomorphology and water systems, and the fact the World Heritage area is surrounded by other public lands as part of the boundary integrity for the property.

Boundary integrity is central to the integrity of the property. An assessment of the impacts on World Heritage values should include an assessment of impacts on the integrity of the property, including an assessment of impacts on buffer areas.

Response

Further assessment of potential impacts on World Heritage values is provided in Appendix C to this report. This includes consideration of buffer areas and boundary integrity.

Issue 5

Wilderness is part of the integrity of the property. An assessment of the impacts on the integrity of the property should include an assessment of impacts on wilderness areas, both within and adjacent to the World Heritage property. The EIS has not assessed the impact of inundation on wilderness areas outside the current boundary of the World Heritage area.

Response

Further consideration of the potential impacts of the Project on wilderness areas both within and outside of the GBMWHA is provided in Section 4.1.9.2 against the matters identified in section 6 of the *Wilderness Act 1987*.

Issue 6

It is recommended that comments on World Heritage provided in the consistency review be addressed.

Response

Matters raised during the consistency review process have been considered as part of developing responses to World Heritage issues in this report (refer Appendix C).

Issue 7

It is recommended that the Project impacts on World Heritage values be assessed against:

- the listing criteria for the WH area
- the Statement of Outstanding Universal Value, and
- the integrity and management arrangements (which are detailed in the Statement of Outstanding Universal Value).

Response

Further assessment against the Statement of Outstanding Universal Value, the listing criteria and integrity and management arrangements is provided in Appendix C to this report.

4.1.9.9 Impacts on World Heritage values are not proportionate to inundation area

The EIS states that the area impacted by the Project (i.e. 304 hectares) is 0.03 percent of the World Heritage area, and therefore the Project impacts will not be significant. The diminution of values on any area of land with World Heritage values is significant. The World Heritage values include the diversity of species (e.g. of Eucalyptus species), the high number of threatened species or species endemic to the area (e.g. Wollemi Pine), threatened ecological communities, and habitats with a restricted range (e.g. for the Regent Honeyeater) – all of which contribute to the area's World Heritage status. These factors mean, by definition, they are not widespread or abundant across the World Heritage property.

The significance of impacts should be assessed on impacts on the World Heritage values in the directly impacted area, not based on the proportion of the World Heritage area impacted. The habitats and values in the World Heritage area are not evenly distributed.

It is recommended that the impacts on the World Heritage values in the inundated area not be assessed on a percentage of the World Heritage area impacted by inundation.

The impacts on listed World Heritage values (species, habitats and communities within the impact area) should be assessed at a local, not regional or property-wide, scale. The impacts on World Heritage values are not proportionate to the percentage of the World Heritage area directly impacted.

Response

Further assessment against the Statement of Outstanding Universal Value and individual component values that make up the OUV is provided in Appendix C to this report. This considers the potential impacts at the local level (i.e. within the Project study area but also more broadly to the total GBMWHA. This approach is considered valid as it places the potential impacts of the Project in the context of the broader GBMWHA.

4.1.9.10 Assessment of all biodiversity values that are part of the OUV

Issue 1

There is insufficient analysis of World Heritage values related to biodiversity in Section 6.1 of Appendix J which focuses on species listed as threatened or endangered and presents brief analyses of impacts to Eucalyptus species, scleromorphic species, ant-adapted plants and vertebrates (specifically platypus, short-beaked echidna, Macquarie perch/Blue Mountains perch and Regent Honeyeater); and very brief analyses of impacts to reptiles and amphibians.

The ecosystems of the WH area are globally significant because they contain outstanding examples of the evolution and adaptation of the Eucalyptus genus and eucalypt-dominated vegetation. The evolutionary processes include the full range of interaction between eucalypts, understorey, fauna, environment and fire.

Response

Further consideration of potential impacts of incremental temporary inundation on the OUV components of the GBMWHA potentially affected by the Project is provided in Appendix C to this report. This addresses the matters noted.

Issue 2

It is recommended that an assessment of the impact of temporary inundation on those aspects of the World Heritage value be undertaken. At a minimum this should include all ecological communities and species within the impact area as significantly impacted for the purposes of offsetting. This is particularly important given the proposed mitigation for loss of or damage to those values is offsetting only the area currently listed as World Heritage.

Response

WaterNSW refers to Section 5 of Appendix J World Heritage Report that fully explains the adoption of an upstream impact area for the purposes of offsetting. The below extract states:

> *The upstream impact area has been used as a means to offset the potential impacts of the Project on World Heritage values, particularly with regard to biodiversity and heritage values that form a significant part of the OUV of the GBMWHA. For the purposes of offsetting the potential impacts of the Project, a precautionary approach has been taken and it has been assumed that there would be a complete loss of environmental values in this area. In reality, this is unlikely as sensitive areas/sites would have differing risks of impact depending on their respective locations in terms of elevation.*

The EIS explained that the focus of the Warragamba Offset Program related to World Heritage areas will be the purchase of land suitable for inclusion in the National Park and protected areas system potentially included within the World Heritage. These amendments are further described in the revised offset strategy in Section 3.3.

4.1.9.11 Assessment of impacts on threatened species

Issue 1

The EIS's conclusions of minimal impact on threatened species is not supported by the data or evidence in the EIS or insufficient information is provided. For example:

- *Eucalyptus benthamii* (Camden white gum) – there is no information available on the impact of repeated flooding on mature trees of as only juveniles were included in the study referred to in the EIS. The CSIRO study has limited application as it was not commissioned for the Project and did not address the specific questions raised by the Project.
- Regent Honeyeater (*Anthochaera phrygia*) – the EIS bases its conclusion of minimal impact to this species on the extensive area of available habitat nearby. This species has very specific habitat requirements and suitable habitat is limited. The EIS does not assess the suitability of adjoining woodland habitat for Regent Honeyeater. This is a critically endangered species, and one of the reasons for its rarity is that it is forced out of woodland habitat through competition with aggressive species such as noisy miners which are associated with disturbed habitat.

Response

The magnitude of project temporary inundation is a function of flood frequency and location within the catchment. Existing temporary inundation already occurs up to around three metres above FSL. The Project could increase temporary inundation around the lake foreshore by about 8.6 (total 12.6) and 10.8 (total 14.8) days for the respective 1 in 20 and 1 in 100 year chance in a year events, however, these durations decrease significantly for locations away from the lake and up the tributaries, which is explained in Chapter 15 of the EIS.

WaterNSW confirms that CSIRO was commissioned to undertake an inundation experiment with *Eucalyptus benthamii* (Camden White Gum), a species in the Project study area specifically to inform the EIS. The full CSIRO report is provided in Appendix H to Appendix F1 *Biodiversity Assessment Report – Upstream*.

Notwithstanding the findings in the impact assessments within the EIS, the upstream impact area has been used as a means to offset the potential impacts of the Project. For the purposes of offsetting the potential impacts of the Project, it has been assumed that there would be a complete loss of environmental values in this area. In reality, this is unlikely as sensitive areas/sites would have differing risks of impact depending on their respective locations in terms of elevation relative to Lake Burragorang.

Issue 2

Appendix F1 Upstream BAR states that 'the local population potentially impacted by the Project comprises a minimum of 21-35 individuals', which 'represents 5-7 % of the estimated population of the Regent Honeyeater'. However, the EIS does not provide a comparison with population sizes in other areas or the impact of the loss of 21-35 individuals on a local breeding population. The EIS states that 'this breeding population represents one of less than five known remaining breeding populations that are known to support at least 20 individuals', which indicates the significance of the potential loss of this breeding population.

The assessment of the impact does not reflect the significance of the impact of the Project on Regent Honeyeater or provide strong evidence for the justification of minimal impact. It is not credible to dismiss the value of habitat where a significant percentage of the total population of a critically endangered species was observed during the study to be feeding and breeding.

Response

The importance of the Regent Honeyeater population within the study area is highlighted within the EIS as evidenced by the statements quoted in the comment. Additional information on the Regent Honeyeater was provided in Table K.1 of Appendix F1. The population was found as a result of targeted surveys undertaken by the assessment team for the Project.

Issue 3

A more comprehensive assessment of World Heritage values related to biodiversity and a full analysis of impacts on those biodiversity values than that provided in Section 6.1 of Appendix J should be undertaken. This should include:

- An assessment of impacts on the other components of the area's OUV:
  - ongoing ecological and biological processes
  - the evolution of eucalypt species
  - Gondwanan flora and fauna associations

  - taxa of conservation significance i.e. species and communities which are endemic or have a restricted range – e.g. endemic plants are part of the OUV but have not been assessed
- A table showing each ecological community and threatened species and for each World Heritage value and attribute listed under the EPBC Act with the following information:
  - extent in the construction area, upstream and downstream
  - PCTs and the corresponding hectares impacted by the Project needs to be converted to the equivalent EPBC TECs. The basis for determining equivalence also needs to be outlined in the MNES chapter/appendix i.e. based on Conservation Advice, or dominant species, etc
  - area (hectares) impacted in the construction area, upstream and downstream (for the 1 in 5 year, 1 in 100 year and PMF event)
  - proposed mitigation
  - proposed offset.

Response

Additional assessment has been undertaken with regard to potential impacts on World Heritage values and is presented in Appendix C to this report. This includes consideration of the matters identified above.

4.1.9.12 World Heritage Committee's request

Issue 1

The UNESCO World Heritage Committee decision in July 2021 included a request that the EIS:

1. Fully assesses all potential impacts on the OUV and other values including Aboriginal cultural values [and]
2. [Considers] whether raising the wall could exacerbate bushfire risk and recovery of species and habitat within the world heritage areas and to refer the EIS to World Heritage Centre.

The EIS has not addressed the requests of the World Heritage Committee.

It is recommended that the EIS address the World Heritage Committee's request that 'the EIS fully assesses all potential impacts on the OUV and other values including Aboriginal cultural values'.

Response

Further consideration of potential impacts on World Heritage values, including Aboriginal cultural heritage values, is provided in Appendix C to this report.

Issue 2

While the EIS concludes that the 2019-20 fire impacts have no bearing on the Project impacts, it does not provide sufficient information or to determine that, or to determine if the area that will be inundated is important to species and habitats that were impacted by the 2019-20 bushfires.

The EIS does not identify the value of the unburnt areas as refugia supporting the recovery of species from the catastrophic 2019-20 bushfires and therefore it does not assess the impacts of inundation on those refugia.

It is recommended that the EIS address the request from the World Heritage Committee that 'the EIS [considers] whether raising the wall could exacerbate bushfire risk and recovery of species and habitat within the World Heritage areas'.

Response

With regard to the issue of areas within the Project upstream area potentially serving as refugia to support the recovery of species, please refer to the response provided to the third issue in Section 4.1.9.6.

The request from the World Heritage Committee is considered in Appendix C to this report.

4.1.9.13 Cumulative impacts

The assessment has not sufficiently addressed cumulative impact. The parameters of cumulative impact are not defined i.e. multiple extreme events that are likely to impact on the species, habitats and processes that support persistence of species. For example, the 2019-20 bushfires followed an extreme drought and were followed by an extreme flood event.

It is recommended that the cumulative impact of multiple events that are likely to impact protected area values and World Heritage values, including impacts on species, habitats and processes that support the persistence of species be more thoroughly addressed.

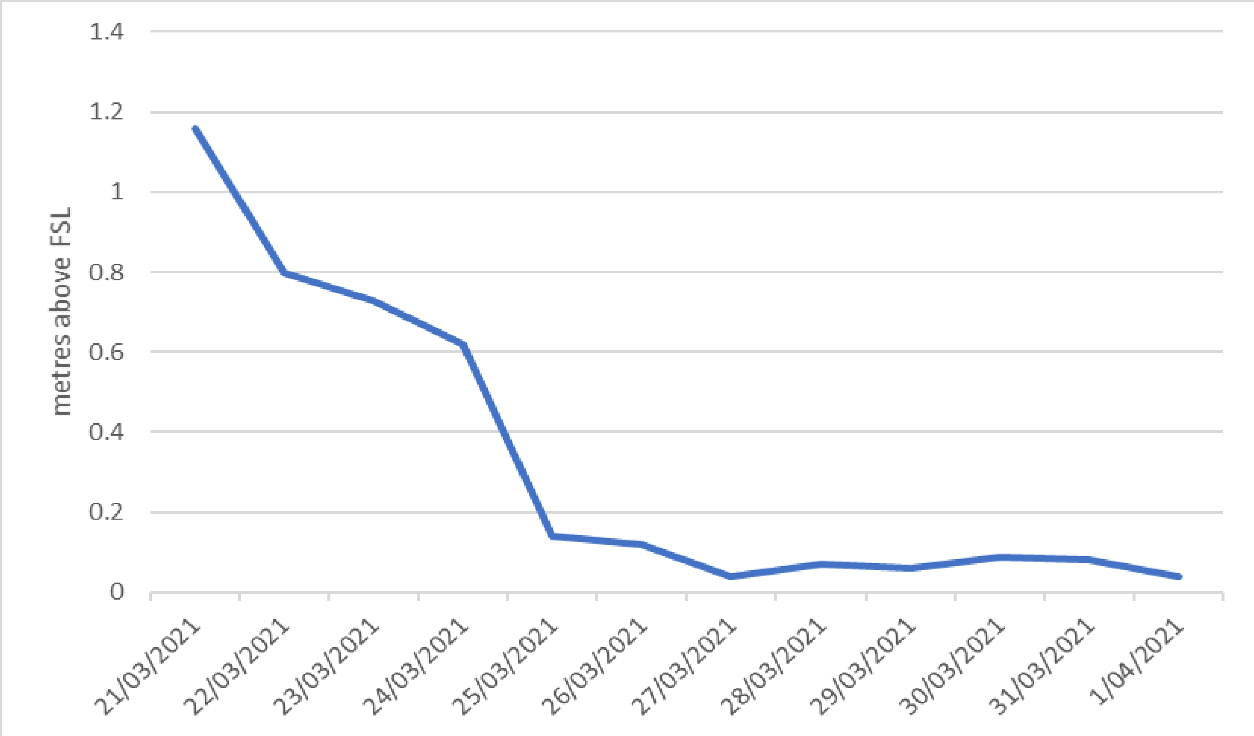
Response

The approach to the assessment of potential cumulative impacts provided in the EIS is consistent with the approach generally taken for SSI/SSD proposals in NSW.

The March 2021 flood event was the first significant flood event to follow the 2019-2020 bushfire event which, for the Wollondilly area, was declared as 'extinguished' by the NSW Rural Fire Service on 10 February 2020 following a torrential rain event over the preceding week. The frequency of occurrence for this event is estimated at 1 in 40 chance in a year at Warragamba Dam (Infrastructure NSW 2021), peaking at 1.16 metres above FSL for one day. Water levels remained above FSL for 12 days but were above 0.2 metres above FSL for only four days (refer Figure 4-10).

Potential cumulative impacts would relate principally to temporary inundation of areas of the catchment affected by the bushfire event, and which would have been in a state of recovery at the time of the flood event. Given the short period of time that water levels were substantially above FSL, the potential for material cumulative impacts from this flood event is considered to be very low.

Figure 4-10 Water levels at Warragamba Dam for March 2021 flood event



4.1.9.14 National Heritage list

The SEARs requirement that land to be included on the National Heritage List be assessed has not been addressed. This includes land identified in the current National heritage list proposal for Greater Blue Mountains Area that is currently with the Commonwealth for consideration. This would require an assessment of impacts on their potential outstanding universal values.

It is recommended that impacts on potential outstanding universal values of lands proposed for addition to the National Heritage List (Yerranderie, Nattai and Burragorang State Conservation Areas) be assessed.

Response

These adjoining lands have been considered in the additional assessment provided in Appendix C to this report.

4.1.9.15 Aboriginal cultural heritage

EES notes from Appendix K that the Registered Aboriginal Parties (RAPs) do not support the Project and recommend it not proceed.

A critical issue is the RAPs' disengagement in the process in relation to the assessment of Aboriginal cultural values. Given the RAPs' disengagement with the assessment process, the intention to consult the RAPs as part of assessment of the EIS proposal is strongly supported.

It is recommended that the RAPs views are considered in assessing the proposal and if this recommendation is not supported then WaterNSW should provide reasons for that decision.

Response

Consultation with Aboriginal stakeholders is described in Section 18.3.1 of the EIS and in Section 6 of *Appendix K Aboriginal Cultural Heritage Assessment*. Consultation has been carried out in accordance with the requirements of applicable legislative instruments and guidelines as identified in Section 6 of Appendix K.

Where provided, the RAPs views have been considered in the assessment for the Project. As noted in management measure ACH1, WaterNSW would continue consultation and engagement with the RAPs for the duration of the Project.

4.1.9.16 Cumulative impacts on Aboriginal cultural heritage

Appendix K notes that the '…Project is seen by the RAPs as a further accumulation of impacts to Aboriginal cultural heritage that has previously been affected by the original development of the Warragamba Dam.'

It is recommended that the cumulative impacts on Aboriginal cultural heritage (ACH) be assessed in acknowledgement that previous destruction and irreplaceable loss of ACH heightens the need to protect existing heritage.

Response

Consideration of potential cumulative impacts on Aboriginal cultural heritage values is provided in Section 18.9.5 of the EIS, Section 10 of *Appendix K Aboriginal Cultural Heritage Assessment* to the EIS, and Section 12.5 of Appendix 1 to Appendix K. This acknowledges the impacts on Aboriginal cultural heritage values from the original construction of Warragamba Dam in 1960.

Further consideration of potential cumulative impacts on Aboriginal cultural heritage values is provided in the supplementary Aboriginal cultural heritage assessment provided in the PIR.

4.1.9.17 Assessment of Aboriginal cultural heritage values

Issue 1

The ACH values assessment is a desktop assessment only and has not been informed by Aboriginal people who have cultural association, because of Aboriginal people disengaging from the process. RAPs did not want to participate in the cultural values assessment and did not provide knowledge-holders. Consequently, the cultural values assessment has been sourced from other reports and documents.

Response

The comment regarding the cultural values assessment being sourced from other reports and documents is not correct. The Aboriginal cultural heritage assessment involved consultation in accordance with the applicable legislative requirements and the guidelines identified in Section 6 of Appendix K *Aboriginal Cultural Heritage Assessment* to the EIS and in Section 18.3 of Chapter 18 of the EIS.

The cultural values assessment was initially integrated into the body of Appendix K, however, this was subsequently separated into a separate document provided as Appendix 2 to Appendix K. Further assessment of potential impacts of the Project on cultural values was carried out as part of this process in response to feedback provided by agencies during the EIS consistency review. This included additional consultation with Aboriginal stakeholders, however, limited feedback was obtained as noted in Appendix 2 Section 3 of the cultural values assessment report. The final draft cultural values assessment report included feedback obtained from the RAPs review.

Further, the advice from HeritageNSW noted in their submission that

> *The cultural values assessment is sufficient as a desktop assessment, acknowledging the limited engagement with the Registered Aboriginal Parties (RAPs). The report identifies known cultural values attributed to the Burragorang Valley and defines the risks to those values.*

Issue 2

Alternative predictive modelling tools (e.g. the Aboriginal Sites Decision Support Tool) could have improved the survey design and helped to restore the confidence of the RAPs. The ACH assessment report did not assess Potential Archaeological Deposits. This is problematic considering the erosional nature of soils subject to periodic inundation.

Response

The survey followed the methodology that was agreed with RAPs as per the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*. The agreed survey design focused on: visiting known sites of high significance and importance; surveying areas predicted to be of high likelihood to contain Aboriginal heritage sites based on a landscape model using slope classes (used successfully in sandstone environments elsewhere in the greater Sydney area); and opportunistically surveying areas of high archaeological exposure below the FSL of the lake. The Aboriginal Sites Decision Support Tool is described by HeritageNSW as being a tool 'developed to meet the needs of regional planning'. The tool is an excellent and highly informative product, however the agreed methodology included consideration, at finer scale, of most criteria considered by the Aboriginal Sites Decision Support Tool: 'such as proximity to water, vegetation, terrain, soils and other features.'

The supplementary Aboriginal cultural heritage assessment provides additional predictive modelling, including the use of the Aboriginal Sites Decision Support Tool, and further consideration of Potential Archaeological Deposits. The Supplementary Assessment also includes further information and detail regarding the expected impacts of temporary inundation of soils, and Potential Archaeological Deposits within the Project area.

Issue 3

There was no agreement that the upstream impact area used to quantify biodiversity impacts would also apply to ACH assessment. The area assessed for ACH impacts should have been based on factors relevant to the Aboriginal cultural landscape and the context of Aboriginal heritage and cultural values.

Response

WaterNSW undertook the necessary engagements with agencies including Heritage NSW (formerly OEH) on the various methodologies and approaches to be implemented in delivering the outcomes required to respond to the SEARs. One of these was establishing an assessment framework to address the infrequent and variable nature of flood events in depth and duration for the upstream area. The agencies consulted included EES,NPWS and Heritage NSW (OEH). The assessment approach reached was clearly outlined in the EIS and resulted in definition of the Project Upstream Impact Area (PUIA). The outcomes included:

- An agreed approach to identifying the likely area of temporary inundation upstream as a result of the Project (based on the likely maximum inundation in a 20-year period)
- The temporary inundation area will be common for all EIS impact assessments on biodiversity, World Heritage, protected lands and Aboriginal cultural heritage

WaterNSW can only assume that over time this knowledge may not have reached the EES Heritage team assigned to review the EIS.

This notwithstanding, the supplementary Aboriginal cultural heritage assessment provided in the PIR considers the broader upstream study area in the context of the flood events identified in the SEARs against the individual sites across the study area.

Issue 4

The Aboriginal cultural heritage assessment (ACHA) report and the Aboriginal heritage chapter both refer to the number of archaeological sites in the World Heritage area and that no cultural values sites are in the impact area within the World Heritage area. This contrasts with the statement in the ACHA report that the whole cultural landscape is highly significant.

Response

Clarification of this matter is provided in Appendix C to this report and aligns with the position presented in Appendix K. In particular, the CVA and ACHA (page 31) both note that the cultural landscape encompasses intangible values that are not necessarily represented by archaeological sites or identified cultural sites. In this regard, the position presented is not in contrast or inconsistent.

Issue 5

The ACHA report and Appendix K incorrectly identify that Aboriginal heritage is not part of World Heritage values and note it is included in the GBMWHA strategic management plan. Aboriginal heritage is part of the World Heritage values, as it is part of the integrity of the property.

Response

Section 8.4 of Appendix K clearly identifies that Aboriginal heritage forms part of the World Heritage values of the GBMWHA and notes the importance of the inter-relationship between heritage values encompassed within the GBMWHA.

Issue 6

There is a risk that cultural values of high significance have not been identified, resulting in impacts on those values not being assessed.

Response

This is a risk common to all major infrastructure proposals that potentially affect Aboriginal cultural heritage sites. No specific details have been provided with regard to the basis for the perceived risk. However, it is noted that the Aboriginal cultural heritage assessment has, as far as practicable, been carried out in accordance with relevant legislative requirements and guidelines, and accordingly, this risk is considered to have been minimised to the maximum practical extent.

Issue 7

It is recommended that the RAPs' position of not participating in the cultural values assessment be considered. Even without the in-depth stories or analysis of information, the RAPs have said the cultural values are of high significance.

Response

The reference to the RAPs' position of not participating in the cultural values assessment is assumed to be based on the discussion provided in Section 3 of Appendix 2 to Appendix K. However, prior consultation had been carried out as documented in Section 6 of Appendix K. Feedback from this process has been incorporated into the cultural values assessment. The Executive Summary of the

Aboriginal cultural heritage assessment acknowledges the significance of the cultural values noting:

> *The cultural landscape is assessed to be of very* high significance.

Issue 8

It is recommended that the significance of the cultural landscape and the impact area within the World Heritage area as part of that significant cultural landscape be acknowledged.

Response

This is addressed in the Aboriginal cultural heritage assessment report (page 64) which states:

> *While the PUIA contains only 304ha of GBMWHA land (a proportion of 0.03% of the total GBMWHA area) it contributes overall to the GBMWHA cultural values as it is a cultural landscape with a rare and representative example of the interconnectedness of tangible and intangible values.*

Issue 9

It is recommended that reference (from the Statement of Outstanding Universal Value) to the Aboriginal cultural values of the World Heritage area and that this is part of the World Heritage values be acknowledged.

Response

Acknowledgement that Aboriginal cultural values comprise part of the OUV of the GBMWHA is provided in the supplementary Aboriginal cultural heritage assessment provided as part of the PIR.

Issue 10

It is recommended that the significance of the cultural landscape and the detailed issues in the ACHA report, some of which were not referred to in the main chapters of the EIS be addressed when considering the Project.

Response

The issues surrounding the significance of the cultural landscape have been incorporated into the recommendations contained with the EIS, and will be subject to ongoing consultation commitments, and management strategies made in the EIS recommendations and the PIR.

Issue 11

The outcomes of the Aboriginal cultural heritage assessment have not been recorded in the Aboriginal Heritage Information Management System (AHIMS) as required in the SEARs. It is recommended that the records of archaeological surveys be provided to DPE for recording in the AHIMS.

Response

The site recording forms have been uploaded to the AHIMS Quarantine Station but have not been accessioned pending resolution of agreement of the multiple knowledge holders to be identified on the AHIMS records. Heritage NSW and WaterNSW are consulting with the RAPs about this matter, and the process was still underway at the time of preparation of the Submissions Report.

4.1.9.18 Mitigation measures

Issue 1

ACH assessments would normally include an option for a major project not proceeding as a mitigation measure and, where that is not possible, state other available mitigation measures. It is recommended that the option of the Project not proceeding as a mitigation measure and, where that is not possible, other available mitigation measures be addressed.

Response

Section 3.4 of the EIS provides a detailed discussion for justification of the Project. As noted, the Project is required to reduce flooding impacts on downstream communities and urban development in the Hawkesbury-Nepean Valley. The unique topography of the Hawkesbury-Nepean Valley results in extensive and damaging floods, especially for flood events greater than the 1 in 100 chance in a year flood. The current number of people affected by a 1 in 100 chance in a year flood is 55,000.

As also noted, the risk would increase as the number of people, properties and businesses in the catchment increases over time. Further, because of the limited capacity and flood prone evacuation routes from developed areas of the floodplain, there is a risk of the loss of human life when significant flood events occur.

Not proceeding with the Project (the 'do nothing' option) is not considered a viable course of action. Sections 2.6 and 2.7 of the Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW, while focused on conservation and net positive ESD and intergenerational equity outcomes, do not canvas an option of 'do not proceed'. The purpose of an assessment is to document cultural heritage values, apply realistic and practical impact mitigation measures, and present an assessment of impact to the identified values to inform determining authorities in making the decision on project progression.

Issue 2

It does not appear that the proposed mitigation measures have been discussed with the RAPs. An Aboriginal Cultural Heritage Management Plan (ACHMP) has not been developed. Consequently, the RAPs have not agreed to management protocols.

Response

Section 6 of Appendix K *Aboriginal Cultural Heritage Assessment* details the consultation process carried for the assessment of potential impacts of the Project on Aboriginal cultural heritage values. As indicated, consultation was in accordance with the *Aboriginal cultural heritage consultation requirements for proponents 2010* (DECCW 2010a) which sets out a four stage process, the fourth stage being provision of the draft cultural heritage assessment report to registered Aboriginal parties for their review and comment. The management recommendations presented in Section 11 of Appendix K were included in the draft report provided for review and comment.

The Aboriginal cultural heritage assessment report(pages 47-49) provides the following detail on comments received from the 10 RAPs who provided a response to the draft report (22 RAPs were registered and were provided with all the reports):

> *There were two RAPs who were supportive of the Aboriginal cultural heritage assessment, however the majority of the comments received from the RAPs were unsupportive of the Project and the Aboriginal cultural heritage assessment that had taken place. The main issues raised in the comments are summarised below:*

- *The Project represents a cumulative impact and continuation of the loss of values from the original Warragamba Dam construction and flooding of the Burragorang Valley.*
- *Given the size and scale of the Project, and the length of the Aboriginal Cultural Heritage Assessment Report not enough time was allowed for review.*
- *The cultural heritage survey did not cover enough of the potentially impacted area.*
- *Inaccessible areas should be accessed for appropriate survey coverage to be achieved.*
- *The Draft Report failed to capture the high significance of the area, and the relationships of sites to each other and the landscape.*
- *Culturally important objects should be left on country, not moved off country.*
- *Mitigation of harm via contribution to the broader communities understanding of the Aboriginal heritage of the Burragorang Valley was not appropriate.*
- *The Draft report failed to convey the importance of the cultural landscape and its values.*

Further assessment work (including the cultural values assessment) was conducted after receipt of these comments. In response to the next draft of the Aboriginal cultural heritage assessment report the following was resolved during face-to-face meetings with RAPs:

> *The following additions/amendments to this Aboriginal Cultural Heritage Assessment Report were agreed at the meeting:*
>
> - *Inclusion of a clear statement that the Registered Aboriginal Parties do not support the project*
> - *Updated detail in the final recommendations of the report.*

Issue 3

It is recommended that an Aboriginal Cultural Heritage Management Plan be developed.

Response

Management measure ACH3 commits to the preparation of an Aboriginal Cultural Heritage Management Plan (refer Table 18-27 and Table 29-14 in the EIS).

Issue 4

It is recommended that mitigation measures including actions to manage impact to sites prior to harm from inundation be required (for example surface collection of artefacts or salvage). The protocols for these should be developed before any approval with the RAPs and the Gundungurra Consultative Committee and could be developed when preparing the Aboriginal Cultural Heritage Management Plan.

Response

As per management measure ACH3, preparation of the Aboriginal Cultural Heritage Management Plan would occur prior to construction. The Management Plan would further consider the merits of salvage activities in relation to the likely harm from the Project and identify where this may be appropriate (e.g. sites within the infrequent inundation zones are not likely to experience a degree of harm that would warrant destruction via salvage). These matters will require ongoing consultation with the Aboriginal community. As stated

> *The ACHMP would be developed and managed in consultation with the RAPs and relevant regulatory authorities.*

Issue 5

It is recommended that mitigation measures should consider salvage of deposits either by:

- RAPs highlighting which deposits need to be excavated via salvage before the raising of the wall, or
- continued monitoring to highlight that the inundation is slowly damaging the sites through erosion.

Response

As per management measure ACH3, preparation of the Aboriginal Cultural Heritage Management Plan would occur prior to construction. The Management Plan would further consider the merits of salvage activities in relation to the likely harm from the operation of the Project. This would identify where this may be appropriate to be done (e.g. sites within the infrequent inundation zones are not likely to experience a degree of harm that would warrant potential destruction via salvage).

WaterNSW recognises that these matters will require ongoing consultation with the Aboriginal community. As stated:

> *The ACHMP would be developed and managed in consultation with the RAPs and relevant regulatory authorities.*

Issue 6

It is recommended that the following additional measures should be considered and discussed with the RAPs and the Gundungurra Consultative Committee:

- the ACHMP should be prepared before an approval if the RAPs and Gundungurra Consultative Committee are willing to engage in this process.
- the ACHMP should be used to manage those sites not being impacted to ensure their condition is kept to a high standard and cared for, given the loss of other values in the area. The ACHMP should look to manage the wider landscape not just the impact area.
- other management or mitigation measures that the RAPs and the Gundungurra Consultative Committee may propose, given they do not appear to have had input on the measures included in the EIS.

Response

As per management measure ACH3, preparation of the Aboriginal Cultural Heritage Management Plan would occur prior to construction:

> *The ACHMP would be developed and managed in consultation with the RAPs and relevant regulatory authorities and stakeholders.*

4.1.9.19 Engagement of archaeologist

The EIS recommends an archaeologist is employed in WaterNSW. An archaeologist would only be useful where qualifications in archaeology are required for requirements relating to the ACHMP and approval of the EIS and associated methodologies. An Aboriginal heritage specialist who is an Aboriginal person would provide better cultural support. This issue should be discussed with the Aboriginal community.

It is recommended that WaterNSW fund an Aboriginal Identified position with relevant technical skills and experience in NPWS for the entire operating period of the raised dam wall through a community service obligation mechanism.

Response

It is assumed that the reference to the recommendation of employment of an archaeologist in WaterNSW is referring to management measure ACH8 which states

> *WaterNSW would consider engaging an in-house archaeological specialist support in line with other state government agencies.*

WaterNSW currently employs an Aboriginal Engagement Manager. The purpose of the role is to support WaterNSW in fostering cultural inclusion and representation of Aboriginal interests both with regard to the Project and more widely across the organisation. The current incumbent has played a key role key role in developing WaterNSW's Reconciliation Action Plan representing WaterNSW in providing ideas and insights into how WaterNSW is tracking as an organisation, as well as providing feedback into current processes and procedures with how WaterNSW engages with the First Nation communities.

4.1.9.20 Non-Aboriginal heritage in parks

Issue 1

The Historic Heritage Management System (HHIMS) maintained by NPWS constitutes the register that NPWS is required to establish and maintain under section 170 of the *Heritage Act 1977*. This is a register of heritage items on national park estate. There is no reference in Chapter 17 *Non-Aboriginal heritage* to items in national parks on the s.170 register.

Response

Further assessment has been carried out with regard to items on the NPWS section 170 register that could potentially affected by the Project through temporary inundation in the upstream catchment. This is provided in the supplementary non-Aboriginal heritage assessment provided as Appendix G to the PIR.

Issue 2

The EIS states that Jooriland homestead (which may be affected by the Project based on the modelled inundation levels) is not listed on any statutory heritage register, and that to determine its heritage significance an assessment should be undertaken by the asset owner (i.e. NPWS). HHIMS provides information on the Joorilands homestead, which has been assessed as having local significance and a Conservation Management Plan has been completed for this site.

Response

Further assessment has been carried out with regard to this heritage items and this is provided in the supplementary non-Aboriginal heritage assessment provided as Appendix G to the PIR. The assessment includes consideration of the Conservation Management Plan.

One building is currently affected by the PMF associated with the existing dam. The Project will affect a second building on the homestead site.

All buildings are below the level of the 1 in 100 chance in a year flood event with the Project.

Issue 3

NPWS is the consent authority for any heritage items in parks (not the local council), therefore NPWS should be referred to in the EIS.

Response

The EIS has been finalised for exhibition and will not be revised. Clarification on matters such as that noted above is provided through the Submissions Report and/or PIR.

WaterNSW acknowledges NPWS's advice that it is the relevant consent authority for any heritage items in national parks.

Issue 4

The are seven other records in HHIMS in the potential inundation area: the yards at Murphys Flat, ruins across river north of Murphys, Orange Tree Flat House on Little River, Old Cedar Rd, Black Dog Ridge, Kiaramba Hut on Cox's Arm.

It is recommended that the EIS identify all items on NPWS section 170 heritage register HHIMS, especially Jooriland homestead, including its significance, so that the management measures at 17-12 NAH1 are applied.

Response

As noted above, the EIS has been finalised for exhibition and will not be revised.

The locations of the items noted above have been reviewed using a GIS with reference to a range of flood events up to the PMF. Kiaramba Hut on Cox's Arm is located above the Project PMF and would therefore not be affected by the Project. Black Dog Ridge Track and Old Cedar Road are located outside of the upstream study area (above the Project PMF) and similarly would not be affected by the Project. The following table provides a summary of existing and potential risks of temporary inundation on the remaining items.

Table 4-8 NPWS s170 heritage items potentially affected by the Project

Location	Flood event (1 in x chance in a year)									
	1 in 5		1 in 10		1 in 20		1 in 100		PMF	
	E[1]	P[1]	E	P	E	P	E	P	E	P
Joorilands Homestead	N	N	N	N	N	N	N	N	Y[2]	Y[2]
Murphys Flat Yards	N	Y[3]	N	Y[4]	N	Y[5]	Y	Y	Y	Y
Stone Hut Ruins	N	Y[3]	Y[6]	Y[6]	Y[7]	Y[7]	Y	Y	Y	Y
Orange Tree Flat House	N	N	N	Y	N	Y	N	Y	Y	Y

1.E = existing; P = Project
2.One building sits within the existing PMF; an additional building would sit within the Project PMF
3.A small part of the area is within the Project in 1 in 5 event
4.Most of the area is within the Project in 1 in 10 event
5.Most of the area is outside the existing 1 in 20 chance in a year event but within the Project 1 in 20 event
6.Partly affected by existing 1 in 10 chance in a year event; about half the area is within the Project in 1 in 10 event
7.Partly affected by existing 1 in 20 chance in a year event; most of the area is within the Project in 1 in 20 event.

Further discussion and assessment is provided in the supplementary non-Aboriginal heritage assessment provided as Appendix G to the PIR.

Issue 5

It is recommended that WaterNSW consult NPWS on any works and related impacts associated with the Jooriland homestead.

Response

WaterNSW will consult with NPWS on any works and related impacts associated with the Jooriland homestead. This is captured through a new environmental management measure NAH15 in Appendix B.

Issue 6

It is recommended that a heritage impact statement (as per Heritage Council of NSW terminology) be prepared for this property, including consideration of alternatives to the Project impacts or mitigation measures proposed for any impacts.

Response

Chapter 4 of the EIS provides a detailed discussion regarding options and alternatives considered for the Project and the process for identify the preferred option assessed in the EIS. Chapter 17 of the EIS provides an assessment of potential impacts on non-Aboriginal heritage and identifies a range of management measures.

Further discussion of potential impacts on non-Aboriginal heritage considering these matters is provided in the supplementary non-Aboriginal heritage assessment provided as Appendix G to the PIR.

4.1.9.21 Offsets

Issue 1

NPWS provided comments in June 2020 on the EIS's consistency with the SEARs, noting that offsets for impacts on protected area values must be in addition to any existing requirements related to offsets for biodiversity or other specific attributes of the land. This is recognised in other major project planning approvals.

Response

The approach in the Warragamba Offset Program has been amended and is described in the revised offset strategy in Section 3.3.

Issue 2

The EIS does not demonstrate how it complies with the *Environmental Offsets Policy* October 2012 under the EPBC Act to offset all World Heritage values.

Response

As noted in Section 11.3 of Appendix J (World Heritage Assessment)

> *DAWE has advised that as the Department has endorsed the NSW Biodiversity Offsets Scheme, provided WaterNSW complies with the scheme, it is not required to simultaneously comply with the EPBC Environmental Offsets Policy.*

Section 13.2 of Appendix J provides details regarding the proposed offset strategy and how it accords with the NSW Biodiversity Offsets Scheme. The revised offset strategy is similarly considered to accord with the NSW Biodiversity Offsets Scheme.

The above DAWE advice relates to biodiversity which forms part of the World Heritage values. With reference to the revised offset strategy (refer Section 3.3), the Project is considered to be consistent with the eight requirements for offsets in the EPBC Environmental Offsets Policy.

Issue 3

The SEARs require WaterNSW to address in the EIS 'an assessment of the cumulative impacts of the project' and 'a compilation of the impacts of the project that have not been avoided'.

Response

The EIS has addressed cumulative impacts within the various EIS assessment chapters. For example, Project impact assessments have considered existing upstream inundation resulting from backwater and local catchment flooding, existing downstream flood extents and damages, identified local and regional project developments during the project construction period, and existing upstream and downstream geomorphology impacts. Further information is provided in supplementary reports and technical notes undertaken since exhibition which are included as appendices to this report and to the PIR.

A compilation of the impacts of the Project that have not been avoided is provided in Chapter 29 of the EIS.

Issue 4

The EIS has not fully responded to recommendations provided following the review of consistency of the draft EIS with the SEARs, or the requirement to assess cumulative impacts.

Response

Finalisation of the EIS included consideration of all recommendations and advice provided during the consistency review process and the discussion in the EIS was revised where considered appropriate. Consideration of potential cumulative impacts is provided in Chapter 28 of the EIS and further details are provided in Section 4.1.9.13 of this report.

Issue 5

Operational procedures to minimise inundation times are identified as a mitigation measure. The EIS does not provide sufficient detail about the proposed offsets and mitigation measures and how these interact with each other and with the operational procedures for the dam, i.e.:

- Biodiversity Offsets Strategy
- Warragamba Offset Program
- Environmental management plan (required under section 64C of the *Water NSW Act 2014*)
- ACHMP.

Response

Further details with regard to the revised offset strategy are provided in Section 3.3 of this report. These cover both biodiversity values and other environmental values including Aboriginal cultural heritage. Additional details regarding operation of the Project are provided in the PIR. Specific details regarding how all management components and activities would interact would be developed should the Project be approved. However, in general, it is anticipated that these would be broadly similar to current management of the Special Areas.

Issue 6

It is recommended that the EIS detail how the operational procedures will be prepared and who will be involved in developing them. The operational procedures will need to address impacts on ACH in parks, biodiversity in parks, historic heritage in parks and other park values.

Response

Matters related to development of final operation procedures are outlined in the PIR.

Issue 7

It is recommended that the EIS clarify how the EMP will interact with other offsets and mitigation measures to reduce and manage impacts from the proposal and from inundation events.

Response

Section 13.2.4 of the EIS identifies that the EMP would be separate to the proposed Warragamba Offset Program and is a separate legislative obligation under the WaterNSW Act. The scope and content of the EMP have yet to be developed.

Issue 8

It is recommended that the EIS address the cumulative impacts on all values in parks which will result from the additional inundation – in terms of both frequency and duration – in the current flood zone i.e. the 'bathtub effect' zone between the current FSL and 2.78 metres above FSL.

Response

The 'bathtub effect' relates to flooding downstream of Warragamba Dam as explained in Section 15.4.3.1 of the EIS. It does not apply to the area upstream of Warragamba Dam between FSL and 2.78 metres above FSL.

It should be noted that the EIS does not use the term 'current flood zone' to refer to this area which is located between FSL and 2.78 metres above FSL. This area is already subject to temporary inundation from the existing dam. The Project would increase the depth and duration of this temporary inundation as identified in Section 15.6.3 of the EIS. The Project would also result in an increased frequency of temporary inundation upstream as identified in Section 15.6.4 of the EIS.

Consideration of cumulative impacts on national parks values for potentially affected NPWS estates is addressed in Tables 10-1, 10-2, 10-3, and 10-4 in Appendix J *World Heritage assessment*.

Issue 9

It is recommended that conditions of approval require NPWS involvement in preparing the operational procedures.

Response

WaterNSW is the owner and operator of Warragamba Dam and is accountable for its safe operation among other functions as required under the *Water NSW Act 2014*.

4.1.9.22 Warragamba Offset Program

Issue 1

It is recommended that the EIS and the Warragamba Offset Program implement NPWS' previous recommendations (see NPWS comments on consistency with SEARs).

Response

WaterNSW advises that the approach in the Warragamba Offset Program has been amended and is described in the revised offset strategy provided in Section 3.3 of this report.

Issue 2

It is recommended the proposed Warragamba Offset Program for the upstream study area recognise the impacts on protected area values and World Heritage values and detail how those impacts will be offset.

Response

WaterNSW advises that the approach in the Warragamba Offset Program has been amended and is described in the revised offset strategy provided in Section 3.3 of this report.

Issue 3

It is recommended offsets for impacts on park values and World Heritage values comprise additions to the parks affected (or nearby parks) in the World Heritage area.

Response

WaterNSW advises that the approach in the Warragamba Offset Program has been amended and is described in the revised offset strategy provided in Section 3.3 of this report.

Issue 4

It is recommended offsets for impacts on park values and World Heritage values include compensation and management costs for park additions be provided for enhanced (landscape scale) land management activities in national parks which are part of or adjacent to the World Heritage area.

Response

WaterNSW advises that the approach in the Warragamba Offset Program has been amended and is described in the revised offset strategy provided in Section 3.3 of this report.

Issue 5

It is recommended WaterNSW identify acceptable offsets for impacts on park values and World Heritage values by applying the principles in the NPWS Revocation, Recategorisation and Road Adjustment Policy, and consult NPWS about the suitability of lands proposed to be acquired for compensation.

Response

WaterNSW advises that the approach in the Warragamba Offset Program has been amended and is described in the revised offset strategy provided in Section 3.3 of this report.

Issue 6

It is recommended for conditions of approval require WaterNSW to consult NPWS in preparing the Warragamba Offset Program and approval from the Deputy Secretary, NPWS in relation to protected areas values and World Heritage value.

Response

WaterNSW notes the advice and considers no further response is required for this issue however note that this is a matter for DPE to consider as part of their assessment. WaterNSW advises that the approach in the Warragamba Offset Program has been amended and is described in the revised offset strategy provided in Section 3.3 of this report.

Issue 7

It is recommended the proposed advisory committee for the Warragamba Offset Program is not established, as it would duplicate legislated advisory bodies under the NPW Act and the World Heritage advisory committee and has not been justified (under 6.2 Offset strategy for upstream operational impacts

Response

WaterNSW notes the advice and considers no further response is required for this issue. However, it is also noted that this is a matter for DPE to consider as part of their assessment.

WaterNSW also notes that the approach in the Warragamba Offset Program has been amended and is described in the revised offset strategy provided in Section 3.3 of this report.

4.1.9.23 World Heritage

NPWS comments on consistency with SEARs noted that the draft EIS did not sufficiently address offsets for World Heritage values, including the specific need to demonstrate 'at a minimum, how the proposed offset will improve the integrity and resilience of the heritage values of the impacted heritage place or property.'

The EPBC – Environmental Offsets Policy states

> *Offsets for impacts on heritage values should improve the integrity and resilience of the heritage values of the property involved. This may include offsets in areas adjacent to the property.*

Statements in the EIS relating to offsets for impacts on World Heritage do not align with these concepts.

Also note that for impacts on World Heritage values to be sufficiently offset, the EIS must first clearly articulate those values and impacts. Earlier comments address deficiencies in the identification and evaluation of impacts on World Heritage Values. The EIS should be clear about how the Project will avoid, mitigate and compensate for World Heritage values that fall outside the NSW Biodiversity Offsets Policy. The EPBC Act provides the appropriate framework for the evaluation and offset of World Heritage values.

For example, the EIS does not provide any assessment of endemic species – endemic species contribute to the OUV of the area. Some endemic species will not be assessed under the NSW Framework for Biodiversity Assessment.

Recommendations

- The EIS and the Warragamba Offset Program implement NPWS' previous recommendations in relation to offsets for impacts on World Heritage values, particularly the specific need to demonstrate 'at a minimum, how the proposed offset will improve the integrity and resilience of the heritage values of the impacted heritage place or property.'
- The EIS and the Warragamba Offset Program identify options to avoid, minimise and offset World Heritage impacts based on a full assessment of impacts using the appropriate assessment and offset frameworks for World Heritage under the EPBC Act.
- Heritage NSW and the Gundungurra Consultative Committee are involved in determining offsets relating to Aboriginal heritage values, including consideration of the outcomes of the

Aboriginal cultural heritage management plan and information that is available as a result of the other management measures for Aboriginal heritage.

Response

WaterNSW advises that the approach in the Warragamba Offset Program has been amended and is described in the revised offset strategy provided in Section 3.3 of this report.

Management measure ACH3 as presented in Table 29-14 in Chapter 29 of the EIS stated

An Aboriginal Cultural Heritage Management Plan (ACHMP) would be developed for the Project and implemented as part of the Construction Environmental Management Plan (CEMP).

The ACHMP would be developed and managed in consultation with the RAPs and relevant regulatory authorities. The AHMP would provide specific guidance on measures and controls to be undertaken to avoid and mitigate impacts on Aboriginal cultural heritage during construction.

The second paragraph has been amended to include consultation with other relevant stakeholders in addition to RAPs and relevant regulatory authorities. The revised management measure is provided in Appendix B to this report.

4.1.9.24 Protecting land owned by WaterNSW under a BSA

The EIS proposes three options for establishing a potential biodiversity stewardship agreement (BSA) as part of the Project (under EIS Section 13.5.1 Offsetting through a site secured stewardship agreement):

- Protecting land owned by WaterNSW under a BSA
- Purchase of land and protection of land under a BSA
- Purchase of land and protection of land through inclusion in a national park under a Plan of Management.

Lands owned by WaterNSW (i.e. as part of the catchment of Warragamba Dam) are already protected and managed under the *Water NSW Act 2014*, and therefore are likely to be ineligible as biodiversity offsets under a BSA. Consequently, WaterNSW's potential options are purchasing land and protecting it under a BSA; or purchasing land and protecting it by transferring it to NPWS for management as part of a national park under the *National Parks and Wildlife Act 1974*.

Recommendations

- For impacts on values that would otherwise be offset by a BSA, that WaterNSW acquire suitable land for addition to a national park and management under the *National Parks and Wildlife Act 1974*.
- If suitable land is not available, that WaterNSW provide supplementary measures (including compensation and management costs) to NPWS for enhanced land management activities in national parks that are part of or adjacent to the World Heritage area.

Response

WaterNSW advises that the approach in the Warragamba Offset Program has been amended and is described in the revised offset strategy provided in Section 3.3 of this report. This addresses the above recommendations.

4.1.9.25 Biodiversity offsets related to NPWS lands

The EIS states that 'where biodiversity credits are not available, or where better conservation outcomes would be achieved through measures directly related to particular species, supplementary measures may be considered as an appropriate offset' (under Section 13.5.3 Supplementary measures).

The four-tier decision hierarchy which proponents must follow when identifying supplementary measures should state, for actions relating to impacts on NPWS-managed lands, that those actions occur exclusively on NPWS-managed lands.

Recommendation

- That a condition be added to the four-tier decision hierarchy to require, for actions relating to impacts on NPWS-managed lands, that those actions occur exclusively on NPWS-managed lands.

Response

WaterNSW notes the advice and considers no further response is required for this issue. It is however noted that this is a matter for DPE to consider in its assessment of the Project.

WaterNSW also advises that the approach in the Warragamba Offset Program has been amended and is described in the revised offset strategy provided in Section 3.3 of this report.

4.1.9.26 EPBC Act Environmental Offsets Policy requirements

The assessment against the Environmental Offsets Policy (Table 13) does not address impacts on park values. Note that the Framework for Biodiversity Assessment (FBA) is designed for offsetting impacts on values which are not already protected, e.g. in national parks or other legislatively protected areas.

Recommendations

- WaterNSW should detail mechanisms for assessing land for inclusion in NPWS estate and timelines and mechanisms for triggering supplementary measures for when appropriate lands are not available for inclusion in offsetting impacts on NPWS lands.
- WaterNSW commit to funding an Officer in NPWS to facilitate the process of securing offsets and covers associated costs for the duration of the Offset Program, given the length of time such an offsetting program will take with respect to the impact on park and the requirement for assessment and ground truthing of any purchases.

Response

With regard to the first recommendation, WaterNSW advises that the approach in the Warragamba Offset Program has been amended and is described in the revised offset strategy provided in Section 3.3 of this report.

With regard to the second recommendation, WaterNSW has already identified and secured the required skilled resources to facilitate the process of delivering on securing offsets in line with the revised approach outlined in the PIR with background in delivering similar large offset packages.

4.2 Department of Planning, Industry and Environment: Water / Natural Resources Access Regulator

4.2.1 Water take and use

Issue 1

The Proponent should:

- Clarify where the water for construction (183 ML) will be sourced and confirm the strategy to obtain adequate entitlement
- Confirm if any groundwater take is predicted, and if so provide an estimate of the water take and any licensing requirements.

Response

Section 5.4.8.2 of Chapter 5 of the EIS notes that water required for construction activities would generally be sourced directly from Lake Burragorang at the dam where possible. This will depend upon the Contractor's success in obtaining water access entitlements through an application. This water source will not be suitable for all construction activities and therefore existing potable water supply would also be tapped and metred for consumption under water take license conditions for servicing site facilities, concrete production and other site activities. If no water take is permitted from the dam storage all water will be sourced from the potable supply system.

Groundwater will not be sourced for use in any construction activities.

Issue 2

The Proponent must ensure sufficient water entitlement is held in a water access licence/s to account for the maximum predicted take for each water source prior to take occurring.

Response

WaterNSW notes the advice.

4.2.2 Groundwater impacts

The groundwater-related requirements specified in the project SEARs relating to potential groundwater impacts have not been fully addressed. The Proponent should provide additional evidence to support the low risk of groundwater impacts that are implied in the EIS.

Response

Further detailed consideration of potential impacts on groundwater is presented in the expert technical review provided as Appendix E to this report. This provides evidence to support the impact assessment in the EIS that there is a low risk of potential impacts to groundwater systems and users (both human and environmental) because of the Project.

The Project does not align specifically to an aquifer interference activity as defined under the *NSW Aquifer Interference Policy* (AIP) (DPI 2012), however, for the purpose of the supplementary assessment, the AIP framework has been used to validate that the Project would have minimal impact on groundwater systems.

Numerical groundwater modelling is not appropriate for assessing groundwater impacts for the Project given that the timescale for operation of the FMZ is days to weeks, and groundwater models are not designed to assess groundwater impacts arising from such short and episodic surface water events.

Further detailed consideration of potential impacts on groundwater is presented in the expert technical review provided as Appendix E to this report.

Section 4.2.1 of the technical review provides a description of the existing hydrogeological environment for the Warragamba Dam/Lake Burragorang locality, noting that the Hawkesbury Sandstone geologic unit hosts a major regional aquifer in the area surrounding Lake Burragorang.

Groundwater within the sandstone aquifer is recharged by rainfall across the sandstone outcrop of the lower Blue Mountains west of the Lapstone Structural Complex (LSC) and losses from Lake Burragorang. The groundwater flow direction is consistently west to east from Lake Burragorang, with groundwater flow across the LSC.

An analysis of groundwater levels from a test bore (W7A, located about 1.9 kilometres to the south of Warragamba Dam) for the period mid 2008 to mid 2012 indicated:

- Dam water levels are always higher than sandstone water levels, which confirms that the dam is losing water to the regional sandstone aquifer
- The sandstone water levels don't respond to individual rainfall events and sudden dam level rises. There were two sharp rises in dam storage level (i.e. increases between 4–6 metres) in February and December 2010, with no corresponding sharp increase in groundwater level
- Groundwater levels respond slowly to longer periods of rainfall and increasing dam storage levels with the first noticeable, and very slight, rise in groundwater levels in early 2010
- The groundwater level in August 2010 was 99 mbgl[23] (91.5 mAHD) and by August 2012 had risen slowly to 97.6 mbgl (92.9 mAHD) – a very small increase of 1.4 metres. The data confirms lagged and only very slight increases in groundwater levels as the dam fills to FSL of 116.72 mAHD.

Work carried out by Parsons Brinckerhoff in 2008 and 2009 completed environmental and radioisotope studies on groundwater samples from Warragamba to Wallacia. This found that groundwater within the Hawkesbury Sandstone aquifer was derived from rainfall with a corrected age of 4,800 years before present (BP) at Warragamba and up to 30,600 years BP at Wallacia. Groundwater ages are significantly older within the LSC and along the groundwater flow path from west to east. This age data confirms low permeability for the sandstone aquifer and slow natural migration.

Landholder water bores around Lake Burragorang target the Hawkesbury Sandstone and the closest landholder bores are three kilometres away from the dam wall. Historically there have been no large rises in groundwater levels following sharp increases in dam storage (as observed at WaterNSW monitoring bores located close to the dam), consequently landholder water bores targeting the Hawkesbury Sandstone are highly unlikely to experience any groundwater level change. Terrestrial vegetation around Lake Burragorang is unlikely to be relying on groundwater in sandstone aquifers due to deep groundwater levels (i.e. typically greater than 50 mbgl) and therefore vegetation fringing the lake is highly unlikely to be groundwater-dependent.

23 metres below ground level

Groundwater levels in the Hawkesbury Sandstone system fluctuate naturally during high and low rainfall periods, and the anticipated changes due to the Project are expected to be within these natural ranges.

Downstream of Warragamba Dam, the alluvial groundwater system is an unconfined, permeable aquifer, with groundwater levels representing the depth to the water table. The depth to groundwater is within 10 m of ground surface, although water levels are typically shallower at 5-6 mbgl on lower alluvial terraces.

Groundwater levels respond directly and immediately to rainfall recharge, and rainfall is the main recharge mechanism, along with stormwater from ephemeral creeks and urban areas. Occasional overbank flooding surcharges groundwater levels for short periods but this water then drains back to the Nepean/Hawkesbury River.

From available water level data, recharge areas are inferred to be associated with natural runoff from Lapstone Creek, Rickabys Creek, Eastern Creek and numerous other smaller creeks plus stormwater discharges into several of the upper lakes within the Penrith Lakes Scheme. Flood inundations typically have a very short duration and are not considered a primary recharge mechanism to the alluvial aquifer.

Groundwater level contours (refer Figure 4.7 in Appendix E) show the groundwater flow direction is towards the Hawkesbury/Nepean River, where there is no tidal influence. The groundwater elevations confirm that the river is a gaining stream as groundwater levels are typically slightly above river levels. This implies that the river receives baseflow from the alluvium to provide a component of flow in the river except when the river is in flood. Baseflow contributions from the alluvial groundwater system are estimated to decrease downstream in the tidal areas.

Landholders and potential GDEs accessing alluvial groundwater are unlikely to experience reduced groundwater availability due to reduced flood inundation areas. Groundwater levels in the alluvial groundwater systems fluctuate naturally during high and low rainfall periods, and the anticipated changes due to the Project are expected to be within these natural ranges.

Tunnelling associated with the Western Sydney Airport and other major projects under construction in Western Sydney is within the Ashfield and Bringelly Shale (Wianamatta Group) geology located above the Hawkesbury Sandstone groundwater system. These projects are located 10 kilometres from Warragamba Dam on the other side of Nepean River which is a groundwater discharge zone, therefore the potential for interaction with the Hawkesbury Sandstone aquifers around Lake Burragorang is considered negligible.

The additional analysis provided in the expert technical review supports the conclusions of the assessment in the EIS with regard to the likely limited impact on the recharge of the downstream alluvial aquifer. As the review notes, the alluvial aquifers are recharged predominantly via direct rainfall recharge, along with stormwater from ephemeral creeks and urban areas. Occasional overbank flooding surcharges groundwater levels for short periods but this water then drains back to the Nepean/Hawkesbury River.

As noted in Section 9.5.1 of the EIS, the four high priority GDEs identified in the *Greater Metropolitan Region Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources* (NSW Office of Water 2011), these being Pitt Town Lagoon, Long Swamp, Longneck Lagoon, and O'Hares Creek, would not be affected by the Project. The location of each GDE relative to selected flood events was reviewed using GIS and all would continue to be inundated by the 1 in 5 chance in a year event and larger events with the Project.

4.2.3 Work approval modification

Modification to work approval 10CA117212 will be required so that it reflects the amended specifications for the project.

Response

WaterNSW notes that work approval 10CA117212 is for water supply works and water use within the Current Upper Nepean And Upstream Warragamba Water Source. Should the Project be approved to proceed the relevant works approval(s) will be amended to reflect the final specifications for the Project.

4.2.4 Geomorphology impact assessment

4.2.4.1 General

Recommendations – Prior to Determination

The applicant should provide a more detailed geomorphology assessment, particularly in relation to:

i. Hydraulic effects – of altered regulated river discharges through both weir-controlled and uncontrolled river sections of the Hawkesbury-Nepean River.

ii. Erosion risk hotspot modelling

iii. Riparian vegetation – Clarifying the impacts on riparian vegetation both up and downstream of the dam in terms of bank stability and vegetation losses due to changes in inundation and flow regimes.

iv. Sediment deposition – The Hydrology and Soils reports should identify in detail the sources and stores of sediment in reaches which will be directly or indirectly affected by changes in water level (SEARs 20.4d). Where these cannot be quantified, they should be identified and mapped corresponding to River Styles reaches. With this information, risk to instream features from changing erosion/deposition with fluctuating lake level can be more readily assessed.

v. Ancillary features – The proponent needs to better define the 'ancillary features' (SEARs 20.4a) including "Natural processes within rivers…". This is not described in the main body of the EIS except for site specific descriptions included in the Geomorphic Assessment (Appendix N2).

vi. Impact risk – Assess the likelihood of increased bank saturation leading to cantilever bank failure along weir controlled reaches of the Nepean River

Recommendation – Post Approval

The proponent should prepare a management strategy to mitigate impacts to those sections of rivers impacted by the project from within the emergency storage limit of Lake Burragorang and downstream to the effective tidal zone of the Hawkesbury-Nepean River.

Response

Detailed responses to the above matters and related details are provided in the following sections.

4.2.4.2 Hydraulic effects

Further details should be provided regarding the hydraulic effects of altered regulated river discharges through both weir-controlled and uncontrolled river sections of the Hawkesbury-Nepean River.

Response

Additional downstream analysis

Further technical work has been undertaken on the matter of bank stability downstream. The river banks exhibit existing significant bank instability in some reaches, and the focus of this additional work has been on identifying any changes that could result from the project. While a range of bank failure modes have been explored, the principal focus was on bank slumping due to saturation, and block failures due to erosion and undercutting, as potential effects of the FMZ operating.

The findings on bank slumping related to saturation were that in all cases (events, locations) the FMZ operation would reduce the risk of bank slumping. The bank materials are relatively permeable interbedded sand and silt, where the pore water in the banks responds relatively quickly to water level changes in the river channel. During a flood, the rising water buttresses the bank, increasing the relative factor of safety, but under the existing situation, the higher flood peak and relatively rapid recession means that hydraulic gradients in the bank materials become relatively steep, and there is an increased risk of slumping in the later recession phase of the hydrograph relative to the static situation prior to the flood. In contrast, the FMZ operation does not have such high peaks, and therefore not as much pore water within the bank soils. Also, the recession is staged and of lower magnitude, enabling the pore water pressures to adjust, reducing the effect on relative factor of safety during the recession. Thus, the risk of bank slumping failure under FMZ operation would be reduced.

Bank failures due to erosion of banks and undercutting leading to block collapse are driven by possible changes to bed and bank erosion within the river. Analysis was undertaken of 'effective stream power' from flood simulation hydrographs for a range of flood events (1 in 5 to 1 in 100 chance in a year) at 18 sites along the river for the existing scenario relative to FMZ operation. This shows that in most reaches and for most events the FMZ operation results in reduced erosion potential due to there being less 'cumulative effective work' done on the river banks and bed. In effect, this is due to the stream power in existing peaks being more erosive than that in the lower but more extended FMZ operation. The exception is in the reach from North Richmond to slightly downstream of Cattai Creek, where the potential erosion is increased due to increased flow volume in the river channel in larger flood events. This occurs because the lower flood peaks means that less flow escapes and flows across and through the floodplain. This potential effect on erosion is most pronounced around and downstream of Windsor through to Cattai Creek.

One other bank failure mechanism is localised erosion from floodplain flood water returning to the river channel. Under FMZ operation, because floodplain flow and ponding will be reduced, this risk of bank failure will be reduced by FMZ operation.

For the background technical assessment of bank stability effects, refer to the Technical Note on downstream bank stability in Appendix G. For aspects related to changes in erosion potential refer to the Technical Note on downstream erosion and sediment transport in Appendix G.

Additional upstream analysis

For tributaries flowing into Lake Burragorang, there will be localised deposition in the lower reaches of the tributaries affected by FMZ operation. this will mean that a slight wider footprint including adjacent floodplain will have some sediment deposition. However, channel sediment will still be able to move through to the lake, if slightly attenuated. The effects are minor, and the details of the footprints affected are shown in the technical note on upstream watercourses.

The number and coverage of sites assessed for scour and erosion potential has been extended, and the results presented in the downstream erosion and sediment transport technical note. While the density of sites is not as suggested in the submission, they cover the different types of river form along the downstream reach (river style, geology and channel form), and have a much denser focus in the middle reach (North Richmond to Cattai Creek) which appears to be most affected.

4.2.4.3 Erosion risk hotspot modelling

The erosion risk hotspot modelling presented in the Geomorphology Technical Assessment (Appendix N2 to the EIS) does not provide sufficient resolution to identify risk relating to channel processes that may be used to design mitigation measures for flooding scour. The erosion risk hotspot modelling is at too coarse a scale to allow an assessment of appropriate conditions for flood water release rules during operation of the temporary flood capture and release mechanism proposed.

Response

The erosion risk hotspot modelling was only undertaken upstream around Lake Burragorang and was not intended to address channel processes, only processes associated with the lake.

Downstream of the dam, the number and coverage of sites assessed for scour and erosion potential has been extended, and the findings presented in the downstream erosion and sediment transport technical note in Appendix G. The sites assessed cover the different types of river form along the downstream reach (river style, geology and channel form), and have a much denser focus in the middle reach (North Richmond to Cattai Creek).As part of the work, a site inspection was undertaken of the river from North Richmond to Sackville, following the floods in July 2022. This has informed the analysis and assessment behind that technical note.

The analysis has been extended to cover more sites, and to carry out a more detailed assessment of potential for both sediment transport and potential bank erosion, using time series data for flow, stream power and shear stress, and calculations undertaken of cumulative sediment transport capacity and cumulative work done.

4.2.4.4 Riparian vegetation

Clarify the impacts on riparian vegetation both upstream due to the vegetation composition as ridgetop species which will now be submerged during flood events and changes in flood inundation extents and durations downstream are not quantified. Chapter 28 of the EIS also states there will be impacts such as loss and fragmentation of habitat, and potential impacts to flood dependent threatened species and vegetation communities downstream but there is no further information. This suggests that riparian vegetation may be significantly impacted by the increased inundation due to the proposed works, but the effects are not stated in the EIS.

Response

An analysis of vegetation condition has been carried out using survey plots in the upstream study area to assess resilience to temporary inundation (refer Section 4.1.6.2). This examined vegetation condition for a riparian vegetation community and a eucalypt woodland community, respectively:

- HN574/PCT 1105 River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion
- HN527/PCT 840 Forest Red Gum–Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion

The analysis benchmarked the number of native species against the Sydney Basin IBRA Region and the South Eastern Highlands IBRA Region. The analysis distinguished between plots within the area of existing impact (from the existing dam) and above this area (which would be affected by the Project).

The results for the riparian vegetation community show that vegetation in the area of existing impact is broadly consistent with the community condition benchmarks suggesting that this community has a significant degree of resilience to temporary inundation – which would not be unexpected for a riparian vegetation community.

As described in Chapter 15 of the EIS, changes to the downstream flooding regime would generally comprise:

- A reduction in flood frequency and extent for flood events of a specific frequency of occurrence
- A longer duration of temporary inundation, up to 10 days, for low-lying areas while the FMZ is being emptied.

Additional investigation into potential impacts of the Project on downstream bank stability (refer Technical Note in Appendix G) identified that there would be a reduced risk of gravitational slumping while water levels were dropping following the flood peak, and a reduced risk of localised erosion resulting of overbank flows returning to the river from the floodplain. This would reduce the risk to riparian vegetation associated slumping and erosion of the river banks.

The additional assessment identified a potential increase risk of bank notching and localised failures due to retaining high and constant recession flows and levels for an extended period of time. It also identified that there would be an increase in potential fluvial bank erosion in one reach (North Richmond to below Cattai Creek) that could lead to increased mass failures. Both of these could impact on riparian vegetation at a local level.

4.2.4.5 Sediment deposition

The Hydrology and Soils report should identify in detail the sources and stores of sediment in reaches which will be directly or indirectly affected by changes in water level (SEARs 20.4d). Where these cannot be quantified, they should be identified and mapped corresponding to River Styles reaches. With this information, risk to instream features from changing erosion/deposition with fluctuating lake level can be more readily assessed.

Response

Sediment sources and loads have been identified in Appendix N2 of the EIS. There is significant sediment load in the river and sediment extraction from the river. The Project will not change the load discharged from the Warragamba Dam, or extraction activities downstream. The effects of the Project apply solely to any increased risk of bank erosion/failure downstream affecting sediment supply, and hydrograph changes affecting ability to transport sediment.

Additional analysis undertaken on the risk of downstream erosion and sediment transport (refer Appendix G) involved time-series analysis of sediment transport capacity at 18 sites in events from the 1 in 5 to the 1 in 100 chance in a year flood events for existing and raised dam FMZ operation scenarios. This found that the FMZ operation is likely to result in reduced sediment transport capacity through most downstream reaches. Consideration of the residual sediment transport capacity under FMZ operation compared to the expected sediment loads coming into the river system suggests that there is a reasonable possibility of increased sedimentation during 1 in 5 to 1 in

10 chance in a year flood events, but probably less of an effect from the FMZ operation in larger events.

The relatively minor effects expected from the Project do not warrant a comprehensive sediment modelling study.

For the upstream catchments flowing into Lake Burragorang, the principal sediment components of relevance are the coarser sediment from influent tributaries (principally from sand sizes up), and finer particles from silt sizes down. The coarser material will deposit in the lower reaches of the tributaries and rework over time into the delta areas at the discharge into the lake. More detail on this process and the consequent effects is provided in the technical note in Appendix G. The finer sediment will deposit within the lake apart from colloidal particles that will pass right through to downstream. The Project will make no material difference to the behaviour of the fine sediment, as the supply will not change, and this material will continue to either deposit as before, or will pass right through the river system.

Downstream of the dam, while the flow peaks will be reduced for moderate to large floods, the hydrographs will have long tails with relatively high ongoing flow rates. Therefore, while the maximum transport capacity will be lower, transport capacity will continue for much longer and will be able to continue to move sediment load through the river system. The studies conclude that the FMZ operation is likely to result in reduced total sediment transport capacity through most reaches, although in larger events there is likely to be sufficient residual capacity to transport the expected sediment loads entering the river.

The sedimentation that currently occurs on the floodplain under current operation will be predominantly finer material such as sand (and possibly some fine gravel), from the suspended sediment load contained within the upper portion of the water column in the river during flood flows. While the main channel can convey high concentrations, when that sediment is conveyed onto the floodplain sediment transport capacity there is lower, particularly in many quieter flow areas. That sediment will be deposited in those areas, and also in other floodplain areas during the flood recession.

The sediments that would have deposited on the floodplain will in future be largely confined within the river channel.

4.2.4.6 Ancillary features

The proponent needs to better define the 'ancillary features' (SEARs 20.4a) including 'Natural processes within rivers …'. This is not described in the main body of the EIS except for site specific descriptions included in the Geomorphic Assessment (Appendix N2).

Response

The reference to 'ancillary features' in the SEARs is interpreted as referring to infrastructure to support construction of the Project (such as coffer dams, batch plants, material storage areas, and worker facilities as noted in Section 5.1.2 of the EIS). It is not interpreted as referring to matters such as natural processes in rivers, rather that the assessment should include consideration of potential impacts of such ancillary features on 'natural processes within rivers, wetlands, estuaries, marine waters and floodplains that affect the health of the fluvial, riparian, estuarine or marine system and landscape health (such as modified discharge volumes, durations and velocities), aquatic connectivity and access to habitat for spawning and refuge.'

4.2.4.7 Impact risk

Assess the likelihood of increased bank saturation leading to cantilever bank failure along weir controlled reaches of the Nepean River is not assessed.

Response

As outlined in the technical note on downstream bank stability (refer Appendix G), the risk of bank failure due to bank saturation will be reduced under the FMZ operation. While the reach upstream of Penrith Weir was not specifically analysed as part of the bank stability study, the principles behind the analysis and conclusions would also be valid in this reach.

4.2.4.8 Commitment to mitigation

Issue 1

It is noted that none of the recommendations from the Geomorphology Technical Assessment (Appendix N2) were included in the EIS (Chapter 29 *EIS Synthesis, Project justification and conclusion*) as recommended conditions of approval, or conditional action.

Response

WaterNSW notes that the mitigation measures from Appendix N2 were not collated in Chapter 29 of the EIS. Since public exhibition of the EIS, additional geomorphology analytical work has been undertaken both upstream and downstream to address specific further requirements from issues raised. This included further analysis on downstream erosion and bank stability from recent flood events since March 2021. The mitigation measures in Appendix N2 will be reviewed and revised as appropriate based on this further work and included in the revised environmental management measures in Appendix B to this report.

Issue 2

The proponent should prepare a management strategy to mitigate impacts to those sections of rivers impacted by the project from within the emergency storage limit of Lake Burragorang and downstream to the effective tidal zone of the Hawkesbury-Nepean River.

Response

WaterNSW would consider only those impacts related to those sections of rivers from within the emergency storage limit of Lake Burragorang and downstream to the effective tidal zone of the Hawkesbury-Nepean River that can be demonstrated as being attributable to the Project could be considered in the DPE assessment.

4.2.5 Hydraulic modelling

The proponent should update the hydraulic model to incorporate significant flood events to the ROBOR and TUFLOW models used to assess likely impacts in the river network.

Response

The hydraulic modelling for the EIS was prepared at a time prior to the finding of reviews of recent flood events in 2021 and 2022. Infrastructure NSW has prepared a report reviewing the March 2021 flood event (*Hawkesbury-Nepean River March 2021 Flood Review*). As part of the review, Warragamba Dam flood mitigation scenarios were modelled to determine what difference these measures would have made to the height and timing of the March 2021 flood downstream. These scenarios all involve creating air space for the temporary capture of floodwaters.

Appendix F to the March 2021 flood report provides details of the methodology and results of the assessment. In particular, Section 2.3 in Appendix F notes that the March 2021 flood was used to validate the TUFLOW hydraulic model developed for the Hawkesbury-Nepean River as part of the Hawkesbury-Nepean River Flood Study and provided the following conclusion below.

The proposed dam raising would have reduced peak flood levels by 5.3 m at Penrith and 3.4 m at Windsor. Compared to the option of permanently lowering FSL by 12 m, the dam raising would have provided additional peak level reductions of 3.0 m and 1.5 m for Penrith and Windsor respectively. The raised dam would also have spared the new Windsor Bridge from being overtopped, significantly reducing closure time.

4.2.6 Flood management framework and plans

The detailed operational protocol should include a Flood Mitigation Zone[24] (FMZ) Drawdown Framework for releasing water from the FMZ, which should include:

- A river management plan to identify sections along the Hawkesbury-Nepean River that require stabilisation measures
- An annual report on the operation of the FMZ Drawdown Framework
- A catchment erosion management plan.

Response

WaterNSW notes the advice and considers no further response is required for this issue.

4.2.7 Mitigation and monitoring

Issue 1

The applicant should develop a specific Trigger Action Response Plan (TARP), which should:

- Address key river processes that may be affected by the partial regulation of the Hawkesbury-Nepean River.
- Address alteration of shear stress and bank saturation due to extension of high flows in the Hawkesbury-Nepean River during flood water releases from Warragamba Dam.
- Incorporate recommended actions from the Geomorphology Technical Report, including monitoring and audit of altered flows on banks and bed of the Hawkesbury-Nepean River and mitigation measures should alteration of channel hydraulics and bank saturation lead to scour or bank failure
- Include performance review and reporting the effectiveness of monitoring arrangements and mitigation measures employed on river reaches affected by altered flows as a consequence of any flood storage release mechanisms.

Response

WaterNSW concurs with the above recommendation but notes that this measure, if adopted, would only cover those measures, monitoring and actions that can be shown to be attributable as a net additional impact arising directly from the Project. WaterNSW notes that there are already many existing river management actions under various public instruments and authorities, existing regulatory frameworks and processes that should already cover the issues above.

[24] The submission uses the terminology ‘Flood Management Zone’, however, the EIS uses the term ‘Flood Mitigation Zone’ and this latter usage has been adopted for consistency in this report.

For example the existing hydrometric network, including river level gauges, is integral to the management and operation of Warragamba Dam. WaterNSW confirms that the existing network would continue to be maintained. Information on water levels and other related information is available through WaterNSW real-time data website. WaterNSW also produces reports on significant flood events such as the March 2021 event, available from WaterNSW website.

Issue 2

DPIE-Water recommends that all mitigation measures (MM) within the Geomorphology Technical Assessment (Appendix N2) classed under Geomorphic stability program (that is, MM48-52) and Hydrology (that is, MM56, 57, 63, 65, 66) should be adopted as minimum operational actions should the project be approved.

In particular, the following Mitigation Measures identified in the Geomorphology Technical Assessment are critical impact management actions:

- MM48 – Audit and investigation of riverbanks (e.g. materials, riparian vegetation, existing patterns of erosion and the vulnerability to future erosion caused by the project) should be carried out to determine specific capital works requirements to mitigate the projects effects. Focus of the investigation should initially be on high risk reaches, but also investigate potential localised risk sites in medium risk reaches
- MM49 – survey bank erosion protection structures, including weirs to determine capital works or other measures required to mitigate project effects
- MM51 – Bank erosion control at identified locations within 'High' rated reaches
- MM52 – Bank stabilisation work in vulnerable areas in reaches ranked as at Medium risk.

These measures should be designed in consultation with the relevant NSW Government agency and should incorporate land and/or boat survey to monitor changes in channel geometry and excessive erosion as part of the WaterNSW Data Quality and Monitoring Improvement Program (as per MM5 and MM33).

Response

As noted in the response to the first issue in Section 4.2.4.8, the mitigation measures in Appendix N2 will be reviewed and revised as appropriate based on the additional geomorphology work and included in the revised environmental management measures in Appendix B to this report.

Issue 3

The applicant must ensure river flow gauges are maintained and report on flood sources, water level and discharges into Warragamba Dam and on tributaries that drain into the Hawkesbury-Nepean River.

Response

The existing hydrometric network, including river level gauges, is integral to the management and operation of Warragamba Dam. WaterNSW confirms that the existing network would continue to be maintained. Information on water levels and other related information is available through WaterNSW's real-time data website[25]. WaterNSW also produces reports on significant flood events such as the March 2021 event, available from WaterNSW's website.

[25] https://www.waternsw.com.au/waterinsights/real-time-data

4.3 Heritage NSW

It is noted as per Heritage NSW's (HNSW) advice that comments are provided as delegate of the Heritage Council of NSW under the *Heritage Act 1977*.

4.3.1 Archaeological Assessment Report

4.3.1.1 Subsurface testing and potential archaeological deposits

As standard practice, HNSW requires the identification of potential archaeological deposits and the subsurface testing of those deposits to establish their archaeological significance. As part of the background research, the Archaeological Assessment Report clearly articulates the potential for subsurface archaeological deposits to be present within the assessment area. The results of the assessment do not consider the potential for deposit to exist and there has been no exploration of these values.

Niche Environment and Heritage (Niche) (2021, pg. 28) states that 'Alluvial deposits have a high significance within the Subject Area, as they have the potential for deep stratified deposits preserving *in situ* evidence of occupation including repeated occupation over many thousands of years.'

There is a relatively small amount of this deposit type remaining in the area, due to the inundation caused by the existing dam. The current proposal will result in the further inundation of what appears to be the remaining alluvial deposits. Without appropriate subsurface testing of these landscapes it is not possible to understand the implications for the potential loss of this deposit and the cumulative impact this would have.

Similarly, there are potential archaeological deposits identified in many of the rock shelters that will be impacted. There has not been excavation within these features and, while the report recommends this occurs if the project proceeds, it does not identify which sites will require excavation.

Allowing post-approval excavation and possible dating of deposit in a rock shelter presents a significant risk that impact will be approved to a site while the significance is unknown.

HNSW sees this as a risk, particularly as there is limited potential to influence inundation areas once approval is granted.

Response

Niche, on behalf of WaterNSW, has compiled further information in a Supplementary Assessment to the Aboriginal Cultural Heritage Assessment (Supplementary Assessment to the ACHA) which is provided in the PIR. This addresses the issue of potential archaeological deposits by providing further detail from site recordings, additional detail on landforms with sub-surface potential and extrapolating the results of survey in areas of very high visibility and exposure to adjacent unexposed areas. The ACH methodology agreed with the RAPs did not include proposals for test excavation of potential archaeological deposits, and discussions during the fieldwork and community consultation activities, the RAPs, anecdotally, do not support a sub- surface testing regime.

The Supplementary Assessment to the ACHA describes the anticipated effects of short-term infrequent inundation on archaeological deposits. The net effect of the Project on archaeological deposits above the FSL is not assessed to be the same as the long-term, semi-permanent inundation observed below FSL. This is evidenced by identification of sites with archaeological deposit being present in the area above FSL. These sites have already been subject to short term inundation over 1-2 days on nine occasions between 1961 and 2022 post dam construction. The ACHA (Appendix K to the EIS) presents this information (for the period prior to 2022) on pages 74-75.

The Supplementary Assessment to the ACHA includes recent investigative field work to locate existing Aboriginal cultural heritage sites in Longneck Lagoon in the valley that was subject to temporary inundation of around one week from the recent 2022 flood events. This type of inundation at Longneck Lagoon is due to backwater flooding which will be of similar nature to that that would be experienced in the upstream lake that would rise above FSL and then recede again as the FMZ was discharged.

4.3.1.2 Survey results and predictive model

Niche (2021, p.32) state that 'the survey coverage achieved for the Subject Area presents a strong representative sample of the landscape.' HNSW would expect this statement to illustrate why deviating from the standard 100 percent survey coverage is an appropriate approach. While HNSW acknowledges that Brayshaw (1989), as referenced in the Archaeological Assessment Report, has previously suggested 30 percent as an acceptable threshold, HNSW would still anticipate a justification in the context of the current proposal. There is also some ambiguity around the survey coverage. Detailed maps showing survey coverage need to be included in the report.

HNSW considers that visibility is a limiting factor for the survey and suggests that the identification of features such as artefact scatters, grinding grooves and engravings are strongly linked to visibility of the ground surface. Many of the site photographs provided as appendices depict a landscape with clear visibility restrictions. Additionally, the inability to relocate previously recorded features, for example stone artefacts within sites, has been directly attributed to visibility restrictions in the site descriptions.

It is likely that site numbers have been underestimated and the effective survey coverage is significantly less than the 33 percent survey coverage stated. This calls into question the suitability of the survey and likely means that the numbers of sites predicted to occur across the unsurveyed impact area have been underestimated. By not fully considering the limitations of the survey at this point in the report, the subsequent sections that rely on these results are compromised.

Consequently the updated predictive model is unlikely to be accurate for open sites unless ground surface visibility was 100 percent. If it is assumed that visibility was on average 50 percent (the reality is it is likely to be much lower) this would double the number of predicted open sites within the proposed impact area.

The use of 'Soil Landscape hectare (ha) per open site' rather than the conventional number of sites per hectare is misleading and makes comparison of site frequency between soil landscapes challenging. With widely different survey coverage and size of soil landscapes across the assessment area, the number of artefacts per hectare is the clearest way to compare site density. By not clearly stating the density of sites per hectare with full consideration of the impact that visibility has upon the likelihood of identifying sites, the predictive model cannot be accurately relied upon

It is important to note the predictive model is based on numbers of sites rather than features. One site can be comprised of several features over a large area such as a scarred tree, artefact scatter and grinding grooves. The numbers of features therefore are also likely to be greater than the number of sites predicted.

Additionally, by grouping a range of features into the 'open site' classification, a degree of nuance associated with the predictive model is unable to be understood, and several site types are not accounted for, leading to a possible underestimation of the numbers and natures of sites.

Response

Survey coverage

The *NSW Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* does not mandate 100 percent survey coverage but rather states

> *The purpose of the archaeological survey (sometimes called a field survey) is to record all (or a representative sample of all) the material traces and evidence of Aboriginal land use that are:*
>
> - *visible at or on the ground surface, or*
> - *exposed in sections or visible as features (e.g. rock shelters, rock art, scar trees)*
>
> *and to identify those areas where it can be inferred that, although not visible, material traces or evidence of Aboriginal land use have a likelihood of being present under the ground surface (potential archaeological deposits).*

The archaeological assessment involved background research, consultation with RAPs to agree on an appropriate methodology for assessment. The ACH field survey was undertaken covering a total area of 2,655 hectares or around 50 percent of the upstream study area (5,280 hectares) and adjoining lands. Note that the upstream study area includes 2,935 hectares that is affected by a PMF event from the existing dam. Of the surveyed area approximately 33 percent (464 hectares) was in the Project Upstream Impact Area (PUIA) of 1401 hectares. The field survey found 334 cultural heritage sites within the study area and adjoining land. Using a predictive model, it was estimated that there would be a total of 174 archaeological sites within the PUIA. The Archaeological Assessment Report in does not claim that the effective survey coverage was 33 percent, rather that 33 percent of the PUIA was surveyed which was the recommendation of earlier assessments for baseline.

The proposed methodology, survey strategy and predictive model were provided to RAPs for review on 5 March 2018. The methodology was also discussed at numerous information sessions (refer Section 6.3 and Appendices 3, 5, 7, 8 and 11 of Appendix K for details). Of the RAPs who provided written responses to the Stage 2-3 proposed methodology consultation document, 86.7 percent (n=13) endorsed, supported and/or had no objections regarding the proposed methodology. One RAP group requested full survey coverage while another requested consideration of creation story sites/locations as part of the survey program.

In response to these requests/comments, an additional 45 targeted survey locations were added to the field program with an objective to more fully sample and understand the cultural landscape and increase the survey coverage. The additional survey objectives consisted of sites and areas related to the Gundungurra Dreaming stories, and sites also related to the more recent history of the area such as farming selections. It was considered that the revised approach would allow for the identification and assessment of the highly significant areas of the Burragorang Valley to make sure cultural information is not lost. The additional survey work proposed resulted in the survey covering a greater sample of the study area but did not result in a program to survey the entire area.

The survey methodology was therefore developed and informed based on information gathered from various reputable sources including AHIMS, place nominations, previous local and regional archaeological investigations, consultation with RAPs, and field surveys. Specifically, the areas for the field survey were identified and amended based on the results of consultation with RAPs.

Survey coverage maps in accordance with Code were provided in the Archaeological Assessment Report in Annex 2, Figure 16 and Figure 17.

The *NSW Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* articulates the difference between visibility (the amount of bare ground (or visibility) on the exposures which might reveal artefacts or other archaeological materials) and exposure (the percentage of land for which erosion and exposure was sufficient to reveal archaeological evidence on the surface of the ground). It is assumed the HNSW comment refers to both visibility and exposure, as required by NSW regulation.

Visibility was not a limiting factor to the extent implied given the extensive survey conducted below FSL where exposure and visibility were at ~100 percent.

Predictive model

The Supplementary Assessment to the ACHA provides a detailed predictive model for the Project area based on these results. In summary, the assessment was based on evidence from both within the PUIA (where usual considerations of exposure and visibility do apply, as noted in the issue) and the survey from below FSL, which was conducted in conditions of excellent archaeological exposure and visibility. Surveying deflated landscapes such as this provides an excellent sub-surface sample. It is worthy to note that the Project conducted a pedestrian survey covering a total of 2,655 hectares, comprising areas above and below the FSL of Lake Burragorang (Archaeological Assessment Report, page 32).

The predictive model was based on the survey results, and is accurate inasmuch as it is derived from the patterning of the records of the survey, extrapolated over a larger landscape. The model presented results based on the full survey of 2,655 hectares, rather than just the PUIA, including extensive survey (776 ha) in areas below FSL where exposure and visibility was very high. As noted on page 107 of the Archaeological Assessment Report, 'the predictive analysis was based on extrapolating the results of the survey across the entirety of the EUIA [including below FSL], PUIA and Above PUIA'. The areas of long term inundation below FSL are lag surfaces on which stone artefacts are conflated, exposed and revealed with very little issue of visibility. The incorporation of these relatively higher exposure and visibility levels of the 776 hectares means there would not likely be a 'doubling of sites in the impact area' as areas of high exposure and visibility were targeted. The survey of these areas meant the Archaeological Assessment Report was able to report a basic artefact analysis of 1765 artefacts with 1348 artefacts from 217 open sites, and 417 artefacts sampled at 63 rock shelter sites (Archaeological Assessment Report, page 88).

The *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* does not specify a convention for describing site or feature density in predictive models. Using landscape area per site, rather than site per landscape area removes the need to have fractions of sites per hectare.

The groupings were used to overcome the generally small numbers of some site features known in the study area (Archaeological Assessment Report, Table 58, page 136) and do not obscure things as profoundly as indicated in this issue. In lieu of precise predictive modelling from low feature numbers page 109 of the Archaeological Assessment Report clearly states that the landscape would contain sites and features 'in similar proportion to known site occurrence'.

Further details are provided in the Supplementary Assessment to the ACHA (provided as Appendix F to the PIR), including additional maps showing the survey coverage presented in the Archaeological Assessment Report in greater resolution.

4.3.1.3 Site analysis

A basic artefact analysis of artefact types across the assessment area and some research questions have been identified that need to be incorporated into the statement of significance and the scientific value of sites. There has, however, been only limited analysis of other site types such as rock shelters and grinding grooves. Some level of formal analysis such as grinding groove length has been undertaken as several of these traits have informed the updates to the predictive model. They are not, however, clearly articulated in the analysis.

The detailed rock art assessment is challenging to follow and many of the charts are not labelled so that they can be easily understood. HNSW considers that a fuller consideration and discussion of the regional motif and pigment data is required to compare to the current assessment area. Full documentation and base line recording are recommended.

Other elements such as the possible cultural markings at Ashtons 1 45-4-0966 and the engraving of the jumping women at Warragamba 74 need further clarification.

Response

Detailed analysis was not attempted owing to the relatively small sample of grinding groove features and the relatively small number of rock shelters likely to be affected by the Project. The lack of analysis of these features and sites does not have a material impact on the assessment.

Ashtons 1 (45-4-0966) is an open site with axe grinding grooves. The field notes record a feature at the site described as 'possible cracking and cultural marking'. The site contains 12 axe grinding grooves. The original recording of the site in 1999 documented 11 axe grinding grooves, and did not note any other artefactual markings at the site. While the field notes are of interest, they do not specifically refer to the markings being either definitively artefactual or art.

There is no engraving of jumping women at Warragamba 74. Warragamba 74 is the cliff associated with the Jumping Woman Story (CVA page 99). Below the cliff this place is also recorded as a place where kangaroos were driven when hunting. Oral history records the engraving of a macropod here but this has never been found.

4.3.1.4 Significance assessment

HNSW has concerns regarding the suitability of the scientific significance assessment. There appears to be a disconnect between the site descriptions from fieldwork and the subsequent report assessment.

The insufficient consideration of potential archaeological deposits and visibility limitations has resulted in higher significance ratings being placed on sites with higher recorded artefact numbers. HNSW notes that several photographs of artefact scatters identified as high or moderate significance are ex situ and located within denuded landscapes and consequently good visibility. This has resulted in higher numbers of artefacts being recorded. Other sites, with fewer visible artefacts, but significant visibility restrictions and what appears to be potential archaeological deposits have generally been assigned lower significance ratings due to fewer artefacts being recorded.

HNSW would anticipate that the eroded artefact scatters have relatively lower potential for scientific investigation. Conversely, if there is potential for artefact scatters within potential archaeological deposits in situ, HNSW would anticipate a greater scientific significance and a recommendation for further testing to establish the nature and extent of the deposit. There has been limited consideration of potential archaeological deposits in open sites, despite the soil landscapes suggesting very good subsurface potential. HNSW requests consideration of these values.

Response

The Supplementary Assessment to the ACHA (provided as Appendix F to the PIR) provides additional assessment of individual sites and appraisal of statements of significance and the scientific value of sites. Please refer also to previous responses.

4.3.1.5 Rock shelters

Issue

The rock shelters recorded as part of this assessment have been generally assigned a low scientific value. The presence of concentrated, multi-feature occupation sites with evidence of cultural activities and potential for unexplored subsurface deposit, presents an excellent opportunity for scientific investigation. HNSW considers that without further investigation of potential archaeological deposits within each of the rock shelters, the significance of the sites remains unknown.

HNSW suggests that by more clearly defining the statement of significance and potential research questions, there would have been a clearer framework of values for Niche to investigate. Additionally, consideration of significance and value at orders of scale, may have provided a comparison with the broader archaeological record of NSW.

The presence of such clearly defined cultural values associated with this landscape, presents a rare opportunity to contextualise physical sites and places within a cultural framework.

Overall, HNSW considers that there is an underestimation of the significance of the sites in this area.

Response

Assessments of significance were conducted as per the current guidelines and criteria. For archaeological significance the Archaeological Assessment Report (pages 111-112) used the guidelines provided by the *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW,* assisted by the criteria defined by the NSW National Parks and Wildlife Service in its Aboriginal Cultural Heritage Standards and Guidelines Kit. The CVA and ACHA followed the significance assessment guidelines of the *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW*.

4.3.1.6 Impact assessment and consideration of Ecologically Sustainable Development

It is not possible to fully consider the impact caused by the proposal without a full appreciation of the value of this landscape.

There is limited consideration of the potential impacts of flooding on archaeological sites, and the report does not draw strongly on broader literature to support the assessment. HNSW notes that as part of the survey there were several examples of the impacts of inundation, however images and descriptions of this are unclear.

The survey below the full supply level was an excellent opportunity to document the impacts caused by inundation, though this opportunity has been largely overlooked. This evidence could have been used to clearly demonstrate both the known and potential risks to sites as a result of inundation and enable mitigation actions to be developed. This would have enabled more targeted consideration of impacts specific to, for example, the flooding of medicinal springs and impacts to rock art. Site by site consideration of potential impacts, supported by both survey evidence and the broader literature is recommended.

HNSW views this as a significant and irreversible impact to a unique cultural landscape, that is not represented elsewhere due to the specific cultural values of the place. The area has already been compromised by the construction of the existing dam and the cumulative impact, were this project to proceed, would be significant.

Response

The ACHA notes that the cultural landscape is assessed to be of very high significance and it specifically classifies the archaeological component of the cultural landscape as being of high significance.

The archaeological sites are understood as a group as being of High Significance as a tangible record of traditional Aboriginal occupation and use of the landscape, particularly in the period prior to European invasion and influence on the Gundungurra lands.

The Supplementary Assessment to the ACHA presents further information, site-by-site, of potential impacts of temporary inundation for HeritageNSW consideration. As described in the ACHA (pages 74-75) pre-existing temporary inundation '[has made] no discernible change in the upper area of the EUIA, certainly it has not left the upper part of the EUIA as a scalded surface lacking vegetation.' For this reason the impacts below FSL (many decades of permanent inundation) are not an appropriate analogy for the predicted impacts from the Project (temporary inundation for periods less than two weeks at most).

4.3.1.7 Ecologically Sustainable Development

The impact assessment needs to consider the predicted sites not identified and engage better with the predicted levels of significance. If the existing significance assessment of known sites is used, it could reasonably expect that a total of 140 low value sites, 10 moderate value and 21 high value sites will be located. It is therefore important to consider the impact to these predicted sites to identify management options and consider whether impact to 21 highly scientifically and culturally significant sites is appropriate. Without further survey of the impact area and potentially subsurface excavation, the presence and scientific values of the predicted sites are unknown and cannot be fully considered.

HNSW considers that it is difficult to justify the further impact to these values and that it is necessary to explore options to redesign or mitigate impacts. The principles of ESD need to be applied and provide the opportunity for the proponent to argue why the proposal is acceptable. Without this information, HNSW is unclear on the impact assessment or consideration of principles of ESD in the various reports, or the cumulative impact chapter of the EIS.

Response

A predictive model is discussed in Appendix K (Sections 18.5.1 and 18.6.4) to the EIS. The model included consideration of previous archaeological surveys and assessments in the local area and wider surrounds, the distribution and patterning of known sites, landform units and landscape context, and previous known land uses. Therefore, sites predicted to occur within the study area reflect characteristics of described landforms and known sites, with similar significant rankings and management options. This approach is consistent with contemporary practices and guidelines for undertaking predictive analysis (see Appendix K to the EIS).

Management measures have been refined as shown in Appendix B and further discussed in the Supplementary Assessment to the ACHA (refer Appendix F to the PIR).

OEH was a member of the Interagency Committee set up to undertake Stage One of the Hawkesbury-Nepean Valley Flood Management Review in early 2013 in response to the NSW Government's adoption of *The State Infrastructure Strategy 2012-2032* and ongoing community concerns about flood risk. In early 2014, the NSW Government established the Hawkesbury-Nepean Valley Flood Management Taskforce to advance the work carried out by Infrastructure NSW and the 2013 Review. The Taskforce include representatives from 11 agencies including OEH (Infrastructure NSW 2017).

The methodologies used by the Taskforce to evaluate infrastructure and non-infrastructure options are described in Section 3 of the Taskforce report *Resilient Valley, Resilient Communities* (Infrastructure NSW 2017). As noted in the report, an environmental, cultural and social impact assessment was undertaken for the shortlisted flood mitigation infrastructure options investigated by the Taskforce. The Taskforce report concludes with the presentation of the Flood Strategy identifying the Strategy vision, Strategy objective, and guiding principles to deliver the nine identified outcomes.

Consideration of ESD matters, including with regard to Aboriginal cultural heritage, is provided in Chapter 29 of the EIS in Table 29-22 *Project justification with regard to the objects of the Environmental Planning and Assessment Act 1979.*

4.3.1.8 Mitigation and recommendations

The report recommendations are not mitigation measures but instead recommendations to undertake the minimum required level of survey, site recording and investigation.

A detailed site recording and a management plan cannot offset the loss of these values and no impact should be approved while the significance and number of sites is unknown. If the proposal was to be approved, both intangible and tangible Aboriginal cultural heritage values would be irreversibly impacted.

HNSW does not support a proposal where the archaeological values are not understood and where assessment of values is proposed to be deferred to the post approval stage.

Response

The ACHA has been prepared in accordance with the SEARs, relevant legislation and guidelines (see Appendix K of the EIS), and a consistency review undertaken by DPIE prior to public exhibition. Since EIS exhibition there has been substantial additional work and consultations undertaken for cultural significance, potential impacts and management measures. Additional information is provided in the Supplementary Assessment to the ACHA (Appendix F to the PIR). Revised management measures are included in Appendix B and further discussed in the Supplementary Assessment to the ACHA.

4.3.1.9 Other comments

The following issues need to be considered by WaterNSW:

- Provide evidence that AHIMS site cards have been submitted and the report updated. It is the responsibility of the consultants to submit site recording forms
- Consider indirect impacts such as vibration, dust etc for those sites in proximity to the dam wall construction area. Appropriate management strategies must then be proposed and discussed in the assessment

- Undertake a new AHIMS search as the previous search is over 12 months old
- Ensure all site photographs are appropriately scaled in line with Requirement 7b of the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (DECCW 2010)
- Include consideration of the Aboriginal Place nomination in the report. Please note that there are cross references in the text that refer to this subheading that does not appear to exist.
- Cross check all documents to ensure there are no discrepancies between the EIS, ACHA and Archaeological Assessment Report. Several discrepancies relating to the numbers of sites and features recorded and proposed to be impacted were noted across all reports
- Update all references to reflect the updated National Parks and Wildlife Regulation 2019.

Response

The site recording forms have been uploaded to the AHIMS but have not been formally submitted pending resolution of agreement as to the Aboriginal community members to be identified on the cards with regard to permission to access site details. This process was still underway at the time of preparation of the Submissions Report.

Consideration of potential impacts of the Project on Aboriginal cultural heritage values included the construction area. Section 9.2 of Appendix K *Aboriginal Cultural Heritage Assessment* concluded that

> *There are no known Aboriginal cultural heritage sites within the proposed construction footprint at the dam wall, and much of the proposed construction activity will take place in areas that were previously developed during the original dam construction.*
>
> *The proposed surface infrastructure avoids all rock shelters, grinding grooves and natural landscape features and therefore there would be no potential surface disturbance impacts to any of these site types or any sites with moderate or high scientific significance.*

Given the absence of any known Aboriginal cultural heritage in proximity to the construction area, the potential for indirect impacts is considered remote. Management measure ACH3 provides for the development of an Aboriginal Cultural Heritage Management Plan as part of the CEMP. This would also manage indirect impacts, where relevant.

A new AHIMS search has been carried out and the results are documented in the Supplementary Assessment to the ACHA provided as Appendix F to the PIR.

Site photographs presented in the Archaeological Assessment Report, CVA and ACHA are examples that were considered most fit for purpose, informative and illustrative in illustrating features being presented in the reports. Not all of these images were taken with a scale.

Section 1.5.2.1 of Appendix K *Aboriginal Cultural Heritage Assessment* provides details regarding the Aboriginal Place nomination noting

> *The nomination covers the Gundungurra creation story or creation Song line, 'The Journey of Gurangatch and Mirrigan'. Some details and the importance of the story and cultural landscape it creates and describes are discussed in the CVAR (Appendix 2). The story documents the creation of two of the main rivers in Gundungurra Country, the Wollondilly River and Coxs River, with several of their associated tributaries such as the Kedumba River and Jenolan River. It also includes the creation of landscape features along the Great Dividing Range.*

The discussion also notes that at September 2021, the nomination of the Aboriginal Place was yet to be determined or declared by the Minster for the Environment. Heritage NSW advised that this was unchanged as at October 2022.

The Supplementary Assessment to the ACHA, Submissions Report and PIR have been reviewed for inconsistencies and refer to correct regulatory instruments.

4.3.2 Cultural values assessment

Issue 1

The cultural values assessment is sufficient as a desktop assessment, acknowledging the limited engagement with the Registered Aboriginal Parties (RAPs). The report identifies known cultural values attributed to the Burragorang Valley and defines the risks to those values.

Response

WaterNSW notes the advice and considers no further response is required for this issue.

Issue 2

Aboriginal community knowledge, comments and concerns have not been appropriately or adequately considered and addressed. The aim of the consultation process is to involve the Aboriginal community in decision making and afford opportunities to provide informed comment on the proposal. HNSW notes the Aboriginal community has clearly expressed its concern with this proposal, but it appears the concerns have not been addressed and there has not been a concerted effort to redesign or appropriately mitigate the impacts.

HNSW notes that the ACHA and supporting documents placed on EIS exhibition have not been provided to the RAPs for review and therefore, Stage 4 consultation has not been completed.

As the current document version is significantly different to the version previously provided to the RAPs for comment, on 29 April 2021, HNSW expects that the RAPs would have been provided an opportunity to comment on the most recent version prior to exhibition. This means that HNSW cannot appropriately consider all feedback provided by the RAPs as part of its review.

Response

Section 6 of Appendix K *Aboriginal Cultural Heritage Assessment* details the consultation process carried out for the assessment of potential impacts of the Project on Aboriginal cultural heritage values. Consultation was in accordance with the Aboriginal cultural heritage consultation requirements for proponents 2010 (DECCW 2010a). The management recommendations presented in Section 11 of Appendix K were included in the draft report provided for review and comment.

The ACHA accompanying the EIS addressed comments raised by the RAPs. A Supplementary Assessment to the ACHA has been prepared in response to EIS submissions, which is included as Appendix F to the PIR. This has been provided to the RAPs for review; responses were pending at the time of finalisation of this report.

4.3.3 Environmental impact assessment

HNSW considers that Chapter 18 of the EIS de-emphasises the risks presented by this proposal to Aboriginal cultural heritage. The risk assessment concludes that, without mitigation, impacts will occur which will have medium consequences for Aboriginal cultural heritage. While the EIS considers this a high risk, it is suggested that the consequences of unmitigated impact are higher than reported by the assessment.

The assessment concludes that there will be a 'possible contribution to cumulative impacts' (EIS p18-74) because of the proposal. HNSW is of the view that the impact will result in at least a moderate level of cumulative impact causing an increased risk to Aboriginal cultural heritage.

Response

The risk assessment presented in Chapter 18 of the EIS provided a combined risk assessment of all sites within the EUIA and PUIA. Further impact assessment is provided in the Supplementary Assessment to the ACHA (Appendix F to the PIR), which provides a more detailed analysis of individual archaeological sites within the area potentially affected by various flood events, including the 1 in 10, 1 in 20, 1 in 50 and 1 in 100 chance in a year events. It is important to note that potential hydrological impacts on individual sites will depend on a site's location within the catchment and exposure to potential inundation. For example, sites near the perimeter of the lake may be subject to relatively higher inundation durations than sites further up the rivers and tributaries.

4.3.4 Mitigation measures and recommendations for Aboriginal heritage impacts

The suggestion that the mitigation measures, as currently presented, are appropriate to mitigate the risk to medium, with only minor consequences for Aboriginal cultural heritage, demonstrates a lack of understanding of the value of Aboriginal cultural heritage and the finite nature of these heritage values.

HNSW considers that the mitigation measures proposed are insufficient to adequately reduce the risk to an acceptable level. While the exploration of offset areas that include similar Aboriginal cultural heritage values is desirable, the sites specific to the proposal area, cannot by their nature occur elsewhere and consequently offsetting will not adequately address the impacts.

Response

The mitigation measures proposed in the EIS are drawn from the ACHA, the CVA and Archaeological Assessment Report. The measures have been developed based on consultation with RAPs and a consideration of the potential impacts of the Project on tangible and intangible heritage values. The mitigation measures were made with reference to the *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW 2011* and were mindful of the advice therein:

> *Do not propose any avoidance, conservation and/or mitigation measures that are not possible or outside the financial viability of your proposed activity.*

The nature of the predicted impacts from temporary inundation mean that avoidance for tangible heritage sites within the temporary inundation zone is not likely to be achievable during project operation. This being the case, the recommendations for mitigation forwarded in the Archaeological Assessment Report, CVA, ACHA and EIS have focussed on practical, and in some cases ongoing, responses to the predicted loss of cultural heritage values and inter-generational equity.

The recommendations include commitments both prior to construction, during Project operation and importantly on an ongoing basis. The aim of the mitigation measures is to:

- Initiate a robust and ongoing process for management of heritage sites and values affected by the Project (Consultation)
- Mitigate harm through management of archaeological heritage (Management of impacts on cultural heritage)

- Raise awareness of heritage values (Management of impacts on cultural heritage)
- Develop ongoing agency (not Project) specific Aboriginal heritage policy and processes, including employment of specialists (Management of impacts on cultural heritage)
- Conduct further site recording for information and archival purposes (Site recording)
- Facilitate more frequent access to country for continuation of cultural, spiritual and educational practices to improve inter-generational equity (Access to Country)
- Reconcile previous harm by returning objects to country (Cultural values recording and education)
- Contribute to inter-generational equity through recording of primary material associated with important stories, sites and places (Cultural values recording and education).

4.3.5 Impacts to State Heritage Register-listed Items

HNSW notes that the proposal has limited but direct impacts to known Environmental Heritage sites (Post Contact) situated in the below-dam environment.

The proposed SSI construction area will directly affect one State Heritage Register (SHR) item – Haviland Park (SHR no. 01375), and is adjacent to two further SHR items: Warragamba Emergency Scheme (SHR no. 01376) and Megarritys Bridge (SHR no. 01367), located at Warragamba Dam, Warragamba NSW, that are not directly impacted.

Haviland Park (SHR no. 01375) is an example of high-quality visitor facilities provided by the former Water Board at dam sites. It contains numerous archaeological, architectural and engineering remnants from Warragamba Dam's construction. The park commemorates the role of Haviland in numerous landscaped parks and is highly valued by the community as a place for recreation, leisure activities and sightseeing.

The Warragamba Emergency Scheme (SHR no. 01376) is representative of the collective response to Sydney's water shortage during the Second World War period. All of the components are excellent examples of the civil engineering skills of the times. The Balance Reservoir is particularly significant because it provides a stilling pool downstream of Warragamba Dam for the purpose of flood discharge. The group of five cottages associated with the construction of the dam are considered to be of high significance because they housed the operations staff between 1940 and 1959.

Megarritys Bridge (SHR no. 01367) is of high significance as it serves the function of carrying the major Warragamba pipeline across Megarritys Creek. It is historically associated with the Warragamba Emergency Scheme, and at the time of construction was one of the largest concrete arch bridges in NSW. It is a unique item of engineering heritage as its design is based on an innovative 'bow string' arch design rather than the more common 'decked' arch design.

Apart from the above SHR items within the construction area, there are 65 further SHR items within the Warragamba Dam Raising study area located downstream from Warragamba Dam, which will be potentially affected by the Warragamba Dam Raising SSI development through changes in flooding regimes.

Response

As explained in Section 17.5.2.1 and Table 17-9 of the EIS, there would be a reduction in the number of Commonwealth, State and LEP listed heritage items that currently experience flooding. Given the reduced risk to downstream heritage items with the Project, it was not considered necessary to provide a detailed analysis of how many of the remaining 65 SHR items will be subject to less flooding from the Project.

4.3.6 Flood modelling and risk to downstream sites

Issue 1

HNSW notes that the existing flood risk to these items from the current dam, and the EIS assessment that flood event modelling with the Project may reduce potential impacts to downstream heritage sites in the order of 10-30 percent overall. This is supported.

By the broader nature of potential flood event modelling, the Warragamba Dam Raising SSI development could also affect three places listed on the World Heritage List, five places listed on the National Heritage List, three places listed on the Commonwealth Heritage List, 793 places listed on Local Environmental Plans and the State Environmental Planning Policy, 76 places listed on State Agency section 170 Heritage and Conservation Registers, 40 items on the NSW Maritime Heritage Database and an unknown number of potentially significant heritage items not listed on the statutory registers, such as the 1850s Jooriland Homestead which is potentially significant and discussed in the supporting impact assessment as referred to below.

HNSW notes that the supporting non-Aboriginal heritage impact assessment does not align with the methodology as proposed in Warragamba Dam Raising Non-Aboriginal Heritage Specialist Report Scope for Assessment of Impacts, prepared by Artefact Heritage Services and dated 18/10/2018 (Our Ref. DOC17/517925-1) and Warragamba Dam Raising Non-Aboriginal Heritage Specialist Report: Response to OEH comments, prepared by Artefact Heritage Services and dated 08/11/2018 (Our Ref. DOC17/517925-6). Section 1.4 of the supporting assessment, entitled 'Assessment approach,' provides no reference to these documents.

Response

The methodology in the documents referred to was provided based on the understanding of the flooding data and potential impacts at that time. Since then, further work was undertaken on the flood modelling and the greater understanding was used to assess potential inundation for the heritage items which fed into the impact assessment. This simplified methodology was agreed to by the project team and used moving into the EIS assessment as it reflected the nature and quantum of potential impacts.

Issue 2

Section 4 of the supporting assessment, titled 'Existing Environment', contains entries for a select number of sites in the upstream and construction study areas. While it discusses the Warragamba Emergency Scheme (SHR no. 01376), it does not discuss Megarritys Bridge (SHR no. 01367), both of which are in the immediate proximity of the construction study area but not directly impacted. Section 4 does not contain details on the listed heritage items in the downstream study area.

Response

Megarritys Bridge is within the extent of the PMF associated with the existing dam, and potentially affected by this event. This risk will reduce with the Project. The existing 1 in 100 chance in a year flood extends up Megarritys Creek past the bridge location whereas the same event with the Project does not extend up the creek at all. The location is not affected by more frequent flood events and this risk will reduce with the Project.

Heritage items potentially affected in the downstream study area are identified in Table 7.6 in Appendix I *Non-Aboriginal Heritage Impact Assessment* to the EIS. As explained in Section 17.5.2.1

and shown in Table 17-9 of the EIS, there would be a reduction in the number of downstream Commonwealth, State and local-listed heritage items that experience flooding with the Project for all events. Given the reduced risk to downstream heritage items with the Project, it was not considered necessary to provide a detailed assessment of potential impacts.

Issue 3

HNSW notes that the site inspections associated with the supporting assessment were undertaken on two days (17/11/17 and 8/3/18) and limited to select heritage items in the upstream study area and the construction study area. While the Warragamba Emergency Scheme (SHR no. 01376) has been inspected, Megarritys Bridge (SHR no. 01367) has not been inspected and the Jooriland Homestead has also not been inspected. This level of survey and site inspection is inadequate for such a large-scale project.

Response

WaterNSW arranged further investigations into the potential impacts associated with the proposed flood mitigation works for non-Aboriginal heritage in response to submissions. The supplementary assessment report is provided in Appendix I and provides further details of the assessment for these two sites.

The report concluded that the overall impacts with the Project for these two sites is neutral.

Issue 4

HNSW notes that the archaeological assessment as contained in Section 5 of the supporting assessment is limited to the construction study area of the Warragamba Dam Raising SSI proposal and does not address archaeological potential and significance of the numerous listed items assessed as likely to be affected by this proposal which are outside the construction study area.

Response

WaterNSW arranged further investigations into the potential impacts associated with the proposed flood mitigation works for non-Aboriginal heritage in response to submissions. The supplementary assessment report is provided in Appendix I.

Potential impacts on non-Aboriginal heritage in the upstream area are assessed in Section 7.3 of Appendix I *Non-Aboriginal Heritage Impact Assessment* to the EIS and in the supplementary assessment provided in Appendix I to this report. Potential impacts in the downstream area are assessed in Section 7.4 of Appendix I *Non-Aboriginal Heritage Impact Assessment*.

As explained in Section 17.5.2.1 and shown in Table 17-9 of the EIS, there would be a reduction in the number of downstream Commonwealth, State and local-listed heritage items that experience flooding with the Project for all events. Given the reduced risk to downstream heritage items with the Project, it was not considered necessary to provide a detailed assessment of potential impacts.

Issue 5

The construction study area has been assessed as having moderate to high potential for retaining an historical archaeological resource associated with the construction of the Warragamba Emergency Scheme and the construction camp and township in the 1930s and 1960s (section 5.2). While associated with a listed item of State heritage significance (the Warragamba Emergency Scheme, SHR no. 01376), this archaeological potential has been assessed as meeting the significance criteria at a local level without a clear explanation as to why it would not meet the significance criteria at state level given the unique and pioneering nature of the SHR item. Further justification on this point is recommended, with a view to comparative assessment as justification, for example in relation to Nepean Dam (SHR 1368).

Response

Although the item itself has State significance the research potential of the archaeological resource is limited as it is generally limited to 'works' as opposed to relics, and unlikely to contain artefact deposits. The assessment of local significance is deemed appropriate for the potential resource. This assessment will be discussed in more detail in the Archaeological Research Design for the construction site which will be included in the PIR.

Issue 6

The 1850s Jooriland Homestead has been identified as a potentially significant heritage item located within the study area upstream from Warragamba Dam which, according to the supporting assessment, will be inundated as a result of the proposed development leading to 'additional deterioration of the structures that remain standing within the homestead site' (Section 7.3.4). The location of the Jooriland Homestead could not be found on the heritage mapping as contained in the supporting assessment. The heritage significance of the Jooriland Homestead has not been discussed in detail and no impact mitigation and management measures have been proposed.

Response

Part of the Jooriland Homestead is affected by the PMF associated with the existing dam, affecting one building (woolshed). The shearers quarters and sheds which are located outside of the existing PMF would fall within the Project PMF. All buildings fall outside of the existing 1 in 100 chance in a year flood event and would also fall outside of the Project 1 in 100 chance in a year flood event.

Further investigations and assessments for the Joorilands Homestead with regard to potential impacts of the Project, including mapping to show the locations of the buildings relative to flood contours have been undertaken. A supplementary non-Aboriginal heritage assessment report is provided in Appendix I with further details of these assessments.

Issue 7

The supporting assessment provides general large scale (1:300,000) maps of heritage items within the study area and the flood mitigation zone inundation discharge area downstream. No clear and detailed mapping including sensitivity mapping identifying the individual heritage items to be affected by this proposal has been provided. This detail should be provided in an addendum at the RTS stage.

Response

There are a number of listed heritage items which fall within the overall footprint of the Project, most of which will not be impacted or impacted at less than a minor level in worst case scenario flooding events. Given there are numerous sites, high level mapping of heritage items in the downstream area was justified to capture the scale of the project footprint. Detailed mapping and sensitivity mapping of these numerous sites was not deemed feasible given the large scale of the study area.

WaterNSW arranged further investigations and assessments into potential impacts associated with the proposed flood mitigation works for non-Aboriginal heritage in response to submissions. A supplementary non-Aboriginal heritage assessment report is provided in Appendix I with further details of these assessments.

Issue 8

The assessment of impacts within the upstream study area is not supported by sensitivity mapping.

Response

WaterNSW arranged further investigations and assessments into potential impacts associated with the proposed flood mitigation works for non-Aboriginal heritage in response to submissions. A supplementary non-Aboriginal heritage assessment report is provided in Appendix I with further details of these assessments. This includes mapping with regard to the changed flood risk in the upstream study area.

Issue 9

Section 7.4.3 of the supporting assessment identifies three items listed on the World Heritage List, four items on the National heritage list, 15 items listed on the NSW State Heritage Register, 184 LEP listed items, 1 item listed on the State Environmental Planning Policy and 17 items listed on State Agency section 170 Heritage and Conservation Registers located in the downstream area that will be affected by the proposal. Section 7.4.5 of the impact assessment states that 'it is noted that additional impacts would occur to heritage items within the areas potentially subject to downstream impacts, where low level flooding would be extended in duration. This includes a range of built heritage, landscape, archaeological and maritime items.' Although Section 7.4.5 states that 'management measures associated with these impacts are included in Section 8.0,' Section 8 of the supporting assessment contains no impact management and mitigation measures specific to heritage items within the downstream study area.

Response

The incorrect reference to Section 8 in relation to specific mitigation measures for downstream heritage items is noted. As explained in Section 17.5.2.1 and shown in Table 17-9 of the EIS, there would be a reduction in the number of downstream Commonwealth, State and local-listed heritage items that experience flooding with the Project for all events. Given the reduced risk to downstream heritage items with the Project, it was not considered necessary to address mitigation measures that ultimately will be subject to less flooding from the Project.

Issue 10

The assessment identifies 40 items listed on the 'NSW Register of Shipwrecks' [sic] (the NSW Maritime Heritage Database) as potentially affected by the proposed SSI development. HNSW notes that the list includes 32 shipwrecks, four aircraft, three items of infrastructure and one other item (WWII Z Special Unit Camp). HNSW also notes that three of the 32 shipwrecks are listed as 'refloated' and two are listed as 'salvaged.' According to the supporting assessment (Sections 7.4.3.4 and 7.5), maritime heritage items downstream from Warragamba Dam are likely to be impacted. This indicates that although 40 maritime heritage items are identified, not all may be impacted, however the assessment is not clear on this point. Although Sections 7.4.3.4 and 7.5 of the assessment state that impacts to maritime heritage items will be managed according to the measures identified in Section 8, Section 8 of the supporting assessment contains no impact management and mitigation measures specific to maritime heritage.

Response

Section 8 of Appendix I *Non-Aboriginal Heritage Assessment Report* to the EIS presents mitigation and management measures for identified impacts on non-Aboriginal heritage items.
Sections 7.4.3.4 and 7.5 note that it is anticipated that impacts on maritime items and shipwrecks downstream would be low in comparison to existing flooding conditions. While not stated in

Appendix I, based on the analysis of hydrology and water quality, the downstream influence of the Project ceases at around the Wisemans Ferry locality (refer for example, Section 11.2 of Chapter 11 *Aquatic ecology* of the EIS).

The net incremental change of the Project, if Warragamba Dam contributes to a flood event, is that the flows in the river from the FMZ discharge would be longer than currently occurs with the existing dam. Given this low risk change in flow release regime and there are also other downstream influences by rivers and other Sydney dams (such as flooding from downstream catchments), no specific mitigation or management measures are proposed.

Issue 11

HNSW notes that Section 8 of the supporting assessment contains a concise table (Table 8.1) of general mitigation and management measures pertinent specifically to Haviland Park (SHR No. 01375), the Warragamba Supply Scheme (Water NSW s.170 Register No. 4580161, LEP No. I270), the 'Warragamba Dam Site' and 'the adjacent terrace garden on eastern bank' and referring to the construction study area in general. Apart from this table, the supporting assessment makes no recommendations as to impact mitigation and management for significant non-Aboriginal heritage sites within the proposal's operational study area.

Response

The Project study area is defined through the SEARs which set the upstream study area as the Project PMF and the downstream study as the existing PMF. The assessment of potential impacts on non-Aboriginal heritage items has been carried out with reference to these two areas.

As noted previously, the Project would generally reduce the extent of downstream flooding and there would be no increased impact on significant non-Aboriginal heritage sites. In view of this, specific mitigation and management measures were not deemed necessary.

While there are no significant non-Aboriginal heritage sites in the upstream area, mitigation measures for the section 170 items in the upstream area are identified in Section 6.3.2 of the PIR, and are also included in Appendix B.

Issue 12

Chapter 28 of the EIS (*Cumulative Impacts and interactions*) identifies in Table 28-4 that potential non-Aboriginal heritage cumulative impacts are 'unlikely' as 'Heritage items potentially impacted are restricted to items near the construction area, and would not be impacted by other identified projects/developments'. This conclusion is not reflective of the impact assessment set out in Appendix I (*Non-Indigenous Heritage Assessment Report*).

Response

The cumulative impact assessment for Chapter 28 assesses the Project against other projects being planned or delivered as identified in Table 28-2. In the context of assessment of heritage items against those listed projects the potential cumulative findings in Table 28-4 are correct. The heritage items at the construction area at the dam itself will not be impacted by other projects as mapped. The heritage items in the upstream study area are in lands where access is restricted to the public and therefore not considered as necessary to add in Table 28-4. The downstream heritage items already experience flooding and would gain a net benefit from the Project. There is also no construction activity downstream of Warragamba auxiliary spillway and there would be no operation of the FMZ in any event until at least six years post planning approval following construction completion for the downstream heritage items to obtain the net benefit. The projects that may be underway at the time of the dam operating as an FMZ will be completely different to those considered in Table 28-3 and therefore not considered in the summary of findings Table 28-4.

4.3.7 Recommendations with regard to non-Aboriginal heritage matters

In assessing the project, Heritage NSW notes that the appendix supporting the EIS has not clearly demonstrated what the impacts to known and potential heritage items will be and how any impacts may be mitigated. In view of these concerns, HNSW recommends that the following points are addressed in an addendum to the EIS provided at the Response to Submissions phase of the Project.

Recommendation 1

The supporting non-Aboriginal heritage impact assessment should be revised to adequately assess the potential impacts to non-Aboriginal heritage items within the Warragamba Dam Raising operational study area. This should include the construction area and the upstream and downstream study areas and recommend appropriate management and mitigation measures based on the items' archaeological and heritage significance, and the assessed levels of impact.

Response

Further information with regard to potential impacts of the Project in the upstream study area is provided in Appendix I. This includes mapping with regard to the changed flood risk in the upstream study area. Further assessment has also been undertaken on a number of items on the NPWS Section 170 heritage register in the upstream area, and this is documented in Appendix I.

Recommendation 2

The revised report should contain a detailed assessment of significance of the archaeological potential within the construction area, clearly explaining the level of significance of expected archaeological remains contained within the construction impact footprint based on comparative analysis and previous assessments.

Response

A non-Aboriginal Archaeological Research Design (ARD) has been prepared for the construction area of the Project and is provided in Appendix H to the PIR. This explains the level of significance expected in the impact footprint, including comparative analyses of previous assessments.

Recommendation 3

The revised assessment should contain a clear discussion of the significance of the Jooriland Homestead and outline adequate impact mitigation and management measures for this item.

Response

Further consideration of potential impacts on the Jooriland Homestead is provided in Appendix I. This includes consideration of relevant matters in the existing NPWS Conservation Management Plan for this site.

Recommendation 4

The revised assessment should contain clear and detailed mapping of individual listed heritage items within the Warragamba Dam Raising study area, including the construction zone and the upstream and downstream study areas. This should be supplied as a mapping appendix in the addendum.

Response

Detailed mapping of NPWS section 170 registered sites in the upstream area that are within, or partially within the PMF has been produced, and this is documented in Appendix I. Detailed mapping for the construction zone and relevant items is already included in the EIS.

Mapping of the remainder of heritage-listed items in the upstream and downstream areas is not required in detail as impacts are assessed as being less than minor. Detailed mapping would not add relevant information to the assessment, outcomes or management measures.

Recommendation 5

The revised assessment should discuss in sufficient detail the potential impacts to SHR-listed items, and items listed on the NSW Maritime Heritage Database in the downstream study area, to outline appropriate impact mitigation and management measures specific to these categories of heritage items.

Response

Detailed mapping of SHR-listed items in the upstream and downstream areas is not considered necessary as impacts are assessed as being less than minor. This level of mapping would not add relevant information to the assessment, outcomes or management measures.

The hydrological modelling for the Project (refer Chapter 15 of the EIS) shows that the area downstream of Warragamba Dam would experience a reduction in the height of flood peaks compared to the existing situation. The frequency of flood events of a specific chance of occurrence in a given year would also reduce, i.e. they would be less frequent than currently occurs. Operation of the FMZ would result in an increase in elevated water levels until the FMZ had been emptied, however, these flows would remain within the main channel of the Hawkesbury River and would not spill onto the floodplain. Downstream flood events would continue to be influenced by inflows from other catchments. Impacts to any existing maritime heritage would be less than minor as assessed in the EIS.

Recommendation 6

The revised report should contain detailed sensitivity mapping indicating which upstream and downstream heritage items are expected to experience positive impacts and which individual items are expected to experience negative impacts. This should be supplied as a mapping appendix in the addendum.

Response

Further information with regard to potential impacts of the Project in the upstream study area is provided in Appendix G to the PIR. This includes mapping with regard to the changed flood risk in the upstream study area. Given the general reduction in flood frequency, extent and depth in the downstream study area and the associated reduced risk of temporary inundation to heritage items, detailed sensitivity mapping for these heritage items is considered of minimal value.

Recommendation 7

The revised assessment should contain recommendations as to the next steps to be undertaken in the management of non-Aboriginal heritage items within the Warragamba Dam Raising study area including the upstream and downstream study areas.

Response

As no significant impacts are identified within the upstream or downstream areas, no next steps are recommended. The mitigation measures identified in the EIS apply to the construction area.

Recommendation 8

The cumulative impact assessment should be revised for the project for non-Aboriginal heritage to reflect the amended assessments required to inform the RTS submission.

Response

The cumulative assessment has been reviewed with regard to the additional assessment carried out for the identified NPWS section 170 items in the upstream area. This identified that significant impacts are unlikely. Accordingly, it is considered there would be no material change to conclusions of the cumulative impact assessment.

Recommendation 9

The Proponent should undertake a Heritage Interpretation Plan to guide post-approval public education and engagement outcomes. This should be prepared at the project inception and draw on the additionally required environmental heritage assessments noted above.

The Heritage Interpretation Plan should be delivered through a range of interpretative products and devices to tell the rich story of the Cultural Landscape, Aboriginal connections to Country, the Dam construction, and associated heritage places and stories.

Response

Management measure NAH2 provides for the incorporation of a heritage interpretation strategy into future designs and planning together with investigation of opportunities for interpretive displays in appropriate locations. A heritage interpretation strategy is a good document to explore the opportunities for interpretation as part of the Project, and determine whether a Heritage Interpretation Plan would be required to be produced. This would be confirmed should the Project be approved.

4.4 Department of Primary Industries (Agriculture)

DPI Agriculture provided advice that the reduction in the height and extent of flood events on rural zoned land within the catchment will have a positive benefit for the agricultural community by reducing the risk of loss/damage to livestock, crops and agriculture business by allowing additional time to prepare for flood events.

DPI Agriculture also advised that the negative impacts from the Project, including elevated sediment deposition during flooding and the inundation of low-lying areas for more prolonged periods during flood events, could potentially impact some agricultural businesses. The economic loss from prolonged inundation is rated in the EIS as high compared to the rating of extreme for the risk associated with flood events with the current wall height of the Project. Consequently, there is greater benefit to be gained for agricultural businesses from a reduced level and extent of flooding than from minor impacts associated with the extended retention of floodwaters. The deposition of sediment during flood mitigation is also low risk and discharges appear to be short lived and cover a limited spatial extent.

DPI Agriculture advised that other minor impacts are associated with the quality of the water during the construction phase from the concrete batching plant, materials storage and vegetation clearing (22 hectares) at the dam site may impact stock and domestic water supply as well as irrigation for agriculture. The management measures in the EIS to avoid, minimise or manage potential risks to be included in an Erosion and Sedimentation Plan is fully supported.

Response

WaterNSW notes DPI Agriculture's support for the Project including the management measures in the EIS during construction. WaterNSW commits to these management measures for the Project.

WaterNSW's water quality policy is committed to:

- Effectively managing declared catchment areas and water management works in these areas to protect and promote water quality based on a multi-barrier approach
- Supplying water that complies with appropriate water quality guidelines or standards to minimise risks to public health.

WaterNSW is legislated to ensuring water quality within its operations and continues to undertake extensive water quality monitoring within its catchments, storages, and rivers. WaterNSW applies these requirements in contractual arrangements with our delivery contractors in any capital works program and the same would apply with the delivery contractor for the dam raising project.

4.5 Department of Primary Industries (Fisheries)

Issue 1

There is only one species or sub species of *Macquaria* within the Warragamba Dam study area, not two, regardless of the ongoing taxonomic clarification discussion. All the *Macquaria* species endemic to the Hawkesbury-Nepean catchment are either Blue Mountains Perch (*Macquaria* sp. *nov. 'hawkesbury* taxon') if eventually formally recognised as a separate species, or else a subspecies of Macquarie perch (*Macquaria australasica*).

Consequently:

- The preferred habitat of Blue Mountains Perch does exist in the upstream study area/FMZ. Blue Mountains Perch have been recorded in four streams within the upstream study area/FMZ – Coxs River, Kowmung River, Kedumba River and Little River, plus in a number of tributaries in the downstream area (Bruce *et al*. 2009; Robinson *et al*. 2013)
- Impacts from this proposal are likely to occur to both critical habitat and to Blue Mountains Perch populations upstream of the dam within the four tributaries, noted above and highly likely in other tributaries not yet surveyed
- Blue Mountains Perch data appears to indicate that breeding occurs mainly Jan-Mar, with occasional later spawning events, as listed in the IUCN assessment for Blue Mountains Perch, not Oct-Jan when Macquarie Perch spawn
- Part of the EIS's reasoning behind declaring a low risk to these fish is that their habitat only occurs in upstream catchments. Blue Mountains Perch generally occur at 100-175 metres altitude, and in the reaches just above Warragamba FSL (currently 178 metres altitude, proposal is +14 metres = 192 metres), so all reaches within the Coxs River, Kowmung River, Kedumba River, and Little River that will be within the proposed new FSL are considered to be critical habitat for Blue Mountains Perch, as noted in the IUCN assessment describing the habitat at Blue Mountains Perch sites DPI Fisheries surveyed within the proposed inundation zone.

The confusion generated by the species classification has resulted in a number of errors and inconsistencies in the EIS. As a result, the Department has concerns about the potential impacts of this proposal being understated in the EIS. This is of particular concern when assessing the test of significance for threatened species impacts. The Department recommends these issues be reconsidered, having regard to the matters raised above.

Response

The current FSL is 116.72 mAHD, not 178 mAHD as identified in the DPI Fisheries submission. It is reiterated that there would be no change to the FSL as stated variously in the EIS (refer for example Section 5.2.7 *Operation of the dam for flood mitigation*).

Additional assessment into potential impacts on riffle habitat has been carried for the Submissions Report and is described in Section 4.1.6.2 of this report in response to similar issues raised in the DPE EES submission. This used depth-duration curves for the 1 in 5, 10, 20 and 100 chance in a year events for a cross section in proximity to a riffle feature in the Wollondilly River to assess the potential incremental impacts of the Project.

The analysis noted the following:

- The maximum duration of temporary inundation is 10 days for the 1 in 100 event (and which is a relatively rare event); this is unlikely to be a significant constraint to breeding in the context of the length of the breeding season
- There is a negligible increase in the depth of temporary inundation for the relatively more frequent 1 in 5 chance in a year flood event
- With reference to the water depths noted in the *National Recovery Plan for the Macquarie Perch (Macquaria australica)* (CoA 2018), the maximum incremental depths for the 1 in 5 and 1 in 10 chance in a year events would be unlikely to be a material constraint to breeding.

On this basis, the reasoning for a low risk/no significant impact determination is considered appropriate.

It is understood that at present it cannot be concluded whether the individuals that have been recorded and identified within the published literature as occurring in the upstream study area are either Macquarie Perch or Blue Mountains Perch. DPI Fisheries advice is that all individuals recorded are either one or the other(and not two co-existing populations as is the interpretation from the EIS).

Issue 2

In dealing with risk assessments related to aquatic ecology, the EIS appears contradictory. (Table 11.9) states that upstream operation risks, before mitigation, are High (orange), and are still Medium (yellow) after mitigation, but there appear to be no proposed mitigation measures for upstream impacts. In Table 27-19 Water quality risk analysis notes: 'Rapid filling of the FMZ may result in reduced water quality, however this was assessed as being relatively minor and no significant upstream water quality changes would occur.'

Response

With regard to the key impact 'upstream flood inundation causing changes to aquatic habitats and water quality', Table 11.9 in Chapter 11 of the EIS identifies mitigation measure AE5 as reducing the upstream operational risks from high to medium. Mitigation measure AE5 states

> *Aquatic habitat would be protected in accordance with Section 3.3.2 Standard precautions and mitigation measures of the Policy and guidelines for fish habitat conservation and management (2013 update) (Fairfull 2013)'.*

As indicated in Table 11.7 in Chapter 11 of the EIS, the responsibility and timing of this impact are associated with pre and during construction works and are not 'operational' impacts. This can also be seen from the advice provided in Fairfull (2013) which relates to construction activities only. The only relevant safeguard noted would be

> *Ensuring that the area is rehabilitated after completion of works in accordance with a NSW DPI approved method or plan. This may involve establishment of native riparian vegetation.*

It is noted that the construction works for the raised dam will not affect upstream riparian vegetation only vegetation at the actual wall itself.

It is agreed that there are differences between Table 27-19 in Chapter 27 of the EIS and Table 11.9. The risk levels are high to medium but the text notes no significant impacts to upstream water quality would occur. This is still considered a reasonable conclusion to draw based on assessment of risk, evidence provided on likely impacts on water quality and erosion.

Issue 3

The months with the highest average rainfall and highest risk of floods for the catchments are all Jan-Mar (BOM), which coincides with the Blue Mountains Perch spawning season. If the increased dam height results in the extra stream reaches being flooded while they are attempting to spawn, this could greatly reduce the available spawning habitat for the species, due to flooding of riffle habitat and increased smothering of habitat with silt. The Department recommends that these impacts need to clearly identified in the EIS, considered in the test of significance and mitigation or offsets measures proposed.

Response

As noted in the response to the first issue in this section, additional assessment into potential impacts of the Project on riffle habitat has been carried for the Submissions Report and is described in Section 4.1.6.2 of this report. The analysis identified that it was unlikely that there would be significant incremental impact on this habitat from the Project.

The risk of increased smothering of habitat with silt is considered low. It is noted that this is an existing risk associated with the transport of sediment through the channel system. Additional assessment has been carried out with regard to upstream sediment movement (refer Appendix G). This confirmed the findings of the EIS assessment i.e. that the nature of sediment transport in the upstream area would generally be unchanged but that the Project may result in some spatial changes with sediment settling further upstream in channels (referred to as the 'transportation zone' in the supplementary assessment), and the sediment may take longer to travel through the zone to the lake.

Related to the above point, the increased extent of backwater associated with the Project would contribute to the potential for finer particles to settle out in channel reaches not previously affected by backwater. However, as water levels drop in the lake and the reach of channel affected by backwater recedes back towards the lake, the hydraulic gradient would increase with a concurrent increase in the potential for sediment to be remobilised. This is an existing process but, as noted, the Project may change the spatial pattern of this process.

Impacts relating to the above (i.e. loss and alteration of spawning habitat) may be minimal, however, as a precautionary approach and due to the limited understanding of current distribution and abundance of Macquarie perch/BMP within the upstream impact area, WaterNSW would consult with NSW DPI Fisheries with regard to developing management actions to improve knowledge of impacts and support recovery. These management actions could be included in the offset strategy outlined in Section 3.3.

Issue 4

The EIS notes that impacts on macro-invertebrate assemblages associated with poor water quality due to the operation of the FMZ having an impact on the food sources of the fish. This would result in impacts to the Blue Mountains Perch and the Department recommends this is clearly identified in the EIS and test of significance.

Response

The EIS concludes that there is unlikely to be a significant impact on water quality due to the operation of the FMZ. WaterNSW agrees that poor water quality could potentially impact on macro-invertebrate assemblages and food sources for fish which does occur from flood events from the existing dam. As water quality is unlikely to be a significant impact from the FMZ discharge compared to existing flood conditions, WaterNSW would consult with DPI Fisheries with regard to developing management actions that could be included in the offset strategy outlined in Section 3.3.

Issue 5

The geomorphology assessment has a considerable amount of information relating to the potential increase of sediment loads and deposition from out of channel erosion and translocation of sediment features upstream. There is a need to correlate the amount and location of this deposition of material with the geomorphic structures required by Blue Mountains Perch to spawn to quantify potential habitat loss.

Response

WaterNSW agrees that sedimentation of suitable spawning habitat (i.e. gravel shoal/riffle beds) is a risk. Further information on sediment and erosion resulting from the operation of the Project (refer Appendix G) indicates the risk of increased sedimentation and erosion is low. As this risk is low the advice of DPI Fisheries would be sought in developing management actions that could be included as part of the offset strategy approach outlined within the PIR.

Issue 6

The added impact of more frequent bushfires due to climate change needs consideration. The recent floods following the recent bushfires in the region resulted in significant amounts of eroded material washing into known Blue Mountains Perch habitat areas.

Response

The issue of eroded material washing into known Blue Mountains Perch habitat areas as a result of climate change and bushfires is an existing risk. The Project may change this risk through increasing the area of temporary inundation for a flood event of a specific frequency; for example, an additional 283 hectares would be affected for the 1 in 5 chance in a year event. This represents a larger source area for eroded material to be transported from the land surface into drainage channels.

Section 28.4.10 of the Cumulative Impacts and Interactions chapter of the EIS addresses the cumulative effects of the 2019-2020 bushfires only and considers this as an existing risk which is separate to the Project.

Issue 7

DPI Fisheries recommends the following conditions for the proposal.

- A Blue Mountains Perch Monitoring and Recovery Program is to be developed in consultation with DPI Fisheries. Major points to address include:
  - recovery actions to include investigations of potential mitigation strategies to address sedimentation and siltation of key breeding habitat of Blue Mountains Perch, if monitoring detects an impact on those habitats
  - monitoring is to occur for five years after the first new FSL event to determine if any impacts have occurred from the inundation and the controlled lowering of water levels. If impacts are detected, then mitigation or offset measures must be developed and implemented as part of the recovery program.
- FSL levels to be maintained for a maximum of two weeks. DPI Fisheries to be notified if the FSL level is to be maintained for longer than two weeks in the period from 31 December to 31 March each year. This would allow DPI Fisheries to consider if there are any Blue Mountains Perch mitigation actions to be implemented.

Response

The above recommendations are for DPE to consider in its assessment of the Project. However, as previously noted, mitigation and management measures could be included for Macquarie Perch/ Blue Mountains Perch in the offset strategy.

As noted elsewhere in this report, the risk of sedimentation and siltation affecting Blue Mountains Perch breeding habitat is an existing risk. It is WaterNSW's view that DPI Fisheries would be the appropriate organisation with primary responsibility for any Monitoring and Recovery Program supported by WaterNSW with regard to matters that are attributable to the Project.

With regard to references to 'FSL' in the recommendations, as per the response to the first DPI Fisheries issue, the meaning of this has been misinterpreted, and 'FMZ' is the appropriate term to use.

The statement 'FSL levels to be maintained for a maximum of two weeks' in the second recommendation is presumably referring to the maximum period that the FMZ would be in operation as indicated in the EIS. However, from an operational perspective, the objective would be to empty the FMZ as soon as practicable, but concurrently balancing downstream operational objectives. It is suggested that this sentence be removed from the recommendation.

4.6 Environment Protection Authority

4.6.1 General

Although water storage is not a scheduled activity under the *Protection of the Environment Operations Act 1997* (POEO Act), activities such as concrete works and crushing, grinding and separating of waste streams as outlined in the EIS may require licensing under the POEO Act if the thresholds stated in the legislation are likely to be exceeded.

Response

As identified in Section 2.4.5 of Chapter 2 of the EIS, construction of the Project would be below the activity thresholds detailed in Schedule 1 to the POEO Act for cement handling and other relevant activities. WaterNSW agrees that a license under the POEO Act may be required. The need for an

Environment Protection Licence (EPL) would be assessed as part of detailed design and construction planning when a project delivery contractor has been engaged. Should it be required, which is likely, the application for the EPL would be undertaken by the construction contractor.

4.6.2 Process water and contaminated runoff discharges

Issue 1

'Significant' quantities of concrete dust and slurry would be generated from hydro blasting which will have high suspended solids and high pH. The EIS indicates 50 megalitres of water will be required for hydro blasting. Concrete dust will also be generated from demolition activities. The EIS has not provided details on how the concrete dust and the hydro blasting slurry will be managed and therefore whether a water quality impact assessment and mitigation measures are required.

Response

Concrete dust will be generated from concrete demolition activities such as concrete cutting, and hammering and hydro blasting of the dam face. As outlined in Table 7-1 in Appendix E to the EIS, mitigation measures have been considered for dust control including from concrete demolition activities. WaterNSW has committed to measures to manage dust during construction through a Dust and Air Quality Management Sub-Plan that will form part of the Construction Environmental Management Plan (CEMP). The CEMP will be developed by the construction contractor once selected as part of the detailed design and construction planning process.

Controls will include suitable concrete dust suppression and/or collection techniques, such as mist sprays, and will be used during cutting, grinding or sawing activities likely to generate dust in close proximity to sensitive receptors.

The expected volume of water required for hydro blasting is five megalitres and not 50 megalitres as identified in Table 1-2 of Appendix N1.

Hydro blasting will remove existing surface concrete from the downstream face of the dam to a depth of 20-50 millimetres which will provide a surface for bonding the new concrete. The loose concrete cuttings and water will collect at the toe of the dam within containment bunding on the dry dissipator floor.

The slurry will then be pumped to a series of settlement tanks located above the dissipator behind the central spillway training walls. The fine particles settle in the tank from screens and baffles (using flocculants) as water passes through the tank. The water then passes through a small modular water treatment plant (including pH treatment) before being discharged or reused. The following photograph shows the typical used to collect, treat and store treated wastewater for reuse.

Photo 1 Example of water collection, treatment and reuse plant

Issue 2

Wastewater generated from concrete batching plants would be incorporated into the concrete batching process, however, runoff from the plants would contain concrete and materials used in the manufacturing process that could impact water quality. The EIS indicates the concrete batching plants would have a dedicated drainage system that drains to treatment facilities such as a treatment pond or water treatment plant and that water would be either discharged or reused where possible. If a discharge to waters is necessary, a water quality impact assessment consistent with section 45 of the *Protection of the Environment Operations Act 1997* (POEO Act) is required.

Response

WaterNSW has not yet engaged a delivery contractor to progress detailed design and construction planning. The CEMP will be developed by the construction contractor once selected as part of the detailed design and construction planning process.

Section 27.4 in Chapter 27 of the EIS outlines water generated from the construction activities. Further details on the surface water, pollution risk controls and treatment facilities and discharge will be identified and assessed as part of detailed design and construction planning.

All water used in construction activities, including stormwater runoff, will be managed and controlled in accordance with the POEO Act and regularly audited for compliance. In particular, the CEMP (Soil and Water Quality Management Sub-Plan) will detail requirements for undertaking a water quality impact assessment in accordance with section 45 of the POEO Act.

Issue 3

The EIS indicates a 90th percentile 5-day rainfall event would be the basis to capture and treat runoff from construction areas. It should be noted that standard erosion and sediment controls based on *Managing Urban Stormwater Soils and Construction* Volume 1 (the Blue Book) are not appropriate for managing potential water pollution risks associated with contaminated sediments and runoff. Where stormwater is expected to contain pollutants other than 'clean' sediment at nontrivial levels the proponent should consider additional or alternative treatment measures to mitigate potential water pollution risks

Response

During construction, management of surface water from stormwater runoff and erosion of surfaces in and across construction areas including laydown and storage sites can be effectively managed by measures such as erosion and sediment control considering the guidance (as appropriate) in:

- *Managing Urban Stormwater: Council Handbook* (draft) (EPA 1997a)
- *Managing Urban Stormwater: Treatment Techniques* (draft) (EPA 1997b)
- *Managing Urban Stormwater: Source Control* (draft) (EPA 1998)
- *Managing Urban Stormwater: Soils and Construction* Volume 1, 4th ed. (Landcom 2004)
- *Water Discharge and Reuse Guideline* (TfNSW 2015)

Warragamba Dam and adjacent lands within the fenced boundaries already contain an existing network of stormwater and sewage drainage and collection systems that manages wastewater and surface water run-off. Section 27.4 of Chapter 27 in the EIS discusses potential water quality impacts generated from the construction activities. As identified in Figure 5-2 in Chapter 5 of the EIS, the key areas of construction activities are on the dam itself and material storage in open areas near the dam entrance.

Appropriate bunding and drainage for surface water will be installed and linked where appropriate to the existing network for unpolluted sources.

Contaminated water from construction activities will be contained into sumps, basins, settlement tanks or the like and transferred to water treatment facilities at both sides of the dissipator. Post-treated water would be either directed to the stormwater system or downstream of the cofferdam.

Water discharged back into the river system would be managed through compliance with required treatments and regulatory license conditions.

The dissipator pond at the base of the dam would require constant draining to create safe and dry working conditions to enable the dam wall to be thickened. The coffer dam, to be installed downstream of the dissipator pond, would prevent water from the Warragamba River from flowing back into the dissipator pond. For reference a layout and cross section of the cofferdam is provided in Appendix A to the PIR.

WaterNSW has not yet engaged a delivery contractor to progress detailed design and construction planning. The CEMP will be developed by the construction contractor, once selected, as part of the detailed design and construction planning process and will contain further details on the surface water and pollution risk controls and treatment facilities outlined above.

WaterNSW is committed to treatment measures to mitigate potential water pollution risks associated with contaminated sediments from surface water runoff and construction activities.

Issue 4

The EPA recommends the proponent:

- Considers options for increasing onsite storage to enable increased reuse, reducing potable water demand, and avoiding or minimising the need for a discharge
- Provides a water balance that clearly details the predicted frequency, duration and volumes of water to be discharged under a range of scenarios (including typical and worst-case scenarios)

- Where a discharge is required, provide further details on:
  - proposed treatment plants (including specifications and design details, including expected treatment performance for all pollutants of concern at the site)
  - water treatment ponds sizing and design rainfall event
- Considers additional or alternative treatment measures where stormwater is expected to contain pollutants other than 'clean' sediment at non-trivial levels
- If construction phase discharges are to occur, the potential impact of those discharges must be considered consistent with the relevant matters under section 45 of the POEO Act, including:
  - estimate the expected frequency and volume of discharges
  - characterise the expected quality of each discharge in terms of the typical and maximum concentrations of all pollutants likely to be present at non-trivial levels
  - assess the potential impact of each discharge on the environmental values of the receiving waterway consistent with the national Water Quality Guidelines (ANZG 2018)
  - where relevant, identify appropriate measures to mitigate any identified impacts
- Develops a monitoring program that can inform a Trigger Action Response Plan (TARP). The TARP should include contingencies to identify and manage any unpredicted impacts and their consequences to ensure corrective actions are implemented.

Response

WaterNSW has not yet engaged a delivery contractor to progress detailed design and construction planning. The CEMP will be developed by the construction contractor, once selected, as part of the detailed design and construction planning process and will contain further details on the above issues. However, further responses are provided below.

Onsite storage

The construction area layout will incorporate drainage and storage infrastructure suitable for retaining and treating water generated from construction activities to acceptable water quality levels before on-site reuse or discharging back into the environment. Stored water would be reused as much as possible for non-potable uses such as dust suppression and hardstand cleaning.

Water balance

The CEMP (Soil and Water Quality Management Sub-Plan) will detail requirements for preparing water balances during various construction phases which will be defined in the detailed construction program and methodology. Water balances will include assessment of construction layout characteristics (existing and new temporary drainage infrastructure, active/non-active, hardstand/unsealed, stockpile/storage areas, buildings, roads, paved areas etc.) and assess stormwater generation and runoff. A 90th percentile 5-day rainfall event would be the basis for mitigation measures to capture and treat runoff from construction areas. This is equivalent to approximately 48 millimetres of rainfall.

Discharge management

As noted above, drainage infrastructure, storage and any treatment/management requirements (such as reuse, flocculation/settlement, oil/water separation, energy dissipation, etc.) will be incorporated in the construction layout design, while stormwater management will be detailed in the CEMP (Soil and Water Quality Management Sub-Plan). Design requirements and the CEMP will be in accordance with regulatory and compliance requirements, national Water Quality

Guidelines (ANZG 2018) and adopted sustainability objectives and targets (see Chapter 23 of the EIS).

Potential pollution risks will be identified and included in the risk register . Identified risks would be assessed in accordance with section 45 of the POEO Act and national Water Quality Guidelines (ANZG 2018). Assessment requirements will be detailed in the CEMP (Soil and Water Quality Management Sub-Plan) and include full details of the discharge (pollutant concentrations and thresholds, volume, frequency, potential environmental impacts) and, where relevant, identification of appropriate measures to effectively mitigate identified impacts.

Monitoring

The CEMP, and relevant sub-plans, will document monitoring, corrective action and reporting requirements, including preparing a monitoring program that can inform a Trigger Action Response Plan (TARP). As noted, the TARP will include contingencies to identify and manage any unpredicted impacts and their consequences to ensure corrective actions are implemented.

4.6.3 Other construction activities

The EIS does not provide any details regarding potential water pollution impacts or identify practical measures to avoid impacts associated with the following construction activities:

- Controlled blasting
- Underwater excavations
- Boat ramp construction
- Dewatering activities and water diversions
- Use of epoxy resins
- Thermal discharges from concrete cooling pump systems.

Additional information is required to identify all potential water pollution risks and ensure all practical and reasonable measures to avoid, minimise and mitigate impacts have been appropriately considered and adopted.

For the construction activities identified above, the EPA recommends the proponent:

- Assesses potential impacts on water quality within Warragamba Dam and the downstream receiving environment
- Considers potential cumulative water quality impacts associated with all construction activities
- Provides further information on the practical measures to avoid, control or mitigate water pollution (including water reuse).

Response

The EIS includes discussion for construction works in various EIS chapters including:

- Chapter 5 Project description
- Chapter 7 Air quality
- Chapter 15 Flooding and hydrology
- Chapter 19 Noise and vibration
- Chapter 22 Soils
- Chapter 23 Sustainability

- Chapter 26 Waste
- Chapter 27 Water quality.

Specifically, Chapter 27 considers potential water pollution impacts (including cumulative impacts) and outlines management measures that can be practically and effectively implemented to manage potential pollution risks.

WaterNSW has not yet engaged a delivery contractor to progress detailed design and construction planning and will not do so before a decision is made on the Project. The delivery contractor will be responsible for preparing a CEMP and relevant subplans (see Appendix D for a draft table of contents and proposed subplans for the CEMP), which will include preparation of a detailed construction methodology. Figure 5-2 in Chapter 5 of the EIS provides the construction footprint, showing location of site facilities and laydown areas.

The detailed construction methodology will define construction staging and further details of construction site layout including material storage, construction water and sediment controls, site construction activities, plant and equipment, and any other related issues. The methodology will include a risk register and identify any specific management or mitigation controls. Outcomes of this will result in the preparation of various site management tools, which will be documented in the CEMP and include method statements (activities and control actions, plant and equipment, specific risks, approvals, training and competencies), Environmental Sensitive Area Maps, Environmental Design Constraint Maps and Environmental Control Maps.

In Chapter 27 of the EIS, WaterNSW provided a list of potential construction activities that relate to dam construction water quality management measures as potential risk areas for water quality controls. The list in the EIS, however, included activities that are either no longer applicable or modified for these specific dam raising works as noted below:

- Controlled blasting: this would occur at the interface with the rock abutments at small, isolated locations only if excavation by mechanical means is unsuccessful. If controlled blasting is required then the appropriate permits, licenses and controls will be implemented in accordance with requirements of the relevant regulatory authorities. Controls for water quality run off from blasting activities will be site erosion and sediment controls directed to treatment facilities prior to any reuse or discharge.
- Underwater excavations: there are no planned underwater excavations. All excavation work is on the downstream side of the dam along the abutments and downstream of the auxiliary spillway.
- Boat ramp construction: there is no requirement for a new boat ramp as the existing one will be utilised as needed.
- Dewatering activities and water diversions: there are no water diversions required for construction works. The dissipator pond at the base of the dam would require constant draining to create safe and dry working conditions to enable the dam wall to be thickened. This would require the construction of a temporary coffer dam downstream of the dissipator pond which would prevent water from the Warragamba River from flowing back into the dissipator pond.
- Use of epoxy resins: this will follow manufacturers recommendations regarding controls for avoiding water contamination.
- Thermal discharges from concrete cooling pump systems: the use of a cooling pipe system during concrete placement for maintaining temperature control has been modified to the use of an ice chiller plant within the concrete batch plant during concrete mix production.

WaterNSW is legislated to ensuring water quality within its operations and continues to undertake extensive water quality monitoring within its catchments, storages, and rivers. WaterNSW applies these requirements in contractual arrangements with our delivery contractors in any capital works program and the same would apply with the delivery contractor for the dam raising project.

WaterNSW has committed to management measures for water quality and would continue to:

- Assess potential impacts on water quality within Warragamba Dam and the downstream receiving environment including cumulative water quality impacts during construction
- Monitor water quality in the storage and downstream river to avoid, control or mitigate water pollution as an existing specific function of WaterNSW operations.

4.6.4 Erosion and sediment control

Issue 1

Approximately 22 hectares of vegetation will be cleared for the construction works. The proponent has committed to erosion and sediment controls to be designed, installed, and operated in accordance with Managing Urban Stormwater: Soils and Construction (Landcom 2004). The EPA notes the drinking water catchment surrounding Warragamba Dam should be considered a 'sensitive' receiving environment as per *Managing Urban Stormwater: Soils and Construction* and enhanced soil and erosion measures should be applied.

Examples of enhanced erosion and sediment control measures include (but are not limited to):

- Stage construction activities so that land disturbance is confined to the minimum area possible
- Use timber windrows during clearing to assist erosion control
- Retain vegetation within flow lines for as long as possible
- Retain groundcover on soils to minimise the potential loss of sediment
- Treat topsoils with a high level of care to enable reuse of soils in rehabilitation phases
- Use surface covers and binders to limit soil loss; and install clean water diversions early and ensure prompt stabilisation and rehabilitation of the site.

Response

Warragamba Dam is Sydney's major water supply source and WaterNSW agrees that the surrounding drinking water catchment is a 'sensitive' receiving environment, and is committed to including erosion and sediment control measures.

WaterNSW's water quality policy is committed to:

- Effectively managing declared catchment areas and water management works in these areas to protect and promote water quality based on a multi-barrier approach
- Supplying water that complies with appropriate water quality guidelines or standards to minimise risks to public health.

Protecting water quality is a key function of WaterNSW water quality operations across all dams in NSW and therefore especially important during construction.

Each year WaterNSW publishes a report describing the results of the water quality monitoring undertaken for the previous 12-month period. The report is provided to meet WaterNSW's statutory obligations under the operating licence however it also provides useful water quality information to the public. This obligation continues for the WaterNSW capital works program on dams and within catchments in contractual arrangements with delivery contractors on projects.

The delivery contractor for Warragamba Dam Raising will be responsible for preparing a CEMP and relevant subplans. Details of erosion and sediment controls such as extent, sizing, types of controls to be installed for soil and erosion measures have not yet been finalised. These will be developed by the delivery contractor(s) during detailed design and construction planning within the construction footprint boundaries identified in Chapter 5 of the EIS. WaterNSW has committed to include a range of management measures including the measures suggested above.

Issue 2

The EIS indicates approximately 183 megalitres of water is required for construction and would generally be sourced from the potable water supply. However, it is unclear if the proponent has considered all reasonable and practical measures to enable greater reuse of water collected within sediment basins to reduce the reliance on potable water.

Response

As noted in the response to the first issue in Section 4.6.2, the expected volume of water required for hydro blasting is five megalitres and not 50 megalitres as identified in Table 1-2 of Appendix N1. This reduces the total volume of water for construction activities to 138 megalitres.

The Project sustainability strategy is discussed in Chapter 23 of the EIS. The intention is to minimise the use of potable water as much as possible through strategies such as water efficient design, reuse and harvesting site runoff. Water use objectives, targets and reporting requirements will be included in the Sustainability Management Plan (SMP).

Issue 3

The EPA recommends that the proponent:

- Provide a water balance that clearly details the predicted frequency, duration, and volumes of water to be discharged under a range of scenarios (including typical and worst case)
- Provides further details on the erosion and sediment control approaches, including enhanced erosion controls and sediment basin sizing
- Considers reuse of any water collected within sediment basins to avoid or minimise discharges and reduce the reliance on potable water
- If stormwater is expected to contain pollutants other than ‘clean’ sediment at non-trivial levels (e.g. oils and grease, metals) additional or alternative treatment measures are recommended to avoid, minimise and mitigate potential water pollution risks
- If construction phase discharges are to occur, the potential impact of those discharges must be considered consistent with the relevant matters under s45 of the POEO Act, including:
  - estimate the expected frequency and volume of discharges
  - characterise the expected quality of each discharge in terms of the typical and maximum concentrations of all pollutants likely to be present at non-trivial levels
  - assess the potential impact of each discharge on the environmental values of the receiving waterway consistent with the national Water Quality Guidelines (ANZG 2018)
  - where relevant, identify appropriate measures to mitigate any identified impacts
- Develops a monitoring program that can inform a Trigger Action Response Plan (TARP). The TARP should include contingencies to identify and manage any unpredicted impacts and their consequences to ensure corrective actions are implemented.

Response

WaterNSW has responded to this issue in the previous responses.

These recommendations will be fully addressed during the detailed design stage, preparation and implementation of the CEMP and sub-plans, and throughout the five-year construction period. Importantly, risk assessment and management will be integral throughout the construction period, which includes ongoing risk identification, mitigation, reporting and auditing

4.6.5 Dissipator pond

The EIS indicates coffer dams established in the dissipator pond could be used to capture runoff from the dam wall construction and hydro-blasting. It is unclear how the proposed water treatment ponds will be managed to prevent discharges to the downstream environment, and how contaminated water within the dissipator ponds will be managed in the event Warragamba Dam needs to release flows.

The EPA recommends that the proponent considers how contaminated water and sediment within the dissipator ponds will be managed if Warragamba Dam needs to release water.

Response

This is considered in Section 27.4.1.4 in Chapter 27 of the EIS. Other than entrained sediment in normal dam release flows down the spillway, there are no planned sources of potential water contamination from the dissipator as it will be kept dry during construction. Normal seepage from gates, dam drainage and groundwater ingress will be collected within the dewatered dissipator and pumped into the site run-off treatment system.

The purpose of the coffer dam, to be installed downstream of the dissipator pond, is to prevent water from the Warragamba River from flowing back into the dissipator pond and works area.

The CEMP (Soil and Water Quality Management Sub-plan) will be developed by the construction contractor and detail the process for developing and implementing area specific soil and erosion measures and construction water treatment during the various construction stages.

4.6.6 Contamination

Issue 1

The EPA notes that the Warragamba Dam viewing platform was previously notified to the EPA under the *Contaminated Land Management Act 1997* (CLM Act). The Soils and Contamination Assessment report did not include further details on this notified site.

Response

Figure 22-3 in Chapter 22 of the EIS identifies the Warragamba Dam viewing platform(purple) to be located at the end of Eighteenth Street and is outside of the construction footprint area. This location would not be used for construction use and will remain accessible to the public for viewing.

Issue 2

The Soils and Contamination Assessment report did not mention if fill materials were used in the areas surrounding Warragamba Dam at the time of its construction. The contamination investigation would benefit from intrusive sampling to verify the desktop study conducted to date.

The Soils and Contamination Assessment report states that the likelihood of widespread contamination is low based on the reviewed documents. However, as no intrusive investigations have been undertaken, ecological and human health risks posed by contamination have not been properly determined.

The EPA recommends that appropriate contaminated site investigations – carried out by appropriately qualified contaminated land consultants – should be completed covering the areas likely to be disturbed as part of the development to determine what remedial and management measures are required. The investigations should assess all relevant media and justify if the proponent believes that groundwater testing is not necessary. Works should also consider whether asbestos is present in any building materials prior to the demolition works.

Response

A Preliminary Site Investigation (PSI) has been undertaken to identify and describe potential contamination on the proposed construction area and adjacent lands. This work was undertaken by an experienced contaminated land professional and reviewed by a NSW EPA-accredited site auditor. The PSI is provided in Appendix H.

WaterNSW has not yet engaged a delivery contractor to progress detailed design and construction planning and will not do so before a decision is made on the Project. As part of the development, a detailed site investigation will be developed by the delivery contractor(s) during detailed design and construction planning within the construction footprint boundaries and adjacent lands.

The PSI identifies various areas of potential fill material as follows:

- Site 2: three asbestos impacted areas and an open landfill area containing drums
- Site 3: demolition fill material from the auxiliary spillway
- Site 4: building demolition fill material on the north-western half of Haviland park
- Site 5(a): two areas of possible filling on the western and eastern parts of the site
- Site 5(b): demolition and landscaping fill materials on the southern part of the site.

A Sampling, Analysis and Quality Plan (SAQP) has been prepared which includes a detailed sub-surface investigation of potential fill areas. The SAQP is also provided in Appendix H.

Issue 3

The following guidance documents cited in the Soils and Contamination Assessment report are out of date:

- Guidelines for Consultants Reporting on Contaminated Sites (OEH, reprinted 2011). There is a 2020 version.
- *Guidelines for the NSW Site Auditor Scheme* (DEC 2006). There is now a 3rd edition, published in 2017.

The Soils and Contamination Assessment report did not identify other guidelines considered under section 105 of the CLM Act.

Response

The updates to the guidance documents listed in the EIS are noted and included in the PSI and SAQP reports as follows.

PSI

- NSW EPA (2020): *Contaminated Land Guidelines: Consultants Reporting on Contaminated Land*
- NEPC: National Environment (Assessment of Site Contamination) Protection Measure (NEPM 2013).

SAQP

- Australian Standard AS4482.1-2005 *Guide the investigation and sampling of site with potentially contaminated soil Part 1: Non-volatile and semi-volatile compounds*
- Government of Western Australia: Department of Health (2009), *Guidelines of the Assessment, Remediation and Management of Asbestos Contaminated Sites in Western Australia*
- NEPC: National Environment Protection (Assessment of Site Contamination) Measure 1999 (ASC NEPM)
- NSW EPA (1995): *Sampling Design Guidelines*
- NSW EPA (2014): *Waste Classification Guidelines, Part 1: Classifying Waste*
- NSW EPA (2020): *Contaminated land guidelines: Consultants Reporting on Contaminated Land*.

Issue 4

It is recommended that a NSW EPA-accredited Site Auditor be engaged for the entire project footprint and throughout the duration of works for this project to ensure that any work required in relation to contamination is appropriately managed, including any unexpected contamination finds, so that there is confidence that the site will be suitable for the proposed use.

Response

WaterNSW does not consider that a NSW EPA-accredited site auditor is required to be engaged for the entire duration of the Project because the contamination risk remains localised and is avoidable from disturbance for the planned construction activities. As noted in the response to the second issue in this section, an EPA-accredited site auditor has been involved in the preparation of the PSI and SAQP.

Work required to manage any disturbance of contaminated soils will be appropriately managed by the construction contractor in accordance with the CEMP and associated protocols (see Appendix B – S1 to S6).

Issue 5

It is recommended that the proponent submit Interim Audit Advice from a NSW EPA-accredited Site Auditor commenting on the nature and extent of the contamination and what further works are required as part of the Response to Submissions report.

The following information should be provided as part of the Response to Submissions report:

- A Sampling and Analysis Quality Plan (SAQP), prepared in accordance with the relevant guidelines made or approved by the EPA under section 105 of the CLM Act to ensure that field investigations and analyses will be undertaken in a way that enables the collection and reporting of reliable data to meet project objectives, including (where applicable) the relevant site characterisation requirements of the detailed or targeted site investigations
- A Detailed Site Investigation (DSI), that investigates the nature and extent of contamination in the soil, and groundwater, to adequately inform what management measures or

remediation would be required to safeguard the environment and people during construction and operation of the proposed SSI
- Interim Audit Advice from an NSW EPA-accredited Site Auditor commenting on:
  - the nature and extent of the contamination; and
  - the adequacy of the Soils and Contamination Assessment (Appendix N1) and the SAQP and DSI once completed, and any other contamination investigations which have been completed for the project.

Response

As noted previously, further site investigations have been undertaken to identify and describe potential contamination on the proposed construction area and adjacent lands. This work was undertaken by an experienced contaminated land professional and reviewed by an NSW EPA accredited site auditor (see Appendix H).

The PSI report builds on information provided in Appendix N1 to the EIS and includes a more detailed review of historical information, including assessing available reports, records, photos, and aerial maps, site inspection and interviewing personnel with knowledge of the area.

The construction area was divided into five distinct areas, which are shown on Figure 4-11. Eight potential Areas of Environmental Concern (AEC) were identified as follows:

- AEC 1: areas near former/existing building structures from weathering and/or ineffective demolition of hazardous building materials
- AEC 2: historical and/or existing equipment storage areas (from weathering of equipment stored on unsealed ground for long periods) and historical construction areas (e.g. from equipment/machinery leaks and/or other general construction practices)
- AEC 3: areas of stockpiling/filling (from materials of unknown origin and/or quality
- AEC 4: fuel storage/re-fuelling from possible leaks and/or spills (at the helicopter pad and near a back-up generator)
- AEC 5: an electrical transformer within Site 3 from possible leaks/spills of insulation oils
- AEC 6: contamination containment cell located within Site 1 and known asbestos contaminated area located immediately off-site (to the east) of Site 2
- AEC 7: area of potential metal contamination associated with former grit blasting activities within Site 1
- AEC 8: core park road dump area (from potential presence of wastes such as drums) - note that this area is outside of the construction site domain and will not be disturbed.

Potential AECs were classified from low to high concern, with most areas classified as moderate concern. A preliminary conceptual site model was prepared, and plausible source-pathway-receptor linkages identified.

Based on the PSI findings, further stages of investigation are recommended. These are detailed in the SAQP in Appendix H.

WaterNSW proposes that a detailed site investigation (DSI) would be undertaken by the delivery contractor before the commencement of construction. The DSI would be undertaken in accordance with the SAQP with oversight by a NSW EPA-accredited site auditor.

The PSI has been reviewed by a NSW EPA-accredited site auditor who has confirmed that there is sufficient information to accurately characterise potential contamination risks. The auditor has also endorsed the adequacy of the SAQP. As noted above, the DSI would be undertaken in accordance with the SAQP, with oversight and sign-off by a NSW EPA-accredited site auditor.

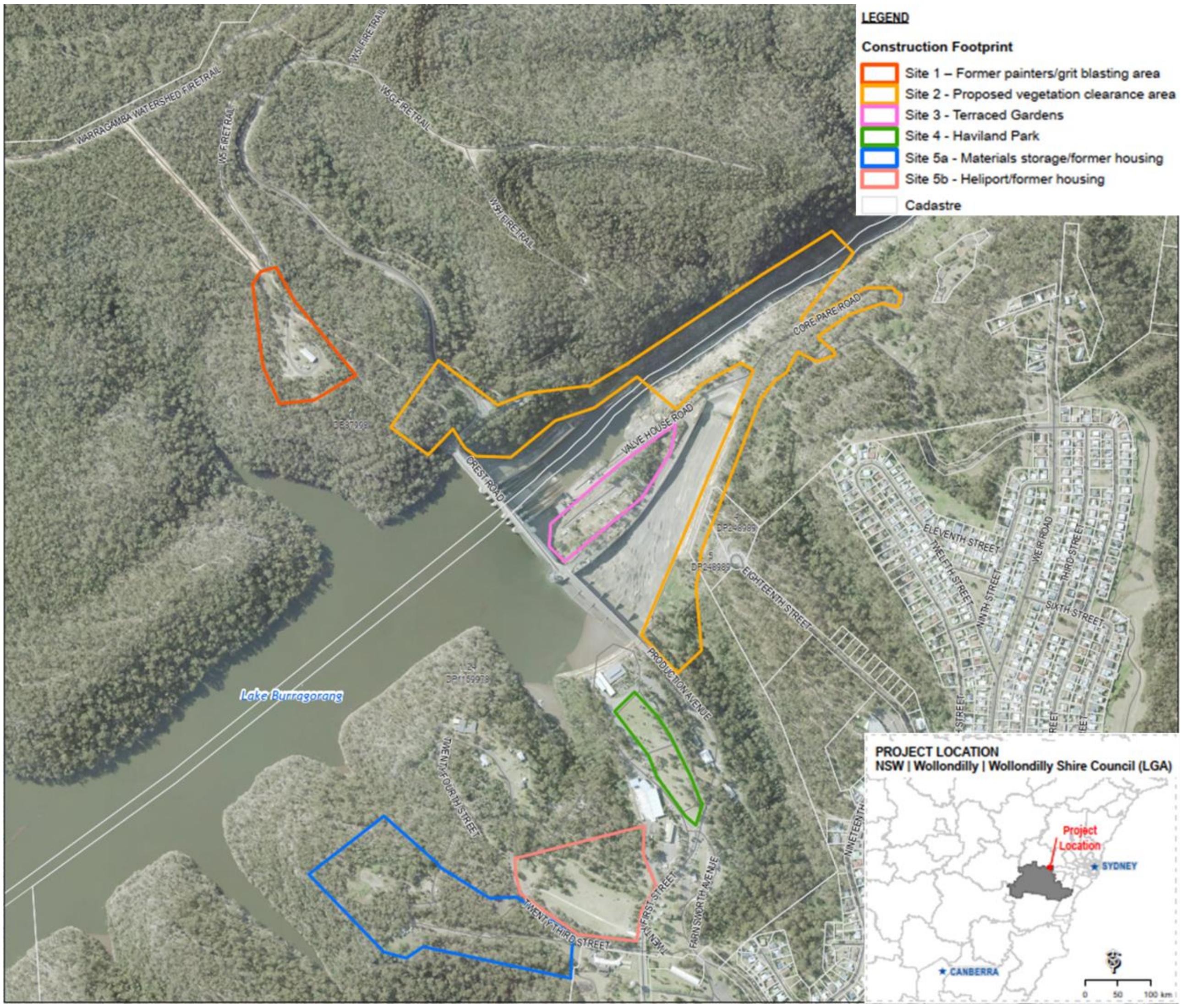


Figure 4-11 Construction footprint

4.6.7 Noise and vibration

Issue 1

The EPA has reviewed the Noise and Vibration Impact Assessment (NVIA) and generally considers it to have satisfactorily considered construction impacts.

Response

WaterNSW notes the advice from the EPA that the NVIA has satisfactorily considered construction impacts.

Issue 2

The predicted construction noise levels at sensitive receivers provided in Section 5.2 of the NVIA may be approximately 1 dB to 2 dB higher than those shown if a more conservative 50 percent ground absorption factor is adopted. While this is not expected to substantially change the outcomes of the assessment, all feasible and reasonable noise mitigation and management measures should be implemented to address any additional impacts arising from this change.

Response

The CEMP will include a Construction Noise and Vibration Management Plan (CNVMP), which is discussed in Chapter 19 of the EIS. The plan will include processes and responsibilities to assess, monitor, minimise and mitigate noise and vibration impacts during the various construction stages.

Issue 3

The EPA expects that the existing traffic volumes along Warradale Road will be lower, resulting in more appreciable noise increases/impacts at receivers along this section. It is recommended the proponent implement all feasible and reasonable noise mitigation and management measures to address any construction traffic noise impacts along the southern access route, particularly along Warradale Road and leading into Warragamba.

Response

WaterNSW confirms that the CEMP will include a CNVMP which will include feasible and reasonable noise mitigation and management measures. These measures will also be referenced, as relevant, in the Traffic Management Plan (TMP).

Issue 4

The EPA notes that the proposed construction activities associated with this project are predicted to significantly impact many receivers in the surrounding community for both daytime and out-of-hours works. Construction traffic noise is also likely to affect some receivers along the proposed transport routes. The proponent should implement all feasible and reasonable noise mitigation and management measures to address these impacts, as outlined in Section 7 of the NVIA.

Response

WaterNSW confirms that the CNVMP and TMP will also provide the framework for preparing area specific management plans, including identifying traffic routes and sensitive receptors, operational restrictions and consultation.

Issue 5

EPA's recommended noise and vibration conditions of approval covering construction hours, blasting, and the application of reasonable and feasible mitigation measures.

Response

It is anticipated that should the Project be approved, these matters would be captured in conditions of approval relating to preparation of the CEMP and relevant sub-plans, and will include ongoing compliance tracking and reporting.

4.7 Sydney Water Corporation

Responses to comments provided in Appendix 1 to Sydney Water's submission are provided in Section 4.7.4. Duplicate issues have not been addressed.

4.7.1 E-flows and water quality at North Richmond

Issue 1

Sydney Water notes that the project enables e-flows but does not assess their impacts (positive and negative fully) with a view that this was completed in the Metropolitan Water Plan 2017 to some extent, and would recommend that it be reviewed as part of work associated with the future Water Sharing Plan.

Currently, Sydney Water does not shut down North Richmond for anything except large flood events, so it is unlikely that environmental flow releases will significantly impact the operation of North Richmond from a water quality perspective. Increased flows through the river are likely to reduce algae.

Response

WaterNSW notes the advice from Sydney Water and considers no further response is required.

Issue 2

Changes in flow regimes (in addition to environmental flow releases) need to be assessed for impacts in terms of quality and production capacity at North Richmond.

Response

The principal changes to flow regimes due to the Project will be associated with operation of the FMZ. The assessment of potential impacts on water quality from changes to flow regimes have been addressed in Section 27.5 of the EIS that concluded

> *In summary, there would be negligible impacts on the downstream environment from the changes in water quality from the FMZ discharges.*

The operation of environmental flows does not form part of the Project. Water releases under an environmental flow regime would not occur when the dam is in flood operations mode.

4.7.2 Prospect/Warragamba/Orchard Hills impacts

Issue 1

Sydney is already exposed to risk of a boil water alert during high flow events through Warragamba, as seen in recent flood events. Generally, this is caused by high turbidity/colour in the dam resulting in an inability to treat water to the right standard and/or an impact on capacity of the plants due to the poor-quality water.

Based on the understanding Sydney Water has of the release regime, the general intent is to release floodwater at a slower rate. Previously, overtopping of the dam would rapidly discharge poorer quality water. This will now be held back with water stored in the dam for extended periods, risking a more prolonged exposure of the water filtration plants to poor quality feed water, impacting the treatment plant's ability to operate at capacity and increasing chances of failure to supply water and the need to boil water. It is very difficult to forecast the magnitude of the impacts as all events in the dam are specific and discharging water over the dam wall is just one mechanism used to manage poor quality water. Changes in water depth and impacts of stratification are difficult to quantify, but based on the approach outlined, the existing risks will likely be increased.

Response

The risks associated with periods of poor water quality (caused by high turbidity inflows as evidenced in the 2021 and 2022 inflow events) in Lake Burragorang is an ongoing issue and will not fundamentally change with the Project. The extent of impact that the high turbidity inflow has on the lake and in turn offtake selection is both seasonal and event-dependent.

Section 27.5.2 in Chapter 27 of the EIS addresses how inflows enter the lake and water quality is managed. Inflow events that occur in the winter months sees water enter and then accumulate low down in the storage. As the accumulating volume increases, this displaces cleaner water in the upper layers higher in the water column which can be discharged downstream through the spillway when the lake level rises above FSL. During these inflow events, offtake selection of water for drinking purposes is made from the cleaner surface water layer. For winter events, inflows with elevated turbidity are generally captured within the storage. It can take from weeks to months for water quality parameters to reduce to pre-event levels.

The inflow processes will remain unchanged with the Project. Inflows accumulating in the lower levels will continue to displace cleaner water in the upper layers into the FMZ. This will be discharged downstream by a drawdown process within two weeks. A benefit of the raised dam is that as the lake level rises and moves into the FMZ, the ability to 'follow' the rising water level and place screens higher in the water column while maintaining the minimum distance from the surface will be available to the dam operators. For a winter-based event, the impacts of poor water quality (high turbidity) with flood mitigation will be the same as with current operations.

Inflow events that occur in the summer months enter in the surface layer. During these events, inflows will accumulate in the surface layer. As the accumulating volume increases above FSL, water is discharged downstream through the spillway. During these events, offtake selection of water for drinking purposes is made from the cleaner water layer lower down. This means that the volume of inflow with elevated turbidity up to FSL would be captured within the storage. It can take from weeks to months for the water quality parameters (turbidity) to reduce to pre-event levels. This is evidenced with in-lake water quality three months post the March 2022 event yet to return to pre-event levels. It is anticipated that with flood mitigation the time to return to pre-event levels (turbidity) would be marginally extended.

In both current and flood mitigation modes, selective withdrawal is used to supply the best available raw water for drinking water purposes. This is and will continue to be informed by the real time water quality monitoring program and modelling systems.

A further benefit of flood mitigation is that the syphoning effect caused by discharge over the drum which tends to lift sediments up through the water column and impact selective withdrawal will be mitigated. Delaying releases will give more time for sediments to settle and reduce risk on the selective withdrawal process.

Issue 2

There are potential opportunities to actively manage the water quality through more targeted release through the e-flows line. Modifying locations of take-off and selecting specific layers for river discharge via the environmental flows infrastructure could be a way to manage poor quality events. This is recommended to be included in design and operation to ensure that the potential to manage water supply risk is maximised.

Response

WaterNSW notes the advice from Sydney Water and will be considered as part of the design and operation to ensure that the potential to manage water supply risk is maximised.

4.7.3 Requested clarifications

4.7.3.1 Executive Summary

On page 15, it is noted that 'during most of the construction phase, the maximum water level of the dam will need to be maintained at around five metres below full supply level to allow construction activities to operate safely'.

Sydney Water notes that a five metre reduction in full supply level (FSL) is equivalent to an estimated 18% dam capacity. Depending on the duration of construction, this could have an impact on yield for Sydney Water's drinking water supply. Construction is expected to take about five years. his could substantially increase operation of the Sydney Desalination Plant or accelerate major bulk water upgrades. Reflections of this cost impact will need to be assessed.

Response

The temporary reduction in full supply level of five metres to accommodate the construction of the dam raising has been considered in the NSW Government's *Greater Sydney Water Strategy*, which articulates the plans for securing ongoing water supply for the city.

4.7.3.2 Chapter 5 Project description

Chapter 5 of the EIS notes there may be a 30 percent drop in volume for Greater Sydney storage due to the lowering of FSL by 12 metres. Sydney Water would welcome a detailed comparison between the options, including the option to reduce the FSL, and assist Water NSW in informing and normalising any alternative options that are being considered from a resilient and reliable water supply perspective.

Response

The NSW Government adopted the Taskforce flood strategy recommendations in 2016 which included raising the dam for flood mitigation purposes. The EIS assessments are based on the recommendation to raise the dam for flood mitigation.

Section 4.3 in Chapter 4 of the EIS provides a detailed summary of the options considered by the Hawkesbury-Nepean Valley Flood Risk Management Strategy Taskforce. This included consideration of reducing the FSL by five metres or 12 metres to create a dedicated FMZ, and which is discussed in detail in Section 4.4.1 of the EIS.

If an alternative of lowering the FSL permanently was adopted, greater Sydney's water supply system would incur major additional investment and operating costs to replace the lost water supply storage. Reducing the available storage at Warragamba would result in additional water being drawn from alternative sources which are considered in the NSW Government's *Greater Sydney Water Strategy*, which articulates the plans for securing ongoing water supply for the city.

4.7.3.3 Chapter 27 Water quality

Issue 1

Currently Sydney Water can source select from the top to the bottom of the dam. With the raised wall, does this mean Sydney Water will not be able to extract from the top when water is stored for flood attenuation (i.e. current outlets will/will not change)?

Response

WaterNSW will continue to work closely with Sydney Water to meet its needs in the provision of a high quality raw water supply. There will be no change to the existing levels at which water can be drawn from or to the configuration of the current offtake works.

Issue 2

During some events, the flood water skims across the surface of the dam and is released. In others, the flood water enters the dam lower in the storage and the better quality water is above the flood layer. Will water be released from the surface (i.e. top percent of the dam) or what level will it be released from?

Response

Temporarily stored inflows that exceed FSL will be released from the 'surface' through the gated conduits. WaterNSW will continue to work closely with Sydney Water to meet its needs in the provision of a high quality raw water supply.

Issue 3

Sydney Water is heavily dependent on adjusting the offtake to Prospect/Orchard Hills/ Warragamba water filtration plants to manage water quality. It is critical that this is provided for.

Response

There will be no change to the configuration of the outlet works for Sydney's water supply with the Project. WaterNSW will continue to work closely with Sydney Water to meet its needs in the provision of a high quality raw water supply.

Issue 4

Sydney Water understands the e-flows release will allow for release from 17 layers of the dam. It would be beneficial if these release layers could be adjusted with the function of releasing poor quality water as required from the dam to protect the water supply.

A further improvement would be to enable connection of the Warragamba pipelines to the e-flows 17-layer offtake arrangement.

Response

The e-flows infrastructure flow regime is to mimic the flow of the river if the dam was not in place and is not for water supply to Prospect WFP.

The e-flows outlet infrastructure will not be connected to the water supply pipelines.

Issue 5

Can it be confirmed that the proposed offtakes to Prospect WFP will remain the same as the current?

Response

WaterNSW confirms that the current configuration of the offtake to Prospect WFP will remain the same.

Issue 6

In Section 27.5.3 which discusses upstream water quality, Sydney Water recommends that where adjustments to treatment processes are referenced, it should be noted that there are additional costs, potential customer impacts (e.g. temporary changes in taste) and even likely to be additional treatment plant upgrades required where the cost would ultimately have some impact on customer's bills. It may be beneficial (changed from necessary) to modify operation of the dam wall raising until such time as suitable treatment upgrades can be implemented.

Response

The timing for WaterNSW to operate the dam with a new flood mitigation function would be determined by the appropriate regulatory authorities.

Issue 7

Table 27-8 summarises key finding and outcomes over the past 15 years. Adding known Sydney Water treatment plant incidents such as extended issues at Prospect WFP after 2012/13 and after February 2020 would be a useful addition to the table.

Response

WaterNSW notes the advice and suggested addition.

4.7.4 Appendix 1 to Sydney Water submission

Note: issues are ordered as per EIS structure.

4.7.4.1 EIS Executive Summary

Issue 1

Please note the potential impact on the North Richmond water delivery system (e.g. disruption in supply and potential for additional upgrades and/or loss of water supply to customers).

System storages are limited and could empty (i.e. loss of water supply to customers) with a longer duration flood with reduced treatment plant production due to poor raw water quality and/or flooding of key infrastructure (e.g. pumps to the water filtration plant, connecting pipework from the North Richmond plant across the bridge to the rest of the system etc).

Amendment recommended: please note that there is a heightened risk of loss of water supply to customers in the local area during an extended event but that this is offset by the reduced damage to property and loss of life (please clarify if this is the case) and efforts would be made to limit the impact of flood waters on key crossings (including connections for essential services such as water) and control the quality of discharge from Warragamba Dam to help Sydney Water to maintain supply to customers in the North Richmond delivery system.

Response

The objective of using the dam for flood mitigation is to reduce risk to life and property damage. There are already flood incident management procedures and controls in place to manage flood water impacts in the valley, including key crossings, which would continue with the new flood mitigation function available from the dam raising. The quality of FMZ discharge water is a function of the time taken to draw down the FMZ back to FSL.

Issue 2

A five metre reduction in FSL is equivalent to an estimated 18 percent of dam capacity ... depending on the duration of construction this could have an impact on yield for Sydney's drinking water supply ... construction appears to take about five years from the start (reference note on p14 above Figure 11 in Exec Summary) ... this could substantially increase operation of the Sydney Desalination Plant or necessitate the need to accelerate major bulk water upgrades and it would be good to reflect the cost impact of this.

Please also reference the sections where construction controls are captured to minimise the risk of contamination of the dam (e.g. runoff through construction site, management of spills, leaching of concrete etc.).

Response

The temporary reduction in full supply level of 5 m to accommodate the construction of the dam raising has been considered in the NSW Government's Greater Sydney Water Strategy (August 2022), which articulates the plans for securing ongoing water supply for the city.

The need to increase the operation of the desalination plant or accelerate bulk water upgrades would depend on a multi-year dry period occurring during the construction period sufficient to draw the storage down to levels that trigger these measures. These matters have been considered and comprehensively covered in the NSW Government's *Greater Sydney Water Strategy* which articulates the plans for securing ongoing water supply for the city.

Early works prior to construction will include the installation of environmental controls including those to manage risks to water quality (refer Section 5.4.6.1 in Chapter 5 of the EIS. The CEMP will include management measures to minimise and manage water quality impacts (refer management measure WQ2).

Issue 3

Figure 13 (Project description): This is throughout each of the relevant diagrams in the EIS. It does not seem that there should be change to dry weather inundation level, however the diagram implies this would be the case. I assume it relates to the role of the drum gates but we request that this be clarified.

Response

It is unclear what is meant by 'dry weather inundation level', however, if this is referring to FSL, this would not change with the Project as stated in Section 5.2.7 of the EIS.

Issue 4

Given that more rainfall events would be retained by the project, and for longer, we do not think the area from FSL to 2.8 metres above FSL is unaffected. The maximum duration of inundation changes from 4 to 10 days, thus the impacts of inundation in this range would differ from current state.

Response

WaterNSW undertook the necessary engagements with agencies on the various methodologies and approaches to be implemented in delivering the outcomes required to respond to the SEARs. One of these was establishing an assessment framework to address the infrequent and variable nature of flood events in depth and duration for the upstream area. The identification of an upstream impact area is to recognise the probabilistic basis of flooding and variable extent of affected land. The approach reached is clearly presented in the EIS and resulted in the defining of the Project Upstream Impact Area.

The EIS has described this area between 2.8 metres above FSL (RL 119.5 mAHD) and 10.27 metres above FSL (RL 126.97 mAHD).

4.7.4.2 EIS Chapter 5 Project description

Sydney Water would welcome a detailed comparison between the options including the option to reduce the FSL and assist WaterNSW in informing and normalising any alternative options that are being considered – from a resilient and reliable water supply perspective.

Response

WaterNSW refers to Chapter 4 of the EIS which draws extensively on the *Hawkesbury-Nepean Valley Flood Risk Management Strategy Taskforce Options Assessment Report* (Taskforce Options Assessment Report) published by Infrastructure NSW in January 2019. This report includes detailed comparisons of options. The Hawkesbury-Nepean Valley Flood Management Taskforce was established by the NSW Government in 2014 and has extensively assessed alternatives and options for flood mitigation including options to lower the full supply level and height options for raising the dam. The Taskforce found that the most effective and efficient infrastructure option to reduce risks to life and property from flooding is to raise the Warragamba Dam to provide a flood mitigation zone of around 14 metres.

WaterNSW also notes that this finding has been subsequently confirmed by the *Greater Sydney Water Strategy* which endorsed Infrastructure NSW's assessment and highlighted the relative costs of alternative options.

4.7.4.3 EIS Chapter 27 Water quality

Issue 1

EIS Section 27.2.4.1: The impact of inundation is covered in a lot more detail in Section 27.5.3 – could we reference the later chapter for more detail re NOM etc so that readers know that the impact of inundation (as opposed to runoff) has been considered in addition to the surrogate events.

Response

WaterNSW notes the advice and considers no further response is required.

Issue 2

EIS Section 27.2.4.1: Expanding on the above comment – the report only considers degradation in water quality in terms of the effects of inundation. An additional impact is the increased need to store water in the dam for an extended period, potentially prolonging the impact of degraded water quality on treatability of dam water, and therefore prolonging the risk of a boil water alert for Sydney. Additional attention is needed with respect to the ability to offtake water of different quality either for river discharge or for supply to the Warragamba Pipelines.

Response

WaterNSW will continue to work closely with Sydney Water to meet its needs in the provision of a high quality raw water supply. The quality of FMZ discharge water is a function of the time taken to draw down the FMZ back to FSL.

4.8 NSW Health

4.8.1 Drinking water quality

Issue 1

NSW Health has concerns for drinking water quality during construction and operation of the flood mitigation works proposed. Warragamba Dam was built for drinking water and holds approximately 80 percent of the drinking water supply available to Sydney. Any impact on the water quality in the dam either during construction or operation could be critical to the safe delivery of drinking water in Sydney.

Response

WaterNSW's water quality policy is committed to:

- Effectively managing declared catchment areas and water management works in these areas to protect and promote water quality based on a multi-barrier approach
- Supplying water that complies with appropriate water quality guidelines or standards to minimise risks to public health.

WaterNSW is legislated to ensuring water quality within its operations and continues to undertake extensive water quality monitoring within its catchments, storages, and rivers. WaterNSW applies these requirements in contractual arrangements with our delivery contractors in any capital works program and the same would apply with the delivery contractor for the dam raising project.

Each year WaterNSW publishes a report describing the results of the water quality monitoring undertaken for the previous 12-month period. The report is provided to meet WaterNSW's statutory obligations under the operating licence however it also provides useful water quality information to the public.

WaterNSW provided a detailed assessment of potential impacts on water quality with regard to construction activities in Section 27.4 in Chapter 27 of the EIS, and acknowledges the critical role that Warragamba Dam plays in Sydney's water supply security. WaterNSW has committed to a comprehensive range of management measures to effectively manage risks to water supply during construction (refer Appendix B of this report). This is also addressed in responses provided in Section 4.6 of this report.

Section 27.5 of Chapter 27 similarly provides a detailed assessment of potential impacts on water quality with regard to operation of the Project. Discussion is supported by Appendix Q (Water Quality Statistical Analysis) to the EIS. This is also addressed in responses provided in Section 5 of this report.

Section 27.5.2.3 (Current management systems) in Chapter 27 provides a detailed description of existing management systems, practices and procedures that WaterNSW uses to manage water quality in the dam and specifically raw water supply for drinking water purposes. WaterNSW recognises the need for, and commits to management measures that will be required due to operational impacts by the Project (refer Appendix B of this report). These include the following:

- Continuation, monitoring and, where necessary, modification of water quality management measures to address operational impacts of the Project (WQ1)
- Updating the Sydney Catchment Aquatic Real-time Management System (SCARMS) and the Sydney Catchment Aquatic Real-time Information Support System (SCARISS) to include the raised dam, new outlets, and operation of the FMZ (WQ5)

- Review and updating as required of the Catchment to Customer Risk Assessment to reflect any new or changed risks to the quality of raw water supply for drinking water purposes from the operation of the FMZ (WQ6).

Issue 2

One of the key controls at the dam is the ability to draw water from multiple offtake depths, selecting the best quality to be supplied for treatment. Should the dam need to be operated at a lower level during construction this would limit the ability to avoid poor quality water in the dam by changing offtake depth. Construction activities may also reduce water quality in the dam. The EIS notes that water quality risks from demolition and construction are high if not managed correctly.

Response

The depth that water is extracted to supply drinking water is varied by alternating a screen and stopboard configuration upstream of the dam. The strategic altering of the screens in response to seasonal and event-based changes in water quality ensures the best available water quality is always supplied.

WaterNSW manages source selection on behalf of Sydney Water with the draw off level ranging from FSL to 62 metres below FSL. While the maximum water level would be reduced by five metres during construction, there would still be 57 metres in the water column from which to draw water from.

WaterNSW will require the construction contractor to ensure that access is available for screen changes and this process will be formalised during the detailed design process.

While the water available for supply may be reduced due to the lower level of operations during construction, the water supply quality will be managed as outlined in environmental management measure WQ1.

The risk to water quality from construction activities is recognised and addressed through environmental management measures WQ2 and WQ3 (refer Appendix B) and in responses provided in Section 4.6 of this report.

Issue 3

The EIS reports that during operations for flood mitigation, the extra water held back by the higher wall would need to be released within a period of hours to up to two weeks to prevent ecological damage in the forests along the lake shores. Periodic inundation of the additional catchment area during flood operations is likely to affect water quality in the dam by increasing turbidity, colour and organic material. Inflows will enter the dam at different levels depending on hydrological conditions and may impact the ability to select water of a quality that is treatable. Assessment of the ability for Sydney's water filtration plants to treat water of a lower quality should be made as this could impact the ability to produce sufficient safe drinking water.

Response

The Project would result in an increase in level of periodic temporary inundation above the full supply level due to flooding events, principally around the margins of Lake Burragorang. Further clarification regarding potential changes to hydrology and flooding is provided in Appendix D to the PIR, and water quality impacts are discussed in Chapter 27 of the EIS.

Table 27-16 in Chapter 27 assesses the upstream operational impacts in the raised dam both qualitatively and quantitatively based on the condition of the dam at the time of assessment and available historical data. Overall once mitigation measures proposed are implemented the residual risk has been assessed as low or no change from existing.

Furthermore, the potential influences on drinking water quality already exist and are effectively managed through a range of water quality management measures. Management measure WQ1 provides for the continuation, monitoring and, where necessary, modification of these measures to address operational impacts of the Project.

Additionally, to ensure that raw water quality can be maintained, WaterNSW is committing to management measures WQ4, WQ5 and WQ6 to address the additional changes and monitoring that will be required for the raised dam.

Issue 4

It is recommended that the proponent provide more details of potential management options during construction and operations, and consult with Sydney Water to ensure that impacts on drinking water quality can be adequately mitigated.

Response

Management measure WQ2 addresses inclusion of management of potential water quality impacts during construction as part of the CEMP. Should the Project be approved, this would be prepared by the delivery contractor and would include consultation with relevant stakeholders, including NSW Health and Sydney Water. Further details are provided in responses in Section 4.6 of this report.

As previously noted, management measure WQ1 provides for the continuation, monitoring and, where necessary, modification of existing water quality management measures to address operational impacts of the Project. This will include continued consultation with NSW Health and Sydney Water as required.

4.8.2 Health and socio-economic impacts

The EIS indicates that the proposal will not eliminate all flooding downstream, so planning control measures on floodplain development will still be required to protect vulnerable communities.

Response

Implementation and maintenance of planning control measures downstream of Warragamba Dam is a separate matter to the Project. This is managed by DPE and TfNSW as part of the Hawkesbury-Nepean Valley Flood Risk Management Strategy Outcome 3 *Strategic and integrated land use and road planning*.

4.8.3 Air quality, noise and vibration

Impacts to air quality, noise and vibration during construction will need to be managed to prevent health impacts for nearby communities.

Response

This is acknowledged in the EIS through the various environmental management measures identified in Chapter 29, Tables 29-7 and 29-15, and in the updated list of environmental management measures provided in Appendix B to this report.

4.9 Transport for NSW

4.9.1 Construction traffic and impacts

Issue 1

Appendix O *Traffic and transport assessment* does not provide information regarding Silverdale Road (unclassified regional road)'s current upgrade project nor accounts for its impact in this report. Silverdale Road Safety upgrades Stage 2 (which covers the section of Silverdale Road used for construction vehicles movements by this proposal) has begun construction as of September 2021 and is expected to be completed in Q4 2022 therefore impacting the throughput and performance of the road at this section.

Response

WaterNSW understands that the Silverdale Road Safety Upgrades Stage 2 project is expected to be complete in Q4 2022[26]. Should the Warragamba Dam Raising Project be approved, construction would commence after this time. There would therefore be no impact on throughput and performance of the road at this section at time of project construction.

Issue 2

There will be likely growth of traffic along Park Road due to the development and operation of Western Sydney Airport and the new precinct at Bradfield. The EIS traffic study should address this anticipated growth.

Response

WaterNSW has reviewed available information, such as the Western Sydney Airport and Sydney Metro–Western Sydney Airport EISs as part of the traffic and transport assessments. Neither EIS forecasts an increase in traffic on Park Road. While there would be an increase in traffic on The Northern Road (with all stages of the upgrade being completed in 2021), traffic resulting from these projects would bypass the Park Road/The Northern Road intersection and would use the new section of road.

Issue 3

EIS Appendix O, Table 7.2 provides a high-level contingency plan. With respect to the proposed contingencies for pavement failure at the Blaxland Crossing bridge, it is recommended that a detour plan excluding Park Road and the subsequent bridge route be prepared.

Response

WaterNSW commits to complete the intersection upgrade works prior to commencement of construction as outlined in Section 4.3.1 in Appendix O to the EIS.

WaterNSW has undertaken a search of project documents for the auxiliary spillway project for information on the temporary signalisation of the intersection of Warradale Road and Production Avenue, however, was unable to locate any such information. After the project was completed in 200,1 a number of temporary buildings, including the project site office, were lost to fire and many records were destroyed.

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[26] https://www.wollondilly.nsw.gov.au/shire-projects/council-projects/silverdale-road-safety-upgrades/stage-1-silverdale-road-safety-upgrades/

Issue 4

TfNSW seeks clarification regarding the potential impacts on road capacity ahead of a flood event and the proposed ceasing of construction activity to ensure evacuation roads in the Wallacia floodplain are available at full capacity in the event of a flood. Traffic Management Plans will need to be discussed as part of the emergency strategy.

Response

Section 5.4.6.2 in Chapter 5 of the EIS notes that early works for construction would include maintaining a lower full supply level during construction of approximately five metres below FSL. This will provide a safety time buffer for clearance of construction activities from the central spillway and dissipator ahead of forecast spills.

The existing communication protocols between agencies prior and during a flood event will include the delivery contractor. These agencies are WaterNSW, SES and the BOM.

The delivery contractor will have Emergency Response Procedures (ERP) for flood risk in place as agreed with the agencies. A key outcome of the ERP will be to reduce construction personnel attendance to site should a likelihood of a spill increase as informed by forecast advice from the BOM and WaterNSW. This will alleviate road capacity risk as construction traffic will be significantly reduced from hours to 2 days prior to the event, leaving sufficient road capacity for local population evacuation that require movement through Wallacia.

Table 24-21 in Chapter 24 of the EIS also lists a range of management measures that would be implemented to manage and mitigate traffic-related impacts from the Project. Management measure TT1 addresses preparation of a CTMP and includes a contingency plan to manage traffic in the event of road closures due to emergencies such as significant flooding. This has been amended to include consultation with relevant roads authorities, including TfNSW, during preparation of the CTMP (refer Appendix B).

4.9.2 Impact on closure of major roads

Appendix O, Section 5.2.2 discusses the Project's impact on major road river closure times due to flooding. This indicates that four bridges are severely impacted by the Project. It is noted that the only mitigation proposed is detour arrangements to mitigate these delays. TfNSW would like to understand if there have been any other mitigation measures explored other than detour arrangements.

Response

The focus of the Project is to prevent loss of life and damage to property through reducing the flood peak. This also means that less of the road network will be impacted by flooding. However, the prolonged releases will increase closure times for some low-lying bridges during infrequent but large flood events.

WaterNSW considers that when a bridge is no longer safe to pass from flood waters that the appropriate safe mitigation measure would be to redirect traffic along alternative routes that were unimpeded by flood waters and safe to travel. Section 24.4.3.3 in Chapter 24 of the EIS provides discussion on the alternative routes explored by WaterNSW.

TfNSW has noted in its submission that it is responsible for other outcomes of the Infrastructure NSW HNVFMR strategy including appropriate evacuation routes which would better inform alternate routes.

Mitigation measures other than detour arrangements, as is the current practice in flood events, have not been explored.

4.9.3 Traffic modelling

Traffic modelling for the base condition is based on traffic surveys conducted in 2018 with future year modelling based on 2022. Given that the construction period for this project is set to occur between 2022-2025, it is recommended that the traffic modelling and analysis be updated to reflect the volumes and conditions for these years.

Response

Table 24-10 in Chapter 24 of the EIS indicates that in 2022 all intersections with and without Project-related traffic would operate at Level of Service (LOS) A in the AM and PM peaks, except for The Northern Road/ Park Road intersection which would operate at LOS B. Section 3.2.4 in Appendix O, includes a 3.5 percent annual growth rate applied to 2018 surveyed traffic volumes to estimate 2022 base traffic volumes to estimate the construction year 2022 traffic and to capture any additional traffic from future planned development. WaterNSW considers that the assumed annual growth rate is high, and conservative, and reasonable given that the NSW average is 1.6 percent annual growth rate. In view of this, further traffic modelling is not considered necessary at this time.

Construction of the Project, should it be approved, would commence after 2022 and it is not envisaged that an increase in background traffic volumes due to the later construction start date would result in significant deterioration of intersection performance, given all intersections are predicted to be operating at LOS A in 2022, except The Northern Road/ Park Road intersection, which is predicted to be operating at LOS B.

4.9.4 Purpose of the Project

TfNSW supports the overall flood risk management strategy to reduce risk to life and property.

Response

WaterNSW notes the support expressed for the flood risk management strategy.

4.9.5 Flood management strategy

TfNSW supports the overall flood risk management strategy to reduce risk to life and property.

Response

WaterNSW notes the support expressed for the flood risk management strategy.

4.9.6 Flood modelling

The flood modelling being developed by TfNSW can consider a variety of HNV regional flood scenarios. TfNSW seeks clarification regarding the potential impact on regional evacuation road capacity during controlled releases from the dam.

Response

Section 24.4.3 in Chapter 24 of the EIS and Section 5.2.1 in Appendix O to the EIS discuss potential impacts of the Project on downstream transport and road corridors. This notes that, depending upon the location and relative height of the road or transport corridor, the changes in downstream flooding due to the Project would have different impacts depending on downstream locations of TfNSW assets. A key objective of the Project is to delay peak flooding downstream to allow evacuation routes to remain open for longer and to provide increased opportunity and additional time for a greater number of people to self-evacuate via road.

Table 24-13 in Chapter 24 provides the extended estimated durations that river crossings will be closed compared to the closing times that occur with flood events from the existing dam. These extended durations of closures would be similar for extended closure of roads leading to and from these river crossings. The assessment focusses principally on changes to bridge closure time of key river crossings rather than the capacity of evacuation routes as the former is the more critical issue for initial evacuation

The assessment notes that once the peak of a flood event has passed and emptying of the FMZ has commenced, low-level flooding would occur until the FMZ was emptied. The majority of the FMZ would be emptied at a constant rate of about 100 gigalitres a day for up to 12 days, which may result in the extended closure of some crossings, particularly those with a low level relative to a waterway.

The extended duration of bridge closures was modelled with flood operating rules that incorporate the FMZ function guided by the operating objectives (the first priority being dam safety) outlined in the EIS. TfNSW would be informed of the extent of closures for bridges, similar to the existing flood operations, in coordination with the SES and the BOM. Each flood event varies in depth and duration and the assumed extended durations are modelled against defined flood frequencies. There could be events between these defined flood frequencies where extended durations will vary as to the extent of time a bridge is closed, as was the case for the three recent flood events in March 2021, March 2022, and July 2022.

4.9.7 Evacuation impacts

TfNSW notes that the forecast reduction in risk to life and property from increased evacuation times. TfNSW supports the overall flood risk management strategy, to reduce risk to life and property.

Response

WaterNSW notes the support expressed for the flood risk management strategy.

4.9.8 Social impacts

TfNSW supports the overall flood risk management strategy to reduce risk to life and property.

Response

WaterNSW notes the support expressed for the flood risk management strategy.

4.9.9 Economic impacts

TfNSW supports the overall flood risk management strategy, to reduce risk to life and property. However, the forecast increase in flood duration from controlled releases could cause potential disruption to TfNSW operations and assets across the HNV. TfNSW requests further information on this aspect.

Response

WaterNSW notes that the aspect of extended flood duration of TfNSW river crossing assets are discussed in Section 24.3 in Chapter 24 of the EIS. Refer also to the response provided in Section 4.9.6.

To assist TfNSW with its responsibilities, WaterNSW also refers TfNSW to Table 24-13 in Chapter 24 of the EIS, which provides a detailed summary of 12 major road crossings affected by existing flooding for nine different flood events, and shows how the Project would affect the duration of closure times. Of the 12 crossings, three (Cattai Creek Bridge, Yarramundi Bridge, new Windsor Bridge) would experience longer closures, this being associated with operation of the FMZ. This is also illustrated in Figures 24-27 to 24-34 inclusive. While the length of closure times would be greater for the bridges noted, the time to closure would be extended for most bridges and for most flood events as shown in Table 24-19 in Chapter 24 of the EIS, allowing more time for evacuation should it be required (and noting that the Project will reduce flood risk, thereby reducing the numbers needing to be evacuated).

Section 24.4.3.3 in Chapter 24 of the EIS discusses alternative routes that could be used in the event of closure of Windsor Bridge, Yarramundi Bridge and Cattai Creek Bridge, including consideration of the potential impact of additional traffic on these routes for the period of closure. It was concluded that the additional traffic would be unlikely to cause congestion on these routes.

TfNSW has identified in its submission responsibility for delivering Outcome 8 *Adequate local roads for evacuation*, undertaking around 40 high priority local evacuation road upgrades which may also consider their operations and impact to other assets for evacuation purposes.

5

Response to public authority submissions

5 Response to public authority submissions

This section provides responses to issues raised in submissions from eight councils and an electricity distributor (Endeavour Energy). There was substantial diversity in the presentation of issues in each submission and the approach taken in this section has been to reflect the structure of each submission as far as practicable to assist submitters in identifying where issues raised have been addressed. For several submissions, additional clarification has also been provided at the beginning of the individual section.

5.1 Blue Mountains City Council

5.1.1 Aboriginal cultural values of the Gundungurra First Nation

Issue 1

Blue Mountains City Council does not support the view of the EIS that the damage from the dam wall raising on the indigenous cultural values of the Gundungurra First Nation are acceptable and instead supports the view of the Gundungurra First Nation RAPs that the raising of the dam wall and the resultant predicted flood zones, poses a serious and irreparable threat to the significant tangible and intangible Aboriginal Cultural values of Gundungurra Country.

It is Council's view that the Project will not only result in the loss of a spectacular and extant cultural landscapes, now so rare within close proximity to Sydney and as such an important cultural symbol, but that it will also have a profound impact on the health and well-being of Gundungurra people suffering the resultant cultural loss.

Response

WaterNSW notes the view of Council. The Aboriginal heritage cultural and social value impacts of the Project were recognised in the cultural heritage assessment process and report (Chapter 18 of and Appendix K of the EIS respectively).

Issue 2

Council accepts the views of the Gundungurra people that the cultural heritage assessments done to support the EIS, whether anthropological or archaeological, are inadequate and not proportionate to the context and importance of this rich cultural landscape. Council's ongoing consultation with Gundungurra Traditional Owners on the Aboriginal Cultural Heritage Assessment Report indicates the Traditional Owners' dissatisfaction with the assessment process, the conclusions of the Aboriginal Cultural Heritage Assessment Report and the lack of compensation or redress for damage to loss of cultural sites and Native Title rights.

In particular, Traditional Owners have communicated their dissatisfaction publicly at the inadequate resources directed to the assessment of the Aboriginal cultural values of the inundated area. This follows on from their earlier criticisms of the draft Aboriginal Cultural Heritage Assessment Report, described by Traditional Owners as 'inadequate' and 'hard to follow', in addition to only surveying a small, supposedly representative, proportion (26 percent) of the total area impacted. Symptomatic of the inadequate consultation was the 40 days provided to respond to a large and complex 2000 page draft report.

Council strongly urges the NSW Government to undertake a more complete cultural assessment of the impacted area in the final EIS, involving Traditional Owners, as well as providing longer periods for Traditional Owners to comment on subsequent cultural heritage studies

Response

The methodology used in preparing the ACHA included the following:

- Developed and agreed in consultation with Registered Aboriginal Parties (RAPs), which included the Gundungurra Traditional Owners
- Survey work and assessment was conducted in accordance with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010 and* included advice from RAPs on locations of all known sites to be surveyed. These and around an additional 300 unknown sites were located and surveyed.
- Reviewed by Heritage NSW to confirm it met requirements prior to the assessment being undertaken. The agency did not raise any issues with the proposed methodology and survey area.

The ACHA was used to support the EIS, which has been undertaken in accordance with the SEARs, relevant legislation and guidelines (see Chapter 18 of the EIS). A consistency review of these requirements was undertaken by DPIE prior to public exhibition. Extensive consultation was undertaken during the ACHA preparation and feedback considered in the EIS. A detailed consultation log is provided in Appendix 3 in Appendix K to the EIS. The consultation log includes details of consultation, key issues raised and follow up actions. It should be noted that at the request of some of the RAPs the consultation log was not publicly available during the EIS exhibition period.

Since EIS exhibition there has been substantial additional work and consultation undertaken to better inform cultural significance, potential impacts and management measures. Additional information is provided in the PIR.

Issue 3

The EIS makes no reference to the Department of Planning, Industry and Environment *Draft Greater Sydney Water Strategy*, which was exhibited concurrently with the EIS. The EIS does not address the inherent contradictions of the Warragamba Dam Raising Proposal with the Draft Greater Sydney Water Strategy Priority Challenge 5: 'Improving water management outcomes for Aboriginal people. We need to plan for and manage water to support Aboriginal rights, interests and access.'

Council strongly believes that the above priority challenge in the *Draft Greater Sydney Water Strategy* is in direct contradiction to the proposed raising of Warragamba Dam, as the proposal poses an unacceptable loss of Aboriginal cultural values, infringes on Aboriginal rights and is based on inadequate anthropological and archaeological assessment. Council recommends that anomalies between the draft EIS and the *Draft Greater Sydney Water Strategy* are specifically addressed in the final EIS.

Response

WaterNSW advises Council that there is no contradiction between the Warragamba Dam Raising Project and the *Greater Sydney Water Strategy*[27]. The latter is for the purpose of securing the water supply for Sydney for the medium to long term (to 40 years). As the dam raising project is for flood

[27] The final Strategy was released in August 2022.

mitigation and not a water supply security focus, the Project has a different intent and objective to the *Greater Sydney Water Strategy*.

5.1.2 Aboriginal cultural heritage assessment (Chapter 18)

Issue 1

The proposed raising of the dam wall will negatively impact the Aboriginal cultural heritage values of the Lake Burragorang area and its tributaries, including hundreds of registered and unregistered Aboriginal cultural heritage sites on AHIMS and an Aboriginal Place nomination. The cultural landscape is assessed in the Archaeological Report to be of very high significance. The potential impacts to the Aboriginal cultural heritage values (both tangible and intangible) of the area are considered unacceptable.

Response

WaterNSW notes Council's view that the potential impacts to the Aboriginal cultural heritage values (both tangible and intangible) of the area are considered unacceptable.

The ACHA has been undertaken in accordance with the SEARs, relevant legislation and guidelines (see Section 1.0 in Appendix K to the EIS), and a consistency review undertaken by DPIE prior to public exhibition. Subsequent to the EIS public exhibition, further work and analysis has been undertaken with regard to cultural significance, potential impacts and management measures. This supplementary information is provided in Appendix F to the PIR, and includes:

- Anticipated effects of short-term infrequent inundation on archaeological deposits. The net effect of the Project on archaeological deposits above the FSL is not assessed to be the same as the long-term, semi-permanent inundation observed below FSL. This is evidenced by identification of sites with archaeological deposit being present in the area above FSL. These sites have already been subject to short term inundation over 1-2 days on nine occasions between 1961-2022 post-dam construction.
- Recent investigative field work to locate existing ACH sites in Longneck Lagoon in the valley that has been subject to temporary inundation of around one week from the recent 2022 flood. This type of inundation at Longneck Lagoon is due to backwater flooding, which would be similar to managing a FMZ, with flood water rising above FSL and then receding. FMZ operation is further discussed in the PIR.

Issue 2

The assessment process undertaken to date as documented in Chapter 18 and Appendix K does not adequately identify, investigate or assess the impacts to Aboriginal cultural heritage. For example, the limited desktop research and small surveyed area. Potential site distribution or predictive modelling reasoning is not adequately provided. Further archaeological field survey is required to appropriately investigate the Aboriginal cultural heritage within the study area. In addition, the extent of the inundation and its associated impacts to Aboriginal cultural heritage at different water levels is unclear from the EIS documentation.

Response

The methodology for the ACHA for the Project is detailed in Section 18.2 in Chapter 18 of the EIS. The assessment was conducted in accordance with relevant guidelines and regulation, including:

- *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010, the Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales 2010*
- *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW 2011*.

The proposed methodology, survey strategy and predictive model were provided to RAPs for review on 5 March 2018. The methodology was also discussed at numerous information sessions (See Appendix K of the EIS - Section 6.3 and Appendix 3, 5, 7, 8 and 11). Of the RAPs who provided written responses to the Stage 2-3 proposed methodology consultation document, 86.7 percent (n=13) endorsed, supported and/or had no objections regarding the proposed methodology. One RAP group requested full survey coverage while another requested consideration of creation story sites/locations as part of the survey program. In response to these requests/comments, an additional 45 targeted survey locations were added to the proposed field program with an objective to more fully sample and understand the cultural landscape and increase the survey coverage. The additional survey objectives consisted of sites and areas related to the Gundungurra Dreaming stories, and sites also related to the more recent history of the area such as farming selections. It was considered that the revised approach would allow for the identification and assessment of the highly significant areas of the Burragorang Valley to make sure cultural information is not lost. The additional survey work proposed resulted in the survey covering a greater sample of the study area but did not result in a program to survey the entire area.

The survey methodology was therefore developed and informed based on information gathered from various reputable sources including AHIMS, place nominations, previous local and regional archaeological investigations, consultation with RAPs, and field surveys. Specifically, the areas for the field survey were identified and amended based on the results of consultation with RAPs.

Niche on behalf of WaterNSW has compiled further supplementary information, which is provided as Appendix F to the PIR. This addresses the issue of potential archaeological deposits by providing further detail from site recordings, additional detail on landforms with sub-surface potential and extrapolating the results of survey in areas of very high visibility and exposure to adjacent unexposed areas. The ACH methodology agreed with the RAPs did not include proposals for test excavation of potential archaeological deposits, and discussions during the fieldwork and community consultation activities the RAPs, anecdotally, do not support a sub- surface testing regime

WaterNSW undertook the necessary engagements with agencies including Heritage NSW (formerly OEH) on the various methodologies and approaches to be implemented in delivering the outcomes required to respond to the SEARs. One of these was establishing an assessment framework to address the infrequent and variable nature of flood events in depth and duration for the upstream area. The agencies consulted included EES, NPWS and Heritage NSW (OEH). The assessment approach reached was clearly outlined in the EIS and resulted in the defining of the Project Upstream Impact Area (PUIA).

The outcomes included that:

- *An agreed approach to identifying the likely area of temporary inundation upstream as a result of the Project (based on the likely maximum inundation in a 20-year period)*
- *The temporary inundation area will be common for all EIS impact assessments biodiversity, World Heritage, protected lands and Aboriginal cultural heritage.*

Issue 3

The archaeological assessment of significance is not clearly supported or evidenced, for example, Aboriginal sites are identified as having 'low' significance without clear reasoning or explanation. There is very limited archaeological investigation (and no sub-surface test excavation) to truly understand and consider the Aboriginal cultural heritage values of individual sites to be impacted, nor the broader cultural landscape as a whole.

Response

Please refer to above responses. Additionally, Section 18.8.1 in Chapter 18 of the EIS provides an overview of the assessment of significance. The Burra Charter and the NSW OEH Policy *Guide to investigating assessing and reporting on Aboriginal Cultural Heritage in NSW* (OEH 2011) were referred to and applied in the cultural assessment process. These documents identify cultural significance as being derived from four heritage values: Aesthetic, Historic, Scientific and Social.

For sites that meet one or more of those four heritage value criteria, a grading was applied to measure the value/significance of those sites within the PUIA. The grading of cultural values is described in Table18-18 in Chapter 18 of the EIS. A grading of scientific significance, in accordance with the *Aboriginal cultural heritage standards and guidelines kit* (NPWS 1997) is provided in Section 18-19 in Chapter 18 of the EIS. These descriptions were applied to inform the gradings allocated to cultural sites.

Issue 4

Consultation with Registered Aboriginal Parties indicates overall objection to the assessment and proposal, which is noted in the report and referenced to confirm that consultation has been undertaken in accordance with the Aboriginal cultural heritage consultation requirements for proponents 2010. However, the proposal does not adequately address the concerns raised throughout the consultation process, rather instead noting that consultation occurred.

Response

Please refer to above responses.

Consultation with RAPs and Aboriginal community members has been ongoing since mid-2017 and has continued throughout EIS development. Consultation details and a consultation log of around 214 pages of records are provided in Section 6 and Appendix 3 in Appendix K to the EIS. The consultation log includes details of consultation, key issues raised and follow up actions. At the request of some of the RAPs the consultation log was not publicly available during the EIS exhibition period.

An example of incorporating consultation feedback into the EIS relates to the comments received from the 10 RAPs who provided responses to the draft ACHA (see Section 6 in Appendix K to the EIS):

- There were two RAPs who were supportive of the Aboriginal cultural heritage assessment, however the majority of comments were unsupportive of the Project and the Aboriginal cultural heritage assessment that had taken place. A summary of the main issues is provided below:
  - the Project represents a cumulative impact and continuation of the loss of values from the original Warragamba Dam construction and flooding of the Burragorang Valley
  - given the size and scale of the Project, and the length of the Aboriginal Cultural Heritage Assessment Report, not enough time was allowed for review
  - the cultural heritage survey did not cover enough of the potentially impacted area
  - inaccessible areas should be accessed for appropriate survey coverage to be achieved.
  - the Draft Report failed to capture the high significance of the area, and the relationships of sites to each other and the landscape
  - culturally important objects should be left on country, not moved off country
  - mitigation of harm via contribution to the broader communities' understanding of the Aboriginal heritage of the Burragorang Valley was not appropriate

  - the Draft report failed to convey the importance of the cultural landscape and its values.
- Further assessment work, including undertaking a CVA, was subsequently conducted and the ACHA updated. In response to the next draft of the ACHA during face-to-face meetings with RAPs, the following additions/amendments to this Aboriginal Cultural Heritage Assessment Report were agreed:
  - Inclusion of a clear statement that the Registered Aboriginal Parties do not support the Project
  - updated detail in the final recommendations of the report

Issue 5

The Aboriginal Cultural Values Assessment (CVAR) attempts to identify the cultural values of the areas to be impacted and outlines mitigation measures for the Project, however the appendix identifies that the methodology was limited by Aboriginal cultural knowledge holders who chose not to participate at the time, and the majority of RAPs declined to nominate Aboriginal cultural knowledge holders on the basis that they did not trust the intent of the Proponent or the assessment process.

While identifying 45 locations of cultural value in the study area, the methodology utilised does not sufficiently address the identification and understanding of Aboriginal cultural heritage values of the area, nor do the recommendations adequately address the proposed impacts to Aboriginal cultural heritage.

Response

WaterNSW notes that the submission from Heritage NSW advises

> *The cultural values assessment is sufficient as a desktop assessment, acknowledging the limited engagement with the Registered Aboriginal Parties (RAPs). The report identifies known cultural values attributed to the Burragorang Valley and defines the risks to those values.*

Issue 6

Many of the management recommendations identified should be undertaken irrespective of the Project or its impacts.

Response

WaterNSW would consider for those management measures in the Cultural Values Assessment report, that are not Project-dependent, to be considered for inclusion into aligned actions bound within the WaterNSW Reconciliation Action Plan (2022).

5.1.3 Native Title issues

Issue 1

Both Council and the NSW Government, including NPWS and WaterNSW, are party to the Gundungurra Indigenous Land Use Agreement (GILUA), established under the *Native Title Act 1993* (NT Act). Despite the area proposed to be inundated being subject to this agreement, the EIS is largely silent on the GILUA and its implications.

The inundation as proposed would have significant potential to be a Future Act under the NT Act, and to potentially extinguish Native Title. As such, Council would like the matter specifically addressed in the EIS and a determination made as to whether the Warragamba Dam Raising Project represents a Class 1 Post Registration Act under the GILUA. This would take the action outside of the alternative regime established under the GILUA, and require it to be dealt with under the negotiation provisions of the NT Act.

The EIS does not acknowledge this as a potential issue with the NSW Government yet to commence any negotiation under the NT Act in that regard. Proceeding with the action in the absence of adequate negotiation under the NT Act could expose it, and consequently the taxpayers of NSW, to significant compensation.

Any action by the NSW Government in this matter complies with the GILUA and that the issue of Native Title is explicitly addressed in the EIS. Council's view is that the State Government is obliged to consider, and to demonstrate how it has considered, whether the proposed inundation is a Class 1 Post Registration Act under clauses 14.3, 14.4 and 14.5 of the GILUA.

There is a high likelihood that the proposed action would result in the extinguishment of Native Title and as such, there is no leave to carry out the act other than through dealing with the Native Title interests through the relevant provisions of the NT Act. As a minimum the EIS should be open and transparent about this matter, including how the proposal, and by extension the NSW Government, intends to address the implications of the GILUA and the extinguishment of Native Title. Council urges the NSW Government to meet its legal and moral obligations to the Gundungurra Native Title interests, and to be mindful of the potential for compensation to be triggered in this matter, and its fiscal obligations to the tax-payers of NSW.

Response

The Project maybe a Future Act under the *Native Title Act 1993* (NT Act) as it has the potential to impact Native Title rights and interests. It is proposed to occur within land that is covered by the Gundungurra Indigenous Land Use Agreement (GILUA). Under the GIULA there are three key types of future activities which are dealt with in the agreement. Where the proposed act is not covered by the GIULA, the parties agree that any Future Act will be dealt with under the NT Act.

The three types of activities are as follows:

- Class 1 Post Registration Acts (Class 1 Acts)
- Class 2 Post Registration Acts (Class 2 Acts)
- Class 3 Post Registration Acts (Class 2 Acts).

Class 1 Acts are a 'compulsory acquisition of the whole or any part of native title rights and interests' or the grant of a freehold estate. If the Project is a Class 1 Act then it would be dealt with subject to the provisions of the *Native Title Act 1993* and consultation in accordance with the regime for Class 1 Acts under the GIULA would be required.

The Project does not require the compulsory acquisition of land nor the granting of freehold estate. The EIS details the potential impacts from the operation of the Project including temporary inundation.

The catchment area above the existing FSL behind Warragamba Dam that would incur temporary inundation from the operation of the Project is within the Agreement Area described in the GILUA.

WaterNSW manages the catchment area which includes decisions on when to close the area in times of significant wet weather and/or upstream flooding events where rainfall runoff causes unsafe conditions of entry. These access controls are contemplated in the GIULA as Class 3 Acts, and are carried out with input from the Consultative Committee. The current management of the inundation areas and broader catchment would continue with the Project.

Should the Project proceed, the same catchment management and access arrangements for ensuring safety of the public will apply and temporary inundation will still occur above the FSL but up to a higher level than the existing inundation. The Project would not alter the rain or runoff down the slopes of the catchment but would capture inflows up to the top level of the FMZ as described in the EIS.

Class 2 Post Registration Acts comprise the following acts:

- The compulsory acquisition of all interests including native title rights and interests
- The grant of a lease or licence
- Construction or establishment of Public Works (as defined under the NT Act)
- Preparation, adoption and implementation of a plan of management for any part of the Agreement Area.

The Project will not comprise a Public Work where WaterNSW proposes and delivers the Project because WaterNSW is not a Government agency for the purposes of the Public Works definition in the NT Act. However, it is possible that if the Project proceeds, a modified plan of management may apply to part of the Agreement Area. This may render the operation of the Project as a Class 2 Act. Any management plan would be developed after determination of the Project.

To the extent that the Project does not comprise a Class 2 Act, it may comprise a Class 3 Act. Under the GILUA there are no further procedural rights agreed in relation to Class 3 Acts and the parties agree that the Non Extinguishment Principle applies.

Although a formal notification may not have been undertaken there has been extensive consultation since around 2017 with representatives of the GILUA as part of the overall ACHA process. Further discussions are proposed with the indigenous bodies that are party to the GIULA to confirm agreement to the process where practicable. Where the Project falls under section 24KA of the NT Act, and not as a Class 2 Act, no notification is required, however, ongoing consultation will be occurring as stated in the EIS.

Consultation has occurred with the Gundungurra Tribal Council Aboriginal Corporation and the Gundungurra Aboriginal Heritage Association Inc as documented in Section 2.6.2 of Chapter 2 of the EIS:

> *The ILUA includes the establishment of a consultative committee and input by the Gundungurra people for management of land and waters covered by the ILUA, including Lake Burragorang and the Warragamba area. Consultation has been undertaken with this committee as part of the Project development and approval processes ... Issues identified during the consultation have been addressed in the design, operation and mitigation measures developed for the Project.*

In addition, the EIS addresses the management and mitigation measure related to potential impacts to Aboriginal cultural heritage which includes continued consultation by WaterNSW with Traditional Owners and other stakeholders including:

- WaterNSW would continue consultation and engagement with the Registered Aboriginal Parties for the duration of the Project
- An Aboriginal Cultural Heritage Management Plan (ACHMP) would be developed for the Project and implemented as part of the Construction Environmental Management Plan (CEMP). The ACHMP would be developed and managed in consultation with the RAPs and relevant regulatory authorities. The AHMP would provide specific guidance on measures and

controls to be undertaken to avoid and mitigate impacts on Aboriginal cultural heritage during construction

- WaterNSW would develop and implement a policy to improve access for Aboriginal community members to Country they have cultural connections with that are under WaterNSW management
- The GILUA will be considered when implementing management and mitigation measures forthcoming from the Project.

5.1.4 Integrity issues in the development of the EIS

The NSW Government's actions have consistently pre-empted the outcomes of the EIS. This is exemplified in the passing of the Water NSW Amendment (Warragamba Dam) Bill 2018, which has the effect of amending the *National Parks and Wildlife Act 1974* to allow the temporary flooding of the World Heritage listed Blue Mountains National Park. The passing of such a significant and highly specific enabling piece of legislation should have been informed by the EIS, and not enacted prior to the completion, or indeed the commencement of, the assessment process.

Pushing legislation through to allow this project, before environmental, cultural, or economic impacts have been assessed has made a mockery of due process and risks the assessment becoming little more than a box-ticking exercise, with the NSW government making clear they will press ahead regardless of the findings.

Response

The amendment of the *Water NSW Act 2014* through the Water NSW Amendment (Warragamba Dam) Bill 2018, including consideration of relevant issues, was a matter for the NSW Parliament.

Part 5A of the *Water NSW Act 2014* provides for the development of an EMP to address the issue of temporary inundation from the Project on national park land. The development of the EMP is contingent upon approval of the Project. As per section 64C(1), WaterNSW is required to consult with the Chief Executive of the Office of Environment and Heritage[28] (now Heritage NSW) with regard to the matters to be addressed in the EMP. The EIS and supplementary investigations would inform this process.

5.1.5 Alternatives to the dam raising proposal

Issue 1

An informed assessment of whether or not the dam wall raising proposal should go ahead requires a thorough exploration of alternative approaches to flood mitigation and adaptation in the EIS. In addition, the EIS should consider what additional benefits could be achieved beyond flood mitigation alone. This is currently lacking from the project proposals and the EIS.

Response

WaterNSW refers to Chapter 4 of the EIS which draws extensively on the Hawkesbury-Nepean Valley Flood Risk Management Strategy (Flood Strategy) Taskforce Options Assessment Report published by Infrastructure NSW in January 2019, and which includes detailed comparisons of options. The Hawkesbury-Nepean Valley Flood Management Taskforce (the Taskforce) was established by the NSW government in 2014 to develop and assess potential alternatives and options for reducing

[28] This is the wording as used in section 64C, however, this role disappeared with the abolition of OEH in 2019. Most of the functions of OEH were transferred to the Environment, Energy and Science Group within DPE. The equivalent role is now the Environment and Heritage Coordinator-General.

flood impacts and risks in the valley. The Taskforce found that the most effective and efficient infrastructure option to reduce risks to life and property from flooding is to raise the Warragamba Dam to provide a flood mitigation zone of around 14 metres.

In June 2016 the NSW Government adopted the recommendations of the Taskforce in delivering nine outcomes to maximise the flood risk mitigation benefit as outlined in the executive summary of the EIS. The investigation into alternative approaches to address flood mitigation in the valley has been extensively undertaken since 2014.

The EIS re-assessed a number of options as part of the assessment process and as directed by the SEARs. The re-assessment referred to the earlier assessments undertaken for the HNVFRS and the Taskforce Review, but with updated and refined data and decision support tools including in flood modelling, property information, evacuation modelling and response levels, fatality functions and damage assessment. The re-assessment of those options was undertaken against four key performance indicators.

The re-assessed alternatives considered in the EIS included:

- Raise Warragamba Dam spillway levels
- Lower Warragamba Dam FSL by 12 metres or by five metres
- New or upgraded regional evacuation roads
- Dwelling buyback – of residential properties within the 1 in 100 chance in a year flood
- Prevent new dwellings within the 1 in 500 chance in a year flood.

The reassessment confirmed the raising of Warragamba dam as the most effective and beneficial option, and as the option that best met the Flood Strategy's risk reduction objective.

Issue 2

Potential alternatives that have been inadequately explored include lowering the dam storage level to increase flood mitigation capacity while at the same time coupling this with the development of rainfall-independent water sources such as increasing water recycling and renewable energy powered desalination plants. Building this increased capacity in rainfall-independent water supply sources is consistent with Priority Two of the *Draft Greater Sydney Water Strategy* to build resilience to drought and a changing climate by 'planning for new infrastructure with a focus on rainfall-independent supply, enabling an 'enduring supply' during drought and managing storage depletion to reduce the risk of reaching extremely low dam levels.'

Response

The raising of Warragamba Dam is to provide flood mitigation benefits for downstream communities and not for additional water supply for Sydney. It is therefore beyond the scope of this Project to consider water supply alternatives, or to consider the *Greater Sydney Water Strategy* in terms of water supply and water security for Sydney.

The *Greater Sydney Water Strategy* (Priority 2) recognises the need for future additional rainfall independent water supply systems, such as desalination, to support Sydney in the future. Also, at Priority 2 (Section 2.5) is '*Respond to the impacts of flood mitigation decisions on the system*' and which specifically addressed the potential raising of Warragamba dam. Therefore, the draft Strategy has been developed cognisant of the Project and its implications, should it progress.

The lowering of the FSL would require an alternative water supply to make up the water storage volume lost. This would be in addition to the already recognised need for another water supply source such as a desalination plant. Any alternative supply will have associated design, approval processes, construction, and operation costs.

Issue 3

Blue Mountains City Council recommends that independently run hydrological modelling is undertaken to assess the degree of flood mitigation that could be achieved with major investment in rainwater and stormwater harvesting and reuse in the multitude of urban and extensively cleared catchments that feed into the Greater Hawkesbury Nepean catchment. For example, could largescale stormwater and rainwater harvesting and reuse initiatives throughout the catchment, in combination with other flood mitigation measures and flood adaptation measures (such as improved evacuation routes, property buyback and a moratorium on development in flood affected areas), negate the need for the dam wall to be raised. Implementing water sensitive initiatives throughout the multitude of urbanised and highly cleared landscapes that feed floodwater into the Hawkesbury Nepean floodplain would also have many environmental and community benefits in addition to flood mitigation.

Response

East coast lows are the dominant storm mechanism for large floods, which are characterised by 3-4 days of intense rainfall that is well in excess of any practical harvesting approach. A decentralised network of smaller scale stormwater detention and/or storage structures has generally been shown to be insufficient and ineffective in mitigating flood events due to their small volumetric size being quickly overwhelmed. Studies have shown that they would not have any measurable impact on peak flood levels where the dominant flood mechanism is flooding from the Hawkesbury and Nepean Rivers. Detention style approaches would technically make flooding worse as more runoff would coincide with peaks from the Nepean and Warragamba river systems.

It is noted that stormwater management, water sensitive urban design and general water efficiency requirements already exist within urban areas of the Greater Hawkesbury-Nepean catchment. Cleared agricultural land is used for agricultural purposes with stormwater harvesting designed and scaled for that purpose and uncleared areas are not suitable for the development of stormwater detention systems.

Furthermore, the large Warragamba catchment is the main contributor of floodwaters in major flood events (up to 70 percent), has limited urbanisation, and plays a significant role in downstream flood risk due to its location immediately upstream of the valley development.

Issue 4

Council strongly advocates for further detailed investigation of alternatives in the EIS and of the possibilities for reallocation of the estimated $2 billion in construction and biodiversity offset costs, to flood mitigation downstream of the dam and water sensitive initiatives in the upstream urbanised and highly cleared catchments that feed into the Hawkesbury Nepean floodplain. This could include initiatives such as better flood evacuation infrastructure, the buyback of flood prone lands and the creation of a green band of public land in the Hawkesbury Nepean floodplain for biodiversity and public recreation and to act as the green lungs for the City of Sydney.

Response

Project alternatives are addressed in the above responses. WaterNSW clarifies that the EIS contains the quantity of biodiversity credits and not an estimated value as noted in the above issue. The Biodiversity Offsets Strategy (per Chapter 13 of the EIS) sets out the approaches available to fulfil offset requirements and how these may be implemented. The revised offset strategy is provided in Section 3.3).

Issue 5

Funding could be provided to the councils within the Greater Hawkesbury-Nepean catchment to develop water sensitive city strategies such as the award winning Blue Mountains Water Sensitive City Strategic Plan, and to fund the delivery of water sensitive urban design projects to help capture, infiltrate and/or reuse stormwater locally. This would both decrease local water demand and reduce the flood surges from all the hard surfaces of the urbanised areas within the Greater Hawkesbury-Nepean catchment.

Supporting local governments to create stormwater harvesting reuse schemes and build green infrastructure may result in significant flood mitigation outcomes but will also result in significant water savings, increase water literacy in the community, combat extreme heat days and the heat island effect, support clean healthy waterways suitable for community recreational pursuits and create green liveable cities for present and future generations. This flood mitigation approach would be consistent with the stated objective in the *Draft Greater Sydney Water Strategy*: *Putting water at the heart of our city and communities – We need to make our city cooler and greener, and maintain healthy waterways and ecosystems*.

Response

Refer to Issue 3 response with regard to Council's suggestion of alternative reuse schemes. Allocation of funding to local government authorities for water management projects is a separate matter to the Project.

Issue 6

WaterNSW should also consider viable alternatives like improved catchment management in cleared farmland areas, particularly in the highly cleared Mulwaree, Wollondilly and Coxs catchments, which contain municipal and farm dams that could be enlarged to provide floodwater detention with limited biodiversity impacts, and in fact, if done well, biodiversity benefits. Over-cleared catchments could be strategically revegetated to reduce erosion and runoff. Highly eroded and degraded streams could be reconstructed to reinstate the 'chain of ponds' morphology that is believed to be their natural state (in lower order streams). This would retain more water, including floodwaters, in those catchments and their floodplains, potentially improving landscape productivity for farming and biodiversity outcomes, if appropriately managed.

Response

Refer to previous responses in this section with regard to alternatives. The alternatives suggested in Council's submission would not provide the temporary storage capacity (about 1000 gigalitres) or operational flexibility in controlling downstream flows post-flood peak to deliver the downstream flood mitigation benefits that would be provided by the Project.

Issue 7

Rather than investing in a higher Warragamba Dam, which also represents a single point of failure, funds could be invested in improvement of many smaller dams in highly modified landscapes, and in stormwater management of urban centres (for example Goulburn, Lithgow, Moss Vale, Mittagong/Bowral, Blue Mountains) where runoff could be detained in tanks and artificial wetlands, reducing peak flows into the Warragamba catchment. This approach would foster regional employment, improve water quality, improve biodiversity values and rural productivity, and spread the risk of failure across many structures and areas, rather than concentrating risk at one point, where failure could be catastrophic.

Response

Refer to previous responses in this section with regard to alternatives. The alternatives suggested in Council's submission would not provide the temporary storage capacity (about 1000 gigalitres) or operational flexibility in controlling downstream flows post-flood peak to deliver the downstream flood mitigation benefits that would be provided by the Project.

Issue 8

The flooding extent maps shown at the end of Chapter 15 of the EIS highlight that the dam wall raising project would achieve only minimal reductions in flood extent – that is large areas would still flood around Penrith, Richmond, Windsor etc, even if the dam wall was raised. There is particularly minimal difference in the PMF scenario which presumably poses the greatest risks to human life and property.

Response

Downstream flood extent maps for existing conditions and with the Project are presented in Section15.14.2 in Chapter 15 of the EIS. Maps cover the range of SEARs events.

The objective of the Project is for flood mitigation to reduce the risk to life and property damage in the downstream communities. The EIS acknowledges that the Project will not eliminate flood risk entirely and that flooding will still occur, as other rivers downstream of the dam also contribute to flooding in the Hawkesbury-Nepean Valley.

The flood maps show considerable areas of property that are modelled as to not experience flooding across the full range of flood events. These areas benefiting from the flood mitigation outcome of the Project will also have other benefits in terms of property not damaged, infrastructure not damaged or unusable, businesses and employment continuing, social connections maintained among other benefits. For those areas that are still affected by flooding with the Project, the characteristics of that flood, notably the height of the floodwaters and duration of higher water velocities of flood events, will be different and generally not as great as that experienced without the Project.

The PMF is described in Section 15.2.1.2 in Chapter 15 of the EIS as the

> *largest flood that could conceivably occur at a location, … The PMF is a hypothetical flood estimate relevant to a specific catchment [and] represents a notional upper limit of flood magnitude. In other words, the PMF is so unlikely it is impossible to estimate the chance of it occurring.*

The role of other catchments and inflows from other rivers will affect the extent of the PMF. Therefore, the PMF maps presented are for information and comparative purposes and completeness of flood information within the EIS as a standard and routinely used flood event type in modelling, but the flood event is unlikely to ever eventuate. The PMF is also required to be taken into consideration for floodplain risk management per the NSW *Floodplain Development Manual* (DIPNR 2005) (as noted in Section 3.2.1.3 in Chapter 3 of the EIS) with regard to managing the impact of flooding on urban and other development in flood-prone areas.

Issue 9

The EIS reveals that the proposal would not prevent significant flooding on the Hawkesbury-Nepean floodplain, not least because the Warragamba catchment is only one source of floodwaters to the

Hawkesbury Nepean Floodplain. At best, the project is a partial flood mitigation measure, and a very economically, ecologically, and culturally expensive one. It represents a worst-case example where a technological 'fix' is applied to a problem without adequate regard to what might be done to reduce the problem in a more systematic manner.

Response

Mitigation is by definition a reduction, not elimination. Therefore all 'mitigation' measures are by definition partial and not total.

The NSW Government Flood Strategy has always acknowledged that the role of the Project is to significantly reduce the high flood risk exposure in the Hawkesbury-Nepean Valley.

The Project has evolved from previous investigations and assessments, and is one of nine outcomes recommended to be progressed under the Flood Strategy; an outcome to reduce flood risk in the Hawkesbury-Nepean Valley. The stated objective of the Flood Strategy is

> *to reduce flood risk to life, property, and social amenity from regional floods in the Hawkesbury-Nepean Valley now and in the future.*

The outcomes to be delivered by the Flood Strategy towards the overall objective propose a mix of infrastructure and non-infrastructure measures including:

- Outcome 3: Strategic and integrated land use and road planning
- Outcome 4: Accessible contemporary flood risk information
- Outcome 5: An aware, prepared and responsive community
- Outcome 7: Best practice emergency response and recovery
- Outcome 8: Adequate local roads for evacuation.

Activities towards meeting the outcomes of the Flood Strategy are being progressed. An Interim evaluation of the Flood Strategy to June 2021 has been published, which outlines the progress made for each of the outcomes.

The EIS reassessed a number of options as part of the assessment process and as directed by the SEARs. The reassessment referred to the earlier assessments undertaken for the Flood Strategy and the Taskforce Review but with updated and refined data and decision support tools including in flood modelling, property information, evacuation modelling and response levels, fatality functions and damage assessment. The reassessment confirmed the raising of Warragamba Dam as the most effective and beneficial option, and as the option that best met the Flood Strategy's risk reduction objective.

The reassessment of the Project and alternatives within the EIS was undertaken with the application of four key performance indicators.

The EIS for the Project, as does the preceding work by the Taskforce, states that the raising of Warragamba Dam wall will not entirely eliminate flooding due to several catchments and river systems flowing into the Hawkesbury–Nepean floodplain upstream or near the Penrith, Richmond and Windsor centres in particular. The EIS states that based on historical flood information the Warragamba Dam catchment contributes up to 70 percent of flows during flooding events into the Hawkesbury-Nepean Valley (EIS Executive Summary page 4). This percentage will vary depending on factors such as the quantity of precipitation falling over various parts of the catchment.

The Project will not address the existing challenges posed by the gorge terrain downstream of Windsor and any implications that may have on flooding backing-up (the 'bathtub' effect) impacting the Windsor, Richmond and surrounding areas.

Issue 10

Blue Mountains City Council recommends an independent cost-benefit analysis of different flood management and adaptation scenarios to investigate whether the minor reduction in flood extents warrants the massive financial, cultural and environmental costs of the proposed project and whether there is a better and more holistic big picture solution. This analysis should consider the potential loss of capacity at Lake Burragorang due to sedimentation caused by erosion of a de-vegetated FMZ (due to loss of vegetation caused by inundation), and also erosion of upstream catchments and waterways, due to failure to effectively manage erosive forces such as urban and farmland runoff in an era of climate change induced extreme weather events.

Response

Before Warragamba Dam was completed in 1960 the upstream catchment was significantly cleared of vegetation up to the FSL. If removal of vegetation has resulted in loss of capacity in Warragamba Dam, it would have occurred since 1960. However, repeated bathymetric surveys since 1960 have shown no significant loss in storage volume. WaterNSW does not agree with the assumption that there would necessarily be a loss of vegetation associated with operation of the FMZ. As noted in the EIS, it has been assumed that there would be a total loss of biodiversity values in the upstream impact area for the purpose of offsetting. However, additional work undertaken during preparation of the Submissions Report suggests this is a very conservative position and unlikely to be realised.

WaterNSW together with NPWS already actively manages the wider catchment of the Warragamba Dam.

5.1.6 Justification for the upstream impact area

Issue 1

Despite acknowledging in the EIS that the dam wall will be technically raised by 14 metres, the upstream 'Impact Zone' (defined as the additional area flooded above existing levels periodically inundated by floodwaters) has been calculated to be the equivalent of a net increase of 7.5 metres of water level rise in terms of impact. This net water level rise impact figure has been achieved by subtracting the temporary flood inundation suggested to be occurring behind the existing dam wall during flooding events from the known 14 metres that the dam wall will actually raise flood waters.

Response

The Project proposes to raise the central spillway crest by around 12 metres and the auxiliary spillway crest by around 14 metres above the current FSL. The current FSL is 116.72 mAHD; this will not change with the Project.

WaterNSW undertook the necessary engagements with agencies on the various methodologies and approaches to be implemented in delivering the outcomes required to respond to the SEARs. One of these was establishing an assessment framework to address the infrequent and variable nature of flood events with regard to depth and duration for the upstream area. The identification of an upstream impact area recognises the probabilistic basis of flooding and variable extent of affected land. The approach to defining the upstream impact area is presented in the EIS (refer Section 8.2.5.2 in Chapter 8 for example).

To establish a likely upstream impact area a full range of flood events and lake variables were modelled to generate around 20,000 synthetic flood events, which represent around a 200,000 year period of time. Within each 20-year period across the 200,000 year modelling representation the peak level was chosen and the average of all the 20-year peak levels was adopted as the likely impact area. Note it is an area and not assigned a probability of occurrence, however, it is close to a typical 1 in 20 year event. Within a 20 year period at least one large event above FSL would be captured for the modelling, which has been validated from flood records of the existing dam in the 60 year operating life of the dam. Note that the same modelling was undertaken to assess the likely inundation area for both the existing dam and with Project, and the impact area is the net difference between the two areas as the existing dam already floods above the FSL as validated by flood records.

The EIS also states that a precautionary approach has been taken and for the purposes of offsetting the potential impacts of the Project, it has been assumed that there would be a complete loss of all environmental values in this area.

Issue 2

The EIS has used averaged 1 in 20 chance in a year flood data for these calculations, rather than 1 in 100 chance in a year flood data as was used in the preliminary EIA, to estimate the predicted 'Impact Zone'. In contrast, whenever the EIS is promoting the flood mitigation values of the dam; for example in the executive summary and in the flooding chapter, the EIS uses 1 in100 chance in a year event data, and even 1 in 500 chance in a year and 1 in 1000 chance in a year event data, rather than the 1 in 20 chance in a year flooding averages selectively chosen for calculations of the impact zone and required biodiversity offsets.

The cynical use of these two creative accounting techniques has had the effect of minimising compensation costs payable by the NSW government by artificially reducing the environmental impact zone by >50 percent and the subsequent compensation payable by more than $1 billion as well as reducing the area impacted within the World Heritage area to 304 hectares.

Response

WaterNSW notes Council's view and refers to the response to the first Issue in this section. It is not clear what Council is referring to with regard to 'the preliminary EIA'. However, WaterNSW advises that consultation with agencies during preparation of the EIS resulted in the identification of a likely upstream impact area for the purposes of offsetting. The SEARs also required that flood extents and hydrology assessments be undertaken across a range of flood events as outlined in Chapter 15 of the EIS.

Issue 3

The impact zone in the EIS is significantly understated. Despite the raised dam providing a flood mitigation zone of 14 metres above FSL, the EIS is based on an average or likely upstream inundation level of just 10.3 metres above FSL, that is 3.7 metres less.

The EIS further reduces this understated impacted area by regarding the first 2.8 metres above FSL as already being destroyed by past inundations, which the EIS suggests is currently occurring behind the existing dam wall during flooding events. This results in the impacted area being just the 7.5 metres strip of land between the existing maximum inundation of 2.8 metres and 10.3 metres above FSL, amounting to 1,400 hectares.

The raised dam will contain inflows above 10.3 metres, up to the crest of the central spillway, 12 metres above FSL. A mega-flood would result in significantly higher inundation levels (as indicated in Figure 15-30 in Chapter 15 of the EIS) with depths for a 1 in 100 year flood and the PMF of 16 metres and 27 metres above FSL respectively.

During significant flood events, which are predicted to become more common with climate change, the inundation area will likely be many times larger than for the 'average/likely inundation', especially due to the flatter upstream topography

Response

WaterNSW refers to the response to the first issue in this section. Further, it should be noted that the existing dam configuration has an elevation difference between FSL (116.7 mAHD) and the Crest Road level (around 130 mAHD). This provides an area that can already retain large inflow events. The historical flood records of the dam have validated the modelling of a likely inundation area for the existing dam at around 2.8 metres above FSL from a flood event in 1961. Should the Project not proceed, these areas above FSL are still at risk of temporary inundation. In addition to the above response outlining why an upstream impact area was chosen, the flooding above FSL is an existing risk and is not accounted as part of the upstream impact area.

Issue 4

The EIS bases its compensatory biodiversity offsets payable on the average/likely inundation of 10.3 metres above FSL, not the full FMZ depth of 14 metres or the maximum depths for a 1 in 100 chance in a year flood and the PMF of 16 metres and 27 metres above FSL respectively. This is further reduced by regarding the first 2.8 metres above FSL as already being destroyed by past inundations, which the EIS suggests is currently occurring behind the existing dam wall during flooding events.

As a consequence, the compensatory Biodiversity Offsets payable by the NSW government have been effectively reduced to less than half the area that will be periodically inundated over time. The choice of these assumptions has the effect of reducing the subsequent compensation payable by the NSW government by more than $1 billion.

Council believes that the assumptions underlying these calculations are not credible, that the assumptions and associated calculations have been calibrated to enable the dam raising proposal by substantially reducing the project's biodiversity offset responsibilities and that substantially greater environmental impacts than what have been assessed are likely to occur, warranting much higher biodiversity offset payments.

Council recommends that the biodiversity offset calculation assumptions are reviewed by an independent panel of experts to assess their credibility, particularly given the significant financial advantages to the NSW Government associated with downplaying the flooding impacts and the biodiversity offsets payable.

Response

WaterNSW notes Council's views, however, refers to the previous responses in this section for this issue.

Issue 5

The EIS states that upstream inundation will increase from up to four days at present to up to 14 days with a raised wall. The EIS notes that flood events vary widely as do the appropriate responses. The key issue is whether the proposed drawdown procedure would result in the full capacity of the FMZ being restored and the upstream inundation being released within the claimed 14 days.

The pragmatic decision of governments during flooding would be to delay any releases until downstream flooding had subsided to the extent that FMZ releases would not add to or prolong any flooding. The priority would be to not add to downstream flooding rather than minimise the duration of upstream inundation. Such delaying of FMZ releases would result in upstream inundation for significantly longer than 14 days.

Response

The EIS flood extents downstream were modelled using the operating objectives noted in the EIS and an FMZ drawdown framework that used a targeted duration to drawdown the FMZ back to FSL within 14 days.

The outflow modelling for the EIS takes into account the sizing of the FMZ gated outlets, which have a designed maximum discharge rate of 230 GL/d. If required, this maximum rate can be initiated for about 2-3 days if a subsequent flood event is expected prior to the FMZ being emptied. Thereafter, this rate is reduced to 100 GL/d in a constant flow until the FMZ is discharged and the lake level returns to the existing FSL. If there is no forecast subsequent event a lower constant discharge of around 100 GL/d is modelled to draw down the water level to FSL again and limit further downstream flooding.

Therefore, during the constant discharge flow, the FMZ will be released in a controlled manner through the gated outlets and discharged at a rate that does not cause further impacts that exceed the previous flood level peak as the level recedes gradually back to normal river levels. The constant discharge to drawdown the FMZ can also be varied below the constant rate should the Warragamba contribution be required to ramp down in response to other sources of flooding impacts as part of the current flood incident management operations for the valley.

For those flood events that exceed the FMZ capacity, the operator would not initiate the new gates until the flood peak has passed, and therefore has no ability to control water discharging over the crests.

5.1.7 Assessment of aquatic ecology and water quality impacts

Issue 1

Council requires more detail, description and quantification in Chapter 11 *Aquatic ecology* such as:

- Exactly what area/length of riffle/pool/run sequences in the Lake Burragorang tributaries that will be inundated during temporary flooding
- Exactly what habitat niches that exist in these reaches, and what aquatic fauna (invertebrates and vertebrates) depend on those particular niches
- Even though flooding of riffles, pools, runs, etc may be temporary (up to two weeks according to the EIS), the effects of that inundation may be long lasting. For instance cobble/boulder riffle zones may be smothered with sediment during periods of inundation. This would not recede with floodwaters and may cause permanent damage to these habitat niches, meaning the loss from the area of species dependent on those niches, such as certain families of caddisfly, mayfly, stonefly and other macroinvertebrates (with knock-on effects through aquatic and terrestrial food webs).
- BMCC aquatic scientists have advised that the macroinvertebrate results are not adequately described: Exactly which taxa are found in the reaches that will be inundated? Which rare taxa occur? Which taxa are dependent on particular niches such as cobble/boulder riffles that will disappear during inundation and that will be permanently altered by sedimentation remaining after floodwaters recede?

- The effects on Platypus, Rakali and other aquatic vertebrates are not mentioned. What will happen when their burrows are inundated under 14 metres of water and smothered in layers of sediment?

Response

Please refer to responses provided in Section 4.1.6 of this report.

Issue 2

The EIS does not mention the high potential for 'blackwater' events and associated fish kills and impacts on other aquatic fauna. Raising the dam wall would cause inundation of huge areas of terrestrial vegetation and associated leaf litter and other organic material in the FMZ.

This in turn is very likely to cause decomposition of that organic matter, raising dissolved organic carbon (DOC) levels and causing dissolved oxygen (DO) to crash as the organic matter is consumed by microbes. This could result in mass fish kills across Lake Burragorang, as well as knock-on effects on water quality, potential blue-green-algal blooms and rising treatment costs for raw water to meet drinking water standards.

While blackwater events are considered 'natural' phenomena in some areas, this would not be the case for such events caused by the raising of the Warragamba Dam wall.

Response

The matters raised in the above issue are existing risks for the current dam that can temporarily inundate areas above the FSL (and which is validated by flood records since 1960). With the Project there will a net increase of additional depth and duration of temporary inundation above what occurs now. However, it needs to be considered that:

- Inflows of rainfall runoff that flow over and through the natural environment would pick up and be affected by vegetation decomposition materials and other organic matter will not change with the Project. The quantum of this would be affected by the amount of rainfall and other external events such as storm damage, erosion and sediment runoff.
- Algae blooms can affect, and have previously occurred in, Lake Burragorang under existing dam conditions and operations, as with many other lakes and river systems. For example, there was a notable algae bloom covering much of the lake surface in late 2007. Such algae blooms at Lake Burragorang are managed by Water NSW and the water quality is closely monitored and actions taken as needed to protect the drinking water quality. This will continue should the Project proceed.

Issue 3

The risks outlined in Chapter 27 of the EIS are focused on raw water supply for human drinking water consumption and fail to take into account likely ecological water quality impacts. The water quality risk analysis at the end of the chapter is flawed. The surrogate events used to determine the likely upstream water quality impacts of the dam wall raising:

- Are based on past events (1998 and 2012) during which the largely unvegetated full supply level (FSL) zone was inundated, unlike the proposed FMZ which contains densely forested vegetation communities that will contribute much higher organic loads that will decompose (raising DOC and dropping DO) during inundation.
- Do not analyse or report on dissolved organic carbon levels or dissolved oxygen levels. These extremely significant parameters are absent from the EIS analysis.

The statement within the risk assessment in Chapter 27 of the EIS that the 'rapid filling of the FMZ may result in reduced water quality, however this was assessed as being relatively minor and no significant upstream water quality changes would occur' is flawed. The assessment mentioned did not take into account two of the most significant water quality parameters that will be impacted by inundation.

Chapter 27 of the EIS states that the water quality impacts from past inundation of the denuded FSL (the 'surrogate events') would likely be worse than water quality impacts from future inundation of the heavily vegetated FMZ if the dam wall is raised. While this may be true for parameters such as turbidity, the converse is the likely reality for parameters such as DOC and DO; that is the ecological water quality (and by extension drinking water quality) impacts of inundation of the FMZ are actually likely to be far worse than rapid inundation of the unvegetated 'mudflats' up to the FSL.

Response

WaterNSW refers to the previous responses provided in this section. Additionally:

- With the current dam configuration, there will be temporary inundation of an area of land above the FSL, such as when the dam spills during high inflows
- The area of the FMZ affected by temporary inundation will depend on the type of flood event. The more frequently occurring floods are the smaller flood events, that is a smaller portion of the FMZ from the FSL is affected but more often. Some of this area is already affected by flood events
- Inflows of rainfall runoff that flow over and through the natural environment would pick up and be affected by vegetation decomposition materials and other organic matter. The quantity of this would be affected by other external events, such as bushfire, storm damage, insect attack, etc.

Issue 4

The potential for oxygen-depleted, high-DOC 'blackwater' to spill and degrade water quality downstream of the dam wall is not explored at all. Section 27.5.3.2 in Chapter 27 of the EIS discusses the potential for increased levels of DOC/natural organic matter (NOM) resulting from decay of inundated vegetation. Associated human health risks arise from the reaction between disinfection agents (e.g. chlorine) and NOM, producing disinfection by-products (trihalomethanes), which can be carcinogenic.

While the EIS acknowledges this human health risk resulting from decay of inundated vegetation, it does not mention the associated crashes in dissolved oxygen and aquatic fauna impacts that would result from such decay of inundated vegetation. An adequate assessment is needed to establish how far downstream these impacts could potentially extend. In addition, a post-bushfire flooding scenario (such as occurred in 2020) should be considered to understand potential compounding effects in addition to inundation of vegetation in the FMZ alone.

Response

The potential for oxygen-depleted, high-DOC 'blackwater' to spill and degrade water quality downstream is an existing risk that is managed by WaterNSW through existing water quality management processes and procedures. Should the Project be approved, these would be reviewed to identify any required changes to address any material changes to the water quality risk profile.

Please refer to the response provided in Section 4.1.9.13 with regard to the potential cumulative impacts from bushfire events.

Issue 5

It is suggested that the Warragamba Dam Raising proposal is not consistent with the *Draft Greater Sydney Water Strategy* Priority 4 (Our waterways and landscapes are healthy) and Section 4.1 (Maintain and improve ecosystem health).

Response

The objective of the Project is related to flood mitigation and not for water supply, and as stated in Section 3.3 of Chapter 3 of the EIS, is to

> *Reduce risk to life and property downstream in the valley by raising Warragamba Dam wall.*

Nevertheless, the potential impacts to water quality including the quality of Sydney's water supply provided from Lake Burragorang is a matter considered within the EIS and of the Project.

Broadly, the Project can be considered consistent with the *Greater Sydney Water Strategy* Priority 2 '*Our water systems are sustainable for the long term and resilient to extreme events*'. The Project will contribute to managing flood events and their impacts downstream. The introduction of Priority 2 identifies the key challenges, and how these are reflected in the Project:

- Building resilience to a changing climate – which the SEARs and Project has recognised in the allowance for climate change impacts to rainfall and flood events
- Supporting the economy and jobs – achieved by the Project by the flood mitigation benefits on downstream communities, reduced number of properties affected or the scale of impact, and the lower and/or managed disruption to the economic businesses and employment.
- Putting water at the heart of the city and community – mitigating flood extents will avoid or manage inundation of greenspaces downstream and the effects of receding floods such as sediment and other deposits.

Priority 2 also notes that the strategy also considers the potential impact of Government decisions about reducing flood risk in Western Sydney. Under Priority 2, Action 2.5 is to '*Respond to the impacts of flood mitigation decisions on the system*' and which specifically addressed the potential raising of Warragamba Dam. Therefore, the Strategy has been developed cognisant of the Project and its implications should it progress.

5.1.8 Assessment of the impact on the World Heritage values of the Greater Blue Mountains National Park

Issue 1

The EIS does not adequately assess the impacts on the Greater Blue Mountains World Heritage Area (GBMWHA). BMCC is of the opinion that the use of creative accounting (see 6.0 for further details) enables the project through 'watering down' and significantly downplaying of the associated impacts on the GBMWHA. Particularly disappointing is the lack of evidence of consultation with the UNESCO World Heritage Committee or acknowledgment of the fact that the proposal is contrary to Objective 1 of the Strategic Plan for the WHA ('*maintain, and wherever possible, improve the current and future integrity of the GBMWHA*').

Response

Further consideration of potential impacts of incremental temporary inundation on the OUV components of the GBMWHA potentially affected by the Project is provided in Appendix C to this report.

The Project was considered by the World Heritage Committee (WHC) at its 43rd Ordinary Session in 2019 and published a decision regarding the Project. This Decision is provided in Appendix J *World Heritage Assessment Report* to the EIS, along with responses to each point in the Decision. Further consideration was given in Decision 44 COM 7B.180 adopted by the World Heritage Committee at its extended 44th Session in 2021 (refer Appendix C).

Consideration of the WHC Strategic Plan for the GBMWHA is provided in Appendix J to the EIS. A response to the management measures nominated for the desired outcomes of the Integrity management issue of the Strategic Plan is provided in Section 9.5.1 in Appendix J. In summary. it states that the Project would not be inconsistent any of the desired outcomes and would support achieving several of those outcomes.

Broadly, the Project has been considered against the World Heritage Impact principles and World Heritage convention management objectives, with a response to Principle and Management objectives respectively provided in Sections 8 and 9 in Appendix J to the EIS.

The matter of consultation with the World Heritage Committee is addressed in the response to the following issue.

Issue 2

UNESCO's World Heritage Committee is not listed as one of the key stakeholders in Chapter 6 (Consultation). Consultation with the GBMWHA Advisory Committee is mentioned briefly in Chapter 21 (Socio-economic impacts), although no details of the intensity of the consultation or the nature of their advice is provided in the EIS.

Response

Section 6.3 in Chapter 6 of the EIS identifies key stakeholders as including special interest groups. The GBMWHA Advisory Committee is identified as a special interest group for the Project.

Chapter 6 (page 6-7) of the EIS identifies that there were three occasions where the Project team met with the GBMWHA Advisory Committee (refer Table 5-1). The Advisory Committee provided feedback to the Project team during preparation of the draft EIS. Feedback used to inform preparation work, and the chapter of the EIS that addresses that feedback, is listed in Table 6-8 in Chapter 6 of the EIS.

Appendix D to the EIS identifies key concerns raised by the Advisory Committee. This report also identifies consultation sessions held with the Greater Blue Mountains World Heritage Advisory Committee (refer Table A-1 in Appendix A *Flood Strategy Engagement* to Appendix D). This is summarised in Table 5-1.

Table 5-1 Consultation with the GBMWHA Advisory Committee

Event	Date	Audience	Type	Matters covered
Meeting with GBMWHA Advisory Committee	2 February 2018	Committee Members	Presentation	Presentation on the Warragamba dam raising EIS process. Covering issues related to the upstream impacts of temporary inundation

Event	Date	Audience	Type	Matters covered
Combined meeting of GBMWHA Advisory Committee and Blue Mountains Regional Advisory Committee	12 May 2018	Members of both committees	Presentation	Flood Strategy – refers and update and Warragamba Adm Raising EIS process
Briefing to GBMWHA Advisory Committee	10 August 2018	Chair and Committee Members	Presentations and Q&A session by Infrastructure NSW, DPIE, and NSW SES	Update on Flood Strategy Impacts on floodplain development Emergency planning and response Integration of flood Strategy outcomes WDR upstream impacts

Issue 3

The UNESCO World Heritage Committee's significant concern that an increasing number of World heritage properties are facing potential threats from major dam projects, considers that the construction of dams with large reservoirs within the boundaries of World Heritage properties is incompatible with their World Heritage status, and urges States Parties to ensure that the impacts from dams that could affect properties located upstream or downstream within the same river basin are rigorously assessed in order to avoid impacts on the OUV.

These concerns are reflected in the position of UNESCO's World Heritage Committee, which has specifically requested that the NSW Government submit the EIS for review by the committee before any final decision about the project going ahead is made. Council notes that in a recent United Nations report, the World Heritage Centre, which advises the UN committee in charge of World Heritage properties, has stated that 'the inundation of areas within the property resulting from the raising of the dam wall are likely to have an impact on the Outstanding Universal Value (OUV) of the property.'

Response

The final EIS was made publicly available via the DPE Major Projects website and would therefore have been available to the World Heritage Committee for its consideration. The IUCN provided a submission to the EIS public exhibition and a response has been provided in Appendix C2 to this report.

Issue 4

Despite the UNESCO's World Heritage Committee stating that raising the dam wall and the subsequent flooding of areas of World Heritage Area will likely have an impact on the OUV of the GBMWHA, the EIS does not acknowledge the UNESCO's World Heritage Committee concerns that the proposal would damage or destroy components of listed Outstanding Universal Values for which the GBMWHA was declared in Appendix J World Heritage Assessment. The EIS does not detail any specific consultation to address or allay the UNESCO's World Heritage Committee concerns.

Response

The comment from the World Heritage Committee was made in 2019 in response to the State Party Report to the Committee, with reference to the EPBC referral. At that time the EIS was still in progress including the detailed assessments and potential impacts on the Outstanding Universal Value were still being developed (and further consideration is provided in Appendix C to this report).

As noted above, three events of consultation with the GBMWHA Advisory committee were held during the preparation of the EIS, comprising presentations and Q&A sessions and discussions including on the upstream impacts of the Project.

The assessments for and preparation of the EIS considered the feedback received from the GBMWHA Advisory Committee as detailed in Section 6.6.4 and Table 6-8 in Chapter 6 of the EIS. The Advisory Committee provided feedback in relation to biodiversity, cumulative impacts, socio-economic and use and property; and World Heritage matters.

Issue 5

There is insufficient consideration of the socio-economic impacts and reputational damage associated with the potential placement of the GBMWHA on the List of World Heritage in Danger in accordance with Article 11(4) of the Convention (refer to Chapter 21 of the EIS). The potential placement of the GBMWHA on the List of World Heritage in Danger would have a significant impact on its vibrant nature and culture based tourism economy, which is based in no small part on its World Heritage branding. The NSW Government should give due consideration to the economic impacts associated with any compromising of the Blue Mountains World Heritage brand, which is not adequately identified and addressed in the EIS.

Response

There is already an existing risk of temporary inundation of part of the World Heritage Area from flood events associated with the existing dam, and this risk existed at the time of the GBMWHA being inscribed on the World Heritage List. As shown in Table 20-8 of the EIS (reproduced on the following page as Table 5-2), the incremental increase in the area potentially affected by temporary inundation is very small relative to the overall area of the GBMWHA.

The assessment of the impacts of the Project determined that the increased area affected by the temporary inundation would not constitute a significant change and is 'not likely to have an impact to the World Heritage values of this area'. As such, it is considered unlikely that the GBMWHA would be listed as in danger or be affected by any repercussions that such a listing may incur. It is acknowledged that there are other factors that need to be considered with regard to potential impacts on the GBMWHA and its OUV, and further consideration of these is provided in Appendix C to this report.

Table 5-2 Area of GBMWHA in upstream study area potentially affected by temporary inundation

Flood event (chance in a year)	Existing area in study affected by temporary inundation (ha)	Area in study affected by temporary inundation with Project (ha)	Change in area (ha)	Increase in area of GBMWHA affected by the Project (%)
1 in 5	283	370	87	0.01
1 in 10	344	510	166	0.02
1 in 20	398	691	293	0.03

Flood event (chance in a year)	Existing area in study affected by temporary inundation (ha)	Area in study affected by temporary inundation with Project (ha)	Change in area (ha)	Increase in area of GBMWHA affected by the Project (%)
1 in 100	559	974	415	0.04

All areas of temporary inundation are within the Warragamba Special Area to which there is no public access and to do so requires entry permits to be issued. Therefore, the impacts to cultural and recreational tourism would be limited and can be controlled.

Issue 6

There is concern that the EIS process is being considered as a formality rather than fundamental to the decision-making process and consideration of environmental impact. This is also reflected in the position of UNESCO's World Heritage Committee which has requested that the NSW Government submit their EIS for review by the committee before any final decision about the project going ahead is made. Council recommends that the comments received from the UNESCO's World Heritage Committee review of the EIS are treated very seriously in the context of the potential placement of the Greater Blue Mountains World Heritage Area on the List of World Heritage in Danger in accordance with Article 11(4) of the Convention.

Council reiterates its previous recommendations that WaterNSW must consider the full range of flood mitigation and catchment management options ., which would assist WaterNSW in coming to the logical conclusion that enlarging Warragamba Dam simply does not stack up and that the unavoidable conflict with the GBMWHA and associated values is one more reason to abandon the proposal.

Response

WaterNSW notes Council's concern regarding the EIS process. This will be a matter for DPE to consider as part of its assessment process which it is assumed will consider how to address UNESCO's requests. Further consideration of the potential impacts of the Project on the affected World heritage area and its associated values is provided in Appendix C.

WaterNSW would refer to previous responses to BMCC submissions (Section 5.1.5) related to the extensive assessment of flood mitigation options undertaken by the Taskforce for the Hawkesbury-Nepean Valley Flood Strategy.

5.1.9 Significant biodiversity impacts and the biodiversity assessment

Issue 1

The EIS does not adequately assess the impacts of the Project on biodiversity. Many areas potentially impacted by inundation, either by the current proposal or by future augmentations of the proposal in response to climate change, were not surveyed at all including the Kowmung River, Cedar Creek, Lacys Creek, Green Wattle Creek, Werriberri Creek, Brimstone Creek and Ripple Creek.

Response

WaterNSW undertook the necessary consultations with agencies including Department of Planning Environment and Heritage Group on the various methodologies and approaches to be implemented in delivering the outcomes required to respond to the SEARs. One of these was establishing an assessment framework to address the infrequent and variable nature of flood events in depth and duration for the upstream area. Table 8-4 in Chapter 8 of the EIS describes the field survey area that was adopted for the Framework for Biodiversity Assessment (FBA) as being the area within a 1 in 100 chance in a year event (1% AEP) plus 9 percent climate change. This equates to an area of about 3,740 hectares.

Further details on the assessment methodology are contained in Section 8.2 in Chapter 8 of the EIS. Should there be future augmentations of the proposal in response to climate change this would be through a separate planning approval process, at the that time.

Issue 2

Raising the dam wall by 14 metres has the potential to impact up to 65 kilometres of pristine rivers, including up to five kilometres of the Kowmung River, a designated wild river and even by this EIS's very conservative Impact Zone estimates1400 hectares of high conservation value bushland. The land to be flooded includes lands of the highest conservation value, including some of the most highly-protected and significant natural landscapes in Australia: in or adjacent to World Heritage-listed, National Park, declared wilderness, declared wild river, and National Heritage status.

Response

The temporary inundation of upstream waterways and associated landscape is identified and assessed in Chapter 20 *Protected lands*, Chapter 8 *Biodiversity upstream*, Chapter 12 *Matters of NES Biodiversity*, and associated appendices to the EIS.

The area and proportion of the World Heritage Area upstream of the Warragamba Dam that would be affected by the Project is shown in Table 8-4 in Chapter 8 of the EIS (see below) and is less than one percent for four of the most likely flood events.

Table 20-8. Area of GBMWHA in the upstream study area potentially impacted by temporary inundation

Flood event (chance in a year)	Existing area in study area impacted by temporary inundation (ha)	Area in study area impacted by temporary inundation with Project (ha)	Change in area (ha)	% increase of GBMWHA affected by temporary inundation due to Project
1 in 5	283	370	87	0.01
1 in 10	344	510	166	0.02
1 in 20	398	691	293	0.03
1 in 100	559	974	415	0.04

The area of the World Heritage Area, national parks and state conservation areas upstream of the dam that would be affected by the impact area (being the land between the current FSL and the Project FMZ) are identified in Table 20-16 in Chapter 20 of the EIS (see below).

Table 20-16. Extent of protected areas within upstream impact area

Protected area	Total area (ha)	Area within upstream impact area	
		(ha)	(% of total area)
Greater Blue Mountains World Heritage Area	1,032,649	304	0.03
Blue Mountains National Park	269,401	535	0.20
Nattai National Park	17,725	284	0.90
Burragorang State Conservation Area	51,032	159	0.56
Nattai State Conservation Area	3,266	51	1.56
Yerranderie State Conservation Area	12,423	274	2.21

Section 20.5 in Chapter 20 of the EIS provides an assessment of the Project on the wild rivers upstream of the dam wall. It states that about 1,285 metres of the Kowmung River that is a declared wild river is located within the upstream Project area. The impact of the Project on the river has been assessed as having 'no material difference' in inundation height for flood events up to the 1 in100 chance in a year event, and a 'very small difference' of up to 0.3 metres up to the 1 in 1,000 chance in a year event. Overall, it is concluded that the Project 'would not impact on the declared wild river section of the Kowmung River'.

Issue 3

The project will impact on one of a handful of known breeding sites for the Regent Honeyeater, one of the rarest birds on earth, and the most threatened bird in NSW of which just 400 remain in the wild. In addition, large areas of predicted habitat which would be impacted by flooding were not surveyed. These areas may provide critical breeding and feeding areas for this critically endangered species and loss of these irreplaceable habitats may not be able to be realistically offset.

Response

The Conservation Advice for the Regent Honeyeater (Commonwealth Department of Environment June 2015) notes the following:

- The species is highly mobile, partly migratory, and able to travel large distances
- The species has some nesting site fidelity but may change breeding nesting site, moving the nest some distance (up to 85 kilometres stated) within a broader site, and may also change breeding sites
- Key threats to the species include the clearing fragmentation and degradation of habitat and in particular loss of large mature trees for feeding and breeding
- The species has a wide geographic range although found in a limited number of locations within that range
- The habitat preferred habitat is of eucalypt woodland and dry sclerophyll forest and riparian vegetation, notably mature eucalypt.

From that Conservation Advice, the Regent Honeyeater has the capacity to seek out and utilise habitat within an area beyond the Project impact area.

The assessment of impact to the Regent Honeyeater is provided in Table 8-33 in Chapter 8 of the EIS. Further detail is provided in Appendix F1 to the EIS. Environment and impact assessment notes the following:

- A large breeding population of the species was recorded during the Project field survey around Tonalli Cove
- Temporary inundation by the Project may impact breeding habitat, reduce foraging habitat, and a flood event during breeding season may result in the death of nestlings
- Species habitat upstream of the Project has been calculated at 1,265 hectares.

Approximately 40 percent of the upstream study area and the upstream impact area that are the habitat of the Regent Honeyeater was burnt in the 2019/20 bushfires. Therefore, the habitat of the Regent Honeyeater was considerably impacted by that event, and birds may have temporarily relocated to avoid that former habitat area.

The assessment notes the mobility of the species, dispersing large distances to reach suitable habitat, and so capacity to relocate their foraging and breeding activities to other suitable habitats in the region. The population recorded in the Study Area is considered likely to be part of the wider Greater Blue Mountains population of potentially between 150 and 350 individuals.

The Project Upstream Impact Area (PUIA) used for the purpose of offsets for biodiversity impacts includes credits for the Regent Honeyeater and is included in the Biodiversity Offset Strategy, which is discussed in Section 6.4 of the PIR.

Issue 4

The level of survey effort for threatened fauna for the large area to be impacted was very low given the scale of the impact, with the limited use of remote cameras, ultrasonic detectors, audiometers and spotlighting to detect rare and threatened fauna, especially in remote locations.

Response

As outlined in Chapter 8 of the EIS Chapter 8, the assessment included a review of various information sources, and field surveys including of native vegetation and threatened species including threatened fauna habitat assessments.

Specifically, field surveys are addressed in Section 8.2.7 in Chapter 8 of the EIS. Surveys were undertaken for native vegetation, threatened fauna habitat, and threatened flora and fauna species. The survey of threatened fauna and habitat is provided in Section 8.2.7.2 in Chapter 8 of the EIS.

Therefore, field surveys were targeted based on the assessment of biodiversity values that identified potential / likely habitat places using the landscape and native vegetation values and assessments. Field survey work was undertaken applying the recommendations of the *Threatened Biodiversity Survey and Assessment: Guidelines for Development and Activities (Working Draft)* (Dept of Environment and Conservation (DEC) 2004).

Issue 5

Limited survey was undertaken for a range of threatened fauna including threatened microbats including the Southern Myotis (Fishing Bat), the threatened gliders such as the Squirrel Glider, Yellow-bellied Glider and the Greater Glider, the Macquarie Perch, and other threatened species such as the Eastern Pygmy Possum, Brush-tailed Phascogale, Brush-tailed Rock Wallabies and Koalas. Very limited amphibian surveys and no targeted searches for the threatened Booroolong Frog and Stuttering Frog were undertaken. Consideration of the Booroolong Frog was dismissed on the basis it does not occur in easterly flowing streams which contradicts the findings of the *Terrestrial Vertebrate Fauna of the Southern Sydney Region* report (DECC 2007) and known records from the Kowmung River (DPIE, 2021). The Stuttering Frog is known from the western part of the catchment and modelling suggests a broader distribution through the catchment and consideration of impacts on this species should also be made.

Response

Refer to the above response for issue 4 about survey to address this issue . Additionally, Section 5.5.2.2 in Appendix F1 to the EIS outlines the fauna survey activity for the assessment process of threatened species and populations. Survey methodology was developed with consideration of the survey effort recommendations of *Threatened biodiversity survey and assessment: guidelines for development and activities – working draft* (DEC 2004) and relevant Commonwealth survey guidelines. For some species, where survey effort was less than required by the guidelines, these were regarded as being present in the study area for the purposes of the assessment. Survey methods were applied as appropriate to various target species of the Greater Glider, Squirrel Glider, Brush-tailed Phascogale, Brush-tailed Rock Wallaby, Koalas and others. The survey methods included spotlighting and call playback, arboreal and ground hair tubes, cage traps, surveys, ultrasonic call detection (bats) remote sensing cameras, Koala spot assessment technique, nest box search and incidental recording during fieldwork. Survey methods were applied within identified suitable habitat areas.

The survey effort is one component of the assessment of impacts per the *Framework for Biodiversity Assessment (FBA)* (OEH 2014), as outlined in Chapter 8 of the EIS. The FBA was undertaken in three stages of which stage 1 is the assessment of biodiversity values of the landscape, of native vegetation and of threatened species of the study area.

Table 5-5 in Appendix F1 to the EIS states that the Booroolong Frog lives withing 100 metres of streams or creek banks, with suitable habitat located downstream of the dam wall, although currently only known from western flowing creeks and rivers, and as such the study area is not suitable habitat. The NSW Scientific Committee final determination (gazetted 13 March 1998) for the Booroolong Frog notes that the species generally inhabits western flowing streams, although a small number have been recorded in easterly flowing waterways. The determination also states that '4 Previously known populations within the Blue Mountains are no longer able to be located'. It is noted this determination predates the DECC report cited in the submission. However, the National Recovery Plan (2012) for the species notes that, regarding its distribution, 'records of the frog in eastern flowing streams south of Sydney are not supported by specimens or photos and require confirmation'. The report *Terrestrial Vertebrate Fauna of the Greater Southern Sydney Region*[29] recognises this species as having key habitat in the western alluvial woodlands and forests and also states that disease has significantly affected the population of this frog species. Amphibious surveys within suitable habitat during optimal weather, with the Booroolong frog as one target species of the survey effort, were undertaken for the Project (refer Table 5-10 in Appendix F1 to the EIS).

Section 8.2.7 in Chapter 8 of the EIS states that expert reports were prepared on specified species including the Stuttering Frog. Table 5-5 in Appendix F1 to the EIS is an assessment of potential presence of species credit species, and notes that the frog lives in rainforest or tall wet forests within 100 metres of streams, of the eastern escarpment and foothills. It also states that while some suitable forests exists in the study area, the distribution of the species has declined and may be unlikely to occur, and the likelihood of occurrence table (Appendix G in Appendix F1 to the EIS) advises the Chytrid fungus may have affected the species presence in the study area. The report

[29] https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/terrestrial-vertebrate-fauna-greater-southern-sydney-region-report-vol-01-070470.pdf

Terrestrial Vertebrate Fauna of the Greater Southern Sydney Region states that disease has significantly affected the population of this frog species.

Issue 6

Insufficient survey was undertaken in creeks and rivers impacted by the proposal for the Platypus and Water Rat (Rakali) with the result that the impact of the proposal on these iconic species also remains largely unknown. In conclusion BMCC would like to highlight that threatened fauna species surveys were substantially less than guideline requirements, field surveys were generally inadequate and when field surveys were acknowledged to be inadequate expert reports were often not obtained.

BMCC would recommend that further threatened fauna species surveys should be undertaken to assess the full impact of the proposal and to determine if the impacts on threatened fauna species, several of which are very rare or occur nowhere else can be realistically offset.

Response

Refer to the above response to issue 4 about survey to address this issue. Additionally, the Platypus and the Water Rat (Rakali) are not a listed threatened species in NSW or of the Commonwealth. Platypus were observed during the field survey activities foraging in deep pools with overhanging vegetation, between shallow riffle systems, within the Wollondilly, Kedumba, Coxs and Nattai Rivers (refer Section 8.3.4.2 (text box) in Chapter 8 of the EIS for aquatic fauna habitats in the study area and Section 12.7.76.2 in Chapter 12 of the EIS for matters of NES).

Issue 7

Flora survey efforts were low, with only 95 survey plots done and less than 50 percent of the study area subject to ground truthing. Inundations will impact on one of the two major sub populations of the vulnerable Camden White Gum (*Eucalyptus benthamii*), up to several hundred hectares of the critically endangered White Box-Yellow Box Blakely's Red Gum Woodland Threatened Ecological Community (TEC), and the Kowmung Hakea (*Hakea dohertyi*).

Response

Refer to the above response to issue 4 about survey to address this issue. Additionally, WaterNSW refers to Figure 8.5 in Chapter 8 of the EIS, and Figure 4-1 in Appendix H1 to the EIS, that compares ground truthing to the 1 in 100 chance in year flood inundation area with Project. It can be seen that the vegetation ground truthing was undertaken in areas that are newly affected for this flood event. The ground truthing was part of the field survey work undertaken to directly compare PCT with flora physically located within that polygon.

The ground truthing, in combination with the previous vegetation survey formed part of the assessment of biodiversity values of native vegetation. The full list of actions under this assessment component include:

- Mapping the extent of native vegetation
- Identify PCTs and ecological communities
- Undertake floristic site surveys, identify any threatened ecological communities
- Identify vegetation zones,
- Assess site value (vegetation condition) and undertake plot & transect site surveys,
- Assess site value score (refer Section 8.2.3 in Chapter 8 of the EIS: Stage 1 Assessment of biodiversity values #2. Biodiversity values of native vegetation of the study area).

This is the second of three components of the Framework for Biodiversity Assessment with the other two components being 1. Landscape values of the study area, and 3. Biodiversity values of threatened species.

Issue 8

Considering the very significant upstream and construction site impacts on threatened biota (including critically endangered ecological communities and species), even within the limited impact zone calculated by the EIS, the proposal is in strong conflict with the aims of NSW and Commonwealth biodiversity conservation laws and policies, and represents one arm of government investing in threatened biota conservation and another proposing to degrade those same assets, all with the same public funds.

Response

Refer to the above responses related to the Project Upstream Impact Area. WaterNSW notes Council's view and considers no further response is required.

Issue 9

Upstream biodiversity impacts are assessed primarily using averaged 1 in 20-year flood data resulting in a relatively small impact zone but downstream economic benefits are assessed using much less likely and much more extreme flood potentials. This inconsistency is indicative of the bias and lack of objectivity that is evident throughout the EIS and when comparing the draft EIA with the final EIS.

Response

WaterNSW undertook the necessary consultations with agencies including various groups within DPE on the various methodologies and approaches to be implemented in delivering the outcomes required to respond to the SEARs. These included the flood extent areas to be assessed for hydrology and biodiversity, and other environmental values both upstream and downstream of the dam. The SEARs also defined the range of the flood events to be considered for flood impacts on downstream communities.

The SEARs key issue 8 Flooding required that the EIS:

- Quantify what flood events can be mitigated by the dam. As the Project could mitigate the effects of the full range of flood events, all these flood events were required to be addressed in the EIS
- Assess and model the impacts on flood behaviour for the full range of flood events up to the PMF. As such the EIS has presented the assessment of a range of flood event types up to the PMF
- Undertake modelling of the Project effects on flood behaviour of the broader catchment including the 1 in 200 and 1 in 500 chance flood events
- Assess emergency management measures for the Project for the full range of flood event risk including the PMF.

Therefore, so as to comply with the SEARs, flooding for a range of flood event types up to and including PMF is presented in the EIS. The SEARs did not specify a flood event type to be used in the assessment of the upstream impacts to biodiversity.

5.1.10 Future dam wall raising in response to climate change

Issue 1

While the EIS proposes an increased upstream inundation of 14 metres now it actually facilitates an increased inundation of 17 metres, with even greater environmental impacts, the inundation impacts of which are not considered at all.

The proposal is arguably 'staged development' that does not disclose the impacts of what is a predicted second stage that is clearly identified as being likely to be necessary. On that basis alone, the EIS cannot inform the Minister of the proposal's true impacts on relevant values upstream and downstream of the dam.

Response

Section 5.3.2 in Chapter 5 of the EIS explains that the design was modified to cater for the potential effects of climate change as required by the SEARs. This was achieved by including provision for future raising of the dam spillway crest height by around three metres should the predicted impact of climate change be realised.

Any future change to the spillway crest height due to climate change was not considered and would be subject to a separate future environmental impact assessment and approval s stated in the EIS.

Issue 2

The EIS claims the PMF is highly unlikely to occur in nature, so has no regard to it when considering upstream impacts on biodiversity, yet the EIS plans for the three metre future extension based on forecast climate extremity inclusive of a worsened PMF. Once again this selective use of assessment parameters is indicative of the inconsistency and bias that typifies this EIS and Council recommends that the EIS is redone to increase the assessments objectivity and credibility.

Response

WaterNSW advises that the SEARs had specific detailed requirements to be addressed in the EIS including what size of flood events and hydrology assessments were to be used for various assessment needs. The PMF was one of these included events to understand the study areas and flood extents that informed a number of SEARs elements. The EIS has followed these requirements as required by the SEARs issued by the Department of Planning and not a '*selective use of assessment parameters*' approach as noted above.

The PMF is defined in the EIS Glossary as

> *an estimate of the maximum flood magnitude possible in a catchment/possible location. The PMF is primarily used in design development and with regard to the Project, is unlikely to ever occur in nature due to the size of the Warragamba catchment.*

To further explain the need in the design to make provision for a future three metre raising of spillways, Chapter 14 of the EIS has assessed the climate change impacts for the raised Warragamba Dam. It notes that to maintain the same level of mitigation, the dam may need to be raised further by up to three metres by 2090. The Project as described in the EIS provides for resilience to make this upgrade in the future if required by raising the abutments of the dam by 17 metres removing any future engineering constraints. A further raising of the dam in the future would be subject to a separate planning approval process as stated in the EIS.

5.1.11 Climate change risks

Issue 1

The assessment methodology used for the climate change risk assessment is out of date and does not meet current standards. Climate risk will often have unknown risk consequence and should be given higher ratings. As old methodologies are used in this EIS this best practice methodology has not been applied and reduces the validity of the assessment.

The standards that would give the best risk assessment would be:

- ISO 14091:2021 Adaptation to Climate Change Guidelines on Vulnerability, impacts and risk assessment
- ISO 31000: 2018 Risk Management guidelines Climate Risk Ready NSW guide – Practical guidance for the NSW Government Sector to assess and manage climate change impacts.

The use of these standards would provide a much improved climate risk assessment that meets with current practice and expectations. It is recommended that these assessments should be redone using the latest standards.

Response

The SEARs for the Project were issued in June 2017 by the NSW Government for key issue standard requirements and project specific requirements, and re-issued in March 2018 to address further Commonwealth Government requirements.

The Project EIS was developed applying the legislation, standards, guides tools etc in place or in use at the time of the SEARs being issued unless the SEARs stipulated a specific version or requirement. The EIS was developed from 2017 and guidelines applied where applicable that were current at the time. Under the requirements of the SEARs it stated *'The Proponent must assess the risk and vulnerability of the Project to climate change in accordance with the current guidelines'*.

Further, to specifically address the suggested two standards noted, ISO 14091:2021 is a generic climate risk assessment process, while ISO 31000: 2018 is the international risk management guideline and Climate Risk Ready NSW guide is a generic NSW guide. The approach adopted in the study is consistent with flood risk management process in the NSW floodplain development guideline. This risk management process has all the standard risk framework components from hazard identification, exposure, venerability and treatment but provides a framework designed for flooding and incorporates the climate change. There would be no benefit in adopting a generic framework to a specific problem when a well proven hazard specific framework exists. More importantly the result would likely be the same.

Issue 2

The risk assessment in Chapter 14 only considered activities or outcomes where the Proponent had ownership, direct control, or influence. Impacts of climate change to activities or outcomes out of the Project's influence were not assessed. This significantly reduces the scope of the assessment and fails to acknowledge that climate risks have a range of interdependencies and they need to be assessed holistically. This raises significant concerns as to the robustness and reliably of this assessment.

Response

The SEARs set out the specific assessment that was required in relation to climate change risk. The issue identified for climate change risk in the SEARs was to ensure 'the project is designed constructed and operated to be resilient to the future impacts of climate change'. The assessment requirement also focused on the risk and vulnerability of the Project to climate change. Therefore, the SEARs were directed at and took the view of climate change to the Project.

With the Project being the construction and operation of a raised Warragamba Dam that would mitigate risk to life and property from flood events in the Hawkesbury-Nepean Valley downstream of the dam.

Section 14.4 in Chapter 14 of the EIS outlines the risk assessment criteria applied. It states that

> *an initial screening was undertaken to consider the impact that all climate variables might have on key Project components ... the elements of the Project for which these climate-related impacts were considered against were determined based on a review of the Project description, consultation with Water NSW and refined during the risk assessment workshop …*

Climate change risks have been assessed based on the scope of the Project and associated components. Table 5-1 in Appendix G to the EIS shows how the screening of risk was undertaken for the project components. The assessment provides appropriate assessment of risk based on the level of detail provided by the concept design. Further review and refinement of the risk ratings and treatments would be carried out during detailed design.

In undertaking the assessment of climate change implications, it was necessary and appropriate to contain this to those directly related to and a consequence of undertaking of the Project.

The assessment of climate change risk and the Project is provided at Section 14.2 (Scope of the Assessment) and Section 14.4 (climate chance risk assessment criteria) in Chapter 14 of the EIS.

Monte Carlo flood modelling applied a range of flood types to develop the flood profile with and without the Project. Flood events that may occur through climate change have been incorporated into this modelling methodology. This is described in Section 15.2.2 in Chapter 15 of the EIS and further detail provided in Section 4.1.7 of this Submissions Report.

5.1.12 Sustainability assessment

The sustainability assessment is entirely inadequate for a project of this magnitude. It fails to set any robust action, targets and shows no ambition to even deliver on current government policy.

Major flaws in the assessment include:

- The use of ISv1.2. This is an outdated tool that sets a significantly lower bar than Isv2.0. The justification for using ISv1.2, being that other projects across Australia still use it, is not a valid reason for using outdated methodologies;
- According to the Infrastructure Sustainability Council, ISv2.0 is a step change for the industry as the benchmark for sustainability performance has shifted what once was considered innovative is now becoming business as usual;
- Using a target performance of 'Commended' the lowest possible rating requiring a score of only 25 out of a possible 110 to reach. Noting this is already in an older and weaker tool (see above comment). This demonstrates a lack of ambition and will essentially allow the Project to deliver outcomes that are lower than current standard practices;
- The GREP assessment is done against the 2014 version of the policy. The current version is 2019 and sets increase standards in a range of relevant areas such as waste, electrical appliances and plant emission. The current actions proposed don't meet all criteria of the new GREP essentially setting sustainability targets below the current baseline used in government agencies

- The assessment commits the Project to no tangible actions or outcomes as the entire assessment is subject to reassessment after approval, meaning there is no guarantee that even commended under an outdate tool will be achieved. The actions where credits are allocated often have non-committal vague language such as 'investigate', 'where practical', 'identify future', 'monitor'. The use of this language gives the project clear room to avoid delivering nearly every action suggested in the strategy.

The assessment is entirely inadequate and should be redone using the latest tools and policies while committing at a minimum standard of 'leading' with tangible clear actions identified to deliver this ambitions and enable the project to be held accountable for sustainability.

Response

The SEARs for the Project was initially released in June 2017 and re-released in March 2018. The IS rating tool v1.2 had been released in 2016. The subsequent v2.0 tool was released in mid-2018, and the v2.1 was launched in mid-2021. As the SEARs were prepared in 2017/early 2018, the SEARs would have recognised the v1.2 of the rating tool as current during their preparation. The release of the v2.0 tool was after the SEARs had been issued and the EIS process including the sustainability component had already commenced, and the v2.1 was released when the EIS was near completion. The SEARs did not specify which version of the rating tool was to be used and therefore the rating tool in place at the date of the SEARs being issued was applied.

The IS rating assessment is one of several sustainability assessments undertaken for the Project, being in tandem with the GREP and the TfNSW SDG.

The SEARs did not specify an appropriate rating target for the Project but set the Project to recommend an appropriate rating target. The ISC website provides a Directory of projects that have attained ratings with the Directory being a 'review all the most progressive assets and projects registered and certified with the ISC for an IS rating'.

The Project has referred to the only other dam project that has achieved a rating as given on the Infrastructure Sustainability Council (ISC) website, being the Enlarged Cotter Dam project, and so relevant and appropriate to be used as a benchmarking project. The Enlarged Cotter Dam project achieved a rating of "Commended". It should be noted that rating was achieved from an assessment against an earlier version of the rating tool, being v1.0, assessed a decade ago using then technologies materials and approaches, and was for the 'Built' project. Therefore, the current WGR project, being at design stage, if in future re-assessed against a later version of the tool for a later stage of the Project (for example design or built), may perform better than this benchmarking project.

The IS rating for 'Commended' as '*indicates that a project is achieving better than business as usual' (*refer Section 23.2.1 in Chapter 23 of the EIS). Therefore, a Commended rating is still a positive outcome.

The Project's 'Commended' rating is as assessed on the early planning stage. There is the potential that as the Project continues, and measures and actions identified in the EIs and subsequently identified and implemented through the design, that the Project may attain an improved outcome than presented in the EIS. Any such re-assessment of the design and/or the built outcome would be done on the versions applicable and current at that time. The potential IS Rating score has been revised in Section 6.6 of the PIR. This has identified that the Project would be able to achieve an 'Excellent' score (more than 50 points).

Similar to the IS Rating tool version used, the GREP in place at the time of the issuing of the SEARs (original and re-issue) was the 2014 GREP, as the 2019 version was released the year after the SEARs and released after the EIS assessment had commenced. Therefore, the EIS was undertaken against the GREP in place at the time of the SEARs being issued, and the version recognised during the preparation of the SEARs.

The assessment of the Project for sustainability measures and actions has been undertaken at the current planning and design stage. This enables early consideration and identification of the sustainability aspects of the Project that can be carried through and addressed in the subsequent detailed design and construction planning phases if the Project proceeds. Should the Project be approved, further design work would be undertaken that would provide more detailed and more certainty of information, that could inform any future reassessment of sustainability outcomes.

5.1.13 Non-Aboriginal heritage assessment

Issue 1

BMCC recommends that further detail and investigation is required to supplement the existing documentation provided in Chapter 17 and Appendix I, in order to adequately assess the impacts on non-Aboriginal heritage. In terms of statutory heritage items located within the Blue Mountains LGA, these include the UNESCO 'The Greater Blue Mountains Area' which is on both the World Heritage List and the National Heritage List, as well as the 'The Greater Blue Mountains Area Additional Values' nominated listing.

Response

Sections 7.3.2 and 7.3.3 in Appendix I *Non-Aboriginal Heritage Impact Assessment* to the EIS identify that consideration of these two items is provided in Appendix J *World Heritage Assessment Report* to the EIS. Further consideration of these matters and other related matters is provided in Appendix C to this report.

Issue 2

There are a number of local and state heritage listed items located within close proximity to the downstream study area within the Blue Mountains LGA that are listed in Schedule 5 of the Blue Mountains Local Environmental Plan 2015 and two on the NSW State Heritage Register, which are visible on Figure 17-10, that are not identified or adequately considered in the assessment.

Response

Chapter 17 of the EIS identifies that the Project would substantially reduce the extent of flooding downstream of Warragamba Dam and have a lower impact to downstream local and state heritage listed items than they would currently experience from flooding events with the existing dam.

The EIS has identified a study area for the assessment of non-Aboriginal heritage (refer Section 17.1.2 in Chapter 17 of the EIS) which, for downstream of the Warragamba Dam, is that area within

> *the existing PMF area of the Warragamba River, the Hawkesbury-Nepean River and its floodplain, and some of the tributaries of the Hawkesbury-Nepean River.*

The Project would result in an increase in the upstream PMF and a decrease in the downstream PMF. This means a reduction in land area between existing and with Project PMF extents downstream. As such, for those heritage items located outside of the PMF of the existing dam, these will also be outside the PMF with the Project.

The assessment of heritage items notes that

> *the Project would reduce the extent of the existing downstream PMF and potential impacts to non-Aboriginal items are expected to be minor.*

The impacts which do still occur would be affected by location in relation to the flood event type and other factors such as the depth of inundation, velocity of floodwater, and duration of inundation resulting from the flood event itself and (if affected) by the release of floodwater from the dam.

Issue 3

Section 17.2.1 notes that only statutory lists have been considered as a part of the assessment process. There is no identification or assessment of any unlisted items of potential heritage significance (except for mention of Jooriland homestead, which also does not provide any investigation or assessment of its significance). This is a key area of concern and further investigation and assessment into non-Aboriginal heritage that is not listed is needed.

Response

The non-Aboriginal heritage assessment (Appendix I to the EIS) has been prepared in accordance with the guideline *Statements of Heritage Impact* (NSW Heritage Office 2002) as indicated in Section 7.1 in Appendix I.

Additional assessment has been carried out with regard to four items (including the Jooriland Homestead) on the NPWS Section 170 heritage register. Details regarding this assessment are provided in Section 6.3 of the PIR.

Issue 4

The background research states that maps for section 170 curtilages are not available for many items on the SHI database and the large number of items within the study area, however it is necessary to review the extent or curtilage of these heritage items as a part of the assessment process.

Response

The section 170 register heritage items identifies all except one as being downstream of the dam wall; with the exclusion of the Warragamba Supply scheme that is within the construction zone. The assessment within Section 17.5.2 in Chapter 17 of the EIS notes that generally there is a beneficial outcome from the Project. For those heritage items currently at risk of a (peak) flood event in the downstream study area, the Project may result in

> *… a reduction in the number of heritage items directly impacted by flooding, heritage items that would continue to be impacted by flooding would generally experience:*
>
> - *a shorter duration of flooding*
> - *a reduction in the depth of flooding*
> - *the same or lower flood water velocities.*
>
> *Overall, the Project would result in a reduction of impacts to downstream heritage items due to a reduction in peak flooding impacts for most events."*

Issue 5

The EIS indicates that the field survey was conducted in 2017 and 2018, over three and a half years ago, and was only undertaken for select listed items. Further investigation, including for non-listed non-Aboriginal heritage is necessary in order to identify whether any unidentified heritage will be impacted.

Response

As noted above, the SEARs required assessment of listed (statutory) heritage items and did not require a search for potential (unidentified) heritage items, being those not listed and not currently provided statutory protection.

Site inspections for heritage items were undertaken in November 2017, March 2018 and June 2019.

Field surveys were undertaken from March 2018 for five heritage items potentially affected by the Project. These surveys were undertaken after the issuing of the Project SEARs, which were initially issued on 30 June 2017 and reissued in March 2018 and formed part of the early activities for the EIS preparation.

For maintained heritage sites, a minor change in the condition of the site would be anticipated from the time of inspection to the published EIS. The impact of the Project would therefore be similar.

Issue 6

The historical overview focuses mostly on Sydney's water supply and the construction of the dam and its associated upgrades. There is very little historical background on the early agricultural history, later referred to as Phase 1 and having nil-low archaeological potential without adequate background research or justification to support this.

Response

The historical overview presented is in respect of the archaeological potential of physical evidence of agricultural activities of the study area, which has been assessed as nil to low. It is highly unlikely that there would have been significant agricultural activity at the construction, and evidence of any such agricultural activities would have been disturbed by the earlier dam construction works and the subsequent dam upgrades. Upstream evidence of agricultural activities may have been affected by the reservoir and inundation, while downstream evidence of agriculture in western Sydney within the study area may have been disturbed or lost from other urban development activities.

Heritage NSW has provided a submission to the Project in relation to non-Aboriginal heritage. The matters raised by Heritage NSW and the response to these is provided above in Section 6.3 of the PIR.

Issue 7

Limited archaeological assessment is provided and focuses only on the construction study area and not the upstream area, which will be impacted through inundation.

Response

Further assessment has been carried out with regard to four items (including the Jooriland Homestead) on the NPWS section 170 heritage register in the upstream area. Details regarding this assessment are provided in Section 6.3 of the PIR.

Issue 8

Site inspection limited to only include the Warragamba Supply Scheme, Warragamba Dam Haviland Park, Warragamba Emergency Supply Scheme, Convict Sites (Old Great North Road) and Ku-ring-gai Chase National Park listing. No site inspection undertaken to identify other non-

Aboriginal heritage that may be impacted by the proposed works. Further investigation (both desktop and physical survey) is necessary as a part of the assessment process.

Response

WaterNSW refers to previous responses above that the Project assessed the potential impacts on listed (statutory) heritage items.

Non-Aboriginal heritage items, particularly built items, in the downstream study area are likely to benefit from the Project through reduced flood extents, water depth and water velocities, and some items may no longer be inundated by certain flood events.

Heritage NSW has provided a submission to the Project in relation to non-Aboriginal heritage. The matters raised by Heritage NSW and the response to these is provided in Section 6.2.3 of the PIR.

Issue 9

BMCC considers that the mitigation measures outlined require further detail.

Response

The management measures outlined in Chapter 17 of the EIS are linked to specific heritage items and elements of those items and are considered to provide sufficient detail so as to be implemented and achieve the intended outcome.

Issue 10

BMCC's concern about the adequacy of the assessment of the non–Aboriginal heritage is echoed by the Blue Mountains Heritage Advisory Committee, which has also expressed concerns in relation to the adequacy of the non-Aboriginal heritage assessment, specifically in relation to the nature of the assessment and the limited amount of research undertaken and detail provided, reinforcing BMCC's recommendation that further assessment is necessary.

Response

Heritage NSW has provided a submission to the Project in relation to non-Aboriginal heritage. The matters raised by Heritage NSW and the response to these is provided in the above responses and in Section 6.3 of the PIR.

5.1.14 Time for comment

The length of the exhibition period for an EIS that contains 29 chapters and over 1500 pages and which took over four years to compile is not considered adequate.

Response

WaterNSW provided an extensive EIS to comply with the details and studies required by DPE as prescribed in the SEARs. DPE determines the duration of any public exhibition for an EIS. The WDR EIS public exhibition was on display for 82 calendar days as compared to the minimum display period of 28 calendar days.

5.2 Hawkesbury City Council

The submission from Hawkesbury City Council highlighted areas where Council recommended for various actions or recommendations be included as part of the finalisation of the EIS. These were captured within 13 discrete summaries of concerns through the submission titled "Key Submission Points". WaterNSW has adopted to provide responses to those discrete submission points that are consolidated in the summary section of HCC submission. WaterNSW also acknowledges Council's advice within their submission of the impacts experienced from the February 2020 and March 2021 flood events which supplements the information contained within the EIS.

5.2.1 General

Issue 1

Hawkesbury City Council's Flood Policy 2020 recognises the need for a collaborative approach to floodplain management across the Hawkesbury-Nepean Valley and demonstrates our commitment to providing up to date and relevant, best practice controls based on consideration of flood hazard and risks.

Response

WaterNSW notes Council's commitment that the Project would support activities relating to mitigation and management of flooding risk across the Hawkesbury-Nepean Valley.

Issue 2

Concerns about the lack of disclosure of documents relating to this project, as detailed in the NSW Select Committee Report.

Response

The documents referred to in the Interim Report of the Select Committee on the Proposal to raise the Warragamba Dam Wall were still drafts and incomplete, and therefore subject to further revision prior to finalisation and submission to DPE which occurred in September 2021. The release of the EIS documents has been in accordance with all applicable statutory requirements.

Issue 3

Council is concerned that there is too much reliance on the Warragamba Dam Raising Project, and that all actions of the Hawkesbury-Nepean Valley Flood Risk Management Strategy – Resilient Valley, Resilient Communities need to be progressed in a coordinated and transparent matter in order to avoid complacency within the community and state agencies that the dam raising project will resolve the issue of floodplain management within the Hawkesbury-Nepean Valley.

Council is awaiting the release or further details of a range of targeted actions across the nine outcomes contained within the *Hawkesbury-Nepean Valley Flood Risk Management Strategy – Resilient Valley, Resilient Communities*, including:

- Outcome 3 Strategic and integrated land use and road planning – strategic land use framework for the Hawkesbury-Nepean Valley being prepared by the Department of Planning and Environment, the details of which are yet to be received by Council
- Outcome 4 Accessible contemporary flood risk information noting that the Regional Flood Study was released in 2019 and that a 2D Model is currently being prepared
- Outcome 8 – Adequate local roads for evacuation – it is understood that TfNSW is working on a program of works to upgrade evacuation routes which is yet to be received by Council.

Response

WaterNSW notes Council's advice and considers no further response is required.

Issue 4

Council is concerned about infrastructure provision, including potential loss of power, telecommunications, and lack of access to emergency services during flood events.

Response

One of the benefits of the Project is to reduce the risk to property damage including infrastructure assets of public utilities. Chapter 21 and Appendix M of the EIS describe the potential impacts to utilities and social infrastructure due to the Project. The loss of utilities due to flood events incurs both direct and indirect costs to communities and businesses. For example, the Yarramundi, Richmond and Windsor bridges are highly vulnerable to floods and are a cause of isolated flood islands, cutting people off from emergency services. The loss of power and water in flood events would exacerbate vulnerabilities in these isolated areas.

However, utilities would be afforded additional protection due to the Project. For example, and as detailed in Section 8.4.5 of Appendix M, electricity outages in Hawkesbury would currently occur in a 1 in 10 chance in a year event. With the Project, electrical outages would only occur in a 1 in 50 chance in a year event. While health facilities, such as the Nepean Hospital, are not affected by flood events, the Hawkesbury District Health Service and Windsor Specialist Medical Centre would currently be impacted by a 1 in 100 chance in a year event but would not be affected with the Project. Further, the Project would improve access to and for emergency services due to increased time to evacuate and the reduced frequency and severity of flood events.

Issue 5

Council is concerned about increased development in areas likely to be inundated or cut off by flooding (Pitt Town, McGraths Hill, South Windsor, Windsor Downs, Bligh Park, etc).

Response

The intention of the Project is not to promote development in the Hawkesbury-Nepean Valley but rather to reduce the risk to life and property in already developed areas. It is recognised that development in the floodplain areas were based on past planning and development guidelines. The Project is part of the Flood Strategy that comprehensively addresses the flood risk in the region and also considers the future land use and planning under Outcome 3 – Strategic and integrated land use and road planning.

Development in the floodplain needs to be carefully managed, now and into the future. Actions are being developed that take a strategic, floodplain-wide approach, integrating flood risk with the land use potential, which will set a settlement pattern for the Hawkesbury-Nepean Valley. The Western City District Plan and Central City District Plan set out a series of principles for land-use planning in the Hawkesbury-Nepean Valley floodplain. These principles guide both strategic planning and development decisions, such as avoiding intensification and new urban development on land below the 1 in 100 chance per year flood. In addition, DPE is leading the development of a Regional Land Use Planning Framework to take account of the impacts of growth across the floodplain.

Issue 6

Inadequate evacuation routes, improvement of which would also improve travel times for those working outside the LGA each day.

Response

Section 6.4.8 in Appendix M of the EIS details the current evacuation routes within the Hawkesbury-Nepean Valley. During EIS preparation, stakeholder consultation raised a need for improved floodplain evacuation routes. A key objective of the Project is to delay peak flooding to provide additional time for the evacuation of flood-affected areas.

Section 8.4.3.1 in Appendix M of the EIS outlines the impacts of the Project on evacuation routes. It concludes that the Project would substantially reduce the frequency of flood events, avoiding evacuation routes being cut from McGraths Hill, Pitt Town and Windsor. For large flood events, the evacuation routes would also remain open longer. This would substantially reduce the risk of loss of life in a major flood event. The improvement of evacuation routes would also indirectly enhance connectivity across the floodplain, including for residents, workers and visitors.

Outcome 8 - Adequate local roads for evacuation – of the Flood Strategy is being coordinated by Infrastructure NSW and is complementary to but separate to the Project and its assessment under the EP&A Act.

Issue 7

Concerns about development along flood evacuation routes which will slow evacuation by Hawkesbury residents.

Response

Outcome 8 - Adequate local roads for evacuation – of the Flood Strategy is being coordinated by Infrastructure NSW and is complementary to but separate to the Project and its assessment under the EP&A Act

5.2.2 Socio-economic

Issue

It is recommended that greater detail regarding the proposed mitigation measures be provided, and in particular, additional information on:

- What proportion of impacted residential properties are expected to benefit from the implementation of mitigation measures that are designed to reduce the impact of FMZ discharge events
- The anticipated duration of the impact on visual amenity associated with the release of the FMZ and what clean-up costs would involve
- How many agricultural and industrial businesses can be expected to be impacted (and for how long) with release of the FMZ, and what proportion of these businesses are expected to avoid this impact with the implementation of the mitigation measure?
- Environmental impacts downstream, including bank erosion, high impacts on critically endangered ecological communities and wetlands, and prolonged flooding of Scheyville and Cattai National Parks
- Concerns on the impacts on downstream prawn and fishing industries, and the need for further details or commitments to mitigate the impacts.

Response

The raised dam and its operation are designed to minimise the number of residential properties impacted by flooding. This is not only by lowering the flood peak so less properties are impacted by flooding, but also emptying the FMZ at a rate of 100 GL/d. This should largely keep flooding within bank and be similar to a 1 in 2 level flood event or minor flood level, well below residential development, and would allow North Richmond and Windsor Bridges to be opened.

The duration of the FMZ drawdown releases are described in Chapter 15 of the EIS and further addressed in the PIR. The clean-up costs will be reduced as the project reduces the flood peak and hence the extent of the area impacted by flooding requiring clean-up. The post releases are contained within the river banks except in the low-lying areas of the Richmond Lowlands.

There is limited development in the area impacted by the FMZ drawdown, the vast majority of the land impacted being agricultural. This area would currently often be subject to small floods (once every two years on average). The project reduces peak flood levels, so there will be no additional agricultural or industrial businesses impacted by the FMZ releases that would not otherwise have been impacted without the Project. Operation of FMZ releases may increase bank full flows for up to14 days than is currently the case for large floods, however this poses a low risk of impacting on commercial estuarine fisheries compared to current impacts from unregulated floods.

Erosion and bank stability during FMZ flows are addressed in Appendix N2 to the EIS. In response to submissions further investigations were undertaken, which are included in Appendix G. It was generally concluded that the Project would reduce the risk of scour and bank failures between Warragamba Dam and Yarramundi, and Cattai Creek to Wisemans Ferry. However, the risk may be higher between a smaller river section of river between North Richmond and Cattai Creek. FMZ operational controls will be designed to manage these risks.

Issue 2

It is considered that the EIS has an apparent over-stating of the benefit to those living in manufactured housing or social housing at risk of flooding (impact 12 and impact 13). It may also wish to consider highlighting the lack of information regarding indirect impacts such as the potential decline in affordable housing as a consequence of the Project and a more confident housing market. It is also recommended that the Government investigate appropriate mitigation measures to address such issues.

Response

Section 8.4.1.1 in Appendix M of the EIS details the impacts to property within the downstream communities currently affected by flooding. The Project would affect property and land use downstream by reducing risk to property damage by reducing the number of properties currently inundated by flooding events.

There are approximately 1,600 social housing properties at risk of flooding in the valley. The reduction of flood flow and extent by the Project would reduce the risk to vulnerable people living in social housing.

By applying the likelihood and consequence criteria outlined in Section 4.5.3 in Appendix M of the EIS, the benefits of the Project to those residents living in manufactured or social housing is significant due to their high vulnerability and due to the likelihood of the impact being almost certain.

The recent flood events from February 2020 to July 2022 highlights why flood mitigation is important for the valley and reducing the risk to flooding to people and property is the basis of the flood strategy for the valley.

Issue 3

It is recommended that given the basis for the assessment of the potential reduction in insurance premiums was a preliminary analysis undertaken in 2014, as the source is preliminary and somewhat dated, further detail on the assessment of this impact, especially as the residual impact is assessed as ‘extreme benefit’ and given community concern about insurance premiums.

Highlight that for many Hawkesbury residents on the floodplain that the costs of insurance are prohibitive, and that it is considered there is a need for a government-based insurance scheme to combat those costs.

Response

The actuarial assessment of flood insurance costs are based on annual average damages, which was confirmed by the 2014 comparison of the government and insurance estimates of flood risk. The assessment of benefits is based on the latest assessment of flood damages on an annual average basis.

Section 8.4.3.1 in Appendix M of the EIS details the costs of property insurance on the Hawkesbury-Nepean Floodplain, which is considered to have the highest single flood exposure in NSW, if not Australia (*Hawkesbury-Nepean Valley Flood Risk Management Strategy 2017*). Engagement undertaken for the socio-economic impact assessment identified that the Project has the potential to reduce insurance for property and business on the Hawkesbury-Nepean Floodplain, which is viewed as a key Project benefit.

Consideration of a government-based insurance scheme in response to prohibitive costs of property insurance is a matter of policy for the NSW Government.

5.2.3 Flood planning

Issue 1

It is recommended that that a further improvement of the EIS could be a commitment that if the project were to go ahead, the updated flood planning documentation would be to consider flood risk to downstream property in a fully probabilistic sense, and with regard for flood islands, so future land use planning can be done accordingly. Also, that the updated flood study be provided to home insurers, so that flood insurance premium reductions can be realised.

Response

The matter of updating flood planning documentation is a separate issue to the Project. It is anticipated that this would be addressed through other outcomes identified in the Flood Strategy, for example Outcome 1 (Coordinated flood risk management across the Valley now and in the future) and Outcome 3 (Strategic and integrated land use and road planning). Updated flood studies are made publicly available and a source of information for the insurance industry as they may use when determining premiums.

Issue 2

The EIS should consider a potential change to floodplain storage between the time of writing of the EIS and completion of the project, and later as a result of development changes resulting from the project.

Response

This is a separate issue to the Project. It is anticipated that this would be addressed through Outcome 1 (Coordinated flood risk management across the Valley now and in the future) and Outcome 3 (Strategic and integrated land use and road planning) of the Flood Strategy (Infrastructure NSW 2017). There would be no development changes due to the Project and the current 1 in 100 chance in a year flood remains the default planning level for the floodplain.

Issue 3

It is recommended that the EIS consider committing to actual mitigation of ecological and geomorphic impacts resulting from the project, rather than just an additional study into the potential for impacts.

Response

Post the EIS exhibition further analysis has been given to matters related to groundwater, geomorphology and biodiversity which are contained within this report and in the PIR. This further analysis also informed the mitigation and management measures as presented in the EIS, and a revision of these has been included in Appendix B to this report.

Issue 4

It is recommended that the EIS note that there are currently areas in the HNV floodplain that do not have a flood warning system.

Response

This is a separate issue to the Project. It is anticipated that this would be addressed through Outcome 4 *Accessible contemporary flood risk information* and Outcome 6 *Improved weather and flood predictions* of the Flood Strategy (Infrastructure NSW 2017).

Issue 5

A lack of water level monitoring and timely access to this information for residents.

Response

This is a separate issue to the Project. It is anticipated that this would be addressed through Outcome 4 (Accessible contemporary flood risk information) of the Flood Strategy (Infrastructure NSW 2017).

Issue 6

Expert advice that changes in land use will change overland flow of water into the Hawkesbury-Nepean basin, rendering the dam less able to mitigate flooding and giving a false sense of security for residents and emergency services.

Response

It is unclear as to the precise nature of the expert advice that is being referred to limiting a meaningful response. However, it is noted that Outcome 3 (Strategic and integrated land use and road planning) of the Flood Strategy (Infrastructure NSW 2019, p38) notes

> *The Warragamba Dam wall raising is designed to reduce flood risk for the current and future population based on development that is currently permissible. As it will not eliminate flood risk entirely, growth will need to be carefully managed in the Valley.*
>
> *While development will still occur in the Valley, the benefits of the dam wall raising in reducing the risk to life and flood damage will be lost if development is not managed in flood-prone areas. This means that areas subject to current flood-related development controls based on the 1 in 100 chance per year flood level (that is, below 17.3 metres above river level at Windsor and 25.9 metres at Penrith) will continue to be subject to controls following the Warragamba Dam wall raising.*
>
> *New development restrictions may also apply — particularly around areas with existing higher flood risk. It is important to ensure that population growth in the Valley is carefully managed,*

> *both in terms of absolute numbers of people and the distribution of the population within the Valley. This means that land use and road planning will need to account for the cumulative impact of growth on road evacuation capacity.*

It is anticipated that the associated actions for this outcome would contribute to mitigating this risk. Other outcomes and their associated actions would similarly contribute to mitigating this risk.

Issue 7

The likely delayed drop in flood levels due to water being released from the dam and the impact of prolonged flooding on downstream communities including ratepayer funded infrastructure.

Response

The Project would significantly reduce flood peaks. Operation of the FMZ following the flood peak would result in an extended period of elevated downstream water levels for up to about 14 days. Flows would be equivalent to about a 1 in 2 chance in a year flood and would largely be contained within the main river channel, with the exception of some low-lying areas such as the river flats between Richmond and Pitt Town.

Consideration of potential impacts on downstream communities is provided in the socioeconomic impact assessment presented in Chapter 21 of the EIS and Appendix M to the EIS. Further consideration of potential impacts on downstream bank stability associated with operation of the FMZ is provided in Appendix G. It was generally concluded that erosion potential would reduce for much of the river length, however an increase in erosion potential would be expected for the section of river between Windsor and Cattai. FMZ operational controls will be designed to manage these risks.

It is noted that flooding is already an existing risk to downstream communities and ratepayer funded infrastructure.

Issue 8

Concerns about water quality following inundation, with upstream organic matter being disturbed during flood events, washed downstream and affecting the Hawkesbury local government area and its residents.

Response

Consideration of potential water quality impacts associated with the Project is provided in Chapter 27 of the EIS. The assessment, based on a quantitative analysis, concluded that there would be negligible impacts on the downstream environment from changes in water quality associated with operation of the FMZ.

It is noted that changes to water quality associated with inundation from flood events is an existing risk to downstream receiving areas.

Issue 9

Lack of flood studies for all tributaries within the valley.

Response

WaterNSW advises that every tributary in the valley was included in the modelling. The flood modelling for the Project and its benefits covered the entire Hawkesbury-Nepean watershed including all tributaries (as outlined in Appendix H1 to the EIS). Stochastic regional rainfall events were generated across the entire catchment, and the amount and timing of runoff and flood levels modelled from the event.

5.2.4 Upstream impacts

Issue 1

It is recommended that the EIS consider the cost effectiveness and environmental efficacy of the proposed offsets program.

Response

The approach to offsetting biodiversity impacts is presented in Appendix F6 to the EIS. The offset program was developed in consultation with government agencies, and was based on an assumed total loss of environmental values in the Project upstream impact area (PUIA).

Further to the proposed biodiversity offset program , the delivery of biodiversity credits would broadly involve identification and costing of a series of on park management actions that would deliver a biodiversity benefit on-park equivalent to the biodiversity credits to be retired, and:

- Management actions would be proposed for each impacted species and ecosystem; that is each species/ecosystem that generates a credit liability will be the subject of targeted management actions
- Management actions would be designed, based on the best available science, to deliver a biodiversity benefit on park for the relevant species/ecosystem that is at least equal to the assumed loss in the PUIA.

The revised offset strategy is discussed in more detail in Section 3.3 of this report.

Issue 2

It is recommended that:

- Other mitigation schemes should be considered in the EIS
- Additional investigation into the expected downstream ecological impacts of the Project should be undertaken
- The EIS should better commit to mitigating upstream impacts resulting from the operation of the FMZ.

Response

With regard to the first and third points, please refer to the response above.

With regard to downstream Project impacts, Appendix F2 to the EIS concluded that there would be overall positive benefits due to reduced flood frequency and extents. In response to submissions further groundwater (see Appendix E to this report), and geomorphology (see Appendix G) assessments were done, which confirmed that the Project would not significantly impact on groundwater resources and current geomorphological river characteristics. However, during FMZ operation a section of river between Windsor and Cattai may experience increased erosion risk.

Issue 3

Council considers that the EIS is unsatisfactory in terms of environmental and cultural heritage impact statements, including the lack of acknowledgement of the impacts on the Aboriginal Cultural Heritage of the Gundungurra People and failure to comply with the Burra Charter.

Response

The EIS has been prepared in accordance with the SEARs and applicable legislative requirements. Similarly, the Aboriginal cultural heritage assessment has been prepared in accordance with relevant NSW heritage guidelines and other guidelines such as the Burra Charter. Further assessment of potential impacts on Aboriginal cultural heritage has been carried out and is documented in Section 6.2 of the PIR. The assessment clearly identifies the potential impacts of the Project on Aboriginal cultural heritage.

Issue 4

It is recommended that:

- The EIS provide more clarity on the likely contents of dedicated Aboriginal cultural heritage management plan and the potential residual impacts of the Project on cultural assets
- The EIS commit to further engage aurally with local Aboriginal communities to gauge local sentiment toward the program, and the establishment and function of the Aboriginal cultural heritage 'keeping place' and the proposed offsets program, and share the results in the EIS
- The EIS state the status of support of Aboriginal parties (e.g. RAPs) of the Project
- The Project engage cultural advisors to ensure that an Aboriginal voice is present when discussing cultural heritage issues.

Response

Further assessment of potential impacts on Aboriginal cultural heritage has been carried out and is documented in Section 6.2 of the PIR.

As per management measure ACH3, preparation of the ACHMP would occur prior to construction. The ACHMP would be developed and managed in consultation with the RAPs and relevant regulatory authorities.

Mitigation measure ACH1 commits to continued consultation and engagement with the Registered Aboriginal Parties for the duration of the Project (refer Appendix B to this report). As previously noted, the proposed biodiversity offset strategy will include management actions that will safeguard environmental qualities.

The views of RAPs with regard to the Project are presented in Appendix K to the EIS.

WaterNSW currently employs an Aboriginal Engagement Manager. The purpose of the role is to support WaterNSW in fostering cultural inclusion and representation of Aboriginal interests both with regard to the Project and more widely across the organisation. The current incumbent has played a key role in developing WaterNSW's Reconciliation Action Plan by representing WaterNSW as one of the three First Nation employees in providing ideas and insights into how WaterNSW is tracking as an organisation, as well as providing feedback into current processes and procedures with how WaterNSW engages with the First Nation communities.

5.2.5 Other findings

Issue 1

The review has also identified a number of general findings as follows:

- The EIS appears to have been based on fit for purpose hydrologic and hydraulics analysis of the impact of the Project on flood conditions in the Hawkesbury-Nepean Valley. There are minor improvements that could be made to the method, however their impact on the results is likely limited, and these improvements could still be utilised at a later date when revising the relevant flood studies.
- Mitigation and management measures relating to the impact of flooding on geomorphology, biodiversity and Aboriginal cultural heritage were found to be light on and non-committal.

- Quantitative figures regarding the impact of flood risk draw from a number of sources over a period of time extending back to 2012. This made it difficult to determine the 'point of truth' between flood risk impacts published in various state government strategic planning documents.
- Within the Socio-economic chapter, there is a reliance on secondary research and older studies to assess a number of impacts. It's not clear the extent to which this detracts from the overall findings.

Response

The environmental assessment for the Project has been based on hydrological modelling carried out for Infrastructure NSW and WaterNSW. The most complete account of this is provided in the Final Report for the Hawkesbury-Nepean Valley Regional Flood Study prepared by WMAwater (2019) on behalf of Infrastructure NSW. As with any such modelling there is always scope for further refinement but the modelling that the assessment has drawn on has been subject to rigorous checking and review, and is considered sufficiently robust for this purpose.

Further consideration has been given to matters related to geomorphology, biodiversity and Aboriginal cultural heritage in this report and in the PIR. This has informed review of the mitigation and management measures presented in the EIS, and revision as considered appropriate (refer Appendix B to this report).

It is unclear what Council's intended meaning is with regard to the term 'point of truth'. It is noted that the understanding of flooding behaviour (and flood risk) in the Hawkesbury-Nepean Valley has been evolving since the 1990s (refer Sections 3.4 and 3.5 of the Final Report for the Flood Study), with the various studies undertaken feeding into strategic and local planning processes that address flood risk.

With regard to the socioeconomic assessment documented in Chapter 21 of the EIS and Appendix M to the EIS, this was informed by a comprehensive engagement program to obtain primary data in order to understand the socio-economic context and to identify impacts and management measures. This was supplemented with secondary research where data was not able to be obtained via stakeholder engagement.

Section 7.4 of Appendix M outlines the engagement activities undertaken specifically to inform the Socio-economic Impact Assessment and the identification and substantiation of potential impacts and benefits. Engagement activities involved communities based in the upstream and downstream areas, and particularly focused on the communities of Warragamba and Silverdale. Direct forms of engagement included the following:

- Scoping interviews with local government authorities and other key stakeholders (16 interviews)
- A phone-based survey (310 organisations contacted, 69 surveys completed)
- A web-based survey (197 organisations contacted, 61 surveys completed)
- A business survey (170 businesses contacted, 50 surveys completed)
- Stakeholder workshops with community representatives and organisations that serve the Warragamba, Wallacia and Silverdale communities (of the 38 invitees, 32 accepted the invitation to participate).

The design and approach to community and stakeholder engagement has considered inclusion of vulnerable groups.

5.3 Hornsby Shire Council

5.3.1 Flooding and hydraulic impacts

Hornsby Shire Council (HSC) is an active project partner in several technical working groups investigating flood modelling and mitigation strategies for the Hawkesbury-Nepean catchment. In particular we are currently involved in Infrastructure NSW's Hawkesbury-Nepean River Flood Study and we have recently engaged consultants from Rhelm to assist a consortium of councils managing the Hawkesbury estuary in filling in knowledge gaps for a Tidal inundation study at the entrance section of the Hawkesbury River system as part of the development of the Hawkesbury-Nepean Coastal Management Program (CMP, further information on this program below).

Wisemans Ferry area represents the upstream LGA boundary for Hornsby Shire. The EIS identifies, based on the downstream hydrological modelling, Wisemans Ferry area as the furthest downstream section of the river system that will be slightly impacted by the dam raising project.

As described in the EIS documentation, HSC acknowledges that Warragamba Dam Raising is a project to provide flood mitigation to reduce the significant existing risk to life and property in the Hawkesbury-Nepean Valley downstream of the dam.

HSC supports the information provided for normal operations of the dam that occur when the dam storage level is at or lower than FSL. As noted in the documentation no changes are expected. These operations are essential contributing to environmental flows in the estuary, which is key to sustaining the ecology of the aquatic fauna of the estuary.

Our main concerns are in relation to the downstream impacts from the management of flood operations in the FMZ when the water level approaches the FSL and/or the 'controlled discharges' as per Fig 9-4 included in the EIS. We consider these operations will have associated socio-economic and ecological significant impacts that have not been sufficiently considered in the EIS documentation.

When the EIS refers to 'downstream' impacts or assessments it focuses mainly in the stretch of river from directly downstream of the dam to Wiseman Ferry after which downstream impacts are negligible. We note that some of the maps provided present the boundary of this project to be the M1 freeway bridge crossing the Hawkesbury from Kangaroo Point to Mooney Mooney. However, most downstream aspects of the various components of the EIS relate to the area from the dam wall to Windsor. Council wishes to highlight that this is not entirely accurate from a hydrological, ecological and water quality point of view.

HSC manages six real-time water quality monitoring stations deployed along the main arm and in some of the major creeks of the Lower Hawkesbury (from Wisemans Ferry to the confluence with Cowan Creek at the mouth, HornsbyShireCouncil (mhlfit.net)). These stations not only collect water quality information, but they are also used to provide advice to the oyster industry on the management of their oyster harvest areas, to assist the school prawn industry in identifying best trawling grounds and to provide daily swimming conditions for community to interact with the estuary in a safe way. In addition, a significant amount of work goes into monitoring the water quality of the estuary which includes harmful algae and pathogens. Based on a close inspection of the HSC monitoring stations data and dam releases when the water level is higher than the FSL over the last 2-3 years we see significant impacts including:

- Significant drops in salinity levels in the Lower Hawkesbury which has impacts on the ecology of the local aquatic fauna and riparian vegetation (mangroves). Impacts on mangroves, in particular, has been exacerbated by the impact from both recent floods in 2020 and 2021
- Significant drops in salinity impacting the period during which oysters can be harvested which creates significant economic consequences to the Hawkesbury oyster industry. This is particularly important when dam releases are around or above 3,500 ML/d for longer than two weeks.
- Changes in salinity and turbidity levels result in changing in the areas used by school prawns and mud crabs which means the industry needs to adapt to these changes
- Overall changes in water quality have been observed when discharges exceed 5000 ML/d during a week. We are expecting associated downstream changes in nutrient cycles and algae species dynamics
- Prolonged discharges also result in changes in tidal exchange and water residence times, in particular for the secondary estuary arms like Berowra Creek, Mangrove Creek, Mooney Mooney Creek and Mullet Creek
- Changes in salinity along the river/estuary, not associated with typical catchment run-off (stormwater, rainfall), are impacting the swimmability algorithm currently used to provide advice on swimming conditions in the Lower Hawkesbury estuary.

Response

The extent of the downstream study area was set through the SEARs (both initial and revised) which required consideration of potential impacts of the Project up to the PMF. During the course of the assessment, it was identified that based on the hydrological modelling and water quality assessment, the downstream influence of the Project extended to the Wisemans Ferry locality, and there were negligible impacts beyond this location.

There have been nine instances since August 2020 where FSL was exceeded. The most recent instance prior to this was in July 2016. Two significant events have occurred in this recent period:

- 21 March to 1 April 2021, Lake Burragorang peaked at 1.16 metres above FSL
- 2 March to 22 March 2022, Lake Burragorang peaked at 1.21 metres above FSL.

Flood modelling for the review of the 2021 flood (Infrastructure NSW 2021) showed that about 60 percent of the volume of floodwaters to Windsor came from the Warragamba catchment, with the remainder being contributed from other tributaries including the upper Nepean River, Erskine Creek, Glenbrook Creek, Grose River and South Creek.

Historically the Warragamba catchment has contributed up to nearly 70 percent to downstream flooding (refer Figure 3-2 in Chapter 3 of the EIS - Relative contributions of different river catchments in range of Hawkesbury-Nepean Valley floods). However, this can vary substantially as was the case for the February 2020 flood event where, due to the low level of Lake Burragorang, the Warragamba catchment contributed only 42 percent to downstream flooding.

5.3.2 Statutory and coastal management framework

The EIS does not consider the objectives of either the *Marine Estate Management Act 2014* or the *Coastal Management Act 2016*. These two overarching statutes govern the management of the NSW marine estate and coastal zone respectively. While we acknowledge that the ultimate goal of the project is to provide flood mitigation to reduce the significant existing risk to life and property in the Hawkesbury-Nepean area, more consideration of the impacts on receiving waters should be provided in the context of the legislation above and the management frameworks, guidelines and programs developed thereunder.

In particular:

- Hawkesbury-Nepean River Coastal Management Program (CMP, See: Hawkesbury Nepean River System CMP (www.hawkesburynepeancmp.org)) – The six councils with management jurisdiction over the lower river (Hawkesbury, The Hills, Hornsby, Kur-ring-gai, Central Coast and Northern Beaches) are working collaboratively to develop a whole of system CMP in accordance with the NSW Coastal Management Framework. The study area for this CMP extends from the tidal limit of the river at Yarramundi to the ocean and encompasses the associated estuaries of Brisbane Water, Broken Bay and Pittwater. The development of a CMP follows a risk-based process whereby threats and stressors to the system are identified, assessed and ultimately addressed through the development and implementation of management actions. CMP's must address the objectives of the Coastal Management Act, demonstrating how these will be achieved and ultimately how management intervention will improve the health and vitality of the coastal zone. The impacts of flooding, particularly the combine process of catchment flooding and oceanic inundation, are key hazards that need to be considered under the CMP. It is recommended that the EIS consider the impacts on the lower river in the context of the CMP with a focus on the first pass risk assessment contained within the stage 1 scoping study and the current Industry NSW (INSW) Flood modelling project.
- Marine Estate Management Strategy (MEMS) Threat and Risk Assessment (TARA, See: Threat and risk assessment (nsw.gov.au)) – MEMS is underpinned by a state-wide TARA which identifies key threats to the NSW Marine Estate in order to prioritise funding and management of these processes. Key priority threats to the NSW Marine Estate include modified freshwater flows and flooding which are both likely to be exacerbated under climate change scenarios. The impacts of these processes along the lower river are multi-faceted ranging from social impacts on the ability of the community to utilise the river for recreation, economic impacts on commercial tourism, fisheries and aquaculture and environmentally ranging from direct impacts on riparian zones, foreshores and wetlands to trophic impacts within the river. While these impacts may be of a relatively short duration presently, it is likely that frequency and duration will increase under climate change scenarios. It is recommended that the EIS consider the impacts on the lower river in the context of the MEMS TARA.
- Need for a collaborative approach across all levels of government regarding floods and floodplain management. This has been highlighted in the *Resilient communities Hawkesbury-Nepean Valley Flood Risk Management Strategy 2017* prepared by INSW. There appears to be a lack of coordinated and transparent alignment between this Strategy and dam proposal.

In summary, the EIS should recognise the social, economic and ecological impacts from prolonged dam discharges and/or flood operations when the water level is higher than the FSL even if these impacts are not as severe as for the areas directly downstream of the dam wall. The commercial fishing industries and recreational users of the Lower Hawkesbury estuary rely on optimal water quality conditions for their operations and activities. We encourage communication regarding dam's water release management with downstream users and management practitioners with the aim of managing flood risk resulting in minimal impacts downstream (Wisemans Ferry to the mouth of the Hawkesbury River).

Response

Mapping for the application of the *Coastal Management Act 2016* within the study area includes wetland areas downstream of the Grose River junction with the Hawkesbury-Nepean River. The application of the *Coastal Management Act 2016* is specifically addressed in Table 3-1 in Appendix F2 to the EIS *Downstream Ecological Assessment*, which notes that the Project could potentially impact on coastal wetlands and proximity areas of coastal wetlands under this Act. Table 3-1 in Appendix F2 to the EIS further notes that development within coastal wetlands is classed as 'designated development' and requires further assessment, however that designated development does not include SSI proposals such as the Project.

The *Marine Estate Management Act 2014* enables the preparation and approval of a Marine Estate Management Strategy, currently the *NSW Marine Estate Management Strategy 2018-2028*, which includes the estuary portion of the Hawkesbury River. As previously noted, the influence of the Project downstream of Wisemans Ferry declines and other factors within the downstream catchment have a greater impact on water levels and water quality.

Potential impacts on wetlands are addressed throughout the EIS including in Chapter 9 and Appendix F2 (terrestrial biodiversity), Chapter 27 (water quality) and Chapter 15 and Appendix H1 (flooding and hydrology). Section 15.7.7 in Chapter 15 of the EIS notes that there would be minimal impacts on groundwater-dependent ecosystems (GDE) such as wetlands. The discharge of water from the FMZ at a rate of around 100 GL/d is assessed as having a marginal benefit to wetlands (refer Table 15-29 in Chapter 15 of the EIS). In response to submissions further groundwater and geomorphology assessments (refer Appendices E and G to this report respectively) were done, which confirmed that the Project would not significantly impact on groundwater resources and current geomorphological river characteristics. However, during FMZ operation a section of river between Windsor and Cattai may experience increased erosion risk. FMZ operational controls will be designed to manage this risk.

Further assessment of potential impacts of the Project has been carried out on Longneck Lagoon, which is identified as a high priority GDE in the *Greater Metropolitan Region Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources* (NSW Office of Water 2011). The assessment was undertaken after recent flooding and assessed resilience of vegetation to periodic inundation. This is discussed in Section 6.7.2 of the PIR.

Potential socioeconomic impacts of the Project on the broader downstream area are considered in detail in Appendix M (*Socio-economic, Land Use, and Property Assessment Report)* to the EIS and in Chapter 21 (*Socio-economic, land use and property)* of the EIS.

5.4 Liverpool City Council

5.4.1 Traffic and transport

Issue 1

While the operation of the raised dam wall is unlikely to generate additional vehicle moments, the construction phase associated with the Project will result in increased vehicle movements on the local road network. To ensure that impacts to the local road network are understood and appropriately mitigated, the impacts resulting from the construction phase must be understood, and strategies developed to deal with these impacts.

The intersection of Northern Road/Park Road is operating at an unacceptable Level of Service (i.e. LOS F) based on 2018 survey data. Consideration should be given to providing some temporary treatments to improve road safety at this intersection during construction. This should be addressed as part of the road safety audit for construction.

Response

Table 24-10 in Chapter 24 of the EIS indicates that in 2022 all intersections with and without Project-related traffic would operate at LOS A in the AM and PM peaks, except for The Northern Road/ Park Road intersection, which would operate at LOS B. Should it be approved, construction of the Project would commence after 2022. It is not expected that an increase in background traffic volumes due to the later construction start date would result in significant deterioration of intersection performance.

Issue 2

The proposed traffic impact mitigation measures in Table 7-1 of Warragamba Dam Raising EIS Appendix O *Traffic and Transport Assessment* should be included in the development consent conditions.

Response

This is a matter for DPE in its assessment of the Project.

Issue 3

A Construction Traffic Management Plan (CTMP) detailing updated construction vehicle routes, number of trucks, hours of operation, access arrangements and traffic control should be prepared for future developments and submitted to Liverpool City Council's Traffic and Transport Section for approval prior to the issue of a Construction Certificate.

Response

Approval of the construction TMP would fall under the SSI approval, which will remove the requirement for Council approval. However, WaterNSW will consult with Council during preparation of the construction TMP. Environmental management measure TT1 (refer Appendix B of this report) has been revised to include reference to consultation with relevant road's authorities.

Issue 4

The CTMP should outline the need for a Road Occupancy Permit issued by Council or Road Occupancy Permit issued by the Transport Management Centre. Works within the road reserve should not commence until the CTMP has been endorsed.

Response

Environmental management measure TT1 (refer Appendix B of this report) has been revised to include reference to obtaining all necessary permits, licences and approvals, including Road Occupancy Permit(s).

Any required works within the road reserve will not commence until the CTMP has been approved.

Issue 5

A Stage 1 road safety audit should be carried out during preparation of the CTMP and submitted to Liverpool City Council for review.

Response

Environmental management measure TT10 commits to the carrying out of a road safety audit (RSA) at the detailed construction TMP development stage. The RSA would form part of the supporting information with regard to submission of the CTMP for approval.

5.4.2 Impacts on downstream biodiversity

5.4.2.1 Survey

The downstream on-ground biodiversity survey area only covered land within the existing 1 in 10 chance in a year flood event. The EIS indicates that the former DPIE agreed upon this approach (as stated on page 9-7). This is in contrast with the substantially larger study area for Matters of National Environmental Significance agreed upon by DoEE (now DAWE), which encompasses land up to the existing PMF.

Given the degree of impact uncertainty, the larger area would appear to be more appropriate to ensure that impacts are not underestimated, and should be supported by an expanded on-ground survey area rather than relying on desktop resources.

Response

The downstream assessment area was agreed to in a meeting attended by representatives from OEH, DoEE, DPE and WaterNSW on 19 September 2017. Please refer to the response provided to the first issue in Section 4.1.2.3 with regard to the agreed downstream targeted survey area.

5.4.2.2 Changes to environmental flows

Infrastructure to allow for the management of environmental flows is proposed as part of the Project. However, potential impacts of environmental flow changes are excluded from the assessment as it is proposed to be considered separately. The SEARs for the project include the requirement that 'The proponent must assess the downstream impacts on threatened biodiversity, native vegetation and habitats resulting from any changes to hydrology and environmental flows.'

Given that changes to environmental flows have the potential to interact with other impacts cause by the Project, potential impacts should be identified and assessed.

Response

As noted in Section 1.2 of the EIS, the Project would take the opportunity during construction to install the physical infrastructure to allow for management of environmental flows as outlined in the NSW Government's *2017 Metropolitan Water Plan*. However, the actual environmental flow releases themselves do not form part of the Project and are subject to separate administration (including assessment) under the *Water Management Act 2000*.

5.4.2.3 Protected lands

Two areas of biodiversity significance within the Liverpool LGA which may be impacted by the proposal are Bents Basin State Conservation Area and Gulguer Nature Reserve. These should be considered by the EIS where appropriate.

Chapter 20 *Protected and sensitive lands* and Table 9-20 should include the consideration of Bents Basin State Conservation Area and Gulguer Nature Reserve.

Response

The two areas noted would experience a reduced extent of flooding (refer Figures 15-58, 15-63, 15- 68, 15–73 in Chapter 15 of the EIS) with the Project. Both areas are considered in the downstream biodiversity assessment (Appendix F2 to the EIS).

5.4.2.4 Management of loss of biodiversity

Issue 1

The EIS acknowledges a high degree of uncertainty with regard to quantifying and qualifying downstream impacts. The resolution of uncertainties included in Table 29-4 for biodiversity are only discussed for upstream impacts but are also applicable to downstream impacts. This includes the following uncertainties:

- Impacts of temporary inundation on vegetation
- Extent of plant community types
- Presence and distribution of threatened species.

The only management measure identified for downstream impacts is to develop an operational protocol for the FMZ. The EIS assumes that the protocol would seek to minimise potential biodiversity impacts downstream associated with inundation. However, this would be subject to meeting operational priorities for protection of life and property (the primary purpose of the project), which introduces significant uncertainty in the feasibility of minimising biodiversity impacts. The EIS should assume that there is limited opportunity for the protocol to minimise impacts to biodiversity to ensure that impacts are not underestimated.

Response

It should be noted that the Project would significantly reduce the extent and frequency of damaging flooding, and hence there would be significant positive benefits in protecting catchment-wide biodiversity. However, operation of the FMZ may result in main river-bank flows for up to a maximum of about 10 days after the flood peak. This would occur if the FMZ is at capacity (1,000 GL), which is equivalent to a greater than a 1 in 20 chance in a year flood. The FMZ would be emptied much sooner for smaller floods.

Table 9-15 in Chapter 9 of the EIS assesses a low risk of potential impact due to low level FMZ flows. This was confirmed by supplementary groundwater and geomorphological studies, which are discussed in the PIR. Management of FMZ discharges will be done to prevent significant overbank flows and operational details are further discussed in Appendix B to the PIR.

Issue 2

No biodiversity offsetting is proposed for impacts to downstream areas despite the identified potential for significant impacts. As noted above, only one management measure has been identified. The EIS appears to identify the difficulties of quantifying the downstream impacts as rationale for the general absence of mitigation and offset measures. However, this should be taken as an indication that a conservative approach is warranted.

Response

In response to submissions additional studies have been undertaken to assess downstream biodiversity responses to potential groundwater and geomorphological changes due to the Project, as well as surveying the effects of recent flooding and temporary inundation at Longneck lagoon. These studies are discussed in the PIR. Assessments of significance were also reviewed and updated. It was generally found that potential impacts on biodiversity would likely be less than presented in the EIS, with only two threatened species assessed as having a potential significant potential impact.

Issue 3

Additional management measures should be prescribed to help mitigate potential downstream impacts. This should include long-term monitoring, preventative measures such as improving riparian vegetation to protect banks from erosion, and protocols for responding to any impacts potentially caused by the Project. Given the potentially significant residual impacts, offsetting measures should be considered.

Response

The EIS and supplementary information do not support the conclusion that there would be 'potentially significant residual impacts'. There would likely be substantial Project benefits as a consequence of reducing the extent and frequency of damaging flooding. As noted, only two threatened species were assessed as having a potential significant potential impact. Managing low level FMZ flows would effectively manage potential biodiversity impacts within the main channel.

5.5 Penrith City Council

The Penrith City Council submission comprised a cover letter providing a summary of key issues and an annexure providing further extensive details for the identified key issues. The annexure included an attachment providing specific details to the second key issue raised by Council regarding development engineering and flood management.

The presentation of issues in this section generally reflects the structure of the annexure to Council's letter. For the purposes of brevity, it has been necessary to paraphrase sections of text provided in Council's submission. Accordingly text such as general observations or similar have not been included in the synopses of issues.

5.5.1 Planning considerations for Penrith LGA

As the proposal is aimed at improving existing flood evacuation opportunities within the Penrith LGA, the statutory planning context including DPE's recent mandating of additional LEP flood provisions must be reconsidered with regard to the following issues.

Issue 1

A policy/strategy of how the new flood risk is to be incorporated post the dam upgrade.

How does Council update its flood studies and floodplain risk management plans?

- Council will need to review and update all its relevant flood studies and floodplain risk management plans. Funding from State Government would be required to review and update its studies.
- Flood models and data from State Government would be required to update Council's studies.

Response

WaterNSW notes Council's views and advises that funding for Council requirements is a matter for NSW Government. Infrastructure NSW is leading the overall Flood Strategy for the valley including Outcome 1 *Regional, coordinated flood risk management*. Council should coordinate with Infrastructure NSW on the need to update Council's floodplain risk management plans.

Issue 2

The EIS states that the flood mitigation capacity of the dam would decrease with time due to climate change (page 5-1 in Chapter 5 of the EIS). If Council revises the flood risk management plans based on the current flood mitigation capacity of the raised dam, those FRMPs would need a constant revision to ensure that the reduced mitigation capacity is considered.

Response

WaterNSW would consider that revision of FRMPs is a prudent undertaking by Council.

WaterNSW understands that responsibility for floodplain planning rests with DPE in accordance with the *Flood Prone Land Policy*. DPE should be approached to provide appropriate advice and direction with regard to revision and updating of council flood risk management plans.

Issue 3

The SEARs require mapping of the Flood Planning Area (Chapter 15, page 15-3) for the new design flood under the Project. This has not been provided.

Response

Mapping of the existing 1 in 100 chance in a year flood extent is provided in Section 15.14.2.4 in Chapter 15 of the EIS. The mapping is overlain with the raised dam for the 1 in 100 chance in a year flood extents for comparison.

Issue 4

A statutory requirement that the downstream floodplain development is not intensified to make use of the reduced flood risk due to Warragamba Dam Raising. This is important because climate change would reduce the dam's risk mitigation capacity and the risk of dam failure would increase, which would require a higher standard of dam maintenance.

Response

Downstream floodplain development is not within the scope of this EIS. The broader Hawkesbury-Nepean Valley Flood Risk Management Strategy Outcome 3 *Strategic integrated land use and road planning* led by DPE and TfNSW consider the future land use planning to ensure that reduced flood risk due to the Warragamba Dam Raising Project is maintained.

Issue 5

How is the revised risk of the modified dam to be conveyed to the community?

Response

It is unclear whether Council is referring to the risk of failure of the dam or to the changed risk for downstream flooding.

With regard to the first matter, operation of Warragamba Dam is subject to the *Dams Safety Act 2015,* which is administered by Dams Safety NSW. As noted on the Dams Safety NSW website[30]

> *Under the Dams Safety Regulation 2019, dam owners must implement a Dams Safety Management System that is compliant with the AS ISO 55001 standard. Under this standard, an owner needs to determine the 'requirements and expectations' of their stakeholders', (or communities).*

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[30] https://www.damsafety.nsw.gov.au/news-and-events/2020/why-its-important-for-dam-owners-to-engage-with-the-community

The WaterNSW website[31] also provides details regarding management of dam safety for Warragamba Dam.

Communication of the changed risk to downstream flooding would be addressed through the Flood Strategy, such as Outcome 4 *Accessible contemporary flood risk information* and the associated actions for this outcome. This is the responsibility of the Hawkesbury-Nepean Valley Flood Risk Management Directorate as noted in the Flood Strategy (Infrastructure NSW 2017).

Issue 6

Does Council need to start updating the flood study well before the wall raising project is completed, so that a new flood study is ready and the new flood planning areas are established and ready to be utilised for development planning and controls?

Response

WaterNSW understands that responsibility for floodplain planning rests with DPE in accordance with the *Flood Prone Land Policy*. DPE should be approached to provide appropriate advice and direction regarding revision and updating of council flood risk management plans.

Issue 7

Statutory requirement to impose restriction on use of the Flood Mitigation Zone of the dam for water supply or any other purposes.

Response

Section 5.2.7 in Chapter 5 of the EIS states explicitly that the FSL will not change and the design of the raised dam does not provide for permanent water storage. Should the Project be approved, it would be only for flood mitigation and not for water supply or any other purpose.

Issue 8

These aspects may impose a significant resourcing and cost burden on councils.

Response

Council is required to regularly update relevant plans and policies. The implementation of an FMZ at Warragamba Dam would not change these functions.

5.5.2 Development engineering and flood management

5.5.2.1 Flood modelling in the EIS

Issue 1

It appears that the modelling work for EIS was being undertaken up until after the March 2021 flood. It is understood that this modelling work is being undertaken as per the recommendation of the 2019 study, where a detailed 2D modelling of the areas downstream of the dam was specified, to update the design flood behaviour as presented in the 2019 study. The reference for the Source: Infrastructure NSW (2021) is not provided in the EIS.

Given that a more detailed model for the areas downstream of the dam is available, the impact of the Project should have been assessed using this detailed model. The 2D (TUFLOW) model used in the EIS is quasi-calibrated and can potentially present an incorrect assessment of Project's impact.

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31 https://www.waternsw.com.au/supply/Greater-Sydney/safety

Response

The development of the EIS has been underway since 2017 and in order to inform the flood extents for the purpose of impact assessments the EIS appropriately relied upon the flood modelling work that had been done prior to the completion of the EIS. Infrastructure NSW Hawkesbury-Nepean River Flood Study including development of a new 2D flood model only commenced after the impact assessments had been completed for the EIS.

Issue 2

The entire suite of modelling undertaken for the Project does not appear to have been peer reviewed although part of the modelling which was adopted from the previous studies has been peer reviewed.

Peer review should be undertaken for the complete set of modelling undertaken for the EIS to improve confidence in the outcomes of the EIS.

Response

The hydrological modelling was undertaken in accordance with Australian Rainfall and Runoff, 2019 (AR&R), which is the national guidance document for flood estimation. The model also referenced a broad body of work and has been extensively peer reviewed by leading academic and industry experts.

Stantec GHD Joint Venture undertook a peer review of the upstream hydrology models (via subconsultant HARC). The climate change component of the hydrological modelling was also peer reviewed by Professor Jason Evans (Climate Change Research Centre, University of NSW) and Professor Seth Westra (School of Civil, Environmental and Mining Engineering, University of Adelaide).

Issue 3

An additional model (Mike 11) to the 2019 study has been used in the preparation of EIS. As stated, the Mike11 model was used to calibrate the RORB model, which can potentially modify the RORB model significantly and output from the newly calibrated RORB model can be significantly different from the outputs obtained in the 2019 study. This implies that the 2019 results presented in the EIS may potentially be incorrect.

Details of further calibration of the RORB model for EIS should be documented. Any differences with the 2019 study should be highlighted.

Response

No changes were made to the RORB model between the Flood Study and the EIS. The model is the same in these studies and was calibrated in 1996 to a range of historical events upstream of the dam and has not changed since.

Issue 4

It appears that the RUBICON model has been further calibrated for the EIS. It has similar implications to the calibration of the RORB model as discussed above.

Details of further calibration of RUBICON model should be included in the EIS. Differences with the 2019 study should be highlighted.

Response

The RUBICON model used for the EIS is the same model used for the 2019 Hawkesbury-Nepean Valley Regional Flood Study (WMAwater 2019).

Issue 5

It appears that a new TUFLOW ('research') model was developed for EIS and 'quasi-calibrated' to historic events and representative design events from the 2019 study. No details about the 'research' model and the 'quasi-calibration' have been provided. It is also not clear if the new model was calibrated to the representative design events from the RUBICON model or the 'poorly calibrated' TUFLOW model in the 2019 study (Appendix D, page D-3 of the 2019 study).

Details of the calibration of the new TUFLOW model should be provided in the EIS. Since the model is quasi-calibrated, sensitivity analysis should be undertaken to demonstrate that the model is fit for purpose.

Response

WMAwater developed a TUFLOW model that was used only to map flood hazard for the 1 in 100 chance in a year event in the Hawkesbury-Nepean Valley Regional Flood Study (WMAwater 2019). After the flood study, this TUFLOW model was refined for other work for WaterNSW and their dam designers. This refined version of the TUFLOW model was used for the EIS hazard and flood function maps. It was not used to assess changed peak flood levels or hydrographs (which used the calibrated, validated, peer-reviewed RUBICON model) and so does not make a material difference to the modelling outputs of the Project.

Issue 6

Flood modelling results have been presented as maps for the existing conditions and those under the Project. It is difficult to visually compare the flood behaviour for the two conditions to assess impact.

Difference maps should be developed and included in the EIS to clearly highlight the impact of the Project.

Response

Difference maps could be produced, however, given the project changes flood levels by 3-4 metres, looking at levels is better as the spatial footprint does not change dramatically. Further, a better comparison is the number of affected properties.

Issue 7

In Appendix H1, the general principle for discharge of floodwaters form the dam has been specified. However, Appendix H2 provides details of the modelling undertaken for a specific discharge (100 GL/d). The EIS does not provide a clear description of the protocol for discharge of floodwaters. The modelling appears to have been undertaken for a preliminary protocol developed by WaterNSW in 2017.

A detailed dam operation protocol should be developed for the dam operation and included in the EIS.

Response

The EIS flood extents downstream were modelled using the operating objectives noted in the EIS and an FMZ drawdown framework that used a targeted duration to drawdown the FMZ back to FSL within 14 days.

The outflow modelling for the EIS takes into account the sizing of the FMZ gated outlets, which have a designed maximum discharge rate of 230 GL/d. If required, outlets can be operated for about 2-3 days if another subsequent flood event is due prior to the FMZ being emptied. Thereafter this rate is reduced to 100 GL/d in a constant flow until the FMZ is discharged and the lake level returns to the existing FSL. If there is no forecast subsequent event a lower constant discharge of around 100 GL/d is modelled to draw down the water level to FSL again and limit further downstream flooding.

Therefore, during the constant discharge flow, the FMZ will be released in a controlled manner through the gated outlets and discharged at a rate that does not cause further impacts that exceed the previous flood level peak as the level recedes gradually back to normal river levels. The constant discharge to drawdown the FMZ can also be varied below the constant rate should the Warragamba contribution be required to ramp down in response to other sources of flooding impacts as part of the current flood incident management operations for the valley. The controlled release of stored water from the FMZ through eight gated conduits is based on operating rules, similar to the existing gate operations but modified to suit eight new gates opened at various stages depending on the lake level.

Further details on flood incident management, dam operations and drawdown framework are provided in Appendix B to the PIR.

Issue 8

Flood modelling is critical to the assessment of the Project and provides the basis of support for the Project. Several models have been used for which details have not been provided. The description of the models presented is insufficient.

The EIS should include a separate appendix with details of the models used, the recalibration of models and how the calibrated models are deemed to be fit for purpose. The description of the models should be improved in the main document of EIS. As an example, it appears that the TUFLOW model was used to calibrate the RUBICON model. This is highly unlikely, however, if this process has been undertaken, it should be detailed in the EIS.

Consideration should be given to have the entire EIS peer reviewed for such a significant project. The EIS is the stage of the project where major changes in the concept design can be made, if identified by the peer review. An EIS that has been peer reviewed would also have a better chance of being supported by the stakeholders.

Response

WaterNSW notes Council's advice, however providing a summary table will not change the findings of the EIS. As part of the WaterNSW assurance process the draft EIS was peer reviewed by technical and legal subject matter experts prior to public exhibition.

5.5.2.2 Dam operation protocol

The operation of the dam has been modelled based on a preliminary flood release protocol. It is not clear whether the operating protocol that has been modelled is optimum in achieving the objectives specified in the EIS. In addition, the current protocol has adverse impact downstream where several bridges would be inundated for a much longer duration for the modelled protocol. It is very surprising to note that a detailed assessment for the operation of the dam has not been undertaken as part of the EIS and has been postponed till the operation of the dam i.e. after the dam has been constructed. Preparation of an operating protocol is also one of the SEARs (No. 6) as presented on Page 15-4 of Chapter 15. 6. The Proponent must detail a framework for managing water releases from the dam that are capable of meeting the objectives of the Project (in terms of flood mitigation), ensures impacts to upstream and downstream areas and ecosystems are minimised. The framework shall include consideration of the potential rates of rise and fall in the river, timing of water releases. These shall include consideration of antecedent, conditions within the river, flooding impacts, and transparent and translucent flows.

A detailed analysis of the dam operations should be undertaken, and an optimal dam operation protocol should be developed. By fixing the dam raising height to 14 metres, an important variable in achieving an optimal solution for managing the flood impact of the Project has been constrained. Ideally, the operating protocol should have been investigated at the same time when the height for the raising of the dam was being investigated.

The operation protocol would also involve integration with a robust flood forecasting system specifically developed for the Project.

The flood evacuation strategy is also affected by the dam operations during floods. A detailed evacuation modelling should also be undertaken while developing the dam operating protocol.

Response

WaterNSW refers to the previous response on operation assumptions used in the EIS modelling. Additionally, the Hawkesbury-Nepean Valley Flood Management Taskforce was established by the NSW Government in 2014 and has extensively assessed alternatives and options for flood mitigation including options to lower the FSL and height options for raising the dam. The Taskforce found that the most effective and efficient infrastructure option to reduce risks to life and property from flooding is to raise the Warragamba Dam to provide a flood mitigation zone of around 14 metres, which is the basis of the impact assessment for the EIS.

5.5.2.3 Dam failure analysis

One of the desired performance outcomes presented in the SEARs requires dam failure assessment as stated below

> *8. Flooding*
>
> *The Project minimises adverse impacts on existing flooding characteristics. Construction and operation of the Project avoids or minimises the risk of, and adverse impacts from, infrastructure flooding, flooding hazards, or dam failure.*

Although the dam failure assessment has not been reported, Appendix H2 on page 4 states the following

> *For this dam breach assessment, TUFLOW HPC has been adopted. TUFLOW HPC is a finite volume model, which makes it very suitable for dam breach assessments. This is because it can handle steep waves and high velocities, and generally with good volume conservation.*

From the above, it appears that a dam failure analysis has been carried out but has not been reported.

The SEARs require dam failure assessment, which hasn't been undertaken as part of the EIS. This assessment is required to prepare emergency management and recovery plan.

In the event of the dam failure, the raised dam wall is likely to have adverse impact compared to the existing conditions. This impact needs to be assessed and shared with the Council, if this cannot be included.

WaterNSW should also provide details how the dam safety is being ensured under the Project.

Response

A dam failure assessment has been undertaken as part of the detailed concept design. This assessment was not required to be included in the EIS.

The SEARs (SEAR 8) identify that 'Construction and operation of the project avoids or minimises the risk of, and adverse impacts from, infrastructure flooding, flooding hazards, or dam failure' is a key issue and desired performance outcome.

The EIS addresses the aspect of dam failure by outlining in Chapter 5 and the Executive Summary of the EIS that the dam raising design has been undertaken in accordance with Dams Safety NSW regulations, which includes meeting societal risk criteria for dam safety against failure.

5.5.2.4 Preservation of flood storage

The Project would create additional storage in the dam for flood mitigation purposes. The Executive Summary of the EIS states

> *The Project does not change the permanent full water supply level of the dam and is solely to provide flood mitigation for downstream communities through the creation of a dedicated air space.*

How would Water NSW ensure that the dedicated airspace for flood mitigation is not utilised by future requirements to store additional water for water supply purposes i.e. the supply level of the dam is not raised. Would this be legislated?

Response

The proposed Warragamba Dam Raising Project is designed as a flood mitigation project, not a water supply project. The FMZ would only be used during floods and not for increasing permanent water supply. WaterNSW is the proponent for the purpose of obtaining environmental planning approvals and the NSW Government is responsible for implementing any legislation if required.

5.5.2.5 Modelling review comments

Issue 1

The flooding results presented in Chapter 15 *Flooding and hydrology* and in Appendix H1 for existing catchment conditions are based on the *Hawkesbury-Nepean Valley Regional Flood Study* prepared by Infrastructure NSW. This flood study assessed the flooding behaviour in the valley using the hydrological RORB model coupled with Monte Carlo modelling approach and 1D RUBICON hydraulic model that was developed as part of the Warragamba Dam EIS 1996. The Regional Flood Study 2019 did not assess the flood impact from the projected Warragamba Dam Wall raising scenario in the valley.

Response

WaterNSW refers to Section 1.1 of the Regional Flood Study, which notes that the report is

> *the technical document describing the **existing** flood behaviour of the main Hawkesbury-Nepean River from Bents Basin near Wallacia and Warragamba Dam downstream to Brooklyn Bridge, and the backwater flooding associated with this main river flooding.*

The assessment of the potential impacts of the Project related to flooding is addressed through the EIS, which draws on the modelling work done for the Regional Flood Study and is presented in Chapter 15 of the EIS. The Regional Flood Study was intended to advise councils and stakeholders of the flood risk from the existing dam, not advocate for the dam raising.

The EIS utilised the modelling used in the Regional Flood Study and undertook additional modelling to assess the difference the raised dam would make to the existing flood risk.

Issue 2

Chapter 15 and Appendix H1 of the EIS refer to the Regional Flood Study when discussing the assessment of the projected dam wall raising scenario. The details flood impact assessment of the projected dam wall raising including flood modelling on the valley is not clearly documented in this EIS.

Response

WaterNSW refers to the previous response.

As required by the SEARs and presented in Chapter 15 and Appendices H1 and H2 of the EIS, flood modelling undertaken for the EIS was used to compare flood behaviour between the existing dam and with the dam wall raised. A suite of comparative maps is provided in Section 15.15 in Chapter 15 of the EIS and in figures provided in Appendix H2 to the EIS.

Issue 3

The flooding hazard results presented in Appendix H2 *Flood Risk Analysis* are based on the TUFLOW HPC model prepared by WMAwater for research purpose. Appendix H2 reported that the model was considered suitable to give a general indication of the velocity distribution for the 1 in 100 chance in a year event for the purposes of determining flood hazard and hydraulic categories. Further refinement and detailed bathymetry are required before this model is suitable for detailed modelling. If the model still requires further refinement before it is suitable to define the flood behaviour, why it has been used in this EIS and what are the implications from its results on decision making – does it fit the purpose for such a major project.

Response

WMAwater's TUFLOW model was only used for flood hazard and function mapping in Appendix H2, not to assess peak flood levels or hydrographs required for informing flood damages and the flood evacuation model. The use of TUFLOW does not make a material difference to the support of the Project. The key flood model outputs were derived from the calibrated, validated and peer-reviewed RUBICON model.

The RUBICON model was chosen because it is a fast-running model, necessary to understand the full variability of flood behaviour across a large regional floodplain and nearly 20,000 modelled flood scenarios.

Issue 4

The *Hawkesbury-Nepean Valley Regional Flood Study, WMAwater 2019* and associated 1D RUBICON model has listed a series of limitations and recommendations that have not been considered in this EIS. Examples of limitations include the usage of the 1D RUBICON hydraulic model that doesn't account for the storages in the floodplains, the discrete location and distance between the cross-sections, absence of proper modelling of breakouts at Emu Plains and Boundary Creek. Example of recommendations include to undertake a detailed joint probability assessment to define the flooding behaviour for Wallacia area and the need for a detailed more contemporary 2D TUFLOW model to assess the flood behaviour in the Valley.

Response

A fast-running model (RUBICON) was necessary to understand the full variability of flood behaviour across a large regional floodplain. Contrary to Council views, RUBICON does account for flood storage, uses a significant number of cross sections, and considers joint probability. Identification in the *Hawkesbury-Nepean Valley Regional Flood Study* of the need for further refinement in a detailed 2D study is a comment on the process of continual improvement, not on any suggested inadequacy of the Regional Flood Study. The RUBICON model is fit-for-purpose for the EIS.

Issue 5

Based on the recommendation from the *Hawkesbury-Nepean Valley Regional Flood Study, WMAwater 2019* Infrastructure NSW is currently in the process of finalising the assessment of flood behaviour in the valley using an updated and more contemporary TUFLOW HPC flood model with the sub-grid resampling approach. How the flood results presented in this EIS compared to the results generated from this updated TUFLOW model for existing condition and for the projected Dam Wall Raising scenario. It should be noted that Figure 18 in EIS Executive Summary EIS refers to the modelling undertaken by Infrastructure NSW to model the March 2021 with the raised dam wall scenario. However, there is no further discussions or details on the modelling for this event in Chapter 15 and Appendices H1 and H2.

Response

The recommendations from the Hawkesbury-Nepean Valley Regional Flood Study, WMAwater 2019 are the responsibility of Infrastructure NSW. However, the TUFLOW model used in the EIS was only for the purpose of flood hazard and function mapping, which is presented in Appendix H2 to the EIS. The model was not used to assess peak flood levels or hydrographs required for informing flood damages and the flood evacuation model, and so the use of TUFLOW does not make a material difference to the support of the Project.

A flood review into the Hawkesbury-Nepean River March 2021 flood was undertaken by Infrastructure NSW as part of ongoing monitoring and evaluation for Outcome 9 of the flood strategy. The flood review was released in December 2021. The March 2021 event occurred after the technical assessment for the EIS was completed, however the EIS Executive Summary utilised data from that review to compare the difference in flood extents if the dam had been raised before the final review was published following the EIS exhibition in December 2021. Since the EIS exhibition there has been two further significant flood events in the valley and these are also under review by INSW.

Issue 6

It is very critical for Council to understand the flood modelling and associate results for the existing catchment conditions before moving to the assessment of the projected Dam Wall Raising scenario. The results listed in Chapter 15 and Appendix H1 for existing conditions are still subject to further review and discussions. For instance, the 2019 Regional Flood Study recommended that more detailed investigation of the interaction of these Warragamba and Nepean Rivers is required ahead of any decision to amend existing flood plans or policies for Wallacia Village. This has not been addressed or discussed in this EIS. Therefore, the comparisons of the results between the existing and the projected dam wall raising scenario are subjective as the existing results still subject to change. In other word, the benefit from the dam wall raising will not be fully appreciated.

Response

The Flood Strategy has an ongoing assessment of flood risk within a continuous improvement framework. This includes 2D modelling of the valley, which is planned for release in late 2022. However, none of these ongoing investigations fundamentally change the magnitude of the flood mitigation benefits of the Project.

Issue 7

It would be more practical if the flood model assessment and associated results in Chapter 15 and Appendices H1 and H2 are coming from one source as this will help in understanding the full benefit of the proposed scenario on the downstream floodplains.

Response

WaterNSW notes Council's advice, but notes that Chapter 15 is a summary collation of the appendices.

Issue 8

Table 3-13 of Appendix H1 (Flooding and Hydrology Assessment Report) shows that the velocities within the main river channel for existing conditions are unchangeable along the river and across the flood events. They are almost in the order of 1 m/s. These results are of concern as other Council flood study results show that the magnitude of the velocity in the main channel is ranging from 2-4 m/s depending on the location and the flood event.

Response

The difference in velocities between reports would be expected as modelling used in the EIS is based on cross sectional average velocities. This is the average velocity across the whole cross section, which may be very wide.

Issue 9

In Appendix H1, page 20 the EIS discusses the use of Mike 11 model as presented below

> *A slightly different analysis approach was adopted for the upstream area. The MIKE11 model was not used to discretely simulate each of the Monte Carlo design flood scenarios. Rather, the MIKE11 model was used to extract rating curves (flow-height relationships) under different dam raising scenarios. These rating curves were used to calculate level hydrographs from flow inputs (from the RORB model) at all cross-sections for the 20,000 Monte Carlo runs of the existing dam and the raised dam option. These level hydrographs were used to obtain estimates of inundation times upstream of the dam and to give an indication of the change in inundation time between the existing dam and the 14 m raised dam option.*

Rating curves from a hydraulic model display hysteresis i.e. a looped rather than a single line relationship. How was the hysteresis affect considered? If an 'average' line was drawn through the loop for use in the above analysis, was there any sensitivity undertaken to assess the impact of this assumption. Was any other assumption used to deal with the hysteresis effect?

Response

Hysteresis was considered in the establishment of the rating curves. Rating curves (Q-H results) for both the rising and falling limbs of the modelled flood event were extracted at every cross section in the model for each time step (15-minute intervals).

As the flow height relationships taken from the MIKE11 model often displayed different relationships for the rising and falling limbs of the hydrographs, an approximation of the rating curves was calculated so that a single relationship could be used when deriving level hydrographs. This was done by taking a weighted average of the flow-height curves for the rising and falling limb shown in the following equation:

$$\text{Average Level} = \frac{(\text{RiseLevel x nRiseLevels}) + (\text{FallLevel x nFallLevels})}{\text{nFallLevels + nRiseLevels}}$$

The weightings used were based on the number of timesteps in the flow height curve because the objective of the level hydrographs was to represent inundation times and the curve that was present for the longest time should therefore have a higher weighting. Hydrographs represent inundation times and the curve that was present for the longest time should therefore have a higher weighting.

Issue 10

For the existing condition, there are discrepancies between the results presented in Chapter 15 and Appendix H1 versus the results presented in Appendix H2. For example, comparing Figure 3-32 of Appendix H1 with Figure 43 of Appendix H2. It looks like the results are coming from two different sources.

Response

The observation regarding differences between results is correct as different sources were used to produce the two appendices.

- Appendix H1 (Flooding and Hydrology) to the EIS came from the RUBICON model
- Appendix H2 (Flood Risk Analysis) to the EIS came from the 2D model developed by WMAwater.

Issue 11

The hazard results presented in Appendix H2 need a second review as they are not consistence across the flood events. For instance, in the same area of Emu Plains the 1 in 100 chance in a year flood hazard is higher than the 1 in 500 chance in a year flood hazard.

Response

The results have been reviewed sufficiently for the purpose of the EIS. Due to the process used to generate the maps they are a combination of the TUFLOW results limited to the extent of the RUBICON results. The TUFLOW 1 in 100 chance in a year flood does not have water in the Emu Plains area so the results come from the RUBICON model. In the 1 in 500 chance in a year flood the TUFLOW model has water in the Emu Plains area and those results are used directly. This is an inadvertent result of the process used. The updated TUFLOW model will replace these results.

Flood levels at Penrith and how much flow occurs is dependent on the amount of vegetation between Victoria Bridge and McCanns Island.

Issue 12

In Appendix H2, the hazard results presented are also not consistence with the Hydraulic Categories results for the 1 in 100 chance in a year flood event in terms of extent. For instance, the hazard map doesn't show backwater via Boundary Creek while the hydraulic categories mapping does show backwater. The same comments apply to the proposed dam wall raising maps.

Response

WaterNSW also refers to the reponse to the previous issue.

Issue 13

The flood level, flood depth and velocity maps for all design flood events for both existing and projected dam wall raising scenarios are missing from the flooding outcomes presented in EIS. Moreover, the inclusion of flood level difference maps for at least the 1 in 20 chance in a year, 1 in

100 chance in a year, 1 in 500 chance in a year and PMF events would be practical to visually appreciate the benefit of the projected dam wall raising.

Response

The approach adopted in Chapter 15 of EIS for presenting flood extents and depths was the use of flood maps, covering events required as per the SEARs and associated tables showing changes to flood depths at modelled cross sections.

Flood level difference maps could be produced, however given the Project changes flood levels by 3 - 4 metres, looking at levels is better as the spatial footprint does not change dramatically. A better comparison is the number of affected properties, which is provided in Chapter 15 of the EIS.

Issue 14

The flood modelling results presented in Chapter 15 and Appendices H1 and H2 show that for the projected dam wall raising scenario the flood levels are dropping dramatically for all designed flood events across Penrith LGA. Refer to Tables 15-20, Table 15-21, Table 15-22 and Table 15-23 in Chapter 15. Of interest are the changes in the 1 in 100 chance in a year flood event that show a drop-in flood level of 4.7 metres at M4 Motorway Bridge and 4.2 metres at Victoria Bridge. These outcomes need to be cautiously interpreted as the issues of the existing condition results are still under discussions and determination.

Response

These flood level reductions demonstrate the mitigation of flows afforded by the Project and do not require 'cautious interpretation'.

Further information is also available in the Hawkesbury-Nepean River March 2021 Flood Review report (December 2021). Significantly, the report identifies that with the flood mitigation operation protocols applied, the peak flood level at Penrith would have been reduced by 5.3 metres with a raised dam.

5.5.2.6 Impacts of raising Warragamba Dam wall on Wallacia Village

The Hawkesbury-Nepean Valley Regional Flood Study 2019 recommended that further investigation of joint probability of Warragamba Dam and Nepean Rivers is needed to determine the flooding behaviour at Wallacia. There is no evidence in the EIS shows how this recommendation has been addressed. Hence, the comparison of the flood results between the existing and projected dam wall raising scenario is debatable as further analysis is required to define existing flood behaviour for Wallacia.

The benefit of the projected Dam Wall Raising scenario on Wallacia Village is prominent when floods reach or exceed the 1 in 100 chance in a year flood event. The flood levels for those rare events are predicted to be lower than current Council adopted flood levels. These outcomes are to be cautiously interpreted as the joint probability analysis has not been undertaken or simply not documented in this EIS. The benefit is very minimal in PMF event as Wallacia will be fully inundated even under the projected dam wall raising scenario.

The Wallacia area is situated in a critical location that could be flooded by the Nepean River flooding as well as from backwater flooding from Warragamba River (Dam overflow). There is a necessity for further joint probability analysis to be undertaken for the existing and projected dam wall raising scenario to properly define the flooding behaviour for Wallacia area. This exercise is currently considered by Infrastructure NSW as part of the update to the Hawkesbury-Nepean River Regional Flood Study. Therefore, without the joint probability analysis results of the interactions between the Warragamba and Nepean Rivers it is impractical to assess the benefits for Wallacia.

Response

The Monte Carlo modelling approach and Rubicon model capture the joint probability of interactions between the Nepean and Warragamba rivers at Wallacia. In accordance with the Flood Strategy's process of continual improvement, the joint probability is being studied in further detail as part of the Hawkesbury-Nepean River Flood Study, which is being prepared by Rhelm for Infrastructure NSW. This does not diminish the reliability of results presented in the EIS.

5.5.2.7 Evacuation review

Issue 1

In Appendix H1, the change in peak flood extent map for the 1% flood event is not provided. We believe that this is an error in the document as the 20% AEP map is provided twice and then the extreme flood event map. The 20% AEP map shows a very positive reduction in flood extents, particularly downstream of the Penrith LGA, which should theoretically ease evacuation congestion along its roads.

Response

WaterNSW notes the advice, however the changed flooding extent for the downstream 1 in 100 chance in a year flood event can also be found in Figures 15-72 to 15-76 inclusive in Chapter 15 of the EIS.

Issue 2

In table 15-10 of Chapter 15 the number of people requiring evacuation is outlined. It would be ideal if the report could also comment on the number of residents that would no longer need to be evacuated after the dam has been raised. This comparison data between existing and raised dam conditions will give a better view of the reduction of people who are within flood evacuation zones. With this data, Penrith City Council will also gain a better understanding of the reduction to road congestion during evacuation to roads within our LGA.

Response

Table 15-28 in chapter 15 of the EIS provides the modelled number of residences affected by flooding with and without the Project and provides an indication of the number of residences that would no longer need to be evacuated after the dam had been raised. These numbers are not broken-down (as in Table 15-10 in Chapter 15 of the EIS) by resident numbers, dwelling type or with consideration of people working within the flooded area.

The number of people potentially requiring evacuation is presented as an indication of the potential effect of a major flood on livelihoods, however, the number of flood affected residences provides a more robust spatial footprint against which the effects of the proposed Warragamba Dam raising can be assessed. Indicative numbers of residents not requiring evacuation under the raised dam scenario may be inferred by multiplying the number of residences by appropriate average number of people per dwelling.

Issue 3

Table 15-29 covers the potential impacts of the prolonged 100 gigalitres per day discharge rate. It is seen that the floodplain road network is not affected apart from two bridges over Cattai Creek. It would be ideal if modelling data is released to substantiate this. Without this data it is difficult to understand what the prolonged impact can have at road cut off points.

Table 15-21 shows that the 1 in 500 chance in a year flood having an elongated period of approximately 7 days of flood levels above 19 mAHD. If another storm even occurs during this period then there is a possibility that residents can be cut off from their properties for days or even a week. If prolonged flooding occurs over cut roadways, the SES will need to have revised community awareness strategies for prolonged flooding which will be a negative social impact. Therefore, this increase in low level flooding and subsequent impacts needs to be further discussed and explained through modelling results.

Response

The EIS is an assessment of impacts from the proposed dam raising and there are other outcomes within the flood strategy led by Infrastructure NSW that address community awareness and communication protocols for flood risks and emergency response.

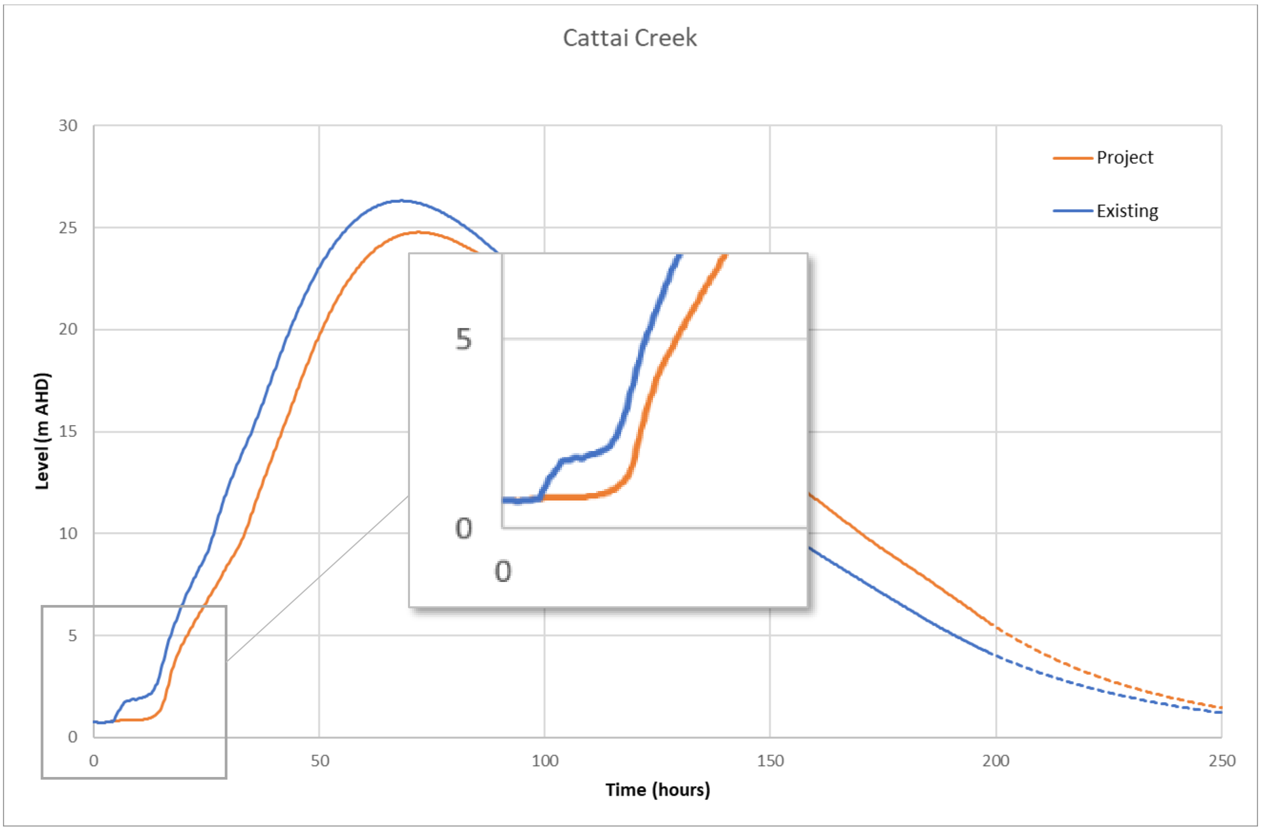
Issue 4

A positive point with the dam raising is the increase in time to road closure. This increase is positive almost across the board except for the PMF event at Cattai Creek Road Bridge as shown in Table 15-26. There is a reduction of three hours compared to the existing conditions. The reason for this is not clear in the EIS and this anomaly should be explained in conjunction with this table.

Response

The information regarding change in the closure time for Cattai Creek Road Bridge has been reviewed and WaterNSW clarifies that the time to closure this location with the Project would increase by about eight hours as shown in Figure 5-1.

Figure 5-1 Existing and with Project PMF hydrographs for Cattai Creek Bridge crossing



Issue 5

Table 21-23 shows the summary of impacts to the downstream communities. It is agreed that impacts will most likely be positive. However, empirical data would better support this for the purposes of validation.

Response

Empirical data is provided in Section 8.4 in Appendix M *Socio Economic, Land Use, and Property Assessment Report* to the EIS, which shows both positive and negative Project impacts to downstream communities. Table 8-26 in Appendix M to the EIS provides descriptions for all impacts that are summarised in Table 21-23 in Chapter 21 of the EIS.

Issue 6

Table 15-12 shows the relevant flood studies and floodplain risk management strategies for the EIS. This list does not include the *Penrith CBD Floodplain Risk Management Study 2020*. Section 8.4.1 of the study discusses regional evacuation routes and should be considered for the EIS as well as evacuation planning.

Response

The flood modelling that informs the EIS flood extents draws upon the Hawkesbury-Nepean Valley Regional Flood Study (WMAwater 2019) prepared for Infrastructure NSW for consistency. The EIS utilised the modelling used in the Regional Flood Study with additional modelling, undertaken prior to 2020, to assess the difference the raised dam would make to the existing flood risk.

5.5.3 Biodiversity conservation considerations

While there are a number of positive implications of the proposed works on flood planning and evacuation capability for the Penrith LGA, there are also equally a significant number of critical environmental concerns identified as a consequence of the proposed works that require careful consideration and address in the assessment of the application. These are outlined below.

Issue 1

The EIS states that the cost-benefit analysis demonstrated that the proposed raising of Warragamba Dam will provide a 75 percent reduction in flood damages on average and reduce current levels of flood damage from $5 billion to $2 billion (2016 dollars). The documentation provided however does not discuss alternative measures that have been explored that would better mitigate the impact of downstream flood impacts as alternative options. This aspect should be better addressed and demonstrate why/how the Project was deemed to be the most appropriate on balance.

Response

The discussion in Chapter 4 of the EIS regarding development of the Project and alternatives considered is largely drawn from the Hawkesbury-Nepean Valley Flood Management Taskforce report, *Resilient Valley, Resilient Communities* (Infrastructure NSW 2017).

Table 4-6 in Chapter 4 of the EIS provides a summary of the alternative options considered by the Flood Strategy assessed against the assessment criteria.

Appendix 5 to the Taskforce report provides details of costs for the various options considered.

Issue 2

Development of the methodology relied upon allegedly involved consultation with the former Office of Environment and Heritage (OEH, now the Environment, Energy and Science (EES) Group within the Department of Planning, Industry and Environment, DPIE), particularly on application of the FBA for the Project. The upstream study area comprises the area between full supply level (FSL) and the Project PMF. This equates to an area of about 5,280 ha. The principal areas of interest in the study area for the assessment are the survey area and upstream impact area. For the Framework for Biodiversity Assessment (FBA) and calculation of offset requirements for the upstream impact area, a precautionary approach was allegedly adopted; this assumed a 100 percent loss of vegetation/habitat within the area between the likely inundation level with the Project (10.25 m above FSL, RL 126.97 mAHD) and the likely inundation level for the existing dam (2.78 m above FSL, RL 119.5 mAHD). The size of this area is about 1,400 ha. The field study area was identified as the area within a representative 1 in 100 chance in a year event (1% AEP) with the Project plus nine percent climate change (that is, a nine percent increase in rainfall under a climate change scenario). This equates to an area of about 3,740 ha.

Response

WaterNSW notes Council's advice and considers no further response is required.

Issue 3

The EIS states that the 1 in 10 chance in a year flood event would have the greatest difference in inundation extent between the existing and Project flood scenarios. It was allegedly agreed that the 1 in 10 chance in a year flood inundation extent would represent the area for the downstream assessment. It was also agreed that survey and assessment within the downstream operational area of the Project would be truncated at the confluence of the Hawkesbury and Colo Rivers. The assessment focuses on potential impacts associated with the survey area (1 in 10 chance in a year flood) and the increased duration of temporary inundation resulting from emptying of the FMZ. A total of 1,370.24 hectares of native vegetation has been mapped within the upstream impact area.

Response

WaterNSW undertook the necessary engagements with agencies including DPE and OEH on the various methodologies and approaches to be implemented in delivering the outcomes required to respond to the SEARs. This included establishing the survey extent for biodiversity assessments both within the upstream and downstream study areas.

For the downstream assessment the agencies agreed to assess the 1 in 10 chance per year flood area. This is because as the Project will reduce the impact area for flood events the downstream areas that are more often flooded could create "dry-out" areas (areas that currently flood, but will not flood as often once a new dam wall is built).

Issue 4

The Project would impact 430.56 hectares of White Box Yellow Box Blakely's Red Gum Woodland CEEC within the upstream impact area. The EIS concludes the Project may impact on a CEEC due to potential impacts to White Box Yellow Box Blakely's Red Gum Woodland CEEC but that these impacts are unlikely to cause the extinction of the CEEC from the IBRA subregion or significantly reduce the viability of the CEEC. This entity is already at risk of extinction, and it is considered that the Project would result in a considerable impact to this community. This aspect requires detailed consideration and further address and explanation from the applicant.

Response

It should be noted that the wording used in the EIS states that the Project *may* impact this CEEC, this reflecting the probabilistic nature of flooding and the variable response of individual species to temporary inundation. It is also reiterated that the assumed total loss of biodiversity values in the upstream impact area was solely for the purpose of offsetting, and is unlikely to be realised. This is reinforced by further work carried out during preparation of the Submissions Report and PIR, described as follows.

Additional investigations carried out included an analysis of vegetation condition using survey plots in the upstream study area to assess resilience to temporary inundation. This examined vegetation condition for a riparian vegetation community and a eucalypt woodland community, respectively:

- HN574/PCT 1105 River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion
- HN527/PCT 840 Forest Red Gum-Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion.

All plots used in the analysis were classed as Moderate/good condition.

The analysis benchmarked the number of native species against the Sydney Basin Interim Biogeographic Regionalisation for Australia (IBRA) Region and the South Eastern Highlands IBRA Region. The analysis distinguished between plots within the area of existing impact (from the existing dam) and above this area (which would be affected by the Project) considering two scenarios:

- The upstream impact area
- The area affected by the existing in 1 in 100 chance in a year flood event.
- Additionally, there is an overlap of these two areas so it would be expected that there would be some similarity in the pattern of the results.
- It should also be noted that, there has not been a 1 in 100 chance in a year flood in the upstream catchment since the dam was constructed. With the Project, the frequency of this flood level would increase to between 1 in 5 and 1 in 10 chance in a year of occurrent for locations around the perimeter of Lake Burragorang. However, the frequency of occurrence for locations up the tributaries would be largely unchanged.

The results of the analysis, which are presented in the PIR, identified that the woodland community has some degree of resilience to temporary inundation.

Issue 5

It is also understood that the Project will impact on 107.09 hectares of River-flat Eucalypt Forest which is listed as an endangered ecological community under the BC Act and critically endangered under the EPBC Act. This is also of particular concern.

Response

As noted in the response to the previous issue, the analysis of vegetation plots to assess resilience to temporary inundation included a riparian vegetation community. The analysis identified that this community has a significant degree of resilience to temporary inundation.

Issue 6

The EIS identifies 76 threatened flora species may be 'adversely impacted' and 16 threatened fauna species may be impacted. It is noted that surveys did not survey the entire impact area and it is possible that other populations or other species are present within the footprint. The EIS has stated that temporary inundation may modify habitat for threatened flora species by altering soil properties such as structure and chemistry or causing erosion in turn affecting plant survivability, growth, germination and/or recruitment. If loss of individuals is experienced, this is likely to contribute to fragmentation and isolation of local populations which represents a significant biodiversity concern.

Response

The comment is noted.

The EIS discusses in detail the survey effort and its limitations. As required by the FBA, species that could be present, according to the relevant databases, are assumed to be present for the purposes of assessment and calculating offsets.

Issue 7

The EIS has concluded that the Project poses potential significant impacts to breeding habitat for the critically endangered species of the Regent Honeyeater that cannot be avoided or minimized. The assessment has concluded in Table 8-33 that a large breeding population of Regent Honeyeaters were recorded around Tonalli Cove. Impacts from temporary inundation may include loss of structural components of the vegetation (for example, *Amyema pendula* and *Amyema cambagei*) within areas of suitable breeding habitat, mortality of nestlings should a flood occur during a breeding event, and potential loss of suitable foraging habitat, specifically feed tree species such as *Eucalyptus melliodora*, *Eucalyptus albens*, and *Eucalyptus eugenioides*. A total of 1,264.55 hectares of habitat for this species will be impacted. The local population potentially impacted by the Project comprises a minimum of 21-35 individuals. This includes the number of adult and juvenile birds detected during targeted Regent Honeyeater surveys conducted in November 2017 (21), and the number of nestlings observed at two nests at the time of surveys (4), assuming each fledged successfully. This figure represents 5-7 percent of the estimated population of the Regent Honeyeater (DoE, 2016) (Kvistad *et al*. 2015) and this breeding population represents one of less than five known remaining breeding populations that are known to support at least 20 individuals (DoE, 2016) (Crates et al. 2018). It is believed that there are less than 350 individuals left in the world (pers. comm Dr. Ross Crates 2021). The loss of a population between 21-35 individuals does not represent 5-7 percent of the estimated population but is actually more like 6-10 percent which must be noted and addressed in the assessment.

Response

The importance of the Regent Honeyeater population within the study area is acknowledged in Section 8.8.5 in Chapter 8 of the EIS, which is emphasised in the extracts quoted in the comment. Additional information on the Regent Honeyeater, including an assessment of Project impacts, is provided in Table K-1 in Appendix F2 to the EIS. The population was found as a result of targeted surveys undertaken by the Project assessment team. The potential significance of the species is accounted for in the offset strategy (refer Section 3.3).

The regent honeyeater is associated with dry and open forest habitat with a large number of mature trees. This type of habitat is associated with 18 PCTs (see Table 5-5 in Appendix F1 to the EIS). These habitat associations have been identified in the Project study area, however, this habitat is also extensively represented throughout the adjoining protected lands.

The Project may cause temporary inundation of an area of habitat known to be used by 5 to 7 percent of the total known population of this critically endangered species. Temporary inundation may result in either: (1) minimal impact where the breeding and foraging habitat remains largely intact; (2) the population relocates to other habitat within the catchment either temporarily or permanently to habitat areas that are either equally productive or potentially to less productive or marginal areas within the catchment; (3) the local population occupies other breeding sites outside of the catchment.

The Project may increase local fragmentation of breeding habitat but is unlikely to significantly increase the degree of isolation of the local population overall given that Regent Honeyeaters can disperse large distances across highly fragmented landscapes to reach suitable habitat. Temporary inundation would be a gradual process allowing any affected birds to readily relocate away from the rising water. If inundation does cause long-term changes to the habitat that make it less suitable for Regent Honeyeaters, then this could cause the loss of one of only a small number of breeding areas.

Issue 8

The EIS has discussed different experiments including *Eucalyptus benthamii* inundation experiment prepared by CSIRO dated 24 April 2019. These experiments are not relevant to the current proposal as:

- The experiment was limited with only inundating the trees at a depth of 30 cm and is not comparable to the depth the downstream banks would receive 2.5 metres
- The experiment was undertaken in Deniliquin in different soil characteristics and climatic conditions than what would occurs in the proposed impact area
- The experiment did not test impacts of inundation of other species associated with the vegetation communities that would be affected.

The EIS also recognizes that there are some key differences between the scenario within which the experiment was carried out and the modelled conditions expected to occur within the Kedumba River population of *E. benthamii*. Specifically, the depth of inundation as a result of the Project is likely to be higher and the extent of duration lower than the experimental situation.

Response

WaterNSW notes Council's view however the experiment on *Eucalyptus benthamii* inundation was undertaken with the objective to investigate the consequences of protracted waterlogging on tree health and survival with an opportunity to utilise a stand of seedlings from the catchment valley located in Deniliquin. The result of the experiment showed that *E. benthamii* appears to be tolerant of shallow flooding of up to six weeks duration. The experiment also included consideration of soil characteristics comparable to the catchment valley.

The maximum changes in temporary inundation for the Kedumba River area would be in the order of an additional 0.5 metres depth and about 0.7 days duration for the 1 in 100 chance in a year flood event, and less than 0.5 metres and 0.5 days for more frequent events. The Project is unlikely to significantly impact this subpopulation.

Issue 9

Construction of the Project would require the clearing of 1.64 hectares of critically endangered Shale Sandstone Transition Forest. This occurrence of SSTF is on the edge of its community's range and therefore has the potential to significantly reduce the viability of the CEEC in the subregion. It will also result in the removal of 20.78 hectares of native vegetation and impact on one known threatened flora species (*Grevillea parviflora subsp. parviflora*), an additional seven potential threatened flora (assumed present) and 15 threatened fauna species. This represents a significant biodiversity concern.

Response

The assessment of potential impacts of the Project on biodiversity values in the construction area has been carried out in accordance with applicable statutory requirements as described in Section 2 of Appendix F3 (*Biodiversity Assessment Report – Construction Area)* to the EIS. Section 7.8 of Appendix F3 to the EIS identifies impacts requiring offsetting, and which include the Shale Sandstone Transition Forest CEEC, *Grevillea parviflora subsp. parviflora* as well as other flora and fauna (refer Table 7-20 in Appendix F3 to the EIS).

Issue 10

According to the ecological assessment, the downstream impact assessment focuses on potential impacts associated with the survey area (1 in 10 chance in a year flood) and the increased duration of temporary inundation resulting from emptying of the FMZ. This was because it was predicted that the 1 in 10 chance in a year event would likely have the greatest change in extent due to differences between the existing and with the Project flood extent scenarios. These events have been modelled using the best available information, however, there remains a level of uncertainty on the frequency and extent of these flooding scenarios. Furthermore, the potential impacts on biodiversity will vary depending on the frequency, duration and extent of flooding experienced following the implementation of the Project and other stresses in the landscape. This requires further address and analysis in the assessment of the application.

Response

Council's submission does not provide any specific details with regard to what is considered to be the remaining level of uncertainty on the frequency and extent of flooding scenarios. The methodology for modelling the downstream hydrological and flooding changes with the Project is described in detail in Chapter 15 of the EIS and in Appendix H1 to the EIS. As noted, modelling has adopted a Monte Carlo methodology to account for the variability in the various factors that influence the nature of an individual flood event.

The EIS (for example Section 8 of Appendix F2 to the EIS) acknowledges the challenges in accurately assigning the potential impacts of the Project on downstream biodiversity values due to the numerous land uses and activities that have an existing impact on the environment and which, to greater or lesser degrees, would be occurring concurrent with the FMZ operation (see Section 3.4 of the PIR).

Issue 11

The document states that the Project will: *increase flood durations within the FMZ discharge area, ranging from an additional five days for a 1 in 5 chance in a year event, up to eight days for a 1 in 100 chance in a year event*. The impacts downstream have been identified as having a:

- reduced frequency of peak outflow occurrence from 1 in 100 chance in a year to about 1 in 1500 chance in a year with the Project
- reduction in peak flow changes from 9,660 m^3/s to 3,800 m^3/s
- reduction of about 1,180 hectares of native vegetation in the catchment previously affected in this event
- increased duration of inundation in FMZ discharge area of about 11 days instead of four days (that is an increase of seven days)
- increased inundation duration of up to 1,926 hectares of wetland and floodplain habitats in the FMZ discharge area.

Response

WaterNSW notes Council's comments and considers no further response is required.

Issue 12

A total of 4,435.8 hectares of native vegetation within the downstream survey area was mapped. Potential biodiversity impacts are principally related to:

- Reduction in flood frequency and extents resulting in reduced water availability to plants and wetland replenishment. As previously noted, the Project would have no impact on local flooding and any flood-dependent vegetation would be largely dependent on local catchment flows, rather than overbank flooding from the Hawkesbury-Nepean River.
- Increase in flood durations within the FMZ discharge area. Once peak flood levels in the downstream river have decreased, the discharge of water from the FMZ would commence. Apart from some piggy-back discharges (or short duration higher discharges) for the first few days after a large flood event, the rate of discharge from the FMZ would be constant at around 100 GL/d. There would be minimal overbank flows, however, low level or backwater flooding would remain in some areas, such as the Penrith Lakes area, due to the inability of tributaries to drain due to high main river water levels. This low-level flooding would persist for five to eight days longer than an existing flood event. Vegetation in these areas that is not tolerant of additional inundation may be adversely impacted.

The report has not adequately examined whether the vegetation in these affected areas is 'tolerant' of the increased time of inundation which must be addressed.

Response

Further assessment has been carried out on the potential effects that changes to hydrology and flooding may have on biodiversity values, including tolerance of vegetation to increased temporary inundation. Further details are provided in Section 6.7 of the PIR.

Issue 13

The EIS identifies that the following impacts could occur:

- Changes to wetland and floodplain vegetation communities and habitats
- Changes to terrestrial woodland and forest communities and habitat
- Bank erosion and slumping resulting in vegetation community and threatened species habitat degradation
- Increased fine sediment deposits reducing water quality
- Displacement of fauna habitat resources
- Displacement of habitat for fauna dependent on riparian or wetland habitats
- Spread of exotic species
- Spread of disease and pathogens.

The risk assessment created to work out whether assessments are required for biodiversity matters is not scientific or robust and is recommended to require further address.

Response

Council's submission does not identify any specific matters to substantiate its view that the risk assessment is not scientific or robust, which limits providing a response.

SEAR 3.2 required

For each key issue the Proponent must:

(a) describe the biophysical and socio-economic environment, as far as it is relevant to that issue;

(b) describe the legislative and policy context, as far as it is relevant to the issue

(c) identify, describe and quantify (if possible) the impacts associated with the issue, including the likelihood and consequence (including worst case scenario) of the impact (comprehensive risk assessment)

Appendix C *Environmental Risk Assessment Procedure* describes the risk assessment methodology used for the Project, noting that it is generally aligned with the requirements of AS/NZS ISO 14001:2016.

Issue 14

The statement as to why the risk for biodiversity was categorized as 'Minor' for 'Bank erosion and slumping resulting in vegetation community and habitat degradation' has been decided as 'The highly cleared and modified landscapes of the Hawkesbury-Nepean catchment are already subject to erosion impacts and the increase in duration of inundation in wetland and floodplain zones is unlikely to substantially change the existing erosion condition in the broader landscape.' Minor having the definition of 'Incidental and localised impacts to natural habitat.' It is understood that reducing the peak flood extents could have implications for species and communities that rely in these flood extents. However, there is no scientific discussion around how these communities have had to adapt to the change in hydrological regimes due to the Warragamba Dam changing the previous flows and flood extents prior to the Dam, or what cumulative impact could this have on these communities and threatened entities.

The potential impact identified as 'Increased duration of inundation in wetland and floodplain vegetation communities and habitats "has been identified as an 'Insignificant consequence'. 'Insignificant impact' Is defined as 'No measurable impact'. It is not clear as to how this conclusion has been drawn from scientific or evidence-based rationale. For example, have there been other examples of impacts that have occurred where the banks have been inundated with water for a substantial amount of time than what the environment has had to get used to since the dam was constructed which altered hydrological regimes?

The EIS states that for areas within the FMZ discharge area, prolonged periods of inundation may have negative impacts on natural successional processes on plant and sedentary fauna species through vegetation damage and bank stability in wetland and floodplain communities. This impact, however, is not expected to be permanent (up to an estimated five days) and is unlikely to result in significant modifications to the existing communities and habitats that are currently subject to wet periods and flooding events. Increased water flows into the Cumberland Plain's wetland and riparian habitats may potentially be beneficial for some aspects of wetland ecosystem health. This does not factor in that it may take much longer for this water to recede in some areas.

Response

The impact assessments contained in the EIS consider the net impacts from changes to flows generated by the new FMZ as compared to the spills generated from the existing dam. The downstream impacts of flows from the existing dam is an existing risk and so discussion on impact changes to species and communities from current spills to prior to the existing dam are not a focus of the impacts being measured for the raised dam.

There are approximately 50 floodplain wetlands that are associated with the Hawkesbury-Nepean River downstream of Pheasants Nest and Broughtons Pass Weirs to the confluence of the Colo River, with the majority found between Richmond and Wisemans Ferry. Important wetlands include Pitt Town Lagoon and Longneck Lagoon which are examples of the EEC *Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.*

For the downstream biodiversity assessment, the 1 in 10 chance in a year flood event was used for impact assessment. The basis for selection of this event is the Project would reduce the impact area for flood events in the downstream areas that are more often flooded, potentially creating 'dry-out areas (areas that currently flood but will not flood as often once the dam wall is raised). These areas would include some of the wetland communities that are also groundwater dependent ecosystems.

Further detailed consideration of potential impacts on groundwater is presented in the expert technical review provided as Appendix E to this report and discussed in Section 6.2.4 of the PIR. This analysis supports the conclusion of the impact assessment in the EIS that there is a low risk of potential impacts to groundwater systems and GDEs because of the Project.

For any flood event that occurs with contribution from Warragamba Dam, the same volume of water would be generated downstream whether through the existing dam or with a raised dam. The FMZ would operate after the flood has peaked and that the flood is in recession, that is coming off the floodplain and released in a controlled manner to keep in bank and not to intentionally increase or extend low level flooding.

Issue 15

In regard to bank erosion and slumping resulting in vegetation community and habitat degradation as a result of the increase in low level flooding and flows within the FMZ discharge area the EIS states that "the survey area is likely to result in increased bank erosion in discrete areas along the main channel of the Nepean and Hawkesbury rivers. Riverbank erosion and bank slumping can be exacerbated by elevated river flows and soil saturation during periods of extended inundation. Changes to vegetation structure, composition, and condition may directly result from these changes to erosive processes for riparian, floodplain, and wetland communities. The area potentially impacted would be small and confined to vegetated areas on alluvial soils immediately adjacent to the main river channel. The EIS then downplays these impacts and does not assess that potential habitat would be inundated for greater periods of time leaving fauna susceptible without appropriate shelter habitat or foraging habitat for longer periods of time and susceptible to predation. The EIS recognizes this but then downplays or does not consider further species by species what could be impacted. This is considered to warrant further analysis and address.

Response

In response to submissions that raised issues about the potential effects of the Project on downstream sediment movement and on river bank stability, additional studies and analysis was undertaken to supplement the findings in the EIS. The outcomes of these additional investigations are provided in Appendix G; reference should also be made to responses provided in Section 4.2.4 of this report.

Issue 16

The offset strategy has referenced the SEARS noting that it stated:

11. *Where a significant residual adverse impact to a relevant protected matter is considered likely, the EIS must provide information on the proposed offset strategy, including discussion of the conservation benefit associated with the proposed offset strategy' and*

19. *Where a significant residual adverse impact to a World Heritage property and/or a National Heritage place is considered likely the EIS must provide information on the proposed offset strategy. The offset strategy must:*

    (i) include a discussion and supporting evidence of the conservation benefit associated with the proposed offset strategy.

    The conservation benefit must demonstrate, at a minimum,

    (ii) how the proposed offset will improve the integrity and resilience of the heritage values of the impacted heritage place or property; and

    (iii) be consistent with the Environment Protection and Biodiversity Conservation Act 1999 Environmental Offset Policy (2012) or an endorsed state policy.

The strategy does not discuss how this has been achieved in the documentation supplied. The Warragamba Offset Program would be supported and complemented by the separate EMP that WaterNSW is required to prepare under Part 5A of the *Water NSW Act 2014* before the temporary inundation of any land protected by the *National Parks and Wildlife Act 1974* can occur. The scope and content of the EMP have yet to be defined but would be consistent with the existing management plans for the national parks and the GBMWHA. The EMP would contribute to the maintenance and strengthening of protected lands values, including biodiversity.

Response

Details regarding revisions to the offset strategy are provided in Section 3.3 of this report. Further consideration of potential impacts on World Heritage and National Heritage values is provided in Appendix C to this report. This provides discussion that the Project would not have a significant adverse residual impact to the GBMWHA or other protected lands subject to the EPBC Act.

WaterNSW notes the views on the contents of the EMP required under Part5A of the WaterNSW Act, which is a separate obligation to the offset strategy. Matters to be addressed by an EMP will be determined after the Project has been approved.

Issue 17

Should the Warragamba Dam Project be approved under the EP&A Act, the National Parks and Wildlife Minister is to determine the matters that are to be addressed by a draft EMP. If the Project is to be approved the EMP should be made aware for comment. There are three key areas for a potential biodiversity stewardship agreement as part of the Warragamba Dam Raising Project:

- Protecting land owned by WaterNSW under a BSA
- Purchase of land and protection of land under a BSA
- Purchase of land and protection of land through inclusion in a national park under a Plan of Management.

Based on the information provided there is no certainty or evidence that WaterNSW will be able to secure offsets or be able to undertake the project and have a No-Net-Loss in respect to biodiversity. Furthermore, further assessment and consideration of downstream impacts as well as further consideration of species that could be impacted upstream need to be undertaken to understand a more accurate extent of the proposed impacts of the Project.

Response

As noted in Council's submission, the National Parks and Wildlife Minister is to determine the matters that are to be addressed by the EMP required under Part 5A of the *Water NSW Act 2014* should the Project be approved under EP&A Act. Part 5A does not specify consultation with any parties beyond the National Parks and Wildlife Minister.

The three options for a potential biodiversity stewardship agreement noted in Council's submission come from Section 8 in Appendix F6 *Biodiversity Offset Strategy* to the EIS. These were one of four types of strategies that can be used to fulfil the offset requirements under the NSW Biodiversity Offsets Policy for Major Projects (NSW Government 2014).

Offsets will be pursued in accordance with the revised offset strategy as described in Section 3.3 of this report.

Issue 18

The likelihood table provided in Appendix G to Appendix F1 *Biodiversity Assessment Report – Upstream* states that there is high likelihood for *Pultenaea villifera* – endangered population as there are records for Yerranderie area and in Nattai National Park. Suitable habitat occurs within the study area. This is further supported in Table 5-5 Assessment of potential presence of species credit species states 'This population is located specifically in the Blue Mountains and Hawkesbury LGAs. A small proportion of the study area occurs within Blue Mountains LGA. The study area contains PCTs associated with the species.' However, in Table 7-2 Description of Project impacts on flora species credit species it states

> *No impacts as no habitat for this endangered population within the study area.*

The only places this species is mentioned is in the three tables as mentioned and so therefore this species has been missed from offset calculations. This requires clarification.

Response

This species is not included in the offset calculations as the offsets apply to the Project Upstream Impact Area. The reference in Table 7-2 in Appendix F1 to the EIS should be read as 'within the impact area', not within the study area.

Issue 19

There are expert reports for Red-crowned Toadlet, Giant Burrowing Frog, Green and Golden Bell Frog, Littlejohn's Frog, Stuttering Frog and Giant Barred Frog in the Construction Area Ecological Impact Assessment. It is not clear why The Giant Barred Frog, Stuttering Frog, Green and Golden Bell Frog was not considered as a potential species for the upstream ecological assessment. Chapter 8 *Biodiversity-upstream* states in Section 8.2.7.2 those expert reports were prepared for three amphibian species (Giant Burrowing Frog, Red-crowned Toadlet, Stuttering Frog) but none of the upstream assessment reports include these expert reports. The expert reports that have been provided for these species have only been prepared for the construction area.

Of further concern is the following:

- The expert reports have DRAFT watermarked on certain pages – it is unclear if these reports have been approved as a final version. This should be clarified.
- The downstream ecological impact assessment map book does not identify what the threatened flora records are – only shown in the legend as 'NPWS Threatened Flora Species within Biodiversity Study Area'. There is no explanation as to why these details are omitted from the maps.

- It does not appear that all of the study area has been site validated therefore there is a high chance that threatened species have been missed and therefore the impacts underestimated.

Response

All of the species mentioned in the comment were considered within the upstream biodiversity assessment. The reasons for including or excluding species from further assessment as species credit species are outlined in Table 5-5 in Appendix F1 to the EIS.

With regard to the specific comments:

- The expert reports are all final reports
- The mapped records of threatened species reflect the results of searches of all the relevant databases with the databases used for the searches described in Section 4.1.1 in Appendix F2 to the EIS
- The EIS clearly acknowledges the limits of the site survey. Where limitations of survey were identified, existing verified mapping or assumed presence has been used to ensure that it was unlikely that threatened species were missed or underestimated (as per FBA requirements).

Issue 20

In relation to the aquatic ecology report, it is not agreed (as outlined in Section 3.7 of the report) that the only two key threatening processes relevant to the proposal will be:

- The installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams; and
- The removal of large woody debris from New South Wales rivers and streams.

The proposal will also result in the degradation of native vegetation along New South Wales watercourses.

It is likely native vegetation upstream will be impacted due to longer periods of inundation. It is also likely that downstream will also incur impacts where flood prone vegetation communities, including riparian vegetation, will be inundated for longer periods which could result in the degradation of these environments. Further consideration and assessment of the consequences of this for aquatic ecology is needed.

Section 4.2.2 of the report does not consider the increased time of inundation of riparian habitats. Furthermore, there appears to be missing information from Table 4-1 where on page 78 the last sentence in the third column ends and there is no continuation of the sentence on the following page which is blank. The following page (page 80) is also blank. This information needs to be made available.

Response

The assessment presented in the EIS and in further investigations provided in this report and the PIR do not support Council's view that there will be an inevitable degradation of riparian vegetation.

Further information relating to potential impacts on riparian habitat is provided in Section 4.2.4.4 of this report and Section 6.6 of the PIR. The Project is unlikely to have a material impact on affected riparian habitats.

The reason for the missing information in the report on the DPE Major Projects website is unclear as it was in the copy of the updated report provided to DPE for public exhibition.

The missing text from Table 4-1 in Appendix F4 to the EIS is shown in bold below:

> *Impacts to aquatic habitat that this species relies on during certain lifecycles stages [are] not anticipated to be impacted during operation of the Project.*
>
> *Increases in turbidity would generally be temporary in nature and associated with flood events, and* ***therefore unlikely to contribute to a permanent reduction in quality of habitat.***

The remainder of page 79 and page 80 in Appendix F4 to the EIS presented the proposed safeguards and management measures, which were largely captured in Table 11-7 in Chapter 11 and Table 29-9 in Chapter 29 of the EIS. The missing table is provided in Section 7 of this report.

Issue 21

Overall the proposal to raise Warragamba Dam will have considerable impacts on the environment, including World Heritage values, notably biodiversity values and Aboriginal cultural heritage which on biodiversity grounds in isolation, suggests the proposal should not be supported.

The Project will result in irreversible and uncertain impacts for biodiversity within the construction footprint as well as upstream and downstream of the project that has not been adequately addressed in the EIS. A number of species have been assumed present for lack of survey effort which without targeted surveys the report does not accurately assess the impacts to threatened species.

There could be additional species within the impact area that have not been considered assumed present or not detected through lack of survey effort. It is considered essential that the Environment, Energy and Science division of the NSW Department of Planning, Primary Industry and Environment commission an independent review of the documentation by relevant species and ecological experts to review the information provided in the EIS to ascertain whether the assessment has been undertaken in accordance with relevant survey guidelines for that species and the impacts accurately considered.

Response

WaterNSW notes Council's view, however advises that the biodiversity assessments included comprehensive database searches, as is standard for such assessments. In accordance with the FBA, where species were considered potentially occurring, they were assumed present and therefore considered in the assessment. The possibility of additional species occurring that have not been considered in the assessment is considered unlikely.

5.5.4 Water quality management

Issue 1

With regard to the operational stages of the development, the Project presents a number of potential impacts to water quality, creek stability and aquatic habitats. It is likely to occur either directly through operational activities, or indirectly through temporary inundation of upstream vegetated areas and soil landscapes during flood events within the FMZ, which may lead to an increase in organic and nutrient concentrations in Lake Burragorang. The project is also likely to present some risks to water quality during the operation of the FMZ, which may have impacts on the raw water supply for drinking water purposes. Some of the key risks to water quality to the upstream environment as a risk of the increased extent and duration of the upstream catchment included increased natural organic matter concentrations, increase pathogens, turbidity, nutrient concentrations.

The consent authority is requested to specifically address these concerns and likely impacts and ensure that are addressed and suitably mitigated via conditions of consent if the application is favourably determined.

Response

The request to address the identified concerns through approval conditions is a matter for DPE in its assessment of the Project.

Issue 2

In terms of potential impacts caused by discharge of the FMZ on downstream water quality, the EIS notes that temporary changes in water quality due to an extended period of discharge from the FMZ may be an issue as the discharge of the FMZ may extend into periods when downstream water quality would have recovered after a flood event. However, the information presented in the EIS concluded that the discharge of the FMZ would have no major impact downstream and noted that the FMZ would only be operational infrequently. The EIS also includes commitments to undertake further monitoring programs to confirm the risk and enhance adaptive responses to manage any changes in water quality due to the project.

The consent authority is requested to specifically address the impacts of the FMZ discharge and ensure that are addressed and suitably mitigated via conditions of consent if the application is favourably determined.

Response

The request to address the identified concerns through approval conditions is a matter for DPE in its assessment of the Project.

Issue 3

With respect to the geomorphological considerations, the reports noted there will be some unavoidable geomorphological impacts on bank erosion. The assessment considered a total of 16 potential impacts from the Project, these comprising four potential impacts in the upstream study area, four potential impacts in the Lake area and eight potential impacts in the downstream study area. The EIS further notes that during the emptying of the FMZ there would be an increase in the duration of sustained flows through the river channel. This would result in water levels within the river channel being maintained at higher levels for a longer period of time.

The EIS notes that the FMZ would be emptied at a constant rate of 100 gigalitres per day. The EIS points out that this could be increased to around 230 gigalitres per day for larger floods allowing the FMZ to be emptied within three to four days. Potential impacts include the possibility of cumulative bank erosion impacts caused by prolonged FMZ flows in parts of the Nepean River, including in the Fairlight Gorge to Penrith Weir and Devlins Road to Grose Confluence reaches.

The EIS indicates that the risks were considered to be relatively low with mitigation measures in place, which include the possibility of direct erosion mitigation measures. With respect to the impacts to the river, there was however limited discussion on impacts such as slumping riverbanks or loss of riparian vegetation because of the increased duration of inundation and resulting saturation of riverbanks.

The consent authority is requested to specifically address these concerns and likely impacts and ensure that are addressed and suitably mitigated via conditions of consent if the application is favourably determined.

Response

In response to submissions further work has been undertaken to assess channel erosion and stability during operation of the FMZ. A technical note is provided in Appendix G; reference should also be made to responses provided in Section 4.2.4 of this report. The technical note identifies that for much of the downstream river length there would a reduction in erosion and bank slumping from the FMZ operation, however for some areas between North Richmond and Cattai Creek there would be increased impacts.

The request to address the identified concerns through approval conditions is a matter for DPE in its assessment of the Project.

Issue 4

If the application is supported by the Department, it will be necessary to consider any impacts to channel stability to ensure that adequate safeguards and monitoring are in place to ensure any impacts are managed. Adequate consideration and resources should also be factored into the Project to ensure that downstream landowners are not adversely impacted because of the Project.

Response

It is presumed that these matters would be considered by DPE as part of its assessment of the Project.

5.5.5 Environmental management considerations

Issue 1

Limited information is provided within the EIS to address pollution management and sediment and erosion control measures for the demolition and construction phases of the development. While these measures are to be put in place outside the Penrith LGA, if they are not, then impacts could flow down river to the Penrith LGA. It is recommended that this be further addressed by the Department in the assessment of the application and via conditions of approval for the preparation of a Construction Environmental Management Plan (CEMP), prepared by a suitably qualified and practicing person detailing sediment and erosion control measures as well as pollution management strategies.

Response

The request to address the identified concerns through approval conditions is a matter for DPE in its assessment of the Project.

Issue 2

It is recommended that a hazardous materials assessment is undertaken for both the demolition and construction phases of the development. Control measures should be included in this.

Response

Management measures are provided in Appendix B to this report. The safety of the construction workforce and public during construction is addressed through management measure HS2. This covers the recommended hazardous materials assessment.

Issue 3

There will be up to 500 workers travelling to site each day during construction as well as up to 104 heavy vehicles during the main works. Detail has been provided as to which route these vehicles will be travelling. It is recommended that heavy vehicles use these distinct travel routes only. These routes should be determined to have the least impact, both noise and air quality, on the residents of the Penrith LGA. No truck movements should occur between the hours of 10 pm and 6 am (unless during an emergency such as floods).

Response

Management measures are provided in Appendix B to this report. Management measure TT1 provides for the development and implementation of a Construction Traffic Management Plan (CTMP) as part of the CEMP. This would address the matter of routes used by construction traffic. Management measure TT9 addresses the issue of out-of-hours heavy vehicle movements.

Issue 4

In relation to air pollution, the demolition and construction phases of the site is over four kilometres away from residents of the Penrith City Council area. It is unlikely that Penrith LGA residents would be affected by dust emissions during demolition and construction, a Dust Management Plan should be prepared for the construction site.

Response

Management measures are provided in Appendix B to this report. Management measure AQ1 provides for the development and implementation of a construction air quality management plan as part of the CEMP.

Issue 5

In relation to noise impacts, it is unlikely that the development will have direct noise impacts for residents of the Penrith LGA. There may, however, be noise impacts from increased traffic, including heavy vehicles. These considerations should be included in a Construction Noise Management Plan.

Response

Management measures are provided in Appendix B to this report. Management measure NV1 provides for the development and implementation of a construction noise and vibration management plan as part of the CEMP.

Issue 6

An overarching CEMP should be prepared for the site and that the Construction Noise Management Plan, Dust Management Plan, Pollution Management Plan, Sediment and Erosion Control Plan and any other sub-plans are formed under the CEMP. The CEMP and any plans should also include strategies for continuous monitoring and evaluation as well as strategies on dealing with complaints and adverse environmental outcomes.

Response

A CEMP will be developed and implemented by the delivery contractor for the Project construction.

5.5.6 Road and drainage asset management considerations

Issue

In the event that the application is favourably determined, it is requested that conditions are imposed for a pre and post construction dilapidation reports with respect to Silverdale Road between Park Road/Mulgoa Road and Blaxland Crossing at Nepean River (end of the Penrith LGA) including a detailed recording of the road pavement condition and bridge structure over the river.

Any deterioration of these assets caused by the construction traffic routes through this area must be repaired at no cost to Council and to the satisfaction of Council's Asset Management Department. Any rectification works required will be subject to a 12-month maintenance period where should any further failures/deterioration of the repaired assets become apparent, these will need to be repaired again at no cost to Council.

The dilapidation reports should include pre and post construction condition assessments of underground stormwater assets including pits and pipes. There are 450 mm diameter pipes on the road and CCTV inspections before and after use of road for heavy (project) traffic are required.

Response

The request to address the identified concerns through approval conditions is a matter for DPE in its assessment of the Project.

5.5.7 Traffic management considerations

Prior to the issue of any Construction Certificate or the commencement of any construction works, the Certifying Authority shall ensure that a Construction Traffic Management Plan is provided to the satisfaction of Transport for NSW, and Wollondilly Shire Council and Penrith City Council that includes:

- All construction heavy vehicle movements to and from the east of the site to be via Silverdale Road, Park Road and The Northern Road only.
- All construction heavy vehicle movements across Blaxland's Crossing Bridge are controlled and monitored to be below the normal loading capacity of the bridge.
- The speed limit for heavy vehicles on Blaxland's Crossing Bridge is reduced.
- Impacts of heavy vehicle movements on Blaxland's Crossing Bridge structure and pavement and Silverdale Road pavement are controlled and monitored.

Response

The proposal is being assessed under Part 5, Division 5.2 of the EP&A Act. Accordingly, the certification process under Part 4 of the EP&A Act does not apply.

Management measures are provided in Appendix B of this report. Management measure TT1 provides for the preparation of a CTMP prior to construction. This specifically notes the issue of speed management of construction-related vehicles crossing Blaxland Crossing Bridge and continuous monitoring of bridge performance. Preparation of the CTMP would include consideration of the specific matters noted.

Preparation of the CTMP would include consultation with Wollondilly Shire Council and Penrith City Council. Should the Project be approved, it is anticipated that the CTMP would be required to be submitted to DPE for approval. A copy of the approved CTMP would be provided to both councils for information.

5.6 The Hills Shire Council

The Hills Shire Council is supportive of the proposal.

Response

Council's support for the Project is noted.

5.7 Wingecarribee Shire Council

5.7.1 Impacts on land within Wingecarribee Shire

The level of impact on land specifically in Wingecarribee Shire has been hard to gauge from the EIS. From what can be seen on low resolution maps in the EIS it appears to impact predominantly on six private properties and the Nattai National Park. Under different flooding scenarios, this level of impact appears to be either an increase in the area affected by temporary inundation, and/or an increase in the frequency in temporary inundation, and/or in increase in the length of time that the land is inundated.

Response

The only land within Wingecaribee Shire that would be affected by the Project is land within the PMF event along about a 4.8 kilometre section of the Wollondilly River. This is mostly national park (Nattai National Park) with a small area of private land. Two parcels of non-national parks land are affected by the Project: Lot 29, DP751293 and Lot 61, DP751293. Both parcels of land are affected by existing flooding from the 1 in 10 chance in a year flood event and larger flood events. The extent and depth of flooding from these events will be approximately the same with the Project. The duration of flooding will increase by less than half a day for the 1 in 10 chance in a year flood event up to about 3.5 days for the 1 in 100 chance in a year flood event.

5.7.2 Flooding scenarios used for the assessment

Assessment of impacts is largely based on flood models for a 1 in 20 chance in a year event. The impacts from events less than 1 in 20 chance in a year are less obvious. While the frequency of these flooding events will be less frequent, the impact can still be long term or permanent. When the event will occur, it could still have a long lasting or permanent effect on significant cultural items, biodiversity integrity and the use and condition of land. The full impact of all flooding scenarios needs to be considered for the project.

Response

Assessment of impacts is based on the 1 in 5, 1 in 10, 1 in 20, 1 in 100 chance in a year events and the PMF event as required by SEAR 8.2 and as identified in Table 15-1 in Chapter 15 of the EIS. Consideration of potential impacts in the upstream area for these flood events is provided in Section 15.6 of Chapter 15.

5.7.3 Impacts on the World Heritage area

The Greater Blue Mountains World Heritage Area starts to the south in the Wingecarribee Shire with the Nattai National Park. Council is concerned about the likely impacts on the World Heritage area.

Response

Further consideration of potential impacts from the Project on the GBMWHA is provided in Appendix C to this report. This supports the conclusion presented in the EIS that the Project is unlikely to have a significant material impact on the GBMWHA.

5.7.4 Impact on Gundungurra land

The heritage impact on Gundungurra land is of great concern to our community. Council understands that a number of submissions are being made which reflect on this issue in detail. Council asks that these submissions be thoroughly considered. As mentioned above, concern is raised that the full impact of the project may be missed in the EIS due to the methodology of assessment. All impacts under all flooding scenarios should be fully assessed. Any amount of inundation (no matter how infrequent) could have permanent consequences on significant cultural items.

Response

Consideration of issues raised in submissions relating to Aboriginal cultural heritage is provided variously in this report such as in Section 4.3 with regard to advice provided by Heritage NSW, Section 4.9 with regard to council submissions, and Section 6 with regard to community submissions.

Further assessment of potential impacts on Aboriginal cultural heritage has also been carried out and is documented in Section 6.3 of the PIR.

5.7.5 Impacts on private property

Six private properties appear to be affected by the Project. Some of the affected residents have indicated that the information they have obtained about the project has been insufficient for them to be fully informed on the full impact on their properties from all flooding scenarios. It is also unclear what restrictions may apply to the use of the land.

Response

Please refer to the response provided in Section 5.7.1 with regard to affected properties.

The Project would not place any restrictions on use of land beyond any that may currently apply.

5.7.6 Alternatives

There are additional alternatives that should have been considered in the EIS. Other upstream alternatives could include flood forecasting, flow management, maximising all upstream reservoir and pumping infrastructure, harvesting/retention (private/public), and maximising catchment management programs (e.g. regenerative farming). A number of these alternatives may add significant regional resilience advantages as well.

Response

A detailed summary of the options considered for the Project and the extensive history of this process is provided in Section C2.6 of this report, and in further detail in Chapter 4 of the EIS. Improved weather and flood predictions is identified as one of the nine key outcomes of the Flood Strategy (Infrastructure NSW 2019b). The other options noted would not provide sufficient capacity to temporarily retain floodwaters nor the management flexibility to control releases to minimise impacts on the downstream flood evacuation network.

5.8 Wollondilly Shire Council

The submission from Wollondilly Shire Council included a covering letter with an attached submission of issues categorised under relevant chapters of the EIS. The executive summary of the submission has been treated as a collation of concerns arising from the specific issues. WaterNSW has provided responses to those discrete submission issues or questions raised by Council which may not include a response to a statement or point of view by Council within the submission.

Council's submission included two supporting documents providing additional details with regard to matters relating to biodiversity and heritage (both Aboriginal and non-Aboriginal). These matters have been considered in the responses provided to Council's issues in this section.

5.8.1 Chapter 2: Statutory and planning framework

Issue 1

The hierarchy of legislation is misleading. In terms of the hierarchy of plans, the National *Environment Protection and Biodiversity Conservation Act 1999* protections afford protection with the World Heritage listing with UNESCO, the National Heritage Listing and these should be clearly addressed and articulated and the strength in terms of hierarchy noted. The 'last' section of the document should be the listed first in order of hierarchy.

Response

The discussion of the statutory and planning framework presented in Chapter 2 of the EIS was not intended to reflect a hierarchy of legislation and this was not required by the SEARs. The Project is being assessed under the NSW regulatory and planning system. Consideration of matters falling under the EPBC Act is being addressed through the assessment bilateral agreement between the Commonwealth and NSW governments as identified under the General Standard SEARs.

Issue 2

The Local Strategic Planning Statement, District Plan and Metropolitan Plan all form part of the planning framework, however, none of the key strategic planning documents are considered nor listed.

Response

The *Greater Sydney Region Plan* (Metropolitan Plan) sets out the strategy to transform land use and transport patterns, and boost Greater Sydney's liveability, productivity and sustainability by spreading the benefits of growth to all its residents. The Plan sets out 10 directions, each with supporting objectives to deliver the strategy. The Project is consistent with and/or supportive of the following directions and objectives:

- Direction 3: A city for people; Objective 7. Communities are healthy, resilient and socially connected
- Direction 10: A resilient city; Objective 36. People and places adapt to climate change and future shocks and stresses
- Direction 10: A resilient city; Objective 37. Exposure to natural and urban hazards is reduced.

The Project would significantly mitigate flood risk on the Hawkesbury Nepean floodplain providing a material benefit to downstream communities.

There are five District Plans that guide implementation of the *Greater Sydney Region Plan* at the district level. The Project sits within the area covered by the Western City District Plan which also takes in the Wollondilly LGA. The Western City District Plan informs local strategic planning statements and local environmental plans, the assessment of planning proposals as well as community strategic plans and policies. The Project is consistent with and supports Planning Priority W20 (Adapting to the impacts of urban and natural hazards and climate change).

As noted on Council's website[32], the Wollondilly Local Strategic Planning Statement (LSPS) (*Wollondilly 2040*) will

[32] https://www.wollondilly.nsw.gov.au/planning-and-development/guidelines-and-controls/local-strategic-planning-statement/

> *… shape how the development controls in the Wollondilly local environmental plan (LEP) evolve over time to meet the community's needs, with the LEP being one of the main tools to deliver the plan.*

The Project is being assessed under Part 5, Division 5.2 of the EP&A Act. As such, it is not subject to the planning controls under the Wollondilly LEP. This notwithstanding, the Project is consistent with and supportive of Planning Priority 18 (Living with climate impacts and contributing to the broader resilience of Greater Sydney).

Issue 3

The studies need to be robust so that appropriate management of impacts can be addressed in the EMP for the Project. Part 5A of the Water NSW Act may not require the Project to obtain a lease, licence etc. to temporarily inundate land protected under the NPW Act however, before they do cause inundation they need to prepare an EMP to the satisfaction of the Minister. The EMP is only as good as the information it is based on and we should argue that the information is flawed/not extensive enough to understand the full extent of impacts.

If the project proceeds, it must be abundantly clear what the full range of impacts will be, the mitigations measures, the environment, social and economic impacts must be completely understood. The work should it go ahead needs to be supported by comprehensive studies that identify full extent of impacts. This does not appear to be the case after having listened to the representation on Aboriginal Cultural Heritage. We could suggest the EMP based on current work/field survey would not meet legislation because it does not do a full and proper assessment.

Response

The supporting studies for the EIS have been carried out to inform the assessment of the Project with regard to relevant matters and requirements for SSI under Part 5 of the EP&A Act. It is anticipated that these studies would also inform development of the EMP required under section 64C of the *Water NSW Act 2014*.

Council's broad statement that EIS information *'is flawed/not extensive enough to understand the full extent of impacts'* is not supported by meaningful reference or analysis. The EIS comprises 30 chapters, of which 22 chapters and associated specialist appendices address key potential impacts. Impact assessment includes:

- Reference to SEARs and identification of relevant assessment requirements and methodologies (including legislation, procedures, survey requirements and best practices)
- Documenting existing environment characteristics and undertaking impact assessment against relevant Project aspects
- Identifying mitigation measures and undertaking residual risk assessments.

This process and the information presented considered stakeholder feedback received during EIS consultation (Chapter 6 of the EIS) and confirmed by a consistency review undertaken by DPIE.

This report and the PIR provide clarification and additional analysis of some aspects of the assessment, including upstream and downstream biodiversity, cultural heritage and archaeology, hydrology and flooding, water quality, groundwater, geomorphology and erosion, contaminated sites and socio economic effects. Some mitigation measures have been revised/updated, which will form the basis for preparing the necessary construction and operational management plans.

Section 64C(1)of the Water NSW Act requires WaterNSW to consult with the Chief Executive of the Office of Environment and Heritage as part of preparation of the EMP relating to the temporary inundation of national park land resulting from the Warragamba Dam project. This consultation will not occur until the Project has been determined. Should the Project be approved, consultation would be initiated and would identify the matters to be addressed in the EMP. The matters to be addressed in the EMP will be determined by the National Parks and Wildlife Minister as per section 64C(2).

At this stage, the claim that the EMP would not meet legislative requirements is considered premature.

5.8.2 Chapter 3: Strategic justification

Issue 1

Chapter 3 mainly focussed on analysing the *Hawkesbury-Nepean Valley Flood Risk Management Strategy* (the Strategy). The protection of life and property are absolute, and this highest principle is supported. The intent of any project seeking this outcome is supported, however this project has been nominated without full transparency of all options, cost-benefit, social and environmental considerations being provided clearly to the community.

The Strategy identified nine outcomes to reduce flood risk and impacts in the valley, and actions for each of those outcomes. One of the outcomes was to reduce flood risk in the Hawkesbury-Nepean Valley by raising Warragamba Dam, and it reveals:

- By raising Warragamba Dam and creating a flood mitigation zone (FMZ) of around 14 metres provided the highest net benefit for reducing flood damages and risk to life compared to other alternatives considered.
- They considered raising it higher but was not taken further given additional cost and impacts.

The outcome/intent to manage risk is not disputed as being important, however, it is argued that there are likely other options that need to be explored and costed (infrastructure costs as well as community/cultural/ environmental cost of impacts).

Such new infrastructure could include redirecting funds from this project to the early delivery of the OSO with greater access to the impacted communities to create safe access and egress and new or upgrade roads to create flood-resistant access for such emergency events. This has the added benefit of serving more than just flood evacuation and can look to support bushfire and other emergency evacuation purposes. Such an option would have less environmental and heritage impacts than a project that would see the complete destruction of environment and heritage values of the NP.

Response

WaterNSW refers to Chapter 4 of the EIS, which draws extensively on the *Hawkesbury-Nepean Valley Flood Risk Management Strategy Taskforce Options Assessment Report* published by Infrastructure NSW in January 2019, and which includes detailed comparisons of options. The Hawkesbury-Nepean Valley Flood Management Taskforce was established by NSW government in 2014 and has extensively assessed alternatives and options for flood mitigation including options to lower the full supply level and height options for raising the dam. The Taskforce found that the most effective and efficient infrastructure option to reduce risks to life and property from flooding is to raise the Warragamba Dam to provide a flood mitigation zone of around 14 metres.

5.8.3 Chapter 4: Project development alternatives

Issue 1

Need more clarity of assumptions used to determine benefits used for Benefit Cost Ratio (of 1.05). Any small decrease in benefits will drop the BCR ratio to less than 1.

Response

The purpose of the EIS is to address the SEARs as issued by DPIE, which are primarily concerned with the assessment of impacts on the listed environmental values resulting from the construction and operation of the Project. A benefit-cost ratio (BCR) summarises the relationship of the relative costs and benefits of a proposed project, which is used to inform government of the value and merits of a proposed project.

The benefit-cost assessment was undertaken in accordance with NSW Treasury Guidelines. This considered all costs mentioned among other cost requirements.

The project costing information provided in the EIS incorporates the level of detail appropriate to an EIS assessment.

The benefits of the Project were considered in the EIS and included projected growth in the valley out to 2041. The benefits of the Project are primarily for past and current development in the valley, as the retention of the current flood planning level after the project reduces the flood risk. In addition, projected climate change increases the future flood risk, and the Project would reduce this increase in flood risk for the current and future population.

Issue 2

Fails to demonstrate the benefits of developing and implementing a contemporary floodplain risk management plan approach (consistent with the State Government Policy for Flood Prone Land) with a combination of strategies and projects. This should demonstrate the benefits of a combination of measures including capping of development and maintaining or reducing population and density through voluntary purchase of worst affected properties.

Response

The objective of the EIS is to assess the environmental impact of raising Warragamba Dam to provide a flood mitigation function as part of a larger overarching management response. All feasible measures were considered and assessed in developing the Flood Strategy, including consideration of contemporary floodplain management strategies. The Options Report[33] outlines this assessment.

Most of the flood risk to life and property is associated with current development in the valley. The Flood Strategy identified that although the population below PMF was projected to double by 2041, the damages for a 1 in 500 year chance in a year event would only increases by 40 percent. Voluntary house purchase was assessed and was found to be extremely expensive, even for houses below the 1 in 100 chance in a year flood level

Issue 3

Need more clarity about the 'social disruption' of voluntary purchase of properties.

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[33] https://www.infrastructure.nsw.gov.au/media/1976/taskforce-options-assessment-report-2019-v2.pdf

Response

Additional assessment has been undertaken of the option to buy or acquire private property as a regional and feasible flood risk reduction measure in the Hawkesbury-Nepean Valley. This is provided as Appendix F to this report and the following is a summary of the assessment.

Three options have been considered and details of these are provided in the following table.

Table 5-3 Property acquisition options

Option	Details
1. Voluntary purchase	This is where the private property owner voluntarily accepts an offer to sell their residential property (building and land) to an authority or entity. This option allows the property owner to buy elsewhere within or outside the community. It results in the removal of the existing development and the rezoning of the land for more flood compatible uses, such as open space. This option has been applied in NSW in areas where there is significant risk to life to occupants or potential rescuers where other management measures cannot effectively address this risk. When recommended in a floodplain risk management plan in NSW, voluntary purchase may be funded by the NSW Floodplain Management Program.
2. Land swap	This is where the private property owner voluntarily accepts an offer to swap their land located in a high flood risk area for vacant land in a low flood risk area. The land swap does not include the house or business premises on the land. The private property owner is typically responsible for building the house or premises on the swapped land through their private funds or insurance payouts.
3. Compulsory acquisition (or resumption)	This is where private property is acquired by a public authority for a public purpose. Acquisition occurs without the consent of the property owner. There is a statutory process for compensation to the property owner.

The following assessment criteria were used to evaluate these options:

- The degree to which the option resulted in significant, regional reduction of flood risk
- Cost of the option
- Likely social and environmental impacts of the option.

These criteria are broadly consistent with those in the Taskforce Options Assessment Report (Infrastructure NSW 2019). Specific details with regard to the findings of the assessment are provided in Appendix F and are summarised as follows.

1. The assessment for the voluntary purchase option noted the following key points:
   - Can be used to directly avoid exposure by targeting high risk properties
   - Are limited in providing significant, regional reduction of flood risk at scale
   - Have had mixed and incomplete uptake in NSW, with some property owners unwilling to participate in voluntary purchase schemes
   - Are expensive and can take a long time to implement
   - Can result in social dislocation for established communities
   - Can be patchy in uptake resulting in vacated land being in separate, unconnected lots, thus limiting the use of vacated land for alternative purposes.
2. The assessment for the land swap option noted the following key points:
   - Can be used to directly avoid exposure by targeting high risk properties
   - Can be limited in providing significant, regional reduction of flood risk at scale
   - Are expensive and can take a long time to implement
   - Can preserve community cohesion for established communities as households relocated together

- Can be patchy in uptake resulting in vacated land being in separate, unconnected lots, thus limiting the use of vacated land for alternative purposes.

3. The assessment for the compulsory acquisition option noted the following key points:
   - Could theoretically provide significant, regional reduction of flood risk at scale
   - Is a high cost option
   - Could take less time to implement than voluntary purchase or land swaps
   - Is likely to generate stakeholder and community opposition due to the compulsory nature of this option
   - Allows for vacated land to be more readily repurposed for alternative uses compared to voluntary purchase or land swaps.

The assessment concluded that these options are unlikely to provide significant, regional reduction in flood risk at a large scale within the Hawkesbury-Nepean Valley. These types of options are generally very costly, involve a complex and lengthy process to implement, and have significant physical and social impacts for affected communities.

5.8.4 Chapter 6: Consultation

Issue 1

Inadequate meaningful consultation regarding upstream and adjacent community impacts.

Response

Section 7.3.1 in Appendix M to the EIS documents the extensive stakeholder engagement carried out as part of the socioeconomic impact assessment. Consultation activities comprised:

- Meetings and briefings with relevant councils, as well as local MPs, senior government executives and their support staff, and special interest groups
- Community information activities such as pop-up information stalls were held at community events, shopping centres and community facilities; information displays at council chambers, libraries, and other facilities; and a dedicated Project website, Project email address and an information line
- Four community updates over the period of EIS preparation
- Consultation with Aboriginal stakeholders
- Community engagement with a broad range of stakeholders was conducted, including interviews with councils and other stakeholder groups, council briefings, meetings with relevant government agencies, and briefings provided and meetings with three special interest groups.

Appendix B to Appendix D *Community Consultation Report* to the EIS also provides a detailed description of consultation and engagement activities carried out for the EIS.

WaterNSW is of the view that the consultation carried out for the Project has been comprehensive and meaningful, and has appropriately informed the assessment for the Project.

Issue 2

The extent, depth, and effectiveness of consultation is unclear in Chapter 6 of the EIS. There is inconsistency in reporting between Chapter 6 and Appendix D; some of the community consultation detail is actually in Chapter 21.

Specific examples for Chapter 6 are:

- Focus is on awareness (of the project and downstream flood risk) rather than obtaining meaningful input about impacts. I.e. awareness regarding the dam-raising project, downstream flood risks, and downstream impacts of flooding.
- Limited engagement. There only seems to have been one workshop day with Warragamba residents, and the key emerging themes are not mentioned (6.4.6). These themes seem to be noted in Chapter 21, and readers are directed there from Appendix D.
- Information is difficult to navigate. E.g. Tables 6.6 – 6.10 are neat and provide a directory of high level concerns raised by specified stakeholders, but the process of navigating to review multiple lengthy chapters and appendices is cumbersome.
- Key information is hard to find. e.g. Survey results are not provided (6.4.5) nor is their location noted in this Chapter. In fact the results are discussed in Chapter 21 albeit in a text-heavy way.
- These results are reported in a confusing/conflicting way: (bold added for emphasis) "Of the 20 business respondents in Warragamba/Silverdale, most recorded a neutral response as to potential effects of the Project construction with the only concern raised being the potential effect being in relation to 'business amenity' (50 percent of respondents reported that the Project may have a negative effect). Reference section 21.6.2.5.

Specific examples for Appendix D are:

- Reporting of feedback from Community Consultation Cluster One (upstream) is presented in a confusing way that is different to the other clusters (2.2)
- There are inconsistencies in how engagement events are reported: e.g. Chapter 6 reports one community workshop in Warragamba whereas Appendix D reports two. Chapter 6 reports eight Community Information Displays whereas Appendix D reports eight Community Consultation Sessions – these give very different impressions of the intent of the events.
- The 'Sentiment' section (fig. 1.1) provides little context about how it was tabulated, and gives the impression that most interactions regarding the dam raising were neutral/apathetic. It minimises the degree of opposition to the project.
- Appendix A to Appendix D outlines Flood Strategy engagement activities which are focused on promoting the project rather than assessing impact.

Response

The identified inconsistencies are acknowledged but are not considered to detract from the findings of the environmental assessment. Consultation for the Project and for key technical investigations such as the socioeconomic impact assessment is considered to have been robust and comprehensive.

Issue 3

In reporting the EIS consultation, concerns seem to have been minimised such as through use of language. For example:

- The language used around water events upstream vs downstream seems to minimise the impact upstream while emphasising the impact downstream; downstream they are referred to as 'floods' and 'flooding' which may be accurate but are also emotive, dramatic terms; whereas upstream they are referred to as 'temporary inundations' which sounds more clinical and benign.

- Language used in the section for Community Consultation Cluster Four is minimising and dismissive e.g. 'According to local stakeholders…', 'They say that…', '…perceived negative impacts', 'Local stakeholders believe…" (2.5.1)

Response

Terms used for EIS consultation are considered to be consistent with language and terminology used throughout the EIS and in technical literature generally. With regard to the first bullet point, 'floods' and 'flooding' are accepted terms for the downstream effects and align with community language and terminology. While upstream inundation could be referred to as 'floods', it is important to recognise the difference between the managed and temporary nature of this flooding compared to that experienced downstream of the dam.

5.8.5 Chapter 7 Air quality

Issue 1

No assessment/modelling on air quality has been carried out to a new residential subdivision west of Marsh Road, Silverdale.

Response

The analysis of potential air quality impacts presented in Chapter 7 *Air quality* and Appendix E *Air Quality Assessment* to the EIS shows that emissions from construction activities would not extend to the new residential subdivision west of Marsh Road, Silverdale.

Mitigation measure AQ1 provides for the preparation of a construction air quality management plan (refer Appendix B to this report).

Issue 2

Total Suspended Particles, the cumulative concentrations and PM10 – 24 hour average particulate matter are likely to be in exceedance at receptor R49 (Receptor 49 has only been identified by latitude and longitude in the report).

Response

Receptor R49 is an open space recreational area located between Farnsworth Avenue and Production Avenue. The location of this receptor is shown on various figures in Chapter 7 of the EIS. This receptor lies within the construction area which would not be accessible to the public during construction.

5.8.6 Chapter 8 Biodiversity – upstream

Issue 1

The magnitude and extent of impacts to threatened species and ecological communities is enormous.

Response

Chapter 4 of the EIS provides a detailed description of the history of the development of the Project and the alternatives considered as part of this process. The criteria to assess alternatives and options for flood risk mitigation included socio-economic, environmental and cultural heritage impacts. A history of options development and assessment is provided in Section 1.2 of this report.

WaterNSW undertook the necessary engagements with agencies on the various methodologies and approaches to be implemented in delivering the outcomes required to respond to the SEARs.

One of these was establishing an assessment framework to address the infrequent and variable nature of flood events in depth and duration for the upstream area. The identification of an upstream impact area is to recognise the probabilistic basis of flooding and variable extent of affected land. The approach reached is clearly presented in the EIS and resulted in the defining of the Project Upstream Impact Area (PUIA)[34].

To establish a likely upstream impact area a full range of flood events and lake variables were modelled to generate around 20,000 flood events, which represent around a 200,000 year period of time. Within each 20-year period across the 200,000 year modelling representation the peak level was chosen and the average of all the 20 year peak levels was adopted as the likely impact area. The area is not related to any particular flood frequency, however, it approximates a 1 in 20 year event. Within a 20 year period at least one large event above full supply level would be captured for the modelling, which has been validated from flood records of the existing dam in the 60 year operating life of the dam. Note that the same modelling was undertaken to assess the likely inundation area for both the existing dam and with Project, and the impact area is the net difference between the two areas as the existing dam already floods above the FSL as validated by flood records.

The EIS also states that a precautionary approach has been taken and for the purposes of offsetting the potential impacts of the Project, it has been assumed that there would be a complete loss of all environmental values in this area. In It is reiterated that this assumption was solely for the purpose of offsetting, and is unlikely to be realised.

The offset strategy has been revised to the approach in delivering the offsets required to retire credits and is further explained in the PIR. The EIS has addressed the impact assessment on biodiversity as required and DFPE will separately make a determination on the Project taking into account the EIS, Submissions Report and PIR).

Issue 2

Legislative Matter: The version of State Environmental Planning Policy (Koala Habitat Protection) referenced is to be clarified and additional assessment considered if required. The Koala SEPP 2020 is referred to in the assessment. Based on the date of publication of the EIS (September 2021), the applicable SEPP to reference is SEPP 2021. It is noted that neither SEPP 2020 or SEPP 2021 apply to developments assessed under Part 5 of the NSW *Environmental Planning and Assessment Act 1979*, therefore further consideration of impacts to koala is not required. However, based on the date of publication of the updated SEARs (March 2018), the Koala SEPP 44 would be applicable and may require additional consideration of koala habitat.

Response

As noted in Council's submission, neither the 2020 or the 2021 versions of State Environmental Planning Policy (Koala Habitat Protection) apply to developments assessed under Part 5 of the EP&A Act. With regard to State Environmental Planning Policy No 44–Koala Habitat Protection, this similarly does not apply to development being assessed under Part 5 of the EP&A Act.

This notwithstanding, consideration to potential impacts on the Koala is provided in the EIS (refer for example Chapter 8).

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34 the term 'PUIA' (Project upstream impact area) was used in the EIS in the context of Aboriginal cultural heritage assessment; elsewhere in the EIS the term 'upstream impact area' was used. Table 8-4 in Chapter 8 of the EIS provides the definition of this area. A more detailed description of the basis for the upstream impact area is provided in Section 3.2 in Appendix F6 Biodiversity Offset Strategy to the EIS.

Issue 3

Water NSW Act 2014: WaterNSW is required to prepare an Environmental Management Plan (EMP) under Part 5A of the *Water NSW Act 2014* before the temporary inundation of any land protected under the *National Parks and Wildlife Act 1974* can occur. Council requests consultation during the preparation of the EMP, relevant to land within Wollondilly Local Government Area.

Response

Council would be consulted with regard to land within the Wollondilly LGA that would be subject to the EMP.

Issue 4

It is strongly recommended that the applicant review the application of the former FBA as opposed to the NSW *Biodiversity Conservation Act*'s Biodiversity Offset Scheme. Specifically, whether the lodgement date of the application is determined by the publication of the SEARs or the publication of the EIS? If the Biodiversity Offset Scheme applies, consideration of Serious and Irreversible Impacts in accordance with Section 9.1 of the Biodiversity Assessment Method is required.

Response

The basis for the Project being assessed under the FBA is set out in Table 8-3 of Chapter 8 *Biodiversity – Upstream* of the EIS in the commentary provided with regard to the *Threatened Species Conservation Act 1995* (TSC Act). As stated

> *The TSC Act was repealed when the* [*Biodiversity Conservation Act 2016*] *BC Act commenced on 25 August 2017. However, the provisions of the Biodiversity Conservation (Savings and Transitional) Regulation 2017 provide for SSI projects to be assessed under the provisions of the TSC Act if the application for the SEARs was made prior to this date. The application was made prior to 25 August 2017 with the SEARs for the Project being issued on 30 June 2017. Updated SEARs for the Project were reissued on 13 March 2018.*
>
> *The biodiversity assessment has been carried out in accordance with the relevant provisions of the TSC Act through the effect of the Biodiversity Conservation (Savings and Transitional) Regulation 2017. Consideration has also been given to relevant matters under the BC Act, particularly about threatened species, populations and ecological communities that may have been listed, or existing listings that may have been amended subsequent to the BC Act coming into force.*

5.8.7 Chapter 9 Downstream ecological assessment

Issue 1

The potential significant impact proposed to a large number of threatened species and ecological communities, including those already listed as critically endangered under State or Commonwealth legislation. This does not align with a key principle of the Project to achieve a 'no-net-loss' of biodiversity.

Response

The key principle to achieve a 'no net-loss of biodiversity is contained in the NSW Biodiversity Offsets Policy. The FBA is not applied downstream as the principles of that assessment cannot be met. Therefore, the assessment of downstream biodiversity impacts used an Assessment of Significance (AoS) approach, which is outlined in Chapter 9 of the EIS.

The downstream AoSs provided in Appendix F2 *Biodiversity Assessment Report – Downstream* to the EIS presented consideration of impacts as concluding they would be unlikely, likely, or potentially unlikely. The third term was used where a potential impact was not unlikely but, reflecting the probabilistic nature of flooding, it could not be concluded that it was likely. However, subsequent to exhibition of the EIS, WaterNSW was advised that the use of this terminology was not appropriate and that impacts needed to be categorised as either likely or unlikely.

In view of this, a review was conducted of all AoSs where it had been concluded that the Project could potentially impact the threatened community or threatened species. This review drew on additional information developed subsequent to the exhibition of the EIS with regard to the effects of temporary inundation on vegetation at Longneck Lagoon, and potential impacts of the Project on groundwater, downstream sediment movement and downstream bank stability.

The review identified that, adopting a precautionary approach, it was likely that the Project could have a significant impact on *Pomaderris brunnea* and *Rhodamnia rubescens*. Proposed management measures for these two species are provided in the PIR.

Potential impacts on native vegetation depends on changes to the risk of flood events having an impact on species or communities. The EIS used a risk assessment methodology to assess impacts, which generally concluded a low to medium risk for some PCTs and species. Further supporting information related to downstream impacts on groundwater, geomorphology and ecology has been included in this report and the PIR. It should also be noted that vegetation potentially affected by FMZ flows is already significantly affected by local catchment flows. For example, the February 2020 flood (about a 1 in 5 chance in a year event) occurred when Warragamba Dam capacity was less than 50 percent full, and all upstream inflow was trapped by the dam with no spill. Downstream flooding was therefore wholly a result of local flooding with no contribution from the Warragamba Dam catchment.

Issue 2

Council recommends that impacts such as structural vegetation changes are considered in an Environmental Management Plan (or equivalent) for the Project and that an ongoing monitoring program is established, particularly in areas closer to the dam wall where impacts from the Project are less likely to be influenced by other co-occurring downstream impacts. The Environmental Management Plan should also include further consideration of and management measures for the potential spread of diseases and pathogens such as chytrid fungus and *Phytophthora cinnamomi* (dieback).

Response

There is no EMP proposed in the EIS for the Project. There is a separate obligation under Part 5A of the *Water NSW Act 2014* which provides for the development of an EMP to address the issue of temporary inundation from the Project on national park land. The development of the plan is contingent upon approval of the Project. As per section 64C(1), WaterNSW is required to consult with the Chief Executive of the Office of Environment and Heritage[35] (now Heritage NSW) with regard to the matters to be addressed in the EMP. The EIS and supplementary investigations would inform this process.

[35] This is the wording as used in section 64C, however, this role disappeared with the abolition of OEH in 2019. Most of the functions of OEH were transferred to the Environment, Energy and Science Group within DPE. The equivalent role is now the Environment and Heritage Coordinator-General.

5.8.8 Chapter 10 Biodiversity – construction area

Issue 1

The biodiversity assessment has been identified as largely complying with the biodiversity requirements listed in the SEARs as well as the Framework for Biodiversity Assessment (FBA) issued by DPIE for State Significant Development Projects. However, the following details outline considered inaccuracies in aspects of applicable SEARs for consideration and response by DPIE: SEAR 6.1: The Proponent must assess biodiversity impacts in accordance with the current guidelines including the Framework for Biodiversity Assessment (FBA), unless otherwise agreed by OEH, by a person accredited in accordance with s142B(1)(c) of the Threatened Species Conservation Act 1995 The Biodiversity Assessment has been identified as largely complying with the Framework for Biodiversity Development issued by DPIE for State Significant Development Projects. However, inconsistencies with the following parts of this Framework have been identified:

- The assessment has not detailed the connectivity value when describing landscape values (Section 4.23. of FBA) in response to the FBA Requirement
- There is viewed as being an insufficient response to the FBA requirement to 'identify reasonable measures and strategies to minimise the impact on biodiversity values.'
- The assessment has not accurately identified biodiversity values in regard to the FBA requirement 'the proponent must seek to avoid the direct impacts on all biodiversity values of the site including (amongst others) areas that contain habitat for threatened species and ecological communities.'
- The BAR is viewed as not adequality responding to the Section 6.1.5.10 of the FBA in terms of only including expert reports based on a desktop analysis rather than for all threatened species assumed present on the development site (as listed within the biodiversity assessment)
- While recognised as being consistent with the FBA, the approach of assuming presence of species rather than undertaking targeted surveys based on habitat analysis is questioned. In this regard, the assessment is not considered to have provided sufficient responses to requested additional information regarding the extent of likely impact as a result of this assumption.
- Separate comments are provided on the chapter of the EIS in regard to the biodiversity Offset Strategy. However, the details of supplementary measures (in addition to retirement of offsetting credits) is viewed as not being sufficient to comply with Section 10.5.7 of the FBA.

Response

Connectivity has been considered in the biodiversity assessment for the construction area; refer for example to Section 3.10.3 in Appendix F3 to the EIS.

Table 10-14 in Chapter 10 of the EIS provides consideration of proposed mechanisms to avoid direct impacts to biodiversity values at the development site. Council's submission does not identify the presumed deficiencies to the assessment provided in this table.

Issue 2

SEAR 6.2: The proponent must assess the downstream impacts on threatened biodiversity, native vegetation and habitats resulting from any changes to hydrology and environmental flows. This assessment should address the matters in Attachment B.

Comments in relation to this matter are provided in regard to the downstream biodiversity assessment component of the EIS. However, as a general comment, this chapter is viewed as having a focus on impacts associated with flooding and has not sufficiently assessed potential impacts resulting from any changes to hydrology and environmental flows.

Response

Biodiversity impacts at the construction area will be associated with construction activities. Given that FSL will not change with the Project, operational impacts to this area associated with changes to hydrology are unlikely. Table 10-18 in Chapter 10 of the EIS provides details of measures to minimise direct impacts of the proposed development during operation.

As stated in Section 5.1 of the EIS, environmental flow releases do not form part of the Project and are subject to administration under the *Water Management Act 2000*.

Issue 3

SEAR 6.3: The Proponent must assess impacts on the following: endangered ecological communities (EECs), threatened species and/or populations, and provide the information specified in s9.2 of the FBA. Specific environmental requirements are provided in Attachment C.

The biodiversity assessment is considered in broad terms to have assessed impacts on threatened ecological communities and species consistent with the FBA. However, the stated broad purpose of Stage 1 of this Framework to provide the preliminary information necessary to inform project planning and is viewed as being compromised by the adopted approach in assuming presence of threatened species on the site rather than undertaking surveys (particularly given the comparatively small direct footprint of 22 hectares). It is requested to be noted that Council would require surveys rather than assume presence for a development where it is the consent authority for similar development footprints.

Response

The construction biodiversity assessment is detailed in Chapter 10 of the EIS and further information provided in Section 4.1.4 and Section 6.5 of this report. The assessment was undertaken in accordance with the FBA and a consistency review undertaken by the DPIE. Section 4.1.4 confirms that under the SEARs, EES can agree to approaches for assessing biodiversity impacts different to the FBA. In pre-exhibition discussions between Planning and Assessment Group, EES, the Commonwealth Department of Agriculture, Water and the Environment, and WaterNSW, the following modifications to the FBA were agreed:

- Surrogate plots could be used where sufficient plots were not able to be surveyed on the construction area site. Except where noted, this has been implemented acceptably
- Plots outside of the construction area site could be used
- Assumed presence be used, based on PCT associations, to develop species polygons for the purposes of calculating species credit requirements for offsets.

WaterNSW does not accept that the assessment against FBA and SEARs requirements is inadequate or is not indicative of potential construction impacts. Potential loss of native vegetation has been quantified and offset requirements outlined in Chapter 13 of the EIS, and further addressed in Sections 4.1 and 5.8.11 of this report. Mitigation measures will be included in the CEMP, which will include a detailed biodiversity management sub-plan.

Issue 4

The EIS requires amendment to be fully consistent with all issued Commonwealth biodiversity related requirements.

The Commonwealth Department of Agriculture, Water and the Environment issued requirements specifically relating to the assessment and management of potential impacts of each component of the development (upstream, downstream and construction footprint) on the above Commonwealth listed species and ecological communities in main body.

The BAR has been identified as being consistent with a number of the requirements. However, it has been identified as having inconsistencies with the following requirement for specific surveys on listed threatened species (viewed as being a consequence of the approach in assuming presence of all such species within the development footprint and not undertaking targeted surveys:

'For each of the EPBC Act listed threatened species and communities likely to be significantly impacted by the development the EIS must provide a separate:

- Description of the habitat (including identification and mapping of suitable breeding habitat, suitable foraging habitat, important populations and habitat critical for survival), with consideration of, and reference to, any relevant Commonwealth guidelines and policy statements including listing advice, conservation advice and recovery plans;
- Details of the scope, timing and methodology for studies or surveys used and how they are consistent with (or justification for divergence from) published Australian Government guidelines and policy statements.'

Response

Please refer to responses provided in Section4 which addresses biodiversity-related issues raised by various government authorities. Additional information is provided on issues raised regarding EPBC Act listed threatened species, including habitat descriptions, conservation status and management, and survey adequacy.

Issue 5

The EIS should provide a specific response to the Desired Outcome for the Major Impacts theme within the Greater Blue Mountains World Heritage Strategic Plan.

The biodiversity assessment should be amended to contain a summary of the World Heritage biodiversity values (broadly based on Appendix J) as well as a response to each of the Outcomes of the Plan that is developed in close collaboration with the GBMWHA committee.

Response

The Strategic Plan identifies four desired outcomes for the Major Impacts theme. Of these, the third and fourth are considered relevant to the Project, and which state respectively:

> *Developments and activities with an unknown but potentially significant impact on the World Heritage and other values of the GBMWHA are either modified to minimise the risk of impact on those values or do not proceed*

and

> *The impacts of surrounding land use on World Heritage values are better understood and monitored.*

Based on the assessment presented in the EIS and the supplementary assessment presented in Appendix C to this Submissions Report, it is considered unlikely that that the Project would have a significant impact on the World Heritage and other values of the GBMWHA.

Further assessment against the Statement of Outstanding Universal Value, the listing criteria and integrity, and management arrangements is provided in Appendix C to this report.

Issue 6

The EIS should incorporate outcomes of consultation (understood to be occurring) with the Greater Blue Mountains World Heritage Authority into the biodiversity assessment document.

Response

It is noted that there is no such organisation as the Greater Blue Mountains World Heritage Authority; it is presumed this is a reference to the GBMWHA Advisory Committee. Chapter 6 of the EIS identifies that on three occasions the Project team met with the Advisory Committee. No further consultation has occurred with the Advisory Committee. However, WaterNSW would consider further consultation as part of preparation of the management plan (refer Section 6.3 of the PIR).

Issue 7

The stated number of credits to be retired through offsetting as a result of the development will likely result in significant expense for the applicant and offsetting may not be able to be achieved based on requirements of the FBA and rules and principles of the NSW Offset Policy.

The EIS should require consultation between the applicant and applicable government agencies to identify an approach that would involve sufficient targeted surveys for threatened fauna species that would accurately identify biodiversity values and credit retirement requirements within resourcing and time constraints. The approach should address the following:

- The approach of the biodiversity assessment in assuming the presence of threatened species on the development site instead of undertaking a threatened species surveys or obtaining an expert report is recognised as being technically consistent with the FBA. However, this approach is viewed as having adverse implications in firstly obtaining an accurate understanding of biodiversity values as well as related suitably ecological rigorous basis for biodiversity offsetting.
- There is a need for more extensive surveys for threatened flora species is viewed as being of particular importance to enable an accurate assessment of biodiversity values and actual threatened species directly impacted by the development as well as informing offsetting.
- A similar level of concern is not expressed in regard to the extent of fauna impacts in comparison to flora surveys given their mobility. However, the undertaking of additional surveys is requested for the purposes of obtaining a more accurate assessment of biodiversity values and threatened species impacted by the development as well as informing offsetting.

Response

Please refer to:

- Biodiversity assessment: Section 4.1 and Section 6.5 provide clarification and additional information on compliance with SEARs and FBA requirements
- Biodiversity offsets: Section 5.8.11 and Section 6.5.8 of this report and Section 6.3 of the PIR provide clarification and additional information on the approach to offset arrangements
- Consultation following the EIS exhibition is addressed in Section 3.2. Consultation with relevant agencies and other stakeholders will continue during finalisation of offset arrangements and biodiversity management plans
- Biodiversity management: Mitigation measures will be included in the CEMP, which will include a detailed biodiversity management sub-plan. The plan will identify requirements for further surveys prior, during and following construction.

Water NSW does not agree that there has been inadequate consultation or that assessment is not consistent with the FBA.

Issue 8

Shortcomings of the adopted approach of the biodiversity assessment in the EIS in terms of identification of the biodiversity values of the site and informing the offsetting approach (whilst recognising consistency of this approach with Section 9.5.2 of the FBA) are:

- The adequate carrying out of statutory responsibilities by the consent authority in assessing and approving the development broadly based on section 5.2 of the *Environmental Planning and Assessment Act 1979*
- The provision of sufficient information to demonstrate consistency with applicable parts of the Greater Blue Mountains World Heritage Area Strategic Plan
- The creation of constraints in responding to information requirements for certain threatened flora species within the FBA
- Inconsistencies with the intended stated outcome of Stage 1 of the Framework for Biodiversity Assessment to 'provide the preliminary information necessary to inform project planning'
- Does not enable accurate identification of impacts on species listed as Matters of National Environment Significance in accordance with the Commonwealth requirements
- Insufficient basis to the development and implementation of an offsetting approach that is in accordance with the NSW Biodiversity Offset Policy
- There is viewed as being significant difficulty in achieving offsetting of the stated credit retirements within the Biodiversity Assessment based on the rules and principles of the NSW Offset Policy.

Response

Chapter 10 of the EIS addresses SEARs and FBA assessment requirements and further clarification and information are provided throughout this report (mainly Section 4) and the PIR (mainly Section 6). There have been ongoing consultations with the DPE, DAWE and other agencies during EIS preparation, consistency review prior to public exhibition and during preparation of this report and the PIR.

Water NSW does not accept that there are shortcomings in the adopted approach for the biodiversity assessment.

5.8.9 Chapter 11 Aquatic ecology

Insufficiently rigorous baseline data to identify impacts to downstream aquatic ecology attributed to the development by the proposed ongoing monitoring, including:

- Overall approach of the aquatic ecology assessment: The aquatic ecology assessment is considered to have adequately considered the applicable statutory and policy framework in describing aquatic ecology downstream of the site (taken as being aquatic plants and animals and their interaction). It is also considered to have broadly addressed the relevant SEAR requirement to 'assess the downstream impacts on threatened biodiversity, native vegetation and habitats resulting from any changes to hydrology and environmental flows'. However, the expressed view in the Assessment that environmental flows does not require assessment as this is regulated separately by Water NSW is not necessarily agreed with given that such flows will likely continue to occur with the raised dam wall. The consideration of this matter and need for any further assessment to fully comply with the above SEAR item by DPIE is requested.

- Adequacy of assessment and baseline data regarding aquatic ecology: The approach of the assessment in basing the description of aquatic ecology on the wide variety of previous surveys and assessments applying to the downstream sections of the Nepean River is recognised as being appropriate. However, the document is noted to state that a dedicated aquatic habitat assessment was not conducted downstream with the description based on studies carried out ranging from 10 to 20 years ago. It is noted in this regard that descriptions of macroinvertebrates (recognised by the assessment as being indicators of water quality impacts) are based on surveys and monitoring carried out in 1999 and 2012 to 2014. The timeframe of these assessments is viewed as not providing sufficiently rigorous and current baseline to adequately identify potential impacts of the construction and discharge components of the development to downstream aquatic ecology.
- Adequacy of assessment of potential impacts to aquatic ecology: The wide variety of impacts to aquatic ecology from these components of the development and likely level of these impacts described by the aquatic ecology assessment are agreed with in principle. The description is noted however to contain a range of generic statements over the likelihood and extent of these impacts such as Warragamba Dam Raising EIS Submissions by Wollondilly Shire Council Page 28 of 78 'Any impacts related directly to construction activities would likely be restricted to within the Warragamba River, and are unlikely to extend into the Nepean River'. The views expressed within the assessment that the potential for impacts on downstream aquatic ecology from the construction is negligible if suitable management measures are implemented is agreed with in principle. In relation to this matter, Council would expect that a detailed strategy for the management of these impacts with demonstrated consistency with the Neutral or Beneficial Effect and approved independently of Water NSW be required prior to the commencement of any works. In relation to this matter, the Assessment is noted to list as a mitigation measure for impacts to aquatic habitat 'Existing monitoring programs would be maintained and augmented as required to monitoring potential impacts resulting from the Project'. Council would expect in this regard that a monitoring program, (expanding on such existing programs) detailing parameters, location, frequency and methodology of aquatic ecology downstream of the site be required prior to the commencement of any construction activity by DPE.
- The need for further surveys and analysis of aquatic ecology: Support is provided to the approach of the assessment and identification of impacts to aquatic ecology from the construction and discharge components of the development based on existing studies in the downstream sections of the Nepean River system. However, appropriate further surveys and monitoring is recommended to obtain current baseline data to enable the proposed ongoing monitoring to identify and rectify any impacts determined to be attributable to the development.

Response

The Project would take the opportunity during the construction period for the dam raising to install the physical infrastructure to allow for improved management of environmental flows as outlined in the NSW Government's *2017 Metropolitan Water Plan*. However, the actual environmental flow releases do not form part of the Project as they are subject to administration under the *Water Management Act 2000*. WaterNSW advises that water releases under an environmental flow regime would not operate in the event that the dam is in flood operation mode.

With regard to downstream aquatic ecology, the net incremental change of the Project, if Warragamba Dam contributes to a flood event, is that the flows in the river from the FMZ discharge would be longer than currently occurs with the existing dam. Given the risk is low for this change in flow release regime and that there are also other downstream influences by rivers and other Sydney dams (such as flooding from downstream catchments), no specific mitigation or management measures for downstream aquatic are proposed.

WaterNSW notes Council's views on the aquatic ecology and considers no further response is required other than to refer to the responses provided to aquatic assessment advice from DPE EES, which are provided in Section 4.1 of this report.

5.8.10 Chapter 12 Matters of NES – biodiversity

Issue 1

The extent and number of threatened species and ecological communities likely to be significantly impacted by the project is not acceptable and does not align with a key principle of the project to achieve a 'no-net-loss' of biodiversity. The EIS should re-evaluate possible avoidance measures.

Response

The principal potential impact of the Project relates to temporary inundation when the FMZ is in operation. Depending on the magnitude of the inflow event and the depth to which the FMZ fills, the incremental duration of temporary inundation would range from a maximum duration of about two weeks around the dam wall and lake perimeter, down to less than half a day up the various tributaries. The incremental depth of temporary inundation would similarly relate to the magnitude of the inflow event.

Significant impact assessments were prepared in accordance with the *Matters of National Environmental Significance Significant impact guidelines 1.1*. There is a practical challenge in applying the significant impact assessment guidelines for the Project, particularly for TECs and threatened flora, as the nature and magnitude of potential impact areas are uncertain and will be dependent on the frequency of the individual flood event, the depth and duration of temporary inundation, and the associated tolerance of vegetation to temporary inundation. While a precautionary approach has been taken in assessing significance of impacts, it should be noted that although the assessment may conclude there could be a significant impact on a TEC or threatened species, the potential for such impacts may in fact be less. Further information is provided in Section 4.

The guidelines address when a significant impact is likely. To be 'likely', it is not necessary for a significant impact to have a greater than 50 percent chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility. If there is scientific uncertainty about the impacts of your action and potential impacts are serious or irreversible, the precautionary principle is applicable. Accordingly, a lack of scientific certainty about the potential impacts of an action will not itself justify a decision that the action is not likely to have a significant impact on the environment.

Avoidance and management measures are addressed in Section 12.13 of the EIS, and additional information is provided in Section 6.6 of the PIR.

Issue 2

It is strongly recommended that the applicant review the application of the former FBA as opposed to the NSW Biodiversity Conservation Act's Biodiversity Offset Scheme. Specifically, whether the lodgement date of the application is determined by the publication of the SEARs or the publication of the EIS? If the Biodiversity Offset Scheme applies, consideration of Serious and Irreversible Impacts in accordance with Section 9.1 of the Biodiversity Assessment Method is required.

Response

The basis for the assessment of biodiversity matters under the former FBA is explained in Section 2.2.2 of Appendix F1 *Biodiversity Assessment Report – Upstream* to the EIS and in the same Section 2.2.2 in Appendix F3 *Biodiversity Assessment Report – Construction Area* to the EIS. As noted, the transitional provisions of the Biodiversity Conservation (Savings and Transitional) Regulation 2017 apply to the Project as the SEARs for the Project were issued prior to the commencement of the *Biodiversity Conservation Act 2016*.

5.8.11 Chapter 13 Biodiversity Offset Strategy

Issue 1

The Project does not seem to have adequately considered the avoidance of impacts to biodiversity and instead is focused on offsetting. Biodiversity offsets are a last resort in instances where an action will give rise to residual impacts, even after the application of management measures.

Response

WaterNSW refers to Chapter 4 of the EIS, which draws extensively on the Taskforce Options Assessment Report published by Infrastructure NSW in January 2019, and which includes a detailed comparisons of options. The Taskforce was established by NSW government in 2014 to develop and assess potential alternatives and options for reducing flood impacts and risks in the valley. The Taskforce found that the most effective and efficient infrastructure option to reduce risks to life and property from flooding is to raise the Warragamba Dam to provide a flood mitigation zone of around 14 metres.

In June 2016 the NSW Government adopted the recommendations of the Taskforce in delivering nine outcomes to maximise the flood risk mitigation benefit as outlined in the executive summary of the EIS. The investigation into alternative approaches to address flood mitigation in the valley has been extensively undertaken since 2014.

The EIS reassessed a number of options as part of the assessment process and as directed by the SEARs. The reassessment referred to the earlier assessments undertaken for the Flood Strategy and the Taskforce Review, but with updated and refined data and decision support tools including in flood modelling, property information, evacuation modelling and response levels, fatality functions and damage assessment. The reassessment of those options was undertaken against four key performance indicators.

The re-assessed alternatives considered in the EIS were:

- Raise Warragamba Dam spillway levels
- Lower Warragamba Dam FSL by 12 metres or by five metres
- New or upgraded regional evacuation roads
- Dwelling buyback – of residential properties within the 1 in 100 chance in a year flood
- Prevent new dwellings within the 1 in 500 chance in a year flood.

The reassessment confirmed the raising of Warragamba Dam as the most effective and beneficial option, and as the option that best met the Flood Strategy's risk reduction objective. The depth of the FMZ and the resultant raising height was optimised by assessing the net benefits provided downstream in reducing risk to life and property. Operation of the FMZ has been set with the constraint of being able to drawdown the FMZ in a maximum of 14 days to minimise potential impacts to upstream environmental values.

The EIS has undertaken impact assessments on the raising of the dam wall as described above. A likely area of upstream inundation was defined from the flood modelling and applied as a total loss of all environmental values as a precautionary approach for the purpose of applying offsets. Given a total loss is applied for biodiversity values in this area there are no further mitigation is proposed.

Issue 2

Calculation of equivalent credit requirements generated from BBAM to BAM conversion needs to be transparent.

The credit offset requirements were calculated in accordance with the legislation that was current at the time – the NSW *Threatened Species Conservation Act 1995* and the associated FBA. Since that time the NSW *Biodiversity Conservation Act 2016* (BC Act) and the associated Biodiversity Offset Scheme was introduced. The calculation of credits is different for the two pieces of legislation. What will be important for the project, is that the method for converting the credits that were calculated and reported on in accordance with the FBA and Biobanking Method (BBAM 2014) to equivalent credits under the BC Act and Biodiversity Assessment Method (BAM 2016) will need to be clearly explained and made public. There is a perceived risk that the number and/or value of credits will be significantly reduced upon conversion to equivalent BAM credits, therefore underestimating the value of impacts to biodiversity by the Project.

Response

The method of converting the credits to the equivalent credits under the BC Act and Biodiversity Assessment Method (BAM 2016) is a matter for DPE.

5.8.12 Chapter 14 Climate change risk

Issue 1

The assessment methodology being used for this assessment is out of date and does not meet current standards.

The standards that would give the best risk assessment would be:

- ISO 14091:2021 Adaptation to climate change Guidelines on Vulnerability, impacts and risk assessment
- ISO 31000: 2018 Risk Management guidelines
- Climate Risk Ready NSW guide – Practical guidance for the NSW Government Sector to assess and manage climate change impacts.

The use of these would provide a much improved climate risk assessment that meets with current practice and expectations.

These assessments should be redone using the latest standards.

Climate risk will often have unknown risk consequence and should be given higher ratings. As old methodologies are used this has not been applied and reduces the validity of the assessment.

Response

The SEARs for the Project were issued in June 2017 by the NSW Government for key issue standard requirements and Project-specific requirements, and re-issued in March 2018 to address further Commonwealth Government requirements.

The Project EIS was developed applying the legislation, standards, guides tools, etc. in place or in use at the time of the SEARs being issued unless the SEARs stipulated a specific version or requirement. The EIS was developed from 2017 and guidelines applied where applicable that were current at the time. Under the requirements of the SEARs it stated

> *The Proponent must assess the risk and vulnerability of the Project to climate change in accordance with the current guidelines.*

Further, to specifically address the suggested two standards noted above, the ISO 14091:2021 is a generic climate risk assessment process, ISO 31000: 2018 is the international risk management guideline, and the *Climate Risk Ready NSW Guide* is a generic NSW guide. The approach adopted in the EIS is consistent with flood risk management process in the NSW floodplain development guideline. This risk management process has all the standard risk framework components from hazard identification, exposure, venerability and treatment but provides a framework designed for flooding and incorporates the climate change. There would be no material benefit in adopting a generic framework to a specific problem when a well proven hazard specific framework exists. More importantly the result would likely be the same.

Issue 2

Page14-1 references other key stakeholders, Who were they? Councils affected should have been included.

Response

This purpose of the climate change risk assessment to inform Chapter 14 of the EIS was to consider the impact of relevant climate projections on the Project construction and its future operation, rather than the impact of the Project on or mitigating the impacts of future climate change.

A workshop was convened to develop risk scenarios that had relationships with Project construction activities and operations of the FMZ with climate variables to establish a risk profile. Those involved included the owner and operator of the dam, designers, operations, modellers and construction expertise.

Issue 3

The risk assessment only considered activities or outcomes where the proponent had ownership, direct control, or influence. Impacts of climate change to activities or outcomes out of the Project's influence were not assessed. This significantly reduces the scope of the assessment and fails to acknowledge that climate risks have a range of interdependencies and they need to be assessed holistically. This raises significant concerns as to the robustness and reliably of this assessment.

Response

The potential impacts of the Project are essentially related to changes to the pattern of hydrology and flooding in relation to the incremental depth and duration of temporary inundation, flood frequency and flooding extent both upstream and downstream of Warragamba Dam. The Project would largely reduce downstream impacts associated with flooding, particularly for overbank flows.

Changes to hydrology and flooding have been assessed using hydrological and hydraulic models as described in the *Hawkesbury-Nepean Valley Regional Flood Study Final Report* (Infrastructure NSW 2019). The hydrological modelling has allowed for climate change as per the recommended approach in the 2019 version of *Australian Rainfall and Runoff* (ARR 2019).

The environmental assessment for the EIS is based on the hydrological modelling therefore implicitly incorporates consideration of climate change risk with regard to the environmental aspects considered such as biodiversity and Aboriginal cultural heritage.

Issue 3

Why are different locations used for upper catchment temperature means, is this to demonstrate the point the project wants?

Response

Section 14.3.1 in Chapter 14 of the EIS provides a summary of temperature and rainfall averages across the catchment, which includes both the upstream catchment (for example Katoomba) and downstream catchment (for example Penrith lakes). The weather stations referenced are provided in Appendix G (Table 2-1) to the EIS and reproduced below. Weather stations represent both the areal extent and elevation changes across both the upstream and downstream environment.

Table 5-4 Weather stations referenced for EIS assessment

Station name	BoM station	Data range	Latitude/longitude	Elevation
Oberon (Springbank)	063063	1946 to 2018	33.67 °S/149.83 °E	1,053
Katoomba (Murri St)	063039	1907 to 2018	33.71°S/150.31 °E	1,015
Goulburn TAFE	070263	1971 to 2018	34.75°S/149.70 °E	670
Penrith Lakes	067113	1995 to 2018	33.72°S/150.68 °E	25
Richmond RAAF	067105	1993 to 2018	33.60°S/150.78 °E	19
Nullo Mountain	062100	1991 to 2018	32.72°S/150.23 °E	1,130
Gosford Narara RS	061087	1954 to 2013	33.39°S/151.33 °E	20

A detailed description of each of the climate model projection datasets is provided in Section 3 in Appendix G to the EIS. Data sets were derived from several sources, which represent both the worst case and the current trajectory for emissions and warming scenarios as follows:

- NARCliM uses a single RCP8.5, high emissions scenario and applies it to the weather research and forecasting (WRF) model to develop high-resolution models for meteorological variables. NARCliM provides dynamically downscaled climate projections for south-east Australia at a 10 kilometre resolution, in line with the CORDEX (Coordinated Regional Climate Downscaling Experiment) framework.
- Centre for Australian Weather and Climate Research Projections is a collaboration between CSIRO and the Bureau of Meteorology, which developed the Australian Community Climate and Earth-System Simulator, available through *Climate Change in Australia* (CSIRO & BoM n.d). Climate projections are provided for all AR5 RCPs, for eight 'clusters' in Australia, which are further divided into smaller regions or 'sub-clusters' to provide finer-scale spatial resolution. The Project site is within the east coast south sub-cluster.

- *NSW Climate Impact Profile – The Impacts of Climate Change on the Biophysical Environment of New South Wales* (Department of Environment, Climate Change and Water (DECCW) 2010e) provides climate projections for a single, high-emissions scenario.
- climatic variables identified as potentially generating risk to the Project include extreme heat (for example, hot days and heatwaves), flood producing rains (for example ECLs), extended wet periods, severe storms (for example, wind, hail, lightening), and extreme fire weather. A summary of projections for these climatic variables relevant to the study area are provided in Table 14-2 in Chapter 14 of the EIS.

Issue 4

Do the temporary mechanisms in place during construction to capture floods result in an increased risk of downstream flooding for the duration of the temporary measures?

Response

The construction of temporary coffer dams downstream of the dam are to allow the dissipator to be drained and remain dry, and to protect the dissipator area from tailwater flows. Temporary cofferdams do not pose an increased risk of downstream flooding.

5.8.13 Chapter 15 Flooding and hydrology

Issue 1

- Chapter 15 *Flooding and hydrology* does not document the determination of the Project Upstream Impact Area (PUIA) used in Chapter 8 Biodiversity Upstream and Chapter 18 Aboriginal Cultural Heritage
- Limited information is provided in Chapter 8 and Chapter 18 on the determination of the PUIA
- The figures showing PUIA are at an inappropriate scale
- The PUIA extent shown in Chapter 8 is different to the PUIA extent shown in Chapter 18.
- PUIA extent as described in Chapter 8 and Chapter 18 is within 200mm of a 1 in 20 chance in a year flood extent (5% AEP) which is inside the extent of a flood at the proposed dam crest level (approx. 1 in 40 chance in a year flood extent)
- PUIA does not represent an appropriate extent.

Response

The term 'PUIA' was used in the EIS in the context of the Aboriginal cultural heritage assessment; elsewhere in the EIS the term 'upstream impact area' was used. Table 8-4 in Chapter 8 of the EIS provides the definition of this area. A more detailed description of the basis for the upstream impact area is provided in Section 3.2 in Appendix F6 *Biodiversity Offset Strategy* to the EIS.

WaterNSW undertook the necessary engagements with agencies on the various methodologies and approaches to be implemented in delivering the outcomes required to respond to the SEARs. One of these was establishing an assessment framework to address the infrequent and variable nature of flood events in depth and duration for the upstream area. The identification of an upstream impact area is to recognise the probabilistic basis of flooding and variable extent of affected land. The approach reached is clearly presented in the EIS and resulted in the defining of the PUIA.

To establish a likely upstream impact area a full range of flood events and lake variables were modelled to generate around 20,000 flood events, which represent around a 200,000 year period of time. Within each 20-year period across the 200,000 year modelling representation the peak level was chosen and the average of all the 20 year peak levels was adopted as the likely impact area. The area is not related to any particular flood frequency, however, it approximates a 1 in 20 year event. Within a 20 year period at least one large event above full supply level would be captured for the modelling, which has been validated from flood records of the existing dam in the 60 year operating life of the dam. Note that the same modelling was undertaken to assess the likely inundation area for both the existing dam and with Project, and the impact area is the net difference between the two areas as the existing dam already floods above the FSL as validated by flood records.

The resultant Project upstream impact area is about 1,400 hectares defined as the area between the existing and with Project likely inundation levels as follows:

- Existing: 119.5 mAHD (2.8 metres above FSL)
- With Project: 127.0 mAHD (10.2 metres above FSL).

The EIS also states that a precautionary approach has been taken and for the purposes of offsetting the potential impacts of the Project, it has been assumed that there would be a complete loss of all environmental values in this PUIA.

Issue 2

Sears Performance Outcome 2. Environmental Impact Statement 1.(q) relevant project plans, drawings, diagrams in an electronic format that enables integration with mapping and other technical software has not been met.

Response

The relevant information, in electronic format, was provided to DPE as requested for public exhibition.

5.8.14 Chapter 17 Non-Aboriginal heritage

Issue 1

The heritage assessment does not consider all heritage places and items in the study area. Lack of knowledge about heritage values prevents a comprehensive assessment of impacts. Undertake a further investigation of all heritage places within the study area; in particular, downstream places that are listed on non-statutory heritage registers.

Response

Further assessment has been undertaken on a number of items on the NPWS section 170 heritage register in the upstream area and this is documented in Section 6.3.2 of the PIR.

Table 17-9 in Chapter 17.5.2.1 of the EIS notes that there would be a reduced risk of flooding to Commonwealth, State and LEP listed heritage items that currently experience flooding with the current dam. This would also be the case for downstream places listed on non-statutory heritage registers. Given the reduced risk to downstream heritage items with the Project, it was not considered necessary to provide a detailed assessment of archaeological potential or significance.

Issue 2

The EIS only gives a generalised assessment of impacts for the majority of heritage places.

Response

As indicated in the response to the above issue, further assessment has been undertaken on heritage sites listed on the NPWS section 170 heritage register in the upstream area.

There would be a reduced risk of flooding to downstream Commonwealth, State and LEP-listed heritage items that currently experience flooding with the current dam.

Issue 3

The heritage assessment does not identify or assess impacts on social heritage values. Consideration of all the cultural significance of heritage places and items, including social heritage values, is best practice in heritage impact assessment, but has not been followed in the preparation of the EIS.

Response

The non-Aboriginal heritage assessment was carried out in accordance with relevant NSW heritage guidelines as explained in Section 5 in Appendix I *Non-Aboriginal Heritage Assessment Report* to the EIS. The heritage assessment criteria includes Criterion D Social Significance (refer Section 5.2 in Appendix I to the EIS).

Consideration of social heritage values is also provided in Appendix M (*Socio-economic, Land Use and Property Assessment Report)* and in Chapter 21 (*Socio-economic, land use and property)* of the EIS.

Issue 4

The options analysis for the Project does not demonstrate a clear consideration of heritage impacts of alternatives to justify the selected approach. Conduct a detailed review of the iterative process of the options analyses and include it in the EIS, to show that non-Aboriginal cultural heritage was meaningfully considered as part of the options selection process.

Response

Section 4.2 of the EIS describes the performance criteria and methodology developed by the Taskforce to assess the alternatives and options for flood risk mitigation. The criteria include socio-economic, environmental and cultural heritage impacts. Cultural heritage impacts include consideration of non-Aboriginal cultural heritage values. Further discussion is provided in Section 4.2.4 of the EIS. The discussion notes that further details are provided in the Taskforce Options Assessment Report (Infrastructure NSW 2019a).

Section 4.4.4 of the Taskforce report describes the preliminary socio-economic, environmental and cultural heritage impact assessment conducted for five infrastructure flood mitigation options with further discussion provided in Section 6.2.5 of the Taskforce report.

Issue 5

The heritage assessment does not include mitigation measures for impacts to downstream heritage sites. The lack of suggested mitigation measures for downstream impacts means that the heritage assessment does not establish that all impacts have been minimised to the greatest extent possible. The heritage assessment does not discuss whether additional mitigation measures have been considered, and whether they could be effective or useful. This suggests there may be further opportunities that have not been identified to reduce the heritage impacts of the project on a large number of heritage places. If no suitable mitigation measures are available for downstream impacts, this should be explained and justified, so the extent of residual impacts can be understood.

Response

As explained in Section 17.5.2.1 of the EIS, there would be a reduction in flood extents to downstream Commonwealth, State and LEP-listed heritage items that experience flooding with the current dam. Given the reduced risk to downstream heritage items with the Project, it was not considered necessary to provide a detailed assessment of archaeological potential or significance, nor to identify specific mitigation or management measures.

5.8.15 Chapter 18 Aboriginal heritage

Issue 1

Options analysis does not appear to account for Aboriginal cultural heritage values. While an iterative decision-making process is discussed in Chapter 4, there is no evidence that any assessment of cultural heritage informed that process. Reference is made to prior reporting prepared for the 2014–2016 Task Force, but no summary of cultural heritage values assessment or Aboriginal community consultation is provided to assist in justifying the final design decision.

While criteria for the assessment of alternatives outlined in Chapter 4.2 include 'socio-economic, environmental and cultural heritage impacts', these are noted as having been discussed elsewhere in the Taskforce Assessment Options Report (Infrastructure NSW 2019a) and no further detail is provided on how they were assessed.

Response

In 2013 the Hawkesbury-Nepean Valley Flood Management Review was undertaken by the NSW Government and found that there was a significant existing and growing flood risk in the valley. The review found that the flood risk could not be addressed by a simple solution or single infrastructure option. The review began in early 2013 in response to the NSW Government's *State Infrastructure Strategy 2012-2032*. The review aimed to develop a package of actions for strategically managing the Valley and making the community more resilient to flood risk.

The review was led by an Interagency Steering Group with representatives from:

- Office of Water
- Sydney Catchment Authority
- NSW State Emergency Service
- Department of Finance and Services
- Department of Premier and Cabinet
- NSW Treasury
- Office of Environment and Heritage
- Department of Planning and Infrastructure and Department of Trade and Investment.

The review explored all options that had the potential to reduce flood risk to life and property, including governance arrangements, policy settings, planning tools, community education and infrastructure. It found that there was no simple or single solution to address the existing flood risk in the Valley, and that this risk would continue to increase unless an integrated strategy incorporating flood mitigation infrastructure, non-infrastructure and policy options was adopted.

The Hawkesbury-Nepean Valley Flood Management Taskforce was established by NSW government in 2014 to develop and assess potential alternatives and options for reducing flood impacts and risks in the valley. The Taskforce found that the most effective and efficient infrastructure option to reduce risks to life and property from flooding would be to raise Warragamba Dam to provide an FMZ of around 14 metres.

In June 2016, the NSW Government adopted the recommendations of the Taskforce in delivering nine outcomes to maximise the flood risk mitigation benefit as outlined in the executive summary of the EIS.

The EIS has then undertaken impact assessments, including for Aboriginal cultural heritage, on the raising of the adopted dam wall solution as described above.

Issue 2

Survey method is inadequate. Develop a revised archaeological survey strategy that:

- Is based on a more rigorous sampling methodology that includes null hypothesis survey locations and greater calculation and reporting of effective survey coverage;
- Considers and actively includes cultural landscapes and ethnographic information; and covers a greater portion of the study area.

Response

Survey methodology

The survey followed the methodology that was agreed with Registered Aboriginal Parties as per the Aboriginal *Cultural Heritage Consultation Requirements for Proponents 2010*. The agreed survey design focused on: visiting known sites of high significance and importance (drawing on information from knowledge holders); surveying areas predicted to be of high likelihood to contain Aboriginal heritage sites based on a landscape model using slope classes (used successfully in sandstone environments elsewhere in the greater Sydney area); and opportunistically surveying areas of high archaeological exposure below the lake's FSL.

The survey methodology agreed with the RAPs was designed in accordance with the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW 2010.* Requirement 5a of the Code describes survey and sampling requirements in NSW as follows:

- *The archaeological survey must not begin until a sampling strategy has been developed. Sampling must:*
  - *include all landforms that will potentially be impacted. Where there is more than one instance of similar or the same landforms that have the potential to be impacted each individual landform must be sampled.*
  - *place a proportional emphasis on those landforms deemed to have archaeological potential, clearly describing and justifying the reasons for their selection (see Requirement 4).*
- *The sampling strategy must:*
  - *describe how sampling relates to the footprint that is proposed to be impacted by the development*
  - *clearly state when a full coverage survey will be undertaken and justify when it is not.*

Field survey

Field surveys focused on areas of spiritual and historical importance as identified by the RAPs, areas that would be disturbed by construction works and areas with high potential for aboriginal sites such as rivers, creek lines and large sandstone rock platforms, boulders and ridgelines.

The Project study area is defined as the area between the existing FSL and the Project PMF. This area encompasses about 5,280 hectares, of which 2,345 hectares lies between the existing and

Project PMF levels. Archaeological surveys were undertaken within the study area, as well as adjoining areas. Some 2,655 hectares were surveyed on foot, which covered the following areas:

- EUIA:
  - below 116.7 mAHD (FSL): already submerged for long periods
  - 116.7 mAHD to 119.5 mAHD: affected by existing flooding and temporary inundation
- PUIA:
  - 119.5 mAHD to 127.0 mAHD: this area covers about 1,400 hectares and is most likely to be affected by the Project during its operational life. The PUIA is based on a statistical analysis of around 20,000 generated flood events which is explained in Chapter 15 of the EIS.
- Remainder of study area:
  - 126.8 mAHD to 143.9 mAHD: this is the area between the PUIA and the Project PMF, and is less likely to be affected by the Project.

Of the total area surveyed, about 464 hectares (33 percent) of the PUIA was assessed. The survey focused on those areas that may receive the most impact by the Project and were predicted to be the most archaeologically sensitive areas, such as ridges, creek lines, flats and slopes from 0-30 percent. Survey coverage was also focused on areas outlined by the RAPs as being connected to the creation story. The survey therefore focused on:

- Areas with potential for Aboriginal objects in the PUIA
- Previously recorded sites that are of high and very high significance
- Areas of cultural significance to the indigenous community.

In response to RAP feedback, an additional 1,219 hectares was surveyed outside the upstream study area (above the Project PMF) and below FSL. Survey below FSL was possible due to the low levels of water within Lake Burragorang at the time and the consequent exposure of Aboriginal objects.

The survey coverage is reflective of the approach to focusing on areas outlined by the RAPs as being connected to the creation story, ridge and creek lines that have archaeological potential. Areas of exposure within the Project area included those areas that had been previously eroded through the original construction and operation of the dam (particularly areas below FSL), or areas that have previously been cleared for agricultural practices and fire trails.

SEARs 10(1) relates to Section 3.1 of the *Guide for investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH 2011). Section 2.4 outlines the requirement of an ACHA is an understanding of the potential cultural heritage values of the study area, and not to document every object within the study area. Given the types of harm that may potentially affect Aboriginal cultural heritage sites, the above coverage presents a strong representative sample of the landscape and is considered adequate.

Further information is provided in Section 6.3.1 and Appendix F of the PIR.

Issue 3

The predictive model [documented in Appendix K *Aboriginal Cultural Heritage Assessment Report*] is flawed due to its limited focus on soil and slope landscape characteristics and its reliance on an inadequate survey methodology.

The archaeological survey strategy was not set up to support a testable and verifiable predictive model, so the scientific merit of the predictive model is flawed.

Furthermore, a revised predictive model is presented, resulting in the prediction that 174 sites could exist within the Project Upstream impact area (PUIA). The modelling to achieve this prediction is formulated around hectares of soil landscape per site found. However, the basis for this is not consistent with the apparent survey method, which largely references slope category rather than soil landscape as the key determinant of which areas were chosen for survey. While soil landscape and slope category are discussed together on a number of occasions, there is no clear demonstration of how the survey method accounted for the total composition of soil landscapes across this survey area, nor the percentages of each soil landscape covered. While the total area of each soil landscape and its proportional relationship to sites found is provided, the validity of this calculation as a predictive modelling method cannot be verified in this context because there is no consistent basis for comparison between the survey method and predictive model.

Response

The predictive modelling presented in the Archaeological Assessment Report in Appendix 1 to Appendix K to the EIS was prepared in accordance with the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW 2010*, in which Requirement 4 states the purpose of predictive modelling is

- *To present a model, or series of testable statements, about the nature and distribution of evidence of Aboriginal land use in the subject area based on the information collected from Requirements 1, 2 and 3.*

For the purposes of satisfying this requirement, predictive models may take the form of simple observations relating past experience and available knowledge, or detailed models and considerations of large landscape areas (see Guilfoyle 2006 and references therein).

The predictive model must:

- *integrate the distribution of known sites, summarised or modelled using the landscape descriptions derived in Requirement 2 (that is. landscape units interpreted in terms of their archaeological potential)*
- *characterise the patterning of material traces from known social and behavioural characteristics evidenced in the ethnohistorical review*
- *consider the distribution of natural resources, and the probable land-use strategies employed by Aboriginal people in the specific landscape context*
- *consider the spatial and temporal relationships of sites*
- *identify what sorts of material traces are predicted to be present, and in what densities*
- *make inferences about past Aboriginal occupation of the landscape based on the evidence collected and presented.*

The Archaeological Assessment Report presents a predictive model in accordance with these guidelines. A supplementary assessment (see Section 6.3.1 and Appendix F of the PIR) provides additional clarification on the predictive modelling, including the use of the Aboriginal Sites Decision Support Tool, and further consideration of Potential Archaeological Deposits. The supplementary assessment also includes further information and detail regarding the expected impacts of temporary inundation of soils, and Potential Archaeological Deposits within the Project area.

Issue 4

National Heritage values have not been assessed [in Appendix K *Aboriginal Cultural Heritage Assessment Report*].

The significance assessment covers criteria related to the *National Parks and Wildlife Act 1974* (NSW) (NPW Act) but overlooks the SEARs requirement that National Heritage values be considered as well. Given the relationship of the site to the Greater Blue Mountains World Heritage Area, the National Heritage List (NHL) criteria under the EPBC Act should be outlined and the identified values assessed against them.

The comments from the RAPs in this section clearly show that the study area in general is of high cultural value.

Response

National Heritage values are addressed in the EIS, including Appendix K, Chapter 20 *Protected lands* and Appendix J *World Heritage Assessment Report*. Additional information is provided in Appendix C (Section C2) to this report.

Issue 5

Cumulative impact assessment is inadequate; it uses historical impacts as a mitigating measure for current additional impacts, does not account for historical loss, and does not account for the views of RAPs/Traditional Owners.

The ACHA acknowledges that there will be harm to all sites within the PUIA, and the degree of harm to those sites is considered to be total. The scientific significance of at last 75 percent of those sites is broadly unknown (based on the current predictive model) and the cultural significance of all of those sites is high.

Despite this position, Section 10 of the ACHA (p 79) states that

> *The ACHA has concluded that considered against the precautionary principle the potential impacts of the Project on archaeological scientific values can be considered relatively minor due to prior or existing impacts.*

This conclusion is entirely at odds with the findings of the report. Giving consideration to the precautionary principle, full scientific certainly about the number, nature and extent of sites within the PUIA is not known. Therefore, the conclusion that the impacts from the project would be minor does not take into account the precautionary principle at all. Instead, it is entirely opposed to the fundamental purpose of the precautionary principle. There is also no rationale for the conclusion that the impacts would be minor. This is simply an assertion by the authors that is unsupported by the extent of impacts outlined in Chapter 9.

The cumulative impact assessment also fails to address the key issue set out by the Aboriginal community—that the existing dam construction in the 1950s is already a source of significant impact to the cultural values of the area, and that this existing impact is entirely unmitigated. Comments from the Aboriginal community state that the current dam represents a historical and inter-generational impact on cultural value

Response

The ACHA makes the point that cumulative impact can only be understood by considering prior impacts: the scale and extent of previous loss effects the magnitude of proposed loss. The ACHA does not use prior impact as a mitigation measure or excuse for additional impact but seeks to point out the scale of prior impact. While the Project is of a smaller scale to the prior impact, it is a cumulative addition to a significant prior impact and loss of values (ACHA page 86):

> *Any future proposed impact must be considered as a cumulative impact on what has already been lost under the waters of Lake Burragorang. The reality of dispossession and forced removal*

> *from traditional and historical lands, and the loss of heritage values (encompassing tangible and intangible heritage sites and places and harm to the storied landscape) has been communicated by the RAPs in very strong terms during the consultation for the Project. The Project is an incremental addition to a previous project (the dam construction) that has caused cultural trauma and significant loss of cultural heritage values.*

The ACHA does use historical impacts from temporary inundation as an analogy to help understand predicted impacts from the Project (ACHA pages 75-76):

> *… floods have left no discernible change in the upper area of the EUIA, certainly it has not left the upper part of the EUIA as a scalded surface lacking vegetation… However, increased inundation and hence increased erosion and deposition in any form will harm the Aboriginal cultural heritage sites present within the PUIA. The harm is the result of either direct action such as the reduction of soil cohesion, or removal or deposition of sediment including archaeological deposit, or the changing in conditions on a rock surface where rock art is present.*
>
> *In addition to the harm to tangible aspects of the cultural values such as cultural and archaeological sites, the project will harm the cultural landscape and associated values as it is regarded by the RAPs as a continuation of the dispossession and significant harm that occurred with the original construction and flooding of the Warragamba Dam.*

The ACHA compares the potential loss of tangible sites and scientific values in the context of prior and existing impact. The Supplementary Assessment (see Appendix F to the PIR) provides an analysis of archaeological sites affected by recent flooding at Longneck Lagoon. The main finding is that sites are generally resilient to temporary backwater inundation, but susceptible to high water velocities and erosion. Geomorphological studies undertaken as part of the EIS (Appendix N2 to the EIS) and additional information provided in Appendix G concluded that the Project would not significantly increase upstream flow velocities and catchment erosion.

The EIS took a precautionary approach and assumed that all archaeological sites within the PUIA would be significantly affected, which was consistent with the approach taken for offsetting biodiversity. Further assessment of identified sites is provided in the supplementary assessment Appendix F to the PIR), which assesses each site with respect to its elevation in the catchment and various flood frequency events. The assessment shows that overall potential impacts are significantly less than the precautionary approach presented in the EIS.

The ACHA incorporates these predicted low impacts to tangible values from temporary inundation into the broader context of prior impact, identified Aboriginal cultural heritage values, and concludes the Project would result in a reduction in the inter-generational equity afforded by the cultural landscape of the study area and its surrounds.

The views of the RAPs, in particular their opposition to the Project based on the grounds of further aggravation of pre-existing cultural harm and cumulative impacts to the cultural landscape, are clearly represented in the CVA and ACHA.

Issue 6

Recommendations do not adequately address the impacts, and do not account for Aboriginal cultural values, but are focused only on the archaeological values.

Response

The ACHA (pages 85-86) includes recommendations drawn from both the Archaeological Assessment and Cultural Values Assessment (identifying the originating report of the recommendations), which are not limited to archaeological values. Further, in response to submissions, mitigation and management measures have been reviewed and updated. These are presented in the supplementary assessment (refer Appendix F to the PIR).

5.8.16 Chapter 19 Noise and vibration

Issue 1

The results of the construction noise assessment have found that construction noise impacts associated with the proposal are predicted to exceed construction noise management level criteria at the majority of receivers in Warragamba throughout the construction program. Predicted noise levels were identified as noticeable to clearly audible for the majority of the receivers.

Response

Potential construction noise impacts are addressed in Chapter 19 of the EIS. The assessment was undertaken in accordance with the SEARs, regulatory framework and relevant guidelines. Noise modelling was undertaken using the ISO 9613 Acoustics – Attenuation of sound during propagation outdoors (International Organisation for Standardisation (ISO) 1996) algorithms, as implemented within the CadnaA 4.5 acoustic modelling package. Potential impacts from additional traffic generating noise from the Project construction were estimated using the Calculation of Road Traffic Noise (CoRTN) model.

The assessment concluded that:

- Residential areas located south east of the construction area may experience 'moderately intrusive' noise levels, with other areas experiencing 'clearly audible' noise levels. No residences were predicted to be within the categories of highly intrusive (>30 dB(A)) or 'Highly noise affective' (>75 dB(A)). Mitigation measures will be developed to manage these potential impacts, which include programming potential noisy construction activities to standard work hours as much as possible.
- Vibration and blasting from construction activities would not have a significant impact at the nearest sensitive receivers
- Traffic noise modelling showed that the addition of Project construction traffic would have a minor impact that is considered barely perceptible to the average person.

Mitigation measures are reproduced in Appendix B of this report, which includes implementation of a construction noise and vibration management plan (CNVMP) and blast management plan (BMP), and ongoing noise monitoring and consultation with potentially affected residents.

The noise assessment was reviewed by the EPA during public exhibition of the EIS and it was noted that it has satisfactorily considered construction impacts and identification of appropriate mitigation measures (refer Section 4.6.7 of this report). The EPA will undertake its detailed assessment following submission of this report to DPE, and will make any further recommendations to DPE accordingly as part of that planning process.

Issue 2

Background noise monitoring and assessment was carried out to the nearest receivers at Warragamba. Whilst the noise contours appear to extend beyond this zone, no noise/vibration assessment was carried out to the new residential subdivision at Silverdale – West of Marsh Road.

Response

Modelled noise contours are derived from various modelled inputs, including cumulative sound power levels of construction plant, topographical characteristics, meteorological conditions and ground absorption. Background noise monitoring data is used in assessing modelled Project noise levels above background levels.

Modelled noise levels around the proposed subdivision west of Marsh Road are around 35 dB(A), which indicates that the Project should not impact in this area.

5.8.17 Chapter 20 Protected and sensitive lands

Issue 1

Councils should be included as core representatives on the Warragamba Offset Program Advisory Committee.

Response

The basis for the proposed membership of the above advisory committee comprises NSW Government agencies and other parties with a statutory and/or policy role in the administration and management of protected and sensitive lands.

Issue 2

The chapter identifies the 'probable maximum flood' (PMF) as a notional upper limit of flood magnitude and does not identify the probability of exceedance of such an event. In particular the chapter notes that the PMF is unlikely to occur in nature given the size of the Warragamba Dam catchment.

The nominated PMF is unhelpful. The extreme risk scenario provided is diversionary as it distracts from less severe but more likely events that may still require mitigation measures. The chapter frequently notes in response to any identified impact from the PMF that such an event 'is unlikely to ever occur in reality'. The concern is that practicable mitigation measures that may have been identified with a lower PMF may be overlooked.

Response

As stated in Section 15.2.1.2 (Terminology) of the EIS

> *The maximum flood level that can possibly occur is the Probable Maximum Flood (PMF) and is the largest flood that could conceivably occur at a location, usually estimated from probable maximum precipitation, and where applicable, snow melt, coupled with the worst flood producing catchment conditions. The PMF is a hypothetical flood estimate relevant to a specific catchment whose magnitude is such that there is negligible chance of it being exceeded. It represents a notional upper limit of flood magnitude and no attempt is made to assign a probability of exceedance to such an event (AR&R 2019).*

The Project PMF has also been used to define the upstream and downstream study areas in accordance with the requirement in Items 8.2, 8.5 and 8.6 of the SEARs to assess the potential impacts of the Project up to the PMF. There is no lower PMF, it is the Probable Maximum Flood.

Issue 3

It is not clear as to what the purpose of Chapter 20 is. Impacts are considered in parts on a site/species basis (noting that these are all dealt with in other chapters) and there is no holistic discussion. For example:

- Chapter 20 focusses on the potential impacts on protected and sensitive lands but does not include any commentary on the significance of the impacts collectively and whether these are justified in terms of the overall benefits of the Project or the relative impacts of alternative options for that matter.

- Likewise the chapter makes reference to scenarios where the dam wall raising may reduce impacts downstream but does not conclude whether there will be more or less impacts on protected lands downstream than the status quo.

Response

Item 13 in the SEARs requires consideration of a range of matters related to protected lands. These are identified in Table 20-1 in Chapter 20 of the EIS together with where in Chapter 20 each of the requirements is addressed.

Potential construction and operational impacts on protected lands are discussed in Sections 20.4 and 20.5 of the EIS respectively and a summary providing a holistic consideration of impacts is provided in Table 20-20. There are no construction activities on protected lands, only future FMZ operations.

The Project would reduce flooding extents downstream and therefore existing impacts of temporary inundation on protected lands would generally be similarly reduced. Operation of the FMZ would affect small areas of low-lying land within the following downstream protected lands:

- Scheyville National Park
- Cattai National Park
- Maroota Ridge State Conservation Area
- Dharug National Park.

These areas already experience temporary inundation from flooding, with or without floodwater contribution from Warragamba Dam. The release of flows from the raised dam's FMZ would occur once the flood was in recession and targeted to be maintained within river bank until the storage is returned to FSL.

Issue 4

Impacts on archaeological sites and Aboriginal cultural heritage are downplayed; acknowledges that there is the potential for other sites to occur but does not propose any mitigation measures, nor really appreciate the significance of such sites.

Response

Consideration of potential impacts on Aboriginal cultural heritage is provided in Chapter 18 and in Appendix K of the EIS. References to Aboriginal cultural heritage in Chapter 20 are in the context of Aboriginal cultural heritage values associated with specific areas of protected and sensitive lands.

Further discussion regarding potential impacts of temporary inundation on Aboriginal cultural heritage sites is provided in Section 6.2.1 of the PIR.

Issue 5

Only about 40 percent of the Greater Blue Mountains World Heritage Area potentially impacted by the Project has actually been surveyed in terms of Aboriginal cultural heritage.

Response

Section 12.1.1 of the Archaeological Technical Report identifies that 57 percent of the GBMWHA in the upstream impact area was surveyed. WaterNSW also refers Council to previous responses to the issue that survey was inadequate.

5.8.18 Chapter 21 Socioeconomic assessment

Issue 1

Chapter 21 gives inadequate consideration to the inequity of burdening the disadvantaged town of Warragamba with five years of construction in order to benefit the people of the Hawkesbury-Nepean Valley. The EIS and SEIA implicitly take the position that the potential benefits to the people of the Hawkesbury-Nepean Valley outweigh the costs to the people of Warragamba, but no cost-benefit analysis appears to have been carried out to establish and justify this position, and alternative options do not appear to have been explored.

Response

WaterNSW refers to Chapter 4 of the EIS which draws extensively on the Hawkesbury-Nepean Valley Flood Risk Management Strategy Taskforce Options Assessment Report published by Infrastructure NSW in January 2019, and which includes detailed comparisons of options. The Hawkesbury-Nepean Valley Flood Management Taskforce was established by NSW government in 2014 and has extensively assessed alternatives and options for flood mitigation including options to lower the full supply level and height options for raising the dam. The Taskforce found that the most effective and efficient infrastructure option to reduce risks to life and property from flooding is to raise the Warragamba Dam to provide a flood mitigation zone of around 14 metres.

The purpose of the EIS is to address the SEARs as issued by the NSW Department of Planning, which are primarily the assessment of impacts on the listed environmental values from the construction and operation of the preferred option to raise the Warragamba Dam to provide a flood mitigation zone of around 14 metres.

Issue 2

Warragamba has a small commercial offering that is highly dependent on tourist trade. This has not been addressed at all and history has shown the disastrous impacts extended works on the dam have had to local businesses.

Response

This issue is addressed in Section 21.7.1.5 of the EIS and in Section 8.2.5.3 in Appendix M to the EIS. A survey of businesses was conducted for the socioeconomic assessment (Chapter 21 and Appendix M of the EIS), which targeted businesses operating in the local communities' study area including Warragamba and Silverdale. Feedback from businesses in Warragamba and Silverdale directly informed the identification of the socio-economic impacts, including the potential effects on tourism in Warragamba as a result of the Project.

Issue 3

Wollondilly Shire Council has not been informed what the expectation is for 'Provide support to Council to assist with Project related administration and enquiries'.

Response

As detailed in Section 6.8 in Chapter 6 of the EIS, a construction community and stakeholder engagement plan would be developed before construction commences and implemented during construction to provide a framework of activities, procedures and policies for engagement. The construction community and stakeholder engagement plan will provide further detail on how the Project will provide support to Wollondilly Shire Council regarding Project-related administration and enquiries.

Issue 4

The SEIA (Appendix M) does not appear to include any plan for ongoing monitoring of social or economic impacts during or after the construction phase. Best practice would suggest that such monitoring should be carried out regularly either internally (project staff) or externally (agencies or community groups), but there appears to be no suggestion that such a plan or financial resources will be available.

Response

Section 9 in Appendix M *Socioeconomic impact assessment* to the EIS details the mitigation and enhancement measures for each identified positive and negative social impact. The monitoring, management and reporting arrangements for each management measure is to be outlined in the Project CEMP. Implementing the CEMP would effectively ensure that the Project meets regulatory and policy requirements in a systematic manner and facilitate continual improvement of its performance. The strategies defined in the CEMP would be developed in consideration of the Project approval requirements, and the safeguards and mitigation measures presented in the EIS, including in the Socioeconomic Impact Assessment (Appendix M). The CEMP would establish the system for implementation, monitoring and continuous improvement to minimise impacts of the Project on the environment.

As stated in Chapter 6 of the EIS, a construction community and stakeholder engagement plan would be developed to provide a framework of activities, procedures and policies for engagement. Outcomes of engagement tools and activities deployed during project construction would inform the monitoring and management of mitigation and enhancement measures, and enable identification of, and response to, any unanticipated social impacts.

Issue 5

Discussion of mental health impacts is limited to the trade-off between the positive impacts of flood risk mitigation and the negative impacts of noise and vibration, without addressing the inequitably distributed impact of loss of connection to country and possible exacerbation of intergenerational trauma for Gundangara people and other indigenous residents.

Response

Chapter 21 of the EIS and Section 8.3.4 in Appendix M to the EIS describe the potential impacts associated with loss of connection to country for Aboriginal peoples. The assessment recognised that temporary inundation of sites of importance to Aboriginal peoples may result in impacts to their wellbeing and may trigger further deeper feelings of disempowerment associated with the temporary loss of access to and ability to manage their country. Mitigation and management measures are proposed in response to these impacts and are detailed in Section 9 in Appendix M to the EIS.

Issue 6

While the EIS is predicated on the principle that the purpose of the Project is solely to improve safety for the Hawkesbury-Nepean Valley, there is no guarantee that the Project will not also be used to justify further intensification of residential development on the floodplain.

Response

The objective of the Project is not to promote development in the Hawkesbury-Nepean Valley but to reduce the risk to life and property in already developed areas. It is recognised that development in the floodplain areas was based on past planning and development guidelines. The Project is part of the Flood Strategy that comprehensively addresses the flood risk in the region and also considers the future land use and planning under Outcome 3 *Strategic and integrated land use and road planning*.

Development in the floodplain needs to be carefully managed, now and into the future. Actions are being developed that take a strategic, floodplain-wide approach, integrating flood risk with the land use potential, which will set a settlement pattern for the Hawkesbury-Nepean Valley. The Western City District Plan and Central City District Plan set out a series of principles for land-use planning in the Hawkesbury-Nepean Valley floodplain. These principles guide both strategic planning and development decisions, such as avoiding intensification and new urban development on land below the 1 in 100 chance per year flood. In addition, DPE is leading the development of a Regional Land Use Planning Framework to take account of the impacts of growth across the floodplain.

Further development within the floodplain would diminish the flood risk reduction by the raised dam and as such addresses this issue by Flood Strategy Outcome 3 – Strategic and integrated land use and road planning led by DPE and TfNSW.

Issue 7

The impacts of reduced safety (and perceptions of reduced safety) for people walking and cycling have not been adequately addressed, particularly in the context of Warragamba's narrow streets and poor way-finding.

Response

This issue is considered in Chapter 21 and Appendix M of the EIS. Section 8.2.3.1 in Appendix M to the EIS details the impact to community safety within the local communities' study area, which includes Warragamba and Silverdale townships. While there would be no direct impact on pedestrian or cyclist movements or paths, there may be an increased safety risk due to the increase in heavy vehicle movements. Table 9-1 in Appendix M to the EIS details the management measures to address the potential impact of an increased safety risk for pedestrians and cyclists.

5.8.19 Chapter 23 Sustainability

Insufficient detail and lack of proper referencing removes the ability to properly assess this chapter.

Unable to properly assess the Sustainability Chapter as it is lacking sufficient detail including examples on how each item is achieved in Tables 23-2, 23-5, 23-6 and 23-7. Information is vague and unclear.

Also lacking adequate referencing throughout tables mentioned above linking referenced documents and other relevant information such as detail from workshops which makes it unable to be properly assessed.

Response

From the general comment raised and without further specific information provided in the submission it is unclear as to the specific detail that Council is claiming is missing.

As a guide, Section 23.2 in Chapter 23 of the EIS provides a detailed methodology for undertaking the sustainability assessment. Specifically, the assessment has used the IS Rating Tool V1.2 and included a gap analysis to facilitate alignment of the objectives and targets of the GREP and TfNSW SDG V4 with the IS Rating Tool V1.2. This is consistent with sustainability assessments for major infrastructure projects in NSW.

Additional sustainability information and discussion is provided in Section 4.1.7.2 of this report. Tables 23-2, 23-5, 23-6 and 23-7 in Chapter 23 of the EIS provide the basis for the sustainability assessment, which is summarised as follows:

- Table 23-2: Potential Project credit achievement: for each of the proposed credits a potential level is provided, together with a general Project comment that addresses the reasoning behind credit adoption.
- Table 23-5: NSW Sustainable Design Guidelines V4.0 compulsory requirements and associated IS Rating Tool Credit V1.2: this table sets out sustainability requirements as per the adopted Rating Tool.
- Table 23-6: Sustainability strategy - goals, objectives and initiatives: this table addresses each of the Rating Tool categories, goals and objectives. These are cross referenced with potential initiatives that were discussed at the workshop and benchmarking exercise.
- Table 23-7: Safeguards and management measures: this table provides a compilation of environmental management measures necessary to successfully meet sustainability goals, objectives and targets, as set out in the preceding tables.

Since the EIS public exhibition, the sustainability assessment has been reviewed as part of responses to submissions. The review was carried out by an accredited ISCA assessor and identified that the Project could achieve an 'Excellent' rating. A copy of the revised sustainability scorecard credit summary is provided as Appendix I to the PIR.

A further review of the revised rating would occur during construction planning and detailed design to monitor any potential changes in component credits that could affect the overall score.

5.8.20 Chapter 24 Traffic and transport

5.8.20.1 Project and study area

The traffic & transport study area focused around the roads and intersections near to Warragamba and not the region that would be used by light and heavy vehicles – as stated in the report.

Response

Heavy vehicles would only use pre-defined fixed routes, namely a northern route and a southern route to deliver construction materials to the dam site, as shown in Figure 24-22 and Figure 24-23 in Chapter 24 of the EIS respectively. Management measure TT10 in Table 24-21 in Chapter 24 of the EIS notes that a Stage 1 Road Safety Audit (RSA) will be undertaken at the detailed construction stage. A Vehicle Movement Plan would also be provided as part of the Construction Traffic Management Plan.

5.8.20.2 Road network

Regional Road network refers to M4 Motorway, The Northern Road and Hume Motorway - these are State managed roads, – most of the access around the site will be via Council managed Region Road network and Council Roads, most of which are outside the study area for traffic impacts.

The maps provided to show the existing environment and the surrounding network for the heavy vehicle access are poorly defined to show State/Regional/Local road classification and stop short of showing how these vehicles exit Wollondilly onto the Hume Highway in the south.

The southern route lists Silverdale Road, Warradale Road and Production Avenue- what happens at the end of Silverdale Road at The Oaks? Looks like the plan is to use Montpelier Drive/Barkers Lodge

Road and Remembrance Driveway, however these roads are not considered in the intersection capacity review (and noting that Montpelier Drive has a 15 T load limit).

Response

Heavy vehicles would only use pre-defined fixed routes, namely a northern route and a southern route to deliver construction materials to the dam site, as shown in Figure 24-22 and Figure 24-23 in Chapter 24 of the EIS respectively.

Figure 24-23 in Chapter 24 of the EIS shows how construction vehicles exit Wollondilly in the south , that is onto the Hume Motorway via Remembrance Driveway at Yanderra.

Heavy vehicles that use that use the southern route will comply with load limits that are in place at the time. It should be noted that construction vehicles from the south could also use the northern route.

In regard to intersection capacity south of The Oaks, heavy vehicles would only be required to turn at the Montpelier Drive/ Barkers Lodge Road and Old Hume Highway/ Barkers Lodge Road intersections. In this regard, desktop assessment indicates that there would be no capacity issues at the Montpelier Drive/ Barkers Lodge Road intersection. While there are existing capacity issues at the Old Hume Highway/ Barkers Lodge Road intersection during the AM and PM peaks, these will be managed through the Construction Traffic Management Plan. During construction planning the traffic routes and road and intersection capacity will be assessed further as part of construction traffic management planning.

5.8.20.3 Major intersections and traffic count survey

Surveys limited to seven key intersections - none of which are outside of the Warragamba/ Silverdale area – what happens when they leave Silverdale Road?

Major impacts to local and regional roads within Wollondilly that have not been considered in the traffic surveys.

Response

Traffic count surveys have been undertaken for most of the relevant intersections relating to proposed haulage routes within Wollondilly. Surveys were not done for the intersections of Montpelier Drive/ Barkers Lodge Road and Old Hume Highway/ Barkers Lodge Road, however desktop assessment concluded:

- There would be no capacity issues at the Montpelier Drive/ Barkers Lodge Road intersection
- There are existing capacity issues at the Old Hume Highway/ Barkers Lodge Road intersection during the AM and PM peaks. Traffic routes and road and intersection capacity will be further assessed during construction planning.

5.8.20.4 Roads and intersection capacity

Issue 1

Data survey base year 2018 with an analysis for future year with construction traffic at 2022 – given that this is a five year construction project – why wasn't the analysis done for 2027?

Response

Table 24-10 in Chapter 24 of the EIS indicates that in 2022 all intersections with and without Project-related traffic would operate at Level of Service (LOS) A in the AM and PM peaks, except for The Northern Road/ Park Road intersection which would operate at LOS B. As noted in Section 3.2.4 of

Appendix O (*Traffic and Transport Assessment*) to the EIS, a 3.5 percent annual growth rate was applied to 2018 surveyed traffic volumes to estimate 2022 base traffic volumes, which was used to estimate the construction year 2022 traffic and to capture any additional traffic from future planned development. The assumed annual growth rate is high and conservative, given that the NSW average is 1.6 percent annual growth rate. In view of this, further traffic modelling is not considered necessary.

Construction of the Project, should it be approved, would commence after 2023 and it is not envisaged that an increase in background traffic volumes due to the later construction start date would result in significant deterioration of intersection performance, given all intersections are predicted to be operating at LOS A in 2022, except The Northern Road/ Park Road intersection, which is predicted to be operating at LOS B.

Issue 2

Impact assessments have only been carried out on seven intersections in the vicinity of the Project site. No assessment was carried out on other intersections along the southern haul route which impacts the towns of The Oaks, Picton, Tahmoor and Bargo.

Traffic count data used is dated 2018 and does not take into account development on the Silverdale/Warragamba area and is no analysis has been done presuming 100% of heavy vehicles using the southern haul route.

Response

As noted, construction traffic using the southern construction route would pass through the towns of The Oaks, Picton, Tahmoor and Bargo.

With the exception of Picton, where northbound traffic would turn left from Old Hume Highway into Barkers Lodge Road and southbound traffic would turn right from Barkers Lodge Road into Old Hume Highway, traffic travelling through the other towns would form part of the main traffic stream. Moreover, all construction vehicle movements would be through vehicle movements, as opposed to turn vehicle movements, therefore there is likely to be minimal impact on the operational level of service of these intersections.

During construction planning the traffic routes, road and intersection capacity will be further assessed further as part of the construction traffic management planning.

5.8.20.5 Property access

It is anticipated that additional heavy vehicles loaded with construction materials will impact existing access to properties with direct access to the two lane, two way undivided carriageways, thereby impacting road safety. This would not be consistent with the SEARs to minimise the impact on connectivity, safety and efficiency of the transport system. The safety of the transport system customers is to be maintained.

Travel speeds impacted for existing traffic with additional heavy vehicles traversing the mountainous section of Silverdale Road to the north of the site and the vertical and horizontal alignment issues of Silverdale Road to the south of the site.

Response

Management measure TT10 in Table 24-21 in Chapter 24 of the EIS notes that a Stage 1 Road Safety Audit (RSA) will be undertaken at the detailed construction stage. Control measures including appropriate mitigation to address safety and other issues would be identified and included in the Construction Traffic Management Plan.

During construction planning the traffic routes and road and intersection capacities will be further assessed as part of the construction traffic management planning. Travel speeds for existing traffic will be addressed in the Construction Traffic Management Plan with appropriate management measures identified, such as avoidance of peak periods by heavy construction traffic that would significantly impact travel speeds of existing traffic.

5.8.20.6 Pavement condition

The assessment of the existing road conditions is limited to the roads surrounding the site and does not go far enough to consider the rest of the network that will be impacted for both the northern and southern haul routes.

All routes within the Wollondilly LGA are either regional or local roads under the care and control of Council and are subject to Council's limited budget to maintain.

Response

Management measure TT8 in Table 24-21 in Chapter 24 of the EIS addresses the preparation of a road dilapidation report for Park Road, Silverdale Road, Farnsworth Avenue, Production Avenue and Warradale Road. The need for inclusion of other roads would be considered as part of construction planning. In this regard, Council and other relevant stakeholders will be consulted regarding the scope of surveys and reporting required. This will ensure that any deterioration to road conditions that is attributable to heavy vehicles traffic generated by the Project is made good by the delivery contractor.

5.8.20.7 Blaxland Crossing bridge

Issue 1

The bridge is a two lane two way bridge with no shoulders and a narrow raised footpath to the northern side of the bridge. The maximum load permitted is 57.5 tonnes. Specialist equipment over this weight would have to find an alternative access route. The study presumes that all heavy vehicles will be 42.5 tonnes. This is considered highly unlikely given the advancements in freight carrying capabilities for Class 2 heavy Vehicles.

An alternative haul route needs to be devised for oversized/over mass loads and included in the EIS and a Traffic Management Plan needs to be submitted for managing heavy vehicle using the bridge for Council's consideration.

Road safety is a major concern given the bridge is two lane with no shoulders and cannot accommodate breakdowns and wide loads. The EIS suggests lowering the speed limit across the bridge for heavy vehicles during construction adding further inconvenience to the existing road users.

Response

Management measure TT1 in Table 24-21 in Chapter 24 of the EIS provides for preparation of a CTMP to manage impacts from construction traffic. As noted, it would include, amongst other matters, a construction contingency plan to manage traffic in the event of emergency road closures due to various factors including bridge load limits. With specific reference to Blaxland Crossing bridge, it would identify speed management of construction-related vehicles crossing the bridge and continuous monitoring of bridge performance.

Council would be consulted during preparation of the CTMP and a copy of the approved CTMP would be provided to Council.

Chapter 24 of the EIS recommends that the posted speed limit on the bridge be reduced for heavy vehicles during construction, however this would only be over a short length of road in the vicinity of the bridge and would result in minimal inconvenience to other drivers. A breakdown of any vehicle on the bridge is an existing risk, however arrangements will be put in place to address such matters, including temporary closure of the bridge, which will be addressed in the CTMP.

Issue 2

The closure times for Blaxland Crossing bridge remain much the same with the Project, providing no relief from flooding issues for the residents of the Warragamba/Silverdale area.

Alternative routes have not been investigated for flood events that close Blaxland Crossing bridge as it was beyond the scope of the assessment.

Response

A key objective of the Project is to delay peak flooding downstream to allow evacuation routes to remain open for longer and to provide increased opportunity and additional time for a greater number of people to self-evacuate via road.

In regard to Blaxland Crossing Bridge, the bridge would be closed during all flood events both under existing conditions and with the Project, apart from the 1 in 5 chance in a year flood event when the bridge would remain open. It should be noted that there would be a small reduction in the time that the bridge would be closed due to the Project. There would also be an increase in the number of hours before the river crossing is closed for all flood events, except the 1 in 5 chance in a year flood event where the time to closure would remain unchanged.

In the event of Warragamba Dam spilling and should it be necessary to close Blaxland Crossing bridge, construction work at Warragamba Dam and material deliveries would have already been suspended one or two days earlier as part of the flood risk construction planning.

5.8.20.8 Construction program, traffic generation and travel routes

As stated in the report, most of the heavy vehicle movements would be trucks delivering material for concrete production with half of the known quarries being to the south of the site-however, the two scenarios used to determine road and intersection capacity assumed 100 percent of deliveries from the north and 50 percent of deliveries from the north. No scenario was considered for all deliveries being trucked in from the south, or the impact on the road network for the entirety of Wollondilly. The EIS does not identify where the raw material will be shipped in from as this is the responsibility of the construction contractor.

Response

Quarries in the Blue Mountains, Southern Highlands, Central Coast and South Coast were identified as capable of supplying coarse aggregates that were found to be suitable for the concrete mix design for the Project. This allows more than one source of raw materials for construction and load sharing of the main travel routes and also provides redundancy capacity for supply and not to be reliant upon one source given the large quantity of concrete production required.

The majority of truck movements would be generated by the delivery of materials for concrete production. There would also be delivery of other materials such as steel, plant and equipment, precast elements and removal of excavated material to spoil disposal locations.

5.8.20.9 Heavy vehicle routes

Issue 1

The southern route listed in the report details the roads to The Oaks – from there the map shows the use of Montpelier Drive. Montpelier Drive has a road load limit of 15 tonne and cannot be used as a haul route

Response

Any use of Montpelier Drive south of The Oaks by construction related vehicles would comply with the 15 tonne load limit. The 21 construction vehicle movements per hour is the estimated total number of construction vehicle movements arriving using both the northern and southern routes. It should be noted that trucks approaching from the south may also use the northern route. Only a proportion of the 21 construction vehicle movements per hour will therefore utilise the route from the south via Picton minimising impacts at the intersection of Barkers Lodge Road and Argyle Street, which will be managed through the Construction Traffic Management Plan.

Only a proportion of the 21 construction vehicle movements per hour would utilise the route from the south via Bargo, Tahmoor, Picton and The Oaks. The majority of construction vehicle movements would be through vehicle movements, as opposed to turn vehicle movements, therefore there is likely to be minimal impact on the operational level of service at the majority of intersections along the route.

Intersections where turn movements are required include the Montpelier Drive/ Barkers Lodge Road intersection and the Old Hume Highway/ Barkers Lodge Road intersection. In regard to these locations, desktop assessment indicates 1) there would be no capacity issues at the Montpelier Drive/ Barkers Lodge Road intersection and 2) while there are existing capacity issues at the Old Hume Highway/ Barkers Lodge Road intersection during the AM and PM peaks, these will be managed through the Construction Traffic Management Plan.

Control measures including appropriate mitigation to address road safety and other issues would also be identified and included in the CTMP. Management measure TT10 in Table 24-21 in Chapter 24 of the EIS addresses carrying out a Stage 1 Road Safety Audit as part of preparation of the CTMP. Any further actions arising from the Road Safety Audit would be carried out as part of finalisation of the CTMP.

Issue 2

The haul route to the north does not address the impact of the steep incline on Silverdale Road from Bents Basin Road to Norton's Basin Road and the effects on traffic speed and road safety.

Response

The above noted issue is recognised as a potential construction impact, which would be temporary throughout the duration of the Project.

Management of this issue will be addressed in the CTMP with appropriate mitigation considered, such as avoidance of peak periods by heavy construction traffic, where this would significantly impact travel speeds of existing traffic.

Issue 3

The proposed southern haul route passes directly in front of four primary schools and one secondary school and the townships of The Oaks, Picton, Tahmoor and Bargo. This will have an adverse effect on road safety, amenity, noise, dust and pedestrian safety.

Response

Control measures including appropriate mitigation to address road safety and other issues would be identified and included in the CTMP. Management measure TT10 in Table 24-21 in Chapter 24 of the EIS addresses carrying out a Stage 1 Road Safety Audit as part of preparation of the CTMP. Any further actions arising from the Road Safety Audit would be carried out as part of finalisation of the CTMP.

5.8.20.10 Road modifications

Temporary long term closure of any public road would be subject to the Local Traffic Committee recommendation to Council and subsequent resolution of Council, with the issuing of a Section 138 permit (*Roads Act 1993*) before presumptions could be made to effect road closures.

Response

The need for the extended closure of any public road under the care and control of Wollondilly Shire Council will be considered as part of construction planning and preparation of the CTMP. Where this is identified, Council will be consulted with regard to all required approvals and permit requirements.

5.8.20.11 Impacts on parking

The potential impact on local parking is considered to be moderate with no access to the Visitors Information Centre Parking area, instead it is proposed that visitors use the existing parking area on Farnsworth Avenue adjacent to the existing recreation area, subject to an agreement with Council. The pressure on parking for a council facility during peak sporting events will be compounded by the closure of the dam visitor's parking area.

Response

As noted, the potential impact on local parking is anticipated to be moderate, as there would be a loss of access to recreational areas. Management measure TT12 in Table 24-21 in Chapter 24 of the EIS addresses development of a parking strategy to better understand the demand and supply of parking spaces.

5.8.20.12 Summary of construction impacts

Road and intersection capacity level is considered to be minor – this cannot be stated as the complete network impacted by the proposed works has not been assessed. The rest of Table 24-12 needs to be reassessed based on additional works that need to be carried out to assess the full impact.

Response

As indicated in Section 24.3.1.2 (Traffic distribution and assignment) of the EIS, the two scenarios used to assess potential impacts on the road network were:

- Scenario 1: 100 percent heavy vehicles using the northern route
- Scenario 2: 50 percent heavy vehicles using the northern route and 50 percent heavy vehicles using the southern route.

While traffic using the southern construction route between the Silverdale Road/ Warradale Road intersection at Silverdale and Remembrance Driveway at Bargo would pass through the towns of The Oaks, Picton, Tahmoor and Bargo, the majority of construction vehicle movements would be through vehicle movements, as opposed to turn vehicle movements, therefore there is likely to be minimal impact on the operational level of service at the majority of intersections along the route.

Control measures including appropriate mitigation to address road safety and other issues would be identified and included in the CTMP. Management measure TT10 in Table 24-21 in Chapter 24 of the EIS addresses carrying out a Stage 1 Road Safety Audit as part of preparation of the CTMP. This would consider the intersections noted. Any further actions arising from the Road Safety Audit would be carried out as part of finalisation of the CTMP.

5.8.20.13 Environmental management measures (Construction traffic management plan)

A contingency plan has not been developed as part of this assessment to detail alternative routes in the event of emergency road closures and the road safety audits are only proposed at the CTMP stage.

Response

Management measure TT1 in Table 24-21 in Chapter 24 of the EIS provides for preparation of a CTMP to manage impacts from construction traffic. The CTMP would include a construction contingency plan to manage traffic in the event of emergency road closures due to various factors. Council would be consulted during preparation of the CTMP and a copy of the approved CTMP would be provided to Council for information.

The CTMP will also address the need for dilapidation surveys. In this regard, Council and other relevant stakeholders will be consulted regarding the scope of surveys and reporting required. This will ensure that any deterioration to road conditions as a result of construction activities is made good by the delivery contractor.

In addition to addressing impacts on the public road network, the CTMP will also address and manage on-site traffic issues, such as queueing of construction vehicles within the construction site.

5.8.20.14 Fire trail access

The Burragorang Valley is the main starting point for bushfires that threaten Wollondilly Shire. The Sheehys Creek fire trail is the primary access to the valley and becomes critical in times of bushfires such as during the Black Summer Bushfire. The fire trail is shown to be inundated by flooding if the wall is to be extended which could lead to damage and undermining of the fire trail, leaving the valley inaccessible during a bushfire event.

Response

The reference to the Sheehys Creek fire trail is taken as referring to Sheehys Creek Road, which crosses the Nattai River connecting to Valley Three Road and W4 Trail. This location, which is also within the existing FSL of Warragamba Dam, is affected by existing flooding and the Project would result in an increase in the depth and duration of temporary inundation. The incremental effect of the Project on temporary inundation is shown in the following table for a location about 1,400 metres upstream of the crossing.

Table 5-5 Changes in temporary inundation depth and duration at cross section NATTAI_1880

	Flood event (1 in x chance in a year)									
	1 in 5		1 in 10		1 in 20		1 in 100		PMF	
	E[1]	P[2]	E	P	E	P	E	P	E	P
Maximum depth (m)	2.8	0.5	3.1	3.2	4.0	7.4	5.9	10.0	14.2	12.0
Duration (days)	6.8	2.4	6.4	3.8	6.7	8.0	6.4	8.3	7.0	6.0

Notes: 1 – E = existing; 2 – P = additional depth/duration with Project

Existing temporary inundation is associated with backwater from lake Burragorang and this would not change with the Project. Backwater flooding typically has very low velocities and consequently low erosion risk. The potential for erosion affecting Sheehys Creek Road would be higher further up Sheehys Creek where it runs parallel to the road due to local catchment runoff with relatively higher flow velocities. This risk would not be due to the Project.

5.8.21 Chapter 26 Waste

Issue 1

Inconsistent with the aims of NSW Waste and Sustainable Materials Strategy 2041 Stage 1 2021-2027 (June 2021) and NSW Government Net Zero Plan Stage 1 2020-2030 Priority 4 (March 2020).

The chapter incorrectly cites the NSW Waste Avoidance and Resource Recovery Strategy 2014–21 (EPA 2014a) as the framework and targets for waste management and recycling in NSW. Despite acknowledging the need for targets in the chapter, the applicant does not commit to any targets for recycling or reuse of waste from the demolition, construction or operations phase.

The sustainability of the Project cannot be assessed without the targets given the number of estimated tonnes which have been listed in Table 26-3 and the unknown status of how many of these tonnes would end up in landfill.

Response

The EIS responds to the revised SEARs as issued in March 2018. The assessment has correctly used the framework prescribed in the SEARs list of guideline documents. The inputs for the development of the EIS were undertaken prior to the release of the *NSW Waste and Sustainable Materials Strategy 2041 Stage 1: 2021-2027* (June 2021).

However, as noted in the *NSW Waste and Sustainable Materials Strategy 2041 Stage 1: 2021-2027*, the NSW *Waste Avoidance and Resource Recovery Act 2001* the NSW Government commits to refreshing and updating its waste strategy every five years and the strategy updates the previous Waste Avoidance and Resource Recovery Strategy 2014–2021.

The targets of the new strategy are to:

- Reduce total waste generated by 10 percent per person by 2030
- Have an 80 percent average recovery rate from all waste streams by 2030
- Significantly increase the use of recycled content by governments and industry
- Phase out problematic and unnecessary plastics by 2025
- Halve the amount of organic waste sent to landfill by 2030.

The proposed management of construction waste presented in the EIS is not inconsistent with these targets. Preparation of the Construction Waste Management Plan during construction planning would include appropriate consideration of these targets and other relevant matters at the time of delivery.

Issue 2

Basic information provided on potential waste disposal locations.

Chapter 26 Waste provides only basic and weak commentary on the possible off site recycling and reuse locations for waste streams. Section 26.3.8 makes comments that existing metropolitan waste management facilities would have capacity to receive the anticipated waste streams generated by the Project. This statement incorrectly cites the status of many metropolitan waste management facilities with most landfills sites nearing capacity. The chapter often refers to disposal and it is likely that some of the facilities will be unable to accept this waste due to closure. No alternative waste technologies are discussed.

Table 26-4 provides a list of 14 operators as options for offsite recycling or reuse however there is no further information provided on the type of waste which would be taken to these operators, amount of waste, whether the operators have the appropriate EPA licences and confirmation from these operators that they are capable of processing the type or amount of waste from the Project.

The lack of detail identifying the recycling and reuse off-site locations which will be used makes the assessment of sustainability in terms of emissions and impact to transport routes impossible.

The chapter also fails to assess the impact of wind erosion on residential properties located close to the materials storage handling area. Stockpiles of concrete, ENM, VEMN and mulch will create significant dust from wind erosion while awaiting transport to offsite locations.

Response

The assessment presented in the EIS was based upon information available at the time. The facilities listed in Table 26-4 in Chapter 26 of the EIS were identified as being able to receive one or more of the construction waste streams. It was not considered necessary to identify specific waste types that could be received at individual facilities. This is typically a detail addressed by the delivery contractor as part of construction planning and preparation of the CEMP.

The issue of potential wind erosion is considered an air quality management issue rather than a waste management issue and is assessed in Chapter 7 of the EIS. There are accepted construction management practices such as covering of stockpiles and watering of exposed surfaces that have proven to be effective in managing dust generation. Management of potential air quality impacts would be addressed through management measure AQ1 (see Appendix B of this report), which commits to the development and implementation of a construction air quality management plan.

5.8.22 Chapter 27 Water quality

Appears to be inconsistent with the aims of the draft Greater Sydney Water Strategy. The viability of the Project needs to be reviewed in further depth by looking at the opportunities presented in the draft Greater Sydney Water Strategy. The issues presented by both bodies of work can have common solutions that have the ability to complement each other and provide a more resilient community and environment in a changing climate.

Response

Chapter 27 of the EIS provides an assessment of the potential impacts of the Project on water quality during construction and operation with regard to the matters identified in the SEARs. The draft Greater Sydney Water Strategy was released in September 2021 after the EIS had been completed (with the EIS being placed on public exhibition on 29 September 2021). It is noted that the final strategy was released in August 2022.

The Greater Sydney Water Strategy makes various references to water quality in the context of water supply security, including noting that flood events can affect water quality in Sydney's catchment areas (and which is an existing issue).

As identified in the strategy, WaterNSW is a key stakeholder in the management of the Sydney metropolitan water supply. The strategy notes (page 12) that WaterNSW has worked with DPE and Sydney Water in a number of areas that support delivery of the strategy. WaterNSW would continue to work collaboratively with DPE and Sydney Water to develop strategies to ensure that Sydney's water systems can respond to growth, while also being resilient to more frequent and severe future drought conditions.

5.8.23 Chapter 28 Cumulative impacts

The chapter fails to address an assessment of cumulative impacts of the Project taking into account other projects that have been approved but where construction has not commenced, projects that have commenced construction, and projects that have recently been completed.

Response

The approach to the assessment of potential cumulative impacts provided in the EIS is consistent with the approach generally taken for SSI/SSD proposals in NSW.

5.8.24 Chapter 29 Synthesis

Section 29.3 regarding design changes to minimise impact for non-Aboriginal (and aquatic ecology) is to 'Provide for a smooth finish to the face of the dam' is comical, tokenistic to the issue and a classic summary of the overall quality of the EIS.

Response

The reference to the smooth profile of the raised dam is in the context of the non-Aboriginal heritage assessment with regard to the indirect (visual) impacts of maintaining the appearance of the face of the current dam as noted in Appendix I to the EIS and Chapter 17 of the EIS. For aquatic ecology impacts a smooth face is preferred over a stepped face for spills over the central spillway crest.

5.9 Endeavour Energy

5.9.1 Affected Endeavour Energy assets

Subject to the foregoing and the following recommendations and comments Endeavour Energy has no objection to the SSI development. Not all of the issues raised in the submission may be directly relevant or significant to the SSI development.

Endeavour Energy provides a copy of its *Flood Response and Impacts on Electricity Distribution Network* to provide advice regarding flood response and impacts on the electricity distribution network for the development of floodplain risk management studies and plans.

From a review of the EIS it appears the only Endeavour Energy electricity assets directly impacted are:

- An 11 kV North Warragamba Zone substation Feeder NG1247 Chlorination Drive and Auxiliary no.2 (and associated low voltage and street lighting). If supply is to be retained, AAP has no issues with the line being relocated
- The Out of Service (OOS) section of 132 kV Feeder DR937. The line is used to connect to the Warragamba Generation Station / hydroelectric power station with the EIS indicates is to be demolished. AAP Branch is unlikely to have any further use for the 132 kV sections in the affected area. The line can be removed but may be able to be used for construction supply.

Response

The advice regarding management of flood risk on electricity infrastructure will be provided to the construction contractor as part of a package of supporting information to the construction contract.

The potentially affected electricity assets are noted. The potential relocation of the 11 kV transmission does not from part of the Project but may be considered during detailed design. Similarly, the demolition of the OOS section of 132 kV Feeder DR937 does not form part of the Project but may also be considered during detailed design and/or construction planning.

5.9.2 Protection of Endeavour Energy assets

Although not held under easement, the overhead power lines traversing the site are protected assets and deemed to be lawful for all purposes under section 53 (Protection of certain electricity work) of the NSW *Electricity Supply Act 1995*. These protected assets are managed as if an easement is in place.

Response

Protection of the overhead transmission lines traversing the construction site will be managed by the construction contractor in accordance with all statutory requirements and the requirements of Endeavour Energy.

5.9.3 Clearance requirements for high voltage lines

Endeavour Energy Mains Design Instruction MDI0044 'Easements and Property Tenure Rights' provides Table 1- 'Minimum easement widths' for low voltage and 11 kV high voltage overhead power lines, being a minimum easement of nine metres, and for 132 kV high voltage overhead power lines with steel towers, being an easement of 30 metres. However in some circumstances these easements may not be warranted or reasonably provided.

As a minimum, any building or structure (including fencing, signage, flag poles, etc) whether temporary or permanent must comply with the minimum safe distances/clearances for voltages up to and including 132,000 volts (132 kV) as specified in:

- Australian / New Zealand Standard AS/NZS7000 – 2016: 'Overhead line design' as updated
- 'Service and Installation Rules of NSW' which can be accessed via https://energy.nsw.gov.au/government-and-regulation/legislative-and-regulatory-requirements/service-installation-rules
- These distances must be maintained at all times.

Response

The clearance requirements with regard to working in close proximity to high voltage overhead lines is noted, and the construction contractor will be required to plan and carry out all work in accordance with these requirements.

5.9.4 Safe working requirements

Work within the safe approach distances requires an authorised or instructed person with technical knowledge or sufficient experience to perform the work required, a safety observer for operating plant as well as possibly and outage request and/or erection of a protective hoarding. The safe approach distance for ordinary persons is three metres for all voltages up to and including 132 kV.

Endeavour Energy's recommendation is that whenever reasonably possible buildings and structures be located and designed to avoid the need to work within the safe approach distances for ordinary persons. Alternatively, in some instances the adoption of an underground solution may be warranted.

Before commencing any underground activity the applicant is required to obtain advice from the *Dial Before You Dig 1100* service in accordance with the requirements of the NSW *Electricity Supply Act 1995* and associated Regulations. This should be obtained by the applicant not only to identify the location of any underground electrical and other utility infrastructure across the site, but also to identify them as a hazard and to property assess the risk.

Response

The safe working requirements with regard to working in close proximity to electricity infrastructure is noted, and the construction contractor will be required to plan and carry out all work in accordance with these requirements. This will include obtaining advice from the *Dial Before You Dig 1100* service.

5.9.5 Information requirements for construction power supply

For construction supply, APP Branch needs to know what the maximum demand is rather than the estimated energy required. Endeavor Energy has provided details of proposed method of supply for potential maximum demand under and over 1 MVA and if the OOS sections of the 132 kV Feeder DR937 are to be used.

As a general observation there does not appear to be much detail provided about the electricity infrastructure required to facilitate the proposed development or the impact on electricity infrastructure either for the construction or the subsequent upstream and downstream impacts of the dam raising.

Response

The maximum likely electricity demand for construction activities will be determined during detailed design and/or construction planning, and this will be informed by the information provided by Endeavour Energy.

The Project is not anticipated to have any material impact on electricity infrastructure once construction is complete.

5.9.6 New/changed network connection

The applicant for the proposed development of the site will need to submit an appropriate application based on the maximum demand for electricity for connection of load in order for Endeavor Energy to carry out the final load assessment and determine the method of supply.

Alternatively the applicant may need to engage an Accredited Service Provider (ASP) of an appropriate level and class of accreditation to assess the electricity load and the proposed method of supply for the development.

The construction of any building or structure whether temporary or permanent that is connected to or in close proximity to Endeavour Energy's electoral network is required to comply with Australian/New Zealand Standard AS/NZS 3000:2018 *Electrical Installations* as updated from time to time. This Standard sets out requirements for the design, construction and verification of electrical installations, including ensuring there is adequate connection to the earth. It applies to all electrical installations including temporary builder's supply / connections.

Response

Section 5.4.13 of the EIS notes that no utilities outside the construction area would require increased capacity or relocation. However, some utilities servicing the dam and associated facilities may require relocation to allow for construction and future operations. These relocations would not affect any services provided to the township of Warragamba or other stakeholders.

The design of the electricity supply for construction together with any required relocations will be carried out during detailed design and the option of engaging an ASP to do this work is acknowledged.

The construction contractor will be required to carry out construction activities in accordance with all relevant statutory requirements and Endeavour Energy requirements. This will include compliance with Australian/New Zealand Standard AS/NZS 3000:2018 *Electrical Installations*.

5.9.7 Easement management and network access

Endeavour Energy's preference is for no activities or encroachments to occur within its easements.

Details of all the proposed works or activities within the easement (even if not part of the Development Application) must be referred to Endeavour Energy's Easements Officer for assessment and possible approval provided it meets the minimum safety requirements and controls.

Response

As far as practicable, planning for construction activities will seek to avoid any works within electricity easements. Where this is not avoidable, Endeavour Energy will be consulted prior to commencement of any such activities, and all minimum safety requirements and controls will be observed.

5.9.8 Prudent avoidance regarding EMF

The electricity industry has adopted a policy of prudent avoidance by doing what can be done without undue inconvenience and at modest expense to avert the possible risk to health from exposure to emissions from electricity infrastructure such as electric and magnetic fields (EMF) and noise which generally increase the higher the voltage.

This means that when designing new transmission and distribution facilities, consideration is given to locating them where exposure to the more sensitive uses is reduced and increasing separation distances.

Where development is proposed in the vicinity of electricity infrastructure, Endeavour Energy is not responsible for an amelioration measures for such emissions that my impact on the nearby proposed development.

Response

The advice regarding prudent avoidance regarding EMF is acknowledged. The construction contractor will be required to give due consideration to this matter when planning the construction site layout and when carrying out construction activities.

5.9.9 Vegetation management

The planting of large trees near electricity infrastructure is not supported by Endeavour Energy due to ongoing costs of management / trimming and risk of falling trees/ branches that cause outages.

Suitable planting needs to be undertaken in proximity of electricity infrastructure. Unsuitable planting may become a safety risk, cause bushfire, restrict access, reduce light or affect supply.

Endeavour Energy's recommendation is that existing trees which are of low ecological significance in proximity of overhead power lines be removed and if necessary replaced by an alternative smaller planting. Any planting needs to ensure appropriate clearances are maintained while minimising the need for future pruning.

Response

Significant landscaping involving the planting of large trees near electricity infrastructure does not form part of the Project. Any landscaping and plantings in proximity to electricity infrastructure will be carried out in accordance with Endeavour Energy requirements.

5.9.10 Demolition and site remediation

Demolition work is to be carried out in accordance with Australian Standard AS 2601-2001: *The Demolition of Structures* (or other current version). All electric cables or apparatus which are liable to be a source of danger, excluding that required for demolition works, shall be disconnected. Appropriate care must be taken to not otherwise interfere with any electrical infrastructure on or in the vicinity of the site.

With respect to site remediation, the decommissioning and removal of redundant electricity infrastructure will be dealt with by Endeavour Energy's Network Connections branch as part of the application for the connection of load for the new development. Endeavour Energy advises that remediation of soils or surfaces impacted by various forms of electricity infrastructure is not uncommon but usually not significant.

Response

The requirements with regard to demolition of redundant electricity supply infrastructure are acknowledged.

The requirement for any site remediation works will be determined during detailed design and will be carried out in accordance with all applicable statutory requirements. This will include appropriate consultation with Endeavour Energy.

5.9.11 Public safety

Workers involved in work near electricity infrastructure run the risk of receiving an electric shock and causing substantial damage to plant and equipment.

Endeavour Energy has provided resources to support public safety in and around Endeavour Energy electricity infrastructure.

Response

The safety of construction personnel, including with regard to risks associated with electricity infrastructure, will be managed through a construction safety management plan (refer management measure HS2 in Appendix B).

Members of the public will be excluded from the construction site.

6

Response to community submissions

6 Response to community submissions

This section provides responses to issues raised in community submissions.

Table A1 in Appendix A identifies the issues raised in community submissions and assigns a code to each issue and identifies where it is addressed in this section of the Submissions Report.

Table A2 in Appendix A lists individual community submissions by the submission number assigned by DPE together with issues raised in the submission using the codes from Table A1.

These two tables allow submitters to identify where issues raised in their submission have been addressed in the Submissions Report.

As noted in Section 2, 519 submissions have not been provided to WaterNSW but as per DPE advice, the issues raised in these submissions have been captured in the summary provided in Attachment B (Amended Warragamba Submissions Summary – Key Issues) to DPE's letter of 17 January 2022.

6.1 Support for the Project

Support for the Project was expressed in 58 submissions, generally under the following themes:

- Avoiding the cost of loss and damage to homes and property from flood events and the subsequent clean-up and recovery; some of these homes were built in what was then a lower flood risk and/or allowed development area
- Protection for businesses and the employment they provide
- Avoiding economic impacts from flood events
- Protecting water quality downstream by limiting the pollution and rubbish picked up by floodwaters moving through urban areas
- Protecting human lives
- Lowering the negative mental health and societal function impacts of flood events and perceived flood danger
- Protecting livestock and wildlife that would be displaced, harmed, and possibly killed by flood events
- Responding to an existing problem of flooding in the developed floodplain
- The construction phase providing jobs and local economic benefits
- The inadequacy of flood forecasting and warnings
- Upstream inundation impacts on the natural environment being temporary and occasional, so environmental considerations should not prevent the project proceeding
- The EIS having used the best available information in the assessment.

A number of submissions gave their support for the Project on the misunderstanding it would increase Sydney's water supply and water supply security, and provide an option for further development to accommodate Sydney's population growth.

Response

WaterNSW notes the support expressed for the Project and provides the following clarification relating to the misunderstood project benefits around water storage and floodplain development.

The sole objective of the Project is to provide flood mitigation benefits and is not intended to increase Sydney's water supply. The Project is expected to provide benefits to life and property downstream, however it does not address further development in the floodplain which is not part of WaterNSW's statutory responsibilities. Outcome 3 of the Flood Strategy (Strategic and integrated land use and road planning), led by DPE and TfNSW, will consider land use planning for the region. DPE Water is responsible for planning for long-term water security through the *Greater Sydney Water Strategy* (DPE 2022).

6.2 Strategic need and justification

6.2.1 Modelling of stated flooding and economic benefits

No modelling of the stated flood and economic benefits of the dam wall raising is outlined in the EIS.

Response

The flood and economic benefits of the Project are outlined in Chapter 4 *Project development and alternatives* of the EIS. The modelling used to determine flooding and benefits has been consistent since the Flood Strategy was prepared by Infrastructure NSW in 2017. The modelling has been calibrated and validated by flood events since Warragamba Dam was built including the floods of 2021 and 2022 in the Hawkesbury-Nepean Valley.

Tables showing flood damage costs and risk to life under different flood scenarios, comparing the dam raising to alternatives, are provided in Section 4.8 in Chapter 4 of the EIS. The approach to the assessment is provided in Section 4.7.

Flood modelling informed the comparative assessments in Chapter 4 of the EIS. Further information on this modelling, as well as the flood mitigation and economic analysis, can be found in Chapter 15 *Flooding and hydrology* and Chapter 21 *Socio-economic land use and property*. Section 15.7.2 in Chapter 15 of the EIS addresses changes of flood characteristics and extents for various flood events compared between the existing dam and with Project. Modelling and analysis demonstrates that while the frequency of a flood event (in terms of chance of occurrence in a year) may be reduced, as would the total flood height by considerable depths. The duration of each flood event at Penrith and Windsor would be 1.5 to 2 or more times longer with associated disruption to society and recovery efforts (Table 15-21). Each of these factors will affect the scale and time period of flooding, evacuation options, the number and level of damage to properties, and risk to life.

6.2.2 Downstream development

A number of submissions expressed the view that the Project is being progressed to enable further urban development on the Hawkesbury-Nepean floodplain by providing flood protection below the existing flood planning levels.

It was suggested that the raised dam would allow for new development and would align with the economic interests of developers to support Sydney's growing population and economic growth.

Response

One of the outcomes identified in the Flood Strategy was to reduce flood risk in the Hawkesbury-Nepean Valley by raising Warragamba Dam. Four key performance indicators (KPIs) were identified to assess methods to reduce the flood risk, the top two KPIs being to minimise lives lost by reduced exposure of properties to flooding and by evacuation, and to reduce property damage from flood events.

In preparing the Flood Strategy, the methodology for assessment of flood mitigation options included establishing the different level of urban development (population) that could occur in the valley by 2041 under current (as at 2017) planning arrangements. As such, the outcomes and actions of the Flood Strategy, and the Project, anticipate and respond to a future higher population, and associated housing, in the Hawkesbury-Nepean Valley.

The Flood Strategy is also referenced in the *Greater Sydney Regional Plan* and the *Western City District Plan*. These plans offer NSW Government endorsed strategic planning guidance for the managed development of Sydney. They also plan for further urban, including residential, development in the western Sydney area of the Hawkesbury-Nepean Valley.

These strategic planning documents respond to the trends and projections of population growth for the city, and to the needs of that growing population for jobs, housing, and services. The Flood Strategy has considered a range of alternatives to reduce the risk to life and property in the floodplain due to overbank flooding including to buy back at-risk properties. This alternative was found to have a negative net benefit due to the high costs and social impact which is further explained in Section 4.5.1.7 and Table 4-6 in Chapter 4 of the EIS.

The Flood Strategy concluded that creating additional airspace above the existing FSL to temporarily hold back flood waters supplemented by the eight other outcomes would provide the most effective flood risk reduction for the valley.

Further development within the floodplain would diminish the flood risk reduction by the raised dam. This issue is addressed through Outcome 3 of the Flood Strategy (Strategic and integrated land use and road planning), led by DPE and TfNSW.

6.2.3 Purpose of the dam

A number of submissions noted the original purpose of the dam as water supply infrastructure, which informed its location and design. As the Project would broaden the purpose of the dam to provide both water supply and flood mitigation purposes, it was questioned as to whether a single dam could operate under these dual and conflicting purposes.

Submissions also raised concerns that in future the additional water capacity for flood mitigation, intended by the raised dam, would be redirected to provide increased water supply capacity that would mitigate future droughts and support the growing population's water needs. As a result, the flood mitigation potential under the current wall raising proposal would cease, and the flood risk to downstream communities would be re-established. Under this scenario, the perceived conflict of the dual use would cease. However, this is not the currently promoted intended outcome of the dam wall raising.

The challenge of a growing Sydney, particularly in terms of population demand for water supply and also existing and future urban development in the floodplain, was raised in a number of other submissions (refer Section 6.10).

Response

Warragamba Dam, that creates Burragorang Reservoir, is currently the key water supply infrastructure for the Greater Sydney Region. The proposed works to Warragamba Dam are to provide flood storage capacity and also to make the dam suitable for flood water release requirements. As such the works will enable Warragamba Dam to meet the dual purpose of water supply storage and flood mitigation. Management measures will inform the flood mitigation operation of the dam.

The Wivenhoe Dam and Somerset Dam in south-east Queensland were built for and operate as both a water supply for the region and flood mitigation infrastructure for the Brisbane River. The flood mitigation component of the dams is informed by and managed according to the *Manual of Operational Procedures for Flood Mitigation* (SEQ Water, currently Revision 16 November 2021).

Wivenhoe Dam, constructed in 1984, has an operational FSL of 65.9 mAHD and a maximum flood storage level of 80.0 mAHD. An auxiliary spillway was constructed in 2005 to support the dam operation in extreme flood events. Somerset Dam construction was completed in 1955. A flood defence wall and removeable barrier were installed in 2016 to raise the flood storage level of the dam by 1.25 metres. Somerset Dam has an operational FSL of 97.0 mAHD and a maximum flood storage level, with the 2016 upgrade, of 108.7 mAHD. While both dams were constructed for dual water supply and flood mitigation purposes, each has undergone subsequent dam wall works to enhance the flood mitigation component.

Infrastructure NSW's *Frequently Asked Questions Raising Warragamba Dam* [36] addresses whether the additional storage capacity will be used in future for water supply. The FAQ document states that the additional capacity would not be used for water supply and explains that:

> *The flood mitigation zone created by the raised dam would only be used to temporarily store floodwaters during floods. The long-term water needs of greater Sydney are met through the mix of water supply and demand measures. This is monitored and regularly reviewed to take account of changes in population growth, water use, climate, technology and other factors. Diversification of supply and demand measures is a key to securing the long-term needs of a growing city.*
>
> *When full, Warragamba Dam already holds approximately 80% of Sydney stored water supplies. An increased reliance on water supplied from Warragamba Dam was considered and rejected in the most recent water planning review. This was for sound reasons including:*
>
> - *The increased risk to water security of further reliance on a single source of supply – not 'putting all your eggs in one basket'*
> - *The potential environmental impacts associated with permanently increasing the level of stored water behind the dam wall.*

As noted in the response in Section 6.1, DPE Water is responsible for planning for long-term water security through the *Greater Sydney Water Strategy* (DPE 2022).

6.2.4 Justification

Many submissions questioned the justification for the Project in relation to the environmental harm that would be caused from the dam raising and the storage of floodwaters. Submissions expressed the view that this environmental harm was unnecessary given the alternatives that were available and the inherent risk accepted by governments and individuals when building in a known flood-prone area.

It was also put forward that the Project has a short-term perspective, and dam raising is an outdated response for flood management.

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36 https://www.infrastructure.nsw.gov.au/media/1723/warragamba-dam-raising.pdf

It was felt the Project is not justified or needed, and there was a lack of trust in governments which may be putting forward the Project for political reasons and as a response to the interests of developers for economic benefit. Relatedly, it was expressed that the Project would enable further development of the floodplain.

It was also felt the decision to proceed with the dam raising had already been made and this process, including documentation, is being tailored to support that outcome. It was also stated that the benefits of the Project were not proven.

Submissions expressed the view that the Project, and its impacts, would be irreversible and would have long term effects on irreplaceable natural environments.

Submissions also noted allowing the development would set the precedent for future developments that would impact protected areas and the natural environment, and would compound the current issue of properties in the floodplain at risk of flooding.

Response

The intention of the Project is not to facilitate development in the Hawkesbury-Nepean Valley but rather to reduce the risk to life and property in already developed areas. It is recognised that development in the floodplain areas was based on past planning and development guidelines. The Project is part of the Flood Strategy that comprehensively addresses the flood risk in the region and also considers the future land use and planning under Outcome 3 of the Flood Strategy (Strategic and integrated land use and road planning) that is being led by DPE and TfNSW.

The Project is not a short-term solution to the flood risk in the region. It has evolved from previous work of government, in particular the Flood Strategy and the Hawkesbury-Nepean Valley Flood Management Taskforce. The Warragamba Dam Raising Project is only one of the recommendations and measures to mitigate flood risk to residents and businesses in the region from a range of other initiatives.

The need and justification for the Project is to provide flood mitigation that will reduce the significant existing risk to life and property in the Hawkesbury-Nepean Valley downstream of Warragamba Dam. Details of the strategic need and justification are provided in Chapter 3 of the EIS.

The EIS for the Project has been prepared in accordance with NSW and Commonwealth legislation while the final business case has been prepared under the NSW Government Treasury Circular (TC16-19) and infrastructure Investor Assurance Framework for major projects.

The NSW Government's decision to proceed with the Project has not been made at this time. This is subject to approval under the NSW EP&A Act, Commonwealth Government approval under the EPBC Act and approval of the final business case for the Project by the NSW Government. The need for, and justification of, the Project is set out in the EIS and the Project's Business Case. DPE will evaluate the need for, and justification of, the Project as part of its assessment. Climate change projections to 2079 (the 2070 projections) have been taken into account in the wall height now proposed and assessed in Chapter 16 of the EIS.

Any future development would be required to be assessed under the legislation of the time and a determination made on its individual merits. Refer also to Section 6.2.2 of this report on the issue of development downstream of the Project in the floodplain.

6.2.5 Project cost

Many submissions expressed concern at the cost of the Project including:

- The high cost is not justified generally
- The high cost for a project that will harm the natural environment is not supportable
- The cost will be footed by taxpayers but will provide limited benefit for government-permitted developments and this spending not being supported
- The potential for the currently estimated cost to increase as the Project progresses
- Ongoing operation and maintenance costs not being addressed
- There will still be a considerable flood risk downstream.

Some submissions expressed the view that developers that would benefit through the enabled development downstream should pay the cost of the dam raising (if it progressed), similar to a user-pays basis.

Related to the Project cost were submissions that sought reallocation of Project funding for alternative measures (refer Section 6.3).

Response

As with all major Government investments, the Project has developed the cost benefit analysis following NSW Treasury Guidelines (TPP 17003 – NSW Government Guide to Cost-Benefit Analysis[37]). This includes assessment of other options in addition to the preferred option. The options assessment in Chapter 4 of the EIS included a benefit to cost analysis summarised in Figure 4-25 and discussed in detail in Section 4.7.8 compared with other options assessed. The cost effectiveness of the preferred option of raising Warragamba Dam shows a benefit to cost ratio of 1.05 with all other options considered deriving a lower value.

A project with benefit to cost ratio of greater than one is expected to deliver a net benefit when compared with the cost of the project. This analysis has informed the final business case for the Project and supports the conclusions in Chapter 4 of the EIS.

The Project costs presented in the EIS excludes those costs associated with the environmental offset requirements (discussed in Section 6.5.8) and any further efforts for species recovery.

The costs of the Project are not an assessment requirement for the EIS. The Project cost-benefit analysis and financial costs would be detailed and considered in the business case that, along with the EIS, will inform the decision on whether to proceed with the Project. The decision will be made by the NSW Government.

Funding allocation is a matter for the NSW Government. Should it proceed, the flood risk mitigation achieved would benefit the existing and future community of the valley. The reduced but ongoing flood risk of the valley is acknowledged in the EIS and the preceding work.

The Project costs have been developed to inform the final business case and as such include a contingency for known risks at the time, assumed delivery timeframes and operational costs to reduce the likelihood of future increases to the cost. It is noted that delays to commencement of construction from the assumed timeframes and factors that are not known at the time may impact future project costs.

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[37] https://arp.nsw.gov.au/assets/ars/393b65f5e9/TPP17-03_NSW_Government_Guide_to_Cost-Benefit_Analysis_0.pdf

WaterNSW acknowledges that raising Warragamba Dam will not eliminate the flood risk in the Hawkesbury-Nepean Valley. The intention of the Project along with the other Flood Strategy outcomes is to reduce the flood risk to life and property in the valley as documented in Chapter 4 (Section 4.7.8) of the EIS.

6.2.6 Historical proposal for dam wall raising

Several submissions noted the early 1990s proposal, including EIS and business case, to raise the Warragamba Dam wall by 23 m and which was subsequently abandoned.

Response

The EIS developed in 1995 assessed the Government's preferred option of raising Warragamba Dam by 23 m primarily to protect the dam from overtopping and possible failure under the probable maximum flood and also to create a flood mitigation zone. In 1997, the Government decided not to proceed with the preferred option and the planning application was withdrawn (for further details refer Section 4.1 in Chapter 4 of the EIS).

Since the decision to not proceed with the 23 m raising of Warragamba Dam, multiple studies have been undertaken by the NSW Government to further explore options for flood mitigation in the Hawkesbury-Nepean Valley, each building upon the work of previous studies. The key studies are:

- 1997–2004: Hawkesbury-Nepean Floodplain Management Strategy
- 2013: Hawkesbury-Nepean Valley Flood Management Review
- 2014-2016: Hawkesbury-Nepean Valley Flood Management Taskforce
- 2017–2021: Hawkesbury-Nepean Valley Flood Risk Management Strategy – Phase One implementation.

Multiple NSW Government agencies have contributed to these studies.

The current Project has evolved from the 2013 Hawkesbury-Nepean Valley Flood Management Review, the Flood Strategy of Infrastructure NSW and the work of the Hawkesbury-Nepean Valley Flood Management Taskforce, a group comprised of representatives across NSW government agencies.

This recent work, and the EIS, has utilised up-to-date and improved information and modelling methods.

The current Project proposes to raise Warragamba Dam abutments and roadway by 17 m, which is a smaller raising than the earlier (1990s) proposal.

6.3 Alternative options to the Project

6.3.1 Assessment of alternatives

A number of submissions expressed the view that alternatives to the Project were not adequately assessed in the EIS, individually or as a combination of actions, including the cost-benefit analysis of the alternatives. In particular, the EIS assessment of a combination of measures is limited and restricted. The EIS also does not assess the economic benefits of alternative measures including avoiding flood damage costs to properties and infrastructure downstream of Warragamba Dam, and broader flood risk benefits that would offset initial implementation costs.

Related issues raised in submissions were:

- The assessment of options does not consider the cost of the environmental harm caused upstream by the Project that would not be incurred through pursuing alternative measures.
- Alternatives proposed would be of lower cost to implement and have lower environmental and cultural impacts while providing mitigation benefits.

Response

The options assessment for reducing the risk to life and property in the Hawkesbury-Nepean Valley presented in Chapter 4 of the EIS is a continuation of work undertaken by NSW Government since 2013. The Hawkesbury-Nepean Valley Flood Management Review concluded that no single mitigation option can address the flood risk precent in the valley with raising Warragamba Dam to temporarily capture flood waters being the only infrastructure option that significantly reduces flood risk.

In 2014, further work was undertaken by the Hawkesbury-Nepean Flood Management Taskforce with its recommendations incorporated into the Flood Strategy released in 2017. The Flood Strategy identified nine infrastructure and non-infrastructure measures with raising Warragamba Dam being the recommended Outcome 2 to be led by WaterNSW.

Subsequently, the Taskforce released the Taskforce Options Assessment Report that investigated further options with recommendations provided in Table 1 of the report.

During each phase of these investigations, less viable options were filtered and only options that could provide further benefits were carried forward. As such, WaterNSW considers that adequate alternatives to the Project were investigated over several options assessments since 2013 to inform the EIS noting that other infrastructure and non-infrastructure options are being further progressed by other agencies to provide comprehensive flood mitigation benefits to the valley. A summary of these assessments is shown in Figure 6-1.

Figure 6-1 Summary of options considered from 2015 Taskforce recommendations

In response to the issues raised, WaterNSW notes options assessed in Chapter 4 of the EIS with the summary of the assessment provided in Table 4-6. This included 20 infrastructure options and nine non-infrastructure options including some that were not previously supported assessed against the following criteria to further filter alternatives:

- Flood peak reduction, 1 in 50 to 1 in 1000 chance in a year range: reduction of the peak flood by at least two metres at Windsor to meet the criteria and a reduction between 1–2 metres to partially satisfy the criteria
- Reduced exposure to floods: reduction of at least 50 percent of floods reaching or exceeding the current 1 in 100 chance a year flood at Windsor to satisfy the criteria and reduction of 25-50 percent to partially meet the criteria)
- More certainty of time for evacuation: provide certainty of over 10 hours for more than 50 percent of the floods reaching or exceeding the 1 in 100 chance year level at Windsor and the evacuation route
- Reduced risk to life: changes to average annual vehicles unable to evacuate
- Valley-wide benefits
- Economic net benefit (high level assessment only)
- Social, environmental and cultural heritage impacts
- Consideration of other factors.

The recommendations from this stage of the review lead to further assessment of five options, these being:

- 14 metre dam raising
- 12 metre FSL reduction
- Five metre FSL reduction
- Buy out properties within the 1 in 100 chance in a year flood extent
- No new development within the 1 in 500 chance in a year flood extent.

The outcomes of this assessment are provided Section 4.8 of Chapter 4 of the EIS, with raising Warragamba Dam providing the greatest number of reductions to people at risk, property damages and being the most cost effective (refer Figures 4-23, 4-24 and 4-25 in Chapter 4 of the EIS).

6.3.2 Property buybacks

It was suggested that downstream properties at risk of flooding should be acquired. The purchased properties could then be used to provide additional open recreational space in western Sydney, or for agricultural purposes.

Response

Consideration of voluntary house purchase is provided in Section 9.1.3 of the Taskforce Options Assessment Report (Infrastructure NSW 2019a) and is summarised in Chapter 4 of the EIS. It was concluded that the large existing urban development in the valley, the high financial and social cost, and voluntary nature of house purchase, precluded it as a feasible regional flood risk management option.

Further analysis of the option of purchasing downstream properties has been carried out during preparation of the Submissions Report, and is provided in Appendix F. This considered three options:

- **Voluntary purchase**: where the private property owner voluntarily accepts an offer to sell their residential property (building and land) to an authority or entity. This option allows the property owner to buy elsewhere within or outside the community. It results in the removal of the existing development and the rezoning of the land for more flood compatible uses, such as open space. This option has been applied in NSW in areas where there is significant risk to life to occupants or potential rescuers where other management measures cannot effectively address this risk. When recommended in a floodplain risk management plan in NSW, voluntary purchase may be funded by the NSW Floodplain Management Program.
- **Land swap**: where the private property owner voluntarily accepts an offer to swap their land located in a high flood risk area for vacant land in a low flood risk area. The land swap does not include the house or business premises on the land. The private property owner is typically responsible for building the house or premises on the swapped land through their private funds or insurance payouts.
- **Compulsory acquisition (or resumption)**: private property is acquired by a public authority for a public purpose. Acquisition occurs without the consent of the property owner. There is a statutory process for compensation to the property owner.

These buyback options have been implemented in localities in NSW, Australia and in international jurisdictions.

The following criteria were used to assess each option:

- Degree to which the option resulted in significant, regional reduction of flood risk
- Cost of the option
- Likely social and environmental impacts of the option.

These criteria are broadly consistent with those in the Taskforce Options Assessment Report (Infrastructure NSW 2019a).

For voluntary purchase schemes, it was concluded that this option:

- Can be used to directly avoid exposure by targeting high risk properties
- Is limited in providing significant, regional reduction of flood risk at scale
- Has had mixed and incomplete uptake in NSW, with some property owners unwilling to participate in voluntary purchase schemes
- Is expensive and can take a long time to implement
- Can result in social dislocation for established communities
- Can be uneven in uptake resulting in vacated land being in separate, unconnected lots, thus limiting the use of vacated land for alternative purposes.

For land swap schemes, it was concluded that this option:

- Can be used to directly avoid exposure by targeting high risk properties
- Can be limited in providing significant, regional reduction of flood risk at scale
- Is expensive and can take a long time to implement
- Can preserve community cohesion for established communities as households relocated together

- Can be uneven in uptake resulting in vacated land being in separate, unconnected lots, thus limiting the use of vacated land for alternative purposes.

For compulsory acquisition, it was concluded that this option:

- Could theoretically provide significant, regional reduction of flood risk at scale
- Is a high cost option
- Could take less time to implement than voluntary purchase or land swaps
- Is likely to generate stakeholder and community opposition due to the compulsory nature of this option
- Allows for vacated land to be more readily repurposed for alternative uses compared to voluntary purchase or land swaps.

The analysis concluded that buyback options are unlikely to provide a significant, regional reduction in flood risk at a large scale within the Hawkesbury-Nepean Valley. Buyback options are generally very costly, involve a complex and lengthy process to implement, and have significant physical and social impacts for affected communities.

6.3.3 Evacuation routes

A number of submissions put forward the upgrading of existing roads and bridges, and so to improve evacuation routes and infrastructure from areas at risk of a flood event to a safe area.

Related to this, submissions sought implementation of improved systems for predicting and warning of flood events that would enable more time for evacuations to be carried out.

Response

The Taskforce Options Assessment Report considered the upgrade to evacuation roads and networks to support people vacating an area at risk of flood, and so protect human life. However, the upgrading of major regional evacuation routes to increase capacity was not recommended to be progressed as it would not reduce/mitigate flood risk. This option has a high cost with limited associated benefit in reducing risk to human life and will not reduce the potential cost from flood damage to property.

However, the assessment concluded that upgrades to local evacuation routes would complement the existing regional evacuation routes.

The assessment also included options to improve awareness, preparedness, and responsiveness as non-infrastructure measures to reduce risk to life and property. These options were:

- Improved floor forecasting and warnings system
- Community flood awareness, preparedness and responsiveness
- Best practice emergency response and recovery.

These options are also found to provide valley wide benefits and these options should be further progressed. A summary of the assessment is provided in the EIS in Table 4-6 in Chapter 4.

The Flood Strategy recommendations from the assessment are now being progressed as the following outcomes of the Flood Strategy separate to the Project:

- Outcome 5: an aware, prepared and responsive community led by Infrastructure NSW, SES and TfNSW
- Outcome 6: improved weather and flood predictions led by the Bureau of Meteorology
- Outcome 7: best practice emergency response and recovery led by SES and Resilience NSW

- Outcome 8: adequate local roads for evacuation led by TfNSW.

These outcomes are led by the nominated agencies and may be subject to their own approvals and business cases.

6.3.4 Lowering the full supply level

If the full supply level (FSL) of the existing dam was lowered, the difference in height between the lower FSL and the current FSL could be used for temporary flood storage. The dam would then not need to be raised.

The loss of storage for water supply could be made up using other water supply sources such as the desalination plant, water retreatment, on-site water detention such as water tanks and use, and improved water management and use by the public.

Response

The lowering of the FSL was an alternative measure shortlisted by the Taskforce and is documented in the EIS. Two options were assessed, being the lowering of the FSL by five metres or by 12 metres from the current FSL to create a flood mitigation zone (FMZ) within the existing dam structure.

Creating an FMZ by lowering the FSL would reduce the permanent water supply volume as per the following table.

Table 6-1 Potential FMZ created by lowering Warragamba Dam FSL

Lowered FSL	Capacity of FMZ created	Reduction in Warragamba storage	Reduction in Greater Sydney storage
-5 m	360 GL	-18%	-15%
-12 m	795 GL	-39%	-31%

The EIS identifies that alternative water supply sources, with associated construction and operational costs, would be required to replace the lost water supply volume and maintain the current level of security of water supply to meet the needs of Sydney. A lower FSL may also affect water quality and treatment requirements for the water supply need.

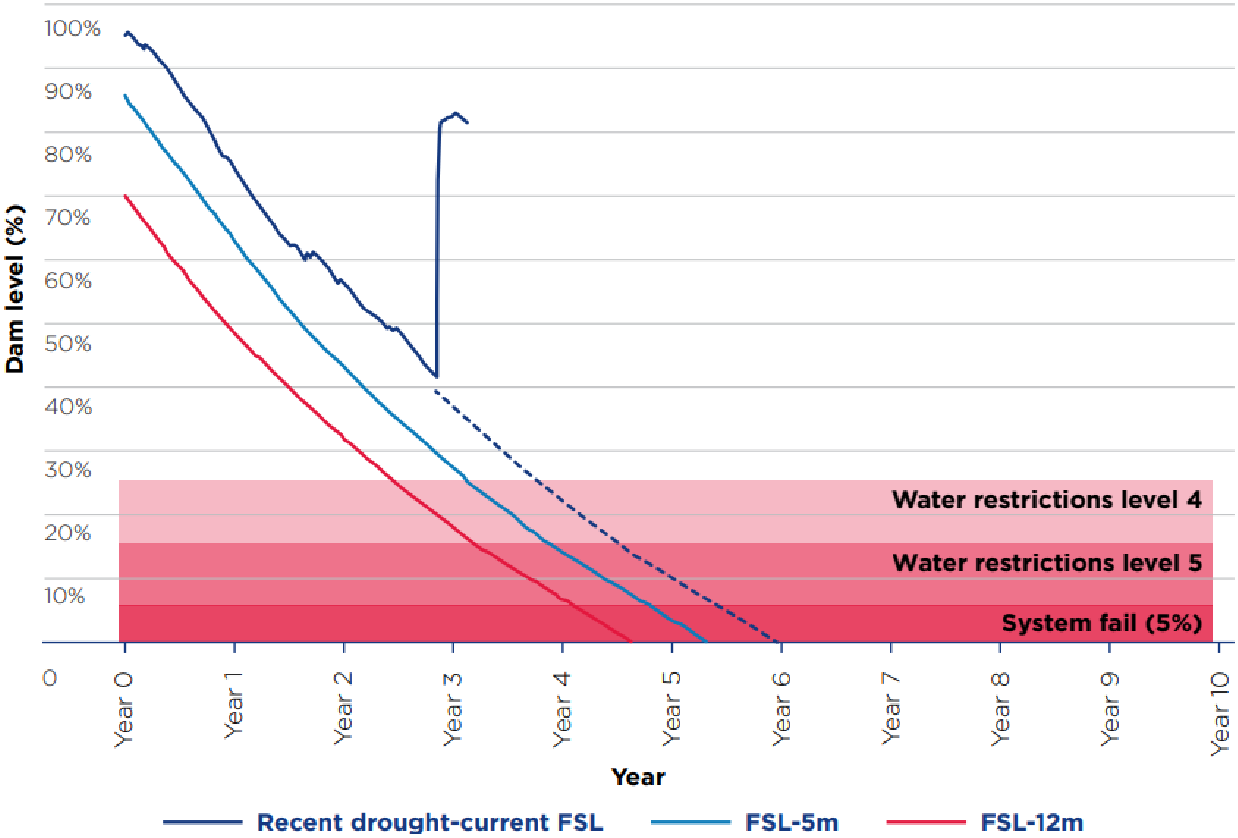
A response on securing Sydney's water supply is provided in Section 6.13.

Lowering the FSL (by five metres or by 12 metres) to provide an FMZ would reduce the heights of flood peaks for all flood events in downstream centres with varying effectiveness. For a five metre lowering, the flood peak at Windsor would be just 60 centimetres lower during a 1 in 100 chance per year flood.

As assessed against the criteria of the Task Force, lowering the FSL does not meet the requirements of minimising risk to human life or the protection of property (and so economic impact). With these deficiencies and the costs of implementation, this scenario has not been progressed.

Figure 6-2, taken from the Greater Sydney Water Strategy, shows how lowering the FSL of Warragamba Dam by five metres or by 12 metres affects storage levels over time under the very low inflow conditions of the 2017-20 drought. The Strategy notes that reducing FSL by 12 metres would reduce the full water supply system storage by about 30 percent, or about 80 GL/year, which would need to be met by a new desalination plant or purified recycled water scheme.

Figure 6-2 Impact of reducing FSL of Warragamba Dam on time to reach critical dam levels



Source: Greater Sydney Water Strategy, DPE, August 2022

6.3.5 Limit development on the floodplain

The current planning system allows development on the floodplain and in flood risk areas. The planning controls should be changed and strengthened to restrict development in these at-risk areas, including to rezone land to be unsuitable for urban development. The details of the planning controls would relate to and protect structures from specified flood risk/flood event type.

Development, and the population it supports, should be encouraged in more suitable locations off the floodplain such as in regional centres with investment in supporting infrastructure that would benefit those communities.

Should the dam be raised, this will encourage further development within the floodplain, placing further people and property at risk of a future flood event, including those events outside the Warragamba catchment. Raising the dam may result in property owners having a false sense of security and expectation that their property will be safe from floods.

Restricting development in the floodplain would also limit exposure to future flood risk under climate change-affected rainfall and associated flood regimes.

Response

The floodplain risk in the valley extends to existing development which was based on past planning requirements and future development. WaterNSW acknowledges that raising Warragamba Dam will not change the fact that there is a flood risk to existing development. The Project would, however, provide additional flood mitigation benefits to these communities.

During the options assessment, buy back of properties at risk in the floodplain and restricting new development within areas affected by the 1 in 500 chance in a year flood event were considered. However, both options were not cost-effective when compared to raising Warragamba Dam (refer Section 4.8 in Chapter 4 of the EIS). In particular, it was identified that the buy back of properties option had a high social impact with uncertainty on communities willing to be relocated.

WaterNSW therefore considers that raising Warragamba Dam would provide the most effective infrastructure solution to mitigate risk to life and property in the floodplain.

The Flood Strategy notes that there is no single solution that can reduce the risk to life and property within the floodplain. Therefore a comprehensive set out outcomes that are being led by various agencies set out within the Flood Strategy to address the flood risk in the floodplain with raising Warragamba Dam being one of nine outcomes.

It is not within the scope of the Project and the EIS to encourage development in places outside of the floodplain nor to change the planning controls and restrict development in the Hawkesbury-Nepean Valley. Outcome 3 of the Flood Strategy (Strategic and integrated land use and road planning), led by DPE and TfNSW, is considering the regional land use planning and settlement strategy for the valley.

It is acknowledged that raising Warragamba Dam and creating flood mitigation benefits may provide a false sense of security for communities living on the floodplain. However, other Flood Strategy Outcomes such as Outcome 5 (An aware, prepared and responsive community) led by INSW, SES and TfNSW is intended to ensure that the communities are better informed and understand their flood risk.

Chapter 14 of the EIS has assessed the climate change impacts for the raised Warragamba Dam. It identifies that to maintain the same level of mitigation, the dam may need to be raised further by up to three metres by 2090. The Project as described in the EIS provides for resilience to make this upgrade in the future if required by raising the abutments of the dam by 17 metres removing any future engineering constraints. Any further raising of the dam in the future would be subject to separate planning approvals.

6.3.6 Water diversion

A small number of submissions proposed diverting floodwaters to avoid urban areas or the bottleneck areas. This included diversion of water to the western side of the range using pipelines or tunnels.

Response

The construction of diversions that would improve the drainage of floodwaters was considered in the Taskforce Options Assessment Report. Specifically, the diversions considered were for channels:

- Between Wilberforce and Currency Creek that would re-join the Hawkesbury River near Sackville that would improve floodwater drainage. This diversion was not progressed as it would not provide the flood mitigation benefits as the dam wall raising despite costing a similar value, and it would have significant environmental impacts.
- From Sackville to the Cumberland Reach portions of the Hawkesbury River. This diversion was not progressed as it would not provide sufficient flood mitigation benefits, and the low elevation and tidal influence at the Sackville gorge areas would limit the rate of flood water drainage.

- From Sackville to Leets Vale portions of the Hawkesbury River. This diversion was not progressed as it would not provide net regional flood mitigation outcomes despite costing similar to the dam wall raising, and the low elevation and tidal elevation at the Sackville Gorge area would limit the rate of floodwater drainage.

An overview of these diversions is provided in the EIS in Sections 4.5.1.4 and 4.5.1. 5 in Chapter 4.

While options involving diversion of floodwater to the western side of the Great Dividing Range via pipelines or tunnels were not considered by the Taskforce, it is anticipated that they would similarly not provide the same level of flood mitigation benefits as the dam wall raising, and would likely have significant environmental impacts.

6.3.7 Dam operation

A small number of submissions proposed changes be made to the operation of the existing dam to manage potential flood events, such as by earlier controlled releases of stored waters to provide some storage capacity for floodwaters.

Response

Changes to the operation of the existing Warragamba Dam were considered in the Taskforce Options Assessment Report. These changes included:

- Pre-releasing water ahead of a predicted flood inflow
- Temporarily holding back floodwaters by use of the dam gates (known as surcharging).

These operational changes were assessed as having limited benefit in mitigating larger floods.

These operational changes would also have negative outcomes and challenges such as:

- A reduction in the evacuation time for some events as released water flows downstream potentially with limited warning
- Loss of water supply, particularly if the flood inflow did not occur as predicted
- Complexity of dam operation
- Increased threat to radial gates
- The later release of any surcharge waters would contribute to any remaining downstream flooding and/or extend the flood exposure downstream (as would the release of FMZ waters under the Project)
- If both a pre-release and surcharge were applied, as well as the flood event, downstream communities would be exposed to longer duration flood risk from the pre-release, event and post-release waters, albeit with a potentially lower flood peak
- The post-release of floodwaters may also extend the duration of inundation and disruption downstream.

An overview of the operational changes considered is provided in Section 4.5.1.2 in Chapter 4 of the EIS. Further details regarding flood operations for the Project are provided in Section 3.4 of the PIR.

6.3.8 Flood forecasting and preparedness

Some submissions proposed that funds be invested in flood forecasting, warning systems and preparedness/response by the community and authorities. This would provide additional time for people to take action. It could be implemented in combination with pre-releases to reduce risk from flood events downstream.

Response

The Flood Strategy identified improved flood event forecasting, community education and preparedness, and best practice emergency response as key outcomes. The Taskforce Options Assessment Report supported progressing these outcomes. This would contribute to protecting human life, support reduced property damage and support recovery.

This warning, forecasting and education activity is separate to but complementary to the Project.

6.4 Consultation for the EIS

A number of submissions raised concerns with the consultation undertaken for the EIS, specifically:

- No transparency of consultations, the government omits inconvenient truths and makes up lies
- The period (of time) permitted to make submissions is insufficient given the length of the EIS
- That the decision has already been made and public submissions critical of the Project will be disregarded
- Query if stakeholders impacted have been given adequate opportunity to have a say that adds weight to finding alternatives.

Response

The EIS has been drafted to address the Secretary's Environmental Assessment Requirements (SEARs) for the Project, issued on 30 June 2017, and as revised and reissued on 13 March 2018.

Consultation undertaken during the preparation of the EIS, for the 18 months between January 2018 to August 2019, is outlined in the EIS in Chapter 6 *Consultation*. This chapter sets out the various community consultation and engagement activities, Aboriginal community consultation to inform the Aboriginal cultural heritage assessment, feedback from local state and federal government agencies and emergency services, and feedback from community special interest groups, affected landowners and businesses. The summary of feedback received during these consultations is outlined in Tables 6-6, 6-7 and 6-8 in Chapter 6 of the EIS.

The minimum length of an EIS exhibition period is 28 days. The EIS was initially placed on exhibition for 45 days from 29 September to 12 November 2021 with the decision on the length of the exhibition period being made by the former NSW Department of Planning Industry and Environment (now Department of Planning and Environment, DPE). During this time, DPE made the decision to extend the exhibition period to 19 December 2021 providing an additional 37 days.

Consultation for the Project was not limited to the consultation for the EIS. Additional consultation activities were conducted by Infrastructure NSW as part of the Flood Strategy. These consultation activities are identified in Table 6-2 in Chapter 6 of the EIS. This report responds to the submissions made by Government agencies, public authorities and the public, and will form part of the subsequent assessment of the merits of and determination of the Project by DPE and the Minister for Planning.

The decision to proceed with the Project has not been made at this time. This is subject to NSW Government approval under the NSW EP&A Act, Commonwealth Government approval under the EPBC Act and approval of the final business case for the Project by the NSW Government.

Details with regard to consultation with government agencies are provided in Section 4 of this report.

6.5 Biodiversity

6.5.1 Impacts on biodiversity and loss of habitat

Submissions expressed the view that the survey effort and assessment is inadequate to determine the biodiversity and habitats within the Project area and the impacts on these from the Project.

Some submissions noted how the EIS concludes that the impact on plant biodiversity of prolonged or repeated inundation with silt-laden waters is unknown but likely to be dire.

Submissions proposed that the precautionary principle should be applied in respect of this unknown impact on biodiversity.

Response

The methodology to assess the biodiversity impacts of the Project is described in the EIS in Section 6.2 of Chapter 8 *Biodiversity – Upstream*, Section 9.2 of Chapter 9 *Downstream ecological assessment* and Section 10.2 of Chapter 10 *Biodiversity – Construction area*. The assessments for the upstream and construction areas were undertaken in accordance with the NSW Framework for Biodiversity Assessment (FBA).

The methodology for assessing the Project's impacts on biodiversity aligns with the FBA, which underpins the *NSW Biodiversity Offsets Policy for Major Projects*. These set out the standard methodology to be used for assessment of biodiversity impacts to major projects in NSW, and subsequently the calculation of offsets as required.

The biodiversity assessment for the Warragamba Dam raising was undertaken in three stages:

- **Stage 1:** Identify biodiversity values of the three aspects of i) Landscape features and attributes; ii) Native vegetation groups with mapping, site surveys and iii) Threatened species with database searches, site surveys.
- **Stage 2:** Assess impacts of development by applying the development to the biodiversity values. Identify potential avoidance, minimisation and mitigation measures that can be incorporated. Identify any offsetting required for residual impacts.
- **Stage 3:** Develop Biodiversity Offset Strategy to achieve the biodiversity offsets required.

The methodology for the site (field) survey components of the assessment was developed to address:

- The requirements of the FBA developed for major projects (NSW)
- Biodiversity matters including specified species as per the SEARs
- OEH requirements and relevant guidance
- Legislative requirements.

An impact area was identified for the purposes of the biodiversity assessment and agreed with the relevant state and federal government agencies. This area is the likely inundation area with the Project and occurs between 2.8 metres above FSL and 10.25 metres above FSL, and is about 1,400 hectares in size. Details regarding the derivation of this impact area are provided in the EIS in Section 8.2.5 of Chapter 8.

A field survey area was also identified for the purposes of the biodiversity assessment. This field survey area is the area of land within the 1 in 100 chance in a year event with a further nine percent allowance for climate change (i.e a nine percent increase in rainfall under a climate change scenario). This equates to a field survey area of about 3,740 hectares.

Section 8.2.7 in Chapter 8 of the EIS describes the methodology and process for the field surveys. Investigations of threatened species commenced with a habitat assessment, general flora and fauna surveys, and targeted surveys as required by the SEARs. Targeted flora surveys applied the survey technique outlined in the *NSW Guide to Surveying Threatened Plants* (OEH 2016) and targeted fauna surveys were based on the survey recommendations of the *Threatened Species Survey and Assessment: Guidelines for developments and activities (working draft)* (DEC 2004).

The methodology for the field survey component is described in the EIS in Section 8.2.7 of Chapter 8, Sections 9.2.4 and 9.2.5 in Chapter 9, and Section 10.2.4 in Chapter 10. Targeted surveys of identified flora and fauna including threatened species are noted. Survey planning also drew on vegetation and habitat mapping.

The use of biodiversity offsets recognises that some ecological impacts of a development are unavoidable and seeks to compensate for those impacts.

The EIS recognises the limitations of the assessment in terms of known information, the variation in vegetation responses to a temporary inundation event, and the uncertain frequency of inundation events (refer Section 8.8.2 in Chapter 8 of the EIS).

The assessment refers to studies on the effect of plant species from temporary inundation (refer Section 8.8.3 in Chapter 8). However, these studies only consider a single inundation event. The effects of repeated inundation events are not addressed. Further investigations carried out during preparation of the Submissions Report and PIR suggest that the position presented in the EIS with regard to the effects of temporary inundation on vegetation may have been conservative – refer, for example to Section 4.1.6 which describes the findings of an analysis of the composition of vegetation communities currently affected by temporary inundation from Warragamba Dam and equivalent communities in areas that would be affected by the Project.

Chapter 8 of the EIS notes that a precautionary approach has been adopted in assessing the potential upstream biodiversity impacts, with measures to minimise impacts for the construction and/or operational phases applied where possible and appropriate.

6.5.2 Threatened species and ecological communities

The Project would impact on threatened species, including through habitat loss, and threatened ecological communities. Many submissions noted that the threatened species surveys were substantially less than guideline requirements. Where field surveys were not adequately completed, expert reports were not obtained.

Response

Threatened species potentially occurring in the upstream and construction study areas were assessed in accordance with the NSW FBA and site surveys. The site surveys were planned with reference to:

- Threatened biodiversity survey and assessment: Guidelines for developments and activities (working draft) (DEC 2004)
- NSW Guide to surveying threatened plants (OEH 2016)
- Relevant Commonwealth survey guidelines (for specific species)
- Habitat assessments to indicate suitability for fauna species, considering aspects such as food sources, nesting and roosting needs.
- Vegetation mapping and survey.

These reference documents are guidelines and allow for the tailoring or modification of the approach as appropriate. Feedback from relevant government agencies that were consulted with regard to the proposed survey methodologies was used to refine aspects of the methodology.

Certain threatened species were specifically nominated for assessment in the SEARs and these have been addressed in the EIS.

In the absence of survey information or expert reports, species presence was assumed and potential impacts assessed accordingly.

6.5.3 Specific species

Submissions identified concerns with the potential impact of the Project on specific fauna species and groups of fauna species and their habitat, being:

- Regent Honeyeater
- Emu population; submissions referred to this as being the last emu population in the Sydney region
- Dingos
- Quolls
- Koalas; submissions noted the loss of koala habitat, on top of the impact of the bushfires in destroying habitat, and the impact on colonies
- Platypus
- Glossy Black-Cockatoo
- Greater Glider and Squirrel Glider
- Powerful Owl
- Rock Wallaby
- Swift Parrot and Turquoise Parrot
- Wombat
- Brown Treecreeper
- Aquatic species including fish and frogs
- Native bees
- Woodland birds.

A number of submissions also raised the length of time for the surveys for some species, including 3.5 hours to survey for koalas and one day to assess the impacts to aquatic life including the Platypus.

Submissions expressed concern with the potential impact of the Project on a number of plant species and ecological communities including:

- Camden White Gum
- Grassy Box Woodlands
- Hanging swamps
- Kowmung Hakea.

Response

As noted previously, the biodiversity assessments for the upstream and construction were carried out in accordance with the FBA. Some of the species noted above are not listed as threatened under NSW or Commonwealth legislation and were therefore not specifically required to be considered in the assessments.

It is also reiterated that given the probabilistic nature of flooding and the related uncertainty around how potential impacts might actually be manifested, offsetting assessed potential impacts was through the upstream impact area where it was precautionarily assumed that there would be a complete loss of environmental values (including biodiversity) in this area. In real-world terms, however, this is highly unlikely.

A response to issues raised in relation to the Regent Honeyeater is provided in Section 6.5.4.

With regard to the other individual species and groups of flora and fauna, the following is noted:

- **Koala:** this species is listed as Vulnerable (NSW) and as Endangered[38] (Commonwealth). The assessment noted that koalas were not located during the field survey activity but were assumed to be present given suitable habitat within the area. The assessment identified that the Project may affect foraging resources and breeding habitat and possible mortality during flood events. The assessment determined that just over 1,380 hectares of suitable habitat in the impact area for koalas would be removed by the Project; and that offsets are to be provided. Appendix F1 to the EIS notes a high likelihood of occurrence with suitable habitat throughout the study area and numerous recorded sightings. The environmental assessment identified that 39 percent of habitat for this species in the upstream impact area was burnt in the 2019/20 fires. Offset credits are identified as required for the potential upstream impacts (35,890 credits) and for the construction area impacts (519 credits).
- **Emu:** the only emu population listed under NSW biodiversity legislation is the *Emu (Dromaius novaehollandiae) population in the NSW North Coast Bioregion and Port Stephens Local Government Area*. This population does not occur in the Project study area. This species was not identified in the database searches as being of particular concern for the assessment but is identified in the fauna species list in Appendix F1.
- **Dingo:** this species is not listed under NSW or Commonwealth legislation. This species was not identified in the database searches as being of particular concern for the assessment.
- **Quoll:** the Spotted-tailed Quoll is listed as Vulnerable (NSW) and as Endangered (Commonwealth). This species was not identified in the database searches as being of particular concern for the assessment but is identified in the fauna species list in Appendix F1 which notes the high likelihood of occurrence and numerous recorded sightings. The EIS identifies the potential of the Spotted-tailed Quoll to utilise riparian vegetation to move through the landscape. The environment assessment identified that 39 percent of habitat for this species in the upstream impact area was burnt in the 2019/20 bushfires.
- **Glossy Black-Cockatoo:** this species is listed as Vulnerable (NSW) and is not listed under Commonwealth legislation. Appendix F1 notes this species as recorded with evidence of feeding in the upstream study area. The environmental assessment identified that 39 percent of habitat for the Glossy Black-Cockatoo in the upstream impact area was burnt in the 2019/20 bushfires.
- **Greater Glider and Squirrel Glider:** the Greater Glider (as a species) is not listed under NSW legislation but is listed as Endangered[39] under Commonwealth legislation. Three populations

[38] At the time of the assessment for this species in the EIS, it was listed as Vulnerable under the EPBC Act. This was changed to Endangered in February 2022.

[39] The Greater Glider was listed as Vulnerable at the time of the environmental assessment.

are listed as Endangered under NSW legislation; none would be affected by the Project. The Squirrel Glider is listed as Vulnerable (NSW) and is not listed under Commonwealth legislation.

- **Greater Glider:** Appendix F1 notes this species has been recorded in the upstream study area. Appendix F5 identified the Project is likely to have a significant impact on the population of the Greater Glider in the Project study area due to the compounding impacts of habitat loss and fragmentation in the post-fire environment. The environment assessment identified that 39 percent of the upstream impact area of suitable habitat for this species was burnt in the 2019/20 bushfires.
- **Squirrel Glider:** the environmental assessment noted that this species was not recorded during the field survey but was assumed to be present. The Project may impact on habitat with a resulting reduction in foraging and nesting sites and possible mortality. An offset has been identified for the loss of habitat. Appendix F1 notes this species as a high likelihood of occurrence with suitable foraging and roosting habitat in study area and numerous recorded sightings. Offset credits are identified as required for the construction area (433 credits) and for the upstream area (27,244 credits).

- **Powerful Owl:** Appendix F1 notes this species as being recorded in the upstream study area and during Project surveys. No specific credit requirements were identified for this species.
- **Rock Wallaby:** the Brush-tailed Rock-wallaby is listed as Endangered (NSW) and as Vulnerable (Commonwealth). Appendix F1 notes this species as having a high likelihood of occurrence with suitable foraging and roosting habitat in the upstream study area and numerous recorded sightings. The species was not recorded during surveys but was assumed to be present with potential impacts being a reduction in foraging resources and shelter sites, breeding habitat and potential mortality during flood events. The environmental assessment identified that 40 percent of habitat for this species in the upstream impact area was burnt in the 2019/20 bushfires. Offset credits have been identified for the construction area impacts (452 credits) and for the upstream area impacts (10,706 credits).
- **Swift Parrot and Turquoise Parrot:** the Swift Parrot is listed as Endangered (NSW) and as Critically Endangered (Commonwealth). The Turquoise Parrot is listed as Vulnerable (NSW) and is not listed under Commonwealth legislation.
  - **Swift Parrot:** The EIS identifies Grassy Box Woodland (found in the study area) as extremely important habitat for this bird. Appendix F1 notes this species as having a high likelihood of occurrence with a suitable habit occurring throughout the upstream study area with numerous recorded sightings. Appendix F5 concluded that it was unlikely that the Project would have a significant impact on this species but, taking a precautionary approach, the Project may have a significant impact (with reference to Commonwealth guidelines criteria) on this species in the upstream study area.
  - **Turquoise Parrot:** Appendix F1 notes this species as having a high likelihood of occurrence with suitable habitat occurring throughout study area with numerous recorded sightings. No offsets were identified as being required for this species.
- **Wombat:** this species is not listed as threatened under either NSW or Commonwealth legislation, and accordingly was not specifically considered in the assessment.
- **Brown Treecreeper:** this species is listed as Vulnerable (NSW) but is not listed under Commonwealth legislation. Appendix F1 notes this species as being recorded during field surveys. No offsets were identified as being required for this species.
- **Platypus:** This species is not listed as threatened under NSW or Commonwealth legislation and accordingly was not specifically considered in the assessment. Appendix F1 notes the species was observed during the Project surveys foraging within rivers in the upstream study area.

- **Aquatic species** are discussed in Section 6.5.5.
- **Native bees:** these are not listed as threatened species under NSW or Commonwealth legislation and accordingly were not specifically considered in the assessment.
- **Woodland birds:** Appendix F1 identifies dry sclerophyll forests and wet sclerophyll forests as habitat for threatened woodland birds, used for foraging, nesting and roosting. Relevant species have been considered on an individual species basis and required offsets identified as relevant.
- **Camden White Gum:** this species is listed as Vulnerable (NSW and Commonwealth). The species also forms part of the group of Eucalypts which form part of the Outstanding Universal Value for the GBMWHA. The species was recorded in the study area. The assessment identified temporary inundation and the species' tolerance to this as potential impacts. The NSW threatened species profile for the Camden White Gum notes there is a major subpopulation in the Kedumba Valley of the Blue Mountains NP. This occurs primarily along the margins of the Kedumba River and is mostly outside the GBMWHA. The maximum changes in temporary inundation for this area will be in the order of an additional 0.5 metres depth and about 0.7 days duration for the 1 in 100 chance in a year flood event and less than 0.5 metres and 0.5 days for more frequent events. The Project is therefore unlikely to impact this subpopulation. Areas of this species occurring along other tributaries would experience similar maximum incremental increases of up to 0.5 metres and 0.5 days of temporary inundation. Offset credits (616) have been identified as required for potential upstream impacts.
- **Grassy Box woodlands:** *White Box-Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the Sydney Basin Bioregion* is listed as a Critically Endangered Ecological Community (NSW) and as Critically Endangered (Commonwealth). Where relevant, offsets for PCTs that conform to this community have been identified.
- **Hanging swamps:** the community *Coastal Upland Swamps in the Sydney Basin Bioregion* is listed as an Endangered Ecological Community (NSW) and an Endangered Community (Commonwealth). Appendix F1 notes this community as having a low likelihood of occurrence in the upstream study area. No offsets were identified as being required for this community.
- **Kowmung Hakea:** this species is listed as Endangered (NSW and Commonwealth). The species was recorded during the Project surveys at one location and the assessment identified that it may be adversely affected by temporary inundation. Offset credits (3,781) are identified as required for the potential upstream impacts.

6.5.4 Regent Honeyeater

The Regent Honeyeater is listed as critically endangered at both NSW and Commonwealth levels, with as few as an estimated 350 individuals remaining in the wild.

There are only a handful of contemporary breeding sites for the Regent Honeyeater and during the EIS field surveys 21 birds, including active nests, were recorded in the upstream study area.

The EIS concluded that the Project poses a potential significant impact to the contemporary breeding habitat for the Regent Honeyeater that cannot be avoided or minimised.

There has been substantial work and investment undertaken to support this species following the update of the National Recovery Plan. It is unacceptable and inconsistent with the National Recovery Plan for any avoidable loss or degradation of breeding habitat to occur.

A number of submissions noted the contradiction between the financial and time investment in implementing the recovery plan and supported the Regent Honeyeater and its habitat, while this Project would detrimentally affect it.

The use of offsets is opposed as these are rarely an appropriate response to proposed biodiversity loss in this case the breeding habitat for the species. Success of offsets for his species are not evidenced and offsets would be unlikely to provide direct benefits for the Regent Honeyeater.

Response

Assessment of potential impacts to the Regent Honeyeater is provided in the EIS in Appendix F1 *Biodiversity Assessment Report – Upstream* and Appendix F5 *Matters of National Environmental Significance – Biodiversity*, and summarised in Chapters 8 and 12 of the EIS. The position presented in the EIS, that the Project could have a significant impact on this species, is a very conservative position, noting the probabilistic nature of flooding and that there is also an existing risk of temporary inundation associated with the current dam.

Potential impacts on the Regent Honeyeater identified in the EIS are primarily related to negative effects on habitat associated with temporary inundation from the Project. Additional investigation carried out during preparation of the Submissions Report included an analysis of two PCTs (refer Section 6.2 in the PIR), one of these being a eucalypt woodland community (HN527/PCT 840 Forest Red Gum-Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion) which is utilised by this species. The analysis considered the following two scenarios

- The upstream impact area
- The area affected by the existing in 1 in 100 chance in a year flood

For the first scenario, the analysis broadly showed that the survey plot in the area of existing temporary inundation falls within the range of results for the survey plots in the area above existing temporary inundation suggesting that this community has some degree of resilience to temporary inundation.

The existing 1 in 100 chance in a year event scenario showed a broadly similar pattern of results to the upstream impact area scenario. It should be noted that there has not been a 1 in 100 chance in a year flood event in the upstream catchment since the dam was constructed so it is unlikely that temporary inundation is a contributing factor to the observed results. However, considering the results for the upstream impact area, which exhibit a broadly similar pattern, there is a possibility that temporary inundation may not have a significant impact on this community.

It is reiterated that it does not necessarily follow that there would be a loss of Regent Honeyeater habitat from temporary inundation – and noting that there is an existing risk in this regard associated with the current dam.

The revised offset strategy (refer Section 3.3) provides for funding to manage protected lands values potentially impacted by the Project. This, together with the Part 5A EMP required under the *Water NSW Act 2014,* will facilitate proactive management of lands containing Regent Honeyeater habitat.

6.5.5 Aquatic species and riparian habitats

Submissions identified concerns with the impacts on fish and other aquatic species requirements, including migration/movements, spawning and other life cycle behaviours and the associated food, depth and flow of waters, and habitat requirements.

The habitat of wildlife will degrade and be lost, affecting their presence in the area and overall species health and survival.

Response

The existing dam, built in 1960, already presents a barrier to fish passage and influences the habitats of aquatic species through regulation of river flows. This will not change with normal operation of the Project. During flood operations, the dam will be operated to manage the effects of downstream flooding and to reduce risk to life and property. This will take priority over mitigating potential impacts on aquatic species and riparian habitats. This notwithstanding, upstream water levels in Lake Burragorang would remain above FSL for a maximum of 14 days as explained in Section 6.8.5 to minimise the potential effects of temporary inundation on upstream vegetation, and noting there is already a risk of upstream temporary inundation from the existing dam.

An analysis of vegetation condition was carried out using survey plots in the upstream study area to assess resilience to temporary inundation for the vegetation community *River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion* (refer Section 4.1.6.2). The analysis showed that vegetation in the area of existing impact is broadly consistent with the community condition benchmarks suggesting that this riparian community has a significant degree of resilience to temporary inundation associated with the existing dam.

Additional assessment (refer Section 4.1.6.2) has also been carried out on potential impacts of the Project on riffle habitat which is used by Macquarie Perch for breeding. This looked at increases to depth and duration of increased water levels for four flood events up to the 1 in 100 chance in a year event. The analysis noted:

- The maximum duration of temporary inundation is 10 days for the 1 in 100 event (and which is a relatively rare event); this is unlikely to be a significant constraint to breeding in the context of the length of the breeding season
- There is a negligible increase in the depth of temporary inundation for the relatively more frequent 1 in 5 chance in a year flood event
- With reference to the water depths noted in the National Recovery Plan, the maximum incremental depths for the 1 in 5 and 1 in 10 chance in a year events would be unlikely to be a material constraint to breeding.

With regard to other fauna that may utilise riffle habitat, given the relatively short durations of temporary inundation associated with the Project and noting that this already occurs, no material impacts are anticipated.

As noted in Chapter 5 of the EIS, the existing eel passageway on the left bank would be modified to continue to allow the migration of eels from the Warragamba River below the dam to Lake Burragorang.

While a separate issue to the Project as noted in the EIS, the design of the Project includes provision for infrastructure which will provide greater flexibility for releases of environmental flows, in turn facilitating better environmental outcomes in downstream aquatic environments.

6.5.6 Additional surveys following 2019-2020 bushfires

No survey of biodiversity was undertaken following the 2019-2020 bushfires which is stated as having impacted 81 percent of the Greater Blue Mountains World Heritage Area, and to have caused the death of millions of animals, including in the area affected by the Project.

Submissions put forward that the impact of this bushfire event on the biodiversity has not been identified through field surveys and has not been taken into account in the assessment.

Response

In February 2020, DPIE released the *Guideline for applying the Biodiversity Assessment Method at severely burnt sites*. This provides guidance to proponents with regard to their assessment depending on its status at the time of a severe bushfire event. Section 4.1.1 of the guideline states that where the Stage 1 BAM assessment has been completed prior to severe bushfire, the assessor should use this information to prepare the impact assessment. As the assessment for the Project was completed prior to the bushfire event, no further assessment has been required.

DPE has released mapping that categorises affected areas in terms of the severity of burning. Most of the upstream study area is mapped as 'Unburnt' or 'Low' with less than 10 percent mapped as 'High' or 'Extreme' – as addressed in the EIS in Section 8.3.11 and Table 8-20.

WaterNSW is required to prepare and implement an EMP under Part 5A of the *Water NSW Act 2014*. The EMP will be developed in consultation with NPWS and will apply to land affected by temporary inundation from the Project. Development of the EMP will include collection of appropriate baseline data to inform monitoring and evaluation of the effectiveness of management measures.

6.5.7 Invasive or introduced species

Biodiversity will be subject to new or increased pressure from weed and exotic plant establishment and introduced animals. This will include in areas of inundation where vegetation is dying, and bank erosion / slippage occurring that provides opportunities for intrusion by plants.

Response

Weeds and exotic plants are noted as already existing within PCTs downstream and upstream of the Project. Introduced animals are also likely to already exist within the Project study area.

The EIS acknowledges that areas disturbed by temporary inundation may be susceptible to weed invasion post-flood events due to germination triggers. It also notes that exotic species, which tend to have broader habitat requirements, could outcompete with native species after inundation events and local condition changes may also favour exotic plants. Invasive aquatic weeds are known to already occur in the Hawkesbury-Nepean catchment.

Weeds and exotic plants are identified as a key threatening process. Temporary inundation may contribute to vegetation communities or species being more susceptible.

A construction environment management plan (CEMP) will be prepared which will include a weed management sub-plan. This will outline the risks and measures to prevent, manage, and monitor for weeds in the construction site and adjacent areas.

As indicated in Section 3.3, as part of the biodiversity offset strategy, WaterNSW will provide funding for on-park management actions that will deliver a biodiversity benefit on-park equivalent to the biodiversity credits to be retired. These management actions will be the responsibility of NPWS and it is anticipated that they would address management of weeds and introduced or invasive species. The EMP required under Part 5A of the *Water NSW Act 2014*, which relates to managing the effects of temporary inundation on protected lands, would also likely include similar management measures.

6.5.8 Biodiversity offsets

The application and calculation of biodiversity offsets was raised in submissions relating to the Regent Honeyeater, the World Heritage area, and the overall affected area.

The issue of offsets in relation to the Regent Honeyeater is considered in Section 6.5.4.

Submissions raised the following in relation to the inadequacies in the use of offsets for impacts specifically within the protected areas:

- The concept of comparable offsets for world heritage values is fundamentally unsound
- The offsets in the EIS are insufficient to preserve the Blue Mountains World Heritage and National Parks areas
- The EIS relies on biodiversity offsets to mitigate the irreparable environmental damage to the biodiversity of these unique areas and internationally significant area.

Submissions raised the following matters in relation to the use of offsets for the impact area:

- The EIS only assessed 7.5 metres of the increased dam wall height and so did not assess the full impact area. This was done in order to reduce offset costs.
- Offsets cannot replace the impacts to biodiversity that will occur
- Offsets do not provide a net gain in appropriate / comparable habitat and biodiversity
- Calculations suggest a total cost of biodiversity offsets at $2 billion. The EIS does not calculate the offset liability for the Project.

Response

The intent of an offset is a way to compensate for those biodiversity values which are lost as a result of a development, with the compensation to be made at another location to achieve a 'no net loss' of biodiversity. Offsets are required after avoidance and mitigation measures are applied to a project to minimise the potential biodiversity losses. The use of offsets is provided for within NSW major projects, for Matters of National Environmental Significance (MNES) under the EPBC Act and specifically for this project via the SEARs. As such biodiversity offsets are an accepted and adopted form of managing and compensating for the impacts of a development.

The biodiversity offset requirement for the Project has been assessed under the NSW Biodiversity Offsets Scheme (BOS) and applied according to the Biodiversity Assessment Framework (BAF). The BOS is established under the *Biodiversity Conservation Act 2016* (NSW) as supported by the Biodiversity Conservation Regulation 2017. The Regulation includes principles for determining 'serious and irreversible impacts on biodiversity values' (at clause 6.7) with respect to calculating offsets under the BOS.

The *NSW Biodiversity Offsets Policy for Major Projects* sets out the methodology to assess the impacts of a major project on biodiversity values and the calculation of offsets. The Policy identifies six principles for consideration in that process. The SEARs identify the need to apply the 13 principles identified in the '*Principles for the use of biodiversity offsets in NSW*' to the downstream impacts. The SEARs direct that the Environmental Offsets Policy of the Australian Government for matters protected under the EPBC Act, including World Heritage values, and its eight requirements be addressed.

Details of the calculation of the upstream impact area, as used for the assessment of biodiversity impacts and subsequent offset credits required, are provided in Section 6.14.3. The calculation methodology was agreed to by relevant government agencies. Calculation of offsets is also required for impacts at the construction site. Offsets are not required to be calculated under the FBA for downstream impacts.

The Project is assessed for its impacts, after the application of measures to avoid, minimise and mitigate impacts, with offset credit requirements calculated using the policies and calculation methodologies for the native vegetation, of listed vegetation (species or communities) or as habitat for listed fauna species that are known or assumed to be present.

Chapter 13 of the EIS outlines the BOS framework for the Project. This chapter also outlines the approach to implementing the Warragamba Offset Program and how suitable land for the application of credits will be identified. As noted in Section 3.3, the offset strategy now includes Identification and costing of a series of park management actions that would deliver a biodiversity benefit on-park equivalent to the biodiversity credits to be retired. This replaces the proposed approach in the EIS which included purchasing or managing land to meet species and ecosystem biodiversity credits. Further work is being carried out in response to

As suitable , publicly or privately owned, has not yet been identified, and the offset requirements are not confirmed, it is difficult to cost the offset program.

The Warragamba Offset Program will consider and respond to non-biodiversity values as well as the biodiversity values of the World Heritage and national park areas.

The NSW Legislative Council is undertaking an inquiry into the integrity of the NSW biodiversity offset scheme. The outcomes of that inquiry may affect the BOS and Program implementation approach for the Project as outlined in the EIS and this Submissions Report.

6.6 Aboriginal cultural heritage

6.6.1 Survey extent

Only 27 percent of the impact area was assessed for the Aboriginal cultural heritage assessment.

Response

The upstream study area and specific areas of investigation adopted for the Aboriginal cultural heritage assessment were considered with reference to NSW government guideline requirements and in consideration of the landscape context. The upstream study area is outlined in the EIS in Chapter 18 (Section 18.1.2).

A total of 2,655 hectares was surveyed on foot as part of the Aboriginal cultural heritage assessment within the upstream study area[40]). This represents about 50 percent of the area between FSL and the Project PMF. This included 465 hectares within the PUIA[41].

An additional 1,219 hectares was surveyed outside the upstream study area and below FSL following consultation with the RAPs. Survey below FSL was possible due to the low levels of water in the dam and the exposure of Aboriginal objects.

40 The upper limit of the upstream study area is defined by the Project Probable Maximum Flood (PMF) and is at an elevation of 143.9 mAHD. The lower limit extends below the full supply level (FSL) of the dam which is 116.72 mAHD. Aboriginal cultural heritage sites are already impacted by the existing dam. The size of the area between FSL and the Project PMF is 5,280 hectares.

41 Project Upstream Impact Area. This is the area between 2.78 metres above FSL and 10.25 metres above FSL. The basis for this area is explained in the EIS, for example in Section 5 of Appendix J World Heritage Assessment Report. The term 'upstream impact area' is also used in the EIS to refer to this area.

SEAR's requirement 10.1 relates to Section 3.1 of the *Guide for Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW* (OEH, 2011a). Further to this, Section 2.4 of the Guideline outlines the requirement of an ACHA to provide an understanding of the potential cultural heritage values of the study area, and not to document every object within the study area. Given the types of harm that may potentially affect Aboriginal cultural heritage sites within the upstream area, the above coverage presents a strong representative sample of the landscape and is considered adequate.

Field surveys focused on areas of spiritual and historical importance as identified by the RAPs, areas that would be disturbed by construction works, and areas potentially affected by upstream inundation such as rivers, creek lines and large sandstone rock platforms, boulders and ridgelines.

The survey also focused on those areas that may receive the most impact by the Project and were predicted to be the most archaeologically sensitive areas, such as creek lines, flats and slopes from 0-30 percent. Survey coverage was directed to areas outlined by the RAPs as being connected to the creation story, and ridge and creek lines that have archaeological potential. The survey therefore focused on:

- Areas that have potential for Aboriginal objects in the PUIA
- Previously recorded sites that are of high and very high significance
- Areas of cultural significance to the Aboriginal community.

The sampling strategy is detailed in Section 9.1 of Appendix 1 to Appendix K *Aboriginal Cultural Heritage Assessment Report,* and follows the:

- *Aboriginal cultural heritage consultation requirements for proponents* (DECCW 2010a)
- *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW 2010b)
- *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH 2011).

6.6.2 Consultation

The traditional owners have not been adequately consulted as part of the assessment of potential impacts on Aboriginal cultural heritage.

Response

The *Aboriginal cultural heritage consultation requirements for proponents 2010* (DECCW 2010a) presents a four-stage consultation process and outlines the roles and responsibilities of the OEH, Aboriginal parties (including local and State Aboriginal Land Councils), and proponents. The consultation process is described in Appendix K (ACHA, Section 3) and summarised in Table 6-2.

Table 6-2 Aboriginal cultural heritage assessment consultation process

Consultation stage	Consultation requirements	Consultation activities
Stage 1 Notifications and registration	This stage of the consultation process is used to identify, notify and register any Aboriginal people or groups who may have a cultural interest in and/or possess cultural knowledge relevant to determining the cultural significance of Aboriginal objects or places within the study area.	A total of 22 RAPs participated in the consultation process. Project notifications were sent on 9 October 2017 to: Blacktown City Council; Metropolitan Local Aboriginal Land Council Blue Mountains City Council; Native Title Services Corporation Limited (NTS Corp Limited) Camden Council; Oberon Council Central Tablelands Local Land Service; Office of Environment and Heritage Deerubbin Local Aboriginal Land Council; Office of the Registrar, Aboriginal Land Rights Act 1983 Gandangara Local Aboriginal Land Council; Penrith City Council Greater Sydney Local Land Services; Pejar Local Aboriginal Land Council Hawkesbury City Council; South East Local Land Services The Hills Shire Council; Tharawal Local Aboriginal Land Council Illawarra Local Aboriginal Land Council; Wollondilly Shire Council Liverpool City Council; National Native Title Tribunal (NNTT).
Stages 2 & 3 Presentation of Project Information and gathering information about cultural significance	Project information and proposed study methodology were provided to RAPs and information sessions held to discuss the Project and any issues raised. Detailed records and comments raised about the study methodology are provided in Appendix K.	Three information sessions were held for the proposed Project methodology. The first was at Berry St, North Sydney on 20 March 2018 and the second was held at the Warragamba Visitors Centre on 4 April 2018. In addition, an information session was held with the Indigenous Land Use Agreement Committee (ILUA) consisting of the Gundungurra Aboriginal Heritage Association Inc. and Gundungurra Tribal Land Council Aboriginal Corporation on 27 March 2018 at the NSW National Parks and Wildlife Service (NPWS) Katoomba office. At the information sessions, a representative of WaterNSW and Infrastructure NSW provided a presentation on the nature and scale of the Project, an overview of the impact assessment process, critical timelines and milestones for the completion of assessment activities and delivery of reports, a discussion of the roles, functions and responsibilities of participants and protocols for the management of any sensitive cultural heritage information. The information session also provided RAPs with an opportunity to raise any cultural issues or comments/perspectives and assessment requirements (if any) regarding the Project or the proposed methodology. A copy of the proposed methodology was provided to all RAPs for their review and comment on 5 March 2018, with comments requested by 9 April 2018, allowing for a minimum of 28 day review period. Due to the second information session falling outside the minimum 28 day project information consultation period, it was extended by a further seven days to allow for sufficient time for the RAPs to provide comments from the information session and the methodology. All RAPs were invited to participate in the field survey and to complete a *Field Survey Engagement Application Form,* which sought responses on:

Consultation stage	Consultation requirements	Consultation activities
		• cultural, social and historical connections to the study area • traditional knowledge of the study area • previous experience in ACHA survey • completion of required inductions • copies of current insurances. Completed questionnaires and insurances were received from 12 RAPs, who were subsequently invited to participate in the field surveys. Survey details and representations are provided in Appendix K (ACHA, Appendix 1).
Stage 4 Review of Draft Report	In accordance with the Consultation Guidelines, a draft ACHA was provided to all RAPs for review and comment on 4 July 2019. A prior meeting was held to discuss the nature of information that would be released with the draft ACHA.	As part of the review process RAPs were offered individual meetings to discuss the draft report and aspects of the Project. RAPs also attended an information session at the Tharawal Local Aboriginal Land Council on 22 July 2019. The closing date for comments was 5.00 pm, 16 August 2019. After review of the initial draft ACHA, Project updates were sent to the RAPs on 16 April 2020, 21 September 2020, 11 February 2021 and 31 March 2021 to ensure the groups were kept up to date with the Project assessment process. On 16 December 2020, WaterNSW facilitated a site visit to provide RAPs with the opportunity to visit the Warragamba Special Area since the bushfires and for RAPs who may not have had access consents. Due to the catchment being closed following a rainfall event the visit was rescheduled to 6 February 2021. Additional cultural assessment studies were also undertaken, which included further consultations. The revised draft report incorporating the Cultural Values Assessment Report (CVAR) was made available to all RAPs on 29 April 2021. Comments were accepted beyond the 28 day period provided for in the consultation guidelines. A meeting was held at Warragamba Dam Visitors Centre on 1 June 2021 to discuss the revised draft report.

Comments on the proposed methodology and the draft ACHA were received from the following RAPs:

- Corroboree Aboriginal Corporation
- Cubbitch Barta Native Title Claimants
- Darug Custodian Aboriginal Corporation
- Darug Land Observations
- Gundungurra Aboriginal Heritage Association Inc.
- Illawarra Local Aboriginal Land Council
- Koolkuna Elders
- Muragadi Heritage Indigenous Corporation
- Murra Bidgee Mullangari Indigenous Corporation
- Kazan Brown and Taylor Clarke.

Comments received and relevant Aboriginal heritage consultant responses are documented in Appendix K (Aboriginal Cultural Heritage Assessment Report, Appendix 1). A total of 186 comments were received, which broadly covered issues related to the adequacy of the Aboriginal cultural heritage assessment in meeting the SEARs and regulatory requirements, reinforcement of the importance of the study area to Aboriginal people, potential impacts that the Project would have on the area's cultural significance, and adequacy of proposed management measures.

WaterNSW has undertaken further consultation with the RAPs during the EIS exhibition and will continue consultation and engagement with the RAPs for the duration of the Project (environmental management measure ACH1 in Table 29-14).

6.6.3 Consent for the Project

A number of submissions noted that Aboriginal stakeholders have not given consent for the Project.

Response

The consent of Aboriginal stakeholders for the Project is not a statutory requirement under NSW or Commonwealth legislation. This notwithstanding, WaterNSW will continue to engage with RAPs and other Aboriginal stakeholders in relation to matters affecting Aboriginal cultural heritage values.

6.6.4 Potential impacts to cultural sites and places and the number of sites

The Project will result in the loss of, or detrimentally affect, indigenous cultural sites and places and of indigenous cultural values.

Some 1,541 identified cultural heritage sites would be inundated by the Project.

Response

There are no known sites of indigenous heritage in the construction footprint area and the area has been previously disturbed from the construction of the original dam infrastructure and subsequent works.

The reduction in the depth, duration and extent of flooding downstream with the Project would contribute to reducing impacts on Aboriginal cultural heritage sites and places currently affected by flooding.

Assessment of impacts of the Project operation on Aboriginal heritage sites in the upstream area is provided in the EIS in Chapter 18 *Aboriginal cultural heritage,* and which identified:

- 120 sites (43 known, 77 estimated) in the PUIA may experience a total loss of value
- 118 sites in the EUIA[42], all known sites, may experience partial loss of value, with some values remaining. Some of these sites are already at risk of temporary inundation when the existing FSL is exceeded during flood events. As such some loss of value may have already occurred
- Different types of cultural sites would be affected by the temporary inundation differently
- 11 cultural places in the PUIA may be partially impacted
- 28 cultural places in the EIUA may be impacted, of which 19 may be fully impacted and nine may be partially impacted.

With regard to submissions that state 1,541 indigenous heritage sites would be inundated by the Project, no information was provided as to how this number was derived.

The survey effort for the Aboriginal cultural heritage assessment identified a total of 334 sites. Of these, 31 were previously recorded sites and the remainder (303) were newly identified sites. Of the total sites of the survey, 43 sites occur in the PUIA.

[42] Existing Upstream Impact Area. This is the area below 2.78 metres above FSL and extends below the FSL.

The archaeological assessment included development of a predictive model to extrapolate the findings of the survey across the wider study area. This predicted a total of 1,122 sites to occur, of which:

- 174 sites are archaeological sites within the Project upstream impact area (PUIA)
- 578 sites are archaeological sites within the Existing upstream impact area (EUIA)
- 370 sites outside the EUIA and above the PUIA.

Further work has been carried out during preparation of the Submissions Report to clarify potential impacts on Aboriginal cultural heritage, and the supplementary assessment is provided as Appendix F to the PIR. Responses to issues relating to Aboriginal cultural heritage are also provided in Sections 4 and 5 of this report.

6.7 Protected lands

6.7.1 World Heritage listing

Many submissions stated that the Project would not be consistent with Australia's obligations under the World Heritage Convention (WHC), and that any damage within its boundaries is completely unacceptable and inconsistent with World Heritage Management principles. It was also questioned whether the World Heritage listing may be in jeopardy including as a result of the impacts of the Project to the Outstanding Universal Value (OUV) of that listing.

Response

The GBMWHA was inscribed onto the World Heritage list for its outstanding universal value and against two criteria being:

- Criterion (ix) to be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal, and marine ecosystems and communities of plants and animals;
  - In the GBMWHA this criterion is met by the Eucalypt dominate vegetation and habitats and the processes in a eucalypt dominant ecosystem including interactions between eucalypts, understory, fauna, environment, and fire, and the Wollemi pine and Blue mountains pine with linkages to Gondwanan taxa
- Criterion (x) to contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.
  - The GBMWHA includes diversity of habitats and plant communities supporting globally significant species and ecosystems, and flora species diversity.

Appendix J to the EIS details the assessment of the Project to the World Heritage areas. Section 7 of Appendix J outlines the decision made by the World Heritage Committee at its 43rd session in respect of the Project and provides information to address that decision. Section 8 provides a response of how the Project addresses the eight World Heritage impact assessment principles, while a response on the Project against the Strategic Plan including the World Heritage management obligations is provided in section 9.

The EIS states that some impacts of the Project on the GBMWHA would not be able to be mitigated or minimised and therefore offsets are required. The EIS concluded that the impacts to the GBMWHA would not be significant and would not result in a material loss or degradation of the

OUV, and that the Project is not considered to be inconsistent with the management obligation and principles for World Heritage Properties (refer Section 13.8 in Chapter 13 of the EIS).

6.7.2 National parks

The Project would impact an estimated 5,700 hectares of national parks, 1,300 hectares of which is within the Greater Blue Mountains World Heritage Area.

Response

Table 6-3 and Table 6-4 present the areas of protected lands affected by the existing dam and the additional areas that would be affected by the Project for the PMF event and the 1 in 100 chance in a year event respectively. These areas were derived through a GIS analysis. The tables also identify the percentages of affected land for the total area of the national park and conservation area. It should be noted that the potentially affected part of the GBMWHA sits within the three national parks identified in the tables.

Table 6-3. Potential increase in flood extent of protected and sensitive lands due to the Project PMF

Protected area	Area of temporary inundation (ha & percent of total area)				Change in area (ha & % of total area)	
	Existing		With Project			
Blue Mountains National Park	1,519	0.56%	2,729	1.01%	1,210	0.45%
Nattai National Park	867	1.70%	1,319	2.59%	453	0.89%
Kanangra-Boyd National Park	7	0.01%	7	0.01%	0	0%
Subtotal: national parks	*2,393*		*4,055*		*1,663*	
Burragorang State Conservation Area	404	2.28%	664	3.75%	261	1.47%
Nattai State Conservation Area	107	3.28%	190	5.81%	83	2.53%
Yerranderie State Conservation Area	665	5.35%	1,123	9.04%	458	3.69%
Subtotal: conservation areas	*1,176*		*1,977*		*802*	
Total	**3,569**		**6,032**		**2,465**	
Greater Blue Mountains World Heritage Area	1,085	0.10%	1,675	0.16%	590	0.06%

Table 6-4. Potential increase in flood extent of protected and sensitive lands due to the Project 1 in 100 chance in a year flood

Protected area	Area of temporary inundation (ha & percent of total area)				Change in area (ha & % of total area)	
	Existing		With Project			
Blue Mountains National Park	663	0.25%	1,467	0.54%	804	0.30%
Nattai National Park	415	0.81%	781	1.53%	366	0.72%
Kanangra-Boyd National Park	4	0.01%	4	0.01%	0	0
Subtotal: national parks	*1,082*		*2,252*		*1,170*	
Burragorang State Conservation Area	189	1.07%	412	2.32%	223	1.26%
Nattai State Conservation Area	46	1.40%	108	3.32%	63	1.92%
Yerranderie State Conservation Area	231	1.86%	624	5.02%	393	3.16%
Subtotal: conservation areas	*466*		*1,144*		*679*	
Total	**1,548**		**3,396**		**1,859**	
Greater Blue Mountains World Heritage Area	559	0.05%	974	0.09%	415	0.04%

From these tables it can be seen:

- The additional area of national parks estate potentially affected by the Project is 1,663 hectares for the PMF event and 1,170 hectares for the 1 in 100 chance in a year event
- The additional area of State conservation areas potentially affected by the Project is 802 hectares for the PMF event and 679 hectares for the 1 in 100 chance in a year event
- The additional area of the GBMWHA potentially affected by the Project is 590 hectares for the PMF event and 415 hectares for the 1 in 100 chance in a year event.

6.7.3 Wild rivers

The Project would impact an estimated 65 kilometres of wilderness rivers including the Kowmung River.

Response

As identified in Section 20.3.4 in Chapter 20 of the EIS, there are three declared wild rivers within or in proximity to the Project study area, these being the Kowmung, Colo and Grose Rivers.

The Colo and Grose Rivers and their respective catchments are downstream of Warragamba Dam. They lie outside the downstream study area and would not be affected by the Project.

As identified in Section 20.5.5 of the EIS, about 1,285 metres of the Kowmung River that has been declared a wild river lies with the upstream Project study area. This section is at the lower end of the declared wild river catchment. An analysis of depth-duration curves for the closest cross section downstream of the declared wild river catchment showed no material difference between the existing situation and with the Project for all flood events up to the 1 in 100 chance in a year event and a very small difference (less than 0.3 metres) up to the 1 in 1,000 chance in a year event. In real world terms, the Project would not impact on the declared wild river section of the Kowmung River.

6.7.4 Wilderness areas

The Blue Mountains contain areas of pristine wilderness of great importance for its environmental and cultural values that must be protected for the future. The impact on wilderness areas is not assessed in the EIS.

Response

Table 6-5 and Table 6-6 show the areas of designated wilderness affected by temporary inundation from the existing dam for five flood events up to the PMF, and the incremental areas that would be potentially affected due to the Project for the same flood events.

Table 6-5 Changes to flood extents for Kanangra-Boyd Wilderness

Flood event (1 in x chance in a year)	Existing (ha)	With Project (ha)	Change (ha)
Blue Mountains National Park			
5	167.28	288.35	121.07
10	196.89	422.03	225.14
20	223.20	602.44	379.24
100	362.10	878.91	516.81
PMF	884.75	1,543.68	658.93
Yerranderie State Conservation Area			
5	26.83	60.69	33.85
10	33.62	98.86	65.24
20	40.25	145.09	104.84
100	77.20	206.25	129.05
PMF	194.58	326.56	131.98

Table 6-6 Changes to flood extents for Nattai Wilderness

Flood event (1 in x chance in a year)	Existing (ha)	With Project (ha)	Change (ha)
Nattai National Park			
5	2.94	5.31	2.36
10	3.99	12.86	8.87
20	5.57	32.85	27.29
100	10.50	65.89	55.39
PMF	60.36	152.04	91.68

The total areas of the Kanangra-Boyd Wilderness and the Nattai Wilderness are 123,322 hectares and 41,327 hectares respectively. For the PMF event, the existing dam potentially affects 0.88 percent of the total area of the Kanangra-Boyd Wilderness and 0.15 percent of the Nattai Wilderness. The Project would potentially affect an additional 0.64 percent of the Kanangra-Boyd Wilderness and 0.22 percent of the Nattai Wilderness.

Section 6 of the *Wilderness Act 1987* provides that

(1) An area of land shall not be identified as wilderness by the Director-General unless the Director-General is of the opinion that:

(a) the area is, together with its plant and animal communities, in a state that has not been substantially modified by humans and their works or is capable of being restored to such a state,

(b) the area is of a sufficient size to make its maintenance in such a state feasible, and

(c) the area is capable of providing opportunities for solitude and appropriate self-reliant recreation.

Section 15.6.3 in Chapter 15 of the EIS provides a discussion and assessment of changes to flood levels and durations of temporary inundation in the upstream study area. The assessment is based on an analysis of depth-duration curves[43] for various river cross sections in the upstream study area. Changes in temporary inundation depth and duration for selected cross sections in general proximity to these two wilderness areas are presented in Table 6-7. The locations of these cross sections are shown in Figure 15-29 of the EIS.

Cross sections COXS_28800, WOLLONDILLY_15000 and NATTAI_1880 are located within Lake Burragorang while cross sections COX_US_9985 and NATTAI_US_11066 are located further upstream from the lake. As can be seen the incremental depth and duration of temporary inundation with the Project falls away markedly moving upstream away from the lake.

The Project will not change the size of the two designated wilderness areas.

Existing access to designated wilderness areas will be maintained and the Project will not restrict opportunities for solitude and appropriate self-reliant recreation.

[43] A depth-duration curve is a graph of depth vs time, and shows the cumulative amount of time that water levels are at or above a specific elevation (depth). Examples of these graphs are provided in Section 15.6.3 of the EIS.

Table 6-7 Changes in temporary inundation depth and duration

Location	Flood event (1 in x chance in a year)									
	1 in 5		1 in 10		1 in 20		1 in 100		PMF	
	E[1]	P[2]	E	P	E	P	E	P	E	P
COX_US_9985 (Kanangra-Boyd Wilderness)										
Depth (m)	2.4	<0.5	4.6	<0.5	5.3	<0.5	6.7	<0.5	15.2	3.5
Duration (days)	5.8	<0.5	5.4	<0.5	6.2	<0.5	5.3	<0.5	7.0	<0.5
COX_28800 (Kanangra-Boyd Wilderness)										
Depth (m)	0.7	2.5	1.3	5.1	2.2	9.1	5.1	10.8	14.0	12.2
Duration (days)	6.8	2.4	6.4	3.8	7.2	8.0	6.4	8.3	7.0	7.0
WOLLONDILLY_15000 (Kanangra-Boyd Wilderness)										
Depth (m)	0.7	2.5	1.3	5.0	2.3	9.0	5.2	10.7	14.2	12.1
Duration (days)	6.8	2.4	6.4	3.8	7.2	8.0	6.8	8.3	7.0	6.0
NATTAI_1880 (Nattai Wilderness)										
Depth (m)	2.8	0.5	3.1	3.2	4.0	7.4	5.9	10.0	14.2	12.0
Duration (days)	6.8	2.4	6.4	3.8	6.7	8.0	6.4	8.3	7.0	6.0
NATTAI_US_11066 (Nattai Wilderness)										
Depth (m)	3.8	<0.5	4.1	<0.5	4.8	<0.5	5.9	<0.5	7.7	7.8
Duration (days)	5.9	<0.5	5.4	<0.5	6.2	<0.5	5.2	<0.5	7.0	<0.5

Notes: 1 – E = existing; 2 – P = additional depth/duration with Project

6.7.5 Reputation and precedent

The areas of World Heritage, national parks, wild rivers, and wilderness are protected under legislation.

The Project goes against the legislated protections that are in place and would have a detrimental impact on the values supporting those places. There are seven layers of protection that these areas are currently afforded.

The Australian and international community has expectations on what these protections are to achieve, the purpose of having such protections, and that they will be applied.

Allowing the Project to proceed will impact Australians and the Australian government's reputation for protecting these places and would be a breach of the obligations of the World Heritage listing and inconsistent with World Heritage property management principles.

Allowing the Project to proceed sets a precedent for other projects that would affect similarly protected places.

The protection and maintenance of the World Heritage area has been inadequately funded for many years.

Response

The areas currently protected by World Heritage, national parks, wild rivers and wilderness will continue to be protected under legislation. The protections afforded to those areas has required additional consideration and assessment of the potential impacts of the Project in the EIS.

The potential impacts of the Project to the World Heritage Area have been considered, and will undergo further consideration, by the United Nations Educational, Scientific and Cultural Organisation (UNESCO). Further consideration of potential impacts to the World heritage Area is provided in Appendix C to this report.

Any future projects within protected areas would need to go through the respective environmental impact assessment processes and to evaluate the merits of that specific project.

Following the Water NSW Amendment (Warragamba Dam) Bill 2018, the amendment to the *Water NSW Act 2014* incorporated Part 5A to the Act, Special Provisions relating to Warragamba Dam. This Part allows for the temporary inundation of land resulting from the Project, including of the national park lands when an approved EMP is in place, without requiring a licence or similar (stipulated) approval. The Bill for this amendment was considered by the Standing Committee on State Development as well as being considered by Parliament prior to it being made.

Funding for protection and management of the GBMWHA is a separate issue to the Project and not the responsibility of WaterNSW. However, the revised offset strategy (refer Section 3.3) provides for funding of the protected lands values offset.

6.8 Hydrology and flooding

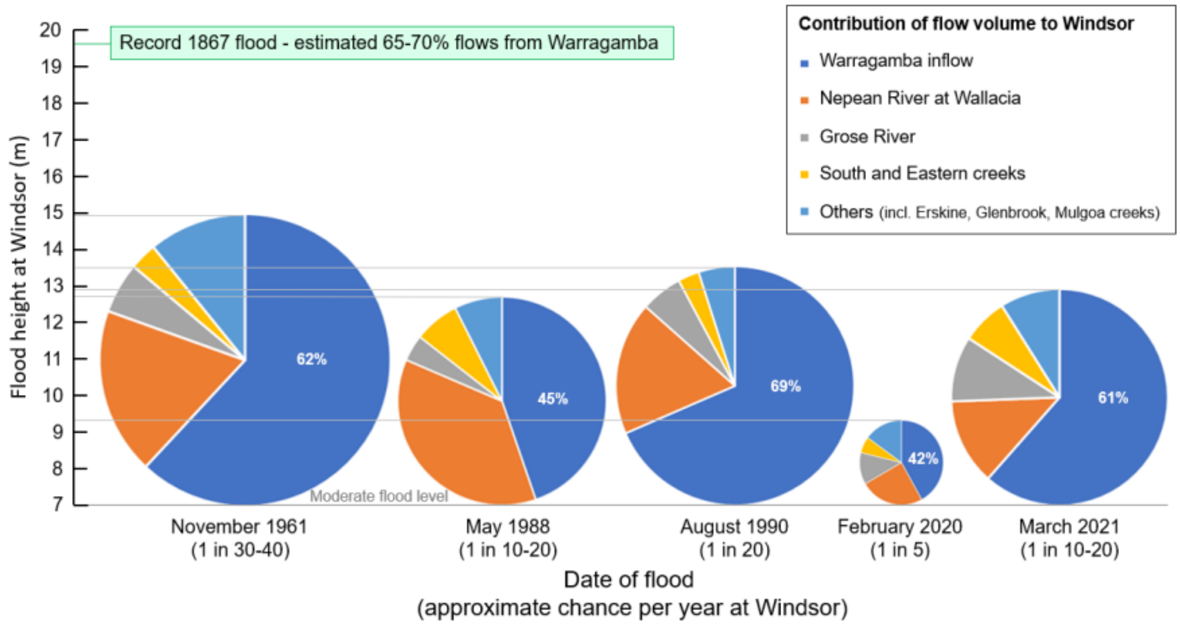
6.8.1 Contribution of Warragamba catchment to downstream flooding

On average, 45 percent of floodwaters are derived from areas outside of the upstream Warragamba Dam catchment. This means that no matter how high the dam wall is constructed, it will not be able to prevent flooding in the Hawkesbury-Nepean Valley downstream.

Response

The Warragamba Dam catchment historically contributes up to 70 percent of flows during flooding in the Hawkesbury-Nepean Valley as shown for a number of historic floods in Figure 6-3. Extensive Monte Carlo modelling of around 20,000 possible floods showed this contribution could range from about 42 percent up to as high as 75 percent.

Figure 6-3 Historic contributions of flood volume to Windsor by subcatchment



Source: *Hawkesbury-Nepean River March 2021 Flood Review* (Infrastructure NSW 2021)

6.8.2 Nepean catchment

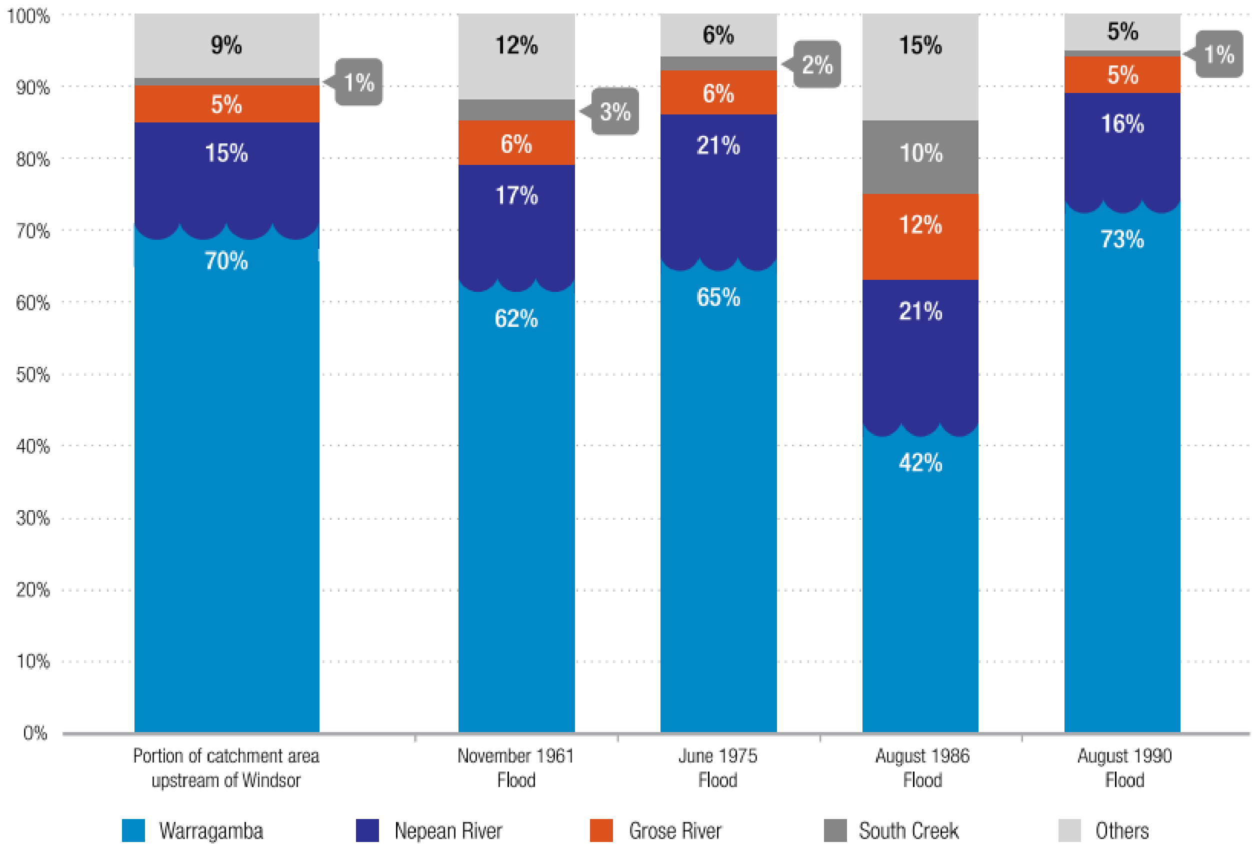
The Nepean catchment could make a significant contribution to flooding in the Hawkesbury-Nepean Valley. Why hasn't the EIS considered this independently without a contribution from the Warragamba catchment?

Response

From Figure 6-3 it can be seen that the Nepean catchment is typically the second largest contributor to downstream flooding with the largest contribution being for the May 1998 event where it was about the same as the Warragamba catchment contribution. However, for the other historic floods the Nepean catchment contribution was substantially less than the Warragamba catchment contribution.

Further information showing the relative contributions of the Nepean and Warragamba catchments is provided in the following figure from the Flood Strategy (and which was also provided as Figure 15-15 in Chapter 15 of the EIS). Again, this shows the relatively smaller contribution from the Nepean catchment.

Figure 6-4 Relative contributions of different river catchments in previous floods in the Hawkesbury-Nepean Valley



Source: *Resilient Valley, Resilient Communities Hawkesbury-Nepean Valley Flood Risk Management Strategy* (Infrastructure NSW 2017)

6.8.3 Flood modelling

The Rubicon model has been superseded by more accurate two-dimensional models. The use of this model needs to be justified.

There are limitations of Monte Carlo with modelling and it has a long history of providing non-conservative results. The EIS needs to clarify use of this approach and any 'adjustments' that have been applied to provide a conservative estimate of downstream flood risk.

Response

The Flood Study reviewed the two-dimensional model TUFLOW HPC (Heavily Parallelised Compute) for the Flood Strategy modelling, however, it was concluded that modelling of the entire valley was not possible due to topographical constraints such as the gorge upstream of Penrith. While the Hawkesbury-Nepean Valley is challenging for two-dimensional models, the quasi-dimensional RUBICON model developed in earlier studies can run fast enough (5000 times faster than the two-dimensional model) and can also be used in the Monte Carlo environment.

The RUBICON model was therefore necessary to understand the full variability of flood behaviour across a large regional floodplain and nearly 20,000 modelled flood scenarios. It has been calculated that running 20,000 events in RUBICON would take a few hours on a typical high end modelling computer running eight cores and use about 40 cents worth of electricity. In contrast, TUFLOW would take 320 years on a single high-end computer and use about $700,000 worth of electricity.

The description and details of calibration of the multiple modes used for the Flood Strategy are discussed in EIS Chapter 15 (section 15.2.2) and Appendix H1(section 2.3).

Flood characteristics of modelled events from the Monte Carlo framework was compared to observed events to confirm that the model was accurately replicating these events. The Flood Study provides discussion on the limitations of the modelling, however it was noted that generally a good representation was observed by the Monte Carlo modelling (refer Section 15.2.2.2 in Chapter 15 of the EIS).

6.8.4 Downstream river system and environmental flows

The floodplains are an important part of the river system and flood events are important to replenish the floodplain landscape with nutrients and soil and to flush the waterways.

The dam will further reduce water flow in the downstream river systems affecting ecosystems and would reduce environmental flows, however, more environmental flows into the river system are needed.

The extended time period of flooding of the area – from the flood event and the subsequently released waters held in the dam – will compound impacts to river ecosystems including the health of plant life.

Submissions also noted that holding back the floodwaters of the raised dam would prolong downstream higher (inundation) water levels, during the period after the peak that the large volume of floodwaters would be released into the river system.

Response

The Project would provide for the temporary storage of floodwater upstream of Warragamba Dam during a flood event. This would then be released in a controlled manner to reduce downstream flooding with water levels being above FSL (in the FMZ) for a maximum of 14 days. There would be no difference between the existing dam and the Project with regard to the volume of floodwater released, only with regard to timing and the pattern of releases. Further details on how the dam would be operated during flood events are provided in Section 3.2 of the PIR.

As explained in Section 5.1 in Chapter 5 of the EIS

> *The Project would take the opportunity, during the construction period for the dam raising, to install the physical infrastructure to allow for management of environmental flows as outlined in the NSW Government's 2017 Metropolitan Water Plan. However, the actual environmental flow releases do not form part of the Project and are subject to administration under the Water Management Act 2000.*

The new infrastructure would allow greater flexibility in managing environmental flow releases and would therefore benefit downstream aquatic and riparian ecosystems.

Potential impacts on downstream terrestrial and aquatic biodiversity are addressed in Chapter 9 and Chapter 11 of the EIS respectively. The latter chapter also considers how potential changes to water quality (assessed in Chapter 27 of the EIS) could impact on aquatic ecology. The EIS identified that releases of floodwaters from the FMZ may have a potential impact on downstream riparian and aquatic ecosystems, principally through water levels being elevated for an extended period of time while the FMZ is being emptied. Potential impacts would be addressed through management measure BDS1 as follows

> *Development of the operational protocol for the FMZ would seek to minimise potential impacts on downstream vegetation from temporary inundation subject to meeting operational priorities for protection of life and property.*

It is noted that downstream riparian and aquatic ecosystems may also be affected by contributions from other catchments downstream of Warragamba Dam that may be occurring concurrently with the emptying of the FMZ.

Operation of the FMZ would result in an extended period of elevated water levels downstream. For the most part this would be confined to the main river channel but some low-lying areas such as the Penrith Lakes and the Richmond Lowlands would experience temporary inundation for up to 10 days.

6.8.5 Upstream inundation

The inundation of upstream areas, including of protected areas that have little existing human disturbance will have a range of effects on the environment. It will cause changes to river and lake hydrology, to ecosystems, and to the landscape. It will cause changes to river and lake hydrology, to ecosystems, and to the landscape. The inundation will affect the health and survival of vegetation, resulting in a new denuded area of soil and rock above the waterline affecting land stability and resulting in a scar or dead zone.

The inundation of the upstream area will cause permanent change to the landscape and irreparable harm to the environment and cultural sites.

While the EIS states the intent that stored floodwaters would be held temporarily for up to two weeks, there is not clear legislated or mandated proposal to formalise that time limit. The potential, including impacts, of storing water longer than two weeks is not considered.

Response

Potential impacts of temporary inundation on the upstream environment are addressed in the respective sections of the EIS, this Submissions Report, and the PIR. Additional analysis carried out during preparation of the latter two reports suggest the findings of the assessment presented in the EIS may have been conservative for some environmental aspects. For example, an analysis of two vegetation communities to temporary inundation (refer Section 6.7.3 in the PIR) showed no marked difference between survey results for the Project and regional-derived benchmarks. It would not necessarily follow therefore that temporary inundation would result in the permanent loss of vegetation in the upstream area.

The assessment presented in the EIS is based on a maximum of 14 days of temporary inundation above FSL. This period was adopted as a precautionary position in view of potential impacts on upstream environmental values. It is important to understand that the water level in the FMZ would not be constant over this time and would be continually dropping, the rate being dependent on factors related to managing downstream flooding. Accordingly, the depth and duration of temporary inundation would not be uniform across the FMZ.

With regard to the issue of WaterNSW being held to the 14 day period, this forms part of the basis for operation of the Project as described in the EIS. Should the Project be approved, the EIS would form part of the approval.

6.8.6 Groundwater systems

Submissions raised potential impacts of the Project on groundwater in relation to:

- The soil's reduced ability to absorb water and recharge the aquifer, which has implications for the future availability of ground (bore) water, particularly during drought
- The Project will compound the existing impact of urban development (hard surfaces, stormwater drainage)
- Changes in groundwater and the water table below the dam structure which would affect the geological strength needed to support the increased forces of the wall height and water held back.

The view was also expressed that Appendix N2 *Geomorphology Technical Assessment* gave only cursory consideration of this issue with no discussion provided in the EIS.

Response

Consideration of potential impacts on groundwater is provided in Chapter of the EIS. Further detailed consideration of potential impacts on groundwater is presented in the expert technical review provided as Appendix E to this report. This provides evidence to support the impact assessment in the EIS that there is a low risk of potential impacts to groundwater systems and users (both human and environmental) because of the Project.

The third issue above is primarily a dam safety issue; responses to these types of issues are provided in Section 6.12.

6.9 Water quality

A number of submissions raised concerns regarding water quality relating to:

- Construction-related pollution entering waterways and management of raw water quality for drinking water
- Contamination of downstream rivers (and land)
- River bank erosion and slumping causing siltation of Lake Burragorang and waterways
- River turbidity
- Risk of eutrophication within Lake Burragorang and downstream from inundated and dying vegetation, and the potential concentration of decaying vegetation between inundation events
- Risks associated with increased concentrations of pathogens in dam water
- Existing and new river pollution and rubbish in the downstream river system including due to runoff from urban areas
- Surrogate events selected to provide an indication of expected water quality impacts from operation of the FMZ are not effective surrogates
- The potential effect of differing lake levels at the time of a significant inflow event and how risks may change depending on seasonal effects, particularly with regard to triggering algal blooms

The implications of reduced water quality were also raised in terms of the management and treatment required to meet drinking water standards.

Response

Chapter 27 of the EIS assesses potential impacts on water quality during construction activities and operation of the Project. The four key risks to water quality in Lake Burragorang related to flood operations are identified as:

- Increased turbidity from erosion
- Increased natural organic matter, which could result in treatability issues and disinfection by-products
- Increased nutrient concentrations resulting in algal blooms (aesthetics, taste and odour, toxins)
- Increased pathogen concentrations.

As a general comment, it should be noted that many issues raised in relation to water quality during flood operations also relate to the existing dam when water levels in Lake Burragorang are temporarily above FSL, with risks being effectively managed through a range of strategies and procedures.

Reference should also be made to Sections 4.7 and 4.8 of this report which address similar water quality issues raised by Sydney Water and NSW Health respectively.

Risks to water quality during construction will be managed through the CEMP which will include a range of measures as identified in environmental management measure WQ2. This will be supported by a construction water quality monitoring program (environmental management measure WQ3).

The risk of increased nutrients and eutrophication is considered in Section 27.5.3.4 in Chapter 27 of the EIS. The likelihood of this being associated with decaying vegetation that has died due to temporary inundation is considered low. An analysis of vegetation condition has been carried out using survey plots in the upstream study area to assess resilience to temporary inundation for the vegetation community *River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion* (refer Section 4.1.6.2). The analysis showed that vegetation in the area of existing impact is broadly consistent with the community condition benchmarks suggesting that this riparian community has a significant degree of resilience to temporary inundation associated with the existing dam.

The risk of increased pathogens is considered in Section 27.5.3.5 in Chapter 27 of the EIS which identifies that there may be a potential risk of mobilisation of pathogens in animal faeces when areas where these occur are affected by temporary inundation. This risk can be managed through measures such as:

- Use of the multi-level offtake to withdraw water from locations in the water column where pathogen concentrations are low
- Sourcing raw water supply for drinking water purposes from other dams when the FMZ is in operation
- Adjusting processes at water filtration plants to increase the removal of pathogens in raw water supply for drinking water purposes.

As noted this is an existing risk that is managed by WaterNSW.

Pollution of the river systems as a result of urban runoff from areas downstream of Warragamba Dam is outside the scope of the Project.

Section 27.2.4 in Chapter 27 of the EIS describes the methodology to assess potential downstream impacts on water quality associated with operation of the FMZ. As noted, this involved:

- Identification of surrogate inflow events similar to expected flood inflows to the FMZ
- Collation and analysis of water quality data from specific events to estimate water quality in the FMZ
- Comparison of predicted water quality in the FMZ with downstream water quality from Hawkesbury-Nepean modelling to identify any impacts in relation to Water Quality Objectives
- Identification of mitigation measures.

With regard to selection of suitable surrogate events, the EIS notes that a conservative position was taken which assumed the water level in Lake Burragorang to be 12-16 metres below FSL with this area containing deposited sediment that could be remobilised during an inflow event. One submission expressed the view that this could not regarded as a suitable surrogate as much of the catchment below FSL would be exposed bare rock.

Sediment is deposited where there are marked changes in velocity and these typically occur where tributary inflows meet the lake. Noting that the lake level can vary over time, these deposits would tend to occur around the margins of the lake, and can occur at and below FSL. In an inflow event, the potential for remobilisation of these sediment deposits will be greatest where tributaries and drainage lines intersect these deposits. The risk of remobilisation will progressively decrease as the water level in the lake rises.

A second observation made with regard to suitable surrogate events related to use of a 2001 study where it was noted that the pollution loads were derived from long-term intermittent rainfall and runoff, and therefore not reflective of what might occur during a significant inflow event. However, it is noted that the survey period for this study included one significant flood event where water rose above FSL. This flood event, which occurred during August 1998, commenced when the lake level was around 12 metres below FSL.

The potential effect of differing lake levels at the time of a significant inflow event and the influence of seasonality on risk to water quality, such as triggering algal blooms, is an existing management issue and unlikely to substantially change with the Project. Lake Burragorang is subject to a range of existing environmental processes that have an impact on water quality. These existing processes include but are not limited to:

- Lake level rising and falling (wet and dry periods)
- Annual stratification and destratification cycle
- Turnover
- Underflows or Interflows
- Inflow events.

These environmental processes, which include the release of metals and nutrients from bottom sediments, will continue to occur under both current operations and any future flood mitigation operations. As such the risks associated with periods of poor water quality in Lake Burragorang is an ongoing issue. The extent of impact is both seasonal and event-dependent and does not fundamentally change with the introduction of a flood mitigation function.

Algal blooms have been experienced within Lake Burragorang, although infrequent. The last algal bloom to occur was in Spring 2007 following a prolonged dry period. In this event the lake was at an historical low level with approximately 1400 hectares of exposed sediments. The water level went from about 24.5 metres below FSL to 15 metres below FSL. Selective withdrawal, as was implemented in 2007, has been shown to be the most effective process to avoid the surface layer containing an algal bloom.

Section 27.5.2.3 in Chapter 27 provides a detailed description of existing management systems, practices and procedures that WaterNSW uses to manage water quality in the dam and specifically raw water supply for drinking water purposes. WaterNSW recognises the need for, and commits to management measures that will be required due to operational impacts by the Project (refer Appendix B of this report). These include the following:

- Continuation, monitoring and, where necessary, modification of water quality management measures to address operational impacts of the Project (WQ1)
- Updating the Sydney Catchment Aquatic Real-time Management System (SCARMS) and the Sydney Catchment Aquatic Real-time Information Support System (SCARISS) to include the raised dam, new outlets, and operation of the FMZ (WQ5)
- Review and updating as required of the Catchment to Customer Risk Assessment to reflect any new or changed risks to the quality of raw water supply for drinking water purposes from the operation of the FMZ (WQ6).

6.10 Land use planning

The Project focuses on protecting current (and future) housing and development broadly on the floodplain, which has a financial focus. The Project will result in further environmental damage to protect built assets in a known flood-prone area. The question of whether the floodplain is the appropriate place for housing has not been addressed.

The Project may give residents a false sense of security about the flood risk to their property.

The existing housing and population in the floodplain will be compounded by any future increase with associated impacts of flood risk and flood events. The justification given for the Project would be in part void by not allowing further development, and so population, in the flood prone areas.

Response

The Project responds to the existing flood risk posed to human life and development on the floodplain. It is not the role of the Project or this EIS to assess the merits of previous planning decisions, those made applying current planning controls, or the validity of those controls. The Project acknowledges that some flood risk from other catchments flowing into the floodplain and other measures to support the community are in progress such as improved evacuation, forecasting and warning, and education.

It is anticipated the NSW Government will continue working towards the Flood Strategy outcomes that include community preparedness, evacuation route upgrades and flood forecasting, and integrated land use and transport planning that recognise the ongoing flood risk and the need for community response.

The Project recognises and accommodates the future population and housing projected for the area as set out by the State government in strategic planning documents including the '*A Metropolis of Three Cities – the Greater Sydney Region Plan*' and the District Plans. It is not the role of this Project EIS to challenge the basis for and guidance within those adopted strategic documents for the development of Sydney.

6.11 Socio-economic

6.11.1 Tourism, recreation, amenity and visual impacts

There were many submissions relating to the social and economic impacts of the Project, particularly with regard to:

- Amenity, including loss of enjoyment and pleasure of the area, negative impacts on mental health and wellbeing
- Views and visual appeal, affected by the inundation zone (for reduced environmental quality of unhealthy and dead vegetation, future eroded and denuded areas)
- Reduced attractiveness for tourism and eco-tourism through exclusion areas, damage to the natural environment and biodiversity, and impact on values of the World Heritage listing and national parks
- Recreational impacts including access to and undertaking activities such as bushwalking, kayaking, nature watching and camping.

Response

The EIS undertook a visual impact assessment for three locations during the construction phase and for eight locations across the upstream, dam site, and downstream study areas for different flood event types during the operational phase. Construction phase works had visual impacts rated from low to high. The operational phase assessment visual impacts range from moderate to high ratings in terms of flood event visual impact, within which the post-Project rating compared to the current time flood event were similar or improved, and the impact (benefit) of the Project was rated as negligible for the upstream zone, the same rating for the dam area, and beneficial for the downstream area. Details of the visual assessment are provided in Chapter 25 *Visual amenity* of the EIS.

Further investigation into potential impacts of temporary inundation on vegetation in the upstream area (refer Section 6.7 in the PIR) suggests this would not necessarily lead to substantial vegetation loss. As such, the magnitude of potential impacts on visual amenity, and related values such as World Heritage, in the upstream area could be less than as presented in the EIS.

The socio-economic assessment (Chapter 21 in the EIS) considered the impacts to the local, upstream, downstream and estuary communities. The concerns raised in submissions seem focused on the upstream impacts on recreation, tourism and overall amenity aspects.

These were assessed in the EIS for environmental and way-of-life grouped impacts in particular, with the significance (risk) ratings from low to high. A range of impacts were identified including to recreational activities, tourism, health and wellbeing, and general enjoyment. Mitigation measures proposed for these reduced the significance rating which included engagement and plans / strategies, with limited material changes proposed.

Social impacts can be highly subjective and perceived impacts may differ, positively or negatively, in scale or form, compared to the reality.

The Project would not affect access for recreational activities. The existing arrangements for catchment protection will remain including where access may be temporarily restricted, such as during bushfire events, which would not change with the Project.

6.11.2 Society values

Many of the submissions expressed a pride and value in the natural environment of the area which they wanted to see retained and protected for now and for the future. They recognised the ecosystem services provided and appreciated having these diverse natural values in a location close to and accessible for Sydney, readily able to be enjoyed. They also noted the importance of nature, species and the ecosystems, for itself separate from people. Such submissions included concerns of the area being special, the long-term impacts of the Project and the irreversibility of it. The submissions express a pride in the identified World Heritage, national parks, and wilderness places of the Blue Mountains.

Through the objections to the Project on this basis, those submitters are promoting these natural values as being more important and to be respected and protected, over the need for the raising of the dam outlined in the EIS.

Response

The submission from the Environment, Energy and Science Group within DPE provided advice related to numerous aspects of protected lands values (refer Section 4.1.9 of this report) which encompass the matters raised above. Readers are referred to the responses provided to issues in that section.

Issues related to potential impacts on World Heritage and National Heritage values were also raised in submissions from the Australia International Council on Monuments and Sites and the International Union for Conservation of Nature. Responses to these issues are provided in Appendix C together with additional assessment of potential impacts of the Project on World Heritage and National Heritage values.

The Project could potentially diminish one or more of the World Heritage and National Heritage values, however, the risk of this is considered low, and noting that there is already an existing risk associated with the current dam. It is considered unlikely that this would present a material risk to the World Heritage listing of the GBMWHA.

The offset strategy (refer Section 3.3) provides for funding of on-park management for the protected lands values offset addressing maintenance and potential enhancement of World Heritage values. The EMP required under Part 5A of the *Water NSW Act 2014* would similarly facilitate maintenance and potential enhancement of World Heritage and National Heritage values.

WaterNSW acknowledges the importance of the natural values of the upstream area but considers these cannot be considered in isolation from the substantial societal benefits that the Project would provide to downstream communities through a significant reduction in risk to lives and property.

6.11.3 Non-indigenous (built) heritage and historical places

The 150 years of European settlement and heritage sites upstream of the dam have been totally disregarded, with the Project potentially damaging numerous historical and heritage places including former houses, industry structures and a grave site. A submission queried if it was intentional that the SEARs did not include such sites in the matters to be addressed in the EIS.

One submission stated that National Heritage items had not been assessed in the EIS.

Submissions also noted that many people had to give up their homes for the construction of the original dam, and that these former residents and their families can still have strong ties to the valley and the places of their former homes. It was stated that this loss of, and connection to, place should be recognised.

Response

Chapter 17 of the EIS addresses the assessment of non-Aboriginal heritage contained on statutory lists including the World Heritage list, National and Commonwealth heritage lists, State heritage lists (State Heritage Register and section 170 registers), local heritage items and of potential heritage and archaeological sites. Nominated National Heritage items are also assessed.

The listed and nominated National Heritage places are identified in Chapter 17 of the EIS in Section 17.3.4.2 of the EIS and the impact assessment is provided in Section 17.5.2.3. Further consideration of potential impacts on National Heritage items is provided in Appendix C to this report.

Additional assessment has been carried out for four items on the NPWS section 170 register in the upstream area, including the Joorilands Homestead. This is provided as Appendix G to the PIR. No listed heritage items were identified in the upstream impact area of the Project.

A detailed assessment that supports Chapter 17 is provided in Appendix I *Non-Aboriginal Heritage Assessment Report* to the EIS. Details of potential impacts to heritage values of the World Heritage area are separately addressed in Chapter 20 and Appendix J of the EIS. Further consideration of potential impacts on World Heritage is provided in Appendix C to this report.

Table 8.1 in Section 8 *Management of non-Aboriginal heritage* of Appendix I identifies proposed management and mitigation measures for the Project. A Heritage interpretation Strategy for the Project is recommended to be progresses. There may be opportunity to address historical elements of the dam development and early settlement content into that strategy and subsequent heritage interpretation.

The SEARs are prepared by DPE and typically do not identify individual heritage items. The SEARs, as worded, capture the requirement to consider potential impacts to non-Aboriginal heritage items in the upstream area.

6.11.4 Insurance

Some submissions noted that the Insurance Council of Australia (ICA) had withdrawn its support for the Project, and expressed the view that money would be better spent on buying back properties that should not have been built in such flood-prone land.

It was also noted that allowing continued and future development in the floodplain will increase the number and value of properties at risk of flooding. This will have implications for insurance premiums that will rise to cover those future large payouts from a flood event. Alternatively these properties will be uninsurable due to high premium costs or companies not providing insurance policies.

It was noted that where insurance is not available or paid out, governments may have to compensate or financially support affected property owners/occupiers because they approved development in flood risk areas.

Response

Prior to the EIS being released for public exhibition in late 2021, the ICA provided a letter (dated 15 February 2021) to the Warragamba Dam Raising Parliamentary Inquiry to update the Inquiry on its position. The ICA letter stated

> *… the position of the general insurance industry is now that without satisfactory environmental and cultural heritage impact assessments being completed and made public to allow for full and open assessment, the industry is unable to support the proposal as it currently stands. We would advocate for the exploration of alternative mitigation options …*

At the time of the ICA letter in early 2021, the draft EIS was still in preparation with only the preliminary assessments available and stakeholder consultation was continuing.

To the best of WaterNSW's knowledge, there has been no update from the ICA since the EIS and the supporting detailed assessments were made publicly available to the community and stakeholder groups. The ICA did not make a submission to the public exhibition of the EIS.

Chapter 4 in the EIS provides a detailed consideration of alternative options arising from the Flood Strategy and as identified and considered by the Taskforce. The Project is one of several measures for flood mitigation in the valley.

Flooding is one of many natural disasters and events that are considered in insurance policies. The content of policies is a broader matter for consideration by the insurance industry, property owners and occupiers, and to limited effect, by state governments.

6.12 Dam safety, maintenance and operation

6.12.1 Geology, design and safety

Concerns were raised regarding geology, design and safety, and included the following:

- There has been no geological study results because no proper feasibility study and costing has been conducted.
- There is no risk assessment with regard to potential dam failure or surrounding geological support failure leading to devastation of the Sydney basin, resulting in millions of lives lost and affected.
- There is no tabulation of how the existing dam has performed and moved and continues to move since it was constructed in the 1950s, nor any explanation of how the proposed additions may affect this movement or the ground water penetration underneath the dam foundations.
- There is no explanation of the ongoing survey and maintenance requirements which will be required to sustain the modified structure and surrounding rock faces.
- There is no explanation as to the geological risk of the dam becoming undermined as a result of 'gravity dam rotation effect'.
- There is no worldwide precedent for creation of a flood mitigation dam on top of an existing working water supply dam for which foundations have already been completed many decades beforehand.
- There is no explanation of how existing dam foundations will be changed by addition of new dam mass on the top and downstream side of the dam.

Response

The assessment presented in the EIS is based on a detailed concept design that has been developed by Australian and overseas dam engineering consultants Stantec GHD Joint Venture. Design development has occurred separately to the EIS. The dam design has been independently peer reviewed by a Dam Expert Review Panel in accordance with the requirements of Dams Safety NSW.

There have been extensive geological studies and site investigations undertaken as part of the detailed concept design. These investigations have informed the detailed analyses of the dam stability.

A dam safety risk assessment has been undertaken for the raised dam design in accordance with the requirements of Dams Safety NSW.

Dam foundation investigations and design arrangements are outlined as part of the detailed concept design studies.

Historical performance of the dam has been assessed and documented as part of the detailed concept design studies.

WaterNSW's Dam Safety Team continuously monitors the performance of Warragamba Dam. The dam monitoring instrumentation and surveillance requirements for the raised dam have been assessed and documented as part of the detailed concept design.

A 3D Finite Element Analysis has been undertaken by dam engineering specialists to assess the performance of the raised dam and its foundations. The analysis has considered all feasible loading scenarios, including the rarest of floods and earthquakes.

Over 80 dams in Australia have been raised at some point after their original construction. There have been higher raisings of concrete mass gravity dams globally, the highest being the Guri Dam in Venezuela, which was successfully raised in the 1980s from 106 metres to 162 metres – a raising of 56 metres. In 2015, the San Vincente Dam in California – a similar dam to Warragamba Dam – was raised by 36 metres to 102 metres. In this context, the proposed Warragamba Dam raising, while a major construction undertaking, is not a pioneering engineering project.

6.12.2 Adequacy of technical studies

The EIS omits essential engineering and post-construction dam maintenance considerations.

The Project exponentially increases the risk of total dam failure, massive flooding of the Greater Sydney Basin, and the total loss of Sydney's primary water supply.

Response

These issues were not identified in the SEARs as specific matters to be addressed in the environmental assessment. Matters related to dam safety sit under the *Dams Safety Act 2015*. As noted in the response to the previous issue, these engineering considerations form part of the detailed concept design, which is a separate body of work developed by Australian and international dam engineering consultants Stantec GHD Joint Venture. The design has been independently peer reviewed by a Dam Expert Review Panel in accordance with the requirements of Dams Safety NSW.

The existing dam maintenance regime will be reviewed and revised as appropriate.

The Project does not increase the risk of total dam failure or loss of Sydney's Water Supply. Dam safety risk assessments undertaken as part of the design outline that the raised dam meets the safety requirements of Dams Safety NSW.

6.12.3 Spillway capacity

The spillway capacity will not be reduced and hence the failure probability of the dam due to flooding will not be changed. Unable to locate any mention in the EIS of the changes to the failure probability of the dam from foundation issues arising from the proposed raising of the dam. Will the risk of dam failure increase due to the raising of the dam?

Response

This information is not a specific SEARs requirement and does not form part of the EIS. A detailed concept design has been developed by Australian and international dam engineering consultants Stantec GHD Joint Venture as a separate body of work to the EIS. The design has been independently peer reviewed by a Dam Expert Review Panel in accordance with the requirements of Dams Safety NSW.

The Project does not increase the risk of dam failure. Dam safety risk assessments undertaken as part of the design outline that the raised dam meets the safety requirements of Dams Safety NSW.

There have been extensive geological studies and site investigations undertaken as part of the detailed concept design. These investigations have informed the detailed analyses of the dam stability.

6.12.4 Dam safety review process

The Project needs to be 'proof engineered' by a reputable international organisation or panel separate from WaterNSW.

Response

The design has been independently peer reviewed by a Dam Expert Review Panel in accordance with the requirements of Dams Safety NSW.

6.12.5 Operation at full supply level

The FSL is 116.22 mAHD based on instruction issued in the late 1980s. Use of 116.72 mAHD has introduced a bias into the flood modelling.

Response

WaterNSW confirms that the current FSL of Warragamba Dam is RL 116.72 mAHD. This level is the top of the drum gate in the central spillway.

6.12.6 End-of-life

There is no consideration of the end-of-life for the dam and associated infrastructure, and the implications of this for the downstream urban area of Sydney.

Response

The design life of the operational dam is identified as being 100 years which would be in 2130, assuming construction being completed by 2030.

The SEARs did not specify that the end-of-life considerations of the dam were to be considered.

The end-of-life stage of the dam is not required to be addressed in the NSW Treasury document TPP18-06 NSW Government Business Case Guidelines.

6.13 Water supply security

Several submissions referred to alternative water supply options in preference to raising the dam wall. In some cases these options were in conjunction with the option to reduce the FSL to make up the 'lost' water storage capacity.

Response

The principal objective of the Project, as stated in Section 3.3 of the EIS, is to reduce risk to life and property damage downstream in the Hawkesbury-Nepean Valley. It is not related to water supply security which was a common misconception identified in many submissions.

With regard to permanently lowering the FSL to provide airspace of the temporary retention of floodwaters, two options were investigated: lowering the full supply level by five metre and by 12 metres. This option is discussed in Sections 4.4 and 4.5 in Chapter 4 of the EIS. This option was discounted due to the significant impact on water supply security and, in the case of the -5 metre lowering option, the very limited benefits in managing floods that pose the greatest risk.

Consideration of these lowering options also noted that new water sources would be required to compensate for the lost volume in Warragamba Dam and the associated reduction in water supply security. The existing desalination plant, which can supply up to 15 percent of Sydney's water supply needs, would not be sufficient to make up the shortfall.

6.14 Environmental assessment

6.14.1 SEARs and ecologically sustainable development

The EIS does not meet the requirements of the SEARs in relation to a sustainable future and is not consistent with the principles of ecologically sustainable development (ESD). In particular the social cultural and environmental impacts are undervalued in the assessment and overall outcome so as to favour the economic benefits. Some submissions suggested the dam raising is part of an endless cycle of people-focused development in the floodplain with increasing risks.

Response

Chapters 7 to 29 of the EIS and related appendices assess and identify measures to avoid, minimise and mitigate the environmental impacts relating to the Project as required by the SEARs.

Chapter 29 of the EIS provides a synthesis of the EIS including the ESD considerations, with Section 29.10 (and Table 29-22 in particular) addressing the social, cultural and environmental elements.

In summary, the Project recognises:

- Benefits of reduced inundation of downstream natural environments
- Significant benefits to the social welfare and structure of downstream communities through flood mitigation
- Consistency with the four principles of ESD being precautionary principle; intergenerational equality; conservation of biological diversity and ecological integrity; and Improved valuation and pricing and incentive mechanisms
- Its role as part of a broader flood risk management strategy

- The need to mitigate environmental impacts to biodiversity and cultural values of temporary (upstream) inundation
- The role of all levels of government and involvement of the community in environmental planning and assessment.

6.14.2 Integrity of the assessment process

The integrity of the environmental assessment is fundamentally flawed and cannot be accepted as a basis for further decision-making by the Minister for Planning.

Some submissions requested an independent review of the assessment be undertaken.

Response

The environmental assessment, and EIS, has been undertaken to address the SEARs for the Project, and with respect of the policies, guidelines and other frameworks.

The assessment of environmental impacts and consideration of the Project will be undertaken as per the legislated process described in Chapter 2 of the EIS. The Project merits, including the EIS process, will be evaluated by DPE against the matters in section 5.19 of the EP&A Act. The Project will be determined by the Minister for Planning. The Project will then be considered by the Federal Minister for the Environment with regard to matters falling under the EPBC Act.

6.14.3 Assessed dam wall height

The EIS only assessed 7.5 metres of the proposed 17 metres increase in the height of the dam as being the impact area. The entire 17 metres should have been considered in the assessment of the impacted area. This results in all assessments being conservative as to the actual damage that will occur.

The EIS does not adequately explain why a 10.3 metre rather than a 14 metre increase in inundation level was used.

Response

With regard to the reference to 17 metres, this is explained in Section 5.1 in Chapter 5 as follows:

> *Peer reviewed climate change research found that by 2090 it is likely an additional three metres of spillway height would be required to provide similar flood mitigation outcomes as the current flood mitigation proposal. Raising the dam side walls and roadway by an additional three metres may not be feasible in the future, both in terms of engineering constraints and cost. The current design includes raising the dam side walls and roadway by 17 metres now to enable adaptation to projected climate change. Any consideration of raising spillway heights is unlikely before the mid to late 21st century and would be subject to a separate planning approval process.*

The upper limit of the FMZ, which is the area that would be affected by temporary inundation with the Project, is defined by the level of the new spillway crest which is 128.5 mAHD (as shown in Figure 5-6 in Chapter 5 of the EIS). This is 11.78 metres above FSL. The assessment has considered potential impacts up to this level, however, given the relative rarity of flood events that would cause temporary inundation, the assessment was weighted toward the more frequent events that would have lower peak flood levels.

The reference to 10.3 metres is the upper limit of the 'upstream impact area' and the basis for development and definition of this area is explained in Section 8.2.5 in Chapter 8 *Biodiversity – Upstream* of the EIS. As noted

> *The probabilistic nature of flooding … presents a challenge in identifying appropriate flood events to inform an assessment of potential impacts, and noting that for a specific flood event of a particular chance of occurrence, there is already an existing potential impact associated with that particular flood event.*

As explained in Section 8.2.5, a Monte Carlo analysis was used to identify the area most likely to be affected over a notional 20-year period for both the existing dam and with the Project. From this analysis, two levels were identified:

- Lower extent: 2.78 metres above FSL (119.5 mAHD)
- Upper extent: 10.25 metres above FSL (126.97 mAHD).

This set the context for the principal focus of the upstream area assessment and, for biodiversity, the basis for offsetting which assumed a total loss of biodiversity values in this area. In reality, this is highly unlikely to occur as has been noted elsewhere in this report.

The use of this modelled outcome impact area was discussed with and agreed to by relevant state and federal government agencies.

6.14.4 Technical assessments

The EIS does not take into account the full environmental and cultural impacts of the Project.

Several government agencies were critical of the environment impact assessment:

- NPWS said it failed to address impacts on species and ecological communities affected by the 2019-2020 bushfires
- Heritage NSW said the EIS failed to properly consider cultural heritage values or adequately consult Traditional Owners
- The Commonwealth Environment Department said the evaluation failed to consider impacts on iconic species like the platypus and told the NSW Government to redo the entire heritage assessment.

Submissions also raised concerns over the adequacy of specific technical assessments, including surveys of threatened species, post 2019-20 bushfire surveys, indigenous heritage surveys, modelling data, and the assessment of alternatives.

Response

The EIS was prepared in consultation with the community and Government agencies, the latter including National Parks and Wildlife Service, Heritage NSW, and the then Commonwealth Department of Agriculture, Water and the Environment. Matters raised by government agencies and other parties during this process were considered and addressed as appropriate in the EIS.

The draft EIS was submitted to DPE for review in mid 2020, with this process involving separate reviews by individual agencies with respect to aspects of the assessment falling under their respective legislative responsibilities. This is normal for major infrastructure assessments. The comments noted above were raised during this process and considered as part of finalisation of the EIS.

Further consideration of agency issues, which cover the points raised above, is provided in Chapter 4 of this report.

6.14.5 EIS consultant

Several submissions stated that the EIS consultant has an established history of abusing indigenous rights and has recently been barred by the World Bank.

Response

SMEC International and four subsidiary SMEC organisations based in India, Bangladesh and Sri Lanka were barred by the World Bank in 2017 for periods of six to 30 months. SMEC International and the four subsidiaries are separate entities to SMEC Australia which undertook preparation of the EIS.

SMEC Australia contracted a number of specialist companies to undertake many of the technical detailed reports including the Aboriginal cultural heritage assessment. These technical reports have informed preparation of the overarching EIS chapters and are provided as appendices to the EIS.

6.15 Construction phase

6.15.1 Construction traffic

The type and number of heavy construction vehicle movements will damage local roads and bridges or require their upgrade, cause vibration impacts to buildings, generate noise and air pollution, contribute to road congestion and affect movement including of emergency services and residents, impact amenity of the village, affect the functioning of local businesses such as delivery of stock and customer access, and pose a safety risk to local residents and the school community. Temporal aspects of construction traffic – day and night, weekends, duration of construction phase – was also raised as a concern.

Response

WaterNSW acknowledges that construction traffic would have an impact on the local communities. Chapter 24 *Traffic and transport assessment* in the EIS summarises the potential construction traffic impacts in Table 24-12 and identifies management measures to minimise the impacts in Table 24-21.

Section 5.4.1 in Chapter 5 of the EIS states

> *If the project is approved, further detailed construction planning would take place prior to commencement to inform a construction environmental management plan (CEMP). This plan would be prepared in accordance with all relevant approval conditions and would also consider methods and the scheduling of activities to minimise impacts on the community and the environment, such as noise, access, and amenity, and would detail mitigation and management measures.*

Section 5.4.12.1 in Chapter 5 specifically addresses construction vehicle movements including the number of vehicles and the anticipated routes of vehicles.

Chapter 24 *Traffic and transport*, and *Chapter 19 Noise and vibration* include consideration of construction traffic on the road network and communities.

A construction traffic management plan (CTMP) will be prepared as part of the CEMP. This will be specific to the transport and traffic impacts for the construction phase. The CTMP will provide the framework for minimising delays and disruption effects, and will identify mitigations and other measures to limit negative impacts both on-site and off-site of the construction area. Details of the CTMP and other traffic and transport-related management measures are provided in Appendix B to this report.

Emergency services agencies were consulted during the preparation of the EIS and their feedback considered during the EIS preparation.

It is not possible to avoid or eliminate all traffic related impacts for the construction of this or any major development / project.

6.15.2 Construction impacts

Construction activities, generally and traffic based, will negatively affect air quality, generate noise, impact resident physical and mental health and enjoyment of the local area. Particular reference is made to the local residential community that includes the elderly, students of local schools and pre-schools. Concern was also raised regarding increased crime rates during the construction period, and reduced tourism and other business trade deterred by the works.

The construction period and the potential to undertake works outside of the stated standard hours was also raised, and the impact of those works at night and on weekends to residents and visitors.

Negative impacts of the construction of the dam will compound with impacts resulting from construction of the Western Sydney Airport.

Response

Section 5.4.1 in Chapter 5 of the states

> *If the project is approved, further detailed construction planning would take place prior to commencement to inform a construction environmental management plan (CEMP). This plan would be prepared in accordance with all relevant approval conditions and would also consider methods and the scheduling of activities to minimise impacts on the community and the environment, such as noise, access, and amenity, and would detail mitigation and management measures.*

The CEMP will confirm the anticipated hours for the majority of works to be undertaken. However, there will be occasion, including to minimise disruption to schools, businesses, and/or traffic flow for example, that works may need to be undertaken outside of standard hours (as acknowledged in Section 5.4.4 (Construction hours) in Chapter 5 of the EIS).

Various chapters of the EIS provide specific consideration of the potential construction phase impacts and outline the mitigation and management measures to minimise those impacts. These include Chapter 7 *Air quality*, Chapter 16 *Health and safety*, Chapter 19 *Noise and vibration*, Chapter 21 *Socio-economic*, and Chapter 26 *Waste*.

The cumulative effects of the construction of the Western Sydney Airport and the possible construction of the Warragamba Dam Raising are addressed in Chapter 28 *Cumulative impacts* in the EIS. The EIS identifies the following potential interactions (Table 28-3) which do not distinguish between construction and operational phases:

- Vegetation clearing
- Impacts to threatened biota
- Aircraft noise
- Alterations to hydrology and groundwater dependent ecosystems

- Traffic and transport
- World Heritage.

A communications strategy outlining how the local community will be advised of upcoming works and disruptions will be prepared and followed.

6.16 Cumulative and ongoing effects

Many submissions state the Project will add to existing and future pressures, such as future bushfires, climate change, urban development, and weeds and feral species, on biodiversity that are already under pressure, particularly for listed threatened or endangered species. The cumulative effects of these pressures, individually and in combination, on the landscape and biota are not considered in the EIS. For example, changes in climate, such as to rainfall and temperatures, may increase bushfire risk, hence both climate change and bushfire will challenge the natural environment affected by the Project.

The effects of the Project will be ongoing, in that they are not a single event but will occur into the future as flood events happen.

In the case of bushfires, as well as the damage caused to the burnt landscape that will take time to rejuvenate, submissions also noted the raised importance of the unburnt areas as a refuge, the risks of soil erosion, nutrient loss, and river siltation from unprotected landscapes, the loss of plants and animals and habitats, the opportunity provided to invasive species and the effect on the values of protected areas. These challenges will be cumulative, with the additional environmental pressures posed by the Project inundating the landscape and the species it will impact over time.

The impact of the Western Sydney Airport on water quality due to fuel dumping, water security and the safety of Warragamba Dam has not been sufficiently considered.

Response

Cumulative effects are addressed in Chapter 28 of the EIS, which addresses the cumulative effects relating to the 2019/20 bushfires and of other major projects and strategic activities in the area with the Project individually (i.e. the Project and bushfire only, or the Project and the Western Sydney Airport only). However, the cumulative effects of more than one of these projects and of natural processes (such as future bushfire and climate change effects) on the landscape and biota and in the context of existing pressures on threatened species, as concurrent activities, are not addressed.

The ongoing effects of the project are recognised in the context of the environment at the time of the assessment. It is difficult to assess the ongoing effects of the Project in a future environment with the number, scale and externality of the variables at play.

Further, the climate change impacts are only provided a high-level assessment as to the effects on the natural environment and as a cumulative effect with respect of the Project.

The Western Sydney Airport is identified as a major project that may have a cumulative effect on the WDR Project. This is addressed in the EIS in Chapter 28 *Cumulative impacts*, with potential interactions of the Airport project and this Project identified at Table 28-3. The potential impact of the operation of Western Sydney Airport on Warragamba Dam operations has been considered in the EIS for Western Sydney Airport and is addressed, as relevant, in the approval conditions for that project.

6.17 Environmental management

A number of submissions raised concerns regarding environmental management generally and as demonstrated by the Project, including:

- Concern with the Government's management and protection of the environment including:
  - that the opportunities and benefits of urban development are prioritised over environmental considerations
  - species being negatively impacted by developments
  - the growing list of threatened species and those at a worsening status over time
- That a long-term view be taken in respect of protecting the natural environment so that it may continue for future generations
- That the ecosystem services the natural environment which would be disrupted and placed under additional pressure by the Project.

Response

The EIS considers the environmental implications of the proposed raising of Warragamba Dam over the construction and operation phases. The protection and management of the environmental aspects of the Project will be taken into consideration in the assessment and determination process, and if progressed in the implementation of mitigations and other measures.

The EIS in Appendix R Proponent's Environmental Record sets out the environmental management record of Water NSW and the environmental framework of Water NSW that will apply to the Project.

The environmental management record of local, state and federal governments is outside the consideration of the Project.

6.18 Climate change

Several submissions raised concerns on the level of consideration of climate change effects and its implications to biodiversity, species and habitat, and the environment generally in the EIS.

Potentially increased rainfall and humidity due to climate change was also noted, and submissions queried whether this was accounted for in the hydrology assessment for the dam and the flood risk assessment of catchments outside the Warragamba catchment.

Submissions also noted the Project's potential contribution to climate change including from decomposing vegetation, loss of carbon sink, and construction activities generating greenhouse gases and utilising raw materials.

Consequences of the Project, namely additional development in the floodplain, were also raised for the heat island effects and microclimate impacts.

Submissions reflected on the role of the natural environment in mitigating and managing climate change outcomes and stated that the Project's negative impacts on vegetation goes against the actions required to combat and mitigate climate change.

Response

The EIS considered the effect of climate change on the construction activities and operational activities of the Project, including the risk of extreme flood-producing rains affecting (i) the flood mitigation outcome of the dam and (ii) the increase in frequency of upstream inundation (Chapter 14 *Climate change*).

The EIS considered the increase in rainfall and subsequent flood risk as a result of climate change under four emission scenarios in Chapter 15 Flooding and Hydrology, section 15.10. The probabilities of flood events at Penrith and Windsor under these scenarios with and without the Project were identified, however the portion of flood risk from catchments outside the Warragamba were not distinguished.

The EIS did not address the potential contribution to climate change or the reduced mitigation value to climate change due to the Project.

The planned future development of western Sydney, including issues of urban heat, will be managed by state and local governments and informed by strategic planning guidance. It is not addressed in this EIS. The cumulative effect of climate change and the Project are addressed in Section 5.4.9.

7

Clarifications and corrections

7 Clarifications and corrections

The following table provides clarifications and corrections identified by WaterNSW subsequent to the exhibition of the EIS, and in submissions.

Table 7-1 General clarifications and corrections

EIS reference	Comment	Response
Table 8-36	The comment provided in the 'Details' column for the Key Threatening Process ' Clearing of native vegetation' was missing the word 'could' and should read as follows: *The change in the depth and duration of inundation as a result of the Project **could** result in the loss of vegetation such that the structure and floristic composition of the PCTs would be modified*.	
Table 13.6	The impact area for PCT HN607 should read 58.94 ha, not 3,058.94 ha.	
Table 13.9	The following flora species should have been identified as number of individuals affected rather than area: • *Callistemon linearifolius* (Netted Bottle Brush) • *Epacris purpurascens subsp. purpurascens* • *Epacris sparsa* (Sparse Heath) • *Eucalyptus glaucina* (Slaty Red Gum) • *Melaleuca groveana* (Grove's Paperbark) • *Rhodamnia rubescens* (Scrub Turpentine). These species are correctly identified in Appendix F6, Table 3-7.	
Figure 15-1	The y-axis label is missing. Should be ML.	Missing y-axis label on Figure 15-11 is 'ML'.
Table 15-12	Reference to 'Brisbane River Foreshore Flood Study'. Should this be: Brisbane Water Foreshore Flood Study?	Yes, the reference should be to the 'Brisbane Water Foreshore Flood Study'.
Table 15-13	Title of Columns 4 and 5. The title should be 'Increase in area due to Project'.	Existing title is 'Area change due to Project' which would be interpreted the same as suggested title.
Table 15-14	Title of Column 6. Title of column should be 'Increase in Depth (m)' as it shows only the increase in water depth above the existing scenario not the actual Project depth.	Agree, suggested title would be more informative.
Table 15-21	The table title should be 'summary change in flood levels and duration for selected flood events'.	Agree, suggested title would be more informative.
Table 28-4	Cumulative impacts on non-Aboriginal heritage are not consistent with Section 7.7 of Appendix I *Non-Aboriginal Heritage Assessment Report*.	Cumulative impacts should be as identified in Section 7.7 of Appendix I.
Appendix H1, Table 3-17	Table 3-17 makes reference to the Draft South Creek Floodplain Risk Management Strategy and Plan (Dec-2019, Penrith City Council), however Penrith City Council adopted the South Creek Floodplain Risk Management Study and Plan in February 2020.	Yes, the reference should be to the South Creek Floodplain Risk Management Study and Plan

EIS reference	Comment	Response
Appendix N1, Table 1-2	Table 1-2 provides estimates of water use for various construction activities. The estimate of 50 ML for hydro blasting of the existing concrete dam wall should read 5 ML.	

Table 7-2 Safeguards and management measures (Table 4-2, Appendix F4)

Impact	Environmental management measure	Responsibility	Timing
Construction			
Obstruction to fish passage	Temporary in stream structures will be constructed in accordance with the NSW DPI policy guideline and will be inserted during low-flow periods with management plans being submitted to NSW DPI detailing how high flow events will be managed. Dewatering of temporary in-stream structure should follow the following guidelines: • NSW DPI is to be notified 7 days prior to any dewatering activities to organise potential fish rescue activities. A separate s.37 permit may be required from NSW DPI to relocate fish. • water is to be pumped a minimum of 30 m away from the waterway and should preferentially not re-enter the waterway. If water is to re-enter the waterway, ANZECC water quality guidelines need to be adhered to with the proponent being required to submit a detailed water quality monitoring program The existing eel passageway would be maintained. Should construction activities require modification to the eel passageway, it would be reinstated as required.	Construction contractor	Pre-construction Construction
	An eel monitoring program would be prepared in consultation with and to the satisfaction of NSW DPI to assess any impacts of the Project on eel passageway. The monitoring program would be implemented prior to construction and remain in place for the duration of construction.	WaterNSW Construction contractor	Pre-construction Construction
Erosion and bank stability	Scour protection and other bank stability mechanisms would be installed in the Warragamba River below the dam to minimise erosion and destabilisation of streambanks.	Design contractor Construction contractor	Pre-construction Construction
Removal of aquatic habitat	Removal of aquatic habitat would be minimised through detailed design.	Design contractor	Design
Water quality	Water quality would be managed in accordance with the approved water quality criteria for construction of the Project.	Construction contractor	Construction

Impact	Environmental management measure	Responsibility	Timing
Aquatic habitat impacts	Aquatic habitat would be protected in accordance with Section 3.3.2 Standard precautions and mitigation measures of the *Policy and guidelines for fish habitat conservation and management (2013 update)* (Fairfull 2013). Existing monitoring programs would be reviewed and revised as required to effectively monitor potential impacts of the Project.	Construction contractor	Pre-construction Construction
Threatened species	Relevant safeguards and management measures detailed in the Draft referral guidelines for the endangered Macquarie perch, *Macquaria australasica* (DSEWPaC 2011) would be implemented as required.	Construction contractor	Construction
Operation			
Obstruction to fish passage	The eel monitoring program would be implemented for a 12 month period following construction. After this time, WaterNSW would review the need for further monitoring in consultation with NSW DPI.	WaterNSW	Operation
Fish kills	A procedure for reporting and responding to fish kills and biosecurity incidents must be developed.	WaterNSW	Operation

8

Project justification

8 Project justification

Justification for the Project is provided in Chapters 3 and 29 of the EIS. As stated in Chapter 3

The Warragamba Dam Raising Project is required to reduce flooding impacts on downstream communities and urban development in the Hawkesbury-Nepean Valley. The unique topography of the Hawkesbury-Nepean Valley results in extensive and damaging floods, especially for flood events greater than the 1 in 100 chance in a year flood. The current number of people affected by a 1 in 100 chance in a year flood is 55,000. The risk would increase as the number of people, properties and businesses in the catchment increases over time. Also, because of the limited capacity and flood prone evacuation routes from developed areas of the floodplain, there is a risk of the loss of human life when significant flood events occur. A detailed and comprehensive Hawkesbury-Nepean Valley flood risk management strategy was developed by a multi-agency Taskforce to investigate alternatives and options to reduce the risks and impacts of significant flood events in the Hawkesbury-Nepean Valley. No other infrastructure alternative or option (and their combinations) investigated by the Taskforce was as effective and viable in reducing flood risks as the Project.

Subsequent to the exhibition of the EIS, a major flood event occurred in the Hawkesbury-Nepean Valley in March 2021 followed by another major flood event in March 2022. The March 2021 flood was the first major flood event (and largest) since 1990 at Windsor and in the lower Hawkesbury River, and the highest flood event since 1925 at Penrith. For both Windsor and Penrith, the March 2021 flood had an estimated frequency of 1 in 20 chance in a year (Infrastructure NSW 2021).

The analysis of the March 2021 flood (Infrastructure NSW 2021; page 72) noted

About 600 dwellings and 300 commercial/industrial buildings (most on rural land) are estimated to have been impacted by the flood. The many caravan parks between Windsor and Gunderman were severely impacted, with over 1400 manufactured homes flooded.

Flooding and riverbank erosion also caused severe damage to local roads, turf farms and vegetable crops.

Coming on the heels of drought, bushfire, the February 2020 flood and storm, and COVID-19, the March 2021 flood is known to have compounded psychosocial impacts on affected communities. This includes already socially vulnerable people.

The analysis also noted (Infrastructure NSW 2021; page 70)

Analysis of the March 2021 flood confirms that dam raising would have provided greater peak level reductions than FSL-lowering or pre-releases. Pre-releases would have brought forward closure of downstream river crossings and the onset of minor flooding, making emergency responses before the flood more difficult.

Anecdotal reports after the flood suggest relatively high levels of non-insurance and under-insurance for floods due to the prohibitively high costs quoted. This emphasises the need for measures to reduce the risk.

The experience of the March 2021 flood provides further justification for the Project.

8.1 Benefits

The principal benefits of the Project are:

- A significant reduction in flood heights and extents for the critical range of major floods events. For example, for the 1 in 100 chance in a year flood, a reduction of flood heights of about 5.2 metres at Penrith, 3.1 metres at Richmond and 4.1 metres at Windsor
- A significant reduction in the number of residential properties impacted by flooding in the critical range of major floods events. For example, for the 1 in 100 chance in a year flood there would an estimated reduction of 5,180 properties (68 percent reduction)
- Flood damage estimates would typically be reduced by approximately 74 to 80 percent for floods up to about the 1 in 200 chance in a year event, reducing to approximately 50 percent for a 1 in 2,000 year chance in a year event.
- Increased opportunities for evacuation as evacuation routes would experience less flooding and a longer period before closure due to flooding. For example, for the 1 in 100 chance in a year flood the Windsor Bridge crossing would remain open for an additional 18 hours
- A reduction in the risk to life due to reduced flooding extents and greater evacuation opportunities
- Potentially lower flood insurance premiums for some residential and commercial premises.

8.2 Impacts

The principal potential impacts of the Project are:

- Changes to the upstream flooding regimes through an increase in the frequency of flooding, and in the depth, duration and extent of temporary inundation. This would be most pronounced in and around the perimeter of Lake Burragorang but would drop off rapidly moving upstream away from the lake. These changes have the potential to diminish other environmental values in the upstream area.
- An increase in the duration of low-level flooding downstream associated with the emptying of the FMZ.
- Potential changes to upstream vegetation communities and fauna habitat associated with differing tolerances and responses to temporary inundation.
- Some Aboriginal heritage sites in the upstream area would experience either increased temporary inundation or are in areas that could newly experience temporary inundation due to the Project. While many sites would only experience relatively minor impacts from infrequent temporary inundation, other highly significant sites such as rock art sites may experience more substantial impacts.
- A potential diminishment of World Heritage and National Heritage values in the upstream area associated with additional temporary inundation (but noting that the World Heritage and National Heritage listings occurred after construction of the dam with the related risk of temporary inundation associated with the dam).
- Potential increased bank erosion downstream associated with discharge of the FMZ, however, the additional analysis carried out during preparation of the Submissions report and PIR has identified that this risk would not be as widespread or unform as assumed in the EIS, with some reaches being at a lower risk while others would have a relatively higher risk.

Summaries of construction and operational impacts are provided in Table 29-5 and Table 29-6 respectively in Chapter 29 of the EIS.

8.3 Ecologically sustainable development

Clause 192(1)(f) of the NSW Environmental Planning and Assessment Regulation 2021[44] requires an EIS to provide

> *the reasons justifying the carrying out of the development, activity or infrastructure, considering biophysical, economic and social factors, including the principles of ecologically sustainable development set out in section 193.*

This was provided in Table 29-22 in Chapter 29 of the EIS which stated

> *The Project is considered to be consistent with the four principles of ecologically sustainable development:*

- ***precautionary principle**: This EIS was prepared adopting a conservative approach which includes an assessment of the worst case impacts and scenarios. This includes assuming that the dam was at full supply level when a flood event occurs – and assuming the presence of many threatened species in the upstream catchment, even though they weren't found during field surveys*
- ***intergenerational equality**: The Project would provide intergenerational equality in terms of flood protection for communities in the Hawkesbury-Nepean Valley as climate change is predicted to increase the future frequency and size and extreme rainfall events*
- ***conservation of biological diversity and ecological integrity**: The design and assessment of the Project has been undertaken with the aim of identifying, avoiding, minimising and mitigating impacts to biodiversity and ecological integrity. Consistent with the TSC Act/BC Act, EPBC Act and the SEARs, a biodiversity offset strategy has been developed to compensate for the unavoidable loss of ecological values because of the Project. The Warragamba Offset Program, National Parks EMP and other measures would be implemented to mitigate and offset impacts on the environment*
- ***improved valuation and pricing and incentive mechanisms**: The value placed on avoiding and minimising environmental impacts is demonstrated in the design features incorporated into the Project. The cost of mitigation measures has been incorporated into the Project cost, as well as the extent of investigations undertaken to inform this EIS.*

The additional investigations carried out during preparation of the Submissions Report and this PIR have clarified some aspects of the assessment presented in the EIS. This suggests the precautionary approach adopted for some aspects of the assessment may have been overly conservative, and that some assumed impacts, such as the total loss of environmental values in the upstream impact area, may not actually be realised.

The revised offset strategy includes a funding component for the protected lands values offset which is consistent with the second, third and fourth ESD principles.

[44] The same requirement is in the 2000 Regulation, Schedule 2, Part 3, clause 7.

9

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A

Appendices

Appendix A

Submissions registers

A1 Agency submissions

Agency	Where addressed in this report
Department of Planning, Industry and Environment: Environment, Energy and Science	Section 4.1
Department of Planning, Industry and Environment: Water / Natural Resources Access Regulator	Section 4.2
Heritage NSW	Section 4.3
Department of Primary Industries (Agriculture)	Section 4.4
Department of Primary Industries (Fisheries)	Section 4.5
Environment Protection Authority	Section 4.6
Sydney Water Corporation	Section 4.7
NSW Health	Section 4.8
Blue Mountains City Council	Section 5.1
Hawkesbury City Council	Section 5.2
Hornsby Shire Council	Section 5.3
Liverpool City Council	Section 5.4
Penrith City Council	Section 5.5
The Hills Shire Council	Section 5.6
Wingecarribee Shire Council	Section 5.7
Wollondilly Shire Council	Section 5.8
Endeavour Energy	Section 5.9

A2 Community submissions

An assessment of each community submission was undertaken, identifying all issues raised and coding the issues raised. A total of 15 key issues and 58 sub-issues were identified and coded throughout the submission review process. Table A1 identifies the issues raised in each submission by issue code and where they are addressed in this report.

Table A1 Issue code and where addressed in this report

Issue code	Issue	Where addressed in this report
A	**Support for the Project**	Section 6.1
B	**Strategic need and justification**	Section 6.2
B1	Modelling of stated flooding and economic benefits	Section 6.2.1
B2	Downstream development	Section 6.2.2
B3	Purpose of dam	Section 6.2.3
B4	Justification	Section 6.2.4
B5	Project cost	Section 6.2.5
B6	Historical proposal for dam wall raising	Section 6.2.6
C	**Alternative options to the Project**	Section 6.3
C1	Adequacy of assessment of alternatives	Section 6.3.1
C2	Property buybacks	Section 6.3.2
C3	Evacuation routes	Section 6.3.3
C4	Lower the full supply level	Section 6.3.4
C5	Limit development in floodplains	Section 6.3.5
C6	Water diversion	Section 6.3.6
C7	Dam operation	Section 6.3.7
C8	Flood forecasting and preparedness	Section 6.3.8
D	**Consultation for the EIS**	Section 6.4
E	**Biodiversity**	Section 6.5
E1	Regent Honeyeater	Section 6.5.1
E2	Impacts on biodiversity and loss of habitat	Section 6.5.2
E3	Threatened and endangered species and ecological communities	Section 6.5.3
E4	Specified species	Section 6.5.4
E5	Aquatic species and riparian habitats	Section 6.5.5
E6	Additional surveys following 2019-2020 bushfires	Section 6.5.6
E7	Environmental management	Section 6.5.7
E8	Invasive or introduced species	Section 6.5.8
E9	Cumulative and ongoing effects	Section 6.5.9
E10	Biodiversity offsets	Section 6.5.10

Issue code	Issue	Where addressed in this report
F	**Aboriginal cultural heritage**	Section 6.6
F1	Survey extent	Section 6.6.1
F2	Consultation	Section 6.6.2
F3	Consent for the Project	Section 6.6.3
F4	Potential impacts to cultural sites and places	Section 6.6.4
G	**Protected lands**	Section 6.7
G1	World Heritage	Section 6.7.1
G2	National parks	Section 6.7.2
G3	Wild rivers	Section 6.7.3
G4	Wilderness areas	Section 6.7.4
G5	Reputation and precedent	Section 6.7.5
H	**Hydrology and flooding**	Section 6.8
H1	Contribution of Warragamba catchment to downstream flooding	Section 6.8.1
H2	Flood modelling	Section 6.8.2
H3	Nepean catchment	Section 6.8.3
H4	Climate change	Section 6.8.4
H5	Downstream river system and environmental flows	Section 6.8.5
H6	Upstream inundation	Section 6.8.6
H7	Groundwater systems	Section 6.8.7
I	**Water quality**	Section 6.9
J	**Land use planning**	Section 6.10
J1	Existing development on the Hawkesbury-Nepean floodplain	Section 6.10.1
J2	Insurance cover	Section 6.10.2
K	**Socio-economic**	Section 6.11
K1	Tourism, recreation, amenity and visual impacts	Section 6.11.1
K2	Society values	Section 6.11.2
K3	Non-indigenous (built) heritage and historical places	Section 6.11.3
L	**Dam safety, maintenance and operation**	Section 6.12
L1	Geology, design and safety	Section 6.12.1
L2	Adequacy of technical studies	Section 6.12.2
L3	Spillway capacity	Section 6.12.3
L4	Dam safety review process	Section 6.12.4
L5	Operation at full supply level	Section 6.12.5
L6	End of life	Section 6.12.6
M	**Water supply security**	Section 6.13

Issue code	Issue	Where addressed in this report
N	**Adequacy of the environmental assessment**	Section 6.14
N1	SEARs and ESD	Section 6.14.1
N2	Integrity of the assessment process	Section 6.14.2
N3	Assessed dam wall height	Section 6.14.3
N4	Adequacy of the technical assessments and EIS	Section 6.14.4
N5	EIS consultant	Section 6.14.5
O	**Construction phase**	Section 6.15
O1	Construction traffic	Section 6.15.1
O2	Construction impacts	Section 6.15.2

Table A2 identifies the issues raised in each community submission. The second column of the table shows the submission number assigned by the Department of Planning and Environment. The third column identifies the issues raised in the submission as per the codes in Table A1.

Table A2 Issues raised by each community submission

No.	Submission number	Issues raised
1.	SE-29064999	E1, F4, J1
2.	SE-29070406	F4, M, O1, O2
3.	SE-29110079	B2, F4, J1
4.	SE-29117710	B2, B5, D, E1, F4, G1, J1
5.	SE-29117992	B2, E2, F4, G1, J1, N2
6.	SE-29131405	F4, G1, J
7.	SE-29133018	B2, H5, I, J1
8.	SE-29147718	B4, C7, F4, G1, J1
9.	SE-29163296	B4, B5, E1, E2, E4, E7, F4, G1, H1, J1,
10.	SE-29163983	B4, M
11.	SE-29234790	B, D, E3, E4, F, F1, F2, F4, G1, G4
12.	SE-29236027	E10, G1, H6, N3, N4
13.	SE-29236151	B4, G1
14.	SE-29239059	B4, B5, L1, M, N4
15.	SE-29279568	B3, B4, B5, C1, C3, C6, D, E1, E2, F2, F4, H7, L1, M, O2
16.	SE-29363005	B4
17.	SE-29378221	G1
18.	SE-29417788	A, B4
19.	SE-29505123	E4
20.	SE-29505150	E4
21.	SE-29509917	H3, H6, N4
22.	SE-29512703	E2, E4, E7, E10, G1
23.	SE-29513742	E2, E4, E10, G1
24.	SE-29513752	E2, E4, E7, G1, G5, N2
25.	SE-29514828	B4, E1, E4, E10, G1
26.	SE-29515155	E2, E4, E10, G1
27.	SE-29515174	E2, E4, E10, G1
28.	SE-29515177	E2, E4, E7, E10, G1
29.	SE-29515202	C1, E2, E4, E10, G1, M
30.	SE-29515519	E4
31.	SE-29515550	E1, E4, E7

No.	Submission number	Issues raised
32.	SE-29515615	E2, E4, E10, G1
33.	SE-29515618	E2, E4, E10, G1
34.	SE-29515674	E2, E4, G1, H1
35.	SE-29516491	E2, E4, E10, G1
36.	SE-29516502	E4, E9, H4
37.	SE-29517023	E4, E10, G1
38.	SE-29517028	E2, E4, G1, N2
39.	SE-29517038	E2, E4, G1
40.	SE-29517101	E2, E4, E10, G1
41.	SE-29517118	E2, E4, E10, G1
42.	SE-29517152	E2, G1
43.	SE-29517154	E4, E10
44.	SE-29517172	E2, E4, E10, G1
45.	SE-29517175	E1, E4, E7
46.	SE-29517852	E2, E4, E10, G1
47.	SE-29517867	E2, E4, E10, G1
48.	SE-29518113	E2, E4, G1
49.	SE-29518120	E4
50.	SE-29518136	E2, E4, E10, G1
51.	SE-29518162	E2, E4, E10, G1
52.	SE-29518242	E1, E2, E4, E7
53.	SE-29518313	E2, E4, E10, G1, J1
54.	SE-29518345	C1, E1, E4
55.	SE-29518391	E2, E4, G1
56.	SE-29518396	E4, G1
57.	SE-29518413	E2, E4, E10, G1
58.	SE-29518429	C1, E1, E2, E4, E7, G1, M
59.	SE-29518462	I, K, O1, O2
60.	SE-29518770	E2, E4, E10, G1
61.	SE-29518775	E2, E4, E10, G1
62.	SE-29518778	E2, E4, E10, G1
63.	SE-29519227	E2, G1
64.	SE-29519248	E1, E4, E9
65.	SE-29519294	E2, E4, E10, G1

No.	Submission number	Issues raised
66.	SE-29519298	E4
67.	SE-29519310	E2, E4, E10, G1
68.	SE-29519482	E2, E4, E10, G1
69.	SE-29519520	E1, E2, E4, E10, G1
70.	SE-29519554	E2, E4, G1
71.	SE-29519600	E4, F4, G1, H6
72.	SE-29519602	E4
73.	SE-29519716	E1, E2, E4, G1, N2
74.	SE-29519718	E1, E4
75.	SE-29519736	E2, E4, E10, G1
76.	SE-29519847	E2, E4, E10, G1
77.	SE-29519871	E2, E4, E7, E10, G1, N2
78.	SE-29519916	E2, E4, E9, E10, G1
79.	SE-29520009	E2, E4, G1
80.	SE-29520162	E1, E2, E4, E7, E10, G1, N2
81.	SE-29520172	E4
82.	SE-29522472	E4, E7
83.	SE-29522501	E2, E4, E10, G1
84.	SE-29522538	E2, G
85.	SE-29522697	C1, D, E1, E2, F1, F4, G1, G3, H1, N2, N4
86.	SE-29522723	B4, E2, E7, G1
87.	SE-29522727	E4
88.	SE-29522752	E2, E4, G1
89.	SE-29522810	E2, E4, E10, G1
90.	SE-29523759	E2, E4, G1
91.	SE-29523781	E2. E4
92.	SE-29523784	E2, E4, E7, E10, G1, N4
93.	SE-29523803	E1, E4, F4
94.	SE-29524310	B4, E2, E4, F4, G1
95.	SE-29524317	B4, C1, E2, E4, E10, G1
96.	SE-29524369	E2, E4, G1
97.	SE-29539962	E2, E4, E10, G1
98.	SE-29540707	E4
99.	SE-29546981	E2, E4, E10, G1

No.	Submission number	Issues raised
100.	SE-29549761	E1, E4, E7, E9, E10, G1, K1
101.	SE-29549924	E2, E4, E10, G1
102.	SE-29550346	E4, E9, F4, G1
103.	SE-29550368	E2, G1
104.	SE-29550491	C1, E4, M
105.	SE-29551968	E2, E4, G1
106.	SE-29553314	E4, F4
107.	SE-29553525	B4, E1, E4
108.	SE-29553745	E1, E4, G1, N2
109.	SE-29553855	E4, E10, N2
110.	SE-29553982	E2, E4
111.	SE-29553989	E4, F4, G1, G2
112.	SE-29555258	E1, E2, G1
113.	SE-29555701	E2, E4, E10, G1
114.	SE-29555704	E4, E10, G1
115.	SE-29555973	E2, E4, E10, G1
116.	SE-29556761	E2, E4, E10, G1
117.	SE-29557324	E2, E4, E9, E10, G1
118.	SE-29559492	E1, E2, E4, E9, G1
119.	SE-29560795	E1, E4, E7
120.	SE-29561026	E4, G1
121.	SE-29561036	E2, E4, E10, G1
122.	SE-29563073	E4
123.	SE-29563112	E2, E4, E10, G1
124.	SE-29563248	E2, E4, E10, G1
125.	SE-29565028	E2, E4, E10, G1
126.	SE-29565275	B4, C1, E2
127.	SE-29565759	E2, E4, E10, G1
128.	SE-29565769	B4, E4, F4, G1
129.	SE-29565874	E4
130.	SE-29566426	E2, E4, E10, G1
131.	SE-29567480	E2, E4, E10, G1
132.	SE-29567496	E1, E4, E10
133.	SE-29568209	E2, E4, E10, G1

No.	Submission number	Issues raised
134.	SE-29568709	E1, E2, E4, E10, N2
135.	SE-29569534	E2, E4, E10, G1
136.	SE-29570395	E2, E4, E10, G1
137.	SE-29570435	E2, E4, E10, G1
138.	SE-29571326	E4
139.	SE-29571452	E2, E3, E4, E10, G1, G4, H6, N2
140.	SE-29572439	E2, E4, G1
141.	SE-29576470	E2, E4, E10, G1
142.	SE-29576486	E4, H5
143.	SE-29576509	E2, E4, E10, G1
144.	SE-29577547	E2, E4, E10, G1
145.	SE-29577679	E2, E4, E10, G1
146.	SE-29577794	E2, E4, E10, G1
147.	SE-29577824	C1, E4, E1, E2
148.	SE-29577827	E2, E4, E10, G1
149.	SE-29578037	E2, E4, E10, G1
150.	SE-29579330	E4, E7
151.	SE-29579433	E2, E4, E10, G1
152.	SE-29580590	E4, E10
153.	SE-29581778	E2, E4, E10, G1
154.	SE-29581823	C5, E4, E2, E9, G1
155.	SE-29582282	E4, E10
156.	SE-29582285	B4, G1, E2, E4, E10, H5
157.	SE-29583300	E4
158.	SE-29583527	E2, E4, E10, G1
159.	SE-29584474	E4, E7, N2
160.	SE-29584477	E2, E7, N2
161.	SE-29584678	E2, E4, E10, G1
162.	SE-29586723	E1, E2, E4, E10, G1
163.	SE-29587027	E2, E4, E10, G1
164.	SE-29587987	E2, E4, E7, E10, G1, N2
165.	SE-29588035	E2, E4, G1
166.	SE-29588777	E2, E4, E10, G1
167.	SE-29589748	B1, C1, E4, E6, E10, G1, G4, H1, K1, N4

No.	Submission number	Issues raised
168.	SE-29591979	E1, E2, E4, G1
169.	SE-29592102	E4, E9
170.	SE-29593954	E2, E4, E7, E9, E10, G1
171.	SE-29594539	E2, E4, E9, E10, G1
172.	SE-29595979	E4, F4, G1
173.	SE-29599741	E2, E4, E10, G1
174.	SE-29602719	E4
175.	SE-29604016	E2, E4, E10, G1
176.	SE-29605711	E2, E4, E10, G1
177.	SE-29606230	E2, E4, E10, G1
178.	SE-29606233	E2, E4, G1
179.	SE-29609767	E1, E2, G1
180.	SE-29611589	E2, E4, E10, G1
181.	SE-29612777	E2, E4, E10, G1
182.	SE-29613617	E2, E4, G1
183.	SE-29615849	B1, C1, F3, F4, G1, G2, G5, H1, H2, N2, N4, N5
184.	SE-29617224	C1, F2, F3, F4, G1, G2, G3, G5, N4
185.	SE-29617370	B1, C1, E2, E3, E6, F1, F2, F3, F4, G1, G3, G5, H1, N2, N4, N5
186.	SE-29617383	E2, E4, E7, G1
187.	SE-29617390	B1, C1, E2, E6, F1, G1, G2, G3, G5, H1, H2, K1, N2, N4, N5
188.	SE-29617406	E1, C7, M
189.	SE-29617424	B2, G4, H2, H3, J1, J2
190.	SE-29617452	C, E2, E4, E7, F4, F2, G1, J1
191.	SE-29617859	C, E1, E2, E3, E4, E6, E10, F1, F2, F4, G1, G3, G5, H1, N4, N5
192.	SE-29617952	E2, G1
193.	SE-29618109	E1, E4, G1
194.	SE-29618112	B2, F4, G, J1, N2
195.	SE-29619415	C, E7, G1, J1, N2, N4, N5
196.	SE-29621790	E2, E3, E4, E7, F1, G1, G2, N2, N4, N5
197.	SE-29621818	B1, B2, C1, E2, E3, E4, E6, E7, F1, F2, F4, G1, G2, G3, H1, H2, K1, N2, N4, N5
198.	SE-29621852	B2, C1, C3, E2, E4, F1, F4, G1, J1, N2, N4
199.	SE-29621876	E1, E2, E3, E4
200.	SE-29621938	E1, F4, G1
201.	SE-29621965	E2, E4, G1

No.	Submission number	Issues raised
202.	SE-29621975	E2, E7, E4, E10, G1, N2
203.	SE-29622014	E4
204.	SE-29622071	E1, E2, E7 E9, F4, H6
205.	SE-29622725	C1, E1, F2, F4, G1, G3, J1, M
206.	SE-29622740	E2, E4, E10, G1
207.	SE-29622924	B1, B2, C1, E2, E3, E4, F1, F2, F3, F4, G1, G2, G3, G5, J1, N4
208.	SE-29624223	B1, C1, E1, E7, G1, G2, G3, G5, N2, N4, N5
209.	SE-29625977	E1, E2, E4, E7, E10, G1
210.	SE-29625981	E2, E4, E10, G1
211.	SE-29626002	B4, E2, E4, G1, H5
212.	SE-29627219	E1, E3, E7, E10, F4, G2, H2, N4
213.	SE-29629460	B2, D, E1, F4, G1, K1, N2
214.	SE-29629709	E4
215.	SE-29629712	B4, E1, E2, E3, E4, E10, F4, G1, G2, G3, H6
216.	SE-29629726	E2, E4, E10, G1
217.	SE-29646535	E1, E7, E9
218.	SE-29650429	B4, B5, E2, E7, E9, G1, G4, J1, J2, K1
219.	SE-29650773	E1, E2, E4, E6, E7, G2, N4, N5
220.	SE-29651465	E2, E4, E10, G1
221.	SE-29653736	E4
222.	SE-29654608	E1, E2, E4, F2, G1, G2, H1, N2, N4
223.	SE-29656275	B4, B5, E1, E2, E3, E4, E6, F4, G1, H1, J1, K1, L1, N2, N4
224.	SE-29656397	C1, C2, E1, H1, H4, K1
225.	SE-29657218	E1, E4
226.	SE-29657863	E2, E4, E10, G1
227.	SE-29658707	E2, E4, E10, G1
228.	SE-29664059	E1, E2, E6, E7, E9, F1, G3, K1, N4
229.	SE-29664335	E1, E4, E10, G1
230.	SE-29664452	E1, E4, E2, G1
231.	SE-29669558	E1, E9, F4, G2, G3, H1, J1, J2, K1, N2, N4
232.	SE-29671124	B5, C5, E4, E10, M
233.	SE-29671752	E1, E2, E4, E9, E10, G1
234.	SE-29672073	B2, F1, F3, H1, N4, N5
235.	SE-29672246	E2, E4, E7, E9, E10, G1

No.	Submission number	Issues raised
236.	SE-29672289	B5, E1, E2, E7, G1, G3, H1
237.	SE-29672329	E1, E2, E3, E4, F4, G2, G3
238.	SE-29672347	E2, E4, G1
239.	SE-29672728	E4, E7, E9
240.	SE-29676958	E2, E4, E7, E10, G1, J1
241.	SE-29677743	B2, E2, E3, E4, E7, F1, F3, G3, H1, N2, N4, N5
242.	SE-29682250	B4, E2, E4, E10, G1
243.	SE-29684994	B4, G3
244.	SE-29687666	B1, B2, C1, E2, E3, E4, E6, F1, F2, F4, G1, G2, G3, G5, H1, N2, N4, N5
245.	SE-29688223	E2, E4, M
246.	SE-29689113	B5, C2, E1, E2, E6, E7, E9, F4, J1
247.	SE-29689725	E4
248.	SE-29694458	C1, E1, E2, E3, E4, F4, G1, G2, G3, H1
249.	SE-29695458	C1, C4, C5, E2, E3, E4, E9, G1, G3, J1
250.	SE-29697525	E4, E10
251.	SE-29699990	E2, E4, E7, E9, E10, N2
252.	SE-29700225	E1, E4, E10
253.	SE-29705319	C1, E2, E6, E7, E9, F4, G1, J1, N2, N4
254.	SE-29705322	B1, B2, C2, C5, E1, E6, F1, H4, J1, N2, N4
255.	SE-29709347	B5, C1, E1, E2, E3, E4, E7, F4, J1, N2
256.	SE-29710590	B4, E1, E4, E7, G1, H6
257.	SE-29712209	E2, E4, E10, G1
258.	SE-29712328	E4, E7, M
259.	SE-29712407	B1, B4, C1, E4, E6, E7, E10, G1, G3, G4, H1, H2, N2, N4
260.	SE-29712437	E1, E2, E4, E7, E9, E10, G1, H1, J1, K, M
261.	SE-29712440	C1, E2, E4, E10, F4, G1
262.	SE-29712979	E2, E4, F4, G1
263.	SE-29713475	C1, E3, E4, E7
264.	SE-29713743	E2, E4, E10, G1
265.	SE-29713746	E1, E2, E4, E7, E10, F4, G1, G2
266.	SE-29731486	C1, E1, F4, G1
267.	SE-29732139	E1, E2, E4, E10, F4, G1
268.	SE-29732165	E2, E4, E10, G1
269.	SE-29732266	E2, E4, G1

No.	Submission number	Issues raised
270.	SE-29732507	E1, E2, E4, E7, E10
271.	SE-29732510	E4, E9, E10, G1
272.	SE-29732549	B1, C1, E2, E3, E4, E6, E7, G1, G2, G3, G5, H2, N2, N4
273.	SE-29732739	B4, E2, E3, E4, E6, E7, E9, E10, G1, H1, H2, J1
274.	SE-29732757	C1, E1, G1, G2, G3, G5, K1
275.	SE-29732979	E1, E4, N4
276.	SE-29733012	B1, B5, C1, E1, E2, E3, E4, E6, F1, F2, F4, G1, G2, G3, G5, H1, H2, N2, N4, N5
277.	SE-29733493	E4
278.	SE-29733534	E1, F4, G1
279.	SE-29733551	C, E4, G1, G4, K1
280.	SE-29733555	E2, E4, E10, G1
281.	SE-29733559	E2, E4, E10, G1
282.	SE-29733653	B1, B2, C1, E1, E2, E3, E4, E6, F1, F2, F4, G1, G2, G3, G5, H1, H2, N2, N4, N5
283.	SE-29733690	B4, C1, E1, E2, E4, E7, E10, F4, G1, G5
284.	SE-29737129	E1, E2, E3, E4, G1, H1, K1
285.	SE-29737150	B4, B5, C1, C2, C4, E1, E2, E9, G1, G2, G3, H3, J1, K1, M, N4
286.	SE-29737173	E1
287.	SE-29737175	B4, C1, C2, E2, F4, G1, G2, G3, H1, H5, K1
288.	SE-29761322	E2, E4, G1
289.	SE-29761381	D, F3, N4, N5
290.	SE-29761413	B4, C1, E2, E4, E6, F4, G1, G3, G5, H1, J1, N3
291.	SE-29761460	B2, B4, B5, C1, C2, C3, C5, E2, E4, E6, F1, F3, G1, G2, G3, H2, J1
292.	SE-29761491	E4, G1, G2
293.	SE-29761498	E2, E4, G1
294.	SE-29761584	E2, E4, E10, G1
295.	SE-29762211	E4
296.	SE-29762231	B2, C3, F1, F4, G1, G2, G3, H1, H2
297.	SE-29762461	G1, G3, N2
298.	SE-29762466	E2, E4, E10, G1
299.	SE-29764959	F4
300.	SE-29764973	E1, E4, E7, E10
301.	SE-29764977	E2, E4, G1
302.	SE-29765230	E2, E4, E10, G1

No.	Submission number	Issues raised
303.	SE-29768515	E1, E7, F2, N2
304.	SE-29768518	E2, E4, F4, G1
305.	SE-29768534	B1, C1, E2, E3, E4, E6, E7, F1, F2, F3, F4, G1, G2, G3, G5, H1, H2, N2, N4, N5
306.	SE-29768613	C1, E2, E4, F4, G1
307.	SE-29769020	B1, B5, C1, E2, E3, E4, E6, E7, F1, F3, F4, G1, G2, G3, G5, H1, H2, N2, N4, N5
308.	SE-29773213	C1, C2, C5, E2, F4, G1, G2, H1, K1, N4
309.	SE-29790039	E4
310.	SE-29796742	E1, E2, E4, G1
311.	SE-29797730	F4, G1, J1, K3
312.	SE-29798481	C4, J1, L1, L2, M
313.	SE-29798858	C5, E2, E4, E6, E7, F1, G1, G2, G3, H1, K1, K2, M, N2, N4
314.	SE-29800104	B2, B3, B5, C2, C3, E9, F1, F4, G1, H1, H2, J1, K1, K2, K3, L1, N2, O1, O2
315.	SE-29813321	B1, B2, E1, E2, E6, E9, G1, G3, H2, N4
316.	SE-29814079	E1, E4, F2, F4
317.	SE-29816840	B5, C, C1, E2, E7, F2, G1, G2, G3, H1, H4, H5, N2
318.	SE-29821728	E2, E4, E10, G1, N2
319.	SE-29823600	C3, C7, H1, H2, H4
320.	SE-29825892	C5, E1, E4, F4, G1, H3, H4, L5
321.	SE-29833214	C1, E1, E4, E7, K1, N2
322.	SE-29839533	C1, E1, E2, E3, E4, F4, G1, G2, G3, K3
323.	SE-29841049	E4, E10, G1
324.	SE-29841137	B2, B4, E1, G1, G3, G4, H2
325.	SE-29843035	E2, E4, E10, G1
326.	SE-29843713	B2, B4, B5, C1, C2, C5, E1, E10, F4, J1, N2, N4
327.	SE-29844020	B1, C1, E1, E6, E9, F3, F4, G1, G3, H1, H2, N4, N5
328.	SE-29885475	B2, E1, N2, N4
329.	SE-29892790	B4, C1, C5, E1, E2, E3, E4, E5, E6, E8, E9, F1, F4, G1, G3, G4, G5, H1, K1, N2, N4, N5
330.	SE-29896208	E1, E2, E4, E7, E9, E10, F4, G1
331.	SE-29902540	E4, E10
332.	SE-29905709	B1, C1, E2, E3, E4, E6, E7, F1, F2, F3, F4, G1, G2, G3, H1, H2, N4, N5
333.	SE-29905711	E4
334.	SE-29906029	E1, E2, E4, G1, M

No.	Submission number	Issues raised
335.	SE-29912004	B2, E1, E7, G2, N2, N4
336.	SE-29912468	E1, E4, E7, E10, M, N2
337.	SE-29913161	E4, E10
338.	SE-29920162	B2, B4, E1, E2, E4, E6, E7, E9, E10, F1, F2, F3, F4, G1, G2, G3, G5, H1, H6, N2, N4
339.	SE-29920623	E4, E7, E10, G1
340.	SE-29920823	E4, E10
341.	SE-29921067	B2, E7, F4, G2, K1, M, N2
342.	SE-29921092	E2, E4, E7, N2
343.	SE-29921411	E1, E4, E10, G1, N4
344.	SE-29923675	B3, B4, B5, C2, E2, E3, E4, E5, E10, F4, G1, G5, J1
345.	SE-29923886	B5, E1, E2, E4, E10, G1, M
346.	SE-29926714	E4, E10
347.	SE-29926727	C5, E2, E3, E4, F4, G1, G2, G3, G5, H1
348.	SE-29926989	B2, B4, E1, E2, E3, E4, E6, E7, E10, F2, F4, G1, G2, G4, G5, H1, N4
349.	SE-29949457	E1, E2, E3, E4, E7, F3, F4, G1, G2, G4
350.	SE-29950769	B1, C1, C2, C4, E1, E2, E2, E3, E4, E6, G1, G2, G3, N4
351.	SE-29956784	B2, B4, E1, E2, E3, E4, E7, F4, G1, G2, G4, H1, N2
352.	SE-29957000	B1, B2, E2, E7, F2, G1, H1, H2, J1, N2, N4, N5
353.	SE-29959051	B4, E2, E4, G1, H4, J1
354.	SE-29963144	B4, B5, C1, E2, F4, F3, G1, H1, N4
355.	SE-29968462	E2, E4, E7, E10, F4, G1
356.	SE-29968707	B2, B4, E2, F4, G1, N4
357.	SE-29971051	E2, G1
358.	SE-29976376	B4, E1, E4, E7, E10, G1, G5
359.	SE-29977770	E1, G1, G3, G4, H6, J1
360.	SE-29979741	B2, E2, E4, E7, E10, G1
361.	SE-29984478	B5, C1, E6, E9, F4, G2, H1, H6, J1, K1, N4
362.	SE-29995553	E2, E4, E10, G1
363.	SE-29998997	B4, B5, E7, H1, H5, J1
364.	SE-29999514	A, B4, H1, H4
365.	SE-30002383	B2, E4, F4, N2
366.	SE-30016011	E4
367.	SE-30029034	B1, B4, C1, E2, E6, E7, F1, F2, G1, G2, G3, G4, H1, H2, J1, K2, N4, N2, N5
368.	SE-30032243	F4, K2,

No.	Submission number	Issues raised
369.	SE-30036615	E2, E4, E10, G1
370.	SE-30050099	E2, E4, E10, G1
371.	SE-30051997	B4, E1, F4
372.	SE-30066947	B2, B5, E1, E7, F4, G1, G2, G3, H1, H6, J1, J2, K
373.	SE-30070262	B2, B4, C1, E2, E3, E6, E7, E9, E10, F4, G1, G2, H1, H4, J1, N4, M
374.	SE-30070364	B1, B4, B5, C1, E2, E3, E4, E6, E7, F1, F2, F4, G1, G2, G3, G4, G5, H1, H2, J1, N2, N4, N5
375.	SE-30070403	E2, E4, G1
376.	SE-30093460	E1, E4,
377.	SE-30104997	B4, E1, F4, H1
378.	SE-30108287	C5, E4, E10, G1, G5, J1
379.	SE-30120200	B1, C1, E2, E3, E4, E6, F1, F2, G1, G2, G3, H1, H2, N2, N4, N5
380.	SE-30131894	E4, E10, G1
381.	SE-30131896	B2, B4, C5, E1, E2, E3, E4, E5, E6, E10, F1, F2, F4, G1, G2, G3, G5, H1, J1, N4
382.	SE-30131920	E2, E4, E10, G1
383.	SE-30140348	E1, E4
384.	SE-30141602	E1, E4, E10, G1
385.	SE-30142387	E1, E4,
386.	SE-30142444	E2, E4, F4, G1
387.	SE-30142450	E1, E4, E7, F4
388.	SE-30155072	E2, E4, E10, G1
389.	SE-30155095	E2, E4, E10, G1
390.	SE-30155178	E4, E7
391.	SE-30157244	E4, E7, M
392.	SE-30157298	E2, E4, G1
393.	SE-30157756	E2, E4, G1
394.	SE-30157803	E2, E4, E7, E10, G1
395.	SE-30159727	B2, B3, B4, C1, E1, E2, E7, E10, G1, F4, H1, H2, K2
396.	SE-30159782	E4
397.	SE-30159973	B2, E4, J1
398.	SE-30160014	E4
399.	SE-30160232	E2, E4, G1
400.	SE-30160279	E4, E7
401.	SE-30160488	E2, E4, E10, G1

No.	Submission number	Issues raised
402.	SE-30160491	B2, C2, C3, C5, C6, C7, E2, E3, E4, G1, G2, G3
403.	SE-30167285	E2, E4, E10, G1
404.	SE-30167382	E2, E4, E10, G1, M
405.	SE-30177744	B2, E4, E2, E7, G1, J1
406.	SE-30177768	E2, E4, G1
407.	SE-30180208	E2, E6, G1
408.	SE-30187492	B6, H2, L1, L4, L5, M
409.	SE-30187529	E2, E4, E10, G1
410.	SE-30203031	E2, E4, E7, E10, G1
411.	SE-30203333	B5, C4, C7, E6, E10, F2, G1, H6, M
412.	SE-30203972	B3, B5, C1, E1, E2, E4, E5, E9, E10, F4, G1, G5, H1, H2, H6, J1, K, L1, N3, N4
413.	SE-30204781	E1, E2, E3, E4, E5, E6, F4, G1, G3, H1, K1, M, N4
414.	SE-30207497	E2, E4, E10, G1
415.	SE-30210539	E1, E4
416.	SE-30224296	E1, E4, E7
417.	SE-30230958	E2, E4, E10, G1
418.	SE-30251245	E4, F4
419.	SE-30264011	E4
420.	SE-30269680	B2, B3, B4, C1, E2, E3, E4, E6, E7, E9, F1, F4, G2, G3, H1, H2, J2, K, N2, N4
421.	SE-30291243	B5, C1, E2, E4, E6, E10, F4, G1, G2, G3, H1, H6, N2, N4
422.	SE-30291269	C1, G1, H6
423.	SE-30294236	C1, E1, E2, E6, F4, E7, G1, G2, G3, G5
424.	SE-30294457	E2, E4, E10, F1, F4, G1
425.	SE-30310047	C1, E1, E2, E4, E10, G1, H1, H2, J1, H4
426.	SE-30313419	E2, E3, E4, F2, F4, G1, G2, G3, N4
427.	SE-30315980	G1, G5, H1
428.	SE-30317566	E4, G1
429.	SE-30320302	B1, B4, B5, B6, C1, C2, E1, E2, E3, E4, E6, E7, F1, F2, F4, G1, G2, G3, G5, H1, H2, J1, N2, N4, N5
430.	SE-30320459	B2, B5, E1, G1, H1, K
431.	SE-30320559	C1, F3, G1, G5, H1
432.	SE-30327453	E4
433.	SE-30329124	B2, C5, E2, E10, F4, G2
434.	SE-30329573	B1, B2, C1, E2, E6, F1, F2, F4, G1, G2, G4, G5, H1, H2, N2, N4, N5

No.	Submission number	Issues raised
435.	SE-30331754	E1, H1, H4, H6
436.	SE-30331857	C2, C5, E1, G1, H1
437.	SE-30365272	C3, C4, C5, E1, E2, E3, E4, E5, E6, F4, G1
438.	SE-30370044	B2, B5, E2, F4, G4, G5, N4
439.	SE-30371112	E2, E4, E10, G1
440.	SE-30391759	B2, F4, G1, H1
441.	SE-30394990	C1, C2, C3, C5, C7, E2, E3, E4, F4, G1, G2, G3, H6
442.	SE-30395527	E2, E4, E7, E9, E10, G1
443.	SE-30398273	C5, E2, E7, F4, G1, G2
444.	SE-30444760	A, B3, J1, K, N4, H6, O2
445.	SE-30450963	E2, E4, E10, G1
446.	SE-30452913	B6, H5, L1, L2, L3
447.	SE-30455777	B2, E4, F4, G3, G4, H1
448.	SE-30460478	B2, E1, E7, G1, H1, H2, J1, N2
449.	SE-30480332	B2, C5, E1, E2, F4, G1, H2, J1, K1, L1
450.	SE-30483746	E1, E4, E7
451.	SE-30490400	B2, B5, C5, F4, G1, G4, H4, J1
452.	SE-30492357	B2, C1, E2, G1, G3, H1, H4, J1
453.	SE-30492373	E7, H, K2
454.	SE-30494310	B2, E1, E2, E7, E9, F4, G1, G3, H3, J1, K2
455.	SE-30494312	E7, N2
456.	SE-30495707	B1, C1, E1, E2, E3, E4, F1, F2, F4, G1, G2, G3, H1, N2, N4
457.	SE-30495718	B2, B5, E7, E9, G1, J1, K, M, N2
458.	SE-30495725	C5, G3, H1
459.	SE-30495757	B2, G1, G2, G5
460.	SE-30495760	B4, C5, E2, G1, H1, N2
461.	SE-30495781	B2, C1, E1, E8, G1, H1, H4, J1, M
462.	SE-30495974	B1, B5, C1, E6, F1, F4, G1, G2, G3, H1
463.	SE-30495977	C1, E2, E3, E4, E7, G1, G2, G3, H1, J1
464.	SE-30495996	B1, E2, E6, F1, N2, N4, N5
465.	SE-30497315	B1, B2, C1, E2, E3, E4, F2, F3, F4, G1, G2, G5, H1, K, N2, N4
466.	SE-30498207	C1, F2, F4, G1, G2, G3, G5, H1, H6
467.	SE-30498212	B4, C1, E7, F4, G1, J1, K1
468.	SE-30498217	E9, G1

No.	Submission number	Issues raised
469.	SE-30498478	B2, E1, E7, E9, F4, G1, G3, H1, H6, J1, K1, M, N4, N5
470.	SE-30498486	B1, C1, E2, E3, E4, E6, F1, F2, F3, G1, G2, G3, G4, H1, N2, N4, N5
471.	SE-30498642	B2, B4, E7, H1
472.	SE-30498667	B4, C1, E7, G1, G3, H1
473.	SE-30499736	B4, C1, F3, F4, G1, G4, H2, J1, N2
474.	SE-30499818	C5, E1, J1
475.	SE-30499821	C1, F4, G1, H1
476.	SE-30499825	E1, E2, E3, E4, G1, G2, G3, G5
477.	SE-30499837	E1, F4, G1, G2, G3, H1, H3
478.	SE-30499960	E7, H1, N2, N5
479.	SE-30499981	C1, C3, C4, C5, E3, E4, F4, G1, G3, G5
480.	SE-30499984	E7, F4, G3, K1, N2, N5
481.	SE-30499986	B2, F4, G1, G2, G5, N2
482.	SE-30500707	B1, E2, E6, N2, N4, N5
483.	SE-30500725	C1, E7, M
484.	SE-30500733	B1, C1, G1, J1, N2, N4
485.	SE-30500737	C1, E1, E7, E10, F4, G1, N2, N4
486.	SE-30501217	C1, E2, F4, G1, K1, M, N5
487.	SE-30501219	B4
488.	SE-30501223	B1, C1, E2, E3, E4, E6, F1, F2, F3, G1, G2, G3, G4, G5, H1, N2, N4, N5
489.	SE-30504715	E, E2, N4
490.	SE-30506714	A, H4
491.	SE-30506716	B5, E1, E2, E3, E4, E6, E7, E10, F1, F2, F3, F4, G1, G2, G3, G5, H1, J1, K1, K2, N4, N5
492.	SE-30506721	B2, B5, E1, F4, J1, M
493.	SE-30506725	B2, B3, G1, G3, H1, M
494.	SE-30507210	E2, F4
495.	SE-30509236	C1, E3, E2, E4, E7, G1, G2, G3, G4, G5
496.	SE-30509247	B4, E2, E4, F4, G1, H1
497.	SE-30510208	B1, B4, C1, C2, C4, E2, E6, F1, F2, G3, H1, K1, N2, N4, N5
498.	SE-30510210	B5, C8, E7, F4, G1, H1, H4, J1, L1
499.	SE-30511464	E1, E2, F4, G1, H2
500.	SE-30511734	E1, F2, F4
501.	SE-30511738	M
502.	SE-30512207	C1, E1, E2, E7, E9, N2

No.	Submission number	Issues raised
503.	SE-30512222	B1, B4, C1, E2, E3, E4, E6, F1, F2, F4, G1, G2, G3, H1, N2, N4, N5
504.	SE-30512225	B4, E1
505.	SE-30512982	C1, F3, F4, G1, L1, N4
506.	SE-30512985	B4, E7, G1, G3
507.	SE-30513051	B2, B4, M, N2
508.	SE-30513087	B3, C4, H2, H5
509.	SE-30513095	B2, E2, E4, F4, G2, H1, H6
510.	SE-30514460	B1, E2, E6, F1, F2, F4, G1, G2, G3, G5, N2, N4, N5
511.	SE-30514486	B2, E7, G1, G2, G5, N2
512.	SE-30514501	C1, C5, G1, H6
513.	SE-30514534	E1, J1, M
514.	SE-30514597	B1, B2, B3, E1, G3, H2, J1, N2, N4
515.	SE-30514684	C1, E2, E6, F1, F3, G1, G2, G5, H1, K1, N2, N4, N5
516.	SE-30516468	B2, G1, H2, J1
517.	SE-30516512	B2, E2, E6, E7, E9, F2, F3, F4, G3, H1, H2, H6, N2
518.	SE-30516566	B5, E6, E7, F4, F1, G1, G2, H2, N2, N4
519.	SE-30520095	C2, C5, E7, G1, G3, G4, H3, H6, K2
520.	SE-30520098	E2, E9, G1, G2, G3, G5, K1
521.	SE-30520117	E2, E4, E10, G1
522.	SE-30523996	B4, B5, C1, E1, E2, E6, E7, F1, G1, G2, G4, H1, M
523.	SE-30523999	C1, E1, F4, G1, L1
524.	SE-30524001	B5, C1, E1, E7, F4, G4, H2, K1, N2, N4
525.	SE-30524005	B6, E1, E7, F4, N2
526.	SE-30524007	B4, E1, E9, F4, G1, K1, M, N2, N4
527.	SE-30524009	B2, E2, G1, G3, N2, N4
528.	SE-30524012	G4, E7, K1
529.	SE-30526726	C1, C5, E7, G1, K1, M
530.	SE-30526729	B2, E9, H1, H4
531.	SE-30526742	C5, E5, F4, G3, H1
532.	SE-30526745	B5, C2, C5, F4, G1
533.	SE-30526747	C1, C2, C5, C6, C7, H1, H2
534.	SE-30526754	E1, G2, G5, J1, N2, N5
535.	SE-30526757	E1, E2, E7
536.	SE-30526776	E4, E7, E10, G1

No.	Submission number	Issues raised
537.	SE-30529222	E2, E7, F4, G1, H1, H3, J1
538.	SE-30530041	E2, E4, E10, G1
539.	SE-30531358	B4, C1, C2, E2, F1, G1, J1, K1, N2, N4, O1
540.	SE-30531361	E2, E4, E10, G1
541.	SE-30551723	E2, E4, E10, G1
542.	SE-30553983	E4
543.	SE-30554242	B2, B3, E2, E4, E7, E10, F4, G1, J1, N2
544.	SE-30556803	E2, E4, E10, G1
545.	SE-30566735	E2, E4, E10, G1
546.	SE-30566899	E1
547.	SE-30566920	B3, B4, C1, E1, E7, G1, H1, H4, N2, N4, M
548.	SE-30575832	B4, E2, E7, F4, H2, N2, N4
549.	SE-30575836	B2, B4, F4, G1, G2, J1
550.	SE-30575881	E2, E3, E4, E6, G1, G2, G3
551.	SE-30575923	B2, G1, J1
552.	SE-30588066	C5, E1, E9, F4, G1, H1, J1, K2
553.	SE-30588157	F4, E1, E2, M
554.	SE-30589334	B2, B6, E1, F4, G1, G2, H1, K1, H6, M
555.	SE-30589464	B1, C1, E2, E6, F1, H1, N2, N4, N5
556.	SE-30589469	B4, E1, E7, G4
557.	SE-30589491	B4, C1, E1, E2, E3, E4, E6, E7, F1, G4, H1, J1, N2, N4, N5
558.	SE-30589494	B2, B4, F2, F4, K1
559.	SE-30589650	B1, C1, E2, E3, E4, E6, F1, F2, G1, G5, G2, G3, H1, N2, N4
560.	SE-30589675	C1, E2, E3, E4, E7, F4, G1, G2, G3, G5, K1
561.	SE-30589711	B2, C1, E2, E6, F3, G1, H1, J1, K1
562.	SE-30589715	B4, E1, E7, N2
563.	SE-30589739	B2, B4, H1
564.	SE-30589819	B2, B4, E7, F2, F3, F4, G1, J1, K1, N5
565.	SE-30589871	E1, E3, E4, E7, E9
566.	SE-30589907	E1, E2, E4, E7, G1
567.	SE-30589947	B2, C5, H1, H6, J1
568.	SE-30590211	E1, E2, E3, E4, F4, K1, N5
569.	SE-30590216	E1, F4, G1, G2, G5, H1, J1, J2
570.	SE-30590239	J1, K1

No.	Submission number	Issues raised
571.	SE-30590255	B4, C1, C5, E1, F4, G1, H1, H3, J1, K1, N2
572.	SE-30592571	E2, E3, F4, G1, G3, H1, J1, K1
573.	SE-30594061	F4, G1, L1
574.	SE-30594070	C1, E2, E3, E6, E9, E10, F1, F4, G1, H1, N4
575.	SE-30594072	C1, E3, E4, F2, F4, G1, G3, G2, H1, K1, M
576.	SE-30594075	B2, C1, E1, E2, F4, N4
577.	SE-30594181	B5, C1, C4, C5, E1, E4, E9, F4, H2, J1
578.	SE-30594211	C1
579.	SE-30594983	E1, F4, H6
580.	SE-30595126	J1
581.	SE-30596560	F4, G1, H2
582.	SE-30596573	C1, E1, E3, E4, E7, G1, G2, K1
583.	SE-30596980	E7, N2
584.	SE-30596984	C1, E1, E7, E10, F1, K1, N2, N4, N5
585.	SE-30597009	C1, E1, K1
586.	SE-30597011	C5
587.	SE-30597063	B2, C1, E1, E9, G4, H4, J1, K3, N2
588.	SE-30597139	B2, B4, B5, C1, C5, E7, H1, H6
589.	SE-30597151	E2, F2, F4, G1, G3, N4
590.	SE-30597164	E1, E2, F4
591.	SE-30598982	B1, B5, C1, E7, F4, G1, H1, N2, N4
592.	SE-30598984	A, B4
593.	SE-30598986	B1, E1, E2, E3, E4, G1, G2, G3, G5, H1, N2
594.	SE-30601463	B2, E1, E7, G1, G3, H1, H6, J1
595.	SE-30601501	C1, E1, E2
596.	SE-30601504	B5, C1, M
597.	SE-30601509	G3
598.	SE-30601600	L1
599.	SE-30601605	C1, F4, K1
600.	SE-30601627	B5, C1, F4, G1, G2, H1, J1, K1, N2
601.	SE-30601684	E9, G3, H1, H6, J1, K1, N2
602.	SE-30601761	E1, J1
603.	SE-30601764	B2, B4, E1, G1, E10, J1, N2, N3
604.	SE-30601767	C1, E2, E6, F4, G3, N3, N4

No.	Submission number	Issues raised
605.	SE-30601771	B4, E1
606.	SE-30602212	B2, E1, F4
607.	SE-30603709	E1, K2
608.	SE-30605462	E4, E2, E6, E10, G1
609.	SE-30605517	B1, C1, E2, E3, E4, E6, F1, F4, G1, G2, G3, G5, H1, N2, N4, N5
610.	SE-30605537	G1, N2
611.	SE-30605544	B2, E7, G1, N2
612.	SE-30605552	C1, E2, E7, F4, K1
613.	SE-30605611	F3, F4, G1, H1, N2, N4
614.	SE-30606207	B4, C1, E7, G1, K1, N2
615.	SE-30606230	E7, B4, G, G3, H1, H6, J1
616.	SE-30606249	E7, F4, G3, K1
617.	SE-30606733	A
618.	SE-30606738	E1, E7
619.	SE-30606741	B4, E1, J1
620.	SE-30606745	B2, E1, E7, H6
621.	SE-30606803	C7
622.	SE-30606815	E1, F4
623.	SE-30606826	B2, G1, H6, K1
624.	SE-30607465	B2, E1, E3, E7, E9
625.	SE-30607469	B2, B4, E1, E5, F4
626.	SE-30607472	C1, E1, E6, E7, F4, G1, H1, J1
627.	SE-30607475	B2, B4, B5, E1, E9, F4, G1, H1, J1, K1, N4
628.	SE-30607478	B4, E7
629.	SE-30607495	E7, G1, N2
630.	SE-30607498	E7
631.	SE-30607501	B2, E1, E7
632.	SE-30607503	B2, E1, E7, F4
633.	SE-30607506	E1, E7, G1, J1
634.	SE-30607509	C1, J1
635.	SE-30607511	B4, C1, F4, G1, G2, H1, N2, N4
636.	SE-30607514	C1, F2, F4, G1, G2, G3, N4
637.	SE-30608212	C1, F1, F4, G1, G2, G3, N5
638.	SE-30608214	B1, C1, E2, E3, E4, E6, F1, F3, F4, G1, G2, G3, N4, N5

No.	Submission number	Issues raised
639.	SE-30608242	C1, F3, H1, N2, N4, N5
640.	SE-30608263	B1, B2, C1, E1, E2, E3, E4, E6, E7, F1, F3, F4, G1, G2, G3, H1, H6, J1, N4, N5
641.	SE-30608291	C1, C2, H6, K1
642.	SE-30608959	E1, E7, F4, G1, G5
643.	SE-30611121	C5, E5, E8, G1, G2, G3, G4, K1
644.	SE-30611124	B2, B4, E6, E7, H1, N5
645.	SE-30611129	C1, E1, E2, E7, E9, F4
646.	SE-30611134	E1, F4, G1, G3
647.	SE-30611146	B4, C7, H3, J1, J2
648.	SE-30611166	E1, E2, E3, E4, F4, G1, G2, G3, G5
649.	SE-30611175	B2, F4, G1, G3, K1
650.	SE-30611184	B2, B5, E7, F4, G4
651.	SE-30611200	E1, E5, G3, K1
652.	SE-30612964	C1, E1, F4
653.	SE-30613238	B2, E1
654.	SE-30613263	B2, E2, E6, E7, F4, G1, G4, H6, J1, N4
655.	SE-30613391	B2, E1
656.	SE-30613410	C1, E2, E6, F3, F4, G1, G2, N2, N4, N5
657.	SE-30613433	B2, B4, E6, E7, F3, G1, G2, N4
658.	SE-30614710	E1, E7, E9, F4, G1, G5, K1, N4
659.	SE-30614714	B2, H4, J1, M
660.	SE-30614737	E1, E7, F4, N4
661.	SE-30615232	B2, E7, F4, G1, G2, G5, J1
662.	SE-30615456	B2, E7, F4, G1, G2, J1
663.	SE-30615963	B4, E1, F4, N2
664.	SE-30615968	B2, B4, E1, E6, E7, G1, G2, G3, H1, J1, N4
665.	SE-30615983	N2, N4
666.	SE-30616005	B2, E7, G1
667.	SE-30616222	E1, G1, G3, H6
668.	SE-30616227	B2, E1, E7, E9, F4, G1, J1, N4
669.	SE-30616232	E1, F4
670.	SE-30616239	E1, F4
671.	SE-30616242	B5, C5, E1, F4, H1, J1
672.	SE-30616245	A, B2, C, M

No.	Submission number	Issues raised
673.	SE-30616249	B2, E1, E7, G1, J1
674.	SE-30616966	B1, B2, B4, C1, C4, C5, C7, F4, G1, G2, N4
675.	SE-30616988	B1, C1, E1, E2, E3, E4, E6, F1, F2, F3, F4, G1, G2, G3, G5, H1, N2, N4, N5
676.	SE-30616990	E1, E7, F4
677.	SE-30617002	E1
678.	SE-30617005	B2, B4, C1, E7, M
679.	SE-30617070	B4, E7
680.	SE-30617096	E7, E9, G1, G2
681.	SE-30617115	B2, C1, F1, F4, G1, G3, K1, N4
682.	SE-30617125	B2, C1, E1, E7, H5
683.	SE-30617141	C1, E1, E7, E9, G1, G2, G4, G5, H1, K1
684.	SE-30617207	B4, E7, F4, G1, G2, G4, J1, N2, N5
685.	SE-30617231	B2, C1, E2, E3, E4, E7, G1, G2, G3, G5
686.	SE-30619208	B2, E7, G1, M
687.	SE-30619957	C1, E1, M
688.	SE-30619964	B2, H1, H3, N4
689.	SE-30619967	J1, M
690.	SE-30619970	B1, C1, E2, E3, E4, E6, F4, G1, G2, G3, G5, H1, N4, N5
691.	SE-30621207	E7, F4, G1
692.	SE-30621236	E2, E6, E7, F1, F4, G1, G2, H1, I, J1, K2, N2, N4, N5
693.	SE-30621239	B2, C1, C3, C4, E7, G1, G2, G4, H2, J1, N4
694.	SE-30621243	B1, C1, E1, E2, E3, E4, E6, F1, G1, G2, G3, G5, H1, N2, N4, N5
695.	SE-30621261	C1, F2, F4, G1, G2, G3, J1
696.	SE-30621711	H2, H3, H4, H6, J1
697.	SE-30622208	B5, F4, G1
698.	SE-30622210	B2, C1, C7, C8, G1, H1, H2
699.	SE-30622212	C1, C5, E4, F4
700.	SE-30622303	E2, E3, E4, E5, E7, G1, G4
701.	SE-30623518	B2, B5, H2
702.	SE-30623528	B2, C1, H4, J
703.	SE-30623533	B1, C1, E2, E6, F1, F2, F4, G1, G2, G5, H1, N2, N4, N5
704.	SE-30625775	E1, F4, H2, J1, M
705.	SE-30628757	C1, C6, H3, J1, M
706.	SE-30628932	C5, F4, G1, G2, H1, H2, J1, L5

No.	Submission number	Issues raised
707.	SE-30635998	C1, E2, E4, E7, E9, G1, N4
708.	SE-30636106	B4, C1, C2, C3, C5, C7, E2, E3, E4, G1, G2, G3, G4, H6
709.	SE-30655829	E2, E4, G1
710.	SE-30664465	B5, J1, N2
711.	SE-30664713	B2, G1, N2
712.	SE-30666771	A, B2, F4, H2, J1, J2, K2
713.	SE-30667244	B1, C1, E2, G1, G5, N2, N4
714.	SE-30667268	E1, E9
715.	SE-30667294	E1, E9, F4, H2, H4
716.	SE-30667312	B1, C1, E1, F4, G1, G5, K1, N2
717.	SE-30667334	B2, E2, F4, G1, H6
718.	SE-30667340	B2, E7, G1, G5, K2, N2
719.	SE-30667431	B2, G1
720.	SE-30667434	E2, J1
721.	SE-30667438	E2, E3, E5, F4, G1, G3, H3
722.	SE-30667440	B1, B2, E1, E2, E6, F2, F4, G1, G5, H1, J1, N2, N4
723.	SE-30667443	E1
724.	SE-30667448	C1, F4, G1, M
725.	SE-30667765	B5, E1, E7, G1, K1
726.	SE-30667784	B2, E6, E7, E9, G1, G3, G4, G5, H2, H4, H6, L5
727.	SE-30667818	E1, G1
728.	SE-30667822	B2, E7, F4, G1, G2, G3
729.	SE-30667861	B4, E1
730.	SE-30667878	E1, G2, H3, H6
731.	SE-30667882	C1, E7
732.	SE-30667886	B1, C1, E1, E2, E6, F1, F3, F4, E7, G1, G3, G5, J1, N4, N5
733.	SE-30668519	B4, C1, E2, E3, E4, E5, E6, E7, F2, F4, G1, G2, G3, H1, H6, N2
734.	SE-30668525	B4, E1, H2
735.	SE-30668583	E1, F4, G2
736.	SE-30668587	C1, H1, J1
737.	SE-30669723	C3, C4, C5, G2, G3, H6
738.	SE-30669726	C1, E2, E3, E4, F2, F4, G1, G2, G3, G5, N4
739.	SE-30669729	E1, E3, E5, G1, G3, K1
740.	SE-30669734	E7, F4, N2, N4

No.	Submission number	Issues raised
741.	SE-30669743	B3, C1, H1, H6
742.	SE-30669749	F4, G4, H6, K1
743.	SE-30669758	B2, H5, J1
744.	SE-30669760	E9, G1, G2, G3, G5, K1
745.	SE-30670002	B2, C5, E1
746.	SE-30670005	B4, C1, E1, E9, G1
747.	SE-30670008	E1, E7, F4, N2, N4
748.	SE-30670011	B1, B4, E2, E6, F1, G2, G3, G4, N4
749.	SE-30670013	B2, C1, E1
750.	SE-30670016	C1, E1, H1
751.	SE-30670019	B1, B5, C1, C5, E6, F1, F4, H1, H2, H6, J1
752.	SE-30672458	A, J1, J2, M
753.	SE-30672958	B3, C5, E1, F4, H2, H6, J1, M
754.	SE-30672983	E2, E3, E4, G1, G2, G3, G5
755.	SE-30672998	B2, E7, J1
756.	SE-30673006	F4, G1, G3
757.	SE-30674212	F4
758.	SE-30678204	B4, F4, G3
759.	SE-30681252	B4
760.	SE-30681274	B2, B4, E1, E2, E3, E4, F2, F4, G1, G2, G3, G5, H1, H6, N4
761.	SE-30681277	C1, E1, E7, G3, G5, H3, H6, K2
762.	SE-30681293	C1, E7, H3
763.	SE-30681298	C1, E1, F4, G2, H1, H6, N4
764.	SE-30681303	C1, C4, C5, C8, E1, E9, F4, G3, H2, H6, N4
765.	SE-30681310	A, J1, M
766.	SE-30681314	B2, J1
767.	SE-30681316	E1, E9, H6, M
768.	SE-30681319	E7, E9, H1, I, J1, M
769.	SE-30681336	C1, C5, E1, E6, E7, F4
770.	SE-30681339	B2, E1
771.	SE-30681350	E7, E9, G1, H6, N2
772.	SE-30681374	E1, E7
773.	SE-30681388	B4, C1, E7, G2, H1, N2
774.	SE-30681398	C6

No.	Submission number	Issues raised
775.	SE-30681403	E1, E6, E7, F4, G1, G3, K1
776.	SE-30681406	B2, E2, F4, G1, H6, K1
777.	SE-30681409	N2
778.	SE-30681412	C1, F2, G1, G2, H1, N4
779.	SE-30681424	E1, F4, H1
780.	SE-30681711	E2, E3, E4, E6, E9, F2, F4, G1, G3, G5, N2, N4
781.	SE-30681715	E1, F4, H1, G1, G5
782.	SE-30681957	C5, E1, F4, H1
783.	SE-30681959	B1, C1, C2, C4, E1, E2, E6, E7, F2, F4, G1, G5, H1, J1, N5
784.	SE-30681962	C1, E2, E6, N4
785.	SE-30681964	E1
786.	SE-30681967	C1, E2, E3, E4, G1, G3, K1
787.	SE-30681983	E2, F2, F4, G1, G2, G5
788.	SE-30681985	B2, C3, C5, E1, E2, F2, F4, G1, G5, H1, H6, N2
789.	SE-30681996	E2, E3, E4, F3, F4, G2, G3
790.	SE-30682006	E7, F4
791.	SE-30682009	C1, C5, E1, E6, G1, H1, N4
792.	SE-30682013	C1, E4, E7, F4, J1, N2
793.	SE-30682018	C1, E1, E2, E3, E4, E7, F3, F4, J1
794.	SE-30682021	C9, E1, E2, E3, E4, E7, F4, G1, G2, G3, H2, H6
795.	SE-30682024	E7, G1, G2, G5, H6
796.	SE-30682026	E2, E3, E4, F2, F4, G1, G2, G3, G5, H6, N4
797.	SE-30684461	B2, F4, H6
798.	SE-30684481	B4, C1, F2, G1, H2, H3, J1, N4
799.	SE-30684488	D, E1, E2, F2, N4
800.	SE-30684499	B4, C1, F4, H1
801.	SE-30684509	E7, N2, N4
802.	SE-30685207	E1, H6
803.	SE-30685243	C1, H6
804.	SE-30685252	E2, E3, F4, G1, G2, G3, G5
805.	SE-30687717	A, B3, H, M
806.	SE-30687958	B1, C1, E1, E2, E3, E4, E6, E7, F1, F3, G1, G2, G3, G5, N2, N4, N5
807.	SE-30687960	B2, B4, E1, F4, G1, G5, H2, J1
808.	SE-30688010	C1, E6, E7, F2, F4, G1, G2, G5, H1, J1, J2

No.	Submission number	Issues raised
809.	SE-30688015	B2, E7, F4, G1, G5
810.	SE-30688018	E7, N2
811.	SE-30688220	B4, E1, E2, E3, E4, E5, E6, F2, F4, G1, G2, G3, H1, H6, N2, N4
812.	SE-30688265	F4, G1, G2, G5, H1, H6
813.	SE-30688288	C1, E1, F3
814.	SE-30689957	B4, F2, G1, G5, H2, H6, N2, N4
815.	SE-30689959	E1, E7, F4, G4, N2
816.	SE-30689962	E7, N2
817.	SE-30689965	B2, E1, F4, J1
818.	SE-30689968	E2, E7, F4, G1, N2, N4
819.	SE-30691457	B2, E1, F4, G1, H1
820.	SE-30691750	B4, C1, E1, E7, F4, H2, H6
821.	SE-30691797	E1, F4, G1, G5, K1
822.	SE-30691799	C1, E1, E9, M
823.	SE-30691803	B2, E1, G1, G4, J1
824.	SE-30691809	E1, E7, F3, G1
825.	SE-30691852	C1, E2, E6, F4, G1, G2, H1, K1, N4
826.	SE-30691857	B4, E7, F4, G1, E2, H1, H6
827.	SE-30691871	E1, E7
828.	SE-30691874	B1, C1, E2, E3, E4, E7, F1, F3, G1, G2, G3, G5, H1, N2, N5
829.	SE-30691981	B1, E2, E3, E4, E6, F1, G1, G2, G3, G5, N2, N4
830.	SE-30691983	E2, F4, H1, H4
831.	SE-30691989	B3, E7, M, N2
832.	SE-30692006	E1, E3, E5, E6, F2, F4, N4
833.	SE-30692222	H6, M
834.	SE-30692229	E7
835.	SE-30692233	B4, E7, J1
836.	SE-30692259	E2, E3, M
837.	SE-30695763	B4, C1, E1, E3, E4, E5, F4, G1, H1, H5, H6, J1, K1
838.	SE-30695859	E7, F4, G1, M
839.	SE-30695874	C1, E2, E7, F4, M
840.	SE-30696481	G2, G3, H6, K1
841.	SE-30698208	E1
842.	SE-30698351	B2, C1, E1, E3, E4, E5, F4, G1

No.	Submission number	Issues raised
843.	SE-30698370	E1, E7, F4, N2
844.	SE-30698375	F4, G1, G3
845.	SE-30699575	E2, E3, E4, G1, G2, G3, G5
846.	SE-30699592	B2, C1, E1, E2, E4, F4, G2, G3, H1, H6, K1, N2
847.	SE-30699595	B4, C2, E3, E4, F1, F4, G1, G5, H1, H6, N4
848.	SE-30699598	B1, C1, E2, E3, E4, E6, E7, F1, F2, F3, F4, G1, G2, G3, G5, H1, N2, N4, N5
849.	SE-30699600	C1, E1, E6, E9, F4, G2, H1, N4
850.	SE-30700496	E2, E4, E10, G1
851.	SE-30701960	B4, C1, E2, E6, F4, G1, H1, N4
852.	SE-30701969	C5, G1, H4, J1
853.	SE-30701973	B4, E1, E7, E9, H6, K1
854.	SE-30702210	B2, E7, G1
855.	SE-30702216	B2, E1, E7, F4, G1, H1, H6, J1, K1
856.	SE-30713063	B2, B4, E2, E3, E4, E6, E7, F2, F4, G1, G2, G3, H3, H6, N2, N4
857.	SE-30736273	B2, C5, E1, E2, E5, F4, J1
858.	SE-30736277	F4, G2
859.	SE-30736316	E1, E7, M
860.	SE-30736318	B2, C4, E1, K3, M, N2
861.	SE-30736320	E1, M
862.	SE-30736775	E1, E7, F4
863.	SE-30736789	E7, F4
864.	SE-30736793	C1, E2, E10, G1, G3, G5, H6, K1
865.	SE-30736806	C1, E1, K1
866.	SE-30736810	B4
867.	SE-30737227	B1, B2, B4, C1, E2, F2, F4, G1, G5, H6, H2, J1, N2, N4
868.	SE-30737765	C1, C4, F4, G1, H6
869.	SE-30738213	E1, E2, E3, E4, G1, G2, G3, H1, K1
870.	SE-30738216	E2, E3, E4, E5, E6, E7, F2, F1, G1, G2, G3, H1, H6, N4
871.	SE-30738234	B1, C1, C8, E1, E2, E3, E4, F2, F3, F4, G1, G5, H2, N4, N5
872.	SE-30738239	F2, F4
873.	SE-30738251	B2, F4, H1
874.	SE-30739214	E7, G1, H1, N2
875.	SE-30739227	E7
876.	SE-30739244	E2, E7, N2

No.	Submission number	Issues raised
877.	SE-30739490	C1, E1, E2, E3, E4, E6, G1, G2, G3, G5, N4
878.	SE-30739496	E7, K1
879.	SE-30740221	B2, E4, E2, E3, E5, E6, F1, F2, F4, G1, G2, G3, G5, H1, H6, K1, N2, N4
880.	SE-30740245	B4, C1, F1, F4, G1, G2, H1, H6, N4
881.	SE-30740709	F4, G1, G2, H1, K1
882.	SE-30740961	B2, F4
883.	SE-30741001	D, E6, E7, F4, G1, G2, G3, H1, H4, H6, K1, N2
884.	SE-30741004	B1, E1, E2, F2, F3, F4, E6, G1, G2, G3, G5
885.	SE-30741008	B4, G1, N2
886.	SE-30741011	B1, B4, E2, E3, E4, E6, E7, F1, F4, G1, G3, G5, N4, N5
887.	SE-30741014	B2, H2, J1, J
888.	SE-30741062	B2, F4, G2, G1, J1
889.	SE-30741065	C1, E1, E5, E6, F1, F2, G1, G2, H1, H6, N4
890.	SE-30741072	C, E1, G5, M
891.	SE-30741076	B5, F2
892.	SE-30741087	L1, L4
893.	SE-30741098	E1, F4, H6
894.	SE-30741103	B4, B1, B5, C2, J1, M
895.	SE-30741115	E7, G1, H4, J1, J, N2
896.	SE-30741215	E7, J1
897.	SE-30741222	C5, C7, C8, D, E7, F4
898.	SE-30741225	H2, J1, N5, N4
899.	SE-30741324	E1, F4
900.	SE-30741342	B2, C8, E2, E5, E3, E7, F4, G1, H1, H2, J1, K1, N2
901.	SE-30741346	B4, C1
902.	SE-30741349	H2, J1, L1, L4, N2
903.	SE-30741355	C1, E6, E7, G1, G5, N2
904.	SE-30741381	E1, E7, G1, G2, K1
905.	SE-30741387	E1, E3, F4, G1, H2, J1
906.	SE-30741389	B1, C1, E1, E4, G3, G2, G1, H1, H6, J1
907.	SE-30741392	E1, E2, H2, J1, K3
908.	SE-30741395	E1, E2, E4, E5, E7, F4, G2, H4, K1
909.	SE-30741397	D, F4, G1, H1, H2, J1
910.	SE-30741408	C1, E7, F2, G1, G2, G3, H1

No.	Submission number	Issues raised
911.	SE-30741413	G1, N4, N5
912.	SE-30741423	C1, E1, E2, F4, M
913.	SE-30741428	E7
914.	SE-30741436	E1, H4, J1
915.	SE-30741462	C1, E6, F1, H1, N4
916.	SE-30741465	E1, E7, F4, J1, M, N4
917.	SE-30741476	E2, E3, E4, E5, E6, F2, F4, G, G1, G2, G3, H1, H6, J1, K1, N2, N4
918.	SE-30741518	B1, C1, E2, E6, F1, G1, H1, N4, N2
919.	SE-30741522	B1, C1, E2, E6, F4, F2, G1, G3, N2, N4
920.	SE-30741527	C1, E2, E4, E7, N2
921.	SE-30745121	E7, G5, H5
922.	SE-30745846	F4, M
923.	SE-30745921	B4, E1, E5, E7, F2, F4, G1, G5
924.	SE-30746743	B3, B4, E7, H2, J1, N2
925.	SE-30746985	B5, E7, N2
926.	SE-30746988	J1, M
927.	SE-30746990	E1, F4
928.	SE-30746997	E1, E5, G1, H2, H6, M, N2
929.	SE-30747018	E1, F4
930.	SE-30747212	E1, E2, E7, G5, H2, J1, N2
931.	SE-30747215	N2
932.	SE-30747459	E7, N2, J1
933.	SE-30747464	E5, E6, E7, F2, F4, G1, N4, N2
934.	SE-30747479	E2, E7
935.	SE-30747707	E1, E6, E7, H4
936.	SE-30748207	G2
937.	SE-30748212	C5, E7, J1
938.	SE-30748215	C2, C5, C8, E10, F4, F2, F3, G1, G3, H2, H1, H6, J1, K1
939.	SE-30748221	F1, F2, F4, N4
940.	SE-30748957	F2, K1, M
941.	SE-30749220	G1
942.	SE-30749223	G1
943.	SE-30749418	E1, E4, E7, H4, J1
944.	SE-30749425	E1, J1, N2

No.	Submission number	Issues raised
945.	SE-30749434	F4, G1, H2
946.	SE-30749437	J1, N2, N4
947.	SE-30749719	H1, J1, J
948.	SE-30750773	C4, C3, C8, E1, E3, E6, F1, G1, G5, H6, J1, K1, N4
949.	SE-30750816	B2, E7
950.	SE-30750818	C1, E5, E6, E7, F1, F2, G5, N2
951.	SE-30750821	B1, B4, H2, J1, M
952.	SE-30750869	C1, G1, N2
953.	SE-30750873	G1, J1
954.	SE-30751243	F4, G1
955.	SE-30751264	G1, J1, M
956.	SE-30751979	C, F4, M, N2
957.	SE-30751990	E1, E5, E7, G1, M
958.	SE-30751993	C1, E1, M
959.	SE-30751996	B4, C1, D, E1, E2, E3, E4, E7, F1, F4, G1, G2, G3, G5, H1, J1, L1, L4, N2, N4, N5
960.	SE-30751998	E7
961.	SE-30752046	C1, E2, F2, F3, F4, G1
962.	SE-30752052	E7
963.	SE-30752055	C5, E2, E4, H6
964.	SE-30752058	E1, E7, N2
965.	SE-30752065	D, E7, N2
966.	SE-30752267	E1, E7, G5
967.	SE-30752477	E6, N2
968.	SE-30752489	G1, G5
969.	SE-30752712	B2, G1, J1
970.	SE-30752735	C1, G, G1, H1 J1, M
971.	SE-30752965	B1, G1, G2, H2, H6
972.	SE-30753236	C1, E7, F4, F2, G1, H, H1, J1
973.	SE-30753245	C6, C7, E1, F2, G1, J1
974.	SE-30754475	E9, F4, F2, G1, H4
975.	SE-30754483	C1, C4, E2, E3, E4, E6, E7, F1, F4, G1, G2, G3, G5, H1, N4
976.	SE-30754487	B2, F4, K1, N4, N2
977.	SE-30754489	E2, E6, F1, N2, N4
978.	SE-30754495	E6, G1, H1

No.	Submission number	Issues raised
979.	SE-30754532	M
980.	SE-30754753	N2
981.	SE-30755968	E7, G5, H2, H4, J1
982.	SE-30756065	G1, H2, H4, J1
983.	SE-30756067	B2, B5, D, H4, H1, N2, N4
984.	SE-30756111	C1, E1, E2, E3, E4, E6, F2, F4, G1, G3, H1, H2, H4, J1, N2, N4, N5
985.	SE-30756147	F4, N4
986.	SE-30756162	B5, E2, E3, E4, E5, E6, F2, F4, G1, G2, G3, H1
987.	SE-30756712	C, E1, E3, E4, E5, G1
988.	SE-30757712	B2
989.	SE-30758128	C, M
990.	SE-30758167	E1, E5, E6, F2, F3, F4, K1
991.	SE-30758170	H4, J1, J
992.	SE-30758174	C, E7, F4, G1
993.	SE-30758177	B2, F4, G1, H1, J1
994.	SE-30758180	E1, E5, F4
995.	SE-30758184	E1, N4
996.	SE-30758188	E7, F4, G1, G2, G5, J1, M
997.	SE-30758195	B2, E2, E3, E4, E5, E6, F4, G1, G2, G3, H6, N4
998.	SE-30759754	B4, E1
999.	SE-30759818	C5, E1, E2, E3, E4, E6, F2, G1, G2, H6, N4
1000.	SE-30759822	C, H1, H4, N4
1001.	SE-30759894	H4, J1, N2
1002.	SE-30759897	B1, C1, E2, E3, E4, E6, F1, F4, F2, G1, G2, G3, G5, H1, N2, N4, N5
1003.	SE-30759926	B1, C1, E2, E7, G5, H2, J1, N2
1004.	SE-30762162	G1, G2, G3, H2, L1, L4, N4
1005.	SE-30762212	F2, G1
1006.	SE-30762215	E7, G5
1007.	SE-30762220	E1, G1, G3, G5
1008.	SE-30762234	B2, E1, M
1009.	SE-30762237	B2, E1, E7
1010.	SE-30762460	F4, G3, H6, K1
1011.	SE-30762469	E1, F4, G3, H5, K1
1012.	SE-30762474	F4, J1

No.	Submission number	Issues raised
1013.	SE-30762479	B4, F4
1014.	SE-30762488	N4, M
1015.	SE-30764075	E7, N2
1016.	SE-30781992	B3, C2, C4, E1, E2, E10, G1, G2, J1, M
1017.	SE-30782197	E1, G1
1018.	SE-30787542	E7, G1, G2, G5, J1
1019.	SE-30787592	B1, E2, F1, F4, G1, G2, G5, N2, N3, N4
1020.	SE-30790468	F4, G5, H2, J1
1021.	SE-30790629	B3, E2, E3, E4, E6, F1, F4, G1, G2, G3, G5, H1, H2, H4, K1, N2
1022.	SE-30790634	C1, F1, F2, F4, H1, N4
1023.	SE-30790716	B4, E1, E7, F2, F4, H4
1024.	SE-30790719	C8, E9, G1, G5, J1, K1
1025.	SE-30793068	E1, E7, F4, G4, J1
1026.	SE-30793071	F4, G1
1027.	SE-30793963	C8, E1, E7, F4
1028.	SE-30795313	E2, E7, F4, G1, G4, J1
1029.	SE-30795505	C1, F1, F2, F4, H1, N4, N5
1030.	SE-30795511	G1
1031.	SE-30795519	C1, F2, F4, H1, N2, N4
1032.	SE-30795522	B1, B2, C3, C4, C5, E6, F4, G1, G5, N4
1033.	SE-30795567	C8, E2, E4, F1, F4, G1, G2, H1, N2, N4
1034.	SE-30795578	D, E1, E7, G1, H6, J1, N2, N4
1035.	SE-30795589	E1, E5, E6, F1, F4, G1, G2, G3, G5, N4
1036.	SE-30795593	E1, E7
1037.	SE-30795597	F2, F4, G1
1038.	SE-30795601	B1, C1, E2, E6, F1, F4, G1, G2, G5, H1, N4, N2
1039.	SE-30795603	N2
1040.	SE-30795764	J1
1041.	SE-30795773	E1, G3, H6
1042.	SE-30795776	E2, E5, F2, F4, G1, G2, G3, H1, J1
1043.	SE-30795812	E2, F4, G, G1, G5
1044.	SE-30795922	E1, M
1045.	SE-30795926	B2, E2, E3, E4, E5, E6, F1, F4, G1, G2, G3, H1, H6, J1, N4
1046.	SE-30795932	E1, F4, N4

No.	Submission number	Issues raised
1047.	SE-30795938	B4, E1, F4, G1
1048.	SE-30795941	E1, J1
1049.	SE-30796058	K1
1050.	SE-30796061	C, N2
1051.	SE-30796063	B1, B2, D, E2, E6, G1, G5, G2, G3, H4, N2, N5, N4
1052.	SE-30798210	E1, E2, E4, F4, H6
1053.	SE-30798227	C, E2, E3, E4, G1, G3, J1, M, N2
1054.	SE-30798230	J1
1055.	SE-30798233	G1, G3
1056.	SE-30798240	E7, F4, G1, K1
1057.	SE-30798242	B4
1058.	SE-30798262	E1, E2, E3, E4, E5, E6, E7, F2, F4, G1, G2, G3, G5, H1, H4, H6
1059.	SE-30798269	B2, E1, E7
1060.	SE-30798293	M
1061.	SE-30798296	B4, E1, E2, F4, M
1062.	SE-30798298	F4
1063.	SE-30798303	E1
1064.	SE-30799457	B2, E7, F4, H2, J1, M
1065.	SE-30799712	G4, J1
1066.	SE-30800213	E1, E3, E6, F1, F2, N2, N4
1067.	SE-30800457	G3, H1
1068.	SE-30800460	E2, E7, G4, K1, N2, N4
1069.	SE-30800467	E7, F2, F3, G1, G3, G5
1070.	SE-30801212	E7
1071.	SE-30801214	E1, E4
1072.	SE-30801217	C, E1, E2, E4, E7, F4, G1, G5, J1, N2
1073.	SE-30814205	B2, B3, E1, E2, E3, F3, G2, G3, H1, H6, I, J1
1074.	SE-30819487	E4, G1
1075.	SE-30820506	B2, B4, C4, G3, H1, H6, J1
1076.	SE-30842842	C1, C2, E2, E3, E4, F1, F2, F4, G1, G5, H2, H6, J1, N4
1077.	SE-30844715	J1, N2
1078.	SE-30860418	E6, E7, G1, G5, H1, H2, J1, N2, N4, N5
1079.	SE-30861498	C, E6, E7, F2, G1, G2, G3, G5, H2, J1, N2, N4
1080.	SE-30861500	E1, E2, G2, N2

No.	Submission number	Issues raised
1081.	SE-30861512	E2, E3, F4, G1, G2, G4, G5, J1
1082.	SE-30865207	E2, E3, F4, G1, G2, G4, G5, J1
1083.	SE-30897809	C7, E1, E3, F4, G, H1, H2, J1, J
1084.	SE-30903735	E1, E4, F4, G1
1085.	SE-30904775	B2, J1, N2
1086.	SE-30904789	B1, E2, E6, E7, E9, E10, F2, G1, G2, G4, G5, H6, H7, J1, N2, N4
1087.	SE-30904962	F2, F4, G1, G2, G4, G5, H1
1088.	SE-30905458	G1, E4, E2, E10
1089.	SE-30908270	E1, E2, E3, E4, E7, E6, E10, F1, F2, F4, G1, G2, G4, G5, H1, H2, H6, J1, N2, N4
1090.	SE-30909973	E2, F4, G1, G2, G3, G5, H1, H2, H4, J1, N2
1091.	SE-30911391	E1, E2, E4, F4
1092.	SE-30922310	B4, C4, E1, K3, M
1093.	SE-30924053	E2
1094.	SE-30928977	E1, E2, E3, F4, G1, G2, G4, G5, H6
1095.	SE-30931246	B4, C2, C5, E2, E9, F4, G1, G2, G3, G5, H2, H4, J1, N4, N2
1096.	SE-30944780	E1, F4
1097.	SE-30944788	H2, J1
1098.	SE-30944806	M
1099.	SE-30944924	B4
1100.	SE-30944933	N2, N4
1101.	SE-30944937	B4, E1
1102.	SE-30945519	B1, B4, C1, C2, C3, C4, C5, E2, E3, E4, E6, E7, F1, F2, F4, G1, G3, G5, H1, H2, H6, J1, N2, N4, N5
1103.	SE-30945522	F4
1104.	SE-30945530	B2, E2, E3, E4, E5, E6, F1, F2, F4, G1, G2, G3, H2, H6, N4
1105.	SE-30945544	J1
1106.	SE-30947216	H1
1107.	SE-30948980	E4, E1, E2, E3, F1, G1, H1, N4
1108.	SE-30953036	C1, E1, E7
1109.	SE-30953052	E1, M
1110.	SE-30953054	E1, F4, G1
1111.	SE-30953057	E1, E2, E3, E4, F4, G1, G2, G5, K1
1112.	SE-30953072	C, G1, G5
1113.	SE-30953077	C, E2, E7, F4, G1, G3, H6, H2, J1

No.	Submission number	Issues raised
1114.	SE-30953083	G4, N2
1115.	SE-30953119	B1, C1, E1, E2, E3, E4, E6, F1, F4, G1, H1, H4, K1, N4, N5
1116.	SE-30956231	K1
1117.	SE-30956251	B4, E3, E4, F4, G1, G2, G3, G5, H2, J1, K1, N4, N5
1118.	SE-30956263	B1, C3, E7, F1, G1, G2, G5, H2, H4, J1, K1, N2, N4, N5
1119.	SE-30956315	B1, C1, E1, F2, G2, K1, N5
1120.	SE-30956318	E2, E4, E7, F1, G1, G3, H1, J1, N4
1121.	SE-30956340	C, E1, E2, E3, E4, E6, F1, F4, G1, G2, G3, H6, H5, K1, N2, N4, N5
1122.	SE-30956398	G1, J1, M
1123.	SE-30956401	B4, C2, F2, G1, G2, G3, G5, H2, J1
1124.	SE-30956435	F4, G1, G2, G3, N2, N4, N5
1125.	SE-30957520	B2, E7, G1, H2, J1, N2
1126.	SE-30957550	C8, F2, N2
1127.	SE-30958518	F2, G5, N2
1128.	SE-30958521	B2, C3, E1, E2, E3, E4, F4, G1, J1, M
1129.	SE-30958528	B1, C2, E1, E7, E2, F1, G1, N2, N4, N5, J1
1130.	SE-30958535	E1, F4
1131.	SE-30958654	B1, E1, E2, E6, E7, F1, G5, N4, N2, N5
1132.	SE-30958656	J1
1133.	SE-30958681	E1, F4
1134.	SE-30958685	E7, G5
1135.	SE-30959241	E1, F2, F3, F4, N2, N4, N5
1136.	SE-30959249	B1, B2, B6, C1, E1, E2, E3, E4, F1, F2, F4, G1, G2, G3, G5, H1, H4, J1, N2, N4
1137.	SE-30961207	B2, E7, G5
1138.	SE-30962925	N2, N4
1139.	SE-30962928	B2, C3, C5, E1, E3, E4, E6, F4, G1, G3, K1, N2, N3
1140.	SE-30963207	B1, B5, C, C8, E1, E2, E3, E4, E6, G1, G3, H1, H2, H4, J1, N2, N4
1141.	SE-30963302	E4, E6, E7, N4
1142.	SE-30963367	E1, E7, G2, G5, K1
1143.	SE-30964023	M
1144.	SE-30964142	B2, H2, J1
1145.	SE-30964207	D, E1, E2, E3, E4, E7, F4, G1, G5, J1
1146.	SE-30964975	E1, E2, E7, G1, J1, N2
1147.	SE-30965457	C, E1, E3, E7, F4, G1, G5, J1, N2

No.	Submission number	Issues raised
1148.	SE-30965496	E6, E7, F2, F3, F4, G1, G3, G5, H2, H6, J1, N2, N4, N5
1149.	SE-30966789	D, E1, E10, F4, G1, N2
1150.	SE-30970649	C, E1, G1, G5
1151.	SE-30970652	E1
1152.	SE-30970655	B4, N2
1153.	SE-30970687	C1, C3, C4, C5, E3, E4, E5, E6, F1, F2, F4, G1, G2, G3, H1, N4
1154.	SE-30970697	B4, C3, C8, E2, E7, F4, G1, G4, G5, J1, K1, M
1155.	SE-30970699	E1, H2, J1
1156.	SE-30970701	E1, E4, G1, G2, G3, G5, K1
1157.	SE-30971560	G1, H3, H4, J1
1158.	SE-30971562	E1, E2, E7, F4
1159.	SE-30971565	C1, F1, F2, F4, H1, N4
1160.	SE-30972209	B4, J1, N2
1161.	SE-30972240	C, E2, E6, F2, F3, F4, G1
1162.	SE-30972252	B1, B5, E2, E4, E6, F1, G1, G3, H1, N4
1163.	SE-30972285	E1, E2, E3, E4, G1, G2, G3, G5
1164.	SE-30972288	G1, K1
1165.	SE-30972342	H2, N2
1166.	SE-30972358	C4, E1, E2, F4, G1, G3, J1, M
1167.	SE-30972361	E1, E6, F2, J1
1168.	SE-30973526	C4, E2, E4, G1, G3, H1, H6, J1, N3
1169.	SE-30973714	E1, E2, E3, E4, E6, F4, G1, G2, G3, G5, N4
1170.	SE-30973717	B4, E9, G1, J1
1171.	SE-30973765	G1, J1, M
1172.	SE-30973774	E1, J1
1173.	SE-30974992	B2, E1, E7, F2, G1, G5
1174.	SE-30974998	E1, E3, E4, E6, F4, G1, G2, G3, G5, H2, J1, N2
1175.	SE-30975001	C3, C4, C5, E2, E3, E4, E7, G1, G5
1176.	SE-30975004	E1, J1
1177.	SE-30975006	E1, J1
1178.	SE-30975008	C, E2, G1, K1, N4
1179.	SE-30975021	H1
1180.	SE-30977911	B1, C3, C4, C5, E2, E3, E4, F4, G, G1, G2, G3, G5, N4
1181.	SE-30981470	B2, G1, H2, M

No.	Submission number	Issues raised
1182.	SE-31016671	A, H2
1183.	SE-31021110	B4, B5, C, C7, E1, G1, H1, H2, H5, J, J1, M, N2, N4
1184.	SE-31028290	B2, E1, E3, E4, F4
1185.	SE-31029215	B2, B5, B4, E2, E7, F4, G1, G2, G5, H4, N2, N4, N5
1186.	SE-31042836	G3, H1, M
1187.	SE-31043021	H5, J1
1188.	SE-31043116	C4, C7, F4, F2, F1, G1, G3, G5, H6, J1, N4
1189.	SE-31043119	C1, E2, E6, F1, F2, G2, G3, H1, N2, N4
1190.	SE-31043127	C3, C4, C5, E2, E3, E4, E5, E6, F4, G1, G2, G3, N4
1191.	SE-31043135	E4, E3, E10, F4, G1, G2, G3, G5
1192.	SE-31043138	J1
1193.	SE-31043145	B5, C5, C2, F2, F4, G1, G5, H1, H6, K, K1, N4
1194.	SE-31044477	B2, E2, E3, E4, E6, F1, G3, G2, H1, H6, M, N2, N4
1195.	SE-31044480	B2, E2, H2, H4, J1
1196.	SE-31044483	E7, G5
1197.	SE-31044495	G1, G2, G3, H1, H6, J1
1198.	SE-31047458	M
1199.	SE-31054636	B5, C2, C5, F2, F4, G1, G5, H1, H6, K, K1, N4
1200.	SE-31054696	E2, F4, G1, C5, G2, N4
1201.	SE-31055252	A, H2, J1
1202.	SE-31055263	C5, E2, E7, F4, N2
1203.	SE-31055351	C1, E1, K3, J1
1204.	SE-31055449	C, E1, E2, E7, F4
1205.	SE-31056048	B5, E1, E2, E3, E4, E6, E10, F2, F3, F4, G1, G2, G3, G5, H1, H6, J1, N2
1206.	SE-31056513	E1, F4, H5
1207.	SE-31056517	B2, E1, E7, F4, H2, J1, N2
1208.	SE-31056598	E3, E4, E5, E7, E10, F4, G1, G2, G3, G5, N2, N3
1209.	SE-31057377	B1, B2, B5, C1, E2, H6, N2, N4
1210.	SE-31058546	C, E1, E2, E7, G1, G5
1211.	SE-31058572	E1, G1, H2, J1
1212.	SE-31058712	G1
1213.	SE-31058715	E2, G1, N2
1214.	SE-31058886	E6, F1, G, G1, G2, G5, H2, J1, N2, N3
1215.	SE-31058892	A, H2, K

No.	Submission number	Issues raised
1216.	SE-31059209	B2, C3, C4, C5, E1, E2, E3, E5, E10, F4, G1, G2, G5, N3, N4
1217.	SE-31059212	G1
1218.	SE-31059256	B2, E1
1219.	SE-31059263	E1, E2, E4
1220.	SE-31059333	B1, B4, E2, E3, E4, E6, F1, F2, G1, G5, H1, N4
1221.	SE-31059340	B5, E1, E7, F4, G1, G2, G3, H1, M
1222.	SE-31062459	C5, E4, E1, E2, F4, G1, G5, H2, H6, N2, N4
1223.	SE-31097843	E1, G1, H2, J1
1224.	SE-31097861	B1, B5, C1, D, E1, F4, H2, J1, M
1225.	SE-31097888	E1, E2, E3, E4, E6, F1, F2, F4, G1, N2, N4, N5
1226.	SE-31097923	E1, E2, E3, E4, F1, F2, F4, G1, G3, G5, N2, N4
1227.	SE-31097926	B1, C1, C3, C5, C6, E1, E2, E3, E4, E6, F1, F2, F4, G1, G2, G3, G5, H1, H2, J1, K1, N2, N3, N4, N5
1228.	SE-31097928	E1, E2, E3, E4, F4, H6, J1
1229.	SE-31103762	E1, E2, E6, E7, F2, F4, H4
1230.	SE-31103802	A, C8, J1, K1
1231.	SE-31103804	N2
1232.	SE-31103834	G2, H2, H6, J1
1233.	SE-31103841	E1, E5, E9, H6, M
1234.	SE-31103843	B4, C3, C5, G4, G5, H6, N2, N4
1235.	SE-31103846	M
1236.	SE-31103850	B2, E1
1237.	SE-31103873	B2, E7, F4, G1, H2, J1, N2
1238.	SE-31103878	B2, E1, G2, H6, H5, M, N2, N4
1239.	SE-31103892	E1, G1
1240.	SE-31103895	E7
1241.	SE-31103898	E1, H5
1242.	SE-31103903	A, H2, J1, K1
1243.	SE-31103936	B2, E2, F4, F2, N5, N2
1244.	SE-31103944	F4, G1, G2, G4, G3, K
1245.	SE-31103947	B2, C1, C7, C6, E1, E2, E3, E4, E6, F1, F2, F4, G1, G2, G3, G5, H1, H2, H5, H6, I, J1, M, N4, N2
1246.	SE-31103949	C2, C4, C7, C8, E1, E2, E10, G1, G2, G5, H6, N2
1247.	SE-31103952	E, E1, E2, E4, E5, E7, E9, F4, G5, J1, N4
1248.	SE-31103955	G1

No.	Submission number	Issues raised
1249.	SE-31105512	B4, F2, F4, G3, H2, H6
1250.	SE-31105522	B4, F2, F4, G3, H2, H6
1251.	SE-31108221	B2, E1, K3
1252.	SE-31108224	C, E1, E7, F4, G1, H2, N2
1253.	SE-31108230	A, H2, J1, K1
1254.	SE-31108960	C, E1, E3, E8, F2, F4, G1, G2, G4, H2, L1
1255.	SE-31125426	DOCUMENT UPLOAD TEST – No submission
1256.	SE-31125647	B4, C5, E2, E3, F1, G1, G2, G3, K1, N2, N4, N5
1257.	SE-31125669	C5, C4, E1, E2, E3, E4, E6, E7, F4, G1, G2, G3, G4, H2, H6, I, J1, K1, M, N5, N2
1258.	SE-31126127	K, K1
1259.	SE-31126797	C2, C3, C8, E1, E2, E3, E4, F4, G1, G3, H2, H4, J1, N2
1260.	SE-31126803	F1, F2, F4, G1, G2, G3, G5, N4
1261.	SE-31126972	F4, G3, H1, N4
1262.	SE-31126979	E7, F4, G1, G2, J1, N2, N5
1263.	SE-31126995	B1, B2, C1, E2, E6, G1, H1, N2, N4
1264.	SE-31133220	G1
1265.	SE-31133224	C1, F4, G, G1, G2, G3, H2, J1, J, N2
1266.	SE-31140251	C2
1267.	SE-31168993	B4, B5, E1, E7, E10, G, G1, G5, H6, M, N2
1268.	SE-31169682	E1, F4
1269.	SE-31169685	C2, C3, C4, C5, E1, F4, F2, G1, G3, G5, H1, J1, J
1270.	SE-31169692	E1, E2, E3, E5, H6, F2, F4, G1, G2, G3, H1, N2, N4
1271.	SE-31174211	K1, K2
1272.	SE-31174221	G3
1273.	SE-31174226	B2, C, E1, E7, F4, G1, N2
1274.	SE-31174228	J1, K3
1275.	SE-31176707	E1, E2
1276.	SE-31193008	B3, H1, H2, J1
1277.	SE-31205899	B2, E1
1278.	SE-31207396	E1, E2
1279.	SE-31207398	E1, E3, E4, E7, F4, G1, G2, G3, G5, H4, H6
1280.	SE-31207454	B4, B5, E1, K3, N2
1281.	SE-31214342	E2, F1, G1, H6, N4
1282.	SE-31214363	C, F1, F2, F3, F4, N4

No.	Submission number	Issues raised
1283.	SE-31217208	B4
1284.	SE-31217210	E1, E7, H6, M
1285.	SE-31217217	B4, E2, G2, H1, N2
1286.	SE-31217267	A, C8, H, K1, K
1287.	SE-31217270	B2, C, E1, E7, F4, G2, G3, G5, N2, N4
1288.	SE-31217274	A, C3, H2, J1, K1
1289.	SE-31217277	B1, B2, B4, B5, C4, E1, E2, E7, F4, G1, G3, H1, K1, K, M, N2
1290.	SE-31217280	B2, E2, E3, E4, E7, F4, G1, G2, K1
1291.	SE-31217283	B4, C, E1, E6, E7, F1, F2, F4, G1, G2, G5, H1, H7, H5, H6, N2
1292.	SE-31220474	E1, E2, E3, E4, E5, E7, F4, G2, G5
1293.	SE-31220476	E1, E2, E3, E4, E5, E7, F4, G2, G5
1294.	SE-31220479	A, H, H2, K, K3
1295.	SE-31220481	A, H2, K1, K
1296.	SE-31220484	B1, H5, H4, N4, N2
1297.	SE-31220487	E1, E2, F4, G1, G3, G5, K1
1298.	SE-31220490	K1, K
1299.	SE-31220493	E2, E3, E4, F4, G1, G5, H1, J1, N4
1300.	SE-31224663	B2, F4, G1, G5, N1, N2
1301.	SE-31224666	B3, B4, C5, C6, E2, E3, E4, H1, H4, J1, J2, M
1302.	SE-31224669	B2, C5, E1, E7, F4, G1, G3, H1, J1
1303.	SE-31224679	E7, F4, G1
1304.	SE-31224694	E1, F4, H6
1305.	SE-31224709	B1, C, C1, E2, E6, F1, F2, G1, G2, G3, G5, H1, N2, N4
1306.	SE-31227965	G1
1307.	SE-31247457	F4, G1, H2, H5, J1
1308.	SE-31247461	B4
1309.	SE-31247487	M
1310.	SE-31247970	B2, E1, E2, E6, F4, G1, G2, G5, N2, N4
1311.	SE-31247976	B5, H4, H6, J1
1312.	SE-31254214	C2, C3, E7, F4, G1, H2, H4, H5, J1
1313.	SE-31257557	M
1314.	SE-31258008	D, E2, E7, F2, F4, G1, G2, G3, G5, K1
1315.	SE-31262283	E7
1316.	SE-31265335	B5, E1, K1, N2, O2, O1

No.	Submission number	Issues raised
1317.	SE-31273964	E1, E2, E3, E4, E7, F4, F2, F1, G1, G2, G3, G5, J1, N2, N4
1318.	SE-31275274	C2, J1, H, H4, O1
1319.	SE-31279084	B1, B3, B4
1320.	SE-31284963	E7, I, M, N4
1321.	SE-31286991	O1, O2
1322.	SE-31297863	B4, B5, E1, E2, E4, E6, E10, F4, G1, G2, G3, G4, G5, H1, H4, N2, N4
1323.	SE-31300178	B1, B2, E1, E3, E4, E5, E6, E7, F4, G1, G2, G3, G5, J1, N4, N5
1324.	SE-31300514	C4, C7, E, E1, E2, E3, E4, E6, F1, F4, G1, N4
1325.	SE-31303684	B2, C, C2, C3, C5, D, E4, F4, F1, G1, G2, J1, M, N2, N4
1326.	SE-31304579	E2, E3, E4, E6, E7, E10, F1, F2, F4, G1, G2, G3, G5, H1, J1, N4
1327.	SE-31320739	E4, E6
1328.	SE-31323951	B1, B2, B4, B5, C2, C3, C5, E2, E3, E4, E6, E10, F1, F4, G1, G3, K1, N2, N4, N5
1329.	SE-31347568	B2, B4, C2, D, F4, G1, H1, H4, H2, J1, M, N2, N4
1330.	SE-31347572	B1, B2, C3, C4, C5, E2, E3, E4, E6, F1, F4, G, G1, G2, G3, G5, J, N4, N3, N5
1331.	SE-31349376	C2, E1, F4, G1, G3, H, H1, H2, H4, H6, J, J1, L1, L4, N2
1332.	SE-31386135	A, C, H2, J1
1333.	SE-31387391	A, C8, K, K1
1334.	SE-31388134	B1, C1, E6, G1, G2, N4
1335.	SE-31389996	B2, C1, C3, C5, E2, E3, E4, E5, F1, F4, G1, G2, G3, G5, N4, N3
1336.	SE-31390002	B1, B5, C3, C5, E10, F1, G1, G4, G5, H2, N3, N4
1337.	SE-31390010	B5, C2, E1, F2, G2, G3, H5, H1
1338.	SE-31390017	E1, E6, F4, G1, N2, N4, N5
1339.	SE-31390019	G2, K1
1340.	SE-31390022	C, E7, E9, G1, G2, N2
1341.	SE-31390084	B1, C1, C5, E2, E6, E10, F1, G1, G5, N2, N4
1342.	SE-31390104	D, E1, E2, E3, E4, E6, E7, F4, G1, G2, G5, J1, N2, N5
1343.	SE-31390188	E2, F2, F3, F4, G1, G5, H6
1344.	SE-31390991	C2, E2, E7, E9, F4, H1, H2, J1
1345.	SE-31391708	B2, C5, C3, E2, E3, E4, E5, F1, F4, G1, G2, G3, G5, N4
1346.	SE-31391711	E2, F4, G3, H1
1347.	SE-31391717	B2, E2, E3, E4, F4, G1, C3, G5, G, H1, H2, H6, K1
1348.	SE-31391721	C1, E7, E9, G1, G3, N2, N4
1349.	SE-31391743	B1, C1, E2, E3, E4, G1, G2, G3

No.	Submission number	Issues raised
1350.	SE-31392468	B2, E1, G1, G2, J1, J
1351.	SE-31392957	E2, F4, G1
1352.	SE-31392966	C, C1, E6, E7, F4, G1, G3, G5, H1, N2
1353.	SE-31392969	B1, C1, E2, E6, E9, F1, F4, G1, H1, N2, N4, N5
1354.	SE-31393078	E1, E2, E4, F4, G1
1355.	SE-31393129	B3, E1, F4, J1
1356.	SE-31393204	E1, G1, G2, K1
1357.	SE-31393207	B2, C1, E1, E2, E3, E9, F4, G1, J, J1
1358.	SE-31393211	E1, E6, G1, G2, G5, H4
1359.	SE-31393707	F4
1360.	SE-31393751	E2, E3, E4, F2, F4, G1, G5, N5
1361.	SE-31395211	B1, C1, E1, E2, E3, E4, E6, F1, F2, F4, G2, G3, H1, N4, N2, N5
1362.	SE-31395462	C, E7, J1
1363.	SE-31395521	B1, E1, E7, F4, G1, G2
1364.	SE-31395527	B2, B4, C3, C4, C8, E7, G1, H1, N2
1365.	SE-31395534	C, C8, E2, E6, E7, E9, F1, F2, G1, G2, H1, N5, N4
1366.	SE-31396215	B1, E1, E2, E3, F1, F4, G2, G1, H1, J1, N4, N3
1367.	SE-31396221	E1, E2, E6, E7, E9, G1, H2, N2, N4
1368.	SE-31396391	E2, E3, E4, G1, G2, G5
1369.	SE-31396397	B4, F4, G1
1370.	SE-31396400	B1, B2, C3, C5, C6, C8, D, E1, E2, E3, E4, E6, E7, F2, F4, G, G1, G2, G3, G5, H1, K1, N3, N2, N4
1371.	SE-31397209	B2, E1, E7, J1, J, N2
1372.	SE-31397213	C2, E, E3, E1, E2, F4, G1, G3, H6, H1
1373.	SE-31397291	E1, G1, G3, H6
1374.	SE-31397296	G, G1
1375.	SE-31400353	B2, C5, E1, H6, N2
1376.	SE-31400381	F2, F3, J1
1377.	SE-31400385	C1, E1, E6, F4, G1, H1, H4, N2, N4
1378.	SE-31400440	B3, E8, F4, G1, H1, H6, J1,
1379.	SE-31400449	E1, E7, G1, H6, J, M
1380.	SE-31401470	B1, B2, B4, B5, C, E2, E3, E4, E6, E10, F1, F2, F4, G1, G2, G3, J1, H1, H4, N2, N4
1381.	SE-31401473	B2, B4, B5, C1, C4, C2, E1, F4, G1, G5, H1, H4, J
1382.	SE-31403210	B1, C1, E2, E6, E7, F1, F2, F4, G1, G2, G3, H1, N2, N4

No.	Submission number	Issues raised
1383.	SE-31403213	B1, C1, E2, E3, E4, E6, F1, F2, G1, G2, G3, G5, H1, J1, N2, N4, N5
1384.	SE-31403221	B3, E1, F4, G, G1, G2, G5, H2, K1
1385.	SE-31403233	E2, E3, E4, G, G1, G2, G3, G5, J1, N4
1386.	SE-31403957	C1, E1, E2, F4, G1
1387.	SE-31404214	B1, C1, E2, E3, E4, E6, F1, F2, F4, G1, G3, G2, G5, H1, J1, N2, N5, N4
1388.	SE-31404235	C8, E7, F4, G1
1389.	SE-31404238	C1, F2, F4, G1, H1, J1
1390.	SE-31404244	B2, C, C5, E1, E6, F1, F2, F3, F4, G1, J1, K1, M, N5, N4
1391.	SE-31404254	E1, E2, E3, G1, H6, J2, N2
1392.	SE-31404257	C2, E1, E7, F4, F2, G3, G5, H1, H2, H6, J1, J, K1
1393.	SE-31404266	G2
1394.	SE-31404299	E2, F2, H4, H6, J1
1395.	SE-31405457	C, E2, F4, G1
1396.	SE-31429741	B1, C, C1, E1, E3, F4, G1, G3, H4, J1, N2
1397.	SE-31429758	C, E1, G2, H4, M
1398.	SE-31431003	E1, E2, F4
1399.	SE-31431103	B5, C1, C2, C5, E1, F2, F4, F3, G1, J1, J2, N2
1400.	SE-31431274	C, E1, E2, F4, G3, I, K1, N2, N4
1401.	SE-31431709	C, E3, E4, E6, E9, F1, F2, F4, H1, J1, N4
1402.	SE-31431714	C5, E1, E4, E9, F4, G1, G4, G5, H4, J1
1403.	SE-31433517	C3, C4, C5, E1, E3, E4, F1, F4, F3, G1, G5, H1, J2, K1, N4
1404.	SE-31433544	E7, G3
1405.	SE-31477639	E1, E2, E3, E4, E7, E10, F4, G1, G2, G3
1406.	SE-31507483	E1, N2, N4
1407.	SE-31520694	B5, E10, F4, F2, H2, J1, J2, L1, L4, N2, N4
1408.	SE-31527975	E2, E4, E6, E10, G1, H1, H2
1409.	SE-31530645	B2, D, E4, E1, E7, E10, F4, G1, G3, G5, H6, N2, N4
1410.	SE-31532513	B2, B4, C, C5, D, E1, F4, N2, N4
1411.	SE-31549607	I
1412.	SE-31550809	G1, G2
1413.	SE-31552012	C, C5, E1, F4, G1, J1
1414.	SE-31557380	C2, C5, C8, E1, E2, E3, E4, F4, G1, G3, H2, J1, M
1415.	SE-31557387	E1
1416.	SE-31558780	B4, B6, H1, H4, J1

No.	Submission number	Issues raised
1417.	SE-31558860	E1, F4, J1, K3, M
1418.	SE-31558883	B5, C, C8, E9, G1, H1
1419.	SE-31558887	B2, E7, G1
1420.	SE-31558892	B1, C1, E1, E2, E3, E4, E6, E7, F1, F4, G1, G2, G3, G5, H1, H2, J1, K1, N4
1421.	SE-31558895	B2, B1, E2, E3, E4, E6, F4, G1, G2, H1, N4, N5
1422.	SE-31559488	B3, E1, E2, F4, F2, G2, G1, G5, H6, J1
1423.	SE-31560963	C5, G2, J1
1424.	SE-31560992	E1, E7, F4
1425.	SE-31560997	B1, C1, G1, E2, G3, F1, F2, F4, N4
1426.	SE-31563961	D, E7, G1, J1
1427.	SE-31564707	C, E1, E2, E4, E7, F3, F4, N2, N4
1428.	SE-31564709	B2, B4, C1, E1, E2, E6, E9, F1, F2, F4, G1, G2, G3, G5, H1, H6, N3, N4
1429.	SE-31564776	C, E2, E3, E6, F2, F1, N2, N4
1430.	SE-31566711	C2, E2, F1, F2, F4, G1, G4, H1, J1, J2, M, N4
1431.	SE-31566731	E1, E3, E4, F4, G1, G2, G3, G5, N2
1432.	SE-31566754	B1, C1, E2, E3, E4, E6, F1, F2, F4, G1, G2, G3, G5, H1, N2, N4, N5
1433.	SE-31568725	G1, G3, G5, H2, J1
1434.	SE-31568728	F4
1435.	SE-31569238	B1, B5, C1, C4, E1, E2, E3, E4, E6, E9, F2, F4, G1, G3, G4, G5, H1, H2, H4, J1, K1, L1, L4, M
1436.	SE-31570465	B2, E1, E2, E9, F4, H1, H4, J1, J2, K1
1437.	SE-31571827	B2, E1, F1, G1, G, H1, H6, N2, N4
1438.	SE-31573278	E1, F4
1439.	SE-31574695	E2, F2, F4, G1, G2, G3, H1, N4
1440.	SE-31584896	E6, F4, G1, H2
1441.	SE-31586733	E1, E2, E3, E4, G1, G2, G3
1442.	SE-31597626	C2, H2, J1, J, L1, L4, O2, O1, O
1443.	SE-31603095	C, C4, C7, C8
1444.	SE-31635504	B5, E2, E9, F4, G1, G2, G, H2, J1, N4
1445.	SE-31643254	E1, E4, G1, G5, G2, H1, H6, J1, J, N4
1446.	SE-31647486	O1, O2
1447.	SE-31674881	B2, E2, E6, F4, G1, G2, G5, H1, J1
1448.	SE-31676761	A, B2, B6, J1
1449.	SE-31696184	B2, B4, B5, C, E1, E10, F4, F2, G1, H1, H2, H4, H6, J, J1, K1, L1, L4, N4
1450.	SE-31701551	B2, B4, B5, C, E1, E10, F4, F2, G1, H1, H2, H4, H6, J, J1, K1, L1, L4, N4

No.	Submission number	Issues raised
1451.	SE-31701553	B2, C, E2, E4, F2, F4, G1, H6, H1
1452.	SE-31701561	C4, F4, G1, M
1453.	SE-31701565	F4
1454.	SE-31704482	E2, E4, F2, F4, G2, G1, G3, H1, J1, J
1455.	SE-31705478	M
1456.	SE-31705492	C, D, E1, E2, E7, F4, G1, N2
1457.	SE-31705597	B2, F4, G1, G2, G3, N4, N5
1458.	SE-31706707	C2, E1, H2, K3
1459.	SE-31706716	B3, E1, E4, F4, G1, G3, H2, J1
1460.	SE-31706720	B4, E1
1461.	SE-31706723	B1, C1, E3, E4, E6, F1, F2, G1, G2, G3, G5, H1, N4, N2
1462.	SE-31706725	G1, G5, M
1463.	SE-31706766	C1, E1, E3, F2, G1, H1
1464.	SE-31706786	C1, E6, F2, H1, N2, N4, N5
1465.	SE-31706999	D
1466.	SE-31707015	A, B1, B2, B3, J1, K1
1467.	SE-31708210	C8, E1, F4, H1, J1
1468.	SE-31708273	B2, C1, E2, E6, F2, F3, G1, G3, N2, N4
1469.	SE-31709341	E1, E4, M
1470.	SE-31711051	E2, E4, E10, G1
1471.	SE-31717246	E4, E10
1472.	SE-31719259	B1, B2, C1, C2, C3, C5, E1, E2, E3, E4, E5, E6, E7, E9, E10, F1, F2, F4, G1, G3, G4, G5, H1, H2, H6, J1, K1, K2, N2, N4, N5
1473.	SE-31725512	B2, B4, E1, E4, E10, F4, G1, H5
1474.	SE-31795495	C5, E1, F4, G2
1475.	SE-31815707	B4, E1, F4, G1, G3
1476.	SE-31815710	G, G5, K1
1477.	SE-31815715	E1, F, G
1478.	SE-31815831	E1, E2, F4, G, O1
1479.	SE-31816622	G, J1
1480.	SE-31816626	B2, E1, E6, G
1481.	SE-31819012	G4, H6, E6, E9, F, H1, N2, N4
1482.	SE-31821960	C, H1, G
1483.	SE-31821989	B4, E1, G1
1484.	SE-31821993	B1, C1, E1, E2, E3, E4, E6, F1, F4, G1, G2, G3, G5, H1, N2 N4, N5

No.	Submission number	Issues raised
1485.	SE-31822013	B4, E4, F, G
1486.	SE-31822039	E1, G1
1487.	SE-31822048	B4
1488.	SE-31822059	E1, F, G1, H1, H4, L, L4, N2, N4
1489.	SE-31822070	B4
1490.	SE-31822075	E1, F, J1
1491.	SE-31822465	E1, F
1492.	SE-31822471	E1, F, G, H1, J1
1493.	SE-31822489	C, F, G1, N2, N4
1494.	SE-31822497	B4, C, E1, E4, F, G2, G3, J1
1495.	SE-31822501	B1, C1, E2, E3, E4, E6, F1, F2, F4, G1, G2, G3, H1, N2, N4, N5
1496.	SE-31822546	E1, K3
1497.	SE-31822549	C, E1, E6, E9, F, H4, J1
1498.	SE-31824208	B4, E1, E4, F, M
1499.	SE-31824219	C2, E1, J1
1500.	SE-31824249	E1, F, G1, H1, N2, N4
1501.	SE-31824279	E, E1, F, G1, J1
1502.	SE-31824310	C, E2, F1, N2, N5
1503.	SE-31831087	F, G1, H4, J1
1504.	SE-31831711	C3, C4, C5, E2, E3, E4, F1, F4, G1, G5, N2, N4
1505.	SE-31833941	C1, E2, E4, E10, F4, G1
1506.	SE-31835257	B1, B2, C1, E1, E2, E3, E4, E6, F2, F4, G1, G2, G3, H1
1507.	SE-31835267	C, E2, E3, E4, F4, G1, G4, G5, H1, J, J1
1508.	SE-31835292	C, E6, E7, E9, F4, G2, G3, H1, H2, H4, K1
1509.	SE-31835325	C, E7, F2, F4, G1, G2, G3, M
1510.	SE-31836781	B4, C2, F, G1, G3, H1, N2, N4
1511.	SE-31836796	C, E1, E9, F2, G, G1, G2, G3, H4, J, J1
1512.	SE-31836804	H2, J1, J
1513.	SE-31836806	C2, C3, N2, N4
1514.	SE-31838468	B5, C, E1, E9, H4, H5, J1, M
1515.	SE-31838470	B1, C1, E2, F1, F2, G1, G5, N4
1516.	SE-31838473	B4, C
1517.	SE-31838963	B5, E6, E7, E9, F4, G2, G3, H1, H4, N2
1518.	SE-31839033	E7

No.	Submission number	Issues raised
1519.	SE-31839038	B4, C, E2, F, G4
1520.	SE-31841030	K3
1521.	SE-31841032	B5, C2, E2, F4, G4, J1, K1
1522.	SE-31841036	C1, E1, E2, E3, E4, E10, F1, F2, F4, G1, G2, G3, G5, H1, N4, N5
1523.	SE-31841039	C, F2, G1, G2, G3, H1, N5
1524.	SE-31841041	E2, E6, E7, F1, F2, G, G1, G2, G3, J1, N4
1525.	SE-31841045	E7
1526.	SE-31841050	C, E2, E3, E4, E7, G1, G2, G3, K1
1527.	SE-31841092	B5, F2, G1, J1 K1, N4
1528.	SE-31843957	E1, E2, E6, E10, F1, F2, G1, G3
1529.	SE-31843964	M
1530.	SE-31843967	J1, M,
1531.	SE-31843970	E2, F, G1, G3, H1, J1
1532.	SE-31843977	E1, E2, G1, G3, I, J1
1533.	SE-31843987	B4, E7, M, N2
1534.	SE-31844164	C, E1, E2, F, K1
1535.	SE-31844180	B4, C1, C2 C4, H1, H5
1536.	SE-31847212	C, N2, N5
1537.	SE-31847333	E2, F, H1, J1, K1
1538.	SE-31847339	B4, E1, F, G
1539.	SE-31847342	B4, C, G1, N4
1540.	SE-31847347	G1, G4, K1
1541.	SE-31847353	K1
1542.	SE-31847787	K, K1, K2
1543.	SE-31849085	E1, J1
1544.	SE-31849468	E1, G1
1545.	SE-31849471	B1, E1, E2, E3, E4, E6, E7, E10, F1, F4, G, G1, G2, G3, G5, N2, N3, N4
1546.	SE-31875729	B1, E2, E3, E4, E6, F1, F4, G1, G5, K1, N3, N4
1547.	SE-31945754	E1
1548.	SE-31952488	Not relevant to project – no submission
1549.	SE-31994034	A, B5, C3, H, J1, K
1550.	SE-32011040	J2, F4
1551.	SE-32011094	B2, E1, H2
1552.	SE-32012516	B4

No.	Submission number	Issues raised
1553.	SE-32012543	E4
1554.	SE-32012552	E1, M
1555.	SE-32012560	C, N2, N4
1556.	SE-32012562	A
1557.	SE-32014462	G1, G2, H2
1558.	SE-32019457	B1, C2, C3, E4, E6, E9, E10, H1, H4, J1, N4
1559.	SE-32019460	E1
1560.	SE-32019462	C7, C8
1561.	SE-32019465	C, C8
1562.	SE-32019467	C, F3, G1
1563.	SE-32019472	E1, E2, F4
1564.	SE-32019474	A
1565.	SE-32019476	E1, M
1566.	SE-32019708	B1, G1
1567.	SE-32019711	C, G2, J1, M
1568.	SE-32019715	E1, E2, F, G1, N4
1569.	SE-32019718	B1, E2, E3, E4, E6, F1, G1, G2, G3, N2, N4, N5
1570.	SE-32019720	B4
1571.	SE-32019723	E2, E4, F2, G1, G2
1572.	SE-32019727	E4, F2, G1, G2, G3
1573.	SE-32019731	G1
1574.	SE-32019734	C
1575.	SE-32019750	J1
1576.	SE-32019958	E2, F2, G1, H6, J1
1577.	SE-32019963	H4, H2
1578.	SE-32019965	E1, F, G1, G3, G4, H1
1579.	SE-32019970	E1, E5, F
1580.	SE-32019974	BLANK – Declaration in relation to previous submission only
1581.	SE-32019977	C7, E7, H
1582.	SE-32019994	B4, D, E2, E4, E10, F, F1, G1, J1, N4
1583.	SE-32023033	E9, G1, G5, N2, N5
1584.	SE-32040748	G1, J1
1585.	SE-32062270	E1, E4, E7, E10, G3, K3
1586.	SE-32063496	B3, E2, E4, E7, E9, E10, F4, G1

No.	Submission number	Issues raised
1587.	SE-32069156	B1, C, E6, F2, G1, G3, H1
1588.	SE-32133519	E1, F, K1
1589.	SE-32134000	C, F2, G1
1590.	SE-32134002	G1, F
1591.	SE-32134943	B1, B4, B5, C1, C2, C3, C, C5, E1, E2, E10, F4, G1, G2, G3, H1, H2, H5, J1, N2
1592.	SE-32134953	E6, F1, F2, F4, G3, G1, N4, N5
1593.	SE-32135812	C2, C3, C4, C5, E2, E3, E4, E5, E6, E7, F4, G1, G, G3, G2, G5, H1, J1, N4
1594.	SE-32136984	J1
1595.	SE-32136998	E1, E5, E7, F4, I
1596.	SE-32137008	C7, E1, F4, J1
1597.	SE-32137016	B1, B5, C1, E2, E3, E4, E6, F1, F4, F2, G1, G2, G3, H1, N5, N4, N2
1598.	SE-32138033	B5, F4, G1, H1, J1, N4
1599.	SE-32138190	E1, F2, F4, G1, J1, N2
1600.	SE-32138199	E7
1601.	SE-32138201	C3, E2, F4, G1, H1, J1
1602.	SE-32138204	E, E1
1603.	SE-32138213	C, G2
1604.	SE-32140293	E1, F, J1
1605.	SE-32140335	C, G1, N4
1606.	SE-32140394	E1, E4, E7, E10, F2, G1, H2, J1, N2
1607.	SE-32142122	C1, E6, F1, F3, F4, F1, G1, G5, G3, H6, H2, N4
1608.	SE-32142458	E1, E2, F, G2, G4
1609.	SE-32142461	B4, C, E1, G1, J1
1610.	SE-32142464	C, E1, E2, F4, G1
1611.	SE-32142957	E2, E6, F4, G1, H2, H6
1612.	SE-32147282	E1, F
1613.	SE-32147330	E2, E3, E4, G1, G3, G4, G2
1614.	SE-32147332	B4
1615.	SE-32147334	B4, C, F, G1, N4
1616.	SE-32148965	G1, M
1617.	SE-32149037	E2, F4
1618.	SE-32149051	G1
1619.	SE-32149056	E2, F, J1
1620.	SE-32151465	F2, N4, N5

No.	Submission number	Issues raised
1621.	SE-32151478	G1, G4, J1
1622.	SE-32151486	C, E2, E4, F4
1623.	SE-32152707	C, F4, F2, G1
1624.	SE-32152980	E1, F4, J1
1625.	SE-32152994	B1, B4, B5, C, E1, E2, E10, F1, F4, G1, G2, G3, H1, J1, N4
1626.	SE-32153007	E1, F4, F, K1, M
1627.	SE-32153231	B5, E2, F4, H, H2
1628.	SE-32153237	E1, E6, F4, G1
1629.	SE-32153248	M
1630.	SE-32154959	E2, E4, F2, F4, G3, H4, N4
1631.	SE-32161129	B5, C, F4, G1
1632.	SE-32161749	B4, B5, C2, E1, G4, G1
1633.	SE-32163957	B1, B5, C1, E2, E3, E4, E6, F1, F2, F4, G1, G2, G3, H1, H2, N2, N4, N5
1634.	SE-32164005	B4, J1, M
1635.	SE-32164117	B2, E1, E4, E9, F4, H1, J1, N2
1636.	SE-32164161	E1, E3, E9, F4, G2, G5
1637.	SE-32164163	B1, C1, E2, F4, G1, H2, H1, K3, N5, N4
1638.	SE-32164979	C, G1, J1, N2
1639.	SE-32165951	C2, E6, E7, F4, H4, H2, J1
1640.	SE-32177502	B2, B, B4, C1, C5, G1, G2, G5, J1
1641.	SE-32183588	D, H2, J1, K3
1642.	SE-32183591	F, F1, F2, F3, F4, G1, G2, G3
1643.	SE-32186721	E2, E4, E10, G1, H2
1644.	SE-32189285	C1, F4, N4
1645.	SE-32189303	C1, C4, C5, C6, C7, G1, N4
1646.	SE-32209959	C1, E2, E4, E6, E10, G1, N4
1647.	SE-32209977	E2, E4, E10, G1
1648.	SE-32211002	B3, B5, C6, C7, E6, F1, G1, G5, H6, H1, K1, K, N2, N4
1649.	SE-32211270	H6, K1, N4
1650.	SE-32237725	B4, B5, E2, E4, E7, E10, F4, H2, N2
1651.	SE-32244118	E1, E2, E3, G1, G2, G3
1652.	SE-32244314	F4
1653.	SE-32244329	E1, K1
1654.	SE-32244644	E1, J1, J

No.	Submission number	Issues raised
1655.	SE-32247978	B5, C5, H1, H2, J1, G1
1656.	SE-32247981	C5, C8, E1, H1, H2, J1
1657.	SE-32249457	E2, E4, E9, F4, G1, G4, G5, H1, H4, J1
1658.	SE-32250537	G1, G2, G5
1659.	SE-32256402	E1, E7
1660.	SE-32256426	E1, E7, E9, N2
1661.	SE-32256429	H6
1662.	SE-32256434	E2, N2, N4, H1
1663.	SE-32256437	B2, E7, G4, J1
1664.	SE-32261985	C2, C3, E4, H2, J1
1665.	SE-32262497	B2, B4, B5, C8, E1, E2, F4, H4, N4
1666.	SE-32262499	C1, G2, H1
1667.	SE-32262707	B1, E2, E3, E4, E6, F1, F4, G1, G2, G3, N2, N4, N5
1668.	SE-32262711	C, E1, J1, M
1669.	SE-32263707	C, E7, F2, F4
1670.	SE-32263714	E7, K3
1671.	SE-32263716	B1, C1, E2, E6, F1, F4, G1, G2, G5, H1, N2, N4, N5
1672.	SE-32263720	B, C
1673.	SE-32263723	B1, B5, C1, D, E1, E2, E3, E4, E6, F1, E10, G1, G2, G3, H1, H4, K, N4
1674.	SE-32263896	C, E6, E9, F2, F4, G1, G2, G5, H6
1675.	SE-32263904	C
1676.	SE-32265210	C3, C4, C5, E1, E3, E4, E6, F4, F1, F2, G1, G2, G3, H1, N4
1677.	SE-32265972	B5, E9, G1
1678.	SE-32266069	C8, E2, F4, G1, H1
1679.	SE-32266076	J1
1680.	SE-32266082	E9, F4, K1, K3
1681.	SE-32266097	C, E2
1682.	SE-32277130	B4, C, C2, E2, E4, E6, E10, G1, H2, H6, J1, N2
1683.	SE-32287407	B4, C1, C4, F1, F4, G1, H1, H4, L1, L4, N1
1684.	SE-32293021	E2, E4, G1
1685.	SE-32332122	C8, H2, J1
1686.	SE-32337566	C3, C8, E1, E2, F1, F4
1687.	SE-32343103	C, D, G1, H2, J1, K3, N2
1688.	SE-32360300	I, N1

No.	Submission number	Issues raised
1689.	SE-32390393	E1, E10, F4, N2
1690.	SE-32398521	B4, E1, E10, F2, G, N2
1691.	SE-32399322	B2, C1, D, H2, H4, J, J1, J2, L6
1692.	SE-32399492	E4, F4, G1, G3, G5, H1, H2, J1, N2, N4
1693.	SE-32429692	B1, B4, C1, C4, C5, E1, E2, E3, E4, E6, E10, F1, F4, G1, G2, G3, G5, G4, H1, N2, N4
1694.	SE-32439030	E1, F4, H2
1695.	SE-32439033	C6, C, J1, L1, L4
1696.	SE-32439036	G1, H1, H2, K1
1697.	SE-32439039	B2, B4, E1, E3, E4, F4, J, N2
1698.	SE-32439044	B4, B4, H2, J1
1699.	SE-32439049	C, F1, F4, G1, H6, J1, J, K1, N4
1700.	SE-32439053	H2, J1
1701.	SE-32439056	H6
1702.	SE-32439058	C6, E1, E2, H1, H6
1703.	SE-32439307	C, E1, E2, E10, H2, J1, N4
1704.	SE-32439312	C3, C4, C5, C8, E2, E3, E4, F4, G1, G2, G3, H1, H2, H6, J1, O2
1705.	SE-32478722	B3, B4, C8, J1
1706.	SE-32479720	C1, E7, F2, F4, G1, G2, K3
1707.	SE-32483738	C2, C3, C4, E2, E6, F, F2, F4, J, N2, N4
1708.	SE-32494417	B4, C, H2, H4, J1, J, L1, L4
1709.	SE-32531239	B1, C, E2, E6, E7, E9, F2, F4, G1, G3, J, J1, N2, N4
1710.	SE-32534774	B5, C, C3, C4, C8, E6, E1, E10, F4, F2, G1, G3, H2, H1, H6, J1
1711.	SE-32543587	C5, C8, H2, J1
1712.	SE-32543637	C5, E1, F4, G1, G2, G3, G4, M
1713.	SE-32543666	C, E2, E3, E4, G1, G2, G3, G5, H2, L1, L4
1714.	SE-32546314	C2, E1, F4, G1, G3, H1, J1, J, N1
1715.	SE-32546330	C1, E2, F4, F2, G1, H6, N2, N4
1716.	SE-32546346	C1, E3, E4, F4, G1, H6, N4
1717.	SE-32546427	L1, L4
1718.	SE-32546437	E2, E3, E4, E5, E10, F2, F4, G1, G2, G3, G5, H, H2, H5, J1, N4
1719.	SE-32547295	B1, E7, F1, G1, G2, G5, H4, I, J1, J, K1, L1, N2, N4
1720.	SE-32547298	C, E1, E2, E3, E4, E8, E9, E10, F4, G1, H6
1721.	SE-32547332	B4
1722.	SE-32547338	C, E7, F2, H2, N4

No.	Submission number	Issues raised
1723.	SE-32547386	E7
1724.	SE-32548262	B1, C, C1, E2, E6, F4, G1, G2, G3, H1, J, N4
1725.	SE-32548279	B4, B5
1726.	SE-32548284	B1, B2, C3, C5, C6, C8, E1, E2, E3, E4, E6, F2, F4, G1, G3, G5, H4, H5, J1, K1, N4, N5
1727.	SE-32549227	E3, E4, E5, E6, F4, G1, G2, G3, G5, H6, N4
1728.	SE-32549230	B5, C2, C5, E2, F4, G1, J, J1, N4
1729.	SE-32549233	B2, C6, E7, E9, F4, F, H1, H2, H4, J1, J2
1730.	SE-32549239	C, F4, G1, H1
1731.	SE-32549242	B1, E2, E6, F1, G1, N2, N4, N5
1732.	SE-32549247	B2, C, E1, E2, E3, E4, E7, F4, G1, G2, G3, H1, H2, H6, J1
1733.	SE-32563717	B4
1734.	SE-32563810	E1, E2, E4, E10, F2, F4, G1, H1, H6, J1
1735.	SE-32566972	E1, E2, E6, G1, G2, G5, H2, N2, N4
1736.	SE-32577730	F4
1737.	SE-32577779	B3, B4, C1, C8, E1, E2, E3, E4, E6, E10, F4, G1, H, H1, H2, H4, H6, J, J1, N2, N3, N4, N5,
1738.	SE-32583718	B1, B2, B3, B4, C3, C4, C5, E1, E2, E3, E4, E10, F4, G, G1, G2, G3, H1, J, N2, N3, N4
1739.	SE-32604367	B2, C, E2, E3, E4, E6, E7, F2, F4, G2, G1, J, J1
1740.	SE-32606722	B2, C, E2, E3, E4, E6, E7, F2, F4, G2, G1, J, J1
1741.	SE-32640083	E1, G, H2
1742.	SE-32640099	C1, E1, E2, F4, G1, H6, N4
1743.	SE-32642090	C1, E1, E2, F4, H6, N4
1744.	SE-32642140	C1, F2, F4, G1, H2, H4, N2
1745.	SE-32642142	B4
1746.	SE-32642144	C1, C2, C3, E1, E3, E4, E8, G1, G2, G3, H6, I, J1
1747.	SE-32642146	C, F2, F4, G4, G3, H1
1748.	SE-32642148	E2, E4, G1, H6
1749.	SE-32644732	B5, C1, C3, C4, E1, E2, E4, E10, F4, G1, G2, H1, H5, H6, I, J1, K1, N4
1750.	SE-32644789	F4, G1, J1, N4
1751.	SE-32644796	C1, E1, E7, E9, G1, H1, J1, N2
1752.	SE-32644802	C, E2, E3, E6, G1, G2, G5, H1, H, H6, J1, N4
1753.	SE-32647709	B3, C, F4, G1, H1, H5, J1, J2, M, N2
1754.	SE-32651208	H2, H4, H6, I, N4

No.	Submission number	Issues raised
1755.	SE-32672330	E1, E2, F1, F2, F4, G1, G2, G3, G5
1756.	SE-32672347	B1, C1, C2, E2, E6, F4, G, G1, G3, G4, G5, H1, H6, N4
1757.	SE-32673967	B2, E1, E2, E7, E9, G1, G2, G3, H2, H6, J1, K1
1758.	SE-32767484	E1, E4, E7, H1, J1
1759.	SE-32767494	B2, E7, G1, N2
1760.	SE-32767513	B1, B4, C1, E2, E3, E4, E6, F1, F2, F4, G1, G2, G3, G5, H1, N2, N4, N5
1761.	SE-32768466	B4, G1, G5, H1, J1, J, K3
1762.	SE-32768469	E2, E1, F1, F2, F4, H2, J1, N2, N5
1763.	SE-32768473	E1, E4, E9, G1
1764.	SE-32768511	B2, E1, E2, E6, F4, G5, H2, J
1765.	SE-32768514	B1, B5, C1, E2, E3, E4, E6, F1, F4, G1, G2, G3, H1, J1, N2, N4, N5
1766.	SE-32768572	B2, E3, E4, G1, N4
1767.	SE-32769467	E2, F4, G1, G3, H2, J, M
1768.	SE-32769571	F2, F4, G1
1769.	SE-32769576	B5, C8, E1, E2, E3, E4, E7, F4, G1, G2, G3, G4, G5, H1, H6, K1, L1
1770.	SE-32769578	B5, C1, E2, E3, F2, G1, H1, H6, N4
1771.	SE-32770737	B2, B3, B4, C2, C4, E2, E3, E4, E9, E10, F4, G1, G2, H2, H6, J1, N2
1772.	SE-32770741	B3, B4, C, C1, D, E1, N1
1773.	SE-32771561	B1, C, C1, E2, E3, E4, E6, F4, G1, G2, G3, G5, H1, H2, H6, K1, N2, N4, N5
1774.	SE-32784644	B2, E2, G1, G2, G5, H1, H2, J1, J, K1, M, N2
1775.	SE-32790080	C1, E1, E2, E4, E6, E10, F4, G1, G4, H2, H1, H6, J1, K3, N4
1776.	SE-32799879	Test lodgement – no submission
1777.	SE-32804776	B2, B5, E1, E2, E3, E4, E6, E7, F1, F2, F4, G1, G2, G3, G5, H1, H5, J1, K1, N2, N4
1778.	SE-32847453	E1, E2, F4, G1, G5, H2, H6, I, J1, N2, N4
1779.	SE-32910598	A, H5
1780.	SE-32847453	E1, F2, F4, G1, G5, H2, H6, N2, N4
1781.	SE-32918975	B5, E1, E6, F4, F, G1, H4, J1, K1, N2
1782.	SE-32921516	C, C1, C4, C5, C8, E1, E2, E10, F2, F4, G1, H2, H1, K1, N2, N4
1783.	SE-32933590	B2, B4, C5, C8, E1, H6
1784.	SE-32959028	C1, E3, E4, E6, E10, F1, F4, G1, G3, G5, H1, K1
1785.	SE-33027178	F4
1786.	SE-33176495	C1, E2, E3, E4, E6, F1, F2, G1, J1, N2
1787.	SE-33202985	B5, C1, C4, E2, E3, E4, E6, E10, F4, G3, G1, H5, H6, J1, N4
1788.	SE-33215518	B2, C2, F4, G1, G2, G4

No.	Submission number	Issues raised
1789.	SE-33260713	B2, E2, F4, G1, K3, M
1790.	SE-33386707	B2, B5, C1, C2, C3, C4, C5, C8, E1, E2, E3, E4, E5, E6, E9, E10, F2, F3, F4, G1, G3, G5, H1, H6, J1, N4
1791.	SE-33411863	B1, B4, B5, C1, C5, D, E2, E3, E4, E10, F2, F4, G1, G3, G5, H6, N4
1792.	SE-33446010	B2, C1, C3, E1, F2, F4, G2, H3, H6, K, N2, O1, O2
1793.	SE-33455368	B4, F4, G1, G5
1794.	SE-33455377	B2, B4, E1, E3, E4, F4, G1, G2, G3, N2, N5
1795.	SE-33460236	B2, B4, B5, E1, F2, F4, H6, K1, N4
1796.	SE-33460252	B2, B4, C1, C2, C5, E1, E4, E6, F4, G1, G3, G5, J, N4
1797.	SE-33460367	B5, C1, C6, C8, E7, G1, G2
1798.	SE-33460370	C1, E1, E3, E4, G1, G3, H3
1799.	SE-33460427	B1, C1, E2, E6, F1, G1, H3, N2, N4, N5
1800.	SE-33460437	B2, C6, E7, K1, M
1801.	SE-33463457	B2, C1, E1, E3, E4, F2, F4, G1, G3
1802.	SE-33463493	B1, B2, B4, E1, E7, F4, G1, G5, H, H2, H3, L1, N2, N4
1803.	SE-33463500	E1, E6, E9, F2, F4, G1, H5, K1, N2, N5
1804.	SE-33463595	B1, C1, E1, E2, E3, E4, E6, E7, F1, G1, G2, G5, H3, N2
1805.	SE-33467484	B2, E1, E7, E9, H5, H6, J
1806.	SE-33467520	B4
1807.	SE-33467771	B4, E7
1808.	SE-33467774	B2, B5, C1, C5, E2, E4, E5, E10, F1, F3, F4, G1, G2, G5, H3, H6, J1, J2, K1, N2, N4
1809.	SE-33467778	G1
1810.	SE-33467801	E1, F2, F4, H5, M
1811.	SE-33470308	E1, E7, F4, N2
1812.	SE-33472030	B2, B4, B5, C1, C5, E2, E3, E4, E6, E9, E10, F4, G1, G3, H2, H3, H4, H5, N2
1813.	SE-33472034	B4, H6, K1
1814.	SE-33479907	B2, F4, H6, J1
1815.	SE-33489071	B1, B2, B3, C1, C4, C7, E2, E3, E5, E6, E8, F1, F2, F4, G1, G2, G3, G4, G5, H3, H6, J, K1, N2, N4, N5
1816.	SE-33492370	C5, F1, F2, F3, F4, G5, L5, M, N2, N4
1817.	SE-33522533	B2, B4, C2, C3, C5, C7, D, E2, E3, E4, E6, E7, F1, F4, G1, G3, G5, H1, H3, H5, H6, I, J, K1, K3, N2, N4, N5, O, O1, O2
1818.	SE-33542296	B4
1819.	SE-33546652	B2, B4, B5, C2, C5, E1, E7, F4, H5, J1, J2
1820.	SE-33571393	B1, B2, B3, E1, G1, G3, H3, H6

No.	Submission number	Issues raised
1821.	SE-33609825	E4, E7, F4, G1, G2, G3, G4, H6, K3
1822.	SE-33609827	E1, F4, H3, H4, J1
1823.	SE-33609832	C1, F3, F4, G1, G3, N2, N4
1824.	SE-33609836	C5, E1, E5, F4, G1, G3, H2, H3, H6, J1, K1
1825.	SE-33609866	B1, E2, E3, E4, E6, E7, F4, G1, G5, H6, N5
1826.	SE-33609905	E9, F3, F4, G1, G5, J1, M, N2
1827.	SE-33609915	B2, B4, B5, C5, E1, E2, E7, E10, F4, G3, H3, J2, N2
1828.	SE-33609923	B2, E7, F2
1829.	SE-33610676	B4, E4, F4, H3, H6, J2, K1
1830.	SE-33610682	B4, E2, E3, E4, E5, E8, G1, G2, G3, I
1831.	SE-33610884	G1
1832.	SE-33613962	C, E1, E7, F4, G1, G3, H6, K1
1833.	SE-33614002	B2, C1, E1, E3, E5, E6, F1, F4, G1, G5, N2, N4
1834.	SE-33615218	B2, C1, C2, C3, C8, E1, E3, E4, E5, G1, G2, G3, H3, H6, I, J1, K3, O1, O2
1835.	SE-33615249	E1, E7, E8, F4, H6
1836.	SE-33617299	B4, B2, C1, C2, C3, C4, C5, C8, E1, E2, E3, E4, E5, E6, E10, F4, G1, G2, G3, G4, H1, J2, N4
1837.	SE-33617776	B4, B6, C8
1838.	SE-33617798	B1, C1, E2, E6, F1, G2, H3, N2, N4, N5
1839.	SE-33617802	B2, C1, E2, E2, E4, E6, F1, G1, G3, H3, N4, N5
1840.	SE-33617806	B2, B4, G1, H2, L1
1841.	SE-33618470	B4, C1, E1, F4, G1, J1
1842.	SE-33618487	B4, E7
1843.	SE-33618490	C, E7
1844.	SE-33618502	B2, F4, G1, H3
1845.	SE-33618513	E2, F4, N2
1846.	SE-33624568	B2, B3, B4, B5, C5, E5, E10, F1, F4, G1, G3, H3, J1
1847.	SE-33663077	B1, C1, E1, E2, E3, E4, F1, F2, F3, F4, G1, G2, G3, G5, H3, J1, K1, N2, N4
1848.	SE-33682672	E1, E7, G1
1849.	SE-33703135	E7, G1
1850.	SE-33706763	B1, C2, C5, E2, E3, E4, E6, E9, F1, F3, F4, G1, G2, G4, G5, H3, J1, N2, N4
1851.	SE-33715528	C2, C5, E5, F4
1852.	SE-33715702	E7, E9, F4, H2, H6, J1, L1
1853.	SE-33721108	B2, B5, C2, C5, E4, E7, F2, L1, O1, O2
1854.	SE-33737533	B4, B5, C1, C2, C3, C4, C8, H2, N2

No.	Submission number	Issues raised
1855.	SE-33744492	B1, C1, C2, C5, C8, E1, E6, E10, F2, G1, H3, H6
1856.	SE-33761796	B1, C1, C2, C3, C4, C8, E2, E4, E6, E7, F1, F2, F4, G1, G2, G3, H3, K1, N5
1857.	SE-33773708	E1, E4, E7, E9, F4
1858.	SE-33775024	E1, E2, E3, E5, E9, E10, I, N1
1859.	SE-33775888	E9, O1, O2
1860.	SE-33791958	B1, C1, C2, C4, C5, C7, G1, H1, H2, H6, N2, N4
1861.	SE-33804743	B2, C1, C2, C5, E1, E2, E3, E4, E6, E7, F1, G1, G2, G5, J1, H4, H6, N2, N4
1862.	SE-33804945	E4, E6, E9
1863.	SE-33808333	B1, B4, B5, B6, C1, C2, C4, C5, C8, D, E1, E10, F4, G1, H2, H3, J1, J2, N2, N4
1864.	SE-33808369	B2, B6, C5, E4, E10, F2, F4, H3, J1, L1
1865.	SE-33809028	B2, B4, C1, D, E2, F4, G1, G5, H1, H2, H3, H4, H5, K1, N2, N4, O2
1866.	SE-33809404	B5, C1, C2, C3, E1, E2, E3, E4, E6, E7, E10, F1, F2, F4, G1, G2, G5, N2, N4
1867.	SE-33809520	E1, E2, E4, E6, E7, E10, G1, N4
1868.	SE-33809663	E1, E2, E4, E7, E10, F1, F2, F4, H6, K2, N1, N2, N4
1869.	SE-33812851	B4, C1, E1, H2, H3, H6, N2, N4
1870.	SE-33833760	B1, B2, B4, B5, C2, C4, C5, E2, F4, G1, G5, H1, J1, K1, N4
1871.	SE-33835157	B4, B5, C1, C2, C4, C5, C7, C8, H2, H3, H4, J2, N1, N4
1872.	SE-33838644	E2, E4, E10, G1
1873.	SE-33839041	B2, B3, B4, C3, C8, E1, E7, F4, G2, H3, J1, K2, K3, N4
1874.	SE-33839044	F2, F4, G1, G5, K3, N2
1875.	SE-33839312	E6, F1, F2, F3, F4, H2, N1, N2, N4
1876.	SE-33846014	B2, B3, B4, B5, C1, C2, C3, C5, C6, C7, C8, D, E1, E2, E3, E6, E7, E10, F1, F2, F3, F4, G1, G2, G3, G4, G5, H1, H2, H4, H6, K1, K2, M, N1, N2, N4, N5
1877.	SE-33846133	B5, C1, C5, E2, E3, E4, E6, E7, E9, F1, F4, G1, G2, G3, H1, H6, K1, N2, N4, N5
1878.	SE-33846137	B1, B2, C1, C4, C5, C8, E2, E3, E4, E6, E7, F1, F2, F3, F4, G1, G2, G4, G5, H2, H4, N2, N5
1879.	SE-33846155	B2, B5, C, E1, E7, H3, H5
1880.	SE-33846158	B4, B5, C2, C3, C4, C7, C8, E2, E3, E4, E5, E7, E10, F3, F4, G2, G3, G5, H1, H6, J1, N4
1881.	SE-33846194	E7, E9, H2, H3, H4, N2
1882.	SE-33862316	C1, E1, E2, E3, E4, E7, E9, E10, F4, G1, G5, N4
1883.	SE-33869273	E1, E2, F4, G1, G5
1884.	SE-33869603	F1, F2, F4, N2
1885.	SE-33869612	E1, E5, E9, E10, H6, N4

No.	Submission number	Issues raised
1886.	SE-33869637	F1, F2, F4, N1, N2
1887.	SE-33869641	B2, B3, B4, B5, C1, C2, C3, C5, C6, C8, H1, H2, H3, H6, L1, L4, L6, M, N4
1888.	SE-33869722	B2, B4, B5, C1, C4, E2, E7, E10, F4, G1, G2, H2, H4, H6, J1, K1
1889.	SE-33869826	B2, B3, C1, C2, C3, C4, E1, E2, E3, E4, E6, E10, F1, F2, F4, G1, G3, G5, H3, H5, H6, J1, N2, N5
1890.	SE-33869841	B2, B5, C2, C5, E2, E3, E4, E7, E10, F3, F4, G1, G2, G3, G5, H1, H4, J1, N4
1891.	SE-33869958	E1, G3, J1, K1
1892.	SE-33869979	B1, E2, E3, E4, E5, E6, E7, F1, F2, F4, G1, G2, G3, G4, G5, H6, K3, N4
1893.	SE-33870281	B2, B4, B5, C2, C3, C4, C5, C8, E1, E2, E3, E4, E7, F1, F2, F4, G1, G2, G3, G5, H1, H3, H5, H6, J1, K1, N2, N3, N4
1894.	SE-33870323	B4
1895.	SE-33870532	B2, B4, B5, G1, H3, H6, J1, N2
1896.	SE-33870587	B4, B5, E1, E4, E7, E10, H1, H2, H3, L3
1897.	SE-33870666	B4, B5, C1, C5, E2, E3, E4, E7, F4, G1, G4, G5, H2, H4, J1
1898.	SE-33871209	B2, B4, B5, C4, C5, C7, E3, F3, F4, G1, G2, G3, G5, H6, J1, N2, N4
1899.	SE-33871247	B2, C1, C2 C4, C5, E1, E2, E3, E4, E5, E6, F1, G1, G3, G5, H1, H4, H6, N2, N4, N5
1900.	SE-33871277	B1, B2, B4, C1, C4, E1, E2, E3, E4, E6, F1, F2, F3, F4, G1, G2, G3, G5, H1, J1, M, N2
1901.	SE-33871280	C1, E1, E9, F4, G1
1902.	SE-33871293	B4, B5, C1, E1, E2, E5, E6, G1, G3, G6, H1, H4, L5, N2, N4
1903.	SE-33874000	B2, B4, C2, E1, E7, F4, G1, G5, H6
1904.	SE-33874155	B2, B4, B5, C1, C2, C3, C4, C5, E1, E2, E3, E5, E6, E9, E10, F2, F4, G1, G2, G3, G4, G5, H2, H5, H6, J1, J2, L5, N1, N2, N4, N5
1905.	SE-33877521	C1, E1, E7, E10, F1, F2, F3, F4, G1, H4, K1, K2, K3, N4
1906.	SE-33877524	C1, C2, C5, E1, F4, G1, G2, G5
1907.	SE-33877553	B4, C1, D, E1, E2, E3, E4, E7, E10, F1, F2, F4, G1, G2, G3, G4, G5, H3, H6, K1, K3, N2, N4
1908.	SE-33877556	B4, E9, G1
1909.	SE-33877559	C1, H4
1910.	SE-33877584	B4
1911.	SE-33877591	E1, G1, H2, N2, N4
1912.	SE-33931328	B4, C1, F3
1913.	SE-33931332	C1, E1, K1
1914.	SE-33938464	E7, F4, K1
1915.	SE-33939373	B1, B4, C1, E2, E6, F1, G1, H1, K1, N2, N4, N5
1916.	SE-33940244	C5, E2, E3, E4, E6, F4, G3, H1, H6, J2, M, N4

No.	Submission number	Issues raised
1917.	SE-33940494	E2, E3, E4, E7, F4, G1, G4, H1
1918.	SE-33940539	E1, E7, G4, K1, M
1919.	SE-33941468	B1, E2, E3, E4, E6, C1, G1, F1, F2, F4, G2, G3, G5, H1, H3, H6, N2, N4, N5
1920.	SE-33941787	C1, E1, G1
1921.	SE-33943207	F2, F4, H6, K1
1922.	SE-33943476	E1, E7, G4, K1, M
1923.	SE-33943497	B3, E1, E2, E7, F3, F4, G4, H2, I, K1, L5
1924.	SE-33943535	C5, E7, F2, G1, H, J1
1925.	SE-33943546	B1, B2, B4, E1, F4, G1, G3, G5, H3, H6, J1, N2
1926.	SE-33943677	B4, E1, F4, G1, H1, N2
1927.	SE-33943702	B2, E7, F2, F3, F4, G1, K1, N2, N4
1928.	SE-33943704	B2, E7, F2, F3, F4, G1, G5, N2, N4
1929.	SE-33944462	E7, G1, J1
1930.	SE-33944469	B4, E1, E6, G1, H3, N4
1931.	SE-33944485	E1, F, G1, G2, G3, K1, J1
1932.	SE-33944495	B1, C1, E7, F2, F4, G1, G2, G3, G5, H6, K1, N2, N4, N5
1933.	SE-33945998	E5, E7, G1, K1
1934.	SE-33947708	B1, B5, E1, E2, E4, E6, E7, E9, F4, G1, G2, G3, G5, K1, N4
1935.	SE-33948460	C1, E7, G1
1936.	SE-33948471	B4, C1, C5, E7, G1
1937.	SE-33960535	B4
1938.	SE-33962290	C1, E1, E2, E3, E4, F1, F2, F3, F4, G2, G3, G5, N2, N5
1939.	SE-33962292	B1, B4, E2, F1, G1, H3, N4, N5
1940.	SE-33962385	C1, F2, F4, G1, G2, G3, H6, N5
1941.	SE-33962551	B2, B3, B4, E1, E5, E7, F4, G3, G4, H4, J1, J2, K1, L5, N2, N4, O2
1942.	SE-33963293	B2, B4, B5, E1, E7, F4, H6, J1, N2, N5
1943.	SE-33979454	B4, B5, N2
1944.	SE-33991815	E2, G1
1945.	SE-33991831	C1, E1, E3, E4, E6, E7, E9, G1, G2, G3, G5, H6, N4
1946.	SE-33991833	E1, E2, E6, E7, M
1947.	SE-34003468	B4
1948.	SE-34003482	E1, H6
1949.	SE-34003486	B1, C1, C5, E7, E10, G1, G3, H1, J1, K1, N5
1950.	SE-34003489	B2, B3, B4, C1, E1, E6, E7, E9, F1, F2, F4, G1, G3, H1, H6, J1, L1, L5, N2

No.	Submission number	Issues raised
1951.	SE-34003495	B1, B2, E2, E6, E7, F1, F2, F3, F4, G1, N2, N4, N5
1952.	SE-34003500	B2, C1, E1, E7, F3, F4, G1, G5, J1
1953.	SE-34003521	B1, E2, E6, E7, F1, F2, F4, G2, G3, H1, H6, K1, N4
1954.	SE-34004706	B4, E1, E2, F4, K1, M, N2
1955.	SE-34004708	B1, B4, C1, C5, E7, E10, G1, G3, G5, H1, H4, J1, K1, N2, N5
1956.	SE-34004710	H2, H3, H5, J1
1957.	SE-34004712	C, E2, F4
1958.	SE-34005464	B1, B4, E2, E3, E4, F4, G1, G2, G3, G5, H6, K1, N2, N4
1959.	SE-34005466	C1, C4, C7, C8, E1, E2, F4, G1, H6, N4
1960.	SE-34005472	E1, K1
1961.	SE-34005475	B2, G3, G5, H6, K2
1962.	SE-34012333	B1, B5, C1, C2, C3, C4, C5, E1, E3, E4, E9, E10, F4, G1, G5, H1, H2, H4, J2, N2, N3, N4
1963.	SE-34012338	B1, E2, E6, F1, N2, N4, N5
1964.	SE-34012382	B4, B5, E1
1965.	SE-34012385	C5, E7, E9, H2, J1, L1, N2, N4
1966.	SE-34012395	B5, C1, E7, F2, F4, G1, G2, G3
1967.	SE-34017731	B4, E1
1968.	SE-34017739	C5, E1, E2, E3, E4, E6, F3, F4, G1, G2, G5, H4, H6, I, J1, K1, N2, N4
1969.	SE-34017756	B2, G1, G2, G5, H1, N4
1970.	SE-34017763	B1, C1, C2, C5, C7, C8, E1, E2, E3, E4, E6, F1, F4, G1, G2, G4, G5, H1, H2, H6, J1, N2, N4
1971.	SE-34017775	C1, E1, F3, F4, G1, G3, K1
1972.	SE-34017846	B2, C1, E1, E2, E3, E4, F4, G1, G3, G4, G5, H6, K1
1973.	SE-34017853	B2, B3, B4, C1, F4, G1, H1, H6
1974.	SE-34018005	E7, F4, G1
1975.	SE-34018044	B2, B6, E7, J1, J2, L1, L5
1976.	SE-34018079	B4, C1, C3, C4, C5, C7, C8, E7, F1, F2, F3, F4, G1, G2, G3, G4, G5, H3, H6, J1
1977.	SE-34018082	E1, F4, K1, N2, N4, O1, O2
1978.	SE-34019957	C1, C5, E1, E2, E3, E4, E5, E6, E9, F1, F3, F4, G1, G2, G3, G5, H1, H6, I, N2
1979.	SE-34020029	B5, C1, E1, E7, E9, E10, G1, N2
1980.	SE-34021211	E1
1981.	SE-34021264	B6, C2, C3, C5, F4, H2, H4, H5, J1, J2
1982.	SE-34021279	B4, B5, C, E1, F4, J1

No.	Submission number	Issues raised
1983.	SE-34021328	C1, E9, G1, J1
1984.	SE-34023738	C1, E3, E4, E6, E9, E10, H2, H6, N2, N4
1985.	SE-34023741	E2, E3, E4, E7, E9, G1, G5, H3, H4, J1
1986.	SE-34025218	B4, E2, E3, E4, G1, G2, G3, G4
1987.	SE-34025229	B2, E2, F4
1988.	SE-34025250	C1, C5, F4, G2
1989.	SE-34025307	C1, E2, E3, E4, E6, E7, G1, G2, G3, G5, H6
1990.	SE-34025352	C5, F4, H3, L5
1991.	SE-34025362	B1, B4, C1, C2, C3, C4, E1, E2, E6, E7, F2, F4, G2, H1, K1, N2
1992.	SE-34025483	B4, B5, H2, H3, J1, J2
1993.	SE-34029538	E1, F2, F4, K1
1994.	SE-34029545	C, E9, G2, M
1995.	SE-34029712	B3, B5, C3, C5, J1
1996.	SE-34035096	B2, B4, G2, H1, K1, L1
1997.	SE-34035100	C1, E1, E7, F2, F4, G1, K1
1998.	SE-34035121	E1, E7, F2, F4, H6, K1
1999.	SE-34035125	B4, B5, E1, E5, F4, G1, G3, H6, K1
2000.	SE-34035138	B1, B2, C1, E2, E3, E4, E6, E9, F1, F3, F4, H5, H6, N2, N5
2001.	SE-34035143	B2, B5, C3, C5, C8, E7, F4, G1, G5, H1
2002.	SE-34035147	B2, C1, E2, E7, F4, G1, G2, G5, H3, J2, L1, N2
2003.	SE-34035169	B4, C1, C5, E1, E2, G1, G2, G3, G5, H3, H6, K1, N4
2004.	SE-34035185	B2, B5, E1, E10, F4, H3, J1
2005.	SE-34040713	B2, E2, E3, E4, E7, E9, F2, F4, G1, G3, H6
2006.	SE-34040716	B2, B4, C1, C2, C3, C5, C6, C8, H2, H3, H6, J1, K, N2, N4
2007.	SE-34040719	B4, F4, G1, K1
2008.	SE-34040722	B2, B5, C1, E1, E2, E3, E5, E7, F2, F4, N2, N4
2009.	SE-34043207	B1, B2, B4, B6, C1, E2, E3, E4, E5, F1, F2, F3, F4, G3, H3, J1, N2, N4, N5
2010.	SE-34043224	B4, B5, C1, C3, C8, E7, F2, F4, H2, H3, H5, M
2011.	SE-34043233	B4, C1, E5, E8, G1, G3, G4, G5, H3, H6, K1
2012.	SE-34043243	B4, C1, C7, D, E1, E5, E7, F1, F, F2, F4, G1, H2, H3, H4, H6, I, N2, N4
2013.	SE-34044459	E1, F4
2014.	SE-34044492	B2, C5, E1, G1, G2, G3, H6
2015.	SE-34044497	B4, E1, E2, E10, F4, G1, G4, H1, H3, H6, J1, N2, N4
2016.	SE-34044507	B2, C5, E9, F3, F4, G1, J1, K3, N2

No.	Submission number	Issues raised
2017.	SE-34044528	B2, B4, B5, C1, C2, C3, C5, C7, C8, E10, F1, F2, F4, E2, E3, E4, E6, G1, G2, G3, H2, H3, H4, H5, H6, J1, N4
2018.	SE-34047968	B2, E1, E2, E6, E7, E9, G4, J1, K1, N2, N4, N5
2019.	SE-34048716	E1, E2, E3, E4, E7, F4, K1
2020.	SE-34048967	B3, B2, B4, B5, C3, C5, D, E1, E9, F2, F4, G1, G3, G4, H3, H6, J1, K1, K3, L1, M, N2, O1, O2
2021.	SE-34049210	C1, E1, G1, G5, H6, K1, N4, N5
2022.	SE-34049476	C1, E2, E4, E6, E10, F1, F2, F4, G1, H3, N4
2023.	SE-34050274	B2, B5, B6, C1, E1, E2, E3, E4, E6, E7, E9, E10, F1, F2, F3, F4, G1, G2, G3, G5, H3, H6, J1, L1, N2, N4
2024.	SE-34050757	B2, B4, C1, E7, H3, J1
2025.	SE-34050760	B4, C1, E1, E2, E4, E6, E7, E10, F2, F4, G1, G2, G3, H2, H3, K1, N3, N4
2026.	SE-34050776	B1, C1, C5, E1, E2, E3, E4, E6, F2, F4, H3, H5, J1, N2, N4, N5
2027.	SE-34051249	B2, F4, G1, G5, H2, H3, J1, N2, N4
2028.	SE-34051707	C1, C5, E1, E7, G3, H3, K1, M
2029.	SE-34051710	B2, C1, C2, C3, C4, C5, C6, E2, E3, E4, G1, G2, G3, H3, H6, K1
2030.	SE-34051712	B2, E1, E2, E8, F4, G3, G4
2031.	SE-34051716	B2, C1, E1, E2, F4, G1, G2, G4, H1, H6
2032.	SE-34051847	B2, B4, B5, E1, F1, F4, G1, H3, H6, J1, N2, N3, N4
2033.	SE-34052015	B4, C1, E1, E2
2034.	SE-34052472	E1, K1, K3
2035.	SE-34052474	E1, F4, H4
2036.	SE-34052977	B2, B3, H3, L1, L3
2037.	SE-34052983	B1, C1, E1, E2, E3, E4, E6, F1, F2, F4, G1, G2, G3, H1, H6, M, N2, N4
2038.	SE-34053471	E1
2039.	SE-34053956	B2, F2, F4, K1
2040.	SE-34054722	B1, C1, E1, E2, E4, F4, F1, G1, H1, N4, N5
2041.	SE-34055803	C1, E2, E4, F4, G1, G2, G3, G4, N4, N5
2042.	SE-34055832	E1, E6, E7, E9, F2, F4, G1, G2, M, N4, O2
2043.	SE-34055837	E1, E2, E3, E4, E9, F1, F2, F4, G1, G2, G3, G4
2044.	SE-34056962	E1, E7
2045.	SE-34057017	B2, B3, B5, C2, C4, C8, E1, E2, E3, E4, E5, E9, G1, G3, G5, H1, H3, H4, H5, I, K1, L5, N4
2046.	SE-34057232	B2, B4, H4, H6, K1
2047.	SE-34059326	B5, C2, C5, C8, E1, E3, E7, G1, H6, J2, N1, N2
2048.	SE-34059330	E1, K1

No.	Submission number	Issues raised
2049.	SE-34060528	B1, B4, C1, E1, E2, E4, E6, F3, F4, H1, N4, N5
2050.	SE-34062574	B5, E1, E2, E3, E8, F1, F4, G1, G2, G4, H1, K1, N4
2051.	SE-34062577	E5, E6, G1, K1
2052.	SE-34062584	E7, F2 G1
2053.	SE-34063969	E1, E2, E7, F4, G1, J1, L4, L2, L5
2054.	SE-34064016	B4, B5, C1, C2, C3, C5, C8, E1, E2, F4, G1, G2, G4, H1, H6
2055.	SE-34065005	B2, C1, C3, C5, C8, F1, F2, F4, G1, G5, H3, J1, N2
2056.	SE-34065100	C8, E2, E7, F4, G1, G2, G3, H6, N4
2057.	SE-34065104	B2, B4, B5, E1, F4
2058.	SE-34065124	B2, B4, B5, C2, C3, E1, E6, E9, F4, G1, G2, G3, H1, H3, H4, H6, J1, K3, L5, N4
2059.	SE-34066720	B1, B2, B4, C5, C8, E1, E2, E4, F1, G1, G2, G3, H1, J2, N4, N5
2060.	SE-34066727	B2, C1, C8, D, E2, E6, F1, F2, F4, G1, G2, G4, N4, N5
2061.	SE-34066793	B2, C4, E1, E2, E7, F4, G1, G2, G4, K1
2062.	SE-34066910	C5, C8, E2, E3, E4, E5, F3, F4, G1, G2, G3, G4, H1, H4, H6, K1, M
2063.	SE-34068993	B1, B2, C8, E2, E6, E9, F1, F3, F4, G1, G2, G5, H3, H6, I, N4
2064.	SE-34069001	B5, C1, C7, E7, F4, G1, G5, J1
2065.	SE-34069720	B4, B5, C2, C3, C5, C8, E9, H2, H3, H4, H6, I, J1, L5, N2, N4
2066.	SE-34069792	B4, F4, G1, G2, I, M
2067.	SE-34069813	C1, E1, E10, G1, G2, H2, H5, L4, N4, N5
2068.	SE-34069835	E1, E2, E4, E6, G1, G2, G4, H6, K1
2069.	SE-34072958	C5, C8, E4, E1, E7, E10, F2, F4, G1, G2
2070.	SE-34983650	E7, H6
2071.	SE-34984142	C1, F1, F2, F4, H2, K3, N2, N4
2072.	SE-34993482	C1, F1, F2, F4
2073.	SE-34993509	B4, B5, C1, C2, C4, C5, E1, E2, E3, E7, F4, G1, G5, H3, H5, H6, J1, K2, M, N2, N3
2074.	SE-34993710	F2, F4, K1

Appendix B

Revised environmental management measures

The following table provides the full set of revised mitigation measures to avoid, mitigate and/or manage the potential impacts of the Project. Additions to mitigation measures provided in the Environmental Impact Statement are shown in **bold** text, with deletions shown with a ~~strikethrough~~.

Impact	ID	Measure	Timing
Air quality			
Impacts from ambient air quality from dust generation and deposition during construction	AQ1	A construction air quality management plan will be developed and implemented to monitor and manage potential air quality impacts associated with the construction of the Project and activities at construction ancillary facilities. The management plan will identify Project construction activities with the potential to have air quality impacts and the controls required to avoid, minimise and mitigate these impacts. The plan will include measures to: • minimise Project and cumulative dust generation from stockpiles, haulage routes, work activities, exposed ground surfaces and materials handling/storage • minimise generator and vehicle emissions during construction • inspect and address corrective actions • modify or cease dust generating works during unfavourable weather conditions • monitor dust levels • respond to complaints about dust and other air quality issues. The Plan will be implemented for the duration of construction.	Pre-construction and construction
	AQ2	Demolition activities, including removal of hazardous materials will be planned and carried out in a manner that minimises the potential for dust generation. Removal of hazardous materials will be completed prior to the commencement of general demolition works.	Construction
Biodiversity: Upstream			
General flora and fauna impacts	BUS1	Biodiversity offset strategy (See Appendix F6 – Biodiversity offset strategy).	Operation
Biodiversity: Construction area			

Impact	ID	Measure	Timing
General flora and fauna	BC1	A flora and fauna management plan (FFMP) would be prepared as part of the CEMP. Native vegetation clearing would not occur until the FEMP is approved.	Pre-construction and construction
	BC2	The FFMP will be prepared to manage the vegetation retained within the development site. The plan would include details on weed and pest management, nest-boxes and fauna habitat maintenance and monitoring procedures.	Pre-construction, construction and post-construction
Degradation of freshwater wetland habitats	BC3	Install appropriate drainage infrastructure (for example, sediment basins, diversion drains), sediment and erosion controls prior to the commencement of construction.	Pre-construction
	BC4	Clearing of vegetation would be timed to avoid periods when rain is forecast	Pre-construction and construction
	BC5	Dust suppression activities to be undertaken where appropriate.	Pre-construction and construction
	BC6	Stabilisation of disturbed areas, including revegetation in accordance with the FFMP, is to be undertaken as soon as practicable after disturbance.	Pre-construction, construction and post-construction phases
	BC7	Emergency response protocols and procedures for implementation in the event of a contaminant spill or leak to be clearly articulated in the construction and operational environmental management plans.	Pre-construction and construction
	BC8	Spill kits to be located to allow for timely response to uncontained spills. Site inductions are to include a briefing on the use of spill kits.	Pre-construction and construction
	BC9	Bio-retention installed in base of channels and swales to capture and store stormwater consisting of bio-filtration layers, planting and subsoil collection and drainage.	Pre-construction and construction
Vegetation removal or disturbance	BC10	Clearly identifying sensitive areas ('no-go zones') which cannot be impacted by construction and managing clearing such that clearing activities are constrained to these approved areas only.	Pre-construction and construction
	BC11	Site inductions will include a briefing regarding the local threatened species and communities on the site, and protocols to be undertaken if they are encountered.	Construction and post-construction.
Weed invasion and spread	BC12	Management of weeds in and adjacent to cleared areas will occur in accordance with the FFMP and CEMP. The plans will include details relating to the monitoring, management, and where necessary, eradication of weeds, disposal of green waste, and vehicle/plant weed wash down protocols, if required.	Pre-construction, construction, and post-construction.

Impact	ID	Measure	Timing
	BC13	Management of noxious weeds is to be undertaken in accordance with the *Biosecurity Act 2017*.	Pre-construction and construction
	BC14	Equipment used for treating weed infestation will be cleaned prior to moving to a new area within the Project area to minimise the likelihood of transferring any plant material and soil.	Pre-construction and construction
	BC15	Soil stripped and stockpiled from areas containing known weed infestations are to be stored on cleared land at least 40 m from native vegetation.	Construction
Impacts to fauna and flora	BC16	Fauna microhabitat such as hollow logs and dead trees should be removed from areas to be cleared and relocated to adjacent woodland habitat.	Pre-construction and construction
	BC17	A nest box and connectivity management strategy would be prepared prior to clearing of hollow bearing trees and connecting links. The strategy would inform the installation of nest boxes and fauna crossings in and between retained native vegetation adjacent to the site, and the on-going monitoring and maintenance of nest boxes and crossings through the construction and operational phases. This strategy would be included within the FFMP.	Pre-construction and construction
	BC18	High visibility plastic fencing is to be installed to clearly define the limits of the works area.	Construction
	BC19	Undertake a prestart-up check for sheltering native fauna of all infrastructure, plant and equipment and/or during relocation of stored construction materials.	Construction
	BC20	Site inductions are to include a briefing regarding the local fauna of the site and protocols to be undertaken if fauna is encountered.	Construction
	BC21	If any animal is injured, contact the relevant local wildlife rescue agency (for example, WIRES) and/or prequalified veterinary surgery as soon as practical. Until the animal can be cared for by a suitably qualified animal handler, minimise stress to the animal and reduce the risk of further injury by: • handling fauna with care and as little as possible • covering larger animals with a towel or blanket and placing in a large cardboard box • placing smaller animals in a cotton bag or plastic bag (smaller reptiles and frogs), tied at the top • keeping the animal in a quiet, warm and ventilated space.	Pre-construction, construction, and post-construction.
	BC22	If any pits/trenches are to remain open overnight, they are to be securely covered, where reasonable and feasible. Alternatively, fauna ramps (logs or wooden planks) are to be installed to provide an escape for trapped fauna. Pits will be inspected prior to work recommencing and any fauna removed by the project ecologist or designated suitably qualified and licensed representative.	Construction

Impact	ID	Measure	Timing
	BC23	The extent of vegetation clearing is to be clearly identified on construction plans.	Pre-construction
	BC24	In circumstances where native vegetation or mature tree clearing is required outside of the biodiversity development site, the project ecologist will inspect the proposed area and provide advice on the impact to flora and fauna and appropriate management.	Construction
	BC25	Directional lighting will be used where lighting is required in construction areas.	Construction
	BC26	Maintenance of construction machinery and plant will be undertaken to minimise unnecessary noise.	Construction
	BC27	Speed limits will be developed to minimise potential for fauna to be struck by a vehicle within the development site. All vehicles and plant in operation during construction are to adhere to site rules relating to speed limits.	Construction
	BC28	Where suitable for the species, and in line with established conservation programs (such as Saving our Species), threatened species translocation will be carried for species occurring within the development site (Red-crowned Toadlet and *Grevillea parviflora* subsp. *parviflora*). Translocation will be carried out in line with Office of Environment and Heritage Translocation operational policy (OEH 2019) and will involve stakeholders from relevant government agencies, and subject matter experts.	Pre-construction
Bushfire risk connectivity	BC29	Bushfire awareness included in staff induction and in toolbox talks pre-commencement.	Pre-construction and construction
Invasion and spread of pathogens and disease	BC30	Implementation of hygiene protocols to minimise risk of spreading pathogens and disease. Mitigations include vehicle and equipment washdowns, and follow relevant guidelines including: Best Practice Management Guidelines for Phytophthora cinnamomic within the Sydney Metropolitan Catchment Management Authority Area (Suddaby & Liew 2008) Hygiene protocol for the control of disease in frogs (DECC 2008) Management plan for myrtle rust on national parks estate (OEH 2011).	Pre-construction and construction.
Biodiversity: Downstream			
Inundation of native vegetation	BDS1	Development of the operational protocol for the FMZ would seek to minimise potential impacts on downstream vegetation from temporary inundation subject to meeting operational priorities for protection of life and property.	Operation
Aquatic ecology			

Impact	ID	Measure	Timing
Obstruction to fish passage	AE1	Access to the existing eel passageway would be maintained. Should construction activities require modification to the eel passageway, works should be carried outside of the period when likely to be used by juvenile eels.	Pre-construction Construction
Obstruction to fish passage	AE2	Where required, temporary in stream structures would be constructed in accordance with the NSW DPI policy guideline and would be inserted during low-flow periods with management plans being submitted to NSW DPI detailing how high flow events would be managed. Dewatering of temporary in-stream structure would address the following matters: NSW DPI would be notified seven days prior to any dewatering activities to assess the need for potential fish rescue activities and to make appropriate arrangements for this. A separate s37 permit may be required from NSW DPI to relocate fish water is to be pumped a minimum of 30 metres away from the waterway and should preferentially not re-enter the waterway. If water is to re-enter the waterway, water quality would be managed in accordance with the approved water quality criteria for construction of the Project.	Construction
Water quality	AE3	Water quality would be managed in accordance with the approved water quality criteria for construction of the Project.	Construction
Erosion and bank stability	AE4	Scour protection and other bank stability mechanisms would be installed in the Warragamba River below the dam to minimise erosion and destabilisation of streambanks.	Pre-construction Construction
Aquatic habitat impacts	AE5	Aquatic habitat would be protected in accordance with Section 3.3.2 Standard precautions and mitigation measures of the *Policy and guidelines for fish habitat conservation and management (2013 update)* (Fairfull 2013).	Pre-construction Construction
Aquatic habitat impacts	AE6	Existing monitoring programs would be reviewed and revised as required to effectively monitor potential impacts of the Project. The review would include consultation with DPI Fisheries.	Pre-construction Construction Operation
Threatened species	AE7	Relevant safeguards and management measures detailed in the Draft referral guidelines for the endangered Macquarie perch, *Macquaria australasica* (DSEWPaC 2011) would be implemented as required.	Construction
Climate change			
Climate Risk – general	CC1	Development of a Climate Risk Management Sub-Plan. The sub-plan would detail the safeguards and management measures required to be implemented during the construction of the Project. The plan should include monitoring to assess progress on major residual risks and serve as a continuous	Pre-construction

		improvement mechanism to manage climate change risks as they become more robust into the future.	
Climate change – changes in extreme rainfall during construction	CC2	Design of temporary infrastructure, for example, coffer dams, diversions, to accommodate climate projections	Detailed design
Climate change – changes in extreme rainfall during construction	CC3	Implement measures to protect the community from potential impacts associated with climate change during construction of the dam, which may include temporary flood barriers.	Detailed design
Climate change – changes in extreme rainfall during design life	CC4	Detailed design will consider inclusion of design / construction elements to allow the dam to be more readily upgraded in the future to allow for climate change scenarios.	Detailed design
Climate change – more intense extreme weather events during construction	CC5	Construction sequencing for major works to consider peak ECL season.	Pre-construction
Climate change – general	CC6	Climate change will be considered during health and safety management planning.	Pre-construction
Emissions	**CC7**	**Opportunities to further mitigate emissions from energy generation and transportation will be considered during detailed design and construction planning.**	**Detailed design Pre-construction**
Flooding and hydrology			
Impacts during construction	HF1	A Construction Flood Management Plan will be developed to minimise any changes in hydrology up and downstream of the dam and minimise risks to the construction site. Construction activities will be sequenced in accordance with Dams Safety NSW guidelines to ensure dam safety during construction. A Dam Safety Emergency Plan will also be prepared in accordance with the requirements of Dams Safety NSW.	Pre-construction
Impacts from operation of FMZ	HF2	A detailed operational protocol for the operation of the FMZ will be developed in consultation with relevant downstream and upstream stakeholders.	Pre-operation
Monitoring	HF3	Investigate water monitoring systems to reflect Project changes in operational protocols.	Pre-operation

		Investigate additional monitoring station downstream of the Kedumba River	
Health and safety			
Dam failure due to design	HS1	The Project will be designed to meet relevant State, national and international dam safety guidelines and in consultation with the Dams Safety NSW.	Design
Safety risks during construction	HS2	A construction safety management plan will be prepared in consultation with relevant stakeholders and will address safety of the construction workforce and public during general construction, in the event of a flood and for other likely hazards or risks.	Pre-construction and construction
Risks from dangerous goods management	HS3	All dangerous goods and materials will be stored and handled on site in accordance with relevant Australian Standards.	Construction
Transportation of dangerous goods	HS4	Materials will be transported in accordance with the Dangerous Goods (Road and Rail Transport) Act 2008 (NSW), Dangerous Goods (Road and Rail Transport) Regulation 2014 (NSW) and relevant Australian Standards.	Construction
Compromise of dam integrity during construction	HS5	ANZEC Guideline overpressure and ground vibration limits, and WaterNSW dam infrastructure ground vibration limits will be met for all blasting activities.	Construction
Bushfire risk	HS6	Construction activities involving ignition or flammable sources will be managed to minimise fire risks. High risk construction activities relating to bushfire, such as welding and metal work, would not be undertaken on total fire ban days, and will be managed as appropriate.	Construction
Ground contamination	HS7	Ground contamination management measures are provided in Chapter 22 (Soils). These include requirements for additional surveys and a protocol for managing unexpected finds.	Construction
Non-Aboriginal heritage			
Impacts on directly affected heritage items	NAH1	Where possible, consideration will be given to conserve and avoid impact to elements of primary significance and heritage items within the construction zone. Where impact and/or removal is unavoidable, the subsequent measures will be enacted. Photographic archival recording and reporting would be carried out in accordance with the NSW Heritage Office's *How to Prepare Archival Records of Heritage Items* (1998a), and *Photographic Recording of Heritage Items Using Film or Digital Capture* (2006). The record would be prepared by a suitably qualified heritage consultant using archival-quality material. Records for SHR listed items would be held at the NSW Heritage Council and State Library. Records for LEP-listed items would be held by the local Council and local library. A copy of the record would be held by the owner of the asset.	Pre-construction

		Appropriate heritage interpretation would be incorporated into the design for the Project in accordance with the NSW Heritage Office's *NSW Heritage Manual* (1996), *Interpreting Heritage Places and Items Guidelines* (2005b), and *Heritage Interpretation Policy* (2005a).	
	NAH2	A heritage interpretation strategy for the Project will be incorporated into future designs and planning. Opportunities for interpretive displays in appropriate locations would be explored.	Design
	NAH3	An appropriately qualified and experienced heritage architect will provide independent review periodically throughout detailed design.	Design
	NAH4	The Project design will be sympathetic to impacted items (including retained significant elements) and surrounding heritage items by minimising impacts to sight lines, views and setting.	Design
	NAH5	Except for heritage significant elements affected by the Project, direct impact on other heritage significant items elements will be avoided.	Design and Construction
	NAH6	Where heritage significant items or elements are to be retained within the construction zone, detailed design will consider appropriate adaptive reuse or interpretive use to be developed in consultation with a heritage architect.	Design and Construction
	NAH7	A moveable heritage item strategy (including a salvage strategy) will be prepared for the Warragamba Supply Scheme. The strategy will be prepared by a suitably qualified heritage consultant in consultation with WaterNSW and include a comprehensive record of significant elements to be impacted. This will include items, machinery and equipment, and commemorative plaques and memorials contained within curtilage of the Warragamba Dam site. The moveable heritage item strategy will form part of a broader interpretation strategy for the Warragamba Supply Scheme.	Pre-construction
	NAH8	The fabric of primary and contributory significance of items proposed for removal will be identified and catalogued according to the significant fabric strategy prior to design development and will be re-used or salvaged where possible. Where not re-used within the design of the Project, the significant fabric strategy will indicate appropriate storage locations as well as appropriate off-site locations where the salvaged elements may be reused in the future. Where large elements are impacted a sample of fabric may be appropriate.	Pre-construction
	NAH9	Methodologies for the removal of existing structures and construction of new structures and infrastructure will be developed to minimise direct and visual impacts to other elements within the curtilages of the heritage items or to heritage items located near works.	Design and Construction
Impacts on heritage visual values	NAH10	Site remediation measures related to construction sites will be incorporated within the Urban Design and Landscape Plan. The objective of the remediation will be to minimise long-term impacts on the	Design and Construction

		visual amenity of the items by recreating a sympathetic environment. A landscape scheme would be prepared for the SHR listed Haviland Park to re-instate planting and landscaping within and around the item's curtilage. The scheme will consider appropriate plantings. Any boundary wall treatment will be designed in consultation with a heritage architect.	
Impacts on archaeological resources	NAH11	An archaeological research design will be prepared and implemented to identify the need for archaeological testing or monitoring. Archaeological mitigation measures recommended in the archaeological research design will be carried out in accordance with Heritage Council guidelines, and where identified in the archaeological research design, would be supervised by a suitably qualified Excavation Director. An Unexpected Finds Policy will be implemented during the Project to manage and mitigate potential impacts to the potential archaeological resource.	Pre-construction
Impacts from ancillary works	NAH12	Ancillary works required by the Project related to batch plant, laydown areas, power supply, drainage facilities and any other works will be designed and constructed to minimise impacts on heritage items and areas of archaeological potential as much as feasible within the context of the Project.	Pre-construction
Impacts to Haviland Park	NAH13	Design and construction within the SHR curtilage of Haviland Park will consider the recommendations of the Warragamba Supply Scheme CMP 2010 (Graham Brookes and Associates 2010) and the significant fabric strategy.	Design and Construction
Impacts to the Warragamba Supply Scheme	NAH14	Design and construction within the s170 curtilage of the Warragamba Supply Scheme will consider the recommendations of the Warragamba Supply Scheme CMP 2010 (Graham Brooks & Associates 2010) and the significant fabric strategy.	Design and Construction
Impacts to NPWS s170 heritage register items	**NAH15**	**WaterNSW will consult with NPWS on any works and related impacts associated with the Jooriland homestead.**	**Design and Operation**
Aboriginal cultural heritage			
Consultation	ACH1	WaterNSW would continue consultation and engagement with the Registered Aboriginal Parties for the duration of the Project.	Pre-construction Construction
	ACH2	An independent facilitator would work with the RAPs and the wider Aboriginal community to develop an Aboriginal advisory group to guide the implementation of Recommendations 8 to 11 in the Cultural Values Assessment Report (Appendix 2 to Appendix K).	Pre-construction Construction Operation
	ACH3	An Aboriginal Cultural Heritage Management Plan (ACHMP) would be developed for the Project and implemented as part of the Construction Environmental Management Plan (CEMP).	Pre-construction Construction

Management of impacts on cultural heritage		The ACHMP would be developed and managed in consultation with the RAPs**, other relevant stakeholders** and relevant regulatory authorities. The AHMP would provide specific guidance on measures and controls to be undertaken to avoid and mitigate impacts on Aboriginal cultural heritage during construction.	
	ACH4	Prior to the operation of the Project WaterNSW to review its assessment processes for works within the upstream catchment to include awareness to personnel undertaking an activity on its behalf of any potential Aboriginal cultural heritage values and objects in the area.	Construction Operation
	ACH5	A cultural heritage awareness and cultural competency training package would be developed and delivered to all WaterNSW staff. The training package would include a site-specific module developed in consultation with the relevant Aboriginal communities and RAPs.	Pre-construction
	ACH6	The site-specific Aboriginal cultural heritage awareness training package would be delivered as part of the site induction for all employees, contractor(s) and maintenance personnel involved in the construction works and ongoing site management and activities in the catchment of Lake Burragorang.	Construction Operation
	ACH7	WaterNSW would develop a formal agency-specific process and policy for undertaking cultural heritage assessments and engaging with the Aboriginal community in line with those developed by other state government agencies.	Operation
	ACH8	WaterNSW would consider engaging an in-house archaeological specialist support in line with other state government agencies.	Operation
Access to Country	ACH9	WaterNSW would develop and implement a policy to improve access for Aboriginal community members to Country they have cultural connections with that are under WaterNSW management.	Prior to operation
	ACH10	WaterNSW would facilitate bi-annual on-country visits open to Aboriginal community members with cultural connections to the area.	Ongoing
Site recording	ACH11	The unsurveyed portion of the PUIA would be surveyed should the Project be approved (survey would include provision for detailed recording of all shelter sites including 3D photogrammetry, planning, detailed photography and scale drawing of any art or other features present).	Prior to operation
	ACH12	The unsurveyed portion of the area above the PUIA within the upstream study area would be sample surveyed to identify sites and places of high significance should the Project be approved (survey would include provision for detailed recording of all shelter sites including 3D photogrammetry, planning, detailed photography and scale drawing of any art or other features present).	Prior to operation
	ACH13	Further detailed impact assessment and recording of all Aboriginal cultural heritage sites and places that are located within the PUIA, sites of high significance in the area above the PUIA within the	Prior to operation

		upstream study area, and all art sites within the upstream study area would be carried out. This would include 3D photogrammetry and high resolution digital photographic records and would include the landscape context of sites and site complexes to capture archaeological and cultural values.	
Cultural values recording and education	ACH14	WaterNSW would consult with the RAPs and the Aboriginal community with regard to carrying out a comprehensive specialist research audit of the holdings of national and international collection institutions to identify cultural materials removed from Country in the Study Area. Subject to proceeding with the audit, WaterNSW would facilitate an access visit for Aboriginal community members to any cultural materials identified in Sydney and Canberra based collection institutions.	Prior to operation
	ACH15	In consultation with the RAPs and the Aboriginal community, WaterNSW would develop interpretative materials on the Aboriginal cultural values and history of the cultural landscape of the Study Area including: a permanent exhibition at the Warragamba Dam Visitor Centre; interpretative signage and audio posts within the Warragamba Dam grounds; and facilitate the provision of Aboriginal-led cultural events (i.e. tours and talks) through the Warragamba Dam Visitor Centre.	Prior to operation
	ACH16	In consultation with the RAPs and the Aboriginal community, WaterNSW would develop a cultural values project to record the Gurrangatch-Mirrigan Dreaming Story route through the photographic recording of specific cultural locations within the Study area (prior to any further impacts), oral history recordings with Aboriginal community members, and documentary research.	Prior to operation
	ACH17	In consultation with the RAPs and the Aboriginal community, WaterNSW would undertake a heritage study of the Aboriginal traditional and historical occupation of the Study area through photographic recording of specific sites (prior to any further impacts), historical documentary research, and oral history interviews.	Prior to operation
Noise and vibration			
Construction noise and vibration	NV1	A construction noise and vibration management plan (CNVMP) will be prepared. The CNVMP will include processes and responsibilities to assess, monitor, minimise and mitigate noise and vibration impacts during construction. The CNVMP will be implemented for the duration of the construction of the Project. The plan will: • identify relevant performance criteria in relation to noise and vibration • identify noise and vibration sensitive receptors and features near the Project • include standard and additional mitigation measures from relevant guidelines and details about when each will be applied • describe the process(es) that will be adopted for carrying out location and activity specific noise and vibration impact assessments to assist with the selection of appropriate mitigation measures	Pre-construction

		• consider cumulative construction noise impacts and construction noise fatigue • include protocols that will be adopted to manage works required outside standard construction hours, in accordance with relevant guidelines including for management of respite periods • detail monitoring that will be carried out to confirm Project performance in relation to noise and vibration performance criteria.	
	NV2	Detailed noise assessments will be carried out for all ancillary facilities required for construction of the Project. The requirement for temporary noise walls within ancillary facilities and adjacent to construction works, and the requirement for other appropriate noise management measures, is to be assessed and implemented prior to the commencement of activities that have the potential to cause noise or vibration impacts.	Pre-construction
	NV3	All residents affected by noise from the construction of the Project and whom may be expected to experience an exceedance of the construction NMLs, will be consulted about the Project prior to the commencement of the activity, with the highest consideration given to those that are predicted to be most affected by the works. The information provided to the residents will include: • general sequencing and locations of construction work • the hours of the Project works • construction noise and vibration impact predictions for the works • construction noise and vibration mitigation measures likely to be implemented on site. Community consultation regarding construction noise and vibration will be detailed in the Community Involvement Plan for the construction of the Project and will include a complaint's handling process. The community will be able to provide feedback via a 24-hour, toll-free Project information and complaints line, a dedicated email address and postal address for the Project. For out of hours works, consultation with affected residents will take place with consideration to Strategy 2 of the ICNG.	Pre-construction
Impacts form out of hours works	NV4	Noisy work and vibration intensive activities (those activities that exceed the vibration criteria) will be scheduled to be undertaken during standard construction hours as far as possible. Works or activities that cannot be undertaken during standard construction hours will be scheduled as early as possible during the evening and/or night-time periods. Where required, respite measures will be implemented for noisy work and vibration intensive activities.	Construction
Construction vehicle noise	NV5	Construction vehicle movements (on and off site) will be managed to avoid or minimise noise impacts. Materials delivery to the construction site would only occur during the day. Mitigation measures for vehicle movements outside of standard construction hours are to be included in the CNVMP.	Construction

Vibration from construction activities	NV6	Vibration generating activities will be managed to minimise the potential for impacts on structures and sensitive receptor(s), including maximising safe working distances where practicable, or use of alternate methods to minimise vibration where safe working distances cannot be achieved. Where alternatives cannot be implemented, vibration monitoring will be undertaken and receptors notified in advance of works.	Construction
Impacts from blasting	NV7	A blast management plan (BMP) will be developed for the Project. This would provide for design and monitoring of trial blasts to confirm site specific conditions and validate local propagation characteristics (develop site specific 'site laws') and confirm the Maximum Instantaneous Charges (MICs) and blast designs to meet vibration and overpressure limits. The BMP would include: • limiting criteria • identified blast sensitive receivers (community and onsite structures) • performance indicators • monitoring protocols • roles and responsibilities • blasting controls • protocols for community consultation, incidents and complaints • contingency protocols • reporting requirements.	Pre-construction Construction
	NV8	The BMP will consider the following with regard to overpressure and ground vibration: • Blast timing: restriction of blasting to between the hours of 9.00 am to 5.00 pm Monday to Saturday with no blasting outside of these times, including on Sundays and Public Holidays. • Blast monitoring and inspection including: monitoring at key sensitive sites and trial blasts to assist in the development of 'site laws' based on monitoring data. • Regular condition surveys and blast monitoring at heritage structures and modification of blast design to meet blast limits at these sites where required.	Pre-construction Construction
	NV9	Mitigation controls will be incorporated into design. A program will be developed for the ongoing monitoring and maintenance of plant and equipment.	Operation
Property and land use			

Construction — Temporary disruption of tourism and recreation uses due to the potential temporary closure of the Warragamba Dam Visitor Centre and Haviland Park.	SE18	Local communities and visitors would be notified about construction activities, the temporary closure of recreation venues, changes in the traffic arrangements and heavy vehicle routes during the construction period. Assess options to continue functions of the Visitor Centre at alternative locations to ensure public safety during construction. Ongoing consultations with relevant NSW Government agencies and local government to identify and implement appropriate solutions to reduce disruption of areas surrounding the Project site. Consult with the local community to select a legacy project to be delivered upon construction completion: • Upgrade the viewing platform on Eighteenth Street with a shelter, interpretive signage and other enhancements. • Develop options to deliver tourism to Warragamba during construction, such as viewpoints, tours or display materials. • Provide alternative BBQ and picnic facilities within the Wollondilly Shire to offset the temporary closure of facilities within the construction area.	Construction
Construction — Delayed travel time in accessing properties due to increased construction traffic.	SE19	Implement the Construction Traffic Management Plan developed as part of the Traffic and Transport Assessment (refer to Chapter 24 and Appendix O of the EIS). Installation of temporary traffic control measures and signage for safe movement of vehicles, pedestrians and cyclists accessing local community facilities, shopping centres and schools. Local communities would be notified about construction activities, the potential temporary closure of recreation venues, changes in the traffic arrangements and heavy vehicle routes during the construction period. Provide support to Wollondilly Council to assist with project-related administration and enquiries.	Construction
Operation Upstream — Community concern regarding effects on World Heritage listed areas	SE20	Regular engagement with local communities (as per a Community and Stakeholder Engagement Plan) to explain actual impacts/benefits, understand concerns and identify mitigation measures. Ensure that environmental impacts are offset, where possible, with a Biodiversity Offset Strategy. Consultation with GBMWHA Advisory Committee and State/Federal government agencies regarding impacts and mitigation measures. Implementation of environmental management plan (EMP) measures which also aid in maintaining the environmental condition of the GBMWHA.	Operation
Operation Upstream —	SE21	Regular engagement with local communities (as per a Community and Stakeholder Engagement Plan) to explain actual impacts/benefits, understand concerns and identify mitigation measures. Ensure that environmental impacts are offset, where possible, with a Biodiversity Offset Strategy.	Operation

Community concern regarding effects on National Parks		Consultation with GBMWHA Advisory Committee, NPWS and State/Federal government agencies regarding impacts and mitigation measures. Implementation of EMP measures which also aid in maintaining the environmental condition of the National Parks.	
Operation Upstream — Two private properties due to temporary and partial inundation of land	SE22	Regular engagement with the two impacted property owners (as per a Community and Stakeholder Engagement Plan) to explain actual impacts and benefits, understand concerns and identify mitigation measures.	Operation
Operation Upstream — Changed access to properties at Yerranderie	SE23	Regular engagement with local communities (as per a Community and Stakeholder Engagement Plan) to explain actual impacts/benefits, understand concerns and identify mitigation measures. Consultation with GBMWHA Advisory Committee, NPWS, and Yerranderie Management Committee and State/Federal government agencies regarding impacts and mitigation measures.	Operation
Operation Downstream — Reduction in the impacts of flooding in the LGAs of Liverpool (primarily limited to Wallacia), Penrith, Blacktown, Hawkesbury, and The Hills (primarily limited to Wisemans Ferry)	SE24	WaterNSW will support the relevant NSW Government agencies and local government to build community awareness on flood risks and specifically the effect which the Project has upon flood risk.	Operation
Operation Downstream — Decreased frequency but increased duration of inhibited access to and from low lying property due to	SE25	Work with relevant agencies to develop and implement updated emergency evacuation plans. Inform stakeholders on the duration of inhibited access to and from properties due to releases from the FMZ.	Operation

longer duration of the FMZ discharge			
Environment			
Construction — Temporary negative visual impacts	SE26	Implement impact mitigation measures as outlined in Appendix P (Landscape and visual impact assessment.) Reduce visual impacts through appropriate landscaping and incorporation of other screening solutions where appropriate. Develop options to deliver tourism to Warragamba during construction, such as viewpoints, tours or display materials.	Construction
Post-Construction — Positive landscape character	SE27	Consult with the local community to select a legacy project to be delivered upon construction completion. Provide information regarding the Project to tourism related agencies to assist them promote the area as a tourism attraction. Rehabilitation and landscaping of the cleared and disturbed areas.	Post construction
Community health and wellbeing			
Construction — Temporary pressure on existing medical and emergency services due to influx of construction workforce	SE28	Engage with medical and emergency service providers as part of ongoing planning and Project development. Provision of appropriate onsite medical response facilities and personnel. Develop and implement safety protocols including an emergency response plan. Provide support to Wollondilly Council to assist with project-related administration and enquiries.	Pre-construction and construction
Operation Upstream — Health effects associated with heightened anxiety	SE29	Regular engagement with local communities (as per a Community and Stakeholder Engagement Plan) to explain actual impacts/benefits, understand concerns and identify mitigation measures.	Operation
Operation Downstream — • Enhanced safety of residential	SE30	WaterNSW will support the relevant NSW Government agencies and local government to build community awareness on flood risks and specifically the effect which the Project has upon flood risk. Publicly disclose the benefits of the Project to stakeholders via various appropriate communication channels as outlined in the Project's Community and Stakeholder Engagement Plan.	Operation

areas due to reduced extent and frequency of floods, including reduced risk of post-flooding infectious disease • Enhanced safety due to improved ability to evacuate communities • Reduced levels of flood risk awareness, reduced (individual) flood disaster planning and increased complacency Improved access to key services, and health facilities		WaterNSW will support the relevant NSW Government agencies involved in the *Hawkesbury-Nepean Valley Flood Risk Management Strategy*.	
Operation Downstream — Occasional reduced access to services and health facilities during discharge of water from the FMZ	SE31	Work with relevant NSW Government agencies and local government to build community awareness on flood risks and specifically the effect which the Project has upon flood risk. WaterNSW will support the relevant NSW Government agencies involved in the *Hawkesbury-Nepean Valley Flood Risk Management Strategy*.	Operation

Operation Estuary — Occasional reduced access to services and health facilities	SE32	WaterNSW will support the relevant NSW Government agencies involved in the *Hawkesbury-Nepean Valley Flood Risk Management Strategy*.	Operation
Way of life			
Construction — Temporary generation of employment opportunities	SE33	Provide a clear and efficient process for people to access information about employment and provide an opportunity to register interest in the Project. Liaise with local job network providers to provide information on employment opportunities to local job seekers. Develop a framework to increase the representation of young people, Aboriginal and Torres Strait Islander people and women in the construction industry by providing employment pathways, training and skills development. Provide support to Wollondilly Council to assist with project-related administration and enquiries.	Construction
Construction — Temporary generation of commercial opportunities for businesses	SE34	Develop a local procurement policy to encourage the Project's contactors, where possible, source their workforce and their suppliers for goods and services locally. Provide a process for local businesses to register interest in project-related supplier and service provider opportunities. Work with the local networks and local businesses to organise and plan for how to benefit from the incoming workforce. Work with government stakeholders to build businesses' capacity through business development and mentoring. Work with the local networks and local businesses to organise and plan for how to benefit from the Project. Liaise with local job network providers to provide information on employment opportunities to local job seekers. Provide support to Wollondilly Council to assist with project-related administration and enquiries.	Construction
Construction — Perceived temporary negative effects on Tourism industry	SE35	Local communities and visitors to be notified about construction activities, the potential temporary closure of recreation venues, changes in the traffic arrangements and heavy vehicle routes during the construction period. Assess options to continue functions of the Visitor Centre at alternative location/s while ensuring public safety during construction.	Construction

		Ongoing consultations with relevant NSW Government agencies and local government to identify and implement appropriate solutions to reduce disruption of areas surrounding the Project site. Work with the local networks and local businesses to organise and plan for how to benefit from the Project. Consult with the local community to select a legacy project to be delivered upon construction completion. Upgrade the viewing platform on Eighteenth Street with a shelter, interpretive signage and other enhancements. Develop options to deliver tourism to Warragamba during construction, such as viewpoints, tours or display materials. Provide alternative BBQ and picnic facilities within the Wollondilly Shire to offset the potential temporary closure of facilities within the construction area.	
P-Construction — Increase in visitation numbers to the dam	SE36	Consult with the local community to select a legacy project to be delivered upon construction completion. Provide information regarding the Project to tourism related agencies to assist them promote the area as a tourism attraction. After construction, add project information to the Visitor Centre display.	Post construction
Construction — Temporary impacts on community sentiment, cohesion, and resentment	SE37	Work with the Dam Fest committee to support its ongoing success during the four-year construction phase. Workforce fundraising to contribute to local Warragamba initiatives as voted by the community. Development and implementation of a Code of Conduct for the workforce. Actively engage with local communities to understand concerns and expectations and identify mitigation measures. Provision of regular Project construction updates to the community. Liaise with local job network providers to provide information on employment opportunities to local job seekers. Consult with the local community to select a legacy project to be delivered upon construction completion. Develop options to deliver tourism to Warragamba during construction, such as viewpoints, tours or display materials. Develop and implement a Local Industry Participation Plan for construction. Develop and implement a Construction CSEP which includes a complaints management process and provision of timely information to communities. On-site parking for all construction vehicles.	Construction

Operation Upstream — Reduced tourism visitation due to perceived environmental impacts Reduction in revenue for nature-based recreation businesses due to perceived environmental impacts Diminished enjoyment of community values Polarisation of community sentiment resulting in reduced community cohesion	SE38	Implementation of EMP measures which also aid in maintaining the environmental condition of the catchment.	Operation
Operation Downstream — Positive economic effects due to reduced flood related damage to property Reduced risk of people permanently and temporarily losing access to housing and accommodation Improved confidence in housing market and	SE39	WaterNSW will support the relevant NSW Government agencies and local government to build community awareness on flood risks and specifically the effect which the Project has upon flood risk. Publicly disclose the benefits of the Project to stakeholders via various appropriate communication channels as outlined in the Project's Community and Stakeholder Engagement Plan. WaterNSW will support the relevant NSW Government agencies involved in the *Hawkesbury-Nepean Valley Flood Risk Management Strategy*.	Operation

potential reduction in insurance premiums Potential reduction in insurance premiums at individual properties Reduction in flood related economic losses for agricultural and industrial businesses Occasional additional economic losses for agricultural and industrial businesses Reduction in flood related economic losses for tourism and recreation related businesses Occasional additional economic losses for tourism and recreation related businesses Improved community cohesion due to improved ability to control flood related risk and plan communities accordingly			
Operation Estuary — Positive economic effects due to	SE40	WaterNSW will support the relevant NSW Government agencies to support the *Hawkesbury-Nepean Valley Flood Risk Management Strategy*.	Operation

reduced flood related damage to property Occasional potential and additional economic losses for fishing and aqua-culture businesses		WaterNSW will support the relevant NSW Government agencies and local government to build community awareness on flood risks and specifically the effect which the Project has upon flood risk. Publicly disclose the benefits of the Project to stakeholders via various appropriate communication channels as outlined in the Project's Community and Stakeholder Engagement Plan.	
Soils			
Impacts on site workers and/or local community through disturbance of known or potential contaminated land(s) or material.	S1	Prior to ground disturbance, further investigations are recommended to assess and manage potential contamination risk. Any contamination would be managed through implementation of an unexpected finds protocol, as discussed below. Site works should be managed to avoid disturbance of known buried contamination (identified as Site A', which is within the boundary of one of the proposed laydown areas) through implementation of adequate protocols to ensure restrictions on ground disturbance in potentially affected areas. The location of this area will be identified on design drawings. Further investigations and management of potential contamination will be undertaken in accordance with NSW regulatory provisions and NSW Environment Protection Authority (EPA) endorsed guidelines, such as (but not limited to): • National Environment Protection (Assessment of Site Contamination) Measure 1999 (April 2013), EPHC 2013, Canberra • NSW EPA Waste Guidelines • Contaminated Land Guidelines - Consultants Reporting on Contaminated Land (NSW EPA 2020) • Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land (DUAP 1998)	Construction
	S2	Should demolition of existing structures within the construction footprint be required then management of hazardous materials would need to be managed through appropriate controls in accordance NSW regulatory provisions, NSW EPA and SafeWork NSW guidelines such as (but not limited to): • Code of Practice – How to Safely Remove Asbestos (SafeWork NSW 2019) • Code of Practice – How to Manage and Control Asbestos in the Workplace (SafeWork NSW 2019) • Construction and demolition waste: A management toolkit, EPA, 2020 • NSW EPA Waste Guidelines	Pre-construction

		• NSW Health and Safety Act and Regulations • Protection of the Environment and Operations Act 1997 These controls will be detailed in the CEMP. A hazardous materials assessment will be carried out prior to and during the demolition of buildings. Demolition works will be undertaken in accordance with the relevant Australian Standards and relevant NSW WorkCover Codes of Practice, including the Work Health and Safety Regulation 2017 (NSW). Due to the age of the dam and ancillary services, not all hazardous materials may have been assessed during previous surveys. Areas of the dam that are to be disturbed as part of the construction works will be assessed for hazardous building materials prior to commencing works. A protocol for managing unexpected finds of hazardous materials will be included in the CEMP.	
	S3	Areas of contamination, if they were to be uncovered during site works could be managed through implementation of an unexpected finds protocol, otherwise initial intrusive assessments could be carried out to gain a better understanding of the potential for contamination to exist in areas that will be disturbed. Soil contamination if identified is likely to be able to be managed through either offsite disposal or on site capping and management. The protocol will include: cease work in the vicinity initial assessment by an appropriately qualified professional further assessment and management of contamination, if confirmed, in accordance with section 105 of the *Contaminated Land Management Act 1997*.	Pre-construction Construction
	S4	Potentially contaminated areas directly affected by the Project will be investigated and managed in accordance with section 105 of the *Contaminated Land Management Act 1997*.	Pre-construction Construction
	S5	Asbestos handling and management will be undertaken in accordance with an Asbestos Management Plan (as part of the CEMP).	Pre-construction Construction
Unexpected finds	S6	Any unexpected contamination finds will be managed through an unexpected finds protocol which will be detailed in the CEMP.	Pre-construction Construction
Accidental spills during construction	S7	Procedures to address spills, leaks will be developed as part of the CEMP and implemented during construction of the Project.	Pre-construction Construction
Impacts to soil and water quality	S8	Measures will be implemented to appropriately store dangerous goods and reduce the potential for environmental contamination due to spills and leaks.	Pre-construction Construction

	S9	A construction soil and water management plan will be prepared for the Project including procedures to manage potentially contaminated stormwater runoff.	Pre-construction Construction
	S10	Development of an operational protocol that balances the multiple objectives from the FMZ, upstream inundation, environmental flows and downstream riverine requirements. The outcome will be to minimise as much as possible the inundation durations in upstream areas and reduce downstream flooding.	Operation
Traffic and transport			
Impacts from construction traffic	TT1	A construction traffic management plan (CTMP) will be prepared which will detail processes to minimise delays and disruptions and identify and respond to changes in road safety due to Project construction works. **Preparation of the CTMP will include consultation with relevant roads authorities.** The CTMP will be prepared in accordance with applicable guidelines and relevant standards, guides and manuals. The CTMP will: • include a construction contingency plan to manage traffic in the event of emergency road closures due to flood, fire, and/or road accidents, road repair works and bridge load limits • ensure all relevant stakeholders are considered during all stages of the Project • provide safe routes for pedestrians and cyclists during construction • comprehensively communicate changes in traffic conditions on roads or paths to community, emergency services, public transport operators, other road user groups and other affected stakeholders • identify measures to manage the movements of construction-related traffic to minimise traffic and access disruptions in the public road network • minimise the use of local roads by the Project's heavy vehicles and identify haulage routes • propose a car parking strategy for construction staff • consider truck telematics to assist the project managers and road network managers to ensure mass limits are adhere to and to reduce congestion/improve safety during peak construction periods • speed management of construction related vehicles to cross Blaxland Crossing Bridge and continuous monitoring of bridge performance • include relevant details regarding required Road Occupancy Permits.	Pre-construction
Worker vehicle impacts	TT2	Carpooling will be encouraged to minimise number of employee vehicles travelling to the site.	Construction

Off-site queuing of heavy vehicles	TT3	Queueing of heavy vehicles will be permitted only within the site perimeter.	Construction
Access to construction area	TT4	All construction traffic will use Production Avenue to access the site.	Construction
Safety of intersection	TT5	The Warradale Road/Production Avenue intersection will be reviewed against the latest relevant Austroads guidelines (for example, sight distances) and appropriate modifications made in consultation with Wollondilly Shire Council to ensure compliance.	Pre-construction
	TT6	Temporary traffic signals will be installed at Warradale Road/Production Avenue intersection.	Pre-construction
Impacts on road condition	TT7	Regular inspection and maintenance will be carried out on Park Road, Silverdale Road, Farnsworth Avenue, Production Avenue and Warradale Road.	Construction
	TT8	A road dilapidation report will be prepared in consultation with the relevant road authority for the Park Road, Silverdale Road, Farnsworth Avenue, Production Avenue and Warradale Road.	Pre-construction
Out-of-hours heavy vehicle movements	TT9	Heavy vehicle site access will be restricted to the standard working hours only. No heavy vehicle access will be permitted for periods outside standard working hours unless required for an emergency, delivery of oversize plant or for other justifiable reason as detailed in the construction traffic management plan.	Construction
Road safety	TT10	A Stage 1 road safety audit (RSA) will be undertaken at the detailed construction traffic management plan development stage.	Pre-construction
Impacts on visitor parking	TT11	Provision of using existing car park facilities on Farnsworth Avenue for visitor centre and Haviland Park will be considered.	Construction
	TT12	Parking strategy will be developed to understand the demand and supply of parking spaces for the visitor centre and Haviland Park during the construction stage.	Construction
Safety of school buses	TT13	Consideration will be given to ensure that the operation of general construction traffic will be minimised during periods of school bus operations.	Construction
Bridge and road closures during flood mitigation zone discharge	TT14	WaterNSW will keep the Bureau of Meteorology (BoM) informed of the discharge volumes from the FMZ. BoM will then combine these releases with other inflows and rainfall forecasts and tell the SES, TfNSW and Councils what the forecast river levels are at agreed gauge locations according to the NSW Flood Warning Service Level Specification.	Operation
Source of construction materials	TT15	Consideration shall be given for materials recovery and re-use opportunities from nearby construction sites such as Western Sydney Airport (WSA), metro or rail tunnels	Construction

Alternate mode to transfer construction materials	TT16	Consideration shall be given to use alternate modes such as rail, where possible, to transfer the construction materials from long distance to reduce number of constructions related heavy vehicle movements on roads	Construction
Visual amenity			
Construction impacts on visual amenity	VA1	Promote public awareness that the site would be closed and provide signs to direct people to Eighteenth Street Lookout.	Construction
	VA2	The clifftop walkway and dam wall pedestrian access will be reinstated to provide an enhanced visitor/ tourist experience and to continue to provide access to the raised dam crest.	Construction
	VA3	Ensure that a similar level of pedestrian amenity is reinstated after construction of ancillary facilities	Construction Design
	VA4	Enhance the quality of all public domain areas that were closed for the duration of construction	Construction Design
	VA5	Provide signage/ interpretation panels referencing the construction scope and construction program.	Construction
Upstream impacts on visual amenity from potential vegetation loss	VA6	Vegetation management – refer management measures BC1 – BC9	Operation
Downstream impacts on visual amenity from potential vegetation loss	VA7	Vegetation management – refer management measure BDS1	Operation
Downstream impacts on visual amenity from potential vegetation loss	VA8	Vegetation management – refer management measures BC1, BC2	Operation
Waste management			
Generation and disposal of waste	W1	A construction waste management plan (CWMP) will be prepared for the Project prior to construction and will detail appropriate waste management procedures. The CWMP will: • document expected waste types and volumes for the Project	Construction Operation

		• describe procedures for managing office and Project waste materials including separation, treatment, reuse and recycling and disposal in accordance with relevant guidelines • detail waste reporting requirements including the implementation of a waste register • detail the process for identifying waste re-use sites including approval requirements • where practicable, structures would be deconstructed rather than demolished to allow as much material as possible to be re-used or recycled off-site.	
Disposal of spoil	W2	A spoil management plan will be prepared for the Project. The plan will detail spoil management measures including spoil haulage routes and spoil disposal sites.	Construction
Water quality			
General water quality impacts	WQ1	Continuation, monitoring and, where necessary, modification of water quality management measures to address operational impacts of the Project. These include: • monitoring DOC levels in the raw water supply for drinking water purposes to identify any increases in DOC levels so that adaptive management can be implemented via the SCRAMS (Sydney Catchment Aquatic Real-time Management System) • sourcing raw drinking water from other dams when the FMZ at Warragamba Dam is in operation or NOM levels are high. • when NOM levels are high in Lake Burragorang, consider adjusting the blend of water being provided to Prospect WFP so a greater proportion of water is supplied from storages with lower NOM levels. • adjusting treatment processes at WTPs to increase the removals of NOMs – this could include increased doing with ferric chloride, reducing chlorination and increasing chloramination (which does not produce THMs) • implementation of the National Parks EMP – which would have as one its objectives erosion control and revegetation of areas impacted by the operation of the FMZ • continued implementation of other erosion management programs in the upper catchment areas such as WaterNSW Grazing and Erosion Program • sourcing raw water supply for drinking water purposes from other dams when sediment levels are high. • sourcing raw water supply for drinking water purposes from other dams when algal blooms occur • use of the multi-level offtake to withdraw water from less turbid locations in the water column • use of the multi-level offtake to withdraw water from lower in the water column as algal blooms only occur in surface layers	Existing and ongoing

		• use of the multi-level offtake to withdraw water from locations in the water column where pathogen concentrations are low • adjusting processes at Water Filtration Plants to increase the removal of algae in raw water supply for drinking water purposes • adjusting processes at Water Filtration Plants to increase the removal of pathogens in raw water supply for drinking water purposes • adjusting processes at water filtration plants to increase the removal of particulates in raw water supply for drinking water purposes.	
Sedimentation and erosion control, vegetation clearing, management of hazardous material and other water quality risks	WQ2	The construction environmental management plan will include management measures for minimising water quality impacts from (as relevant): • process water management • concrete batching plants • controlled blasting activities • hydro-blasting activities • underwater excavations • dewatering activities (such as the dissipation pool) and any water diversions • use of epoxy resins • discharge of concrete cooling pumping system • use of sediment basins and water treatment plants • road and bridge upgrades (including piling). • material storage areas • demolition and other construction activities. Vegetation clearing: • erosion and sedimentation control measures to be designed, installed, and operated in accordance with Managing Urban Stormwater: Soils and Construction (Landcom 2004) • mulch stockpiles would be managed in accordance with Management of Tannins from Vegetation Mulch (Roads and Maritime Service (RMS) 2012). Other water quality management measures are identified in the following chapters: • Soils (Chapter 22, Section 22.10): S8, S9 • Flooding and hydrology (Chapter 15, Section 15.10): H1.	Construction

Construction water quality impacts	WQ3	A construction water quality monitoring program will be developed	Construction
Water quality impacts on raw water for drinking water purposes	WQ4	While the risks to the quality of raw water supply for drinking water purposes have been assessed to be low, further monitoring is recommended to confirm the risk assessment and enhance adaptive responses to any changes in water quality due to the Project.	Pre-operation
Quality of raw water for drinking water impacts	WQ5	The SCARMS and SCARISS (Sydney Catchment Aquatic Real-time Information Support System) will be updated to include the raised dam, new outlets, and operation of the FMZ.	Pre-operation
Catchment impacts	WQ6	The Catchment to Customer Risk Assessment will be reviewed and updated to reflect any new or changed risks to the quality of raw water supply for drinking water purposes from the operation of the FMZ. Implementation of the EMP as required under the Water NSW Act.	Pre-operation

Appendix C

Australia ICOMOS & IUCN submissions and supplementary World Heritage assessment

C1 Introduction

This appendix provides responses to the issues raised in the correspondence from Australia ICOMOS and the IUCN.

As part of preparation of the Submissions Report and PIR, further assessment of World Heritage and National Heritage has been carried out to clarify matters presented in the EIS and supporting technical reports, principally Appendix J *World Heritage Assessment Report*, in response to specific issues raised in submissions. Details are also provided in this appendix.

Warragamba Dam was in existence at the time of inscription of the GBMWHA on the World Heritage List in 2000 and on the National Heritage List in 2007. It is noted that a heritage item can be listed despite it being subject to risks which affect its outstanding universal value (OUV), in this case, temporary inundation from the existing dam. It is further appreciated once a property is listed on the World Heritage List, the Australian Government has an obligation to consider the potential impacts of a proposal on the OUV of the property within the framework of the World Heritage Convention.

This type of temporary inundation risk already occurs on World Heritage land from the lake rising behind the existing dam however there is a net incremental increase of around 300 hectares of World Heritage Land from the lake rising from the operation of the Project as a flood mitigation function.

C2 Australia International Council on Monuments and Sites

C2.1 General

Issue 1

Australia ICOMOS objects to the proposal to raise the Warragamba Dam wall by 14 metres, thereby allowing for periodic inundation of parts of the Greater Blue Mountains World Heritage Area (GBMWHA) and adjacent areas and is strongly concerned at inadequacies of the EIS process and the EIS conclusions relating to cultural heritage.

Response

The Australia ICOMOS objection to the proposal to raise the Warragamba Dam is noted. The objective of the Project is to reduce risk to life and property damage by reducing the extent and frequency of flooding in the Hawkesbury-Nepean Valley.

The Hawkesbury-Nepean floodplain is considered to have the highest single flood risk exposure in NSW, if not Australia. In 2013 the Hawkesbury-Nepean Valley Flood Management Review undertaken by the NSW Government found that there was a significant existing and growing flood risk in the valley. The review found that the flood risk could not be addressed by a simple solution or single infrastructure option.

The review explored all options that had the potential to effectively reduce flood risk to life and property, including governance arrangements, policy settings, planning tools, community education and infrastructure. It found that there was no simple or single solution to address the existing flood risk in the valley, and that this risk would continue to increase unless an integrated strategy incorporating flood mitigation infrastructure, non-infrastructure and policy options was adopted.

The Hawkesbury Nepean Valley Flood Management Taskforce was established by the NSW Government in 2014 to develop and assess potential alternatives and options for reducing flood impacts and risks in the valley. The Taskforce found that the most effective and efficient infrastructure option to reduce risks to life and property from flooding would be to raise Warragamba Dam to provide a flood mitigation zone of around 14 metres.

In June 2016, the NSW Government adopted the recommendations of the Taskforce in delivering nine outcomes to maximise the flood risk mitigation benefit including the raising of Warragamba Dam for flood mitigation. The EIS has then undertaken environmental impact assessments of the proposed dam raising. World Heritage-listed land above the full supply level (FSL) in the upstream catchment, is already subject to temporary inundation from the existing dam. This has occurred on a number of occasions since the dam was constructed in 1960, and more recently in the 2021 and 2022 flood events.

Issue 2

The dam proposal is inconsistent with Australia’s obligations under the World Heritage Convention with respect to the GBMWHA and neither the dam proposal itself, nor the EIS comply with specific Decisions of the World Heritage Committee.

Response

Section 9.1 of Appendix J *World Heritage Assessment Report* to the EIS included an assessment of the Project against the obligations of the World Heritage Convention. The Project is being assessed under the NSW EP&A Act with matters falling under the Commonwealth EPBC Act being assessed through the bilateral assessment agreement between the Commonwealth and NSW governments. Neither process requires compliance with specific Decisions of the World Heritage Committee. This notwithstanding, consideration has been given to the matters raised in Decision 43 COM 7B.2 in Section 7 of Appendix J and in Decision 44 COM 7B.180 in Section C4 of this appendix.

Issue 3

Australia ICOMOS endorses the recommendations contained in the Interim Report, October 2021, of the NSW Legislative Council Select Committee on the Proposal to Raise the Warragamba Dam Wall.

Response

The NSW Government provided a response[45] to the recommendations on 1 April 2022. The recommendations of the NSW Legislative Council Select Committee on the Proposal to Raise the Warragamba Dam Wall and the NSW Government's responses have been considered in preparation of the Submissions Report.

C2.2 Impact on Outstanding Universal Value of a World Heritage Property

Issue 1

The EIS does not 'fully assess' 'all potential impacts' because it does not provide adequate identification, investigation or assessment of the potential impacts of the proposed action on the indigenous cultural values of the GBMWHA, which are attributes that contribute to the integrity that underpins the property's OUV.

Response

Assessment of potential impacts on Aboriginal cultural heritage is provided in Appendix K *Aboriginal Cultural Heritage Assessment* to the EIS and in Chapter 18 of the EIS. This assessment has been used to inform the discussion in Section 6.1.8 of Appendix J *World Heritage Assessment Report* to the EIS.

Further consideration of potential impacts to Aboriginal cultural heritage is provided in the Supplementary Assessment to the Aboriginal Cultural Heritage Assessment (ACHA) prepared as Appendix F to the PIR and discussed in Section 6.3.1 of the PIR.

Consideration of potential impacts on Aboriginal cultural heritage values in the context of a component on the OUV of the GBMWHA is provided in Section C4 of this appendix.

Issue 2

Adverse heritage impacts should be avoided, to the fullest practical extent, within the GBMWHA. The EIS states that '*to compensate for and offset the assessed impact, the Warragamba Offset Strategy focuses on purchasing and managing additional and appropriate land containing the values of the Greater Blue Mountains World Heritage Area to achieve no net loss*'. (Executive

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45 https://www.parliament.nsw.gov.au/committees/listofcommittees/Pages/committee-details.aspx?pk=262#tab-reportsandgovernmentresponses

Summary page 32). This is an erroneous suggestion. The GBMWHA is inscribed on the World Heritage List and loss of attributes which support its OUV, including by periodic inundation, cannot be offset by purchasing alternate land.

Australia ICOMOS therefore supports Recommendation 9 of the Interim Report of the NSW Legislative Council Select Committee on the Proposal to Raise the Warragamba Dam Wall, that the NSW Government:

- Not proceed with the Warragamba Dam wall raising project, if the proposal cannot maintain or improve the current and future integrity of the Greater Blue Mountains World Heritage Area, and
- Pursue alternative floodplain management strategies instead.

Response

The IUCN has similarly advised in its submission (refer Section C3) that it considers that OUV cannot be offset and therefore the concept of compensation plots for the planned loss of OUV is not appropriate. However, it is noted that the World Heritage Operational Guidelines (Part III.I) provide for modifications to the boundaries of World Heritage properties.

Since the GBMWHA was inscribed on the World Heritage List, the level of Lake Burragorang has been above FSL on 17 occasions (these being between March 2012 and July 2022). In all of these events, temporary inundation occurred to varying degrees in the GBMWHA from the existing dam.

The EIS identified that the GBMWHA could *potentially* be affected further by temporary inundation, with the term 'potentially' deliberately used in the context of the probabilistic nature of flood events and the uncertainty around the extent of any impacts to the land and its associated values. Further, if a flood event was to occur, there are numerous varying factors that influence the nature of temporary inundation associated with a specific flood event. And further, there are varying responses ('resilience') to how individual components of the OUV would be affected by the incremental temporary inundation.

In terms of *mitigating* or *offsetting* the potential impact of temporary inundation on the GBMWHA (and other environmental values), a precautionary approach was taken in which an area was identified that would most likely be affected by temporary inundation over a notional 20-year time period[46]. This approach reflected the uncertainty associated with the probabilistic nature of flood events as noted above. It was then precautionarily assumed that there would be a total loss of environmental values within this area. This served as the baseline for mitigating/offsetting potential impacts – which may not actually be manifested to the extent assumed – and which are discussed in Section C6.

Section 4.3 of the EIS provides a detailed discussion regarding the alternatives considered by the Hawkesbury-Nepean Valley Flood Management Taskforce over the period 2014-2016. The Taskforce confirmed the findings of the 2013 Review i.e. that there is no simple solution or single infrastructure option that can eliminate the high flood risk to existing communities in the valley. A combination of infrastructure and policy or other initiatives are required to reduce flood risk by:

- Changing the probability and delaying flood events reaching critical levels
- Reducing the exposure of people, property and assets to flood risk

[46] This area is referred to in as the 'Project upstream impact area' (PUIA), and is based on a statistical analysis of around 20,000 generated flood events which is explained in Chapter 15 of the EIS.

- Increasing the available time to safely evacuate areas exposed to imminent flooding
- Increasing the resilience of communities, property and public assets exposed to floods.

The Taskforce Options Assessment Report (Infrastructure NSW 2019) provides a detailed description of the alternatives and options considered. The proposed raising of Warragamba Dam is one component in a suite of measures to mitigate downstream flood risk as identified in Table 10.1 (Summary of options assessment) of the Taskforce Options Assessment Report. The table also identifies other options considered and the reasons for these not being supported. The report concludes that the proposed raising of Warragamba Dam is the most effective infrastructure solution to provide flood mitigation to reduce risk to life and property damage downstream.

C2.3 Impact on National Heritage values

Issue 1

The dam proposal would affect the National Heritage values of a place on Australia's National Heritage List and would be inconsistent with Australia's National Heritage Management Principles.

Response

The Greater Blue Mountains Area was included in the National Heritage List on 21 May 2007[47]. This post-dates the completion of construction of Warragamba Dam by some 47 years. To date the existing risk of temporary inundation has not been identified as a concern or process that adversely affects the National Heritage values of the Greater Blue Mountains Area.

Section C6 provides details of the revised offset strategy, this comprising:

- A biodiversity offset
- A protected lands values offset
- On-park management costs funding provided to NPWS to manage the protected lands values offset.

Collectively, these three components would facilitate maintenance and enhancement of National Heritage values (and World Heritage values) potentially affected by the Project.

Consideration of how the Project accords with Australia's National Heritage Management Principles is provided in Section C5 of this appendix.

Issue 2

The discussion of Aboriginal cultural values in the EIS does not adequately consider the implications of the inclusion of some of the affected lands on the National Heritage List nor additional potential National Heritage values. More than 300 hectares of the Project Upstream Impact Area (PUIA) is already on Australia's National Heritage List and other potentially affected areas are currently part of an area that is on the Priority Assessment List which is being evaluated for potential National Heritage values by the Australian Heritage Council. This assessment includes potential Indigenous National Heritage values which have been nominated by the Greater Blue Mountains World Heritage Area Advisory Committee. This consideration is directly responsive to a specific requirement of the Australian Heritage Strategy:

[47] https://www.awe.gov.au/parks-heritage/heritage/places/world/blue-mountains

Progressively review existing World Heritage places that have been listed for natural values only to identify whether the areas may contain internationally significant cultural heritage (Australian Heritage Strategy 2015, Objective 1, Action 8, page 19).

As a matter of due process, the Australian Heritage Council should conclude the current Priority Assessment List process and determine whether Indigenous cultural heritage that is within the PUIA has National Heritage value, before any decision is made to proceed with the dam proposal.

Response

DPE has advised that the values for the additional areas being assessed by the Australian Heritage Council are the same as those for the Greater Blue Mountains Area, and identified in the National Heritage listing[48]. Consideration of how the Project is consistent, or otherwise, with these values with regard to Aboriginal cultural heritage is provided as follows.

With regard to completion of the current Priority Assessment List process, this is a matter for the Australian Heritage Council, and is separate to the Project.

Criterion A: Events and processes

Full text of criterion:

The place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history.

With regard to Aboriginal cultural heritage, the explanatory notes to this criterion state:

This criterion applies generally to Indigenous environment places, which have figured in defining events resulting in important changes to the political, economic, or social fabric of Indigenous Australia, relate to economic, political or social processes characteristic of Indigenous Australia during different periods of its history, or places that best demonstrate a characteristic way of life in the history of Indigenous Australia.

The indicator of significance relating to Aboriginal cultural heritage states:

The criterion includes places with features that best demonstrate a characteristic way of life in one or more periods of the history of Indigenous Australia.

The criterion applies to areas with features that relate to a particular way of life important in one or more periods of the history of Indigenous Australia. This aspect of the criterion needs to be handled with considerable sensitivity. It is not meant to cover all areas with a diversity of features that are significant to Indigenous Australians, only those where the features best demonstrate a particular aspect of Indigenous culture or history characteristic of Australia. It encompasses areas important in the history of Indigenous Australia because:

- the features in the area demonstrate one or more important economic, political or social process in the history of Indigenous Australia.

- the features in the area best demonstrate aspects of ceremonies practiced, or beliefs held, by Aboriginal people.

Response with regard to the Project:

48 The Greater Blue Mountains Area, Greater Western Hwy, Katoomba, NSW, Australia

The principal potential impact of the Project on Aboriginal cultural heritage in the upstream area is associated with temporary inundation in the form of:

- Sites and places that are already affected by temporary inundation (from one or more flood events of a specific frequency of occurrence)
- Sites and places that would be newly affected by temporary inundation.

The EIS assessment found that within the part of the PUIA that sits within the GBMWHA there are eight known cultural heritage sites, being seven sites containing stone artefacts and one site containing grinding grooves. The stone artefact sites were assessed as having low archaeological significance, and the grinding groove site was assessed as being of high archaeological significance. None of these sites have been identified as being features that demonstrate economic, political or social processes of particular importance or aspects of ceremonies or beliefs.

Criterion B: Rarity

Full text of criterion:

> *The place has outstanding heritage value to the nation because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history*

The explanatory notes to this criterion state:

> *This criterion applies generally to places possessing uncommon, rare, or endangered aspects of Australia's natural or cultural history where these aspects are of national significance to Australia.*
>
> *Simple possession of uncommonness, rarity, or endangered aspects is insufficient. A good knowledge of the national context of the particular uncommonness, rarity, or endangered aspects of Australia's natural or cultural history possessed by the place and the degree of the importance of this within Australia's natural or cultural history, is critical to an assessment of whether the place is of such significance that it is of 'outstanding heritage value to the nation'.*

The indicator of significance relating to Aboriginal cultural heritage states:

> *The criterion particularly applies to Indigenous ways of life, customs, processes, land-uses, functions or designs that were always few in number, or that are now few in their surviving number due to subsequent destruction. They will demonstrate uncommon aspects of earlier periods of human occupation and activity or a past Indigenous activity that is now rare.*
>
> *Assessment for this value must be from a position of knowledge about places with similar values in their national context. It is important to know the former distribution and abundance of this type of place in Australia. An extant place that is rare must have sufficient elements to make it a good example of its type. A place with this value is also likely to meet other criteria such as (a) and (d) and it should be used cautiously. Rarity is demonstrated by systematic surveys with comparative assessments.*

Response with regard to the Project:

The EIS assessment found that within the part of the PUIA that sits within the GBMWHA there are eight known cultural heritage sites, being seven sites containing stone artefacts and one site containing grinding grooves. The archaeological features, and associated values at these sites are not uncommon, rare or endangered.

Criterion C: Research

Full text of criterion:

> *The place has outstanding heritage value to the nation because of the place's potential to provide information that makes a contribution of national importance to the understanding of Australia's history, cultures, or the natural world*

The explanatory notes to this criterion state:

> *This criterion applies generally to places with a potential to provide information from a variety of sources as a resource for research. This includes natural, Indigenous, historical, social scientific or other information which may be embodied within, be at the place, or be associated with it.*

The indicator of significance relating to Aboriginal cultural heritage states:

> *This criterion applies to sites or areas with potential to contribute to research on Indigenous Australia. The research potential must be demonstrable and must relate to the development of an understanding of Indigenous history and culture.*
>
> *This would include any site or area that has demonstrated potential to produce important information that would contribute to our understanding of the following:*
>
> *- one or more periods in the history of Indigenous Australians;*
>
> *- ways of life or cultures characteristic of Indigenous Australians.*

Response with regard to the Project:

The cultural heritage assessment work for the EIS identified new cultural heritage sites within the Greater Blue Mountains Area, which goes toward improving knowledge of Aboriginal cultural heritage. All archaeological sites contain important information, however the eight sites within the part of the PUIA that sits within the GBMWHA have not been identified as having the potential to make a contribution of national importance to the understanding of Australia's history or culture.

Criterion D: Principal characteristics of a class of places

Full text of criterion:

> *The place has outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of:*
>
> *(i) a class of Australia's natural or cultural places; or*
>
> *(ii) a class of Australia's natural or cultural environments.*

The explanatory notes to this criterion state:

> *This criterion applies generally to places that represent all or the critical elements characteristic of a class or type, style or design of outstanding importance within Australian natural or cultural places or environments.*

The indicator of significance relating to Aboriginal cultural heritage states:

> *The place should represent all or the principal characteristics characteristic of a particular design or style of importance in the history of Indigenous Australia.*
>
> *Most places that could be assessed under this criterion could also be assessed under criterion (a) or (e) and the assessor needs to decide whether an assessment under this criterion will*

contribute to the conservation of the values at the place. The place should be representative of a design or style. It can include images, built structures or designed landscapes characteristic of Indigenous Australia.

Response with regard to the Project:

The EIS assessment found that within the part of the PUIA that sits within the GBMWHA there are eight known cultural heritage sites, being seven sites containing stone artefacts and one site containing grinding grooves. The archaeological features, and associated values at these sites are not of outstanding representative value of a class of either Australia's natural or cultural places or environments.

Issue 3

Australia ICOMOS does not agree with the conclusions reached in Appendix J to the EIS that the dam proposal is consistent with the Australian National Heritage Management Principles, which apply to places on the National Heritage List. Specifically, in view of inadequacies in survey and assessment and consultative processes, the ACHAR and the conclusions which flow from it, do not comply with the following principles:

1. *The management of National Heritage places should use the best available knowledge, skills and standards for those places, and include ongoing technical and community input to decisions and actions that may have a significant impact on their National Heritage values.*

5. *The management of National Heritage places should make timely and appropriate provision for community involvement, especially by people who:*
    - *have a particular interest in, or associations with, the place, and*
    - *may be affected by the management of the place.*

6. *Indigenous people are the primary source of information on the value of their heritage and the active participation of Indigenous people in identification, assessment and management is integral to the effective protection of Indigenous heritage values.*

Response

The extensive flood modelling and analysis done for both the environmental assessment and similar previous work carried out starting with development of the *Hawkesbury-Nepean Floodplain Management Strategy* between 1997 and 2004 has contributed significantly to the understanding of how temporary inundation associated with the existing dam affects the upstream area, and how this would be modified through the Project. This would inform the development and implementation of management activities and strategies for the upstream area.

As documented in the EIS, ongoing consultation with the Aboriginal community has been conducted for the project in a timely way. The EIS through the investigations and conclusions in the ACHAR and supporting cultural values assessment clearly demonstrates that the Aboriginal community has been the primary source of information regarding the value of their heritage. The issue that members of the Aboriginal community have indicated that they do not support the Project is not a failing of the consultative processes – it is the outcome of the consultation.

Section C6 provides details of the revised proposed offset strategy, this comprising:

- A biodiversity offset

- A protected lands values offset
- On-park management costs funding provided to NPWS to manage the protected lands values offset.

Collectively, these three components would facilitate maintenance and enhancement of National Heritage values (and World Heritage values) potentially affected by the Project.

The protected lands values offset would be incorporated into the national parks estate and managed via existing Plans of Management through the funding provided to NPWS. These plans already provide for engagement with the Aboriginal community. For example, Section 4.2.1 of the *Blue Mountains National Park Plan of Management* (NPWS 2001) notes the following policies:

> *The Service will seek to involve the Aboriginal community in the management and interpretation of the park's Aboriginal heritage, including significance assessment, conservation planning, protection, interpretation and promotion.*

and

> *Management activities with the potential to damage Aboriginal sites and places will be preceded by site survey, Aboriginal community consultation and heritage impact assessment. Works will be modified or relocated to protect sites and places of cultural significance.*

Supporting actions in the Plan of Management include:

> *An Aboriginal Heritage Management Group will be established to facilitate Aboriginal participation in Aboriginal site and place management.*

and

> *The Service will continue to liaise with adjoining landholders in the vicinity of Kings Tableland Aboriginal site, as well as the Aboriginal community, to assist in conservation and interpretation of this important cultural precinct.*

Accordingly, it is considered that proposal would be consistent with the Australian National Heritage Management Principles. Further consideration of this is provided in Section C5.

C2.4 Impact on Aboriginal heritage

Issue 1

The Aboriginal Cultural Heritage Assessment Report (ACHAR), at Appendix K of the EIS, does not provide adequate understanding of the nature, extent and significance of the Aboriginal cultural resources that may be affected by the dam proposal and does not fulfil the SEARs for the EIS.

The ACHAR does not meet a fundamental SEARs requirement (3.1) that the 'level of assessment must be commensurate to the degree of impact and sufficient to ensure that the Department and other government agencies are able to understand and assess impacts'.

Response

The Aboriginal cultural heritage assessment has been prepared in accordance with all relevant guidelines, as documented in Appendix K. Further assessment has been undertaken following exhibition of the EIS and this is provided as Appendix F to the PIR.

The Australia ICOMOS submission does not provide any specific details to support its view, however, attention is drawn to the responses to other issues provided in this section.

Issue 2

The EIS is fundamentally flawed because of the inadequate extent of survey undertaken to identify potentially affected Aboriginal sites and the resulting deficiency in assessment and characterisation of predicted impact. It is very concerning that the ACHAR outlines a process for further investigation subsequent to development consent, whereas the further investigation is actually needed to inform consideration as to whether development consent should be granted. Further investigation of known sites, through recording, comparative study and/or test excavation is needed so that their nature, extent and significance can be comprehensively characterised. This is essential given the nature of the threat posed by the dam proposal.

Response

As described in Section 8.1 of Appendix 1 (Archaeological Assessment Report) to Appendix K *Aboriginal Cultural Heritage Assessment Report* to the EIS, the archaeological survey methodology was developed in accordance with the following guidelines:

- *Aboriginal cultural heritage consultation requirements for proponents 2010* (DECCW 2010a)
- *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW 2010b)
- *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH/DPC 2011).

Survey extent

Field surveys focused on areas of spiritual and historical importance as identified by the RAPs, areas that would be disturbed by construction works, and areas with high potential for Aboriginal sites such as rivers, creek lines and large sandstone rock platforms, boulders and ridgelines.

The upstream Project study area is defined as the area between the existing FSL and the Project PMF. This area encompasses about 5,280 hectares, of which 2,345 hectares lies between the existing and Project PMF levels. Archaeological surveys were undertaken within the study area, as well as adjoining areas. Some 2,655 hectares were surveyed on foot, which covered the following areas:

- Existing upstream impact area (EUIA):
  - below 116.7 mAHD (FSL): already submerged for long periods
  - 116.7 mAHD to 119.5 mAHD: affected by existing flooding and temporary inundation
- Project upstream impact area (PUIA):
  - 119.5 mAHD to 127.0 mAHD: this area covers about 1,400 hectares and is most likely to be affected by the Project during its operational life
- Remainder of study area:
  - 126.8 mAHD to 143.9 mAHD: this is the area between the PUIA and the Project PMF, and is less likely to be affected by the Project.

Of the total area surveyed, about 464 hectares (33 percent) of the PUIA was assessed. The survey focused on those areas that may receive the most impact by the Project and were predicted to be the most archaeologically sensitive areas, such as ridges, creek lines, flats and slopes from 0-30 percent. Survey coverage was also focused on areas outlined by the RAPs as being connected to the creation story. The survey therefore focused on:

- Areas with potential for Aboriginal objects in the PUIA

- Previously recorded sites that are of high and very high significance
- Areas of cultural significance to the indigenous community.

In response to RAP feedback, an additional 1,219 hectares was surveyed outside the upstream study area (above the Project PMF) and below FSL. Survey below FSL was possible due to the low levels of water within Lake Burragorang at the time and the consequent exposure of Aboriginal objects.

The survey coverage is reflective of the approach to focusing on areas outlined by the RAPs as being connected to the creation story, ridge and creek lines that have archaeological potential. Areas of exposure within the Project area included those areas that had been previously eroded through the original construction and operation of the dam (particularly areas below FSL), or areas that have previously been cleared for agricultural practices and fire trails.

SEARs 10(1) relates to Section 3.1 of the *Guide for investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH 2011). Section 2.4 outlines the requirement of an ACHA is an understanding of the potential cultural heritage values of the study area, and not to document every object within the study area. Given the types of harm that may potentially affect Aboriginal cultural heritage sites, the above coverage presents a strong representative sample of the landscape and is considered adequate.

Predictive model

The predictive modelling presented in the Archaeological Assessment Report in Appendix 1 in Appendix K to the EIS was prepared in accordance with the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW 2010*, in which Requirement 4 states the purpose of predictive modelling is

- *To present a model, or series of testable statements, about the nature and distribution of evidence of Aboriginal land use in the subject area based on the information collected from Requirements 1, 2 and 3.*

For the purposes of satisfying this requirement, predictive models may take the form of simple observations relating past experience and available knowledge, or detailed models and considerations of large landscape areas (see Guilfoyle 2006 and references therein).

The predictive model must:

- *integrate the distribution of known sites, summarised or modelled using the landscape descriptions derived in Requirement 2 (that is. landscape units interpreted in terms of their archaeological potential)*
- *characterise the patterning of material traces from known social and behavioural characteristics evidenced in the ethnohistorical review*
- *consider the distribution of natural resources, and the probable land-use strategies employed by Aboriginal people in the specific landscape context*
- *consider the spatial and temporal relationships of sites*
- *identify what sorts of material traces are predicted to be present, and in what densities*
- *make inferences about past Aboriginal occupation of the landscape based on the evidence collected and presented.*

The ARCHAEOLOGICAL ASSESSMENT REPORT presents a predictive model in accordance with these guidelines. A supplementary assessment (see Section 6.3.1 and Appendix F of the PIR) provides additional clarification on the predictive modelling, including the use of the Aboriginal Sites Decision Support Tool, and further consideration of Potential Archaeological Deposits. The supplementary assessment also includes further information and detail regarding the expected impacts of temporary inundation of soils, and Potential Archaeological Deposits within the Project area.

Issue 3

Although 43 archaeological sites and 11 other places of cultural significance have been identified, it is estimated that a further 131 sites may be affected. This extrapolation is of questionable validity, and is at best predictive based on the 'normal' and likely to miss any sites that are 'exceptional' to the established pattern. However, without actual information about the actual sites affected, Traditional Owners have effectively been circumvented of the ability to be sufficiently informed about the relevant cultural heritage impacts and therefore the information available to the consent authority is not comprehensive and inadequate.

Response

A total of 334 sites were recorded during the field survey across the areas noted above (refer Table 15 in the Archaeological Assessment Report). The 43 sites and potential affected 131 sites referred to in the Australia ICOMOS submission occur in the area most likely affected by temporary inundation from the Project (between 2.8 metres above FSL and 10.2 metres above FSL).

Section 6.3.3 of Appendix K *Aboriginal Cultural Heritage Assessment Report* to the EIS describes the process followed to facilitate participation by Registered Aboriginal Parties (RAPs) and Traditional Owners in field surveys. A full list of participants is provided in Appendix 10 to Appendix K.

In accordance with Stage 4 of the *Aboriginal cultural heritage consultation requirements for proponents 2010* (DECCW 2010a), a draft of the Aboriginal cultural heritage assessment report was provided to the Registered Aboriginal Parties for their review and comment in July 2019. A revised draft report was subsequently provided for review and comment in late April 2021. WaterNSW has continued to keep the RAPs informed of developments with the Project.

The cultural heritage values of the Project area are clearly presented in the ACHA (Appendix K to the EIS) which documents that the Traditional Owners have clearly expressed their view regarding the Project (that it is an unacceptable impact to a highly valued cultural landscape). Further assessment has been undertaken (refer Appendix F to the PIR) and provided to the RAPs for review and comment. This provided an updated impact assessment methodology that incorporated hydrological impacts predicted within the upstream study area to assess potential impacts at a site by site level. Therefore, it is considered that the Traditional Owners are informed about the value of their cultural heritage that is present, and the extent of potential impacts.

Issue 4

More than 81 percent of the GBMWHA was impacted by the 2019-2020 bushfires. However, the ACHAR fieldwork was completed prior to the fires and the ACHAR advised that 'it was not possible to conduct further survey after the fires'. (ACHAR page 34) and that: 'it is not possible to quantify the effects of the 2019-2020 wildfires on Aboriginal heritage values or individual sites or places in the study area' (ACHAR page 34). This is completely unacceptable, inconsistent with due process and the suggestion that further survey was not possible is untenable. Bushfires can cause damage to Aboriginal cultural heritage sites, such as damage to rock art from intense heat, burning of scarred trees and damage to stone artefacts. Fire can also reveal scatters or other previously unknown sites which may now be exposed in previously surveyed areas.

Response

The archaeological survey methodology was developed in accordance with the following guidelines:

- *Aboriginal cultural heritage consultation requirements for proponents 2010* (DECCW 2010a)
- *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW 2010b)
- *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH/DPC 2011).

Details of the sampling strategy and survey methods are provided in Sections 8.2 and 8.3 respectively of the Archaeological Technical Report. An area of 2,655 hectares was surveyed. This covered areas below FSL (already impacted by the existing dam), areas subject to existing temporary inundation (FSL to about 2.8 metres above FSL), areas potentially affected by temporary inundation from the Project (2.8 metres above FSL to 10.2 metres above FSL), and areas less likely to be affected by temporary inundation from the Project (10.2 metres above FSL). As noted in the Archaeological Assessment Report, the survey coverage is considered to present a good representative sample of the landscape and to provide comparative understanding of the effects of various existing inundation regimes on archaeological attributes

Bushfire is an existing and ongoing hazard throughout the landscape that has impacted, and will continue to impact, on Aboriginal cultural artefacts. As such, the impacts of such events are considered to be externalities that exist irrespective of the Project and do not directly correlate with the assessment of potential impacts associated with temporary inundation within the upstream area. WaterNSW notes that the guidelines do not require resurvey following a bushfire in order to appropriately assess the potential impacts associated with the Project.

Issue 5

While the ACHAR hypothesises that 'the resilience of the cultural landscape suggest the latest fires have not had an impact that would result in a material effect to this assessment', (ACHAR page 34) the impact of the fires is actually completely unknown because further fieldwork was not undertaken. The extent of field survey and the lack of survey following the 2019-2020 fires is a serious and unacceptable shortcoming.

Response

Please refer to the response to the previous issue.

Issue 6

Australia ICOMOS supports Recommendation 12 of the Interim Report of the NSW Legislative Council Select Committee on the Proposal to Raise the Warragamba Dam Wall, October 2021, which proposes:

> *That Water NSW conduct further Aboriginal Cultural Heritage Assessment, including additional field surveys, to address the concerns raised by stakeholders and agencies, particularly in relation to the adequacy of field surveys, and post fire assessment, as well as demonstrating the agreement of RAPs in the significance assessment of sites, and the need for a broader cultural impact assessment of the project.*

Response

Please refer to the response to the fourth issue.

Issue 7

The mitigation and management measures considered in the EIS (Executive Summary page 39) are inappropriate and unacceptable. The EIS proposes 'an Aboriginal cultural heritage management plan to address intergenerational equity including recording of Aboriginal cultural heritage'. Recording is insufficient. The focus should be on avoidance of harm. And yet, the ACHAR concludes, in relation to Aboriginal Cultural Heritage, that if the project proceeds, 'there is no capacity for directly applied management measures for the avoidance or minimisation of harm' (ACHAR page iv).

Response

It is not possible to apply mitigation or management measure to prevent temporary flooding associated with the Project. However, it is considered that there are practicable management actions to minimise the effects of inundation on individual sites in the longer term. The revised offset strategy described in Section C6 provides for a proactive management approach that would provide for and facilitate maintenance and enhancement of Aboriginal cultural heritage values consistent with avoiding and minimising potential impacts as far as practicable.

C2.5 Involvement of Traditional Owners

Issue 1

The process of engagement with Traditional Owners regarding the Dam Proposal has been inadequate and their 'free, prior and informed consent' has not been obtained.

Response

Consultation with Aboriginal stakeholders has been carried out in accordance with relevant NSW guidelines as described in Section 3 of Appendix K *Aboriginal Cultural Heritage Assessment* and which is summarised in Table 18-5 in Chapter 18 of the EIS.

It is presumed that the matter of 'free, prior and informed consent' would be given appropriate consideration by DPE in its assessment of the Project, however, it is also noted that this does not form a formal part of the NSW planning approval process.

Issue 2

The ACHAR notes that the Cultural Values Assessment involved limited consultation with the Registered Aboriginal Parties (RAPs), '*the majority of who were not willing to participate in the formal assessment process or nominate knowledge holders*' (ACHAR page iii). Despite these limitations and the admission that '*locations of cultural value cannot be considered comprehensive*', the cultural landscape was assessed to be '*of very high significance*' (ACHAR page iv).

The EIS states that there has been further consultation with the RAPs during review and revision of the ACHAR. The ACHAR states '*it has been clearly communicated by the RAPs that they do not support the Project*' (ACHAR page iv). Australia ICOMOS notes that, in light of the inadequacy of information available to the RAPS and the circumstances described in the ACHAR, there is no free, prior and informed consent for the Dam Proposal from Aboriginal Traditional Owners. Therefore, Australia ICOMOS supports Recommendation 11 of the *Interim Report of the NSW Legislative Council Select Committee on the Proposal to Raise the Warragamba Dam Wall:*

> *That the NSW Government not proceed with the Warragamba Dam wall raising project should Registered Aboriginal Parties not give free, prior and informed consent for the project to proceed, as required in advice provided to the NSW Government by the Commonwealth Department of Agriculture, Water and Environment.*

Response

As noted previously, consultation with Aboriginal stakeholders has been carried out in accordance with relevant NSW guidelines as described in Section 3 of Appendix K *Aboriginal Cultural Heritage Assessment* to the EIS and which is summarised in Table 18-5 in Chapter 18 of the EIS.

The consultation log provided in Appendix 11 to Appendix K(withheld from public exhibition due to the cultural sensitivity of some information) consists of over 600 pages of consultation records undertaken with the RAPs since mid-2017. This consists of workshops, meetings, fieldwork, telephone calls, correspondence, and similar methods of communication. The RAPs provided feedback to the ACHA report through two consultation periods totalling over 80 days. The RAPs have provided further feedback on the Supplementary Assessment to ACHA undertaken following exhibition of the EIS.

The Government's response to Recommendation 11 of the *Interim Report of the NSW Legislative Council Select Committee on the Proposal to Raise the Warragamba Dam Wall* (NSW Government 2022) states

> *While free, prior and informed consent is not a requirement under NSW law, the NSW Government is listening to and considering the concerns raised by traditional owners.*

WaterNSW is similarly committed to continuation of consultation with Aboriginal stakeholders as per management measure ACH1.

C2.6 Non-compliance with the Burra Charter

Issue 1

The dam proposal is inconsistent with the principles and processes of *The Burra Charter: the Australia ICOMOS Charter for Places of Cultural Significance 2013*.

Best practice heritage practice, including *The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance 2013* (the Burra Charter), requires that the values of a place of cultural significance should be identified prior to decisions which affect those values, and that, while considering and managing other factors, a primary objective should be conservation of those values. The EIS has not involved adequate consultation nor survey work in relation to the ACHAR. There has been insufficient consideration of alternatives to the proposal to avoid harm. Therefore, the EIS does not meet Burra Charter standards and is fundamentally flawed.

Response

Consultation with Aboriginal stakeholders has been carried out in accordance with relevant NSW guidelines as described in Section 3 of Appendix K *Aboriginal Cultural Heritage Assessment* and which is summarised in Table 18-5 in Chapter 18 of the EIS.

With regard to survey effort, please refer to the response provided to the second issue in Section C2.4. As noted, the survey coverage is considered to present a strong representative sample of the landscape.

Chapter 4 of the EIS notes that the significant risk of flooding of the Hawkesbury-Nepean Valley (the valley) has been recognised by local Aboriginal people and since European settlement of the area. Over more than 25 years, alternatives and options for flood mitigation and risk reduction have been investigated by several governments through specialist committees, reviews and a taskforce. The Hawkesbury-Nepean Floodplain Management Strategy (Hawkesbury-Nepean Flood Management Advisory Committee 1997) identifies the following initiatives to mitigate and manage flood risk in the Hawkesbury-Nepean valley:

- Improved evacuation routes
- Better flood forecasting and warning
- Enhanced emergency response to floods
- Faster recovery for affected communities
- Increased awareness of flood risks
- Regional approach to flood planning
- Improved understanding of flood hazards
- Development of best practice land development guidelines.

These initiatives informed further work carried out over the period 1998-2004.

Extensive assessment has been undertaken into the solutions for flood mitigation in the Hawkesbury Nepean Valley since 2013. In early 2013, the *Hawkesbury-Nepean Valley Flood Management Review* (2013 Review) commenced following the Government's adoption of the *State Infrastructure Strategy 2012-2032* and ongoing concerns about flood risk. This found that there was a significant existing and growing flood risk in the valley and concluded there was no simple solution or single infrastructure option that could address all of the flood risk. The 2013 Review identified several priority areas for action:

- Increasing flood awareness and preparedness in the community
- The enhancement of emergency planning, response and recovery
- Better consideration of flood risk in land use planning
- Reviewing governance for effective flood risk management
- Cost benefit assessment of potential flood mitigation infrastructure options.

Following the recommendations of the 2013 Review, the NSW Government established the Hawkesbury-Nepean Valley Flood Management Taskforce (the Taskforce) to develop a whole-of-government approach to flood risk management and preparedness in the valley. Through 2014-2016, the Taskforce built on the preliminary investigations of the 2013 Review, to develop a strategy under the disaster risk management framework of 'prevent, prepare, respond and recover'.

A key objective of the Taskforce was to identify, develop and assess potential alternatives and options for reducing flood impacts and risks in the valley. This comprised:

- Reviewing previous alternatives and options from the 1997 Hawkesbury-Nepean Floodplain Management Strategy and the 2013 Review
- Identifying new potential alternatives or options

- Developing assessment criteria to enable the comparison of different alternatives and options
- Commissioning studies and design work on feasible alternatives and options to provide suitable information to enable their assessment. This included engineering design of relevant options, flood modelling, evacuation modelling to assess risk to life, flood damages assessment, cost estimation, cost benefit analysis, and preliminary environmental impact assessment
- Using the assessment criteria and information from the additional design and studies to evaluate the alternatives and options to determine which, in single or combination, were the most effective in reducing flood impacts
- Developing the Hawkesbury-Nepean Valley Flood Risk Management Strategy (Flood Strategy) for Government's consideration.

The Taskforce confirmed the findings of the 2013 Review, that there is no simple solution or single infrastructure option that can eliminate the high flood risk to existing communities in the valley. A combination of infrastructure and policy or other initiatives are required to reduce flood risk by:

- Changing the probability and delaying flood events reaching critical levels
- Reducing the exposure of people, property and assets to flood risk
- Increasing the available time to safely evacuate areas exposed to imminent flooding
- Increasing the resilience of communities, property and public assets exposed to floods.

The following criteria were used by the Taskforce to assess alternatives and options for flood risk mitigation:

- Significant regional reduction of flood peak
  - reduction in downstream peak flood levels for critical flood range for damages of 1 in 50 to 1 in 1,000 chance in a year for damages and risk to life
  - extent of peak flood level reduction in the valley
- Reduced risk to life
  - reduced exposure to floods
  - flood delay providing a longer window for evacuation
  - average annual vehicles/population unable to evacuate
- Economic costs and benefits
  - capital and operating costs
  - benefits in terms of avoided flood damages
  - net benefit
- socio-economic, environmental and cultural heritage impacts
- other factors.

The assessed alternatives and non-infrastructure measures are detailed in the Taskforce Options Assessment Report (Infrastructure NSW 2019) and comprised:

- Operational alternatives using the existing Warragamba Dam – these primarily modify how the dam is operated but may require some modification to existing infrastructure; these include:
  - opening Warragamba Dam gates more slowly to temporarily hold back inflows ('surcharge' method)

  - pre-releases from Warragamba Dam water supply to create a temporary FMZ in advance of a forecast flood
  - lowering Warragamba Dam's water supply storage to create a dedicated FMZ
  - combined operational alternatives
- New flood mitigation dams – alternatives include new dams built and operated only for flood mitigation:
  - new dams upstream of Warragamba Dam
  - new dam on Nepean River
  - new dams downstream of Warragamba Dam
- Raising Warragamba Dam wall to temporarily store flood waters in a dedicated FMZ – this alternative included detailed consideration of two different heights:
  - raising by 14 metres
  - raising by 20 metres
- Infrastructure upgrades to enhance drainage or protect downstream communities, including:
  - construction of diversion channels to improve the drainage of floodwaters
  - dredging of Hawkesbury River to improve drainage of floodwaters
  - levees to provide localised flood protection to flood prone communities
- Evacuation road upgrades – involving upgrade packages to improve evacuation road network capacity. Two categories of road upgrades were considered:
  - nine evacuation road upgrade packages for major regional evacuation routes
  - local evacuation road upgrades
- Non-infrastructure measures – a wide range of non-infrastructure measures was considered including changes to land use planning controls, improved flood forecasting and response, building community resilience, and better coordination between agencies. Generally, these measures do not result in any reduction in flooding extent or frequency, and so cannot be considered substitutes to flood mitigation infrastructure that would reduce significant existing risk exposure. Nonetheless, these non-infrastructure measures are critical for an integrated and sustainable approach to managing current and future flood risk in the valley.

Assessment of options has included consideration of social, environmental and cultural heritage impacts as described in Section 4.2.4 of the EIS.

The revised offset strategy (refer Section C6) would contribute to and support conservation and maintenance of Aboriginal cultural heritage values within the upstream area. This is consistent with Article 16 of the Burra Charter.

Issue 2

The EIS is inconsistent with several Articles of the Burra Charter. In particular:

- The mitigation and management measures considered (EIS Exec Summary page 39) are inconsistent with an appropriate conservation outcome. The EIS proposes 'an Aboriginal cultural heritage management plan to address intergenerational equity including recording of Aboriginal cultural heritage'. Recording is insufficient and would be inconsistent with the conservation principles in Articles 2 and 3 of the Burra Charter.
- Survey of only a part (about 33 percent) of the directly affected area as noted in the sampling strategy presented in the ACHAR (page 30) has prevented comprehensive

understanding of the definitive extent of cultural resources which would be destroyed. This shortcoming represents a fundamental non-compliance with the core process set out in Article 6 of the Burra Charter.

- There has been insufficient engagement with Traditional Owners. The information available to them through the EIS (including lack of adequate location data – even if it were to be provided in confidence) means that participation by associated people has been thwarted, contrary to the intent of Article 12 of the Burra Charter.
- With respect to non-Aboriginal heritage, there was no process for identification or assessment of unlisted items of potential heritage significance which were not already included on statutory registers or lists (EIS Chapter 17 *Non-Aboriginal heritage*, page 17-5). In view of the nature of the project under consideration this is not consistent with the process outlined in Article 26 of the Burra Charter.

Response

Mitigation and management measures

The mitigation measures proposed in the EIS are drawn from the ACHA, and the supporting the CVA and Archaeological Assessment Report. The measures have been developed based on consultation with RAPs and a consideration of the potential impacts from the Project on tangible and intangible heritage values. The management recommendations were developed with reference to the *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH 2011) and were mindful of the advice therein.

Survey effort

The methodology for the Aboriginal cultural heritage assessment, including the archaeological survey methodology, is described in the response to the second issue in Section C2.4. As noted, a full coverage survey was not undertaken due to the outcomes of the slope and soil analysis as well as the desire of the RAPs to focus on areas highlighted by the creation story. This notwithstanding, as noted in Section 9.1.1 of the Archaeological Assessment Report, the survey coverage is considered to present a strong representative sample of the landscape.

Engagement with Traditional Owners

Article 12 (Participation) of the Burra Charter states

> *Conservation, interpretation and management of a place should provide for the participation of people for whom the place has significant associations and meanings, or who have social, spiritual or other cultural responsibilities for the place.*

Consultation with Aboriginal stakeholders has been carried out in accordance with relevant NSW guidelines as described in Section 3 of Appendix K *Aboriginal Cultural Heritage Assessment* to the EIS and which as summarised in Table 18-5 in Chapter 18 of the EIS. This has informed the assessment of potential impacts on Aboriginal cultural heritage values and the development of the management recommendations presented in Section 13 of Appendix K.

The revised offset strategy (refer Section C6) would contribute to and support conservation and maintenance of Aboriginal cultural heritage values within the upstream area. This is consistent with Article 16 of the Burra Charter.

Non-Aboriginal heritage assessment process

As explained in Section 17.5.2.1 of the EIS, downstream of Warragamba Dam, there would be a reduction in the number of Commonwealth, State and LEP-listed heritage items that experience flooding with the Project for all events. This would also be the case for downstream places listed on non-statutory heritage registers Given the reduced risk to downstream heritage items with the Project, it was not considered necessary to provide a detailed assessment of archaeological potential or significance.

Further assessment has been undertaken on a number of items on the NPWS section 170 heritage register in the upstream area and this is documented in Section 6.2.2 of the PIR.

Issue 3

The dam proposal is inconsistent with the Burra Charter because it would not respect the cultural significance of the affected cultural places and would not avoid or minimise adverse impacts on cultural heritage. Therefore, Australia ICOMOS supports Recommendation 13 of the Interim Report of the NSW Legislative Council Select Committee on the Proposal to Raise the Warragamba Dam Wall, October 2021, which proposes:

> *That the NSW Government, in the final Environmental Impact Statement, clearly demonstrate how the Aboriginal Cultural Heritage Assessment for the Warragamba Dam wall raising project complies with all current guidelines identified in the SEARs, including the*:
>
> - *Burra Charter…*

Response

With reference to the seven steps identified in the Burra Charter process flowchart[49], the following is noted:

1. **Understand the place:** an understanding of the area has been developed through the various studies carried to inform the environmental assessment for the Project
2. **Assess cultural significance:** the cultural significance of the area affected by the Project has been assessed through targeted assessments of Aboriginal and non-Aboriginal cultural heritage assessments documented in Appendices I and K to the EIS respectively and in supplementary assessments provided as Appendix I to this report (Non-Aboriginal cultural heritage) and Appendix F to the PIR (Aboriginal cultural heritage)
3. **Identify all factors and issues:** the environmental assessment has considered all relevant matters in accordance with the SEARs and further assessment of matters related to Aboriginal and non-Aboriginal heritage has been carried out as part of preparation of this Submissions Report and the PIR
4. **Develop policy:** WaterNSW has an existing environmental policy[50] that addresses conservation (and enhancement) of natural, Aboriginal and non-Aboriginal heritage values
5. **Prepare a management plan:** management of identified potential impacts on cultural heritage matters will be addressed through the relevant National Park Plan of Management and through the Part 5A EMP required under the *Water NSW Act 2014*

49 https://australia.icomos.org/publications/burra-charter-practice-notes/#flow_chart

50 https://www.waternsw.com.au/__data/assets/pdf_file/0004/63076/WaterNSW-Environmental-Policy.pdf

6. **Implement the management plan:** as per response to Step 5
7. **Monitor the results and review the plan:** the National Park Plans of Management provide for monitoring of the effectiveness of management measures and for ongoing review. The Part 5A EMP would similarly provide for regular review and revision as required.

C3 International Union for Conservation of Nature

C3.1 Assessment of impacts on Outstanding Universal Value (including conditions of integrity)

The OUV of the property, recognised through its inclusion on the World List, is set out in its Statement of Outstanding Universal Value (SOUV), which was adopted by the World Heritage Committee in 2013 (Decision 37 COM 8E4). This statement provides an entry point from which any EIS should proceed in assessing impacts. In this regard the IUCN notes that the SOUV makes clear that:

> *An understanding of the cultural context of the GBMA is fundamental to the protection of its integrity. Aboriginal people from six language groups, through ongoing practices that reflect both traditional and contemporary presence, continue to have a custodial relationship with the area. Occupation sites and rock art provide physical evidence of the longevity of the strong Aboriginal cultural connections with the land. The conservation of these associations, together with the elements of the property's natural beauty, contributes to its integrity.*

The upstream impact area for the raised dam clearly includes important cultural sites that contribute to the property's integrity. As outlined in the EIS, the project may result in the total loss of a number of known sites with high cultural and scientific significance as a result of their inundation. The inundation of these sites would, therefore, damage attributes of the OUV of the property, and therefore this reported loss is at odds with the conclusion of the EIS that the Project '*would not result in a material loss or degradation of the Outstanding Universal Value of the GBMWHA*'.

Response

Section 6.1.23 of Appendix J *World Heritage Assessment Report* to the EIS stated

> *The Project has assumed a total loss of values within the upstream impact area of which 304 hectares occurs within the GBMWHA. While this scale of impact may not be actually realised, on the assumption of total loss of values, this would result in a diminution of Aboriginal cultural heritage values (loss of 28 sites) and therefore the Project may result in a diminution of this OUV component.*

As noted, in real world terms, it is highly unlikely that impacts would actually be manifested to the extent assumed.

The ACHA compared the potential loss of tangible sites and scientific values in the context of prior and potential future impacts. The Supplementary Assessment to the ACHA (refer Appendix F to the PIR) provides an analysis of archaeological sites affected by recent flooding at Longneck Lagoon that have been subject to temporary inundation of around one week from the recent 2022 flood. The main finding is that sites are generally resilient to temporary backwater inundation which is the similar scenario to that of the FMZ filling. The findings indicate that sites are more susceptible to high water velocities and erosion from runoff from the catchment.

C3.2 Free, prior and informed consent and public consultation

IUCN notes that on 28 August 2020 Traditional Owners formally advised State and National Government consent authorities that they were not properly engaged in the development of the

EIS in relation to the cultural values which contribute to the property's integrity, and do not give free, prior and informed consent for the project to proceed.

The IUCN Advice Note on Environmental Assessment states that all relevant stakeholders should be involved in the assessment process, and the 2015 Policy on World Heritage and Sustainable Development states that States Parties should '*ensure adequate consultations, the free, prior and informed consent and equitable and effective participation of indigenous peoples where World Heritage nomination, management and policy measures affect their territories, lands, resources and ways of life*'. In this context, the EIS therefore does not comply with these principles, noting, as above, that these also relate directly to attributes that are connected to Outstanding Universal Value.

Response

It is noted that the concept of 'free, prior and informed consent' comes from Article 32.2 from the United Nations Declaration on the Rights of Indigenous Peoples[51] which states

> *States shall consult and cooperate in good faith with the indigenous peoples concerned through their own representative institutions in order to obtain their free and informed consent prior to the approval of any project affecting their lands or territories and other resources, particularly in connection with the development, utilization or exploitation of mineral, water or other resources.*

Consultation with Aboriginal stakeholders has been carried out in accordance with the NSW *Aboriginal cultural heritage consultation requirements for proponents 2010* (DECCW 2010a). This sets out a four-stage consultation process and outlines the roles and responsibilities of the responsible NSW agency (currently Heritage NSW), Aboriginal parties (including local and State Aboriginal Land Councils), and proponents. The four stages are:

1. Notification of project proposal and registration of interest
2. Presentation of information about the proposed project
3. Gathering information about cultural significance
4. Review of the draft cultural heritage assessment report.

The consultation process is described in detail in Section 3 of Appendix K *Aboriginal Cultural Heritage Assessment* and is summarised in Table 18-5 in Chapter 18 of the EIS.

The consultation log provided in Appendix 11 to Appendix K (withheld from public exhibition due to the cultural sensitivity of some information) consists of over 600 pages of consultation records undertaken with the RAPs since mid-2017. This consists of workshops, meetings, fieldwork, telephone calls, correspondence, and similar methods of communication. The RAPs provided feedback to the ACHA report in the EIS through two consultation periods totalling over 80 days. The RAPs have provided further feedback on the Supplementary Assessment to the ACHA prepared following exhibition of the EIS.

The requirements to consult with Traditional Owners who hold knowledge about the significance of Aboriginal cultural heritage was part of the heritage assessment process. Despite the increasing recognition of 'free, prior and informed consent' in an international context, it is not part of Australia's domestic law. As result, its application is somewhat constrained.

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51 Resolution adopted by the General Assembly on 13 September 2007.

It is presumed that the matter of 'free, prior and informed consent' would be given appropriate consideration by DPE in its assessment of the Project, however, it is also noted that this does not form a formal part of the NSW planning approval process.

C3.3 Rigorous environmental assessment, based on adequate data and information

Issue 1

The EIS indicates the method for assessing flora and fauna distribution, which forms the basis of analysis of impacts to the OUV of the property, is based on predictive models, as detailed field surveys were not possible due to the size of the study area. The lack of survey coverage and focussed surveys for threatened taxa which contribute significantly to the OUV of the property, and whose presence and range are difficult to establish through predictive modelling, represents a shortcoming in the assessment methodology and undermines the validity of the data on which the findings of the EIS are based.

Response

The statement that the biodiversity assessment is based on predictive models is not completely correct. The methodology for the upstream study area, part of which falls within the GBMWHA, is described in Section 1.5 of Appendix F1 *Biodiversity Assessment Report – Upstream* with details regarding field surveys provided in Sections 4.2 and 5.5 of Appendix F1. Details of targeted flora and fauna surveys are provided in Section 5.5.2 of Appendix F1.

The size of the upstream area is 5,280 hectares, of which 1,360 hectares are within the GBMWHA. Of this, 770 hectares are already potentially affected by temporary inundation from the PMF for the existing dam. The size of the upstream area is acknowledged as a constraint to the level of survey effort in Appendix F1 to the EIS. As noted in Section 5.5.2 of Appendix F1, where potential habitat was present and a species was known to occur at other locations in the locality, it was assumed present. For the PUIA, a precautionary approach of total loss was assumed for the purpose of applying offsets. A protected land values offset, that includes the OUV of World Heritage land within the PUIA, has also been applied as total loss as described in the offset strategy.

Issue 2

Consideration of cultural associations relevant to OUV is not rigorous in the EIS. There have been no physical investigations to enable informed assessment of the sites concerned, and the approach to understanding cultural values requires broadening to encompass concepts of place, landscape, contemporary tradition and living heritage, rather than limiting cultural heritage to known individual sites.

Response

The statement that there have been no physical investigations to inform assessment of sites is not completely correct. As documented in Section 8 of Appendix 1 *Archaeological Assessment Report* to Appendix K *Aboriginal Cultural Heritage Assessment Report*, the assessment included an archaeological survey covering an area of 2,655 hectares with fieldwork being carried out between May 2018 and June 2019.

The cultural values assessment provided as Appendix 2 to Appendix K *Aboriginal Cultural Heritage Assessment Report* considered living places, cultural places, the 19 places connected to the Gurrangatch-Mirrigan Dreaming Track, and the Buru (Kangaroo) Dreaming Story places.

Further consideration of Aboriginal cultural heritage values relevant to the OUV of the GBMWHA is provided in Section C4.4.

C3.4 Post fire recovery assessment

Issue 1

As reported in the EIS, around 70 percent of the upstream impact area was affected by the major bushfires of 2019/20, and a number of species have had their entire global populations, including fire sensitive species, impacted by the fires. The EIS presents information regarding extent, severity, and impact of the bushfires in the upstream impact area of the property. However, the potential of the project to exacerbate bushfire impacts or affect the recovery prospects of key species and habitats, as requested by the World Heritage Committee in Decision 44COM 7B.180, is not considered adequately.

Response

The potential for the Project to exacerbate bushfire impacts is considered to be low. The scenario of a flood event causing temporary inundation in the upstream area following a major bushfire event is an existing risk, noting that the 2019-2020 bushfire event was followed by a significant flood event in March 2021 where the water level in Lake Burragorang reached 1.16 metres above FSL (the full lake level).

The nature of how this potential cumulative impact may be manifested will be dependent on numerous dynamic factors that vary over time. Further discussion in this regard is provided in Section C4.12.

Issue 2

There is no indication that field surveys have been repeated in fire-affected areas. Therefore, the implications of fire damage cannot be adequately considered on this basis, as the data may no longer be valid following the fires.

Response

The assessment of potential impacts with regard to matters that fall under the EPBC Act, including World Heritage, has been carried out under the bilateral assessment agreement established under the EPBC Act as described in Section 2.6.1 of the EIS. As also noted, revised SEARs were issued on 13 March 2018 which contained the EPBC Act assessment requirements provided by the former DoEE. Attachment A to the SEARs provided additional information on the assessment requirements for the EPBC Act.

In February 2020, DPE released the *Guideline for applying the Biodiversity Assessment Method at severely burnt sites* (the Guideline). This provides guidance to proponents with regard to their assessment depending on its status at the time of a severe bushfire event. Section 4.1.1 of the Guideline states that where the Stage 1 BAM assessment has been completed prior to severe bushfire, the assessor should use this information to prepare the impact assessment. As the assessment for the Project was completed prior to the bushfire event, no further assessment, including further survey, has been required.

C3.5 Mitigation measures and identification of reasonable alternatives

Regarding the Warragamba Offset Program proposed in order to minimise the impacts of the project 'where impacts cannot be avoided', it should be noted that OUV, confirmed through the inscription of the property, cannot be subject to excisions and compensation on an area basis. In principle, IUCN considers that OUV cannot be offset and therefore the concept of compensation plots for the planned loss of OUV is not appropriate.

Response

The revised offset strategy described in Section C6 provides for proactive mitigation and management activities to maintain environmental values through the protected land values offset that are potentially affected by the existing dam and that would be potentially affected by the Project. This would materially contribute to the maintenance of biodiversity and Aboriginal cultural heritage values which in turn would contribute to maintaining the World Heritage values of the GBMWHA.

It is noted that the World Heritage Operational Guidelines (Part III.I) provide for modifications to the boundaries of World Heritage properties. It is presumed that this avenue would be available and could encompass suitable adjacent land to support the GBMWHA's OUV should it be required.

C4 Supplementary assessment of World Heritage matters

C4.1 DPE requirement

In its advice to WaterNSW, DPE requested a more detailed assessment of the impacts of the proposal on World Heritage addressing:

- consideration of the Aboriginal cultural heritage aspects of World Heritage
- consideration of the natural and cultural values
- assessment of the impacts of the proposal against the Statement of Outstanding Universal Value for the Greater Blue Mountains World Heritage Area.

The *Matters of National Environmental Significance Significant Impact Assessment Guidelines 1.1* (Impact Guidelines) (DoE 2013) provide the framework for the assessment of various MNES under the EPBC Act. The Impact Guidelines state that:

> *Approval under the EPBC Act is required for any action occurring within or outside a declared World Heritage property that has, will have, or is likely to have a significant impact on the World Heritage values of the World Heritage property.*
>
> …
>
> *An action is likely to have a significant impact on the World Heritage values of a declared World Heritage property if there is a real chance or possibility that it will cause:*
>
> - *one or more of the World Heritage values to be lost*
> - *one or more of the World Heritage values to be degraded or damaged, or*
> - *one or more of the World Heritage values to be notably altered, modified, obscured or diminished.*

This section addresses these matters requested by DPE with regard to the Impact Guidelines.

C4.2 Overview of hydrology and flooding

As previously noted, Warragamba Dam was in existence at the time of inscription of the GBMWHA on the World Heritage List in 2000 and the National Heritage List in 2007. As noted in Section C1, a heritage item can be listed despite it being subject to risks which affect its OUV, in this case, temporary inundation from the existing dam.

Flooding in the catchment upstream of Warragamba Dam comprises two components:

- Local catchment inflows – these are independent of the Project, will not be changed by the Project and are determined by local conditions
- Backwater from Lake Burragorang as inflows enter the lake and exceed outflows at the dam.

Local catchment inflows occur above the upstream limit of backwater from Lake Burragorang. The location of this limit has been identified for the PMF and the 1 in 5, 1 in 10, 1 in 20 and 1 in 100 chance in a year events. The areas above these locations have been excluded from the assessment as they will not be affected by the Project.

Temporary inundation from the backwater effect will change with regard to:

- The lateral extent of temporary inundation
- The depth and duration of temporary inundation
- The frequency of flood events causing temporary inundation.

Further details are provided as follows.

Area of temporary inundation in the upstream area

The additional flooding for flood events up to the 1 in 100 chance in a year event potentially affecting the GBMWHA would occur principally along the Wollondilly River within Lake Burragorang (eastern shoreline) and the main river channel (on the right/eastern bank), and the upper reaches of the Nattai River.

There are no areas of the GBMWHA in proximity to the Coxs River and Kowmung River that would be affected by additional flooding for flood events up to the 1 in 100 chance in a year event.

The size of the upstream study area is 5,280 hectares (defined by the PMF with the Project as per the SEARs). Of this area, 1,360 hectares are within the GBMWHA with 770 hectares already at risk of temporary inundation from the PMF event for the existing dam. The areas of temporary inundation for the existing dam and with the Project for other selected flood events are shown in the following table (Table 4-7 in EIS Appendix J *World Heritage Assessment Report*).

Table C1 Existing and with Project temporary inundation

Flood event (1 in x chance in a year)	Existing (ha)	With Project (ha)	Additional area (ha)
5	28	115	87
10	113	279	166
20	153	446	293
100	288	703	415

Depth and duration of temporary inundation in the upstream area

- For the locations approximating the limit of the 1 in 100 chance in a year event, increases in the maximum depth of temporary inundation with the Project for all events would be half a metre or less.
- Increases in the duration of temporary inundation for all events considered for the Nattai River and Wollondilly River would be less than half a day.
- Increases in the duration of temporary inundation for the Kowmung River would be less than half a day up to the 1 in 5 and 1 in 10 chance in a year events, about 1.3 days for the 1 in 20 chance in a year event, and about two days for the 1 in 100 chance in a year event (these would not affect the GBMWHA).
- Increases in the duration of temporary inundation for the Coxs River would be less than half a day for up to the 1 in 20 chance in a year event and then slightly over half a day up to the 1 in 100 chance in a year event (these would not affect the GBMWHA).

- There is an increase in depth and duration of temporary inundation, with locations within Lake Burragorang generally reflecting the pattern of changes in depth and duration of temporary inundation for the same flood events at the dam wall.

Frequency of flood events in the upstream area

- The Project would result in a shift in the flood frequency curves resulting in events of a specified depth occurring more frequently than currently occurs in the upstream catchment; this is most pronounced at the dam wall and in Lake Burragorang, and decreases moving up the tributaries.
- There is no material difference in the existing and with Project flood frequency curves at upstream locations that approximate the extent of the Project PMF (as would be expected).
- The frequency analysis shows that for the Wollondilly River and Nattai River there is effectively no material change in flood frequencies.
- For the Kowmung River, the flood frequency curves start to diverge at about the 1 in 50 chance in a year event. The current 1 in 100 chance in a year event would occur on average about once every 85 years with the Project.
- For the Coxs River, the curves start to diverge between the 1 in 10 chance in a year and the 1 in 20 chance in a year events.
- The current 1 in 100 chance in a year event would occur on average about once every 70 years with the Project.

Other Lake Burragorang tributaries

There are a number of other tributaries that drain to Lake Burragorang whose upper reaches extend into or are in proximity to the GBMWHA. The catchments for these tributaries represent very minor contributions to Lake Burragorang relative to the overall Warragamba Dam catchment and accordingly were not included in the upstream modelling. As such, information such as depth-duration curves is not available for any of these tributaries.

The following is a summary of characteristics of temporary inundation (existing, with Project) for these tributaries:

- Lacys Creek: about 18 hectares of the GBMWHA lies within the study area (defined by the Project PMF). The existing 1 in 100 chance in a year event does not affect the GBMWHA, the same event for the Project would affect about 11 hectares. Small areas of the 1 in 20 and 1 in 10 chance in a year events (about 2.3 and 0.1 hectares respectively) with the Project also lie within the GBMWHA; none of these events for the existing situation affect the GBMWHA.
- Green Wattle Creek: the existing 1 in 100 chance in a year event does not affect the GBMWHA; the Project would affect about 0.3 hectares.
- Butchers Creek: the existing 1 in 100 chance in a year event affects less than one hectare of the GBMWHA, the Project would affect about an additional 7.7 hectares. None of the other more frequent flood events extend into the GBMWHA in this location.
- Kedumba River: about 1.8 kilometres of the right bank of the Kedumba River is located immediately adjacent to the GBMWHA. This part of the GBMWHA is generally unaffected by the existing 1 in 100 chance in a year event; the Project would affect about 20 hectares of the GBMWHA. None of the other more frequent flood events would affect the GBMWHA.
- Cedar Creek: none of the other existing or Project flood events up to the 1 in 100 chance in a year flood event extend into the GBMWHA in this location.

C4.3 Assessment against OUV of GBMWHA

The assessment in this section broadly follows that presented in DAWE (2022) with regard to the designation of the components of the OUV for the GBMWHA. This notes that the OUV is composed of multiple and inter-related components that, together, constitute the GBMWHA's exceptional significance.

The assessment presented in DAWE (2022) selected eight high-level components that were considered to represent the two criteria of natural heritage values as presented in the Statement of OUV for the property, i.e.

- (ix) be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals.
- (x) contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of Outstanding Universal Value from the point of view of science or conservation.

The selected high-level components and respective descriptions are presented in the following table. These are separated into natural heritage values and integrity. As noted in DAWE (2022), there is considerable overlap among these high-level components, reflecting the interconnectedness of the component values contributing to the OUV of the GBMWHA.

Table C2 OUV components

Component	Description
Natural heritage values	
Gondwanan flora	Primitive rainforest species with Gondwanan affinities that have survived in isolated pockets of the GBMWHA (e.g. Wollemi Pine, Blue Mountains Pine, species of *Lomatia, Dracophyllum, Acrophyllum, Podocarpus and Atkinsonia*).
Scleromorphic flora	Plants having hard, short and often spiky leaves that have evolved in response to conditions of low soil fertility and limited water (e.g. Myrtaceae – eucalypts, Fabaceae – acacias, Proteaceae - banksias, grevilleas and hakeas). Scleromorphic flora cover more than 98% of the GBMWHA.
Conservation-significant flora	Plant species and ecological communities that are identified under the EPBC Act and/or BC Act as requiring special environmental protection due to substantial declines in geographic distribution and/or key species, and because of the presence of ongoing pressures that are likely to continue the trend of degradation and loss.
Conservation-significant fauna	Animal species and ecological communities that are identified under the EPBC Act and/or BC Act as requiring special environmental protection for the same reasons as conservation-significant flora.
Integrity	
Water systems	Aquatic features such as streams, springs, swamps, lakes, waterfalls, seeps, groundwater, and associated water-dependent ecosystems that have evolved in tandem with the geomorphic evolution of the landscape. Examples include the Thirlmere Lakes system in Thirlmere Lakes National Park and the Colo, Kowmung and Grose river systems, parts of which are declared wild rivers under the NPW Act.

Component	Description
Geodiversity	The diversity of geological structures and landforms such as plateaus, cliffs, escarpments, caves, canyons, gorges and pagoda rocks. These provide the setting for the unique biota and contribute to the GBMWHA's indigenous heritage and natural beauty (Washington and Wray 2011, cited in DAWE 2022).
Boundary integrity	Characteristics of the GBMWHA's boundary (e.g. native vegetation buffers, rocky escarpments) that help protect the GBMWHA's OUV.
Indigenous custodial relationships	Culturally important sites such as caves, shelters, hearths, rock art, grinding grooves, scar trees and landscape features). Species that are important for diet, materials, medicine, cultural identity and spiritual values of the indigenous peoples of the area. Intangible values that reflect the connections and interdependent relationship between Indigenous people and their ancestral lands.

C4.3.1 Gondwanan flora

Key representatives of the Gondwanan flora in the GBMWHA are the endemic Wollemi Pine (*Wollemia nobilis*), the Blue Mountains Pine (*Pherosphaera fitzgeraldii*) and *Acrophyllum australe* (DAWE 2022).

Wollemi Pine

The Wollemi Pine is restricted to four small patches in a single location in Wollemi National Park (NSW Scientific Committee 2015). The Project would not affect any protected lands falling within Wollemi National Park. Given the intervening distance (>10 kilometres) between the upstream Project area and Wollemi National Park, the potential for indirect impacts is considered remote.

Blue Mountains Pine/Dwarf Mountain Pine,

The Blue Mountains Pine, also known as the Dwarf Mountain Pine, occurs in the upper Blue Mountains between Wentworth Falls and Katoomba. The species is found within the spray zone or associated drip lines and seepage areas of waterfalls on steep, sandstone cliffs and ledges, at altitudes between 680 and 1000 metres above sea level. The sites face south-east to south-west, and being on near-vertical to vertical slopes or under overhangs, are heavily shaded. The degree of shading from other plants varies from none on exposed cliffs and ledges to up to 70 percent from nearby rainforest plants on larger, lower ledges and overhang caves[52].

The biodiversity assessment for the upstream area (Appendix F1) identified that small areas of suitable habitat occur in the upstream study area. The likelihood of occurrence was identified as moderate. Waterfall spray-zone habitat is marginal in the upstream study area. The species was not recorded during field surveys but was assumed to be present for the purposes of the assessment which identified the potential for temporary inundation to adversely impact this species.

All recorded sightings are from the Katoomba and Wentworth Falls areas which are to the north of and outside of the upstream area, and would therefore not be affected by temporary inundation from the Project. The existing upstream PMF level is 131.2 mAHD and would increase to 143.9 mAHD (at Warragamba Dam). This is more than 500 metres below the lower limit of this species as noted

52 https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10530

above. While the biodiversity assessment adopted a precautionary position with regard to the presence of the species, the likelihood of it being affected by the Project is considered low.

Acrophyllum australe

The biodiversity assessment for the upstream area (Appendix F1) noted that suitable habitat for this species includes sheltered gullies beneath waterfalls and drip zones of rock overhangs and cliff faces, typically where there is a constant source of water. It is generally associated with *Callicoma serratifolia, Dracophyllum secundum, Todea barbata, Alania endlicheri* and *Blechnum ambiguum*. The biodiversity assessment noted that the study area did not contain suitable edaphic or landscape features, or floristic associations for this species. The majority of potential habitat for this species occurs outside of the upstream study area (refer Figure B.7 in Appendix F1) but was included in the assessment through falling within the 500 m buffer used in the biodiversity assessment.

C4.3.2 Scleromorphic flora

A major component of the OUV for the GBMWHA is the high number of eucalypt species and eucalypt-dominated communities present, some 13 percent of all eucalypt species in the world (Hager and Benson 2010).

Hager and Benson (2010) provide a definitive list of the 96 eucalypts (species of the genera *Eucalyptus*, *Angophora* and *Corymbia* in the family Myrtaceae) that have been recorded in the GBMWHA, together with the distribution of the eucalypts in the eight reserves that make up the GBMWHA. Information on the classification and habitats of the different species is also provided. This paper has been used to inform the following discussion with regard to potential impacts of the Project on eucalyptus with regard to the OUV of the GBMWHA.

The Project potentially affects the following protected lands within the GBMWHA:

- Blue Mountains National Park (upstream area)
- Nattai National Park (upstream area)
- Yengo National Park (downstream area).

These areas are already affected by temporary inundation associated with the existing dam. In general, the risk of temporary inundation will increase in the upstream area and decrease in the downstream area.

Table 1a in Hager and Benson (2010) identifies 55 eucalypt species with relatively widespread distributions in the GBMWHA by individual reserves. Of these, 50 species occur in Blue Mountains National Park, 29 species in Nattai National Park, and 24 species in Yengo National Park. In view of their widespread distribution across the GBMWHA, these species have not been considered in the following discussion.

Table 1b in Hager and Benson (2010) identifies 41 eucalypt species with relatively restricted distributions in the GBMWHA by individual reserves. The following table draws from this table and identifies eucalypt species occurring in one or more of the three national parks noted above. Comment is provided for each species with regard to the potential impact of the Project.

Table C3 Eucalypt species with restricted distributions within the GBMWHA potentially affected by the Project

Species	Distribution[1]	Conservation status	Potential impact of Project
Angophora euryphylla	Restricted distribution – sandstone outcrops between the Central Coast and Putty. Occurs in Yengo and Wollemi NPs.	–	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.
Angophora hispida	Widespread on shallow soils on Hawkesbury sandstone plateaus near the coast. Uncommon in the GBMWHA. Occurs in Yengo and Wollemi NPs.	–	Mid-stratum species in PCT 1083 Red Bloodwood–Grey Gum woodland on the edges of the Cumberland Plain, Sydney Basin Bioregion. Occurs within the Burragorang and Wollemi IBRA subregions which overlap with the Project study area. This PCT occurs on crests, ridges and exposed slopes on coastal sandstone plateaux. These features do not occur in the area of Yengo NP potentially affected by the Project in the downstream study area. This species is therefore unlikely to be impacted by the Project.
Eucalyptus aggregata	Occurs on cold alluvial flats from Wallerawang to Victoria. Suitable climatic and drainage conditions are limited in the GBMWHA. Occurs in Blue Mountains NP.	BC – V EPBC – V	Upstream study area does not contain PCTs, specific species associations, and soil type/edaphics associated with this species, therefore unlikely to be impacted by the Project.
Eucalyptus apiculata	Restricted distribution – scattered populations on skeletal soils between Linden and Berrima. Occurs in Blue Mountains and Nattai NPs.	–	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.
Eucalyptus baeuerlenii	Restricted distribution – scattered populations at Wentworth Falls, Budawang Range, Wadbilliga NP. Occurs in Blue Mountains NP.	–	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.
Eucalyptus benthamii	Restricted distribution – alluvial soils in the lower Hawkesbury-Nepean catchment Occurs in Blue Mountains and Nattai NPs.	BC – V EPBC – V	Upper stratum species in PCT 553 Mountain Blue Gum–Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion. Occurs within the Burragorang IBRA subregion which

Species	Distribution[1]	Conservation status	Potential impact of Project
			overlaps with the Project study area. This PCT occurs on sheltered valley flats upstream of Lake Burragorang. This species was recorded in the upstream study area. Bush and England (2019) found that *Eucalyptus benthamii* may be tolerant to temporary inundation for up to six weeks duration to a depth of 30 centimetres, suggesting that the species may also possess similar morphological adaptions to enable some level of tolerance to flood stress. Within the upstream study area, the depth of temporary inundation is expected to be more variable and potentially much greater than 30 centimetres. The NSW threatened species profile for the Camden White Gum notes there is a major subpopulation in the Kedumba Valley of the Blue Mountains NP. This occurs primarily along the margins of the Kedumba River and is mostly outside the GBMWHA. The maximum changes in temporary inundation for this area will be in the order of an additional 0.5 m depth and about 0.7 days duration for the 1 in 100 chance in a year flood event and less than 0.5 m and 0.5 days for more frequent events. The Project is therefore unlikely to impact this subpopulation. Areas of this species occurring along other tributaries would experience similar maximum incremental increases of up to half a day and half a metre of temporary inundation.
Eucalyptus burgessiana	A species endemic to the GBMWHA, with scattered populations on skeletal soils at lower elevations. Occurs in Blue Mountains, Nattai and Wollemi NPs.	–	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.
Eucalyptus camphora subsp. camphora	On open swampy flats from Nullo Mountain to the Megalong Valley. Suitable swampy alluvial soils are limited within the GBMWHA. Occurs in Blue Mountains and Wollemi NPs.	–	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.

Species	Distribution[1]	Conservation status	Potential impact of Project
Eucalyptus capitellata	Locally frequent on sandy soils on coastal foothills between Karuah and Nerriga. Uncommon in the GBMWHA. Occurs in Yengo NP.	–	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.
Eucalyptus cunninghamii	A species endemic to the GBMWHA, with localised populations on skeletal soils in the upper Blue Mountains and Wanganderry Tableland. Occurs in Blue Mountains, Nattai and Kanangra-Boyd NPs.	–	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.
Eucalyptus dendromorpha	Restricted distribution – scattered populations from Mt Tomah to the Budawang Range. Occurs in Blue Mountains NP.	–	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.
Eucalyptus fergusonii subsp. dorsiventralis	Restricted distribution – Lake Macquarie and northern Yengo NP to Mountain Lagoon Occurs in Yengo and Wollemi NPs.	–	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.
Eucalyptus fracta	Restricted distribution – sandstone ranges between the Hunter Valley and northern Yengo NP. Occurs in Yengo NP.	BC – V	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.
Eucalyptus hypostomatica	Localised distribution – the lower Hunter Valley to Kangaroo Valley. Occurs in Blue Mountains, Nattai, Yengo and Wollemi NPs.	–	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.
Eucalyptus ligustrina	Disjunct populations on sandy soils between the Gibraltar Range and Deua NP.	–	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.

Species	Distribution[1]	Conservation status	Potential impact of Project
	Occurs in Blue Mountains and Gardens of Stone NPs.		
Eucalyptus michaeliana	Highly disjunct distribution – Broke to St Albans, Enmore to Wollomombi and in Queensland. Occurs in Yengo NP.	–	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.
Eucalyptus moorei	Disjunct occurrences on sandy soils in the Gibraltar Range, Blue Mountains and the Budawang Range. Occurs in Blue Mountains and Kanangra-Boyd NPs.	–	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.
Eucalyptus muelleriana	Widespread along the coast and escarpment from Bindook Highlands to Victoria. It reaches its northern limit in the GBMWHA. Occurs in Blue Mountains NP.	–	Component of *Burragorang Valley and Gorges* Mitchell landscape. However, this species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.
Eucalyptus prominula	Restricted distribution – skeletal soils from the Watagans to Colo Heights. Occurs in Yengo and Wollemi NPs.	–	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.
Eucalyptus quadrangulata	Disjunct occurrences along the escarpment – Bundanoon to the Bindook Highlands, Barrington Tops to Dorrigo. Occurs in Blue Mountains and Kanangra-Boyd NPs.	–	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.
Eucalyptus ralla	Restricted distribution – sandstone soils from Lake Burragorang to Yalwal Plateau. Occurs in Blue Mountains NP.	–	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.
Eucalyptus squamosa	On sandstone from Cessnock to near Picton. Uncommon in the GBMWHA	–	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.

Species	Distribution[1]	Conservation status	Potential impact of Project
	because it mainly occurs on plateaus nearer the coast. Occurs in Yengo and Wollemi NPs.		
Eucalyptus stellulata	Widespread on cold flats at higher altitudes from the McPherson Range to Victoria. Sufficiently cold conditions are rare in the GBMWHA. Occurs in Blue Mountains and Kanangra-Boyd NPs.	–	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.
Eucalyptus expressa ms. (also known as Eucalyptus sp. aff. eugenioides) (Bees Nest Ridge)	Potential additional species. Restricted distribution – sheltered gullies in northern Wollemi and Yengo. Occurs in Yengo and Wollemi NPs.	–	Species does not occur within PCTs identified in the Project study area therefore unlikely to be impacted by the Project.

1. Details as per Table 1b, column 'Why uncommon in GBMWHA', Hager and Benson (2010)

C4.3.3 Conservation-significant flora

Threatened ecological communities

The biodiversity assessment for the upstream area (Appendix F1) that three of the 18 PCTs potentially impacted by temporary inundation were assessed as conforming to two BC Act-listed TECs. The same PCTs were assessed as an EPBC Act-listed TEC.

PCT 941 (HN553) *Mountain Blue Gum - Thin-leaved Stringybark open forest on river flat alluvium in the Sydney Basin Bioregion* was identified in the study area as a component of River-Flat Eucalypt Forest on Coastal Floodplains, which is listed as an endangered ecological community(EEC) under the BC Act and as a critically endangered ecological community (CEEC) under the EPBC Act. All areas of this PCT mapped in the broader study area were also assessed as the EEC.

Within the study area, River-Flat Eucalypt Forest is distributed in two key locations: along the Kedumba River, and along the Nattai River. The estimated area of the TEC within the upstream impact area is about 107 hectares. The biodiversity assessment identified that temporary inundation could potentially result in loss of and floristic and structural change to this TEC and its values.

PCT 640 (HN527) *Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands* and PCT 1401 (HN557) *Narrow-leaved Ironbark - Forest Red Gum on rocky slopes of the lower Burragorang Gorge, Sydney Basin Bioregion* were identified within the study area as components of White Box Yellow Box Blakely's Red Gum Woodland which is listed as a CEEC under the BC Act.

These two PCTs have also been identified within the study area as components of White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland, listed as a CEEC under the EPBC Act.

Within the study area, the majority of White Box Yellow Box Blakely's Red Gum Woodland is distributed upstream from Higgins Bay, immediately surrounding Lake Burragorang and along the Wollondilly River. The area of these TECs within the upstream impact area is about 431 hectares. The biodiversity assessment identified that temporary inundation could potentially result in loss of, and floristic and structural change to the TEC and its values.

As part of the supplementary biodiversity assessment presented in the PIR, a desktop analysis of vegetation condition was carried out using survey plots in the upstream study area. This examined vegetation condition for a eucalypt woodland community and a riparian vegetation community, respectively:

- PCT 840 (HN527) *Forest Red Gum-Yellow Box woodland of dry gorge slopes, southern Sydney Basin Bioregion and South Eastern Highlands Bioregion*
- PCT 1105 (HN574) *River Oak open forest of major streams, Sydney Basin Bioregion and South East Corner Bioregion.*

All survey plots used in the analysis were classed as Moderate/good condition.

The analysis benchmarked the number of native species against the Sydney Basin IBRA Region and the South Eastern Highlands IBRA Region. The analysis distinguished between survey plots within the area of existing impact (from the existing dam) and above this area (which would be affected by the Project).

The results for the eucalypt woodland community are shown in Figures C1 to C4 inclusive. These show that vegetation in the area of existing impact is broadly consistent with the community condition benchmarks suggesting that this community has a degree of resilience to temporary inundation. A similar, but more pronounced pattern was observed for the riparian vegetation community suggesting a stronger degree of resilience to temporary inundation (which would not be unexpected).

Figure C1 Native species

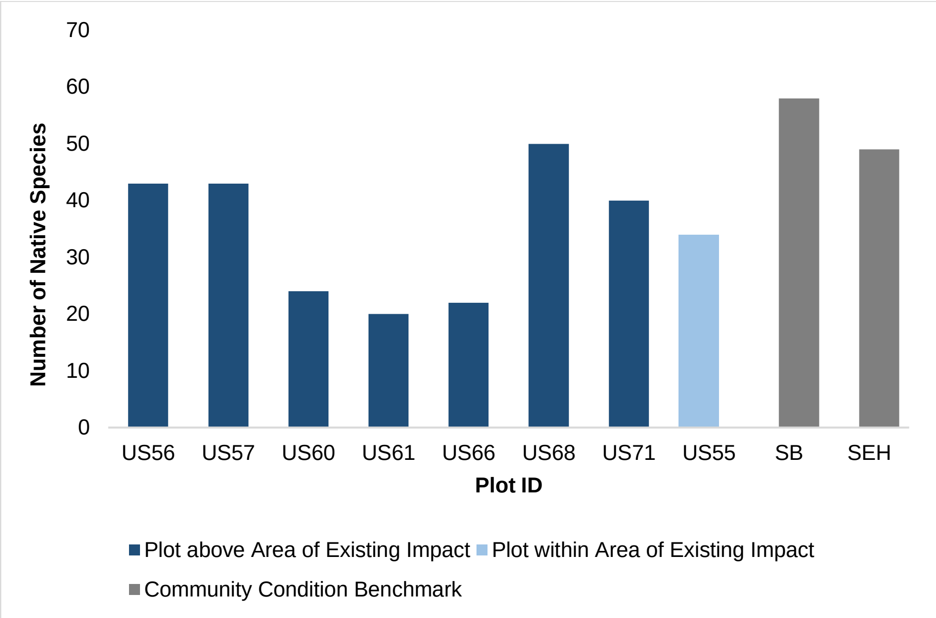


Figure C2 Native ground cover – grasses

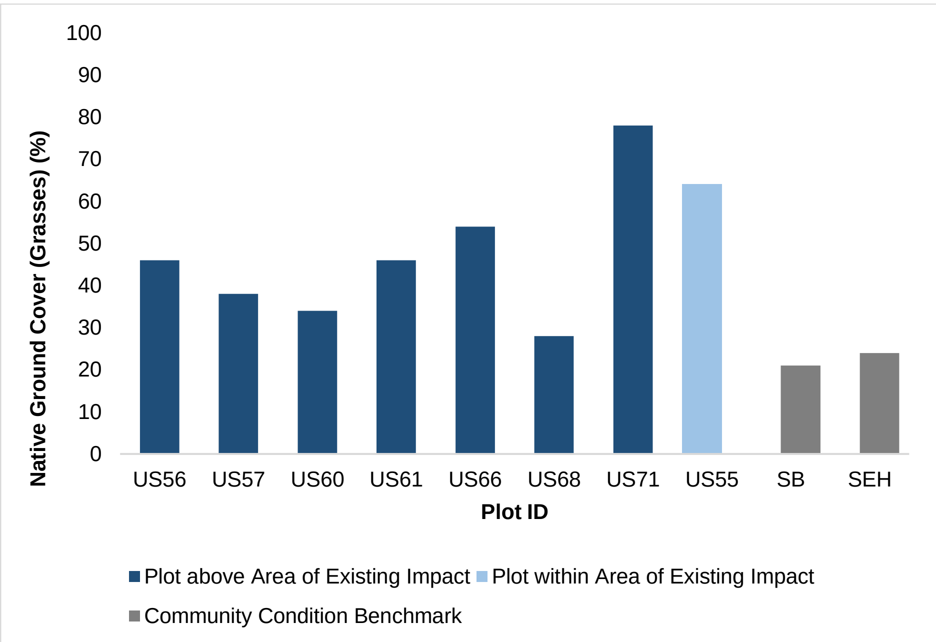


Figure C3 Native ground cover – shrubs

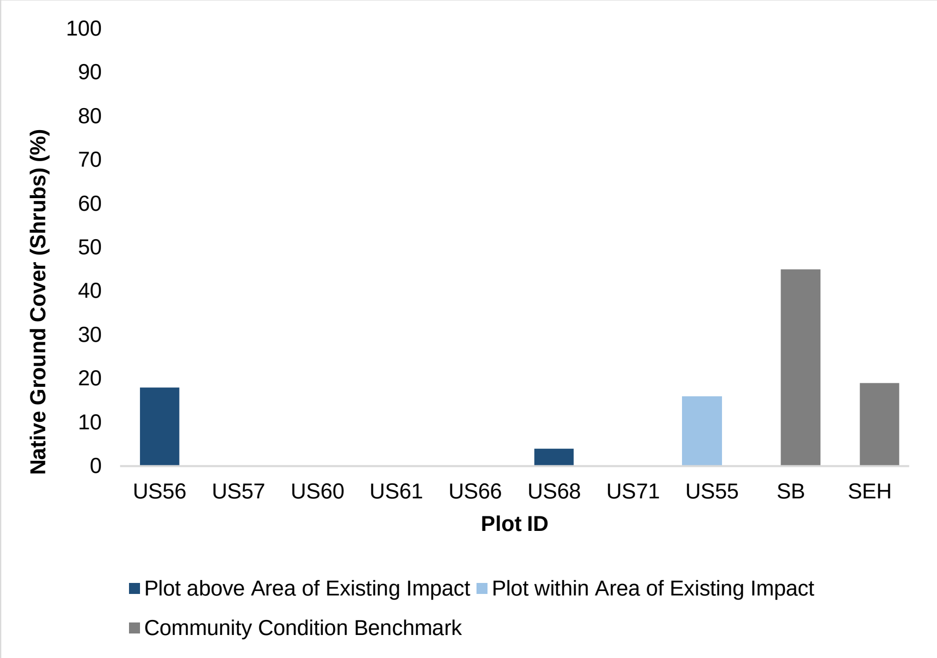
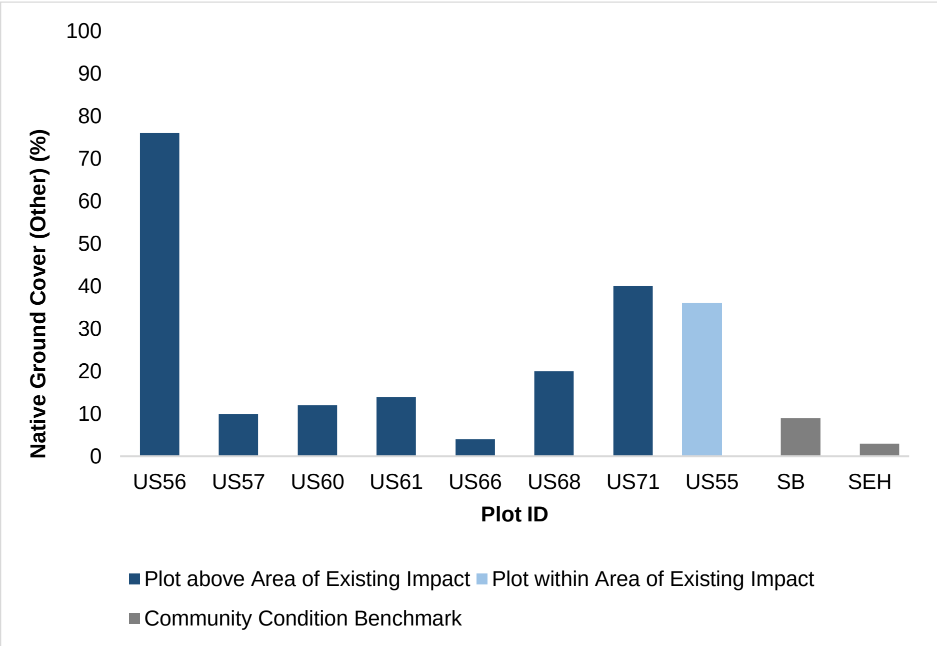


Figure C4 Native ground cover – other



Threatened flora

Table C4 provides comment with regard to potential impacts on threatened flora potentially impacted by the Project. This is based on Table 7-2 in Appendix F1 *Biodiversity Assessment Report – Upstream* incorporating information from additional investigations carried out during preparation of this report and the PIR.

Table C4 Threatened flora potentially impacted by the Project

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
Acacia baueri subsp. aspera	–	V	–	New or additional temporary inundation from the Project may adversely impact this species.
Acacia bynoeana	Bynoe's Wattle	E	V	New or additional temporary inundation from the Project may adversely impact this species.
Acacia clunies-rossiae	Kanangra Wattle	V	–	During surveys for the EIS, this species was recorded upstream of Green Wattle Creek, around the shores of Lake Burragorang and along the main tributaries, including Kedumba, Cox, and Kowmung Rivers. Suitable habitat for the species is found along the western shores of Lake Burragorang from the Wollondilly River to Coxs River. New or additional temporary inundation from the Project may adversely impact this species.
Acacia flocktoniae	Flockton Wattle	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Acacia gordonii	–	E	E	New or additional temporary inundation from the Project may adversely impact this species.
Acacia pubescens	Downy Wattle	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Acrophyllum australe	–	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Ancistrachne maidenii	–	V	–	New or additional temporary inundation from the Project may adversely impact this species.
Asterolasia buxifolia	–	E	–	New or additional temporary inundation from the Project may adversely impact this species.
Asterolasia elegans	–	E	E	New or additional temporary inundation from the Project may adversely impact this species.

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
Astrotricha crassifolia	Thick-leaf Star-hair	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Baloskion longipes	Dense Cord-rush	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Bossiaea oligosperma	Few-seeded Bossiaea	V	V	During surveys for the EIS, this species was recorded upstream of Murphys Crossing on the Wollondilly River, around the shores of Lake Burragorang to around Higgins Bay. New or additional temporary inundation from the Project may adversely impact this species..
Caesia parviflora var. minor	Small Pale Grass-lily	E	–	New or additional temporary inundation from the Project may adversely impact this species.
Callistemon linearifolius	Netted Bottle Brush	V	–	During the current assessment, the species was recorded in three locations: Little River, Tonalli Cove, and along Green Wattle Creek. New or additional temporary inundation from the Project may adversely impact this species.
Callistemon megalongensis	Megalong Valley Bottlebrush	CE	CE	New or additional temporary inundation from the Project may adversely impact this species.
Calomnion complanatum	–	E	–	New or additional temporary inundation from the Project may adversely impact this species.
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Cynanchum elegans	White-flowered Wax Plant	E	E	None – there is no suitable habitat for this species within the upstream study area.
Darwinia biflora	–	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Darwinia peduncularis	–	V	–	New or additional temporary inundation from the Project may adversely impact this species.

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
Dillwynia tenuifolia	–	V	–	New or additional temporary inundation from the Project may adversely impact this species.
Epacris hamiltonii	–	E	E	New or additional temporary inundation from the Project may adversely impact this species.
Epacris purpurascens subsp. purpurascens	–	V	–	New or additional temporary inundation from the Project may adversely impact this species.
Epacris sparsa	Sparse Heath	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Eucalyptus benthamii	Camden White Gum	V	V	The NSW threatened species profile for the Camden White Gum notes there is a major subpopulation in the Kedumba Valley of the Blue Mountains NP. This occurs primarily along the margins of the Kedumba River and was recorded within the riparian area of the Kedumba River during surveys for the EIS. Stands of 18 year-old *Eucalyptus benthamii* appear to be able to tolerate temporary inundation for up to 6 weeks to a depth of approximately 30 cm (Bush and England (2019). This suggests that the species has some tolerance to temporary inundation, which may be expected given its association with forested wetlands. However, impacts to the species due to temporary inundation to greater depths, are less clear. The maximum changes in temporary inundation for the Kedumba River area will be in the order of an additional 0.5 m depth and about 0.7 days duration for the 1 in 100 chance in a year flood event and less than 0.5 m and 0.5 days for more frequent events. The Project is therefore unlikely to impact this subpopulation. Areas of this species occurring along other tributaries would experience similar maximum incremental increases of up to half a day and half a metre of temporary inundation.
Eucalyptus glaucina	Slaty Red Gum	V	V	During surveys for the EIS, this species was recorded across much of the upstream study area, around the shores of Lake

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
				Burragorang and along the main tributaries, including Wollondilly, Nattai, Kedumba, Cox, and Kowmung Rivers. The species may possess some adaptions to flood stress including temporary water logging, however, the Project may still adversely impact this species.
Eucalyptus pulverulenta	Silver-leafed Gum	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Euphrasia bowdeniae	–	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Genoplesium baueri	Bauer's Midge Orchid	E	E	New or additional temporary inundation from the Project may adversely impact this species.
Genoplesium superbum	Superb Midge Orchid	E	–	New or additional temporary inundation from the Project may adversely impact this species.
Grammitis stenophylla	Narrow-leaf Finger Fern	E	–	During surveys for the EIS, the species was found along West Warragamba Wall, and along Werriberri Creek. New or additional temporary inundation from the Project may adversely impact this species.
Grevillea evansiana	Evans Grevillea	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Gyrostemon thesioides	–	E	–	New or additional temporary inundation from the Project may adversely impact this species.
Hakea dohertyi	Kowmung Hakea	E	E	During surveys for the EIS, this species was recorded in one location (Tonalli Cove). New or additional temporary inundation from the Project may adversely impact this species.
Haloragodendron lucasii	Hal	V	V	New or additional temporary inundation from the Project may adversely impact this species.

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
Hibbertia puberula	–	E	–	New or additional temporary inundation from the Project may adversely impact this species.
Hygrocybe anomala subsp. ianthinomarginata	–	V	–	New or additional temporary inundation from the Project may adversely impact this species.
Hygrocybe aurantipes	–	V	–	New or additional temporary inundation from the Project may adversely impact this species.
Hygrocybe reesiae	–	V	–	New or additional temporary inundation from the Project may adversely impact this species.
Isopogon fletcheri	Fletcher's Drumsticks	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Kunzea rupestris	–	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Lastreopsis hispida	Bristly Shield Fern	E	–	New or additional temporary inundation from the Project may adversely impact this species.
Leionema lachnaeoides	–	E	E	New or additional temporary inundation from the Project may adversely impact this species.
Lepidosperma evansianum	Evans Sedge	V	E	New or additional temporary inundation from the Project may adversely impact this species.
Leucopogon exolasius	Woronora Beard-heath	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Leucopogon fletcheri subsp. fletcheri	–	E	–	New or additional temporary inundation from the Project may adversely impact this species.
Melaleuca deanei	Deane's Paperbark	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Melaleuca groveana	Grove's Paperbark	V	–	New or additional temporary inundation from the Project may adversely impact this species.

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
Micromyrtus blakelyi	–	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Olearia cordata	–	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Persicaria elatior	Tall Knotweed	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Persoonia acerosa	Needle Geebung	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Persoonia bargoensis	Bargo Geebung	E	V	New or additional temporary inundation from the Project may adversely impact this species.
Persoonia glaucescens	Mittagong Geebung	E	V	New or additional temporary inundation from the Project may adversely impact this species.
Persoonia hirsuta	Hairy Geebung	E	E	New or additional temporary inundation from the Project may adversely impact this species.
Pherosphaera fitzgeraldii	Dwarf Mountain Pine	E	E	New or additional temporary inundation from the Project may adversely impact this species.
Phyllota humifusa	Dwarf Phyllota	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Pimelea curviflora var. curviflora	–	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Pomaderris brunnea	Brown Pomaderris	E	V	During surveys for the EIS, the species was recorded along the Nattai River, at Tonalli Cove, Higgins Bay, and around Butchers Creek. The local population may have increased as a result of existing temporary inundation. New or additional temporary inundation from the Project may adversely impact this species.
Pterostylis saxicola	Sydney Plains Greenhood	E	E	New or additional temporary inundation from the Project may adversely impact this species.

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
Pultenaea glabra	Smooth Bush-pea	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Pultenaea parviflora	–	E	V	New or additional temporary inundation from the Project may adversely impact this species.
Pultenaea sp. Olinda	–	E	–	New or additional temporary inundation from the Project may adversely impact this species.
Pultenaea villifera – endangered population	*Pultenaea villifera* population in the Blue Mountains Local Government Area	EP	–	None – there is no suitable habitat for this endangered population within the upstream study area.
Rhizanthella slateri	Eastern Australian Underground Orchid	V	E	New or additional temporary inundation from the Project may adversely impact this species.
Rhodamnia rubescens	Scrub Turpentine	CE	–	New or additional temporary inundation from the Project may adversely impact this species.
Solanum amourense	–	E	–	During surveys for the EIS, this species was recorded upstream of Murphys Crossing on the Wollondilly River, around the shores of Lake Burragorang. New or additional temporary inundation from the Project may adversely impact this species.
Tetratheca glandulosa	–	V	–	New or additional temporary inundation from the Project may adversely impact this species.
Trachymene scapigera	Mountain Trachymene	E	E	New or additional temporary inundation from the Project may adversely impact this species.
Velleia perfoliata	–	V	V	New or additional temporary inundation from the Project may adversely impact this species.
Xanthosia scopulicola	–	V	–	New or additional temporary inundation from the Project may adversely impact this species.

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
Zieria covenyi	Coveny's Zieria	E	E	New or additional temporary inundation from the Project may adversely impact this species.
Zieria involucrata	–	E	V	New or additional temporary inundation from the Project may adversely impact this species.
Zieria murphyi	Velvet Zieria	V	V	New or additional temporary inundation from the Project may adversely impact this species.

C4.3.4 Conservation-significant fauna

Table C5 provides comment with regard to potential impacts on threatened fauna potentially impacted by the Project. This is based on Table 7-3 in Appendix F1 *Biodiversity Assessment Report – Upstream* incorporating information from additional investigations carried out during preparation of this report and the PIR.

Table C5 Threatened fauna potentially impacted by the Project

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
Anthochaera phrygia	Regent Honeyeater	CE	CE	During the surveys for the EIS a large breeding population of Regent Honeyeaters was recorded around Tonalli Cove. Impacts from temporary inundation may include loss of structural components of the vegetation (for example, *Amyema pendula* and *Amyema cambagei*) within areas of suitable breeding habitat, mortality of nestlings should a flood occur during a breeding event, and potential loss of suitable foraging habitat, specifically feed tree species such as *Eucalyptus melliodora, Eucalyptus albens, and Eucalyptus eugenioides*. However, it is noted that these three eucalypt species are relatively widespread across the GBMWHA (Hager and Benson 2010).
Cercartetus nanus	Eastern Pygmy-possum	V	–	Species was not recorded during surveys for the EIS but was assumed to be present. Modification of habitat within the upstream study area may reduce the availability of foraging resources and breeding sites. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during a flood event, and loss of suitable foraging habitat.
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	During surveys for the EIS, this species was recorded across much of the upstream study area around the shores of Lake Burragorang, along the main tributaries, including Wollondilly, Nattai, Kedumba, Cox, and Kowmung Rivers, and at Warragamba Dam. Temporary inundation may modify the structure and composition of suitable foraging habitat. It is expected that limited roosting and breeding habitat occurs within the upstream study area, however, the surveys for the EIS did not specifically target this type of habitat. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during a flood event, and loss of suitable foraging habitat.
Heleioporus australiacus	Giant Burrowing Frog	V	V	Species was not recorded during surveys for the EIS but was assumed to be present.

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
				Modification of habitat within the upstream study area may reduce the availability of foraging resources and breeding sites. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during a flood event, and loss of suitable foraging habitat.
Hoplocephalus bungaroides	Broad-headed Snake	E	V	Species was not recorded during surveys for the EIS but was assumed to be present. Low quality habitat for this species may be impacted. The affected habitat is confined to the lower reaches of Lake Burragorang and consists of small ledges with few exfoliated rocks and is moderately to well shaded. The most important areas of habitat in the upstream study area occur along the top edges of the sandstone escarpments, where there are more extensive areas of rock shelf and little shading. These areas are well above the proposed temporary inundation area. Impacts may include loss of habitat components such as exfoliated rocks and hollows, and potential mortality during flood events.
Isoodon obesulus subsp. *obesulus*	Southern Brown Bandicoot (eastern)	E	E	Species was not recorded during surveys for the EIS but was assumed to be present. Modification of habitat within the upstream study area may reduce the availability of foraging resources and breeding sites for this species. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat.
Ixobrychus flavicollis	Black Bittern	V	–	Species was not recorded during surveys for the EIS but was assumed to be present. Modification of habitat within the upstream study area may reduce the availability of roosting and sheltering sites for this species. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat.

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
Litoria littlejohni	Littlejohn's Tree Frog	V	V	Species was not recorded during surveys for the EIS but was assumed to be present. Modification of habitat within the upstream study area may reduce the availability of foraging resources and breeding sites. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat.
Macropus parma	Parma Wallaby	V	–	Species was not recorded during surveys for the EIS but was assumed to be present. Modification of habitat within the upstream study area may reduce the availability of foraging resources and shelter sites. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat.
Myotis macropus	Southern Myotis	V	–	Temporary inundation may modify the structure and composition of suitable foraging habitat for this species within the study area. Most of the habitat potentially impacted comprises suitable foraging habitat. It is expected that some roosting and breeding habitat occurs within the upstream study area, however, the surveys for the EIS did not specifically target this type of habitat. Impacts may include loss of large areas of the structural components of the vegetation within areas of suitable foraging habitat, loss of suitable breeding and roosting habitat, and potential mortality of individuals during flood events.
Petaurus norfolcensis	Squirrel Glider	V	–	Species was not recorded during surveys for the EIS but was assumed to be present. Modification of habitat within the upstream study area may reduce the availability of foraging resources and nesting sites. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat.
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Species was not recorded during surveys for the EIS but was assumed to be present.

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
				Modification of habitat within the upstream study area may reduce the availability of foraging resources and shelter sites. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat.
Phascogale tapoatafa	Brush-tailed Phascogale	V	–	Species was not recorded during surveys for the EIS but was assumed to be present. Modification of habitat within the upstream study area may reduce the availability of foraging resources and nesting sites. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat.
Phascolarctos cinereus	Koala	V	V	Species was not recorded during surveys for the EIS but was assumed to be present. Modification of habitat within the upstream study area may impact on koalas due to the potential reduction in the availability of foraging resources. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat- specifically suitable feed tree species.
Pseudophryne australis	Red-crowned Toadlet	V	–	Species recorded during EIS surveys, calling from East Warragamba Wall and West Warragamba Wall. Modification of habitat within the upstream study area may reduce the availability of foraging resources and breeding sites. Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat.
Varanus rosenbergi	Rosenberg's Goanna	V	–	Species was recorded during EIS surveys near the confluence of the Coxs and Kedumba Rivers. Modification of habitat within the upstream study area may reduce the availability of breeding sites for this species.

Species name	Common name	BC Act status	EPBC Act status	Description of potential impacts to species
				Impacts may include loss of structural components of the vegetation within areas of suitable breeding habitat, potential mortality of individuals during flood events, and loss of suitable foraging habitat.

C4.3.5 Water systems

General

The Project would provide for the temporary retention of inflows to Lake Burragorang up to about 1,000 GL in the FMZ. During operation of the FMZ, the water level in Lake Burragorang would increase above FSL. This would also extend up the tributaries that drain to the lake. As noted previously, this pattern of temporary inundation associated with the existing dam already exists and extends into the GBMWHA.

Floodwaters would be retained for a maximum period of 14 days; it is highly unlikely that this would result in permanent changes to upstream surface and groundwater hydrology.

Groundwater

Consideration of potential impacts on groundwater upstream of Warragamba Dam is presented in the expert technical review provided as Appendix E to the Submissions Report. Section 4.2.1 of the technical review provides a description of the existing hydrogeological environment for the Warragamba Dam/Lake Burragorang locality, noting that the Hawkesbury Sandstone geologic unit hosts a major regional aquifer in the area surrounding Lake Burragorang.

Groundwater within the sandstone aquifer is recharged by rainfall across the sandstone outcrop of the lower Blue Mountains west of the Lapstone Structural Complex (LSC) and losses from Lake Burragorang. The groundwater flow direction is consistently west to east from Lake Burragorang, with groundwater flow across the LSC.

An analysis of groundwater levels from a test bore (W7A, located about 1.9 kilometres to the south of Warragamba Dam) for the period mid-2008 to mid-2012 indicated:

- Dam water levels are always higher than sandstone water levels, which confirms that the dam is losing water to the regional sandstone aquifer
- The sandstone water levels do not respond to individual rainfall events and sudden dam level rises; there were two sharp rises in dam storage level (i.e. increases between 4–6 metres) in February and December 2010, with no corresponding sharp increase in groundwater level
- Groundwater levels respond slowly to longer periods of rainfall and increasing dam storage levels with the first noticeable, and very slight, rise in groundwater levels in early 2010
- The groundwater level in August 2010 was 99 mbgl (91.5 mAHD) and by August 2012 had risen slowly to 97.6 mbgl (92.9 mAHD) – a very small increase of 1.4 metres. The data confirms lagged and only very slight increases in groundwater levels as the dam fills to FSL.

Work carried out by Parsons Brinckerhoff in 2008 and 2009 completed environmental and radioisotope studies on groundwater samples from Warragamba to Wallacia. This found that groundwater within the Hawkesbury Sandstone aquifer was derived from rainfall with a corrected age of 4,800 years before present (BP) at Warragamba and up to 30,600 years BP at Wallacia. Groundwater ages are significantly older within the LSC and along the groundwater flowpath from west to east. This age data confirms low permeability for the sandstone aquifer and slow natural migration.

Historically there have been no large rises in groundwater levels following sharp increases in dam storage as observed at WaterNSW monitoring bores located close to the dam. Terrestrial vegetation around Lake Burragorang is unlikely to be relying on groundwater in sandstone aquifers due to deep groundwater levels (i.e. typically greater than 50 mbgl) and therefore vegetation fringing the lake is highly unlikely to be groundwater-dependent.

Groundwater levels in the Hawkesbury Sandstone system fluctuate naturally during high and low rainfall periods, and the anticipated changes due to the Project are expected to be within these natural ranges.

Wild rivers

The declared wild river sections for the Grose River and Colo River are located outside of the Project study area and would not be affected by the Project. A small section (about 1,300 metres) of the declared wild river section of the Kowmung River is located in the upstream Project study area. An analysis of depth-duration curves for the closest cross section downstream of the declared wild river catchment showed no material difference between the existing situation and with the Project for all flood events up to the 1 in 100 chance in a year event and a very small difference (less than 0.3 metres) up to the 1 in 1,000 chance in a year event. In real world terms, the Project would not have a material impact on the declared wild river section of the Kowmung River.

C4.3.6 Geodiversity

The World Heritage nomination report for the Greater Blue Mountains Area (NPWS and Environment Australia 1998) notes that the relief of the area with recognisable features such as steeply dissected plateaus, precipitous cliffs, waterfalls, broad gorges and dark, narrow canyons contribute to its distinctive character.

The Project would provide for the temporary retention of inflows to Lake Burragorang up to about 1,000 GL in the FMZ. Floodwaters would be retained for a maximum period of 14 days. During operation of the FMZ, the water level in Lake Burragorang would increase. This would also extend up the tributaries that drain to the lake. As noted previously, this risk of temporary inundation associated with the existing dam already exists and extends into the GBMWHA.

The EIS includes an assessment of potential impacts of the Project on upstream geomorphology which takes in part of the GBMWHA. This considered out-of-bank erosion, translocation of sediment features upstream, and in-channel sediment deposition upstream of Lake Burragorang (discussed in Section 5.1 of Appendix N2). The assessment also considered potential impacts in the area immediately adjacent to Lake Burragorang with regard to out-of-shoreline erosion, elevated erosion of shoreline banks, deposition of sediment on sensitive receptors during inundation events, and changes to circulation patterns causing redistribution of sediments(discussed in Section 5.2 of Appendix N2).

The geomorphology assessment identified the potential for some localised changes to geomorphological process in the upstream study area associated with watercourses and with the margins of Lake Burragorang. The area of the GBMWHA along the eastern side of the arm of Lake Burragorang running up to the Wollondilly River may be subject to these changed geomorphological process, however, given these would be localised and considering the small scale relative, any such changes are not regarded as significant. As such, the Project is considered unlikely to have any material effect on geological and geomorphological processes that affect the geo-diversity of the GBMWHA, and accordingly would not result in a material diminishment of this component of the OUV.

C4.3.7 Boundary integrity

Holland *et al*. (2021, p72)note that

> *Boundary integrity refers to the characteristics of the boundary that protect the natural significance values in the GBMA. The integrity of protected areas in the Greater Blue Mountains could be threatened by developments in areas adjacent to reserves. Impacts may be caused by inadequate environmental protection measures during construction, such as clearing of native vegetation on erodible sandstone soils and poorly designed sedimentation controls. In addition, vegetation communities in the Blue Mountains are adapted to the very infertile, skeletal soils derived from Hawkesbury and Narrabeen Sandstones, which make them susceptible to potentially nutrient rich run-off from adjacent land.*

The GBMWHA was listed without a formal buffer zone, yet an essential part of the conservation strategy of World Heritage properties is the protection of the surroundings of inscribed properties (DAWE 2022). The World Heritage listing[53] notes the GBMWHA has a buffer area of 86,200 hectares.

WaterNSW, jointly with NPWS, proactively manages water quality in the upstream catchment area through the special areas and controlled areas provisions in the *Water NSW Act 2014* and the Water NSW Regulation 2020. The area around Lake Burragorang sits within the *Special Areas – No Entry* special area. This extends over parts of the GBMWHA and adjacent buffer areas such as along the Wollondilly River, Kedumba River and the Coxs River.

These legislative arrangements would not change with the Project. As such, it is considered the Project would not diminish this component of the OUV of the GBMWHA.

C4.3.8 Indigenous custodial relationships

The Aboriginal cultural heritage assessment for the EIS identified the potential for the Project to affect cultural heritage values. Additional assessment carried out for the Submissions Report and PIR has provided further clarification on the nature of potential impacts of the Project.

The EIS identified the potential for diminishment of Aboriginal cultural heritage values through an increased risk of temporary inundation of identified and potential archaeological sites from the Project. The additional assessment for the Submissions Report and PIR does not change this conclusion.

The revised offset strategy (refer Section C6) provides for the funding of on-park management for the protected lands values offset. This would support maintenance and potential enhancement of Aboriginal cultural heritage values. This would also be consistent with Article 16 of the Burra Charter.

C4.3.9 Indirect impacts

Section 527E of the EPBC Act provides that an impact may also be due to indirect consequences of an action. The EPBC Act Policy Statement *'Indirect consequences' of an action: Section 527E of the EPBC Act*[54] notes that

> *The Significant Impact Guidelines Policy Statement 1.1) set out that the 'indirect consequences' of an action may include:*

[53] https://whc.unesco.org/en/list/917

[54] https://www.dcceew.gov.au/sites/default/files/documents/epbc-act-policy-indirect-consequences.pdf

(a) off-site impacts including, but not limited to:

(i) downstream impacts (such as impacts on wetlands from chemicals discharged into upstream river systems); or

(ii) upstream impacts (such as the extraction of raw materials which are used to undertake the action), and

(b) actions taken by third parties, where the third party action is facilitated to a major extent by the primary action and the impacts of the third party action were reasonably foreseeable (as set out in sub-section 527E(2) of the EPBC Act).

The Project involves the raising of Warragamba Dam to provide airspace to temporarily retain inflows and to release them in such a way as to reduce downstream flood levels. This will result in the pattern of upstream flooding changing with regard to:

- The lateral extent of temporary inundation
- The depth and duration of temporary inundation
- The frequency of flood events causing temporary inundation.

The indirect consequences of these changes include:

- Potential changes to vegetation in areas affected by temporary inundation, including threatened ecological communities, threatened flora and habitat for threatened fauna, and potential consequential effects
- Potential diminishment of scientific and cultural heritage values of Aboriginal heritage sites in areas affected by temporary inundation
- Potential diminishment of World Heritage and National Heritage values in areas affected by temporary inundation.

These have been considered in the environmental assessment for the Project which is therefore considered to accord with section 527E of the EPBC Act.

C4.3.10 Summary

Table C6 summarises the potential of the Project to diminish the OUV of the GBMWHA with regard to the individual components of the OUV, and also noting that these are already potentially affected by the existing dam.

Table C6 Summary of potential diminishment of OUV components due to the Project

Component	Comment
Natural heritage values	
Gondwanan flora	Low potential for diminishment of OUV
Scleromorphic flora	Some potential for diminishment of OUV but not considered to be significant risk
Conservation-significant flora	Some potential for diminishment of OUV but not considered to be significant risk
Conservation-significant fauna	Some potential for diminishment of OUV but not considered to be significant risk
Integrity	
Water systems	Negligible potential for diminishment of OUV
Geodiversity	Negligible potential for diminishment of OUV
Boundary integrity	Negligible potential for diminishment of OUV
Indigenous custodial relationships	Some potential for diminishment of OUV based on potential impacts of temporary inundation on individual sites (as acknowledged in the EIS) but this would be offset through facilitation of proactive management measures to maintain and enhance Aboriginal cultural heritage values.

Table C7 Assessment of potential impacts of the Project against MNES World Heritage significant impact criteria

Criterion	Assessment
An action is likely to have a significant impact on the World Heritage values of a declared World Heritage property if there is a real chance or possibility that it will cause:	
One or more of the World Heritage values to be lost	The Project would not result in the loss of one or more World Heritage values. The Project only impacts a small area of the GBMWHA and the considerable diversity of eucalypts, flora and fauna would remain in other areas not impacted by the Project. While there is potential for an incremental impact on Aboriginal cultural heritage in the GBMWHA, this would be a diminution (as acknowledged below) rather than a loss of value.
One or more of the World Heritage values to be degraded or damaged	The upstream biodiversity assessment identified the potential for the loss of biodiversity values but noted uncertainty around the specific nature and degree of impacts. Additional investigations carried out during preparation of the Submissions Report and PIR suggest that the assessed significance of potential impacts on vegetation may have been conservative and that vegetation may have a greater resilience to temporary inundation than previously concluded. The revised offset strategy (refer Section C6) and the other mitigation measures detailed in EIS Chapter 29 (EIS synthesis, Project justification and conclusion) would ensure that any degradation or damage to World Heritage values is offset and the overall values of the GBMWHA are maintained in the longer term.

Criterion	Assessment
One or more of the World Heritage values to be notably altered, modified, obscured or diminished	The Project could potentially diminish one or more of the World Heritage values, however, the risk of this is considered low, and noting that there is already an existing risk associated with the current dam. The revised offset strategy provides for funding of on-park management for the protected lands values offset addressing maintenance and potential enhancement of World Heritage values. The Part 5A EMP would similarly facilitate maintenance and potential enhancement of World Heritage values.

C4.4 Cumulative impacts related to bushfire events

The potential for the Project to exacerbate bushfire impacts is considered to be low. The scenario of a flood event causing temporary inundation in the upstream area following a major bushfire event is an existing risk, noting that the 2019-2020 bushfire event was followed by a significant flood event in March 2021 where the water level in Lake Burragorang reached 1.16 metres above FSL.

The nature of how this potential cumulative impact may be manifested will be dependent on numerous dynamic factors that vary over time including any preceding landscape disturbance events (bushfire, major flood).

C4.5 Assessment of the Project against World Heritage Committee Decision 44 COM 7B.180

Relevant matters in Decision 44 COM 7B.180 adopted by the World Heritage Committee at its extended 44th Session in 2021 are listed in full in the following table together with comment as to how each matter relates to the Project.

Table C8 Consideration of relevant matters in Decision 44 COM 7B.180

Matter	Comment
3. Expresses its utmost concern about the unprecedented fires that affected large parts of the property and significantly impacted some areas and habitats, and commends the State Party for its immediate fire-fighting responses, including those targeting specific attributes of the Outstanding Universal Value (OUV) of the property, such as the Wollemi Pine stands	This is considered a separate matter to the Project, but noting that the environmental assessment, and work done subsequent to the public exhibition of the EIS will contribute to improved understanding of attributes of the OUV of the GBMWHA.
4. Welcomes the information provided by the State Party regarding the immediate management responses to the 2019-2020 bushfires, including the assessment of direct and indirect impacts, plans for longer-term actions and the consideration of funding commitments to ensure long-term recovery, and requests the State Party to submit to the World Heritage Centre, for review by IUCN, an update on the process of assessing the impacts of fires on the OUV of the property and its recovery prospects, as soon as this significant information has been collated;	Please refer to previous comment.
5. Takes note of the information provided by the State Party regarding the ongoing preparation of the Environmental Impact Statement (EIS) for the project proposal to raise	Further consideration of potential impacts of the Project on the OUV of the GBMWHA is provided in Section C4.3.

Matter		Comment
	the Warragamba Dam wall, reiterates its request to the State Party to ensure, in line with its commitments, that the current process to prepare the EIS fully assesses all potential impacts on the OUV of the property and its other values, including Aboriginal cultural heritage, and also requests the State Party to thoroughly assess whether raising the wall could exacerbate bushfire impacts on the property and affect the medium- and longer-term recovery prospects of key species and habitats within the predicted temporary inundation areas, and to submit the EIS to the World Heritage Centre, for review by IUCN, prior to its final approval;	Consideration of the potential for the Project to exacerbate bushfire risk is provided in Section C4.4. As noted, the likelihood of this is considered low and the revised offset strategy (refer Section C6) would support the proactive management of this risk.
6.	Notes the initiation of an assessment of the cumulative impacts of existing and planned mining projects in the vicinity of the property, including a specific assessment of all stressors that present a risk to the property's OUV, and the confirmation regarding the development of the airspace and flight path design for the Western Sydney Airport and its subsequent environmental assessment, and further requests the State Party to submit the results of these processes to the World Heritage Centre, for review by IUCN, as soon as they become available	This is considered a separate matter to the Project.
7.	Also welcomes the continued development of a revised Strategic Plan for the property and the confirmation that this plan will undergo consultation with the Aboriginal communities and be subject to the necessary environmental assessment, and also reiterates its request to the State Party to ensure that potential threats to the property from activities outside its boundaries, in particular mining activities, are fully considered in the development of this management framework	Revision of the Strategic Plan is considered a separate matter to the Project. However, it is noted that the Submissions Report and PIR, together with the EIS, may assist in this process.
8.	Encourages the State Party to consult IUCN for advice on the development of the EIS planning documents prior to their finalisation, as well as on the development of longer-term bushfire recovery plans for the property's OUV	This is considered a separate matter to the Project, however, it is noted that the revised offset strategy would contribute to maintenance of the OUV attributes of the GBMWHA.
9.	Also recalling Decision 41 COM 7, adopted at its 41st session (Krakow, 2017), which reiterated the importance of States Parties undertaking the most ambitious implementation of the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC), notes with concern that climate change is recognized as an increasing threat to the property, and further welcomes the efforts of the State Party to develop an understanding of projected changes resulting from climate change in relation to the property's OUV and to strengthen climate and disaster resilience	This is considered a separate matter to the Project. However, it is noted that the revised offset strategy would support maintenance of environmental values in the upstream area from temporary inundation associated with the Project. This may also contribute to developing resilience from climate change and other significant landscape disturbance events such as bushfire.

Matter	Comment
10. Appreciates the efforts made through the Royal Commission into National Natural Disaster Arrangements to look at lessons learned, develop recommendations on how to strengthen emergency management as well as climate and natural disaster risk reduction, and to implement reforms based on experience, and also encourages the State Party to share the lessons learned with other States Parties to the Convention facing similar threats, promoting knowledge exchange on fire management strategies at natural World Heritage properties	This is considered a separate matter to the Project.
11. Requests furthermore the State Party to submit to the World Heritage Centre, by 1 December 2022, an updated report on the state of conservation of the property and the implementation of the above, for examination by the World Heritage Committee at its 46th session	This is considered a separate matter to the Project. However, it is noted that the Submissions Report and PIR would assist in this reporting process.

C5 National Heritage

Parts of Blue Mountains National Park, Nattai National Park and Yengo National Park are within the GBMWHA and are potentially impacted by the Project. Management of these protected areas is carried out under the following plans of management:

- Blue Mountains National Park Plan of Management
- Nattai Reserves Plan of Management
- Yengo National Park Plan of Management.

All three plans of management note that they have been prepared in accordance with the Convention concerning the Protection of the World Cultural and Natural Heritage and in accordance with the Convention, each park will be managed to identify, protect, conserve, present and transmit to future generations, the World Heritage values of the property.

With regard to the management of National Heritage places, the DECCWW website[55] notes

> *To ensure the on-going protection of a National Heritage place, a management plan should be prepared that sets out how the heritage values of the site will be protected or conserved.*
>
> *Plans need to be consistent with the National Heritage management principles. Where a National Heritage place is in a state or territory, the Australian Government must endeavour to ensure that a management plan is prepared and implemented in cooperation with the relevant state or territory government.*
>
> *The Minister for the Environment is responsible for preparing management plans for National Heritage places in Commonwealth areas. Plans are required to be reviewed every five years.*

and

> *The National Heritage management principles provide a guiding framework for excellence in managing heritage properties. They set the standard and the scope of the way places should be managed in order to protect heritage values for future generations.*
>
> *These principles should be used when preparing and implementing management plans and programmes. In the absence of a management plan, they should guide the management of heritage values of a property.*

Under the NPW Act, national parks are managed to:

- Conserve biodiversity, maintain ecosystem functions, protect geological and geomorphological features and natural phenomena and maintain natural landscapes
- Conserve places, objects, features and landscapes of cultural value
- Protect the ecological integrity of one or more ecosystems for present and future generations
- Promote public appreciation and understanding of the park's natural and cultural values
- Provide for sustainable visitor use and enjoyment that is compatible with conservation of natural and cultural values

55 https://www.dcceew.gov.au/parks-heritage/heritage/about/national/managing-national-heritage-places#:~:text=of%20a%20property.-,National%20Heritage%20management%20principles,generations%2C%20their%20National%20Heritage%20values.

- Provide for sustainable use (including adaptive reuse) of any buildings or structures or modified natural areas having regard to conservation of natural and cultural values
- Provide for appropriate research and monitoring.

Given that the existing plans of management have been prepared in accordance with the Convention concerning the Protection of the World Cultural and Natural Heritage, and that they explicitly address management of natural and cultural heritage values, they are considered to be consistent with National Heritage management principles.

C6 Mitigation and management of potential impacts

The offset strategy presented in the EIS comprises two main components:

- A biodiversity offset, as described in in Chapter 13 of the EIS and Appendix F6 to the EIS
- A protected lands values offset, comprising the Warragamba Offset Program, as described in Section 20.7 in Chapter 20 of the EIS.

In delivering biodiversity offsets, the protected lands values offset included purchasing or managing land to also meet species and ecosystem biodiversity credits, national parks values and World Heritage values.

The protected lands values offset, which included purchasing and managing new lands, was to target offset sites that meet both biodiversity and protected lands offset goals.

This revised offset strategy provides the details of these two components as described in the EIS together with changes to the delivery of offsets arising from submissions and further consultation with DPE and other agencies during preparation of the Submissions Report and PIR.

C6.1 Biodiversity offset

WaterNSW consulted extensively with DPE and relevant agencies to resolve how the FBA can be applied to the upstream area that would be subject to temporary inundation from the Project, particularly as the impacts would be infrequent, cumulative and difficult to measure over time.

For the purposes of completing an FBA assessment and calculation of offsets an upstream impact area has been identified where it is precautionarily assumed a 100 percent loss of biodiversity values within the area.

The calculation of impact to be offset as described in the EIS remains unchanged and is based on the assumed total loss of all biodiversity values from temporary inundation associated with operation of the FMZ within the Project Upstream Impact Area (PUIA). The EIS has described this as the area between 2.8 metres above FSL (RL 119.5 mAHD) and 10.27 metres above FSL (RL 126.97 mAHD), equating to an area of about 1,400 hectares. The rationale for this area is described in Section 3.2 of Appendix F6 *Biodiversity Offset Strategy* to the EIS. This defined area is representative of the likely inundation in a given 20year period analysed by selecting the peak inundation level for each 20-year period of modelling of around 20,000 flood events. The area is not related to any particular flood frequency which is a common misunderstanding that has been identified in submissions.

The extent of biodiversity loss in the PUIA is quantified through the Framework for Biodiversity Assessment (FBA) as described in Appendix F1 *Biodiversity Assessment Report – Upstream* (Upstream BAR) to the EIS. The Upstream BAR identifies the extent of loss of relevant species and ecosystems and the corresponding number/type of credits required to offset the impact of the Project. In response to comments made by DPE EHG, the number of credits has been updated and a revised credit report will be lodged with DPE.

As described in Section 5 of Appendix F6, the *NSW Biodiversity Offsets Policy for Major Projects* (NSW Government 2014) prescribes four types of strategies that can be used to fulfil the offset requirements:

- Purchasing credits on the open market and retiring these credits
- Offsetting through a site-secured stewardship agreement where a proponent establishes its own Biodiversity Stewardship Agreement (BSA) site(s), generates its own credits and then retires the credits
- A monetary contribution into the Biodiversity Conservation Fund through which the proponent transfers the credit liability to the Biodiversity Conservation Trust, with the amount currently calculated through the Biodiversity Offset Payment Calculator
- Supplementary measures following the rules prescribed in Appendix B to the policy.

Section 6 of Appendix F6 discusses the implementation of the biodiversity offset for the Project for both the construction and operation phases, reflecting the potential need to offset impacts through more than one strategy.

The Warragamba Offset Program approach presented in the EIS was to target the purchase of land suitable for inclusion in the National Park estate and meet both biodiversity and protected land values offset goals.

Change to offset delivery

Further to the biodiversity offset approach in Appendix F6 to the EIS, the priority approach for the delivery of biodiversity offsets to meet the retirement of biodiversity credits would broadly involve Identification and costing of a series of on-park management actions that would deliver a biodiversity benefit on-park equivalent to the biodiversity credits to be retired. The areas that would receive offset actions apply to national park lands and expanded to areas within the GBMWHA or in adjacent or proximate national park or reserve lands. Additionally:

- Management actions will be proposed for each impacted species and ecosystem, i.e. each species/ecosystem that generates a credit liability will be the subject of targeted management actions
- Management actions will be costed and a Net Present Value determined on the basis of delivery/management in perpetuity
- Management actions will be designed, based on the best available science, to deliver a biodiversity benefit on park for the relevant species/ecosystem that is at least equal to the assumed loss in the PUIA.

The following key principles will apply to this component of the offset strategy:

- Management actions will go beyond 'business as usual' in terms of park management and must be based on the best available science
- Management actions will be on the national park estate, ideally on one of the reserves impacted by or adjacent to the Project; however, where it is not possible to generate a biodiversity benefit on the national park estate, or where it relates to an impact that is outside the national park estate, then the offset would be delivered on alternative land.

The Upstream BAR assumed the presence of several threatened species for the purpose of calculating required species credits. This is likely to overstate the magnitude of potential impacts and the required number of species credits. Should the Project be approved, WaterNSW would seek to have the option to conduct further surveys prior to operation of the Project for species where presence has been assumed, and to review the credit calculations for the relevant species accordingly.

As a second-tier priority approach for delivering biodiversity offsets, land purchased for the protected lands values offset would also target offset sites that, where possible, could also meet biodiversity values to contribute to the retirement of biodiversity credits. It is noted that biodiversity values that exist on land acquired for a protected land offset and subject to 'business as usual' park management cannot be counted towards the biodiversity offset requirements as there is no additional biodiversity benefit provided. It is further noted that additional actions on such land over and above 'business as usual' and core park management, and which deliver an increase or uplift in biodiversity values may potentially be counted as a biodiversity offset.

C6.2 Protected lands values offset

As indicated in the EIS, potential impacts on protected lands values were proposed to be addressed through the Warragamba Offset Program. In addition to biodiversity, this encompassed non-biodiversity matters such as:

- Geodiversity
- Water catchment protection
- Cultural heritage
- Landscape, natural beauty and aesthetic values
- Recreation and visitor use
- Social and economic benefits derived from visitation to these areas.

The Warragamba Offset Program will prioritise land suitable for inclusion in the national park estate containing suitable biodiversity, cultural heritage, landscape and park visitor values and opportunities. Any land containing suitable offsets must also be appropriate for the national park estate. The offset would also include on-park management costs for the newly acquired lands to be included in the national parks estate.

The NSW Government's *Revocation, recategorisation and road adjustment policy*[56] states that

18. When negotiating compensation, NPWS will be guided by the following considerations:

- *the proposed revocation and associated compensation must result in an overall public good outcome having regard to all of the conservation, cultural heritage and other values of the land being revoked and the values of any land provided as compensation*
- *compensatory land should preferably be of greater size than the area of land being revoked, and must at least be of equal size*
- *it is desirable to match the area, type and quality of habitat, and cultural heritage values on land being revoked with the area of land proposed as compensation where possible. Exceptions to this may include:*
  - *compensation that includes a higher conservation priority habitat type (e.g. that is poorly reserved) where the habitat to be impacted is commonly represented within the relevant park*

56 https://www.environment.nsw.gov.au/topics/parks-reserves-and-protected-areas/park-policies/revocation-recategorisation-and-road-adjustment

- *compensation lands that have unique and particularly significant conservation values*
- *it is desirable that land to be transferred as compensation is close to the area being revoked and preferably adjacent to the affected reserve.*

It is intended that as a minimum the quantum of land required to compensate for impact on national parks (including the affected part of the GBMWHA) will be equivalent to or greater than the affected area of national parks estate in the upstream impact area (1,303 hectares) and containing equivalent or superior values noting that there is 304 hectares of GBMWHA to offset. The protected lands values offset will also provide for separate on-park management costs over a 20-year period with funding secured prior to commencement of Project construction.

With regard to prioritising land that improves or supports the OUV for the GBMWHA (and National Heritage values), this will include consideration of, as appropriate:

- Wilderness areas
- Aboriginal cultural heritage
- Plant communities identified in the OUV statement
- Threatened flora species
- Habitat of threatened fauna species
- Other biodiversity-related matters such as scleromorphic species, ant-adapted plants, diversity and characteristics of the flora as a whole, species diversity, vertebrates and invertebrates identified in the OUV statement
- Visual amenity
- Users of the GBMWHA
- Geological structure, geomorphology and water systems.

C6.3 Summary

The offset strategy is largely as proposed in the EIS except that in delivering biodiversity offsets, the priority to retire credits will involve Identification and costing of a series of on-park management actions that will deliver an on-park biodiversity benefit equivalent to the biodiversity credits to be retired. The protected lands values offset will prioritise land suitable for inclusion in the national park estate. Should any of these lands also include similar biodiversity values to those being sought for retirement of biodiversity credits then they could be considered for contribution to those offsets as a second priority. The protected lands values offset will also include on park management costs for the new lands for a 20-year period at commencement of operation of the Project.

C7 Conclusion

The *Matters of National Environmental Significance Significant Impact Assessment Guidelines 1.1* (DoE 2013) provide the framework for the assessment of various MNES under the EPBC Act. The Impact Guidelines state that:

> *Approval under the EPBC Act is required for any action occurring within or outside a declared World Heritage property that has, will have, or is likely to have a significant impact on the World Heritage values of the World Heritage property.*
>
> …
>
> *An action is likely to have a significant impact on the World Heritage values of a declared World Heritage property if there is a real chance or possibility that it will cause:*
>
> - *one or more of the World Heritage values to be lost*
> - *one or more of the World Heritage values to be degraded or damaged, or*
> - *one or more of the World Heritage values to be notably altered, modified, obscured or diminished.*

The guidelines also note that

> *To be 'likely', it is not necessary for a significant impact to have a greater than 50% chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility.*
>
> *If there is scientific uncertainty about the impacts of your action and potential impacts are serious or irreversible, the precautionary principle is applicable. Accordingly, a lack of scientific certainty about the potential impacts of an action will not itself justify a decision that the action is not likely to have a significant impact on the environment.*

With reference to the three matters noted with regard to the World Heritage values of the GBMWHA, and noting that there is an existing flood risk in the upstream catchment associated with the dam that potentially temporarily affects the GBMWHA:

- It is considered unlikely that the Project would result in one or more World Heritage values to be lost
- It is considered unlikely that the Project would result in one or more World Heritage values to be degraded of damaged
- There is potential for some components of the OUV for the GBMWHA to be diminished, such as Aboriginal cultural heritage, through additional temporary inundation associated with the Project.

With regard to the third point, the risk of this would be reduced and effectively managed through proactive managements measures that would be implemented through the environmental management plan required under Part 5A of the *Water NSW Act 2014* and through the funding of on-park environmental management measures.

C8 References

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Hager, T and Benson, D 2010, The Eucalypts of the Greater Blue Mountains World Heritage Area: distribution, classification and habitats of the species of *Eucalyptus*, *Angophora* and *Corymbia* (family Myrtaceae) recorded in its eight conservation reserves, *Cunninghamia* b10(4): 425–444.

Holland KL, Merrin LE, McInerney P, Gilfedder M. 2021, *World Heritage-listed Greater Blue Mountains Area – Regional-scale assessment of potential cumulative impacts of mining on the outstanding universal value (OUV) of the property,* CSIRO, Australia.

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National Parks and Wildlife Service 2001, *Blue Mountains National Park Plan of Management,* NPWS, Sydney.

NSW Scientific Committee 2015, *Wollemi Pine Wollemia nobilis critically endangered species listing*, Sydney.

Office of Environment and Heritage, Department of Premier and Cabinet 2011, *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW*, April 2011, OEH/DPC, Sydney.

Appendix D

Outline Construction Environmental Management Plan

The EIS has addressed potential construction impacts and it was concluded that any impacts can be practically and effectively managed. Mitigation will include a combination of design measures that will be finalised during detailed design (for example, containments around potential pollution sources and structural drainage, noise and dust controls), and management measures that will be fully documented in the contractor's Construction Environmental Management Plan (CEMP).

Many of the issues raised relate to environmental management measures that will be finalised during design and CEMP implementation. Some issues relate to additional environmental assessment and mitigation, which would typically occur as construction activities and site layouts change over the course of the anticipated five-year construction period.

Responses below provide clarification of potential impacts and mitigation measures, and where necessary any additional information not already provided in the EIS. The TOC generally aligns with the framework of AS/NZS ISO 14001:2015 Environmental Management Systems, and includes identification of various subplans that address key environmental aspects identified during the EIS studies and summarised in Chapter 29 *Synthesis* of the EIS. The CEMP will be prepared by the construction contractor, comply with regulatory, Project and permitting compliance conditions, and be reviewed and authorised by WNSW and relevant agencies. The structure of the CEMP is outlined below, however this will be discussed with relevant stakeholders and amended as necessary.

- **Introduction:** Project context, CEMP objectives and preparation, approvals and consultation
- **Planning:** Environmental policy, regulations and permitting, objectives and targets, risk management, compliance tracking
- **Construction works and program:** Site layout and infrastructure, activities, program, plant and equipment, environmental controls, community notifications
- **Environmental management:** Responsibilities, training, communications
- **Implementation:** Activities and controls, records, incident management, emergency response
- **Monitoring and review:** Monitoring plan, inspections, records, auditing, corrective actions and non-conformances, review & continuous improvement.

Environmental Management Sub-Plans:

- Soil and Water Quality Management Plan
- Noise and Vibration Management Plan
- Non-Aboriginal Heritage Management Plan
- Aboriginal Cultural Heritage Management Plan
- Flora and Fauna Management Plan
- Waste Management Plan
- Contaminated Land Management Plan
- Dust and Air Quality Management Plan
- Hazards and Risk Management Plan
- Traffic Management Plan
- Flood Risk Management Plan
- Community Consultation and Complaints Management Plan
- Sustainability Management Plan

CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN (CEMP)

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Appendix E

Expert Groundwater Technical Report, Warragamba Dam Raising EIS – Response to Submissions

Memorandum

Ground floor, 20 Chandos Street
St Leonards NSW 2065
PO Box 21
St Leonards NSW 1590

T 02 9493 9500
E info@emmconsulting.com.au

www.emmconsulting.com.au

3 May 2022

To: Madison Van der Velde
Warragamba Dam Raising Project
WaterNSW
From: John Ross
Subject: Expert Groundwater Technical Report, Warragamba Dam Raising EIS - Response to Submissions

Dear Madison,

1 Introduction

EMM Consulting Pty Limited (EMM) has been engaged by WaterNSW to provide expert advice on groundwater matters raised in submissions to the Environmental Impact Statement (EIS) for the Warragamba Dam Raising Project (the Project). The authors' experience is summarised as an appendix. A glossary is also appendicised to explain the technical terms and acronyms used in this advice.

The advice addresses the issues raised by the Department of Planning, Industry and Environment – Water Group (DPIE-W), in their submission dated 17 December 2021.

This expert hydrogeological advice is provided in addition to the groundwater assessment provided in the EIS at:

- EIS Chapter 15 – Flooding and Hydrology
  - Existing environment
    - Section 15.3.2.3 Groundwater and groundwater dependent ecosystems (GDEs)
  - Downstream project impacts
    - Section 15.7.7 Groundwater
- Appendix H1 – Flooding and Hydrogeology
  - 3. Baseline characterisation – existing environment
    - Section 3.1.1.7 – Wetlands and groundwater dependent ecosystems
    - Section 3.1.2.6 – Groundwater and groundwater dependent ecosystems (GDEs)
  - 4. Environmental assessment – construction phase
    - Section 4.1.1.4 – Water take from surface water and groundwater sources
  - 4. Environmental assessment – operation phase
    - Section 4.2.3.5 – Groundwater

1.1 The SEARs requirements for the EIS

The key water issues raised in the revised Secretary's Environmental Assessment Requirements (SEARs) for the Project are listed in Table 1.1. The groundwater related issues and requirements are underlined.

Table 1.1 Key hydrology issues and requirements raised in the revised SEARs

Key issue and desired performance outcome	Requirement (specific assessment requirements in addition to the general requirement)	Current Guidelines
20. Water - Hydrology Long term impacts on surface water and groundwater hydrology (including drawdown, flow rates and volumes) are minimised. The environmental values of nearby, connected and affected water sources, groundwater and dependent ecological systems including estuarine and marine water (if applicable) are maintained (where values are achieved) or improved and maintained (where values are not achieved). Sustainable use of water resources.	1. The Proponent must consider potential alternatives for managing flood waters and justify the selection having regard to the relative environmental impacts. 2. The Proponent must describe (and map) the existing hydrological regime for any surface and groundwater resource (including reliance by users and for ecological purposes) likely to be impacted by the project, including stream orders, as per the FBA. Mapping must include upstream and downstream tributaries that may potentially be impacted, including: a) the extent of regional flood up to the probable maximum flood; b) flood planning area, the area below the flood planning level (area below the 100 year ARI plus freeboard); c) hydraulic categorisation (floodways and flood storage areas); and d) hazard categorisation. The extent of mapping/modelling used needs to be identified and rationalised. 3. The Proponent must prepare a detailed water balance for ground and surface water including the intake and discharge locations, where relevant, volume, frequency and duration of flooding events (1 in 5 year, 1 in 10 year, 1 in 20 year, 1 in 100 year, and probable maximum flood) and at times of non-flood. 4. The Proponent must assess (and model if appropriate) the impact of the construction and operation of the project and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including: a) natural processes within rivers, wetlands, estuaries, marine waters and floodplains that affect the health of the fluvial, riparian, estuarine or marine system and landscape health (such as modified discharge volumes, durations and velocities), aquatic connectivity and access to habitat for spawning and refuge; b) impacts from any permanent and temporary interruption of groundwater flow, including the extent of drawdown, barriers to flows, implications for groundwater dependent surface flows, ecosystems and species, groundwater users and the potential for settlement; c) changes to environmental water availability and flows, both regulated/licensed and unregulated/rules-based sources; d) direct or indirect increases in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses;	Framework for Biodiversity Assessment – Appendix 2 (OEH, 2014) Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004) and Volume 2 (A. Installation of Services; B. Waste Landfills; C. Unsealed Roads; D. Main Roads; E. Mines and Quarries) (DECC, 2008) NSW Aquifer Interference Policy (DPI, 2012) NSW Sustainable Design Guidelines Version 3.0 (TfNSW, 2013) Risk assessment Guidelines for Groundwater Dependent Ecosystems (Office of Water, 2012

Table 1.1 Key hydrology issues and requirements raised in the revised SEARs

Key issue and desired performance outcome	Requirement (specific assessment requirements in addition to the general requirement)	Current Guidelines
	e) minimising the effects of proposed stormwater and wastewater management during construction and operation on natural hydrological attributes (such as volumes, flow rates, management methods and re-use options) and on the conveyance capacity of existing stormwater systems where discharges are proposed through such systems; and f) water take (direct or passive) from all surface and groundwater sources with estimates of annual volumes during construction and operation. 5. The Proponent must identify any requirements for baseline monitoring of hydrological attributes. 6. The Proponent must detail a framework for managing water releases from the dam that are capable of meeting the objectives of the project (in terms of flood mitigation), ensures impacts to upstream and downstream areas and ecosystems are minimised. The framework shall include consideration of the potential rates of rise and fall in the river, timing of water releases. These shall include consideration of antecedent, conditions within the river, flooding impacts, and transparent and translucent flows. 7. The Proponent must assess the potential impact on groundwater and surface water users, details of how existing water rights will be protected, including with respect to availability, quantity and quality of the water, noting the interjurisdictional users within the potentially impacted area. This would include an assessment of environmental availability, both regulated and unregulated use, licenced and rules-based sources of such water. 8. The Proponent must consider and discuss the rate at which flood waters would potentially recede following a probable maximum flood event, the impact on vegetation both upstream and downstream from the flood and the impact on water quality over time as flood waters are released from the dam throughout the catchment. Geomorphology and river management should be taken into account.	

1.2 Groundwater issues raised by DPIE-Water

DPIE-W recommended that prior to determination, WaterNSW should provide additional evidence to support the low risk of groundwater impacts that are implied in the EIS. Their issues were:

- The groundwater related requirements specified in the SEARs have not been fully addressed.
- The EIS does not present hydrogeological baseline data and groundwater modelling or analytical assessment to allow DPIE-W to conduct an assessment or comment on cumulative groundwater impact.
- The EIS does not mention upstream groundwater impacts, and does not consider any impacts further afield due to the potential propagation of groundwater pressures due to a reservoir level increase of 12 m.
- Downstream, the revised operation of the flood management zone has not been analysed to determine the impact on groundwater availability and reliability for water uses and the environment.

- The EIS does not consider cumulative infrastructure impacts such as the Western Sydney Airport and Aerotropolis developments.

- No technical based groundwater recharge analysis was included relating to flood impacts and the impact on the downstream alluvial aquifer.

2 Methodology

Numerical groundwater modelling is not appropriate for assessing groundwater impacts for this project given that the timescale for flood mitigation capture and release behind the dam is days to weeks, and groundwater models are not designed to assess groundwater impacts arising from such short and episodic surface water events. It was agreed with DPIE-W that a detailed qualitative assessment of the groundwater impacts was sufficient to address their issues.

The following desktop assessment approach was agreed with DPIE-W:

- build on the existing groundwater data included in the EIS by expanding descriptions of the:
  - geology and geological structure;
  - sandstone groundwater system (adjacent to Lake Burragorang) and downstream alluvial groundwater system (Penrith to Cattai floodplain areas);
  - groundwater dependent ecosystems; and
  - use of groundwater in areas adjacent to the dam and within the downstream floodplain areas; and
- include new WaterNSW investigation and monitoring data/information relating to:
  - geotechnical investigations in and around Warragamba Dam;
  - hydrogeological investigations for emergency drought groundwater supplies at Warragamba, Wallacia, Penrith and Emu Plains; and
  - the hydraulic connectivity between the dam and floodwaters, and the adjacent sandstone and alluvial groundwater systems.

This expanded technical review provides evidence to support the impact assessment in the EIS that there is low risk of potential impacts to groundwater systems and users (both human and environmental) because of the Project.

3 Groundwater policy and impact assessment context

The Project does not align specifically to an aquifer interference activity as defined under the Aquifer Interference Policy (AIP) (DPI 2012) however for the purpose of this assessment the AIP framework has been used to validate that the activity has minimal impact to groundwater systems.

3.1 NSW Aquifer Interference Policy

The AIP (DPI 2012) addresses assessment and 'minimal harm' requirements for aquifer interference activities. These are defined under the *Water Management Act* (2000) (under Section 91) as an activity involving either:

- penetration of an aquifer;

- interference with water in an aquifer;

- obstruction of the flow of water in an aquifer;
- taking of water from an aquifer in the course of carrying out mining, or any other activity prescribed by the regulations; or
- disposal of water taken from an aquifer in the course of carrying out mining or any other activity prescribed in the regulations.

The Project is not constructed within a groundwater system, but it has the potential to interfere and obstruct groundwater flows by altering groundwater recharge and flow characteristics. This advice assesses the impact of short-term flood mitigation capture and release on the groundwater systems that could result in more short-term aquifer recharge in the vicinity of Lake Burragorang and less recharge in the downstream floodplain areas because of the reduced extent of overbank flooding. The primary activity of temporarily holding floodwaters behind a larger Warragamba Dam is considered the most important aquifer interference activity.

The AIP defines water sources as being either 'highly productive' or 'less productive' based on levels of salinity and average yields from bores. The AIP further defines water sources by their lithological character, being one of: alluvium, coastal sand, porous rock or fractured rock. The groundwater systems at the Project site are 'less productive' porous rock (in the vicinity of Lake Burragorang) and 'highly productive' alluvium for the downstream floodplain areas.

Projects are required to meet the minimal impact considerations relating to water levels, water pressures and water quality as outlined in the AIP. The minimal impact considerations have been developed for impacts on groundwater sources, connected water sources, and their dependent ecosystems, culturally significant sites and water users.

The definition of 'minimal impact' and the aspects applicable for the project are reproduced in Table 3.1 for porous rock water sources. For this Project, the water table criteria and the water quality criteria are important.

Table 3.1 Minimal impact criteria for 'less productive' porous rock water sources

Water table	Water pressure	Water quality
1. Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 m from any: a) high priority groundwater dependent ecosystem; or b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan. A maximum of a 2 m decline cumulatively at any water supply work. 2. If more than 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 m from any: a) high priority groundwater dependent ecosystem; or b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan if appropriate studies demonstrate to the Minister's satisfaction that the variation will not prevent the long-term viability of the dependent ecosystem or significant site. If more than a 2 m decline cumulatively at any water supply work then make good provisions should apply.	1. A cumulative pressure head decline of not more than a 2 m decline, at any water supply work. 2. If the predicted pressure head decline is greater than requirement 1 above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline will not prevent the long-term viability of the affected water supply works unless make good provisions apply.	1. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity. 2. If condition 1 is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.

Note: Sourced from NSW Aquifer Interference Policy (DPI 2012)

The impact assessment of the Project against these minimal impact criteria is presented in Section 5.

4 Existing environment

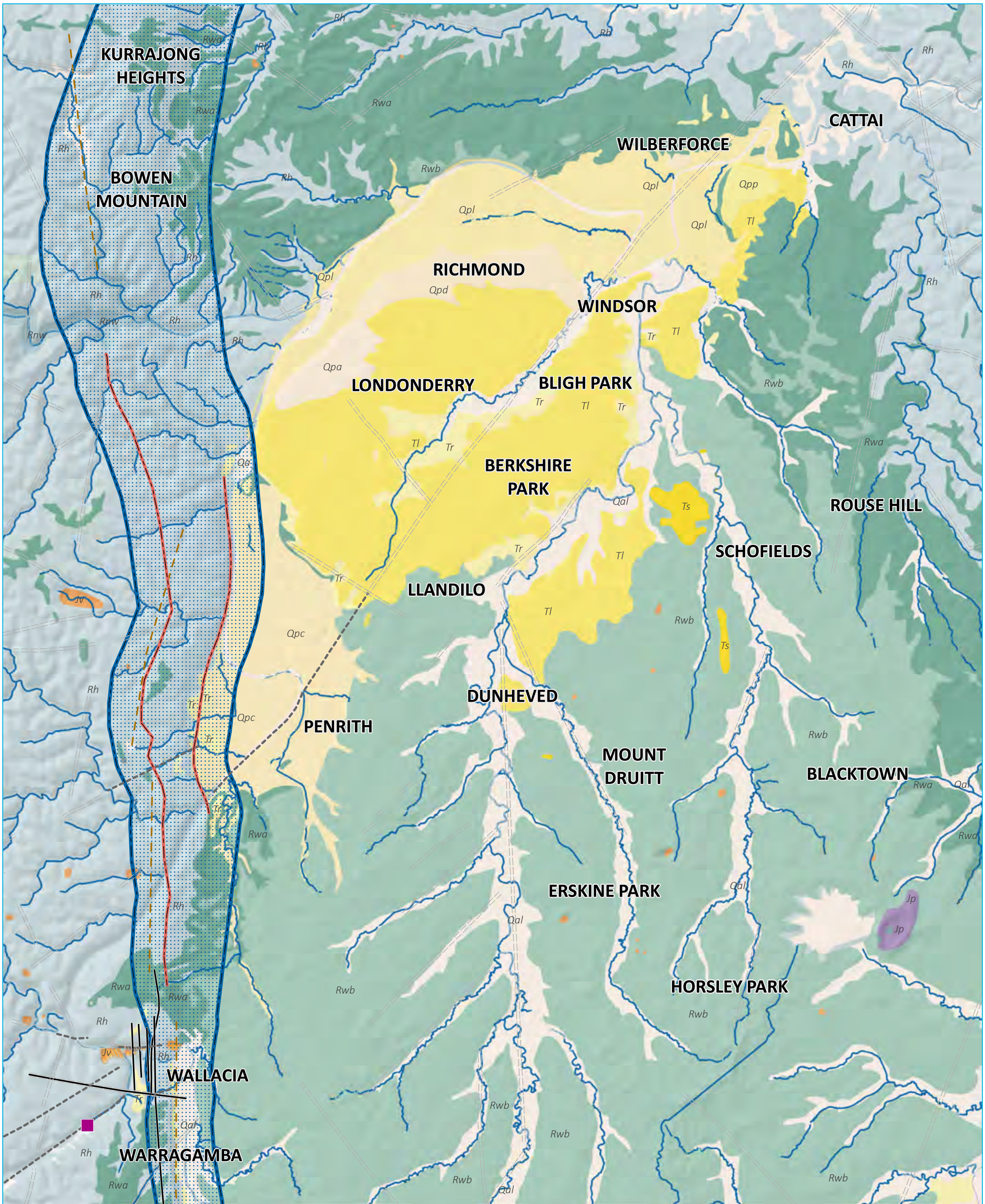
4.1 Geology

The Project is located within and immediately adjacent to the western edge of the central portion of the Permo-Triassic Sydney Geological Basin. The regional geology includes Quaternary alluvium, Tertiary alluvium, and Triassic Wianamatta Group shales, Mittagong Formation and Hawkesbury Sandstone.

The Project is also located close to the Lapstone Structural Complex (LSC), a geological feature trending north-south that occurs immediately east of Warragamba Dam. This structural feature is an association of monoclines and high-angle reverse faults that defines the western limit of the Cumberland Plain and the start of the lower Blue Mountains (Ferguson, Bray & Hatherley 2011). Geological outcrop and structure, including the LSC, are shown in Figure 4.1.

Lake Burragorang is located to the west of the LSC and is incised into the Hawkesbury Sandstone. There is approximately 30 m of Hawkesbury Sandstone underlying the base of the Lake Burragorang in the vicinity of the dam (SMEC 2019). The Triassic Hawkesbury Sandstone occurs across the full of extent of the Sydney Basin and forms the most prominent surficial geological unit within the western portion of the project area (Moffit 1999). In the plateau areas surrounding Lake Burragorang, the Hawkesbury Sandstone can be up to 250 m thick (Parsons Brinckerhoff 2009). In some local areas between Warragamba Dam and the LSC there is a residual capping of Ashfield Shale (part of the Wianamatta Group).

Downstream and adjacent to the Hawkesbury/Nepean Rivers are alluvial deposits beneath the floodplain areas. The thickness of the alluvial deposits typically ranges between 10 - 20 m, with the lateral extent spanning up to 5 km (Parsons Brinckerhoff 2008, Department of Minerals and Energy 1991).



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Source: EMM (2022); DFSI (2020, 2021); ESRI (2022); DPIE (2017); DRE (1991, 1996); Fergusson (2006); Moffitt (1999)

0 2 4 km
GDA2020 MGA Zone 56
N

KEY

- Warragamba Dam
- Named watercourse

Geological structure

- Lineament - inferred
- Lineament - EMM (2020)
- Fault - Fergusson (2006)
- Fault - Moffitt (1999)
- Monocline
- Lapstone Structural Complex
- Nortons Basin diatreme

Geology (Penrith/Sydney 100K, Statewide 250K)

Quaternary

- Quaternary alluvium (*Qa, Qal*)
- Agnes Banks Sand (*Qpa*)
- Clarendon Formation (*Qpd*)
- Cranebrook Formation (*Qpc*)
- Lowlands Formation (*Qpl*)
- Pitt Town Sand (*Qpp*)

Tertiary

- Tertiary (*Tr*)
- Londonderry Clay (*Tl*)
- St Marys Formation (*Ts*)

Cretaceous

- Cretaceous (*Jv*)

Jurassic

- Jurassic (*Jp*)

Triassic

- Wianamatta Group (undifferentiated) | Bringelly Shale (*Rwb*)
- Wianamatta Group (undifferentiated) | Minchinbury Sandstone (*Rwm*)
- Wianamatta Group (undifferentiated) | Ashfield Shale (*Rwa*)
- Hawkesbury Sandstone (*Rh*)
- Narrabeen Group (undifferentiated) | Banks Wall Sandstone (*Rnw*)
- Narrabeen Group (undifferentiated)

Geology and geological structure

Warragamba Dam Raising
Groundwater RTS
Figure 4.1

EMM
creating opportunities

4.2 Hydrogeology

4.2.1 Lake Burragorang/Warragamba Dam

i Hawkesbury Sandstone aquifer

The Hawkesbury Sandstone geologic unit hosts a major regional aquifer in the area surrounding Lake Burragorang, as shown in Figure 4.2. It occurs below Lake Burragorang and beneath the adjacent ridgelines and is essentially a single hydrogeological unit that comprises a series of layered aquifers. It is a semi-confined, dual porosity (matrix and fracture) unit exhibiting variable permeability that is dependent on the extent of fracturing and faulting. Groundwater flows through the interconnected void space between grains of the rock matrix and the secondary features consisting of joints, fractures, faults, shear zones and bedding planes. Groundwater flow is predominantly through these defects in the sandstone (Parsons Brinckerhoff 2009).

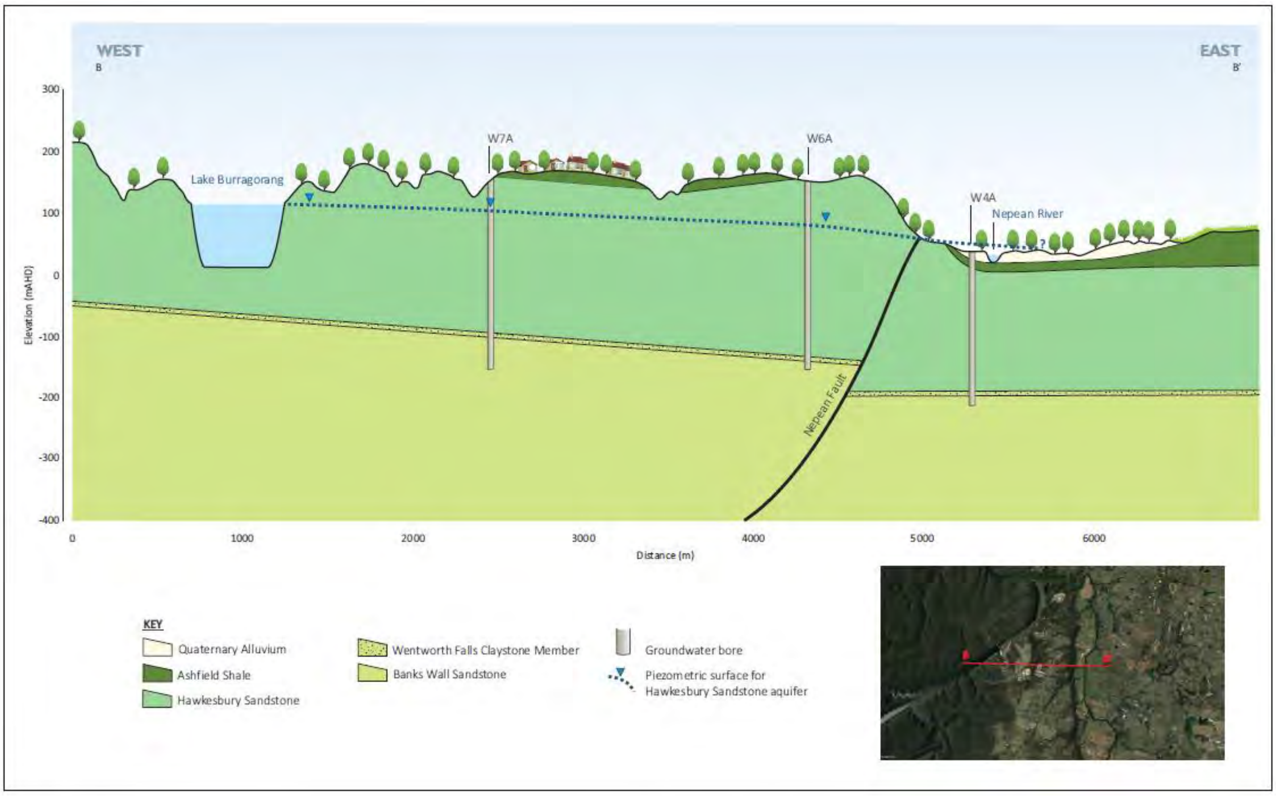


Figure 4.2 Conceptual west-east geological cross section through Lake Burragorang

Groundwater within the sandstone aquifer is recharged by rainfall across the sandstone outcrop of the lower Blue Mountains west of the LSC and losses from Lake Burragorang. The groundwater flow direction is consistently west to east from Lake Burragorang, with groundwater flow across the LSC as shown in Figure 4.3. There are no obvious, local groundwater discharge areas for the sandstone aquifer, although groundwater discharge to the alluvium (where present) and to the Nepean River is assumed based in groundwater flow contours.

During the Millennium drought, groundwater investigations were undertaken at Warragamba and Wallacia to determine the potential of the regional sandstone aquifer for emergency groundwater supply. The closest test bores that target the Hawkesbury Sandstone aquifer were 1.9 km south of Warragamba Dam (Bores 7A and 7B, see Figure 4.). The groundwater level in Bore W7A (GW075140) was 97 metres below ground level (mbgl) in mid 2006 and 99 mbgl in mid 2008. A data logger was then installed between September 2008 and August 2012 to assess rainfall/Lake Burragorang recharge and water level recovery trends after the drought.

A hydrograph for the period mid 2008 to mid 2012 (Figure 4.) shows the groundwater level in bore (W7A) together with the dam storage level, and daily and cumulative deviation rainfall trends. The data indicates:

- dam water levels are always higher than sandstone water levels, which confirms that the dam is losing water to the regional sandstone aquifer;

- the sandstone water levels don't respond to individual rainfall events and sudden dam level rises. There were two sharp rises in dam storage level (ie increases between 4–6 m) in February and December 2010, with no corresponding sharp increase in groundwater level;

- groundwater levels respond slowly to longer periods of rainfall and increasing dam storage levels with the first noticeable, and very slight, rise in groundwater levels in early 2010; and

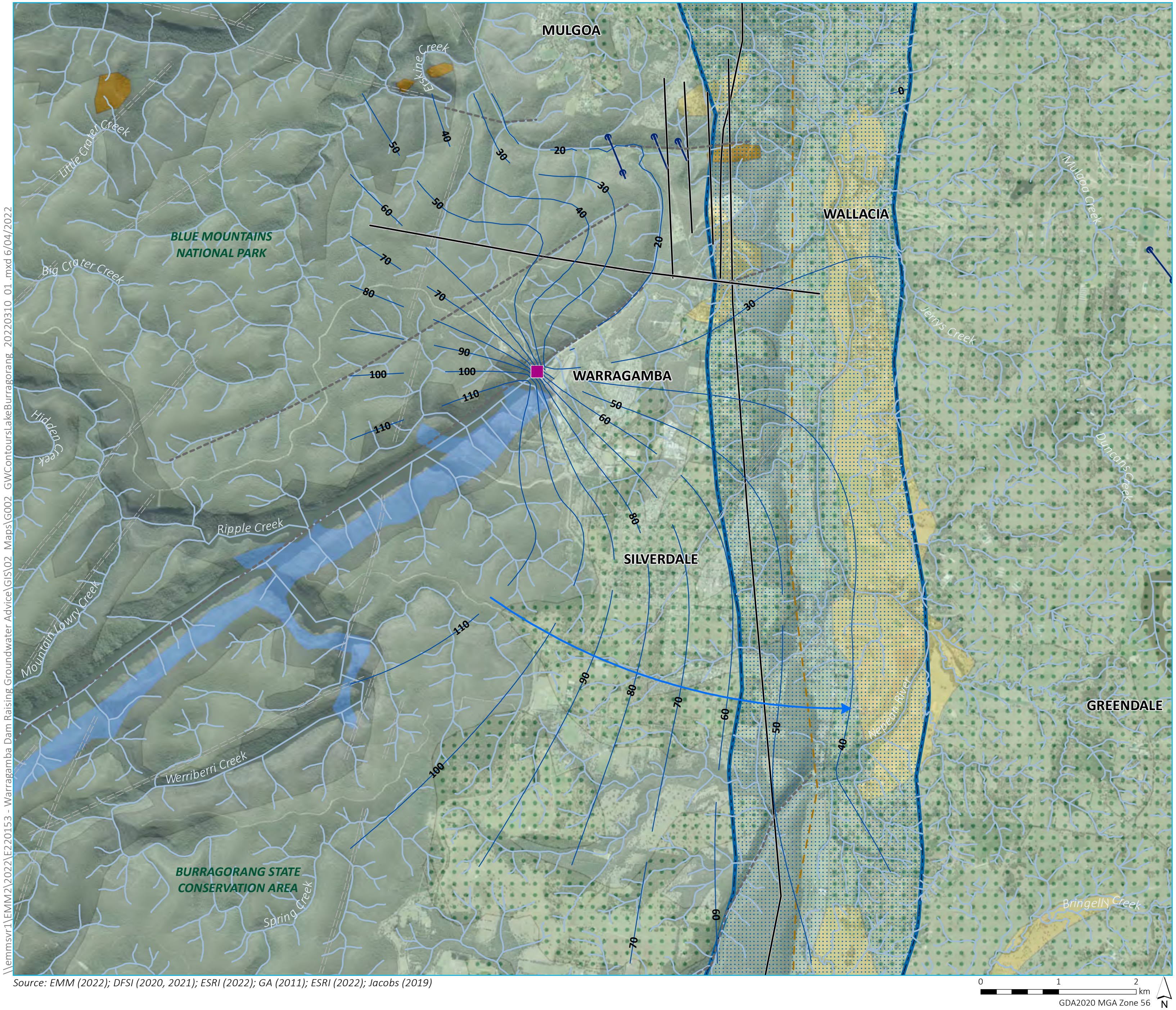
- the groundwater level in August 2010 was 99 mbgl (91.5 mAHD) and by August 2012 had risen slowly to 97.6 mbgl (92.9 mAHD) – a very small increase of 1.4 m. The data confirms lagged and only very slight increases in groundwater levels as the dam fills to its full storage level (FSL) of 116.72 mAHD.

Historical groundwater level data collected by the Metropolitan Water, Sewerage & Drainage Board (MWS&DB) (as presented in Stantec GHD 2019) during and immediately after the completion of Warragamba Dam confirms rising groundwater levels in piezometers in the sandstone aquifer as the storage filled. The greatest rises, at the end of 1961, were within 200 m of the storage with only small rises evident at greater distances.

Today the estimated hydraulic gradient between Warragamba Dam (when full) and Bore W7A is a relatively steep 0.013. The reported hydraulic conductivity from field testing of the deep sandstone aquifers at Warragamba is around 0.1 m/day (Parsons Brinckerhoff 2009) and for the shallow sandstone in the vicinity of the dam it is mostly within the range of 0.001 to 0.09 m/day (Stantec GHD 2019). The groundwater flow directions, shown in Figure 4.3, confirms the steep groundwater gradient from Lake Burragorang, predominantly towards the east and to the Nepean River gorge to the north.

Groundwater quality sampling from bores W7A and W7B indicates conditions are fresh, with an approximate electrical conductivity (EC) of 300 µS/cm, and slightly acidic (pH approximately 6.5) (Parsons Brinkerhoff 2008). The groundwater type was Na-Mg-Cl. The water quality in Lake Burragorang is slightly fresher, with an approximate EC of 250 µS/cm, and neutral (pH 7) (Ecological 2020).

Parsons Brinckerhoff (2008 and 2009) completed environmental and radioisotope studies on groundwater samples from Warragamba to Wallacia and found that groundwater within the Hawkesbury Sandstone aquifer was meteoric in origin (ie derived from rainfall) with a corrected age of 4,800 years before present (BP) at Warragamba up to 30,600 years BP at Wallacia. Groundwater ages are significantly older within the LSC and along the groundwater flowpath from west to east. This age data confirms low permeability for the sandstone aquifer and slow natural migration.



Source: EMM (2022); DFSI (2020, 2021); ESRI (2022); GA (2011); ESRI (2022); Jacobs (2019)

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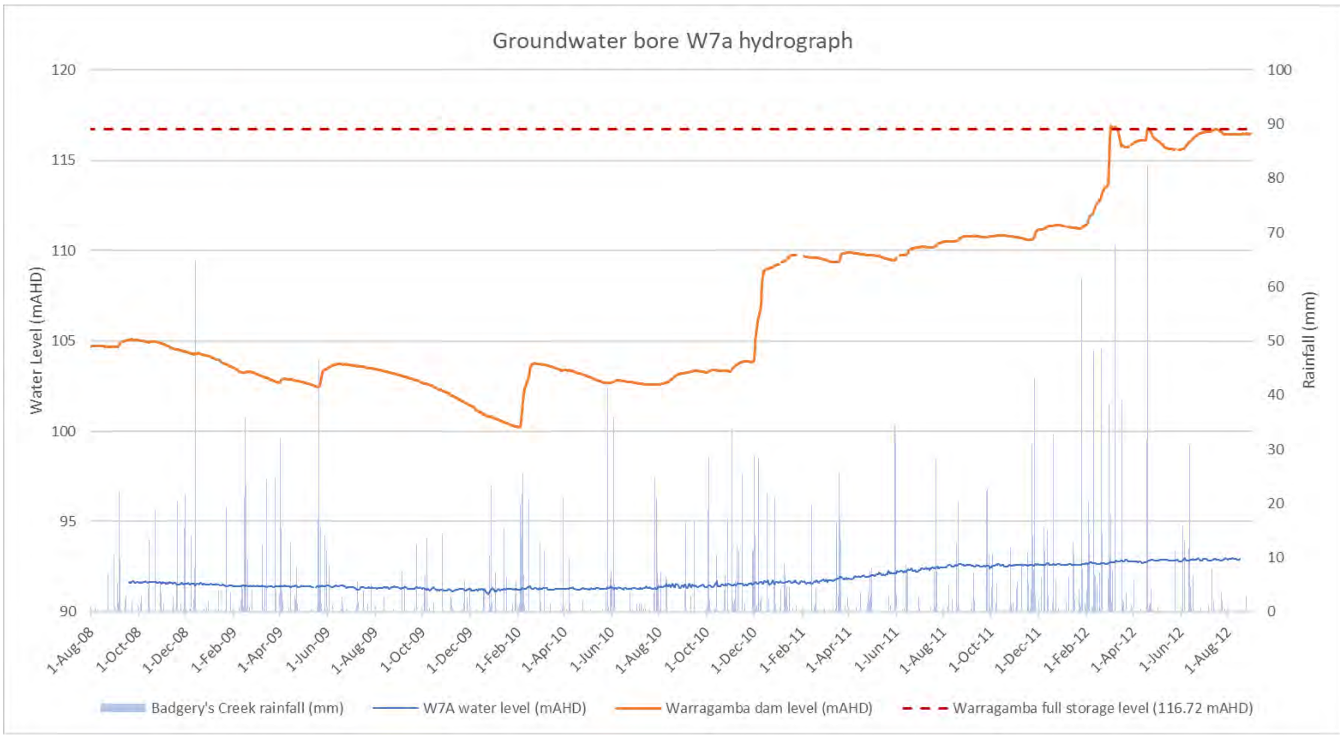
Groundwater flow contours (Lake Burragorang)

Warragmba Dam Raising
Groundwater RTS
Figure 4.3

EMM creating opportunities



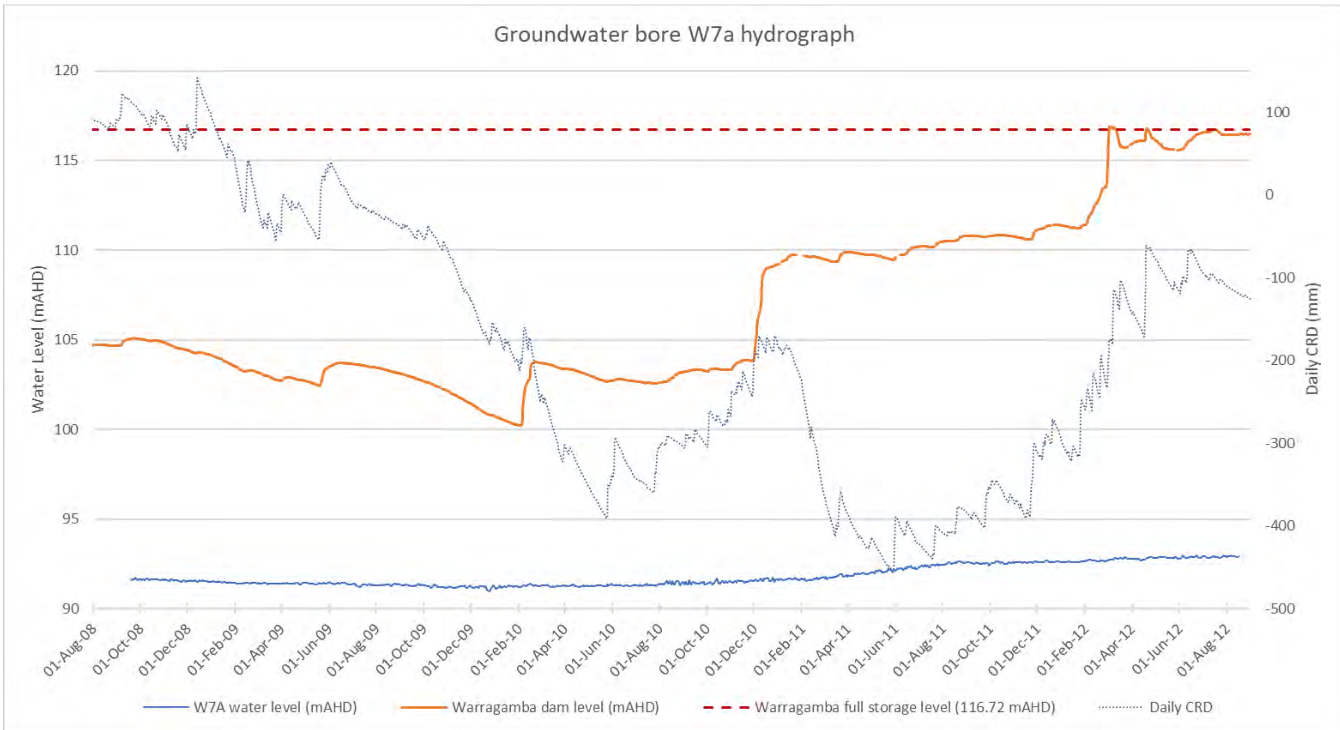


Figure 4.4 **Hydrograph showing groundwater levels for bore 7A, dam storage levels and (a) daily rainfall (b) cumulative deviation from the mean rainfall**

ii Groundwater use

a Landholders

The number and type of private water bores targeting the sandstone groundwater source within 7 km of Warragamba Dam and Lake Burragorang are listed in Table 4.2 with locations shown in Figure 4.5.

Table 4.1 Warragamba groundwater source bores

	Groundwater use types					
	BLR[1]	Irrigation	Recreation	Commercial/ Industrial	Dewatering/ remediation	**TOTAL**
Number of registered groundwater bores	41	12	0	2	0	55

Notes: 1 BLR = basic landholder rights

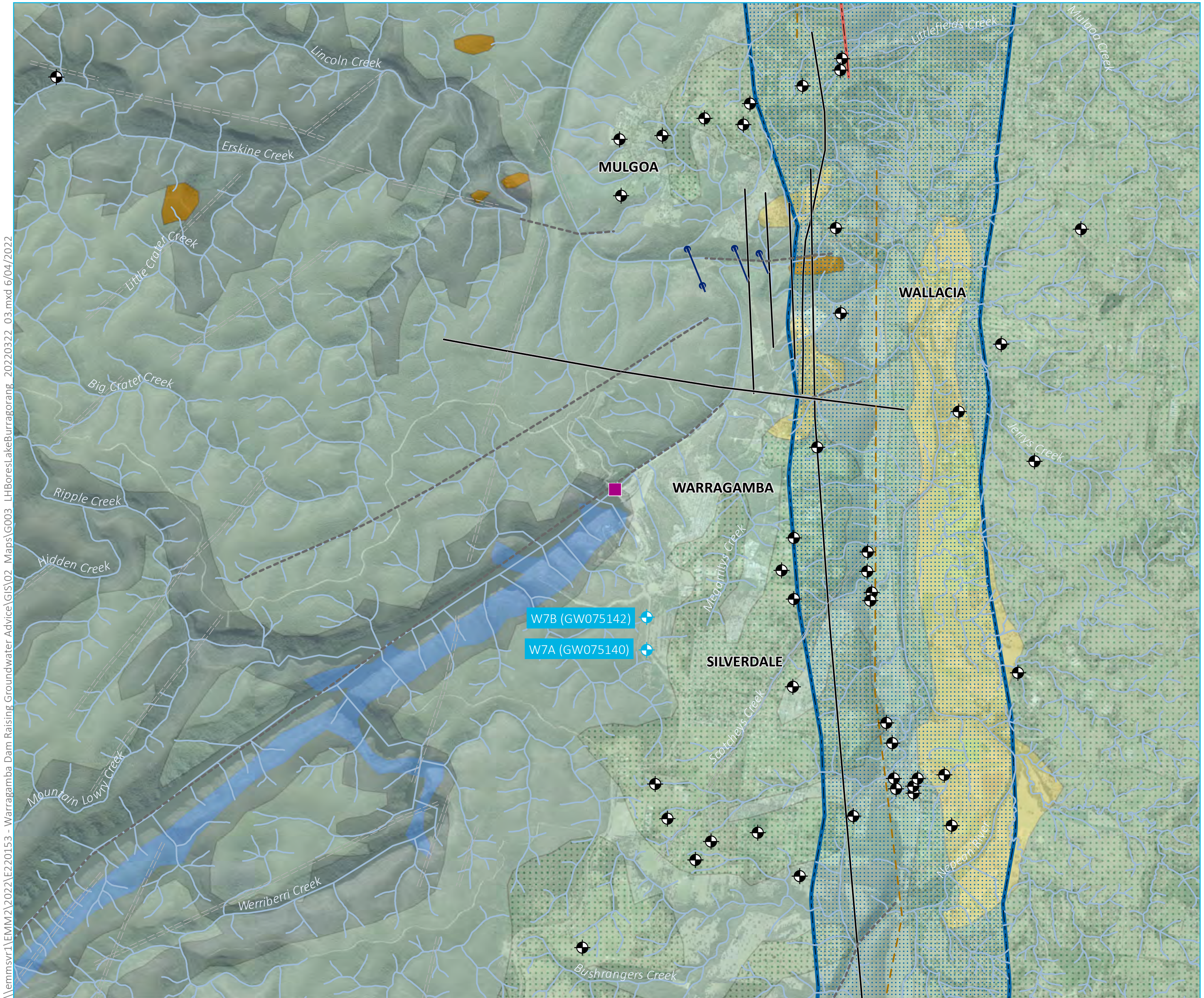
The closest landholder bores are located 3 km to the south of Lake Burragorang. The depth to groundwater in these bores is recorded as 28–85 mbgl.

b Environmental

The Water Sharing Plan (WSP), ie Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 Sydney Basin Blue Mountains and Sydney Basin Central Groundwater Sources, and the Groundwater Dependent Ecosystem Atlas (managed by the Bureau of Meteorology (BoM)) were reviewed to determine whether any groundwater dependent ecosystems (GDE) are likely to exist in the vicinity of Lake Burragorang. These are no listed high priority GDEs in the WSP and the BoM potential GDEs (all terrestrial vegetation) are shown in Figure 4.6. These are listed as moderate potential GDEs but given that the depth to groundwater is generally between 50 and 100 mbgl across the plateau area above Lake Burragorang, the potential GDEs shown in the BoM atlas are highly unlikely to be groundwater dependent.

c Project groundwater use

There are no plans to use groundwater as a water supply source during the construction program (SMEC 2021).



Source: EMM (2022); DFSI (2020, 2021); ESRI (2022); GA (2011); ESRI (2022); BOM (2022)

KEY

- Warragamba Dam
- Landholder bore
- Monitoring bore
- Monocline
- Lineament - Inferred
- Lineament - EMM (2020)
- Fault - Fergusson (2006)
- Fault - Moffitt (1999)
- Dyke or vein
- Lapstone Structural Complex
- Watercourse/drainage line
- Waterbody

Dominant lithology

- Quaternary alluvium and sand
- Jurassic basalts, breccias
- Wianamatta Group Shale, Liverpool Subgroup
- Hawkesbury Sandstone
- Narrabeen Group Sandstone

Landholder bores
(Lake Burragorang)

Warragmba Dam Raising
Groundwater RTS
Figure 4.5

EMM
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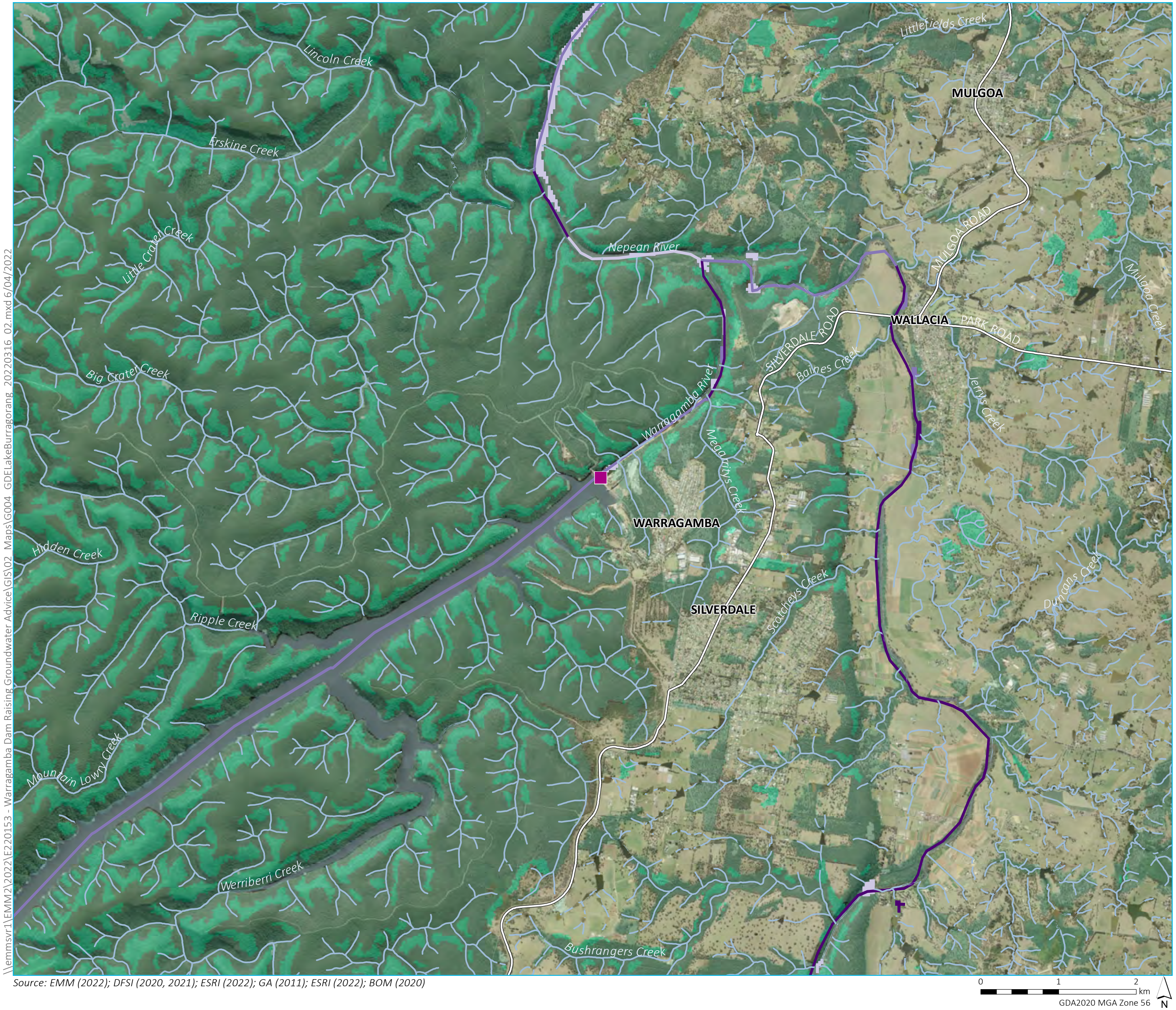

Source: EMM (2022); DFSI (2020, 2021); ESRI (2022); GA (2011); ESRI (2022); BOM (2020)

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KEY

- Warragamba Dam

Groundwater dependant ecosystem (aquatic)

- High potential GDE - from national assessment
- Moderate potential GDE - from national assessment
- Low potential GDE - from national assessment

Groundwater dependant ecosystem (terrestrial)

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Existing environment

- Major road
- Watercourse/drainage line
- Waterbody

Groundwater dependent ecosystems (Lake Burragorang)

Warragmba Dam Raising
Groundwater RTS
Figure 4.6

creating opportunities

4.2.2 Penrith and downstream floodplain areas

i Alluvial aquifer

The Quaternary alluvium, comprising alluvium/colluvium deposits, hosts a major localised groundwater system from Penrith/Leonay, to Cranebrook and to the Richmond lowlands. The alluvial groundwater system is an unconfined, permeable aquifer, with groundwater levels representing the depth to the water table. The depth to groundwater is within 10 m of ground surface, although water levels are typically shallower at 5-6 mbgl on lower alluvial terraces (EMM 2021).

Groundwater levels respond directly and immediately to rainfall recharge, and rainfall is the main recharge mechanism, along with stormwater from ephemeral creeks and urban areas. Occasional overbank flooding surcharges groundwater levels for short periods but this water then drains back to the Nepean/Hawkesbury River. From available water level data, recharge areas are inferred to be associated with natural runoff from Lapstone Creek, Rickabys Creek, Eastern Creek and numerous other smaller creeks plus stormwater discharges into several of the upper lakes within the Penrith Lakes Scheme. Flood inundations typically have a very short duration and are not considered a primary recharge mechanism to the alluvial aquifer.

Groundwater level contours (Figure 4.7Figure 4.) show the groundwater flow direction is towards the Hawkesbury/Nepean River, where there is no tidal influence. The groundwater elevations confirm that the river is a gaining stream as groundwater levels are typically slightly above river levels. This implies that the river receives baseflow from the alluvium to provide a component of flow in the river except when the river is in flood (EMM 2021). Baseflow contributions from the alluvial groundwater system are estimated to decrease downstream in the tidal areas.

Groundwater in the alluvial aquifer has a relatively short residence time, estimated to be less than 50 years (Parsons Brinckerhoff 2008).

ii Groundwater use

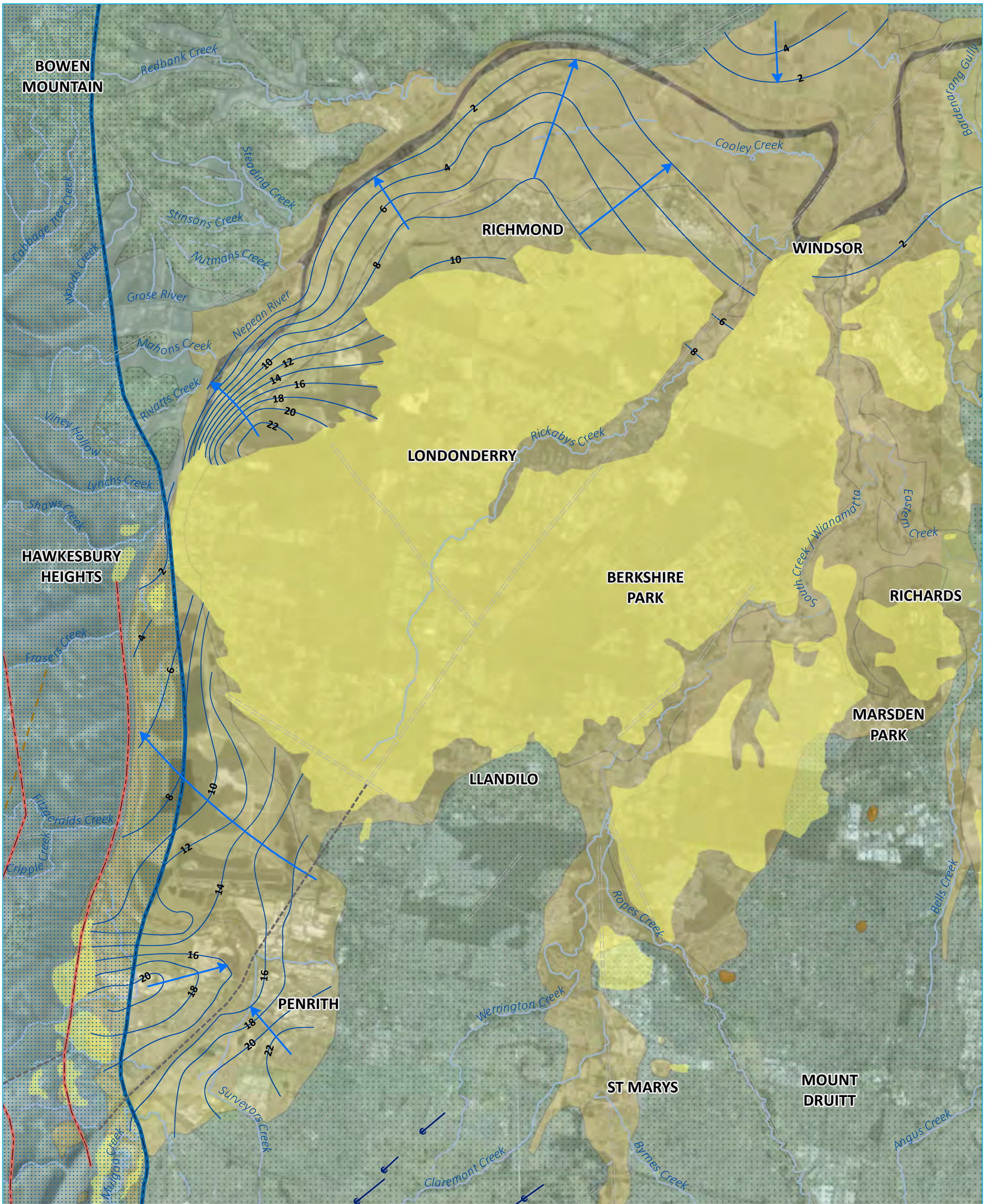
a Landholders

The number and type of private water bores targeting the alluvial groundwater source, ie within the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 Hawkesbury Alluvium Groundwater Source are listed in Table 4.2 with locations shown in Figure 4.8.

Table 4.2 Hawkesbury Alluvial groundwater source bores

	Groundwater use types					
	BLR[1]	Irrigation	Recreation	Commercial/ Industrial	Dewatering/ remediation	TOTAL
Number of registered groundwater bores	56	22	1	6	4	89

Notes: 1 BLR = basic landholder rights



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Source: EMM (2022); DFSI (2020, 2021); ESRI (2022); DPIE (2017); DRE (1991, 1996); Fergusson (2006)

0 2.5 5 km
GDA2020 MGA Zone 56
N

KEY

- Inferred groundwater flow direction
- Groundwater elevation contour (mAHD)
- Monocline
- Lineament - Inferred
- Lineament - EMM (2020)
- Fault - Fergusson (2006)
- Dyke or vein
- Lapstone Structural Complex
- Named watercourse

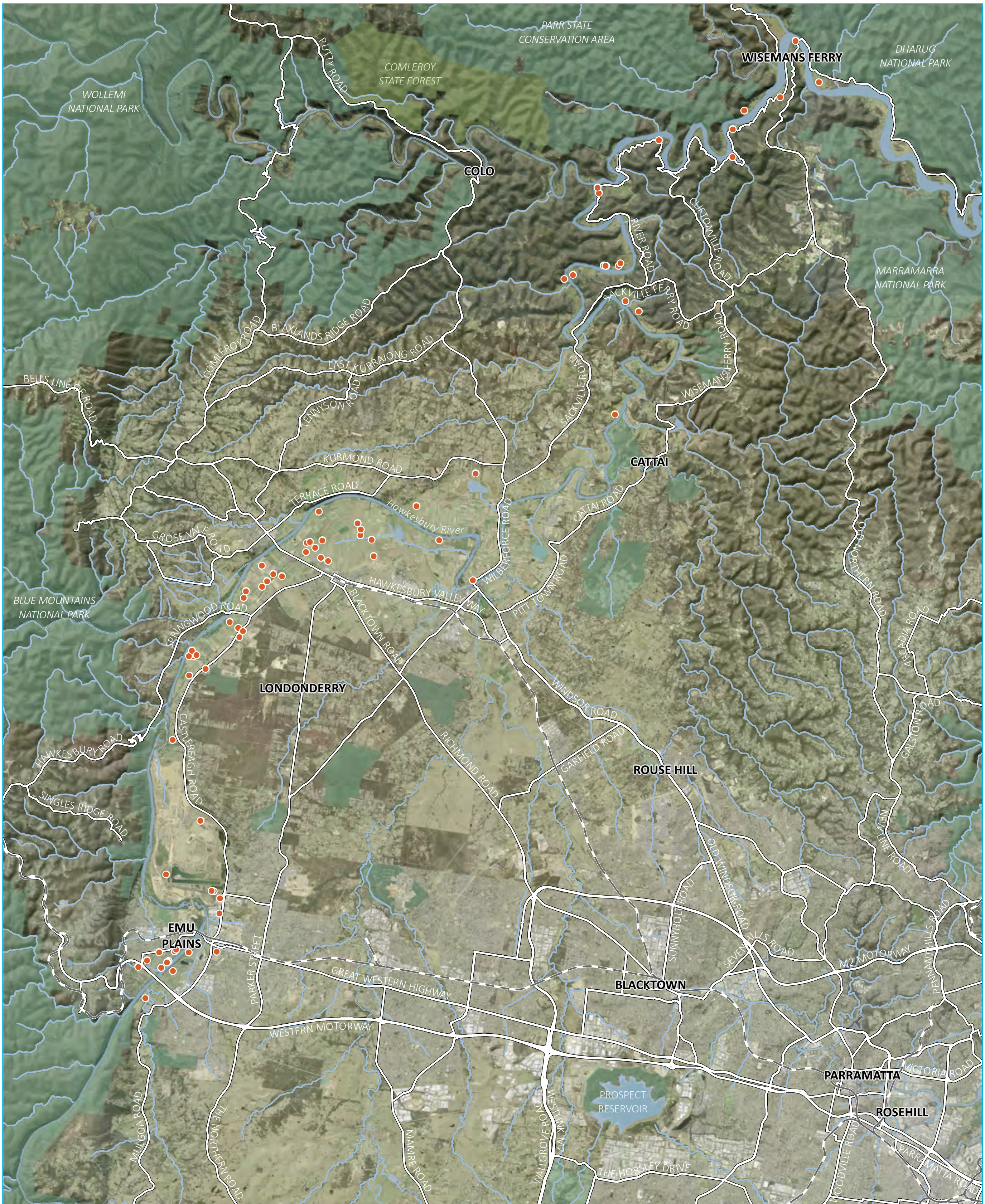
Dominant lithology

- Quaternary alluvium and sand
- Jurassic basalts, breccias
- Wianamatta Group Shale, Liverpool Subgroup
- Hawkesbury Sandstone
- Narrabeen Group Sandstone
- Tertiary

Groundwater flow contours (Penrith)

Warragamba Dam Raising
Groundwater RTS
Figure 4.7

creating opportunities



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Source: EMM (2022); DPIE (2017); DFSI (2021; 2017); GA (2011)

0 5 10
km
GDA 1994 MGA Zone 56
N

KEY

- Landholder bore
- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve
- State forest

Landholder bores (Penrith)

Warragmba Dam Raising
Groundwater RTS
Figure 4.8

EMM
creating opportunities

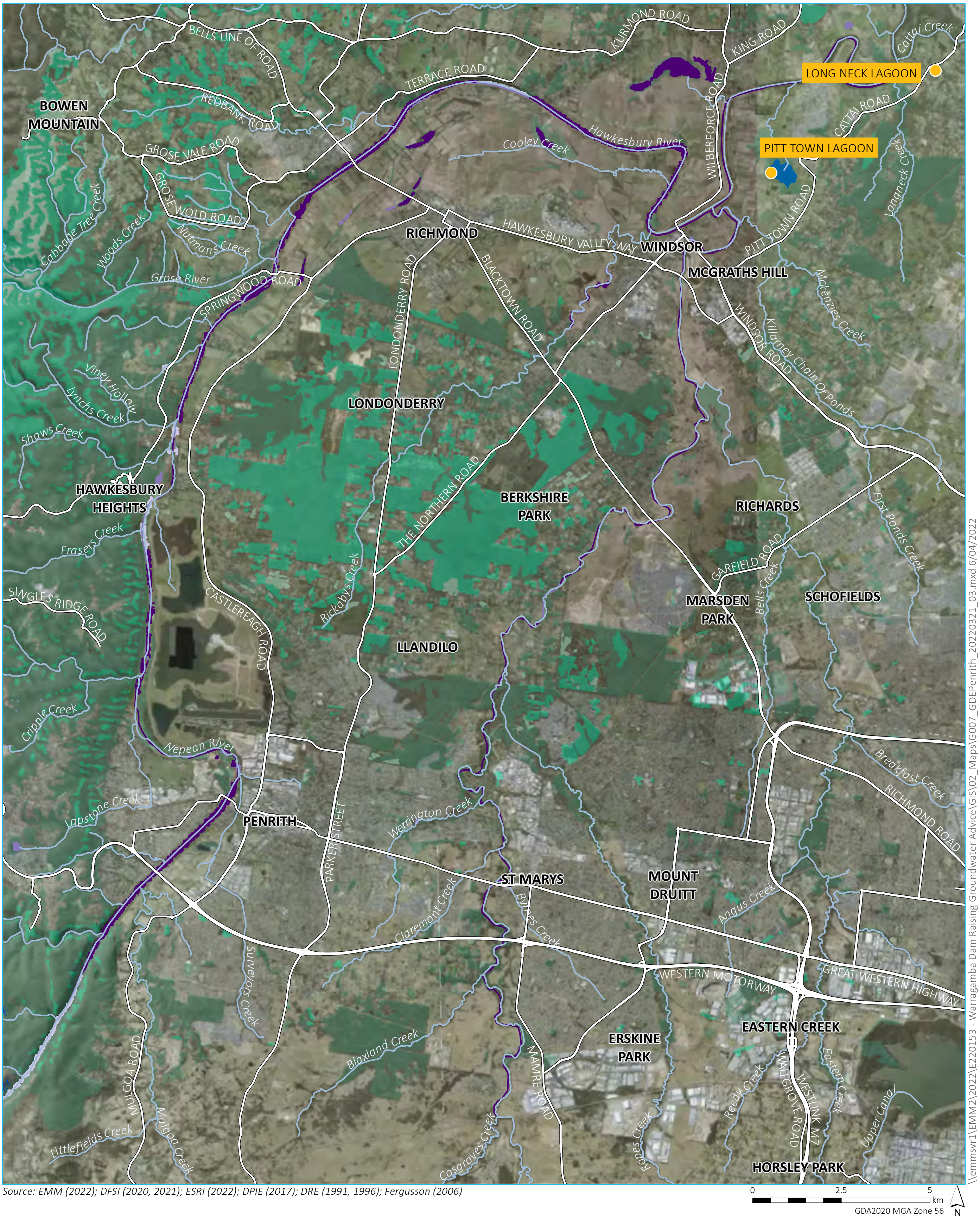
b Environmental

Pitt Town Lagoon and Long Neck Lagoon are listed in the WSP as high priority GDEs in the region. These lagoons comprise Endangered Ecological Communities Freshwater Wetlands on Coastal Floodplains. Pitt Town Lagoon comprises wetlands located on the Hawkesbury River floodplain immediately adjacent to the southern edge of Pitt Town, approximately 4 km north-east of Windsor (see Figure 4.9). Pitt Town lagoon is approximately 2 m higher in elevation compared to the Hawkesbury River. Long Neck Lagoon is a freshwater lagoon with channels and pools about 2–3 m deep with gently sloping margins. Located on the Hawkesbury River floodplain, but listed in the Sydney Basin Central water source, approximately 8 km north-east of Windsor.

Reference to the BoM GDE Atlas identified the following potential GDEs:

- Cumberland River Flat Forest, a high potential terrestrial vegetation GDE, located in thin bands adjacent to the Nepean/Hawkesbury River;
- Coastal Freshwater Lagoon vegetation, a high potential terrestrial vegetation GDE, located adjacent to the Penrith Lakes;
- Coastal Alluvial Floodplain and Cumberland Shale Sandstone Transitional terrestrial vegetation, a high potential GDE, located in small areas in the north; and
- Aquatic ecosystems that rely on the surface expression of groundwater in the Nepean/Hawkesbury River and all major lagoons on the floodplain. These are considered low potential GDEs.

The Penrith Lakes are not included in the BoM Atlas, however it is assumed groundwater discharge occurs to these lakes and this contributes to supporting aquatic organisms in these features.



Source: EMM (2022); DFSI (2020, 2021); ESRI (2022); DPIE (2017); DRE (1991, 1996); Fergusson (2006)

KEY

- WSP high priority GDE
- Major road
- Named watercourse

Groundwater dependant ecosystem (terrestrial)

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Groundwater dependant ecosystem (aquatic)

- High potential GDE
- Moderate potential GDE
- Low potential GDE
- Known GDE
- Unclassified potential GDE

Groundwater dependent ecosystems (Penrith)

Warragmba Dam Raising
Groundwater RTS
Figure 4.9

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5 Impact assessment

The following concise impact assessment is based on the large volume of historical data and trends described in Section 4.

5.1 Groundwater users: landholders and GDEs

Landholder water bores around Lake Burragorang target the Hawkesbury Sandstone and the closest landholder bores are 3 km away from the dam wall. Historically there have been no large rises in groundwater levels following sharp increases in dam storage (as observed at WaterNSW monitoring bores located close to the dam), consequently landholder water bores targeting the Hawkesbury Sandstone are highly unlikely to experience any groundwater level change. Terrestrial vegetation around Lake Burragorang is unlikely to be relying on groundwater in sandstone aquifers due to deep groundwater levels (ie typically greater than 50 mbgl) and therefore vegetation fringing the lake is highly unlikely to be groundwater dependent.

Downstream of Warragamba Dam, the alluvium beneath the floodplain areas is predominantly recharged via rainfall, ephemeral creeks and side slope runon from stormwater. Only minor (short term) recharge is expected from overbank flooding. Landholders and potential GDEs accessing alluvial groundwater are unlikely to experience reduced groundwater availability due to reduced flood inundation areas.

5.2 Groundwater recharge

At Warragamba it is difficult to quantify and separate the recharge to the Hawkesbury Sandstone aquifers from rainfall and dam leakage. While its likely there is a weak relationship between dam level rise and groundwater level rise, rainfall recharge is more likely contributing to groundwater level rise. Groundwater level rise is also gradual and muted, and does not respond to short term rises in dam level.

The alluvial aquifers are recharged predominantly via direct rainfall recharge, along with stormwater from ephemeral creeks and urban areas. Occasional overbank flooding surcharges groundwater levels for short periods but this water then drains back to the Nepean/Hawkesbury River.

5.3 Cumulative impacts

Tunnelling associated with the Western Sydney Airport and other major projects under construction in Western Sydney is within the Ashfield and Bringelly Shale (Wianamatta Group) geology located above the Hawkesbury Sandstone groundwater system. Furthermore, these projects are located 10 km from Warragamba Dam on the other side of Nepean River which is a groundwater discharge zone, therefore the potential for interaction with the Hawkesbury Sandstone aquifers around Lake Burragorang is considered negligible.

5.4 Minimal impact criteria

In accordance with the minimal impact criteria described in the AIP there will be negligible change to groundwater levels and water quality in the Hawkesbury Sandstone and alluvial aquifers owing to short term dam level rises and reduced flood inundation.

Groundwater levels in both the Hawkesbury Sandstone and alluvial groundwater systems fluctuate naturally during high and low rainfall periods, and the anticipated changes due to the Project are expected to be within these natural ranges.

6 Conclusion

In this expert advice, EMM has provided:

- an expanded description of the geology and geological structure;
- a description of the sandstone groundwater system attributes surrounding Lake Burragorang;
- a description of the downstream alluvial groundwater system attributes;
- a discussion of localised ecosystem and consumptive use;

and included new data/information relating to:

- groundwater levels and gradients; and
- groundwater recharge, discharge and flow directions.

To conclude, a short-term rise in Warragamba Dam storage levels from 116.72 to ~128 mAHD is highly unlikely to cause more than a 'minimal impact' on the adjacent and underlying Hawkesbury Sandstone aquifers (both water levels and water quality) and the downgradient alluvial aquifers (both water levels and water quality) beneath the floodplain areas. The risk to these groundwater systems, and their consumptive and environmental users is assessed to be very low.

Yours sincerely

John Ross
National Technical Leader - Groundwater
jross@emmconsulting.com.au

Nina Baulch
Associate Hydrogeologist
nbaulch@emmconsulting.com.au

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Authors

John Ross

John is a senior principal hydrogeologist with over 40 years' experience specialising in water resource, mining, site contamination, infrastructure and natural resource management. During this time, John has held specialist management roles in public and private corporations and consultancies.

John provides technical hydrogeological expertise and advice across the spectrum of water resource development, mining, environmental/water planning, assessment and management projects, including environmental impact assessments, environmental audits and technical reviews, remedial action plans, and groundwater licensing. John also has extensive experience in community and regulatory consultation across the Eastern seaboard, and is a member of several independent advisory panels for government agencies.

John has worked extensively on groundwater investigations in the Sydney Basin, contributing to drought and water supply studies for WaterNSW, strategic and technical/modelling advice private clients, and policy advice to DPIE-Water.

Nina Baulch

Nina is an Associate Hydrogeologist with over 13 years' experience in hydrogeological investigations, project management and analyses for mining, water supply and infrastructure projects. Nina has extensive experience in planning and supervising drilling programs, data analysis and interpretation, and development of conceptual models for groundwater flow systems. This includes financial project management and overseeing other hydrogeological disciplines, such as numerical groundwater assessments. She has written many groundwater assessments and management plans, relying on the interpretation of different disciplines data. Nina has also worked on and project managed numerous hydrogeological investigations across the Sydney Basin, including drought and water supply studies for WaterNSW.

Glossary and acronyms

Term	Definition
AIP	Aquifer Interference Policy
Alluvium	Loose, unconsolidated (not cemented together into a solid rock), soil or sediments (including clay, silt, sand, gravel, cobbles and boulders), eroded, deposited and reshaped by water in some form in a non-marine setting.
Aquifer	A geological formation or group of formations; able to receive, store and transmit significant quantities of water. Means a geological structure or formation, or an artificial landfill, that is permeated with water or is capable of being permeated with water (Water Management Act 2000 definition).
Aquifer interference activity	Means an activity involving any of the following: (a) the penetration of an aquifer, (b) the interference with water in an aquifer, (c) the obstruction of the flow of water in an aquifer, (d) the taking of water from an aquifer in the course of carrying out mining, or any other activity prescribed by the regulation€(e) the disposal of water taken from an aquifer as referred to in paragraph (d).
Aquitard	A geological formation that may contain groundwater but is not capable of transmitting significant quantities of it under normal hydraulic gradients. May function as a confining bed.
BoM	Bureau of Meteorology
Bore	A hole drilled in the ground, a well or any other excavation used to access groundwater. May be used for monitoring of groundwater (including water level, pressure or quality).
BP	Before present

Term	Definition
EIS	Environmental Impact Statement
Electrical conductivity (EC)	Electrical conductivity (EC) measures dissolved salt in water. The standard EC unit is microSiemens per centimetre (µS/cm) at 25°C.
FSL	Full storage level
Gaining stream	A stream where groundwater discharge contributes to streamflow.
Groundwater	Water contained within rocks and sediments below the ground surface in the saturated zone, including perched systems above the regional watertable.
Groundwater Dependent Ecosystem (GDE)	Natural ecosystems that require access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis, so as to maintain their communities of plants and animals, ecosystem processes and ecosystem services.
Groundwater discharge	The process by which groundwater is released into the environment usually either via baseflow or evapotranspiration.
Groundwater flow	Water that flows in aquifers and aquitards.
Groundwater level	The level of groundwater in an aquifer, typically measured in a bore. In the case of an unconfined aquifer, the groundwater level is equal to the water table level.
Groundwater recharge	The process which replenishes groundwater, usually by rainfall infiltrating from the ground surface to the water table and/or by surface water infiltrating to the water table from a stream. Other forms of recharge include flooding and irrigation, and artificial recharge can also occur through various means, including bore injection.
Groundwater system	Multiple aquifers that are overlying or adjacent but not necessarily connected, and are hydrogeologically similar regarding geological province, hydraulic characteristics and water quality. A system may consist of groundwater in one or more geological formations.
Hydrograph	A graph showing the surface level, discharge, velocity, or some other feature of water, with respect to time.
Losing stream	A stream from which water is lost to the surrounding and underlying substrate via infiltration through the streambed and banks.
LSC	Lapstone Structural Complex
mbgl	Metres below ground level
Permeability	The measure of the ability of a rock, soil or sediment to transmit a fluid. The magnitude of the permeability depends largely on the porosity and the connectedness of pores spaces. Synonymous with hydraulic conductivity when water is the fluid involved.
pH	Value that represents the acidity or alkalinity of an aqueous solution. It is defined as the negative logarithm of the hydrogen ion concentration of the solution.
Seepage	The infiltration of water from streams, irrigation channels, water storages, farm dams, natural surface water features and septic tanks into the groundwater system. It is a form of surface water–groundwater interaction and groundwater recharge. The term can also apply to low volumes of groundwater discharge.
Storage	A pond, lake or basin, whether natural or artificial, for the storage, regulation and control of water.
Storage level	The elevation of the water surface in a water storage at a particular time and date, measured relative to a specified datum, typically the Australian Height Datum (AHD).
Surface water	Water that flows over or is stored on the surface of the earth that includes: (a) water in a watercourse, lake or wetland and (b) any water flowing over or lying on land: (i) after having precipitated naturally or (ii) after having risen to the surface naturally from underground.
Water quality	The physical, chemical and biological characteristics of water. Water-quality compliance is usually assessed by comparing these characteristics with a set of reference standards. Common standards used are those for drinking water, safety of human contact and the health of ecosystems.
Water table	The top of an unconfined aquifer which can be either perched or regional. It is at atmospheric pressure and, in a regional context, indicates the level below which soil and rock are saturated with water.
WSP	Water Sharing Plan

Appendix F

Assessment of buyback options

Assessment of buyback options for the Hawkesbury-Nepean Valley

A technical paper to support the environmental impact assessment submissions report for the proposal to raise Warragamba Dam

October 2022

Prepared by Infrastructure NSW

1. Introduction and purpose

Some submissions to the environmental impact assessment (EIS) have suggested buyback options as an alternative to raising the Warragamba Dam.

In addition to information in the EIS and submissions report, this paper further considers the option to buy back private residential property as a regional and feasible flood risk reduction measure in the Hawkesbury-Nepean Valley.

2. Context and approach

2.1 The Hawkesbury-Nepean Valley

The Hawkesbury-Nepean Valley has the highest single flood exposure in NSW, if not Australia, because of its unique landscape and large existing population (Infrastructure NSW, 2017).

The valley covers around 500 km^2 of floodplain in Western Sydney (Figure 1). The floodplain falls mainly within 4 local government areas (LGAs) in Western Sydney: Penrith, Hawkesbury, The Hills and Blacktown. The floodplain also extends to smaller areas of the LGAs of Wollondilly, Liverpool, Central Coast and Hornsby.

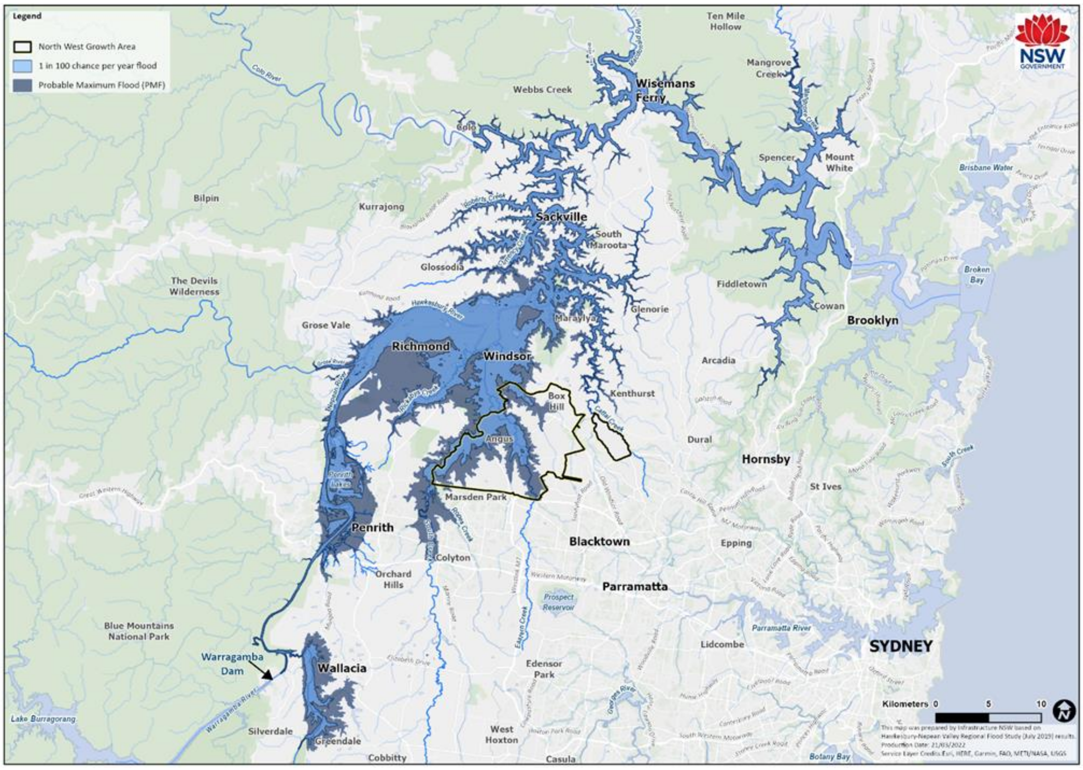

Figure 1 - Map of the Hawkesbury-Nepean Valley Floodplain (source: Infrastructure NSW, 2017)

The valley comprises 3 main floodplains – Wallacia, Penrith/Emu Plains, and Richmond/Windsor (including backwater flooding in South Creek and Eastern Creek). While the Hawkesbury-Nepean floodplains are highly interconnected by the road network, the distribution of the flood risk across these areas varies. The highest risks exist on the Penrith/Emu Plains and Richmond/Windsor floodplains.

2.1.1 Depth of floodwaters in the Hawkesbury-Nepean

Floodwaters in the Hawkesbury-Nepean Valley can be extensive and much deeper than most other floodplains in NSW and Australia. For example, a house in Windsor that is built at the 1 in 100 chance per year flood level, would be inundated with nearly 9 m of floodwaters in a probable maximum flood (PMF) while a house in Penrith would be inundated with around 5.5 m of floodwaters in a PMF (Figure 2). In contrast, the depth of floodwaters above the 1 in 100 chance per year flood level in Lismore for a PMF would be around 3.5 m and for Nyngan around 2.5 m, as illustrated in Figure 2.

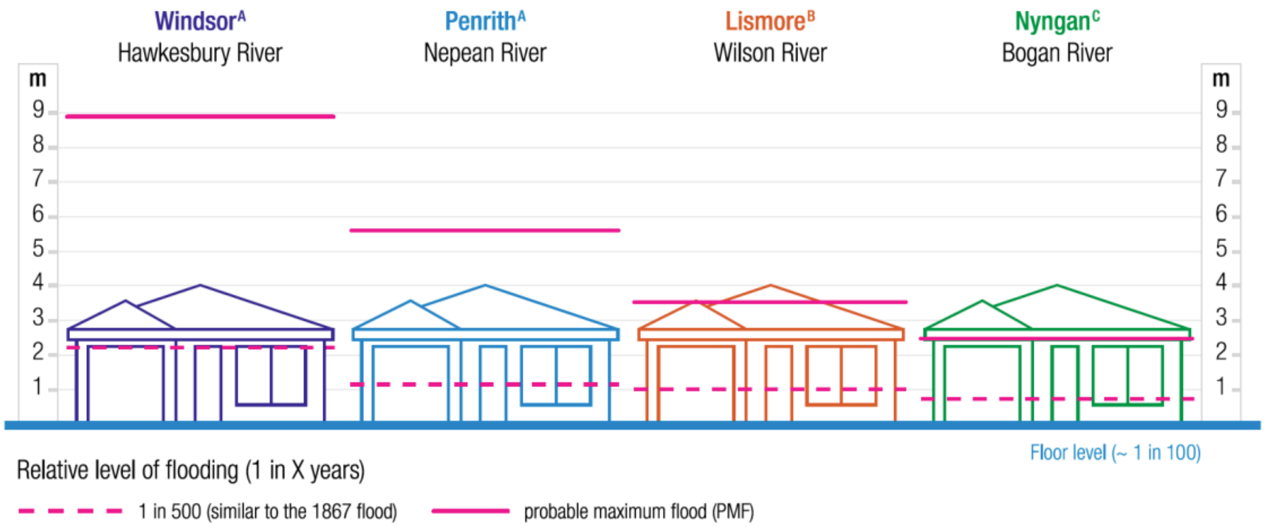

Figure 2 - Comparable depth of probable maximum flood for houses built at the current approved planning level (source: Infrastructure NSW 2019)

This depth of floodwater for rare events presents a significant risk to people's lives, livelihoods, homes and critical infrastructure.

2.1.2 Large and growing population

The large and growing population in the valley means the exposure to flood risk is significant and increasing. More than 140,000 people currently live or work on the floodplain (based on 2018 data). Over 36,700 residential properties, including around 1,900 caravans/manufactured homes (see Figure 3) and 4,500,000 m^2 of commercial space are currently subject to flood risk. This is mainly due to historic development occurring when there was either no flood planning level, or it was lower than the current flood planning level adopted by councils since the mid-1990s.

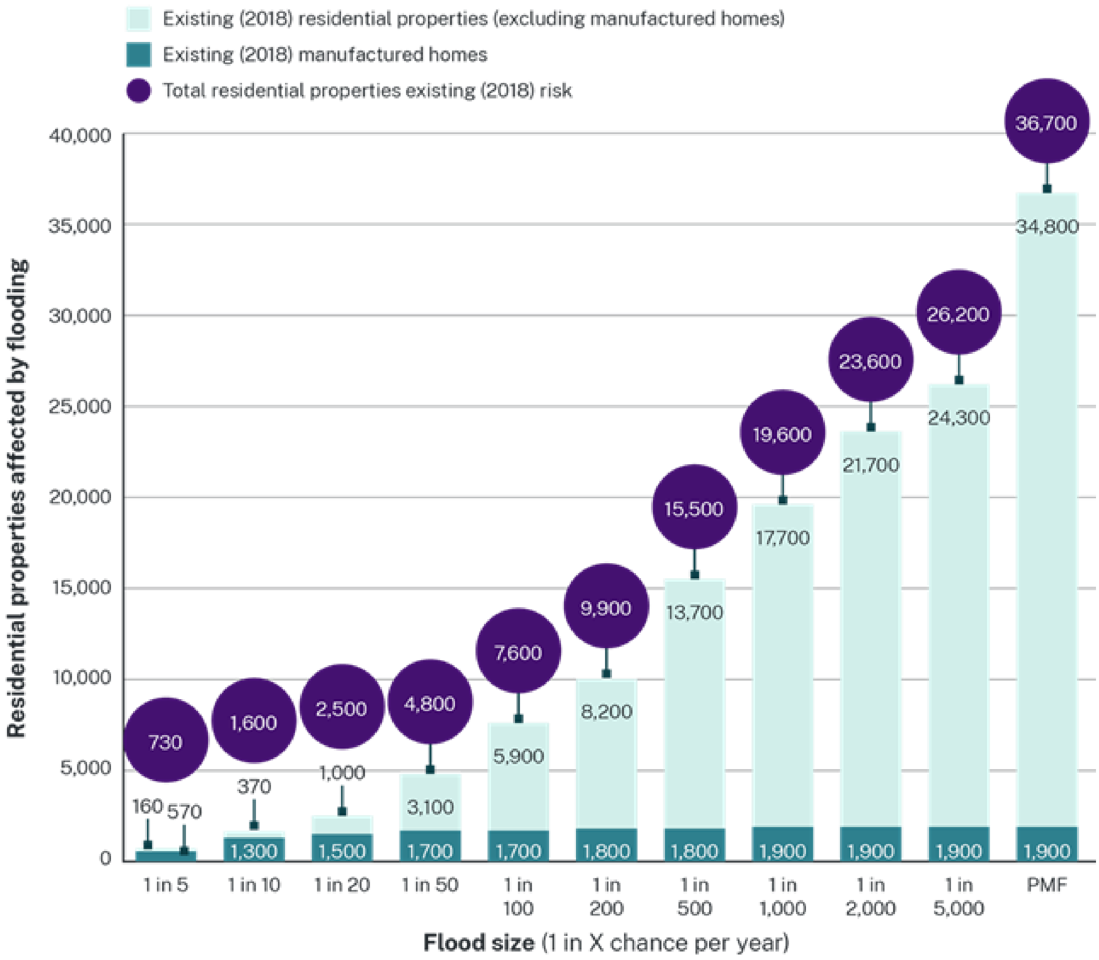

Figure 3 - Number of residential dwellings in the Hawkesbury-Nepean floodplain (source: Infrastructure NSW)

As a result of this large population and expansive development, large flood events would have high economic and social consequences.

If a 1 in 100 chance per year flood occurred (similar to the estimated frequency of the 2011 Brisbane flood) this would impact about 7,600 residential properties, require the evacuation of around 55,000 people and cause around $3 billion in damages.

If a flood similar to the 1867 flood occurred today (around a 1 in 500 chance per year event), about 15,500 residential properties would be impacted, 90,000 people would need to evacuate, and the estimated damages would cost $8 billion.

2.1.3 Legacy of development

The Hawkesbury-Nepean floodplain has a legacy of development that has taken place over more than 200 years. As a result there are developments, including residential properties, that are below the current flood 1 in 100 chance per year flood level. Some of these developments were built before there were any flood regulatory restrictions in place, as was the case throughout the 1800s and early 1900s.

Additionally, as our understanding of hydrodynamic processes has improved, new modelling techniques and technology have refined the calculation of design flood levels over time. This means that some developments from the 1980s and 1990s were built at a previous 1 in 100 chance per year flood level, based on the best available information at the time. These properties are now below the current 1 in 100 chance per year flood level.

The legacy of development also means there is a diversity of built environment forms on the floodplain including:

- heritage houses built at lower levels (some dating from the 1840s)
- suburban housing such as McGraths Hill and South Windsor, which were built when planning levels were lower
- houses on rural properties or agricultural land
- lifestyle and recreational homes functioning as secondary places of residence
- caravan parks and manufactured houses.

Applying buyback options in the valley needs to factor in the diversity of built forms in the valley and how to apply buyback equitably across those diverse forms.

2.2 Buyback options

Broadly, there are 3 main buyback options:

- **Voluntary purchase** – where the private property owner voluntarily accepts an offer to sell their residential property (building and land) to an authority or entity. This option allows the property owner to buy elsewhere within or outside the community. It results in the removal of the existing development and the rezoning of the land for more flood compatible uses, such as open space.
- **Land swap** – where the private property owner voluntarily accepts an offer to swap their land located in a high flood risk area for vacant land in an areas with low or no flood risk. The land swap does not include the house or business premises on the land. The private property owner is typically responsible for building the house or premises on the swapped land through their private funds or insurance payouts.
- **Compulsory acquisition** (or resumption) – private property is acquired by a public authority for a public purpose. Acquisition occurs without the consent of the property owner. There is a statutory process for compensation to the property owner.

These buyback options have been implemented to varying degrees in localities in NSW, Australia and in international jurisdictions.

2.2.1 Floodplain Management Program

The NSW Government's Floodplain Management Program partners with local government to manage flood risk and build community resilience. Voluntary purchase schemes are a part of a range of flood risk management options included in the program.

Under the Floodplain Management Program only local governments are eligible to seek funding for a voluntary purchase scheme; the program is not open to individual land owners (Office of Environment and Heritage, 2013).

Additionally, voluntary purchase schemes under the Floodplain Management Program are only an option where there is an unacceptable risk to life that cannot be managed through other flood risk management measures, such as effective emergency management (Office of Environment and Heritage, 2013).

The discussion below in this paper does not suggest the application of any voluntary purchase scheme under the Floodplain Management Program. Rather it explores the ideas and issues for a different application of buyback schemes.

2.3 Assessment criteria

In assessing buyback options for the valley, the following criteria were applied:

- degree to which the option resulted in significant, regional reduction of flood risk
- cost of the option
- likely social and environmental impacts of the option.

These criteria are broadly consistent with those in the Taskforce Options Assessment Report (Infrastructure NSW, 2019).

3. Voluntary purchase

3.1 Effectiveness in significant, regional reduction of flood risk

Voluntary purchase schemes would remove exposure to flood hazard for property owners participating in these schemes. However, it would be challenging to implement at scale large enough to significantly reduce flood risk on a regional basis across the Hawkesbury-Nepean.

3.1.1 Which flood level?

Voluntary purchase schemes are usually applied to particular flood levels within a floodplain, for example, properties up to a 1 in 20 chance per year flood level. Voluntary purchase schemes are therefore only beneficial in reducing flood risk up to the flood level to which they apply. The higher the flood level chosen to be eligible for a scheme, the more effective that scheme would be in reducing the regional flood risk.

As discussed in section 2.1.1 above, a feature of flooding in the Hawkesbury-Nepean Valley is the great depths of flooding that are experienced for rarer floods. This means that the consequences of flooding in the 1 in 100, 1 in 200, and 1 in 500 chance per year floods (and rarer events) are very significant.

If a scheme applied in the Hawkesbury-Nepean were limited to the 1 in 20, 1 in 50, or even the 1 in 100 chance per year flood level, it would not address the significant risk to life associated with larger, rarer floods.

3.1.2 Scale of application

Given the long history and wide-spread development across the Hawkesbury-Nepean (as discussed in section 2.1.2), the number of properties that would need to be included in a scheme to provide a regional reduction of flood risk would be significant. For example, applying a scheme to properties below the 1 in 20 chance per year flood level would include 2,500 properties and applying a scheme to properties below the 1 in 100 chance per year flood level would include 7,600 properties (Figure 3).

However, even at this scale there would still be a significant residual risk from flooding. As discussed in section 2.1.1 above, the consequences and risk to life from rarer flood events (above a 1 in 100 chance per year flood) is significant for the Hawkesbury-Nepean. If a scheme were to apply to all flood affected land in the Hawkesbury-Nepean, there would be 36,700 properties included in the scheme (Figure 3).

Schemes of this scale are unprecedented in Australia. The largest ever voluntary purchase scheme in Australia is currently being delivered in south-east Queensland as part of the Resilient Homes Fund. The fund includes an allocation of $350 million for the purchase of flood-impacted homes and is expected to purchase approximately 500 homes (Queensland Reconstruction Authority, 2022).

3.1.3 Willingness to participate

A key challenge with voluntary purchase schemes is that not all property owners may be interested or willing to participate. Examples of recent voluntary purchase schemes in NSW are presented in Table 1. A voluntary purchase scheme to remove houses located in the Moorebank floodway, which began in 1984, has stalled at about two-thirds complete nearly 40 years later. A scheme for Lower Prospect Creek that commenced over 30 years ago stalled 20 years ago at about 80% complete, with the remaining homeowners strongly opposing purchase offers at the values set by the Valuer General.

Table 1 - Examples of contemporary voluntary house purchase schemes in NSW

Location	Progress	Comment
Moorebank VP Scheme (Liverpool LGA)	118 of 175 (67%) purchased to 2021.	Commenced 1984.
Milperra VP Scheme (Canterbury-Bankstown LGA)	21 of 25 (84%) purchased to 2021.	Commenced 1984.
Lower Prospect Creek VP Scheme (Fairfield LGA)	72 of 92 (78%) purchased to 2022.	Commenced 1990. Last house purchased in 2002. Strong opposition from remaining landowners.
Wollongong VP Scheme (Wollongong LGA)	23 of 72 (32%) purchased to 2022.	Based on recommendations of 7 adopted Floodplain Risk Management Plans (2002-2014). Purchase rate of 2-3 properties per year.
South Murwillumbah VP Scheme (Tweed LGA)	11 of 15 (73%) purchased to end of scheme.	Commenced 1989. Remaining 4 houses rolled into new scheme in 2019 (see below).
Burringbar-Mooball VP Scheme (Tweed LGA)	5 of 26 (19%) purchased to Jan 2022.	Commenced after 2017 flood. No landowner interest in FY 21/22.
South Murwillumbah & Bray Park VP Scheme (Tweed LGA)	3 of 39 (8%) purchased to 2022.	Commenced after 2017 flood.

Source: NSW Department of Planning and Environment (Environment, Energy and Science), Liverpool City Council, Fairfield City Council, Wollongong City Council, Tweed Shire Council

This partial take-up of offers to participate in voluntary purchase schemes means the risk to life and property is reduced but not removed for a given area, as property owners may choose to remain in a high flood risk area. Consequently, emergency services will need to continue servicing people remaining in these areas in the event of a flood, and critical infrastructure will need to be rebuilt to service impacted dwellings.

The reasons for unwillingness to participate in voluntary purchase schemes varies, depending on property type and demographics. For example, those in heritage homes or on agricultural properties may have very strong social and/or economic ties to their properties. The long history of settlement and inter-generational farming in the Hawkesbury-Nepean Valley increases the social ties to the landscape and reduces and likely uptake of voluntary purchase schemes.

Additionally, for those in caravan parks and manufactured homes, there is the additional challenge of financial constraints limiting options for alternative accommodation, which raises issues of equity. The diversity of built forms underscores the significant challenge of scaling up voluntary purchase schemes to be an effective, equitable and efficient region-wide response to flood risk in the valley.

Interest in voluntary purchase is generally increased when there has been a significant flood, such as the recent floods in the Northern Rivers. The voluntary purchase schemes listed in Table 1 were all impacted, if not triggered, by significant flood losses, namely the:

- 1986 and 1988 Georges River and Prospect Creek floods
- 1998 Wollongong floods
- 2017 Tweed floods.

However, from discussions with the listed councils in Table 1, the window of opportunity for government to purchase flood-impacted houses is typically narrow. These councils have indicated that the reasons include:

- property owners may erroneously judge a flood disaster as a 'one off' and prefer to remain
- properties may change hands privately
- property owners may prefer to increase resilience in their existing homes, such as raising floor heights.

The regional benefits of voluntary purchase scheme depend on the level of cumulative and contiguous uptake, which is likely to be greater after a flood disaster. This compares to a flood mitigation measure such as dam raising, which provides a regional benefit without relying on individual property owners' participation. In recent history, the Hawkesbury-Nepean has not experienced the scale of flood disaster likely to generate broad support for the large-scale relocation that would be required for a significant regional reduction of flood risk.

3.2 Cost

A large-scale buyback scheme in the Hawkesbury-Nepean Valley would be financially costly. The Taskforce Options Assessment Report estimated that the cost of purchasing residential properties located within the modelled 1 in 100 chance per year flood extent at nearly $3.8 billion. Based on the higher mean sales prices from the June 2021 quarter ($876,500 per dwelling) current costing is about $5.2 billion.

In addition, there are costs to government associated with demolition of the purchased buildings and rehabilitation of the purchased sites. Also, given the long lead time taken to implement voluntary purchase schemes, or the need to provide incentives for landowners to relocate, the costs are likely to increase further.

An analysis found that due to the very high costs, the benefit-cost ratio (BCR) of buying back all existing Hawkesbury-Nepean dwellings within the 1 in 100 chance per year flood extent was low (about 0.2) (Figure 4). It is possible that buyback schemes limited to smaller floods such as the 1 in 20 or 1 in 50 chance per year floods might have higher BCRs, but these would be less effective in reducing the risks from larger floods.

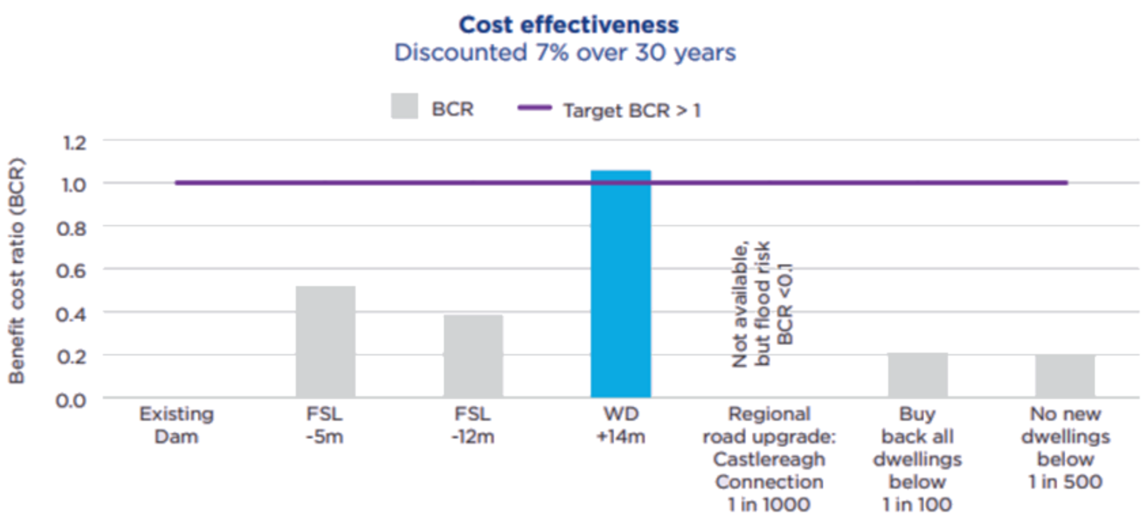

Figure 4 – Cost effectiveness of alternatives to mitigate flood risk (source: Infrastructure NSW, 2021A)

Apart from the costs of voluntary purchase, there would be the ongoing costs borne by councils and service providers to provide services to those residents who have chosen to remain on the floodplain.

However, the costs of voluntary purchase could be partly offset by avoided insurance costs on the part of the property owner and avoided disaster relief and recovery costs for government.

Further, over a long-term horizon there could be a case for voluntary purchase as climate risks increase. Communities may have a growing acceptance of measures to avoid risk to life and damage to property, but the overall success as a regional measure to reduce flood risk would still be contingent on individuals' participation in a voluntary purchase scheme.

3.3 Social and environmental impacts

3.3.1 Social dislocation

A large-scale buyback scheme would entail significant social dislocation for affected communities. Voluntary purchase of properties can result in residents leaving their local community to find suitable homes. Thousands of households would need to find alternative, permanent accommodation. Experience of the March 2021 Hawkesbury-Nepean flood showed that some people forced to temporarily relocate felt a keen sense of loss of community and social dislocation (Infrastructure NSW, 2021B).

3.3.2 Alternative use of land

Properties purchased with NSW Government funds would need to be reverted to flood-compatible uses including environmental, agricultural or recreational purposes. Some of these uses may require ongoing government maintenance. However, the patchy take up of voluntary purchase schemes, where not all property owners agree to participate in the scheme, may limit the potential for a sufficient size of vacated land to be made available for these other uses.

3.4 Summary

Voluntary purchase schemes:

- can be used to directly avoid exposure by targeting high risk properties
- historically have had mixed and incomplete uptake, with some property owners unwilling to participate
- are expensive and can take a long time to implement
- can result in social dislocation for established communities
- can be patchy in uptake resulting in vacated land being in separate, unconnected lots, thus limiting the use of vacated land for alternative purposes.

Given the realities of implementing such a scheme to many thousands of properties, in practice it would be very challenging to apply a voluntary purchase scheme at a large enough scale to provide significant, regional reduction of flood risk for the Hawkesbury-Nepean.

Case study: Christchurch, New Zealand

After the 2011 Christchurch earthquake sequence, the New Zealand Government undertook a large scale voluntary acquisition of properties. The scheme identified land as being in a green or red zone:

- Green zone was land suitable for repair and rebuild and comprised 96% (or 180,000) of residential properties.
- Red zone (Figure 5) was land not recommended for continued residential development in the short term because land repair would be prolonged and uneconomic, or there was an unacceptable level of risk to life from rock fall or cliff collapse. This comprised 4% (or 8,000) of residential properties.

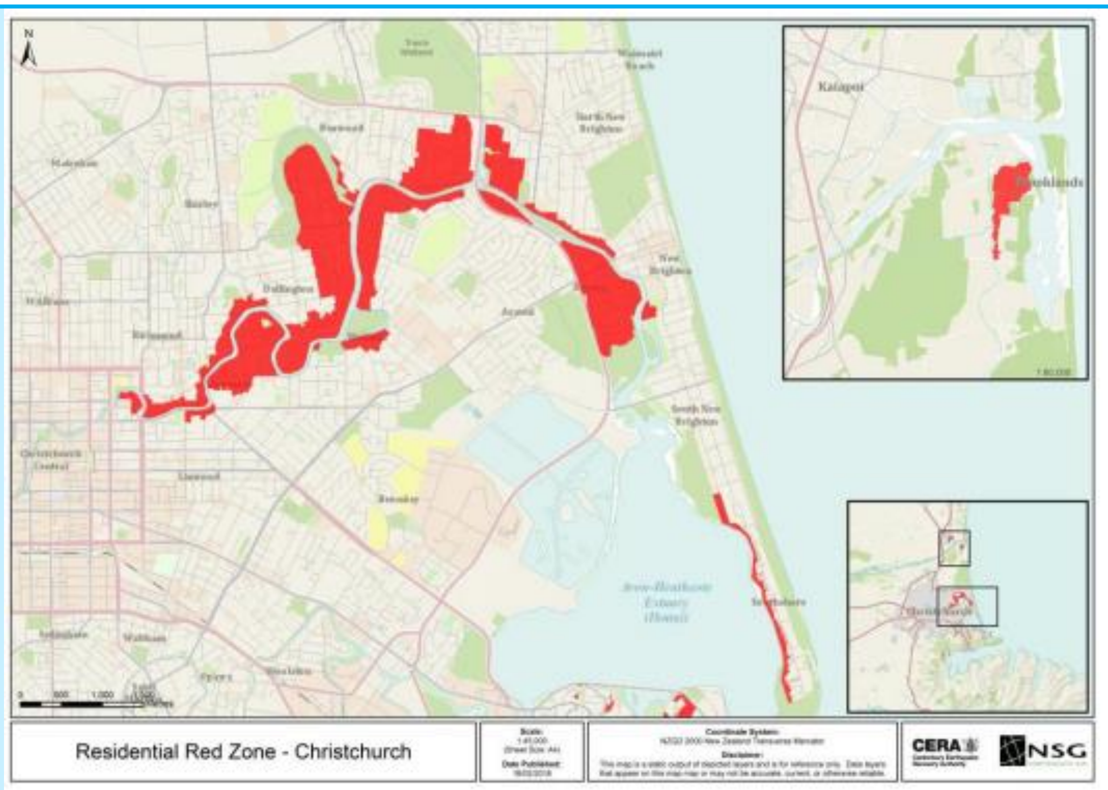

Figure 5 - Map of red-zoned areas in Christchurch, New Zealand (Source: Canterbury Earthquake Recovery Authority)

About 98% of voluntary purchase offers were accepted. The majority of offers accepted involved the government purchasing the land, while the owner recovered the cost of the residential premises through their insurer. The approximate total cost to the New Zealand Government for the voluntary purchase program was $AUD 1.9 billion. This did not include any costs associated with rebuilding premises, as such costs were covered by private insurance.

Key success factors for this high take up of voluntary purchase offers were that:

- the New Zealand Government enacted legislation to establish the Canterbury Earthquake Recovery Authority to coordinate recovery efforts. The authority had wide-ranging powers, such as requiring local government to act as directed, amending or overriding existing planning and regulatory requirements, and a streamlined land acquisition process (Harris, 2016)
- New Zealand has a national property valuation system that enabled the relatively expeditious valuation of property as the basis for government making voluntary purchase offers
- high number of land owners had home insurance (which included earthquake coverage[1]) that provided access to funds for rebuilding.

It would be challenging to replicate these success factors in a voluntary purchase program at a region-wide scale across the Hawkesbury-Nepean Valley because:

- significantly higher property values would mean costs would be significantly higher
- flood insurance is not mandatory and is becoming increasingly unaffordable for those living on the floodplain
- there is currently no legislative or regulatory framework for such an option.

[1] Earthquake insurance is mandatory for all home insurance policy holders in New Zealand and is funded through a levy on home insurance policies with fire hazard coverage.

4. Land swap

4.1 Effectiveness in significant regional, reduction of flood risk

4.1.1 Which flood level?

As with voluntary purchase schemes, the first consideration in how regionally effective a land swap scheme might be will depend on the criteria and flood level for inclusion in a scheme. The higher the flood level chosen to be eligible for a scheme, the more effective that scheme would be in reducing the regional flood risk. The challenges around this issue for the Hawkesbury-Nepean that have already been discussed in section 3.1.1 above also apply to land swap schemes.

4.1.2 Availability of land

Land swaps can be used to directly avoid exposure to flood hazards for at-risk properties. They can be applied to both residential and commercial land. For example, in response to floods in March-April 2022, Tweed Shire Council has called for expressions of interest to participate in an industrial land swap for businesses in Murwillumbah to move into a flood-free zone (Tweed Shire Council, 2022).

Land swaps rely on there being sufficient, vacant land that is:

- in an area with low or no flood risk, preferably above the PMF
- compatible with the preferred use, that is appropriate for the intended residential or commercial purpose
- within a reasonable proximity to the original land
- able to be purchased by the government.

With significant development already across the Hawkesbury-Nepean floodplain, there is limited flood-free, vacant land available for large scale land swaps.

While land swaps can be used to target certain high-risk properties, it is likely to be difficult to upscale this option to provide significant, regional reduction of flood risk in the Hawkesbury-Nepean Valley, given land constraints in Greater Sydney.

4.1.3 Willingness to participate

Like voluntary purchase schemes, property owners may be unwilling to participate, which has implications for the regional effectiveness of the scheme as well as a residual risk to life and land use complications. As these issues are discussed at length in section 3.1.3 above, they will not discussed again here.

4.1.4 Ability to participate

Land swap schemes generally require participants to:

- fund the cost of building a new dwelling on the new land, and
- demolish any existing structures on their old land to leave the land completely cleared.

This requires property owners to have enough capital to clear their old land and rebuild premises on their new land. People who are underinsured or uninsured may not have available funds and are therefore unable to participate in the scheme.

The same implications for regional effectiveness and residual risk to life that apply to schemes due to unwillingness to participate, also apply due to the inability to participate. As these issues are already discussed in section 3.1.3 above, it will not be discussed again here.

4.2 Cost

The cost of land swaps will depend whether government needs to purchase privately-owned land, or already owns vacant land suitable for residential or commercial purposes. If government needs to purchase suitable large tracts of land to enable a significant reduction of flood risk in the Hawkesbury-Nepean, the cost could be very substantial given the price of available land in Sydney and the costs associated with providing supporting infrastructure to service such land. Apart from the unit price of land, the final cost of the land swap will also be determined by the size of land purchased. In addition, there would be costs to government associated with demolition of any buildings and rehabilitation of the affected sites.

Apart from the costs of land swap, there would be the ongoing costs borne by councils and service providers to provide services to those residents who have chosen to remain on the floodplain.

Land swap costs could be partially offset by avoided insurance costs for the property owner and avoided disaster relief and recovery costs for government.

Further, over a long-term horizon there could be a case for land swaps as climate risks increase. Communities may have a growing acceptance of measures to avoid risk to life and damage to property, but the overall success as a regional measure to reduce flood risk would still be contingent on individuals' participation in a land swap scheme.

As part of a portfolio of floodplain management options, land swaps could be part of a targeted program to reduce risk to life.

4.3 Social and environmental impacts

4.3.1 Social dislocation

Land swaps may have the benefit of retaining community cohesion if neighbouring lots in a community are collectively relocated to lower-hazard areas. This helps preserve existing community ties and retains council's existing ratepayer base.

4.3.2 Alternative use of land

The vacated land can be used for a public purpose, such as for environmental and recreational purposes, both of which will require ongoing maintenance. However, if not all property owners participate in the scheme, this may limit the potential for a sufficient size of vacant land to be made available for alternative uses.

4.4 Summary

Land swap schemes:

- can be used to directly avoid exposure by targeting high risk properties
- require sufficient vacant, flood-free land to be available in close proximity
- generally require landowners to have sufficient capital to rebuild and therefore are unable to participate in such a scheme
- are expensive and can take a long time to implement
- can preserve community cohesion for established communities as households relocated together
- can be patchy in uptake resulting in vacated land being in separate, unconnected lots, thus limiting the use of vacated land for alternative purposes.

Given the scarcity of available land in Greater Sydney, and the likely limitations around the ability and willingness of landowners to participate in a scheme, it would be almost impossible to apply a land swap scheme to thousands of properties to be at a large enough scale to provide significant, regional reduction of flood risk for the Hawkesbury-Nepean.

Case study: Grantham, Queensland

After the 2011 floods, the Lockyer Valley Council bought 377 hectares of elevated land and offered to swap this land to residents living in flood-affected areas. About 120 households participated in the land swap at a cost to local, state and federal government of $30 million. Not all landowners participated in the land swap (see Figure 6 and Figure 7) due to either unwillingness or inability to participate. Some had insufficient funds to relocate and/or build new dwellings as landowners had to decommission their old dwelling and then fund the building of their new dwelling as government provided the land, not the dwelling.

The relative success of the Grantham land swap is partly attributed to the proximity of the relocation site to the existing community thus allowing preservation of social networks (Okada, et al., 2014) (Sipe & Vella, 2014). It would be very difficult to replicate Grantham's success in the Hawkesbury-Nepean Valley due to the limited availability of suitable land and the scale of relocation that may be needed.

Figure 6 - Aerial photograph of Grantham, Queensland in 2009, prior to the flood and land swap program (source: Google Earth)

Figure 7 - Aerial photograph of Grantham, Queensland in 2018, after the flood and land swap program, showing partial removal of dwellings from the floodplain (source: Google Earth).

5. Compulsory acquisition

5.1 Effectiveness in significant, regional reduction of flood risk

Given the incomplete uptake of large-scale buybacks through voluntary schemes, a mandatory approach to acquisition would be far more likely to achieve a significant regional reduction of flood risk in the Hawkesbury-Nepean Valley.

5.1.1 Which flood level?

As with voluntary purchase and land swap schemes, the first consideration in how regionally effective a land swap scheme might be would depend on the criteria and flood level for inclusion in a scheme. The higher the flood level chosen to be eligible for a scheme, the more effective that scheme would be in reducing the regional flood risk. The challenges around this issue for the Hawkesbury-Nepean that have already been discussed in section 3.1.1 above also apply to compulsory acquisition.

5.2 Costs

The cost of acquiring land would be based on statutory requirements to compensate with reference to market rates. Given high property prices, like voluntary purchase and land swaps, this would be an expensive option from a fiscal perspective. In addition, there would be costs to government associated with demolition of any buildings and rehabilitation of the affected sites.

Given the compulsory nature of this option, government and service providers can avoid the cost of servicing vacant land as all property owners would have been relocated.

5.3 Social and environmental impacts

5.3.1 Community opposition and resistance

A compulsory acquisition scheme would likely garner significant stakeholder and community opposition given the mandatory nature, particularly if applied at scale across the floodplain. This community resistance to compulsory acquisition has been evident in other infrastructure projects such as for road infrastructure projects (e.g. West Connex). This is likely to be particularly significant where there are large numbers of homes being acquitted and few homes to buy in the same locale and price range.

The reasons for community opposition would likely vary across the demographic profiles reflected in the diversity of built forms in the valley. For example, those with heritage houses and/or on agricultural properties may feel that there is no or limited compensation for those with very strong ties to their property on social and economic reasons, where it would be difficult to find alternative sites. Further, those in caravan parks and manufactured homes may face additional challenges where financial constraints make it difficult to find alternative accommodation. Both of these circumstances raise potentially significant issues of equity.

Additionally, compulsory acquisition is not a preferred approach for democratic governments. The NSW Government has stated that its first preference is to purchase land by agreement with the landowner (Portfolio Committee No. 6 - Transport , 2022). For example, to date, over 80% of NSW Government acquisitions of private land are achieved through agreement between the landowners and acquiring authority. The NSW Government does not approach potential acquisitions lightly and does so where there is significant benefit to the broader public (Portfolio Committee No. 6 - Transport , 2022).

5.3.2 Social dislocation

Like voluntary purchase and land swaps, existing communities would be socially dislocated as those affected by compulsory acquisition would need to relocate elsewhere. As this has already been discussed in section 3.3.1 above, it will not be discussed again here.

5.3.3 Alternative use of land

Given the compulsory nature of this option, where all property owners would need to relocate, any vacated land is more likely to be a contiguous tract of land. This vacated land can be more readily repurposed for alternative uses such as for environmental and recreational purposes compared to voluntary purchase or land swap. However, government would still need to manage ongoing maintenance of this vacated land.

5.4 Summary

Compulsory acquisition:

- in principle could provide significant, regional reduction of flood risk at scale
- is likely to generate stakeholder and community opposition due to the compulsory nature of this option
- is a high cost option
- could take less time to implement than voluntary purchase or land swaps
- allows for vacated land to be more readily repurposed for alternative uses compared to voluntary purchase or land swaps.

Given the lack of community acceptance for large scale compulsory acquisition, it would effectively be socially prohibitive to apply such a scheme at a large enough scale to provide significant, regional reduction of flood risk for the Hawkesbury-Nepean.

6. Conclusion

Buyback schemes can have value in reducing flood risk when applied in small, targeted locations.

Buyback schemes are unlikely to be an effective regional flood mitigation option for the Hawkesbury-Nepean Valley because:

- such a scheme would need to apply to many thousands of properties to deliver a significant regional reduction in flood risk – a scheme of this size has never been attempted in Australia
- applying a scheme to such a high number of properties would have such a high financial cost that it could be fiscally prohibitive
- the unwillingness and/or inability of property owners to participate in a voluntary scheme would limit the regional reduction in flood risk
- while compulsory acquisition could be effective in reducing regional flood risk, it would be socially disruptive and has no precedent at such a large scale
- the lack of appropriate, available land across Greater Sydney would hinder the application of a scheme at a regional scale.

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Appendix G

Supplementary geomorphology assessment

Warragamba Dam Raising - Geomorphology Technical Notes

1. Downstream Bank Stability
2. Downstream Erosion and Sediment Transport
3. Upstream Watercourses

Prepared for SMEC Australia Pty Ltd
Prepared by Beca Pty Ltd
ABN 85 004 974 341

9 September 2022

Creative people together transforming our world

Technical Note

By: Jeremy Eade

Date: 8 September 2022

Subject: **Warragamba Dam Raising – Downstream Bank Stability**

Our Ref: 4512987-194045299-74

ABN: 85 004 974 341

1 Purpose

As part of the Environment Impact Assessment (EIS) for the Warragamba Dam Raising Project, Beca prepared a Geomorphology Technical Assessment (SMEC, 2021) which became Appendix N2 of the EIS (referred to in this note as "EIS N2"). This assessed potential geomorphological effects of the project both upstream of the dam, and in the downstream waterways of the Hawkesbury and Nepean Rivers (HNR).

In response to public exhibition of the EIS, submissions were received that raised questions about the project effects on downstream bank stability.

The main issues on the geomorphology assessment came from the Department of Planning, Industry and Environment (now named DPE) NSW (Water). They recommended further high-level assessment of riverbank stability downstream, particularly from Penrith to Wisemans Ferry.

1.1 Proposed Scope of Work

This study focuses at a high-level on bank erosion / slumping of downstream banks and potential impacts on critical bank top assets arising from the change in hydrological regime due to water being released from the proposed new Flood Mitigation Zone (FMZ). The extent of the study will include the Nepean and Hawkesbury River channels from Penrith to Wisemans Ferry but with a particular focus from Windsor to Sackville. Based on the NSW River Styles, the Windsor to Sackville section is a good representative for much of the at-risk area. The geological conditions of this section are analogous to much of the wider river. This section has also been identified in the BMT WBM (2013) study as being high risk to erosion. The aims and objectives of our study are to carry out a high-level desk-based reviews with a confirmation site visit, of the following:

- Take note of SMEC (2021) in relation to the earlier assessment of downstream bank erosion effects and mitigations.
- Characterise downstream reaches into a framework of approximately three geomorphological domains, including taking *NSW River Styles* into account.
- Undertake a high level site visit via boat to inspect the banks in the North Richmond, Windsor and Sackville area to gain an understanding of the bank materials.
- Identify main factors that drive bank instability and influence the forms of bank erosion that will develop under contrasting stream levels downstream of the dam, including using available WDR borehole data and recent reports related to bank failures during flood events.
- Carry out qualitative risk assessment of the site that will consider the factors that drive bank failure; the likelihood of failures under contrasting river level hydrographs ('Existing' and 'with Project' scenarios).
- Undertake bank stability analyses at selected sites if appropriate taking into account water level hydrographs at the site, for existing and proposed FMZ operation for March 2021 flood, and for 5, 10 and 20 year Average Recurrence Interval (ARI) floods.

This study has been conducted in parallel with one for the Technical Note on Downstream Erosion and Sediment Transport, Beca (2022). Elements of that Technical Note have been brought into this study.

2 Background

Warragamba Dam Raising is a project to provide flood mitigation to reduce the significant existing risk to life and property in the Hawkesbury-Nepean Valley downstream of the dam. This would be achieved through raising the level of the central spillway crest by around 12 metres and the auxiliary spillway crest by around 14 metres above the existing full supply level for temporary storage of flood inflows.

The existing dam has limited flood storage volume to attenuate floods, and therefore its effect on flood peaks in the river system downstream is also limited. Large floods which pass over the dam relatively unmitigated have large erosive power and can inundate areas of the adjacent flood plain in the downstream reaches. The intent of the dam raising project is to reduce the incidence and severity of flooding on the downstream reaches of the river, by holding flow in temporary storage, referred to as the Flood Mitigation Zone (FMZ).

Operation of the FMZ will change the hydrologic regime of the river downstream. Large flood peaks will be attenuated, and the stored water will be released overtime as a sustained moderate flow until the FMZ empties and the dam reverts back to its existing operational regime. The proposed change in hydrologic regime has the potential to alter the geomorphic functioning of the downstream river. Changes to functioning would differ in the different reaches along the Hawkesbury / Nepean River downstream, as the influence of tributary inflows becomes more significant relative to the discharges from the Warragamba dam. A brief summary of the hydrologic changes is outlined below.

Set 1, Small floods (20-year ARI)

In these smaller floods only a limited amount of flood peak attenuation is proposed. After the incoming flood peak has started to fall, the flood water retained in the FMZ is then discharged via gates in the dam at a discharge rate of approximately 1,150 m^3/s (SMEC, 2019).

For the downstream reaches an overall reduction in flow peak will occur, however the river will spend longer at the lower fixed discharge flow. This potentially has implications for the erosion of vulnerable bankside soils and stability of riverbanks, which in some reaches are already highly susceptible to failure.

Set 2, Major floods 50-year ARI and 100-year ARI and Probable Maximum Flood (PMF)

The operational regime for these large floods is to hold back much more flood water in the FMZ than for smaller floods, then discharge that water progressively after flood levels downstream have receded, therefore maximising the use of the available storage and reducing peak outflows as much as possible.

The implications of this regime are a three-stage discharge hydrograph, with the final stage being similar to that for Set 1, described above. For the downstream reaches this constant flow rate release for extended periods has the potential to induce bank erosion in the form of notching at the banks levels of the sustained recession flows.

Predicted dam outflow changes for various flood ARIs are shown in Figure 10 of EIS N2, and Beca (2022) provides hydrographs and commentary on flow rates and changes from Penrith to Wisemans Ferry. Where relevant, these changes are discussed in the results and assessment.

3 Literature Review

The following existing information has been reviewed and referenced in the following sections, and relevant elements used to inform this study.

We found a good body of literature summarising and in some cases mapping existing and possible future erosion risk areas, and studies regarding effects of riparian vegetation on river bank stability. However, we did not find any substantive analytical studies on bank stability in the reaches of the HNR downstream of the Warragamba Dam, nor any that tracked erosion rates at reference points along the river.

EIS N2: Geomorphological Technical Assessment 2021

Beca carried out a Geomorphological Technical Assessment of possible effects of the proposed raising of the Warragamba Dam on upstream and downstream waterways (SMEC, 2021). EIS N2 was prepared in order to identify and assess geomorphological impacts related to the project and provide technical guidance and inform the broader EIS. It includes a limited desk-based review of downstream bank erosion effects and mitigations, plus documentation of site visits to the river at selected locations.

Hawkesbury-Nepean River March 2021 Flood Review

Infrastructure NSW carried out a review of the March 2021 flood event on the Hawkesbury-Nepean River (HNR) (Infrastructure NSW, 2021).This event caused severe flooding in the Hawkesbury-Nepean Valley. The report focuses on the main river between Bents Basin (near Wallacia) and Brooklyn. The report includes an analysis of the flood event, the impacts of the flood (including brief commentary of erosion), and an assessment of the differences that various flood mitigation options would have made to this flood.

BMT WBM Report on Upper Hawkesbury River Bank Erosion Mapping 2013

BMT WBM has prepared a Coastal Zone Management Plan (CZMP) for the Upper Hawkesbury River on behalf of Hawkesbury City Council (Council) (BMT WBM, 2013). The aim of the study was to establish a baseline of bank erosion features and conditions. The study area includes an 80 km stretch of the Hawkesbury River between Yarramundi and Wisemans Ferry. Central to the study was a rapid water-based assessment of foreshore erosion along the Hawkesbury River between Yarramundi and Wisemans Ferry including mapping and field data collection of erosion zones and foreshore structures. The aim was to collate and establish a baseline upon which further data collection and mapping of the study area may be compared.

EMM Memorandum on Expert Groundwater Technical Report 2022

EMM Consulting Pty Ltd was engaged by WaterNSW to provide expert advice on groundwater matters raised in submissions to the EIS for the WDR project (EMM Consulting Pty Ltd, 2022). The groundwater levels and trends were focussed within the Penrith to Windsor areas.

Stream bank erosion: A review of process of bank failure, measurement and assessment techniques and modelling and approaches (Watson 2005)

This report reviews the mechanisms and causes of riverbank erosion and proposes methods for their characterisation; assessment and modelling based on a number of project sites in New Zealand (Watson, 2005). Rapid assessment techniques are presented that are expected to form a more holistic basis for future assessments of bank erosion.

Riparian vegetation and riverbank stability

The effect that riparian vegetation has on improving riverbank stability is discussed in a number of papers used in this review. Hubble, Docker, and Rutherfurd (2010) undertook a review of selected eastern Australian river systems, including the Hawkesbury-Nepean River and the effects that riparian vegetation had on these systems. They found that the presence of riparian forest on riverbanks significantly reduces the likelihood of mass failure due to reinforcement of riverbank soils by tree roots. They also discussed a number of Australian tree species that have specifically evolved deep root systems in response to prolonged dry periods. Docker and Hubble (2009) also discussed specific south-east Australian riparian tree species and the effect their root systems had on enhancing the shear strength of soils beneath them in the riverbank. They found that while variable, two species of eucalypts in particular demonstrated a greater earth-reinforcing potential than the other species in their study. Hubble and Rutherfurd (2010) investigated the relative contributions of vegetation and flooding in controlling channel widening on the upper Nepean River. They found that during drought dominated regimes, the presence, or lack thereof, of riparian vegetation had little influence on bank erosion leading to increasing channel width. However, during flood dominated regimes, banks that had been cleared of riparian vegetation eroded more than banks that had not been cleared. Using geomechanical modelling, they concluded that the difference in erosion rates was due to the effect of tree roots on reinforcing the banks against rotational failures. They also concluded that devegetation amplified the potential for bank failure during the drawdown phase of a flood.

4 Bank Failure Processes

4.1 Factors Driving Bank Failures

Stream bank erosion is a natural geomorphic process which occurs in all channels as adjustments of channel size and shape occur to convey the discharge and sediment supplied from the stream catchment. Bank erosion includes two main groups of processes:

hydraulic processes at or below the water surface entrain sediment and directly contribute to erosion, particularly of non-cohesive banks (i.e. sands and gravels) by processes of bank undercutting, bed degradation, and basal cleanout. Undercutting of the riverbank can result in larger block/rotational failures.

gravitational mass failure processes (including shallow and rotational slides, slab and cantilever failures, earthflows) detach sediment and make it available for fluvial transport.

Two major factors contribute to bank erosion: bank characteristics (i.e. soil type and erodibility potential) and hydraulic/gravitational forces. Processes of surface erosion, development of positive pore water pressure, soil piping, and soil cracking can also contribute to bank erosion. Often banks collapse when they are saturated with water, after the river/channel water levels recede.

The conditions under which different processes occur are determined by bank material characteristics and local soil moisture conditions (O'Neill and Kuhns, 1994).

The stability of a bank primarily depends on channel and flow characteristics, and the type and strength of the bank materials. Factors influencing bank erosion are presented below (Table 1).

Table 1. Factors influencing bank erosion (after Knighton, 1998)

Factor	Relative Characteristics
Storm frequency	Rainfall intensity and duration
Flow properties	Magnitude-frequency, duration and variability of stream discharge Magnitude and distribution of stream velocity and shear stress Degree of turbulence Sediment load
Bank material composition	Size, gradation, hydraulic conductivity, degree of cohesion and stratification of bank material
Bank geometry	Height, slope, length, profile shape
Bank moisture conditions	Soil moisture levels (saturation), seepage, pore water pressures, piping
Channel geometry	Width, depth, slope of channel, stream curvature (concave, convex, straight)
Vegetation	Type, % cover, age, rooting depth, exposed roots, stability
Human-induced factors	Stock and vehicle usage, artificial drainage input

Bank erosion caused by hydraulic action (e.g., fluvial erosion of sandy materials) is closely related to the magnitude and duration of a flood event. Other types of bank retreat, notably mechanical failures under gravity (commonly impacting cohesive materials) are more closely related to pre-storm soil and groundwater conditions produced by antecedent rainfall events.

High river flows and velocities due to high river water level events not only remove material directly from the bank but also scour the base, leading to bank over steepening and gravitational failures (particularly in non-cohesive soils).

The BMT WBM Report (2013) Section 2.2.1 states that '*factors affecting bank erosion in the downstream sections of the Hawkesbury River include wind, wind waves, boat wash, uncontrolled access for farm animals, sediment starvation / bed degradation and slumping (Kimmerikong, 2005).*' This is exacerbated by the lack of riparian vegetation.

Riparian land use also has an effect on the volume, velocity and flow paths of surface runoff which at some locations (e.g. stormwater outlets and overland flow paths) causes localised scour in the river channel and erosion of the riverbanks.

Human influences include water-based development or foreshore structures such as jetties, stairs/ladders, bank protection works and boat ramps. Bank erosion is common around foreshore structures which can redirect flows causing "end effect" erosion to adjacent riverbanks. Pipes and other horizontal infrastructure can also act as preferential flow paths. If improperly designed, structures such as these can exacerbate natural bank erosion.

The EIS N2 (section 5.3.1) reported that cumulative bank erosion can be caused by prolonged FMZ flows. It stated that riverbank erosion and bank slumping can be exacerbated by higher river flows (flood events and FMZ releases).

An investigation by the Queensland Department of Science, Information Technology and Information, as reported in the Wivenhoe and Somerset Dams Optimisation Study, concluded that release strategies that maintain a constant water level for long durations are likely to have a greater impact on downstream bank erosion than a slightly varied flow level (Department of Energy and Water Supply, 2014). This study suggested that a fixed release discharge may cause notching or undercutting at low levels, or completely saturate the bank (increasing susceptibility to mass failure erosion) following higher river water levels (Department of Energy and Water Supply, 2014). A study by Thoms (2017) found that notch development was the dominant instability mechanism noted along the Torrumbarry Weir Pool, River Murray (NSW-Vic border). In this study they found that erosion notches resulted from stable water levels and was promoting other forms of bank instability (Thoms, 2017).

4.2 Bank Failure Mechanisms

The main riverbank failure mechanisms identified in this review, including both literature review and site visits, and also informed by the analysis reported later, are:

- Gravitational/rotational slumping due to excess pore water pressure – As the floodwater recedes, the porewater pressure in the riverbank remains high as groundwater takes longer to drain/recede than the river. The increase in pore pressure in the bank, combined with the floodwater no longer providing a supporting buttress, can result in gravitational slumping of the bank. Non-cohesive soils will drain faster than cohesive soils but will also become saturated faster when flooding does occur.
- Scour/undercutting induced gravitational slumping – erosion at the toe of the riverbank will undermine the upper riverbank. The lack of support causes the riverbank to slump. This occurs in all river environments but is more common on outside bends of rivers.
- Piping type failure – piping type failure is the result of internal erosion by groundwater, within a non-cohesive soil mass. It is common in interbedded non-cohesive soils where groundwater flows preferentially along permeable layers within the soil mass. Silt and fine sand particles can become entrained as the groundwater drains out of the riverbank after a drop in water levels, leading to linear voids or ‘pipes’. These voids can collapse causing mass failure of the soil mass at the riverbank. The ability for the silt and sand particles to become entrained is determined by the ‘exit velocity’ of groundwater as it drains out of the soil. Higher exit velocities will entrain more particles when compared with lower exit velocities. The exit velocity is dependent on the permeability of the soil, and the hydraulic gradient (the difference between the groundwater level in the bank, and the level of the river).
- Overland flow by receding floodwater - Floodwater which has overtopped the riverbank will cause erosion by forming preferential channels on the overlying river terrace. Water will naturally flow towards these channels causing further erosion.

The July 2022 site visit noted significant bank failure resulting from the early July 2022 flood event. All four failure mechanisms listed above could be identified at various locations. Gravitational slumping caused by elevated pore water pressures in the riverbank is the likely cause of the majority these failures although evidence of piping was common upstream from Cattai Creek. Photos from the site visit are presented in Appendix A.

5 Site Characterisation

Rapid assessments of erosion affecting various sites downstream of the Warragamba Dam have been undertaken by BMT WBM (2013) and by Beca (in 2019 for SMEC (2021) and in 2022 for this study).

BMT WBM (2013) undertook a water based rapid assessment of foreshore erosion and field data sheets were used to document site observations.

The extent and locations of the Beca 2019 rapid geomorphological inspections of downstream sites were undertaken on land at a limited number of locations as part of the EIS N2 and are presented in the EIS N2 Figure 33 (DS-01 to DS-12).

Neither assessment method recorded the influence of geology or nature of soils forming the eroding banks or provided details of failure types or mechanisms.

Site visits were undertaken by Beca in July 2022 over two days between North Richmond and Sackville to confirm soil conditions in the riverbank over this section. Selected photos from this site visit are presented in Appendix A.

5.1 Geology and Geomorphology

The geology and nature of the soils downstream of the Warragamba Dam have a strong influence on their erodibility and the sediment derived from riverbed and bank erosion. At a high level we have characterised the downstream reaches into a framework of three geomorphological zones based on the predominant outcropping geological formations that will form the banks and sources of sediment input to the rivers. This approach has been informed by NSW River Styles, but also takes other relevant factors into account, in particular the relative hydrological changes due to the project in different reaches of the river.

The three geomorphological zones are based on an interpretation of the *Penrith Geological Map Sheet 9030 published by the NSW Dept of Minerals and Energy* (Warragamba to Sackville) (Clark and Jones, 1991), and *Sydney 1:250 000 Geological Sheet SI/56-05 3rd Ed published by the Geological Survey of New South Wales* (Bryan J.H., 1966), and local experience of these soil types. Figure 1 shows an excerpt from the Penrith Geological Map showing the area between Warragamba Dam and Sackville. The Nepean/Hawkesbury River is shown as a blue line. The grey (Hawkesbury Sandstone) and green (Ashfield Shale) areas show where rock is mapped at (or very near) the ground surface and is influencing the topography. Yellow (Quaternary alluvium) and light orange (Tertiary alluvium) are weaker interbedded river and floodplain deposits characterised by generally very flat topography. In particular, the current floodplain is composed of Quaternary alluvium. The section of river from Sackville to Wisemans Ferry is not mapped at this detail however is similar in geology to the area between Cattai Creek and Sackville. Upstream of these zones as far as the Warragamba dam the river passes through rock gorges where bank stability is not affected by the change of hydrological function.

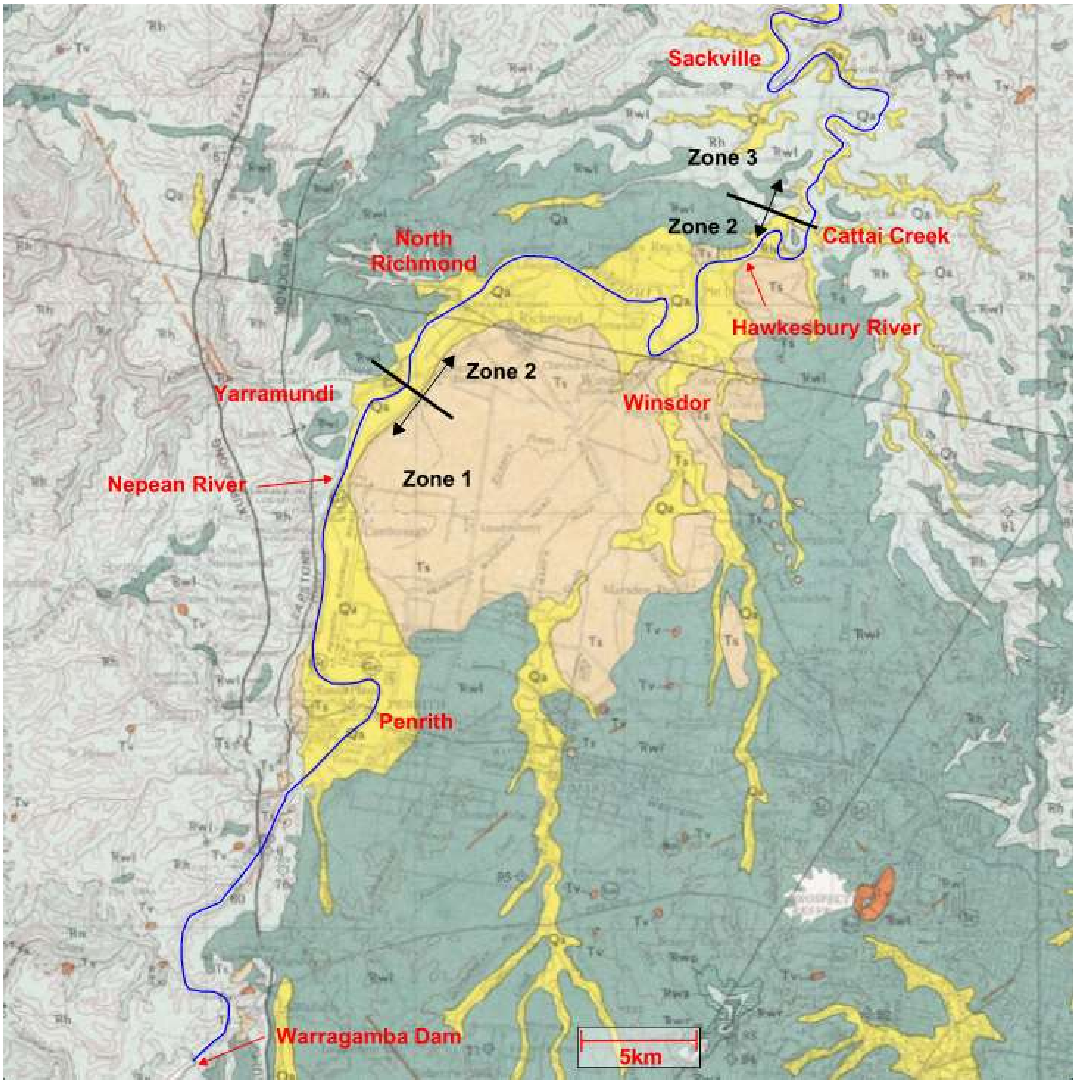

Figure 1. Excerpt from the Penrith Geological Map showing part of the study area and the zones identified below

ZONE 1 -

This zone includes the **Nepean River from Lapstone to Yarramundi Reserve**. It is generally characterised by:

i) A wide floodplain composed of Alluvium (typically Cranebrook Formation, Qpc - gravel, sand, silt, and clay) over the southern half and a narrow floodplain with Hawkesbury Sandstone (Rh – medium to very coarse-grained quartz sandstone) on the left bank over approximately the northern half of the zone.

ii) This reach is classified in the NSW River Styles system as laterally unconfined, continuous channel, low sinuosity, gravel bed from Penrith Weir downstream, and as Water storage, dam or weir pool upstream.

iii) Farming and recreational land includes Penrith Lakes Regional Park and Sydney International Regatta Centre and moderate to high density housing developments concentrated at Castlereagh; Emu Plains and Penrith.

iv) The EIS N2 reports the stream condition is good or moderate, with high or conservation recovery potential and low to moderate fragility, based on NSW River Styles.

v) At the EIS N2 rapid geomorphological assessment sites DS-02 to 08, inferred bank sediments are predominantly sandy gravels and gravely sands with occasional boulder beds.

vi) This reach was not visited during the July 2022 site visits.

ZONE 2 -

This zone includes the **Hawkesbury River from Yarramundi Reserve to Cattai Creek**. It is generally characterised by:

i) A wide floodplain (up to 6 km near Windsor) composed of Alluvium (typically Lowlands Formation, Qpl - gravel, sand, silt, and clay) over the northern half and a narrow floodplain with Ashfield Shale (Ra) on the left bank over approximately the southern half of the zone.

ii) This reach is classified in the NSW River Style system as laterally unconfined, continuous channel, low sinuosity, fine grained bed (to Ebenezer).

iii) Extensive farming land locally with high density housing developments concentrated at North Richmond and Windsor.

iv) The EIS N2 reports the stream generally has low to moderate fragility, based on NSW River Styles.

i) The EIS N2 rapid geomorphological assessment sites DS-07 to 11 are in this reach but are superseded by the July 2022 site visits.

v) The July 2022 site visits included 8 sites in this zone. The bank sediments in this zone are predominately interbedded fine sand and sandy silt.

ZONE 3 -

This zone includes the **Hawkesbury River from Cattai Creek to Wisemans Ferry**. It is generally characterised by:

ii) A narrow floodplain (typically 100 m to 250 m) composed of a mix of Alluvium (Qpo, Qpa, Qph - gravel, sand, silt, and clay) and Hawkesbury Sandstone (Rh) banks sometimes in near vertical cliffs.

iii) This reach is classified in the NSW River Style system as partly confined, planform controlled, low sinuosity, discontinuous floodplain, fine grained bed

iv) Farming land with generally low-density housing developments

v) The EIS N2 reports the stream generally has low to moderate fragility based on NSW River Styles.

vi) The EIS N2 rapid geomorphological assessment site DS-12 are in this reach, but are superseded by the July 2022 site visits.

vii) The July 2022 site visits included 3 sites in this zone between Sackville and Cattai Farm. The bank sediments in this zone are predominately interbedded fine sand and sandy silt. In some areas the sandstone is outcropping directly on the riverbank.

In contrast, the approach undertaken during the BMT WBM (2013) rapid field assessments subdivided the Hawkesbury River into 3 zones that coincide with notable topographical changes observable in the field (channel shape, ground elevation, contributing upstream catchment area, land use, geomorphology/geology). as follows:

Zone A – Yarramundi to Windsor;
Zone B – Windsor to Sackville; and;
Zone C – Sackville to Wisemans Ferry.

5.2 River Bed and Bank Materials

Bed sediment characteristics in the Hawkesbury River from the Grose River junction (Yarramundi Reserve) to Wisemans Ferry have been studied previously (NSW Public Works, 1987). Some of the main findings were:

- The riverbed is comprised of clean sands to muddy sands;
- The fines content is very small (i.e., clean sands) in the upper tidal reaches from Freemans Reach to Windsor;
- The sands remain clean to the vicinity of Colo River, downstream from which the mud content progressively increases.

The Beca rapid geomorphological inspections of downstream sites estimated the compositions of the riverbed but did not record bank compositions. Riverbed compositions at locations DS-03 to DS-12 generally recorded progressive decrease in grain size of bed sediments from fine sandy gravels (DS-03 & 04); gravely sands (DS-06 to 09) and sand (DS-11 & 12).

The July 2022 site visits showed that the riverbank had the following characteristics.

- Between North Richmond and Cattai Creek is fairly consistently interbedded fine sand and fine sandy silt deposits with very low clay content. Ashfield Shale is exposed on the left bank just downstream from North Richmond for approximately 3.5 km. This area is characterised by very steep, and high banks relative to other areas on the river.
- Downstream from Cattai Creek, Hawkesbury sandstone is the predominant geology and is controlling the shape and style of the river. Narrow riverbanks comprising interbedded fine sands and fine sandy silts are present, with sandstone outcropping at river level in many locations.
- Clay content was observed to be very low for the majority of soils observed in this visit.

5.3 Bank Strengths

A single day land-based site visit was undertaken for field data collection on the river downstream of the Warragamba dam, as part of the EIS N2, including to assess bank strengths. These were assessed using a Controls model 16-T0171 pocket penetrometer to indicate bank strengths as a basis to assess impacts of flow changes on bank erosion susceptibility.

It should be noted that pocket penetrometers are designed primarily to assess strength of fine soils with some cohesion (i.e. clayey silts and clays). As the tests appear to have been undertaken on mainly non-cohesive soils caution is required when interpreting the results of these tests. In general, an interpretation of the raw data suggests the average range of shear strengths of soils within all zones (DS-03 to DS-12) would be between approximately 30 kPa to 330 kPa (if tested on cohesive soils). The raw data of the bank strength data are shown in Figure 42 and in Appendix H of the EIS N2.

The EIS N2 (Section 3.2.2) concluded that the strongest and the weakest bank regions were spread over the length of the rivers, including the downstream areas, with no clear spatial pattern. This is not surprising given the uncertainties identified in testing methodology and interpretation.

The bank strengths were not tested during the July 2022 site visits. General observations from the site visit were that the granular riverbank materials observed (fine sands and silts) were loose to very loose (density index <35%). It should be noted that in many cases, the riverbank had significant slumping as a result of the floods which occurred in early July 2022. This will have resulted in strengths significantly lower than in-situ riverbank materials.

In general, exposed Hawkesbury Sandstone (Rh) and Ashfield Shale (Ra) cliffs will have higher relative bank strengths when compared with banks formed of unconsolidated granular (gravel, sand and silt) or cohesive (clay) materials. Sandstone/Shale banks can remain stable for longer periods of time and at higher and steeper slopes when compared to banks formed of granular or cohesive materials.

5.4 Bank Failures

The banks of the zones downstream of the Warragamba Dam (Zones 1 to 3) are characterised by predominantly granular materials (i.e. interbedded gravel, sand, and silt mixes with little clay). These soil types have a high potential for erosion by flowing water.

Erosion of riverbanks is a natural process that occurs in all river environments. The results of BMT WBM (2013) rapid assessments of current bank erosion affecting the Hawkesbury River between Yarramundi and Wisemans Ferry are contained within their report. A headline summary of the main takeaways from this assessment are as follows:

- Bank erosion was observed in all study area zones;
- Overall about 85% of erosion sites were considered to be vertical or steep with the remainder classified as moderate;
- Absent or cleared vegetation was common (70% or more bank erosion sites);
- The majority of bank erosion sites are where significant segments of riverbank have receded or been lost entirely due to bank scour and mass failure resulting in steep or vertical banks;
- Flooding can trigger dramatic and sudden changes in rivers and recent flooding in the area is partly responsible for the bank erosion particularly where the bank is exposed due to lack of vegetation.

The BMT WBM Report (2013) states that bank erosion is likely to have occurred as a result of short-term cumulative impacts on riverbank condition caused by several factors mainly including:

- saturation of banks from off-stream sources;
- inundation of bank soils followed by rapid drops in flow after flooding;
- bank soil characteristics such as poor drainage or seams of readily erodible material within the bank profile.

Both the HNR 2021 Flood Review (Infrastructure NSW, 2021), and the Beca July 2022 site visits identified significant bank slumping as a result of the March 2021, March 2022 and July 2022 floods. Both of these floods have been assessed as 20-year ARI events. Observations from the July 2022 site visits support the assessment made in BMT WBM (2013) that bank saturation and inundation followed by a rapid drop in flow after flooding is a major contributing factor to the erosion. The July site visits also identified a number of sites where significant bank erosion has occurred as a result of overbank floodwaters returning to the river channel as the water level recedes. Significant erosion was observed on both straight sections, and curved sections of the river.

From the literature review it is noted that:

- Reaches downstream of Sackville Ferry where the riverbank is comprised of steep sandstone cliffs and where the riparian vegetation is in good condition are less likely to be adversely affected by higher flow rates and levels in the river, or changes in bank erosion potential.
- The reaches upstream from Sackville to Windsor are already subject to general erosion, due primarily to the high river banks, and the silt-sand bank materials.
- The general rate of bank erosion could potentially increase for the 'with Project' Scenario in the Penrith and Windsor – Sackville (upstream of Sackville Ferry) areas of the Nepean and Hawkesbury Rivers, due to increased duration of flow, and bank materials being more susceptible to erosion.

As outlined later in this study, recent work described in Beca (2022) has also found that hydrological changes resulting from the FMZ operation mean there is increased erosion potential from North Richmond to downstream of Cattai Creek. This reach is geologically similar to much of the Windsor to Sackville reach, and partly overlaps with it.

5.5 Groundwater

Groundwater levels and changes are relevant in assessing the effects of FMZ operation on potential for bank saturation and slumping.

EMM (2022) indicates that the alluvial groundwater system is an unconfined, permeable aquifer with groundwater levels within 10 m of the ground surface in the Penrith area. Although water levels are typically shallower at 5-6 m below ground level on lower alluvial terraces. Groundwater levels respond directly and immediately to rainfall recharge, and rainfall is the main recharge mechanism.

Groundwater level contours from EMM (2022) show the groundwater flow direction is towards the Hawkesbury/Nepean River, where there is no tidal influence. The groundwater elevations confirm that the river is a gaining stream as groundwater levels are typically slightly above river levels. This implies that the river receives baseflow from the alluvium to provide a component of flow in the river except when the river is in flood (EMM, 2020).

6 Risk Assessment

6.1 Concept Level Analysis

Concept level numerical analyses have been undertaken to compare the bank stability of the 'with Project' scenarios against an 'Existing' baseline during 5, 10, and 20 ARI floods, as a measure of Project effects. The analyses have been undertaken using observations from the July 2022 site visits, profiles of the bank at representative locations provided by WaterNSW, and hydrographs for the 5, 10 and 20 year ARI floods for the 'Existing' and 'with Project' scenarios provided by WaterNSW. The July 2022 site visits occurred approximately two weeks after a significant flood event that occurred in the Hawkesbury/Nepean River catchment. Measurements at Windsor indicated that this event is similar in magnitude to the March 2021 flood. Both floods are categorised as a 20 year ARI flood.

The sections selected are named WILBER1, HOPEFARM1, and SACKVILLE1 (Figure 2).

- WILBER1 is in Quaternary alluvium to the north of Pitt Town. The river at this section is classified according to the NSW River Styles as laterally unconfined, continuous channel, low sinuosity, fine grained bed. This classification applies to the river upstream to Yarramundi and downstream to Ebenezer. The predominant geology of this location (Quaternary alluvium) is typical for the river between Yarramundi and Cattai Creek.
- HOPEFARM1 is located approximately 2 km downstream from Cattai Creek. The river at this location is classified according to the NSW River Styles as Laterally unconfined, continuous channel, low sinuosity, fine grained bed. This is the same as WILBER1 however the river at this location is transitioning into narrower floodplain comprising Quaternary alluvium with the river channel controlled by Hawkesbury Sandstone outcrops.
- SACKVILLE1 is located near to the Sackville Ferry. The river at this location is classified according to the NSW River Styles as partly confined, planform controlled, low sinuosity, discontinuous floodplain, fine grained bed. This classification applies to the river upstream to Ebenezer, and downstream past Wisemans Ferry. The river at this location comprises a very narrow floodplain which overlies Hawkesbury Sandstone. Hawkesbury Sandstone outcrops behind the narrow floodplain and controls the path of the river.

Technical Note

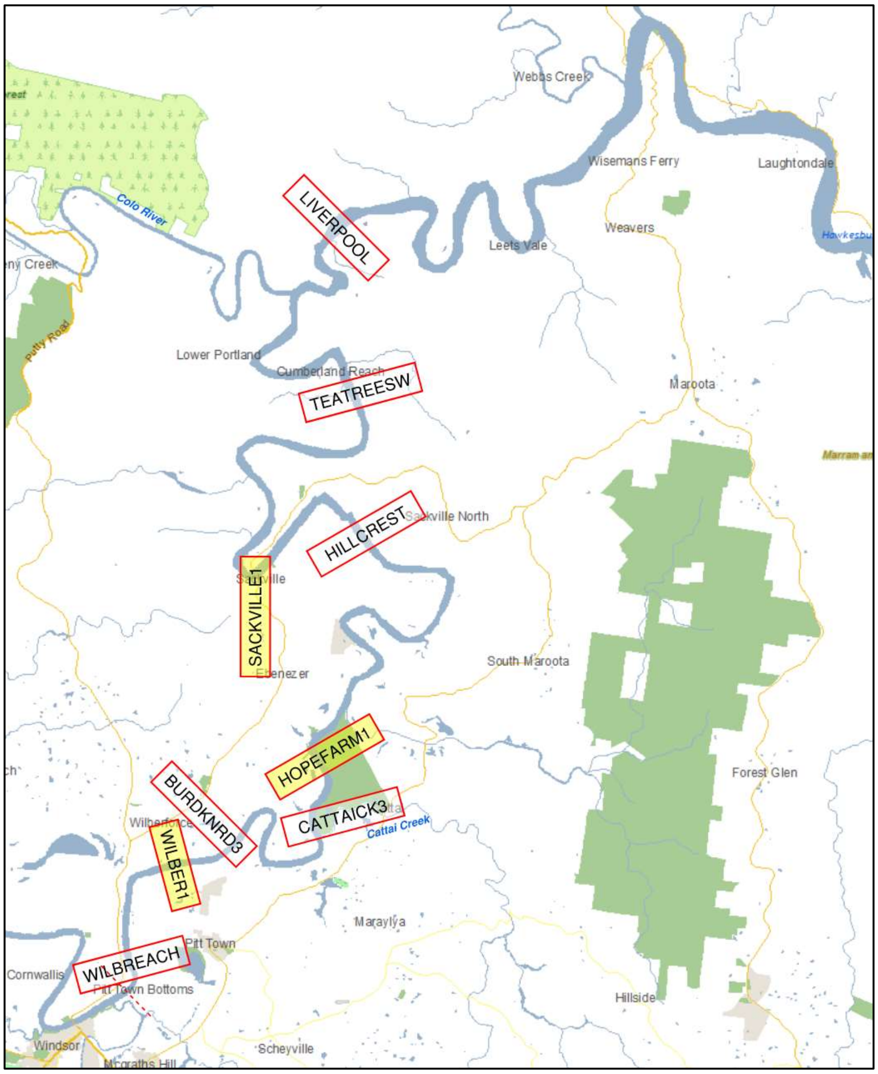

Figure 2. Plan showing some sections provided by WMA Water. The sections used for the concept analysis are highlighted yellow.

The analyses have been undertaken using GeoStudio SEEP/W and SLOPE/W software. It is important to recognise that these analyses are intended to provide relative differences between the operational regimes of the 'Existing' and 'with Project' scenarios at different ARI flood levels. These analyses are not based on site specific investigations or testing, and therefore may not reflect the exact conditions onsite. Typical soil and permeability parameters, for the types of silt and fine sand soils observed during the July 2022 site visits have been used in the sections to quantify differences, if any, in the bank stability between the 'Existing' and 'with Project' scenarios at the different ARI flood levels. Key parameters are outlined in Table 2.

Table 2 - List of key geotechnical and hydrogeological parameters used in analysis

Geology	Unit Weight	Phi	Cohesion	Hydraulic Conductivity	Ky'/Kx' ratio	Compressibility
Quaternary Alluvium	17 kN/m^3	28°	2 kPa	1 x 10^{-6} m/s	0.2	1 x 10^{-5}
Hawkesbury Sandstone*	-	-	-	1 x 10^{-7} m/s	0.7	1 x 10^{-6}

* Hawkesbury Sandstone modelled as bedrock (impenetrable) in slope stability analysis

Groundwater level assumptions are based on an unconfined aquifer with gentle hydraulic gradient towards the river as described in EMM (2020 and 2022), as no site-specific groundwater data was available. The factor of safety for the critical failure at each time increment analysed have been normalised against Day 0 water levels for the relevant hydrograph. The resulting 'relative factors of safety' have been plotted against time for each ARI flood. Plots for the conceptual analyses are presented in Appendix B.

6.2 Existing vs with Project Scenario

We have undertaken a risk assessment based on a comparison of existing conditions, with conditions expected to occur during various flood events where controlled spilling will occur. Riverbank saturation induced slumping has been analysed at a high level, all other mechanisms have been assessed qualitatively.

Gravitational/rotational slumping caused by prolonged saturated/excess pore water pressure

The key differences between 'Existing' and 'with Project' scenarios is that the flood hydrographs in the 'with Project' scenarios have lower peak water levels, and slower water level recessions, than under the 'Existing' scenario. These factors are both key drivers of bank stability under saturation and draw-down.

The concept analysis for each of the sites show that in general, the lowest relative factor of safety (FoS) for the 'with Project' ARI scenarios is generally either the same as, or slightly higher (less likelihood of failure) than those for the 'Existing' ARI scenarios. Our analysis shows that:

- as the floodwaters rise and the riverbank becomes saturated, the relative FoS for both 'Existing' and 'with Project' ARI scenarios increases. This is due to floodwater providing a buttress against the saturated riverbank.
- As the floodwaters recede back to normal, the relative FoS for the 'Existing' scenarios drops to below 1 indicating a higher chance of failure compared to Day 0 (the common start point for the relative FoS assessment in each scenario).
- The magnitude of the drop below 1 is higher as the magnitude of the flood increases.
- In all analyses for the 'with Project' ARI scenarios, the relative FoS initially remains above 1, during the controlled release of water. This indicates a reduced likelihood of failure during this time when compared with Day 0 (the common reference point).
- Towards the end of controlled release of floodwater, and when it ceases, the relative FoS reduces below 1 for a short period before it returns to pre-flood levels.

Technical Note

An example output is presented in Figure 3. All graphical outputs are attached as Appendix B.

A summary of the analysis shows that:

- The relative FoS for both the 'Existing' and 'with Project' ARI scenarios is above 1 during the flood, and until floodwaters have mostly subsided.
- The relative FoS for all 'Existing' ARI scenarios is at its lowest point when the floodwater is within 1-2 m of normal and slowly rises over time.
- The relative FoS for all the 'with Project' ARI scenarios remains above 1 while the controlled water release is occurring. The relative FoS drops to below 1 once the controlled release of water has ceased and the river level returns to normal.
- For all ARI scenarios, the lowest relative FoS was for the 'Existing' analysis.

This therefore suggests that the risk of bank failure due to saturation and rotational slumping will be marginally reduced as a result of the Project at all sites and flood events analysed. The reduction in risk is likely due to the combined effect of a lower flood peak level, and the staged drawdown of the river level. Keeping the river at an intermediate level after a flood event allows groundwater levels in the riverbank to reduce at a slower rate. This, in conjunction with the lower peak flood level, reduces the hydraulic gradient and allows pore pressures in the upper riverbank to dissipate somewhat while the lower riverbank is still buttressed by the intermediate river level.

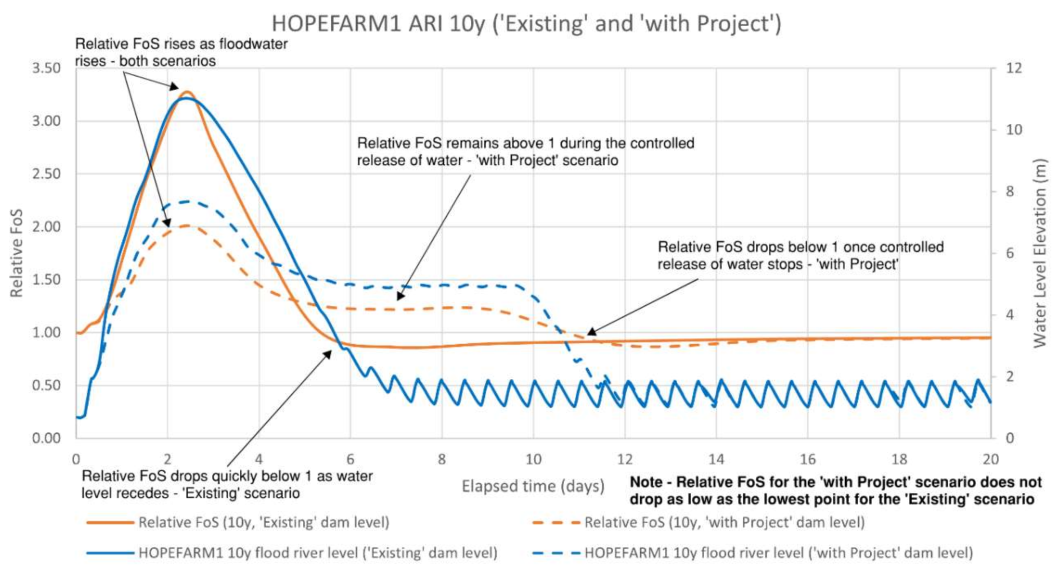

Figure 3. Example plot showing relative factors of safety over time for the 'Existing' and 'with Project' hydrographs at Hopefarm

Scour/undercutting induced gravitational slumping

The risk of scour is discussed in detail in the Downstream Erosion and Sediment Transport technical note (Beca, 2022). A brief summary of the findings of the study, comparing the 'with Project' scenarios to the 'Existing' scenarios are described in Table 3 and mapped in Figure 4.

Table 3 – Potential erosion effects (source Beca, 2022)

Description	Erosion potential
Upstream Penrith Weir	
"Ponded" due to weir. Flood mostly confined. Rock / gravel bed, some cohesive sediments.	Cumulative work done significantly reduced in all FMZ events. Bed and bank erosion potential reduced.
Penrith Weir to Grose River	
Steeper gradient than downstream reaches. Flood mostly confined. Bed gravel to sand.	Cumulative work done significantly reduced in all FMZ events. Bed and bank erosion potential reduced.
Grose River to Cattai Creek	
Significant out-of-channel flood plain flow in 'Existing', but much reduced in 'with Project'. Flat hydraulic grades. Return flow from flood plain around Windsor affects hydraulic grades upstream, even some backflow in 'Existing'. This reduces erosion potential in 50 – 100 year ARI.	
North Richmond – Windsor Bed and banks sandy.	Increased total event flow volume through the channel for 50 and 100 year ARI in 'with Project' results in similar erosion potential to 'Existing' for North Richmond, but by Thornham Park erosion potential in 20 to 100 year ARI is nearly doubled. From Reservoir to Windsor the backwater affects stream power and erosion is reduced for 'with Project', although locally at Freereach there is a slight increase in all events.
Windsor to Cattai Creek Bed and banks sandy.	For this reach there is again an increase in erosion potential from the 20 year ARI event and above, under the 'with Project' scenario, with the effects up to or slightly more than double.
Cattai Creek to Colo River	
Bed and banks sandy. Flood mostly confined.	Effects on erosion potential are variable, with some locations being slightly reduced for 'with Project', and some slightly increased, but on average similar to 'Existing'. The greatest increase occurs in the 50 and 100 year ARI events in the vicinity and immediately downstream of Cattai Creek.
Colo River to Wisemans Ferry	
Bed and banks sandy. Flood mostly confined.	Erosion potential reduced under 'with Project' compared to 'Existing'.

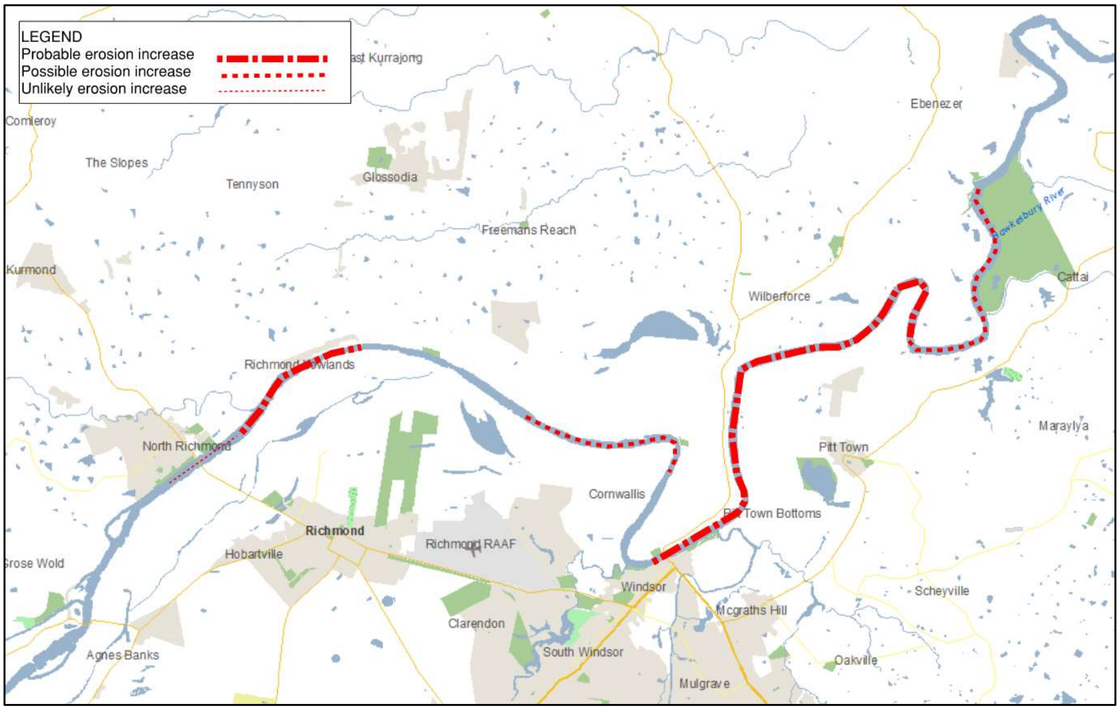

Figure 4 – Map of areas where erosion might increase (source Beca, 2022)

The increased erosion will occur across the whole section of submerged bank section but will be greater towards the base where shear stress increases due to depth. This will also be stronger on the outside of bends.

Based on the results presented in Beca (2022), there is an increase in energy to the bank in some areas between North Richmond and Cattai Creek. The geology of the areas where possible and probable erosion increases (Figure 4) are likely is predominately highly erodible Quaternary alluvium sediments. This will result in increased direct erosion of the bank to the height that it is submerged. This is likely to result in scour/undermining towards the base of the riverbank. Scour of the base of a riverbank will steepen the toe of the bank resulting in an increased risk of mass failure as the toe is critical in providing support to the riverbank as a whole. The exception to this is just downstream of North Richmond where the left riverbank is comprised of Ashfield Shale rock. Ashfield Shale is much less erodible than the Quaternary alluvium which makes up the right bank in this location.

Some of the areas identified in Figure 4 where possible or probably erosion increases in the 'with project' scenarios also coincide with areas where riparian vegetation is very low. The literature review identified that the presence of riparian vegetation helps reduce the risk of bank slumping and erosion (Hubble, Docker, and Rutherfurd, 2010; Hubble and Rutherfurd, 2010). Planting of riparian trees, ideally those specified by Docker and Hubble (2009) may reduce the risk of scour/undermining initiated bank failures.

Piping

There is not enough site specific information available to be able to undertake a detailed piping analysis for the sites. However, based on typical groundwater conditions expected in the soils onsite, and the hydrographs provided we expect that the likelihood of piping is either the same, or diminished as a result of the ‘with Project’ scenarios.

Overland flow by receding floodwater

The ‘with Project’ scenarios reduce the peak flood level for any given ARI event. This is likely to reduce the frequency of flood events where the capacity of the main channel is exceeded, particularly for smaller flood events. As a result, erosion directly caused by receding floodwater as it returns to the main river channel is likely to be reduced. For larger events where floodwaters spill over the banks, the lower peak water level for the ‘with Project’ scenarios will result in lower volumes of water that will be returning to the river.

6.3 Summary of Risk Assessment

Site visits during this assessment, as well as previous literature and experience of the area show that banks comprise gravely sand, sand and silty sand mixtures that are relatively well drained.

Our analyses show that the ‘with Project’ scenarios do not increase the risk of gravitational/rotational slumping as a result of sustained saturation caused by the extended release of water during a flood event. In contrast the analyses suggest that the lower peak flood level, combined with the controlled release of water at an intermediate level, can marginally reduce the risk of a mass failure by allowing riverbank pore pressures and hydraulic gradient to reduce at a slower rate than what is currently occurring under the ‘Existing’ scenario. The risk of piping is also considered to be reduced as a shallower hydraulic gradient will result in lower exit velocities for groundwater draining from the riverbank which will result in less silt and sand becoming entrained.

From the downstream erosion results presented above (Beca, 2022), the main form of increased riverbank erosion for the ‘with Project’ scenario would occur between North Richmond and Cattai Creek. This would be as gravitational failures induced by undercutting and basal cleanout at the base of the predominantly non-cohesive sandy banks. Bank erosion caused by hydraulic action (i.e., hydraulically induced failures) is closely related to the magnitude and duration of a flood event. It should be noted that during both the March 2021, and July 2022 flood events, significant bank erosion occurred in the area between North Richmond and Cattai Creek in what were 20 year ARI events. This implies that erosion is already a significant risk in this area. It is difficult to determine whether a reduction in risk of pore pressure induced failures, piping, and overbank erosion is outweighed by the increase in risk of scour/undermining induced mass failure.

7 Conclusions and Recommendations

7.1 Conclusions

We have undertaken this high level review and analysis using generalised data and typical parameters. No site specific investigation or analysis has been undertaken as part of this study. A summary of the results from this study are provided below.

- The EIS N2 (SMEC, 2021) and BMT WBM (2013) Reports both identified the existing risk of erosion in the downstream reaches varied between Medium and High.
- In ‘Existing’ scenarios, the river returns to its base flows and water levels quickly after a flood event. The riverbank soils however appear to not return to baseline levels as fast

resulting in high pore water pressures and a steep hydraulic gradient, as evidenced in the relative bank stability analysis. This can cause mass failures due to slumping and piping failures.

- In 'with Project' scenarios, the modelling suggests that a combination of a lower peak flood level, and a staged reduction in water level results in lower pore water pressures in the river banks compared to 'Existing' scenarios, and a shallower hydraulic gradient. This results in a reduction in risk of rotational mass failures due to slumping and piping.
- Out of channel effects such as erosion of the bank as floodwaters recede will be reduced due to the lower frequency of such events with lower peak flood levels
- The risk of scour/undermining initiated bank failures is likely to be lower between Warragamba Dam and Yarramundi, and Cattai Creek to Wisemans Ferry.
- The risk of scour/undermining initiated bank failures is likely to be higher between North Richmond and Cattai Creek, based on the fluvial erosion assessment.
- The North Richmond to Cattai Creek area had significant erosion as a result of the March 2021 and July 2022 flood events and is therefore difficult to determine if a reduction of risk for some mechanisms is outweighed by an increase in risk due to scour/undermining.

Therefore, in summary, under the 'with Project' scenario:

- There will be a **reduction** in risk of gravitational/rotational slumping on hydrograph recessions
- There will be a **reduction** of localised erosion resulting from flood plain flow returning to the river
- There will be a possible **increase** in the risk of bank notching and localised failures due to retaining high and constant recession flows and levels for an extended period of time
- There will be an **increase** in potential fluvial bank erosion in one reach (North Richmond to below Cattai Creek) that could lead to increased mass failures.

The analyses used in this study are high level and have typical parameters for the materials seen during the site visits. If needed as part of wider river management studies, more detailed analysis could be undertaken at any specific site, however a site specific geotechnical and hydrogeological investigation would be required. This would need to include geotechnical boreholes, permeability testing, and laboratory testing which would be used to inform parameters for analysis of the site. Based on our experience, this would be unlikely to change our conclusions about the effects of the project.

7.2 Recommendations – potential mitigation

The following recommendations could be considered should the project go ahead to reduce the risk of bank instability. We have not considered how such recommendations might affect outcomes in terms of any other objectives related to FMZ operation (such as risk to life and property), other constraints on FMZ operation, or be combined with whole of government measures for river management.

- The staging of the reduction of water levels in FMZ operation after a flood event could be refined. The hydrographs used in the concept analysis for this study showed one or two stepped reductions in water level. Introducing additional stages, or a gradational reduction in water level would allow pore pressures and groundwater levels to recover at a rate closer to the river. This would further reduce the risk of pore pressure induced slumping and piping erosion.

- The literature review showed that areas where riparian trees are present are a lower risk of bank failure. Significant sections of the river, in particular the North Richmond to Cattai Creek area, have very little riparian vegetation. Planting of selected riparian trees as part of a wider bank management programme could reduce the risk of bank slumping for the North Richmond to Cattai Creek area where scour/undermining initiated bank failure risk is increased in the 'with Project' scenarios.

8 Limitations Statement

This report has been prepared by Beca on the specific instructions of our Client. It is solely for our Client's use for the purpose for which it is intended in accordance with the agreed scope of work. Any use or reliance by any person contrary to the above, to which Beca has not given its prior written consent, is at that person's own risk.

9 Approvals

Prepared by:	**Reviewed by:**	**Approved by:**
Jeremy Eade Associate - Engineering Geology	**Sian France** Technical Director – Hydrogeology **James Burr** Technical Director – Geotechnical Engineering	**Graham Levy** Technical Director – Water Resources Engineering
		on behalf of Beca Pty Ltd

We trust our review and assessments are acceptable.

Should you have any further queries then please do not hesitate to contact us.

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Appendix A – Site Photos July 2022

Image 1. Well vegetated riverbank downstream of North Richmond

Image 2. Evidence of piping in riverbank downstream of North Richmond

Image 3. Left bank of river downstream of North Richmond. Ashfield Shale is the prominent geology resulting in high, steep banks.

Image 4. Riverbank upstream of Windsor. Note significant erosion from recent flood events.

Image 5. Riverbank in the Windsor area. Note significant erosion from recent flood events.

Image 6. Riverbank in the Wilberforce area. Note significant erosion from recent flood events with significant undermining of the riparian vegetation.

Image 7. Riverbank in the Cattai Creek area. Hawkesbury Sandstone is exposed in the lower bank.

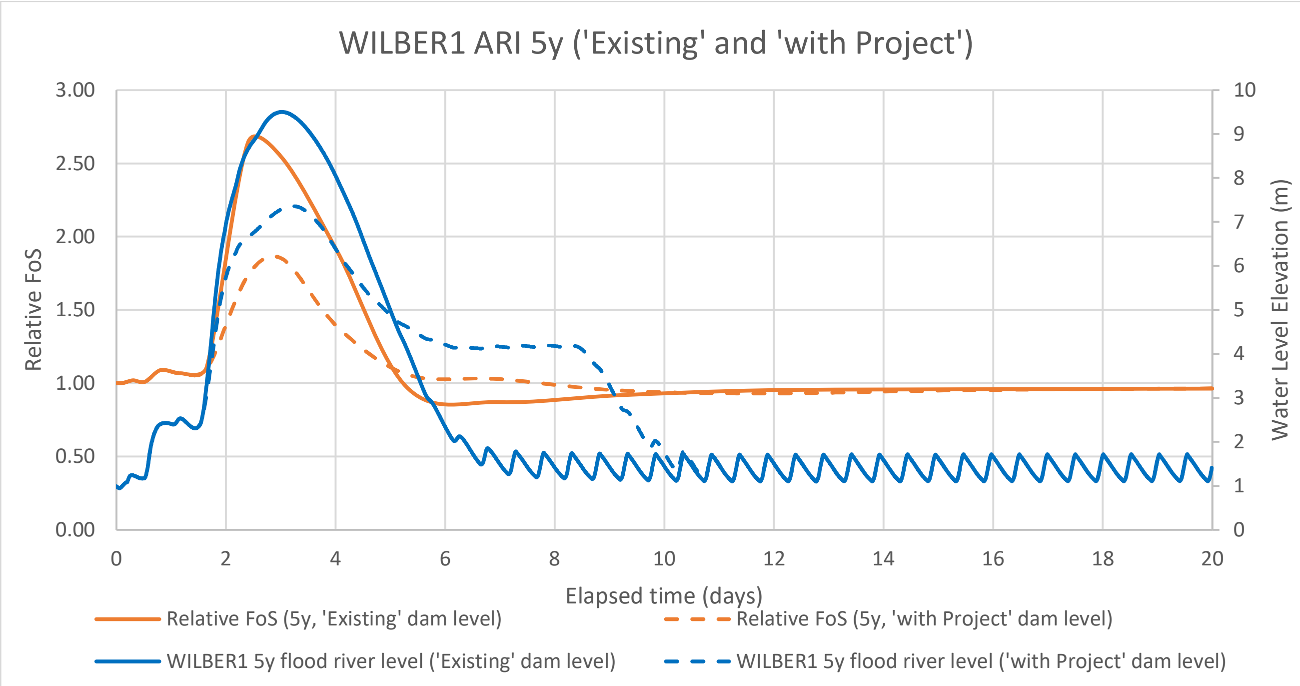
Image 8. Riverbank in the Ebenezer area. There has been significant erosion adjacent to built structures on un-vegetated banks.

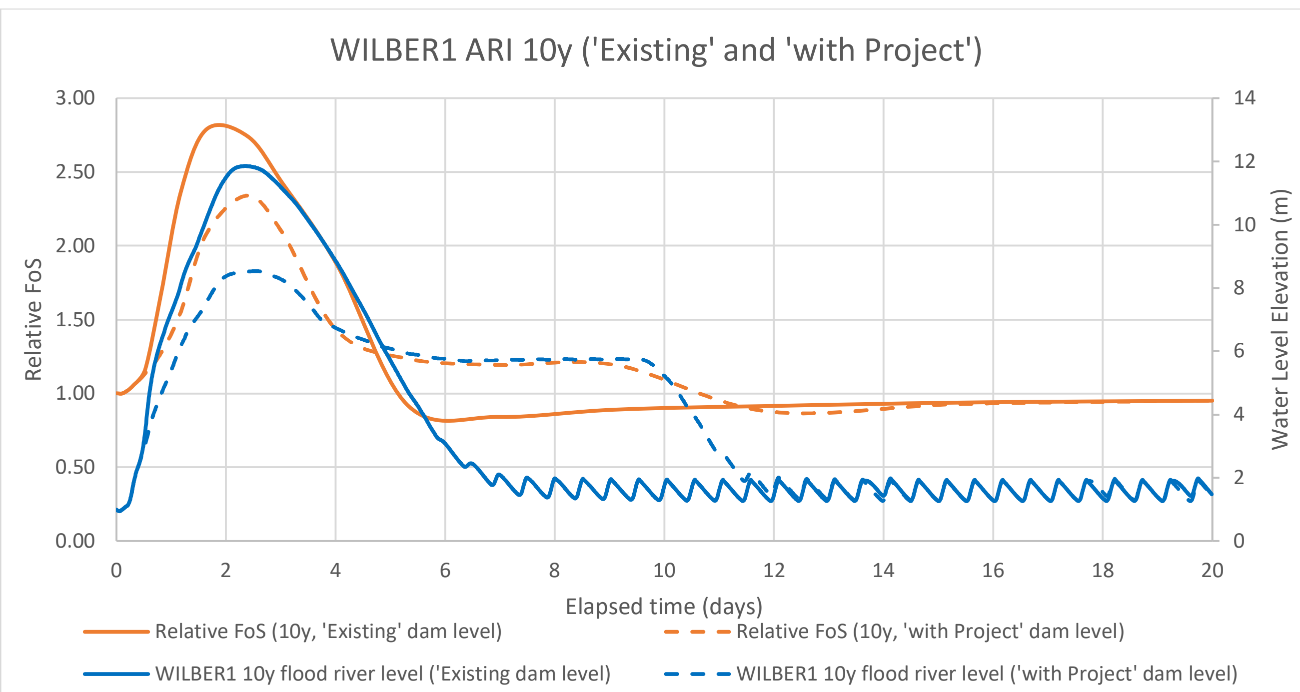
Image 9. Riverbank upstream of Sackville. Riverbank comprising Hawkesbury Sandstone.

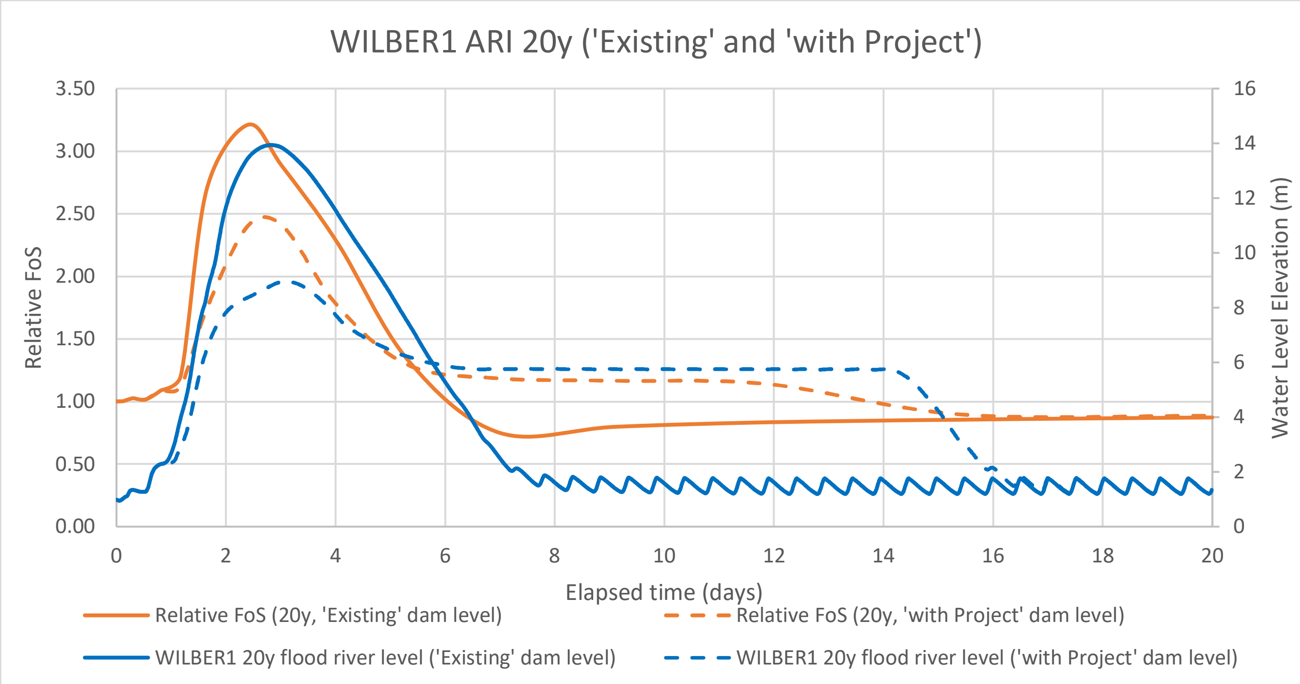
Image 10. Riverbank in the Sackville area. Low narrow river terrace with Hawkesbury Sandstone confining the river (vegetated area in background).

Appendix B – Analysis Outputs

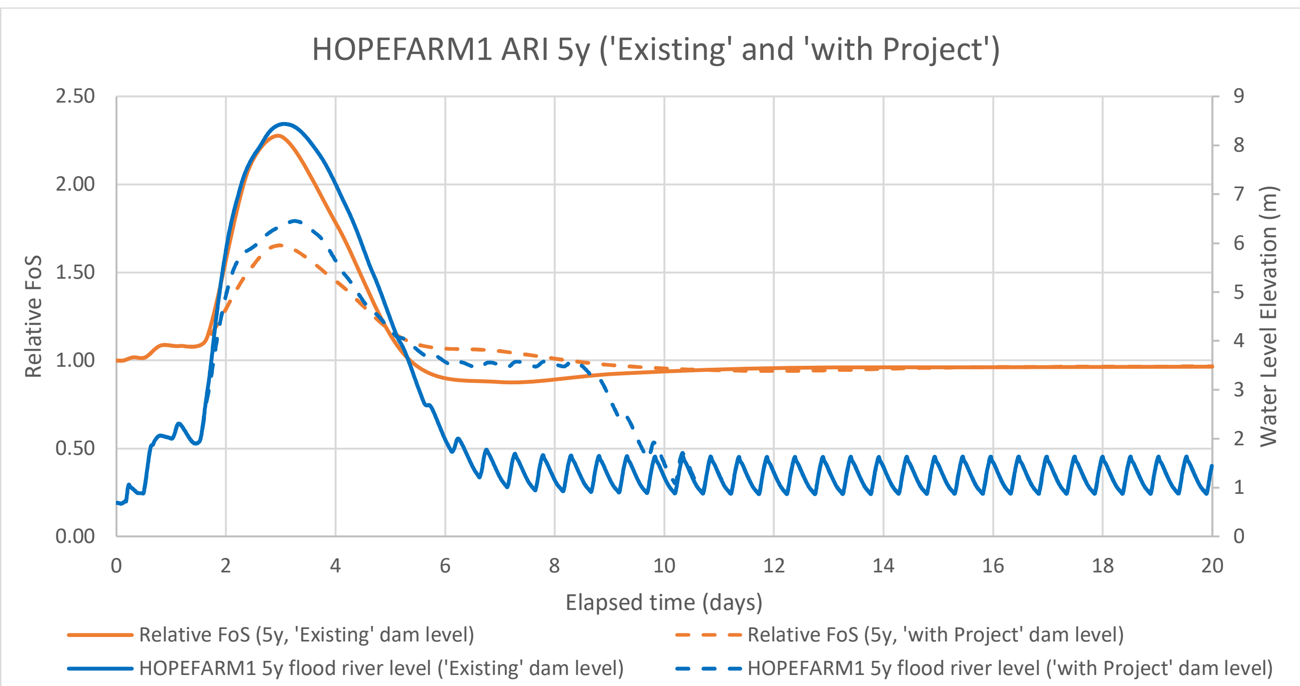
WILBER1

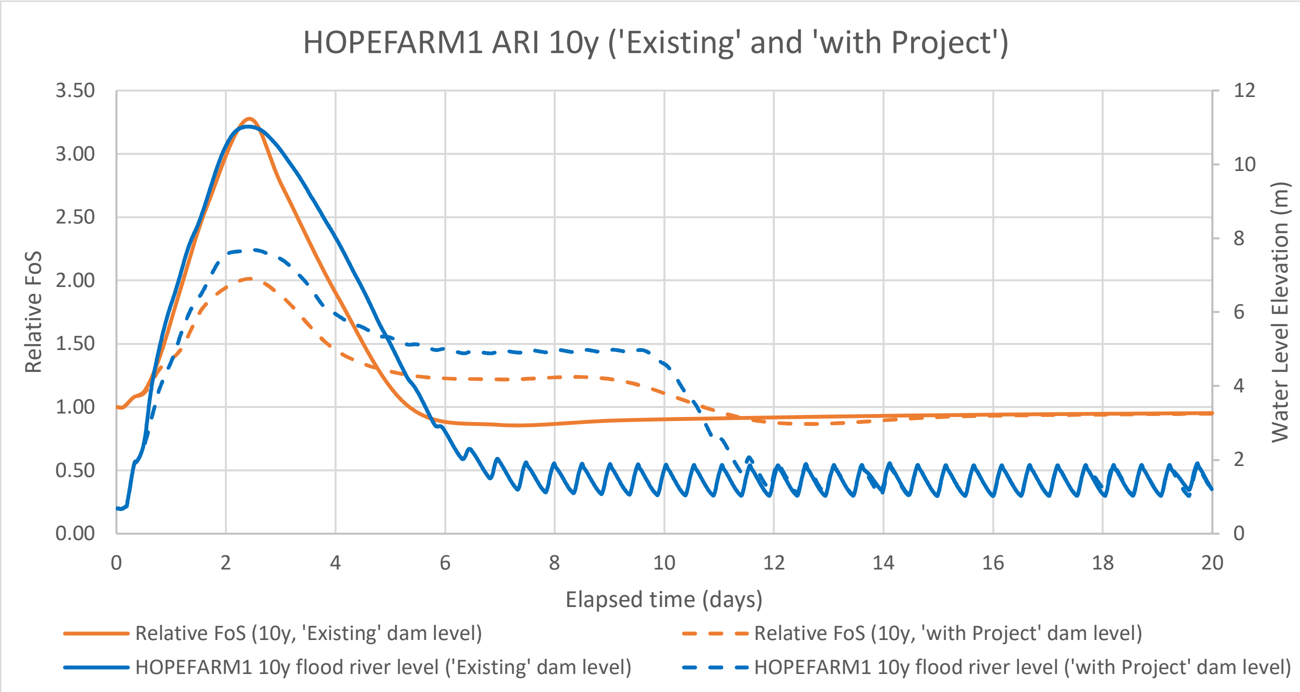


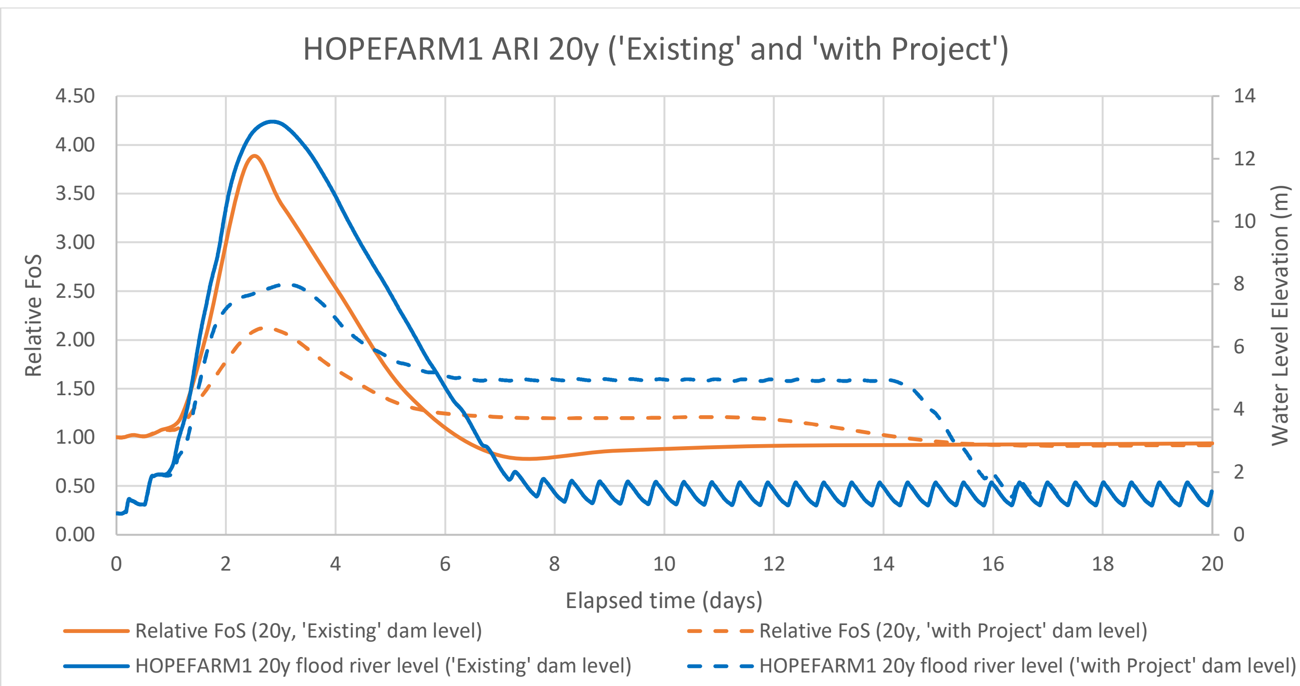



WILBER1 ARI 20y ('Existing' and 'with Project')
Relative FoS
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Water Level Elevation (m)
16
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
20
Elapsed time (days)
Relative FoS (20y, 'Existing' dam level)
Relative FoS (20y, 'with Project' dam level)
WILBER1 20y flood river level ('Existing' dam level)
WILBER1 20y flood river level ('with Project' dam level)

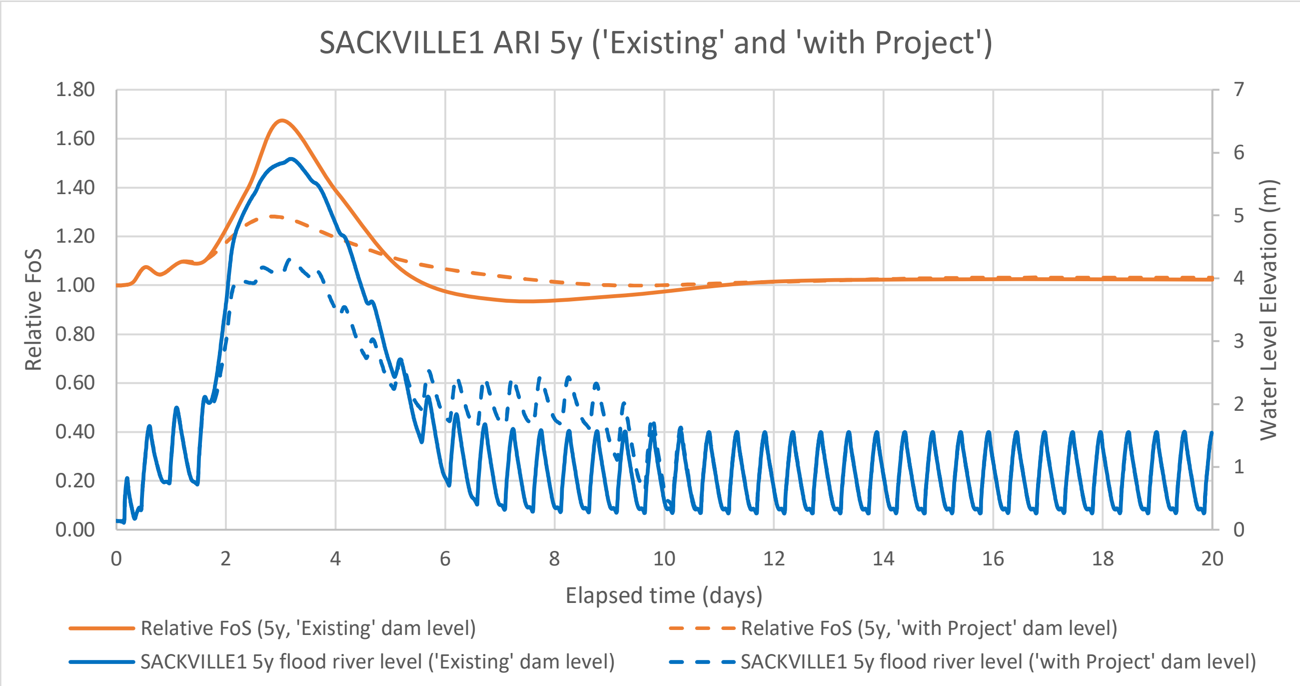
HOPEFARM1

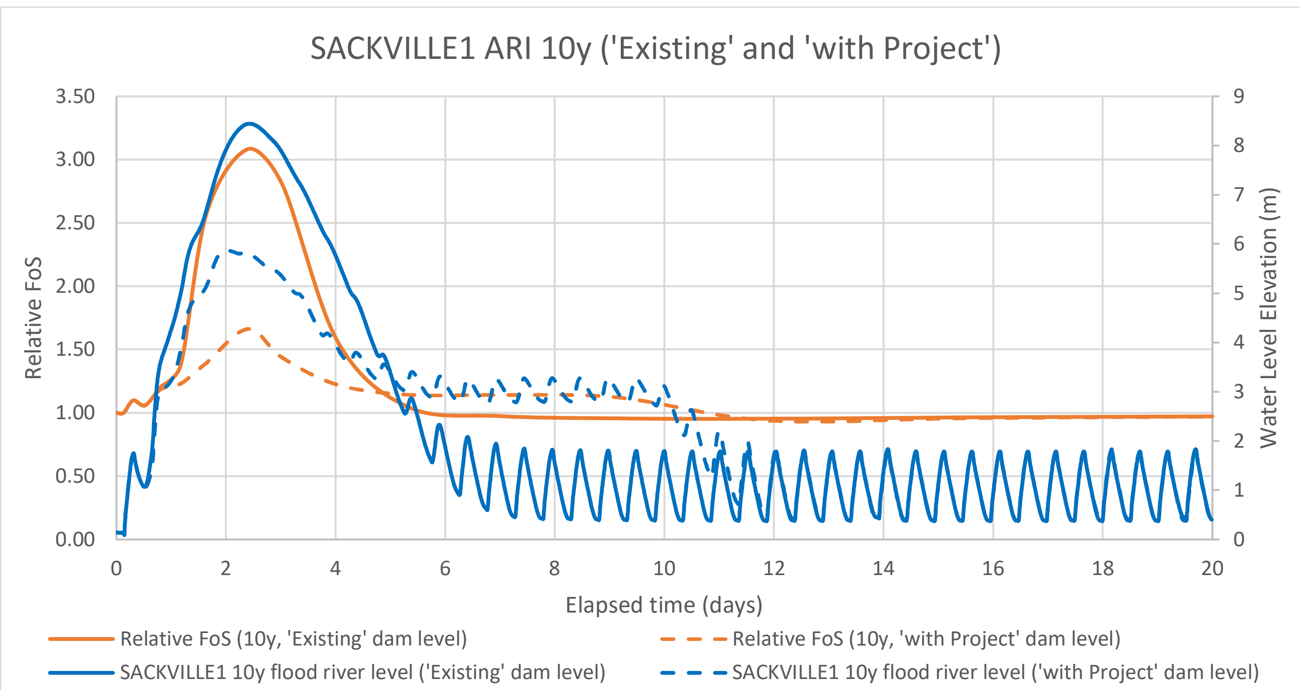

HOPEFARM1 ARI 5y ('Existing' and 'with Project')
Relative FoS
2.50
2.00
1.50
1.00
0.50
0.00
Water Level Elevation (m)
9
8
7
6
5
4
3
2
1
0
0
2
4
6
8
10
12
14
16
18
20
Elapsed time (days)
Relative FoS (5y, 'Existing' dam level)
Relative FoS (5y, 'with Project' dam level)
HOPEFARM1 5y flood river level ('Existing' dam level)
HOPEFARM1 5y flood river level ('with Project' dam level)

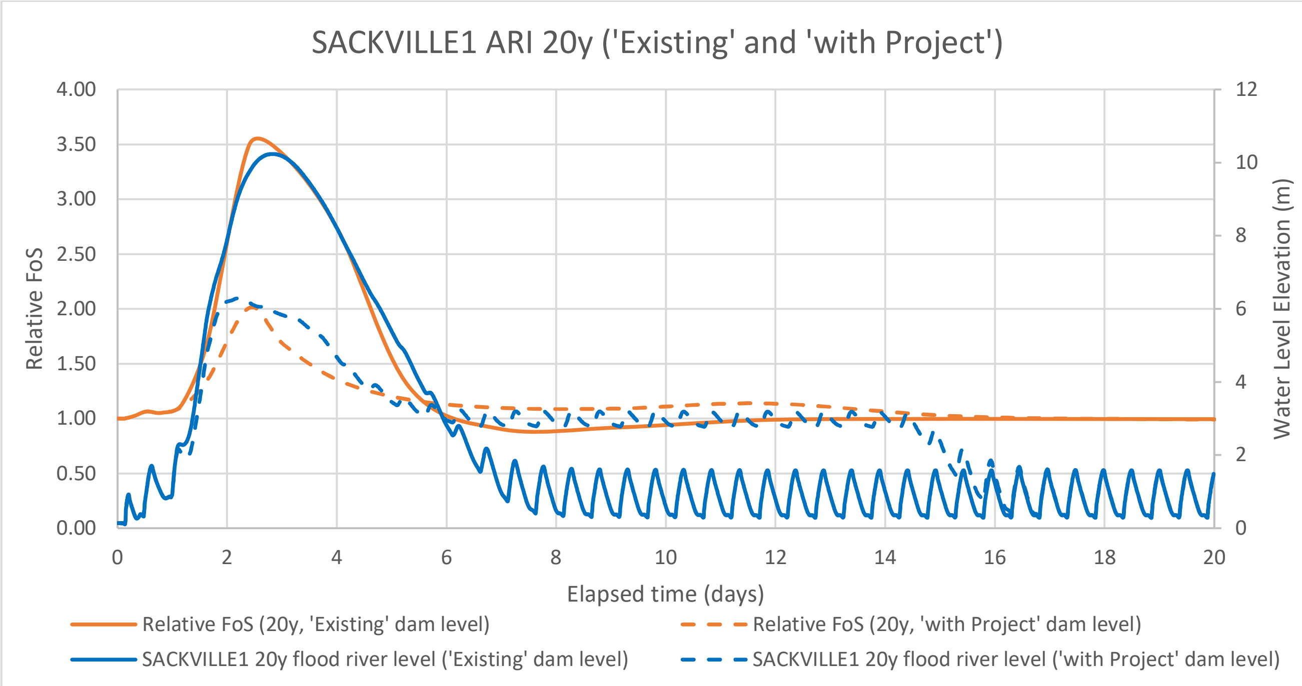

HOPEFARM1 ARI 10y ('Existing' and 'with Project')
Relative FoS
Water Level Elevation (m)
Elapsed time (days)
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
20
Relative FoS (10y, 'Existing' dam level)
Relative FoS (10y, 'with Project' dam level)
HOPEFARM1 10y flood river level ('Existing' dam level)
HOPEFARM1 10y flood river level ('with Project' dam level)


HOPEFARM1 ARI 20y ('Existing' and 'with Project')
Relative FoS
Water Level Elevation (m)
Elapsed time (days)
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
20
Relative FoS (20y, 'Existing' dam level)
Relative FoS (20y, 'with Project' dam level)
HOPEFARM1 20y flood river level ('Existing' dam level)
HOPEFARM1 20y flood river level ('with Project' dam level)

SACKVILLE1


SACKVILLE1 ARI 5y ('Existing' and 'with Project')
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Relative FoS
7
6
5
4
3
2
1
0
Water Level Elevation (m)
0
2
4
6
8
10
12
14
16
18
20
Elapsed time (days)
Relative FoS (5y, 'Existing' dam level)
Relative FoS (5y, 'with Project' dam level)
SACKVILLE1 5y flood river level ('Existing' dam level)
SACKVILLE1 5y flood river level ('with Project' dam level)


SACKVILLE1 ARI 10y ('Existing' and 'with Project')
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Relative FoS
9
8
7
6
5
4
3
2
1
0
Water Level Elevation (m)
0
2
4
6
8
10
12
14
16
18
20
Elapsed time (days)
Relative FoS (10y, 'Existing' dam level)
Relative FoS (10y, 'with Project' dam level)
SACKVILLE1 10y flood river level ('Existing' dam level)
SACKVILLE1 10y flood river level ('with Project' dam level)



SACKVILLE1 ARI 20y ('Existing' and 'with Project')
Relative FoS
Water Level Elevation (m)
Elapsed time (days)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
12
10
8
6
4
2
0
0 2 4 6 8 10 12 14 16 18 20
Relative FoS (20y, 'Existing' dam level)
Relative FoS (20y, 'with Project' dam level)
SACKVILLE1 20y flood river level ('Existing' dam level)
SACKVILLE1 20y flood river level ('with Project' dam level)

Technical Note

By:	Graham Levy, Melissa Halligan	**Date:**	8 September 2022
Subject:	**Warragamba Dam Raising – Downstream Erosion and Sediment Transport**	**Our Ref:**	4512987-194045299-60
		ABN: 85 004 974 341	

1 Purpose

As part of the Environment Impact Assessment (EIS) for the Warragamba Dam Raising Project, Beca prepared a Geomorphology Technical Assessment (SMEC, 2021) which became Appendix N2 of the EIS (referred to in this note as "EIS N2"). This assessed potential geomorphological effects of the project both upstream of the dam, and in the downstream waterways of the Hawkesbury and Nepean Rivers (HNR).

In response to public exhibition of the EIS, submissions were received that raised questions about the project effects on downstream sediment movement (both sand slugs and potential for bed and bank erosion) and on river bank stability.

This technical note builds on the work done previously for the EIS, in particular addressing in more detail the hydrological and hydraulic changes that will occur as a result of the Project, and the potential implications of these for river bank and bed erosion and the ability of the river system to transport sand slugs through the system. These particular questions applied to effects on the rivers downstream of Warragamba Dam.

Beca has prepared a separate technical note in parallel with this note to look specifically at river bank stability. That note draws on some of the hydraulic data and erosion findings set out in this note, and applies them in the context of bank stability. Further, field work conducted for that work has informed the selection of parameters in this analysis.

2 Background

EIS N2 provided information on geomorphological characteristics of the HNR, between the Warragamba River downstream of the dam, through to Cattai Creek. Site work was limited to sites where public land access was possible. The data collected, and the findings, are presented in EIS N2, as follows:

- Locations of ten downstream rapid geomorphic assessment sites, and graphical summaries of bank strength parameters and sediment size, are shown in Figures 42 and 44 respectively, with the detailed field data presented Appendix H and Appendix I respectively.
- The method for downstream geomorphological effects assessment is set out in Appendix A3.4.
- The results of the assessment are in Section 5.3 and Figure 53.
- Risks are assessed in Table 15.
- Aerial historical analysis of the downstream waterway using available aerial photographs covering the 10 assessment sites is in Appendix C.3.
- The rapid geomorphological assessment field sheets are in Appendix G.3.

- Mitigation proposals are set out in Appendix L.

Following the public exhibition of the EIS Department of Planning and Environment (DPE) made requests that were related specifically to sediment movement downstream (to Macdonald River) (in summary):

- More frequent site locations (0.5 to 4.5km), a greater coverage of the river length downstream with a focus on high risk sections and areas deficient in riparian vegetation
- More detailed assessment of erosion potential, considering near bank velocity, unit stream power and bed mobilisation
- More detailed assessment of the ability of the flow to move sediment through, including sediment sources and stores and gravel extraction, with particular mention of the Penrith Weir section.

DPE made further requests that related to more detailed assessment of bank slumping, particularly given the slumping that occurred under the existing regime in floods during 2021 (now further exacerbated in flood during 2022). These are addressed by Beca in a separate Technical Note on bank stability.

In response to DPE's requests, we have:

- Obtained hydraulic data from the flood modelling for more sites along the river, including further downstream and an increased number through the middle reaches where there is a high incidence of bank failure
- Analysed these for changes to potential erosion and sediment transport capacity
- Reassessed the potential effects on erosion and sediment transport.

As part of the bank stability work, Beca undertook field inspections from North Richmond to Sackville which has provided further observations to assist this analysis.

3 Method

3.1 Overview

The Warragamba Dam reservoir has sufficient live storage capacity to influence peak flood flows in the HNR downstream, and the Project would increase that live storage volume, allowing greater capability to manage flood peaks. As a result, in certain moderate to large floods the peak flow would be reduced by storing more flood water in the dam reservoir, and the duration of flood flows extended as that stored water was released over the tail of the storm. This hydrological change is to some extent moderated further downstream, as large tributaries with no flow control mechanisms join the HNR. Further, the geology of the river basin varies, making some reaches more susceptible to hydrological changes than others.

As an overview, the method adopted for this further technical assessment has been based on available hydrological and hydraulic modelling of operational simulations of the raised dam ('with Project'), and comparison of that with current dam operation ('Existing').

In undertaking the assessment, the key was to understand the relative change in sediment transport capacity and potential erosion under the 'with Project' scenario, rather than trying to establish absolute values for these parameters. We therefore sought a simplified analysis that enabled such an assessment.

3.2 Erosion risk assessment

Yang (1974), and Elliot et al (2004), have proposed a relationship for sediment transport and erosion (respectively) in the general form

$$E = A(Q - Q_{cr})^n$$

In Yang, *E* represented sediment load, and *Q* could potentially be based on discharge, stream power, velocity or shear. The method was intended to make a reasonable estimate of absolute sediment load and required a number of parameters relating to sediment characteristics and the specific site parameters in order to put a value on *A* and *n*. In Elliot et al *E* represented potential erosion, and *Q* was discharge. In both cases Q_{cr} was the value of threshold of movement. Elliot et al proposed the equation as a tool for relative assessment of erosion, and recommended a parameter for *n* for cohesive sediments between 0.25 and 1.5, with 1.5 being the default value in the absence of evidence to the contrary in any application. They also noted that other literature, based on bed and bank erosion contributing to sediment load, recommended a value of *n* between 2 and 3.5, which was consistent with sediment transport equations. Elliot et al did not recommend a value for *A*.

In this analysis, we have used stream power as the parameter in place of Q, on the grounds that it is linear function of Q, but also takes into account hydraulic gradient, better representing the difference in sediment carrying capacity between the steeper rising limb and the flatter falling limb of the flood hydrograph. We have used a value of 1 for *A* because we are undertaking a relative assessment of the ‘with Project’ scenario compared to a base scenario of ‘Existing’. We have selected 1.5 as the default parameter for *n*, but also carried out sensitivity testing at 1.0 and 3.5 to identify if this changes the conclusions.

Using flow data from the hydraulic modelling, the unit work done for bank and bed material erosion at each site was calculated using the following equation:

$$Unit\ work\ done = \sum (USP - USP_t)^n \Delta t$$

Where:

USP is unit stream power in W/m²

USP_t is threshold unit stream power at which sediment would move in W/m²

Δt is time step in seconds

The erosion threshold USP was derived from a mix of sources. The threshold for larger sediment representative of bed material in steeper reaches (above 5 mm diameter) was determined using the relationship between increasing sediment size and increasing critical specific stream power in Figure 1 (Gartner, 2016), based on the upper envelope of the different curves. Bed sediment particle size for each site location (where available) was obtained from field data collection set out in the geomorphology report EIS N2 (SMEC, 2021).

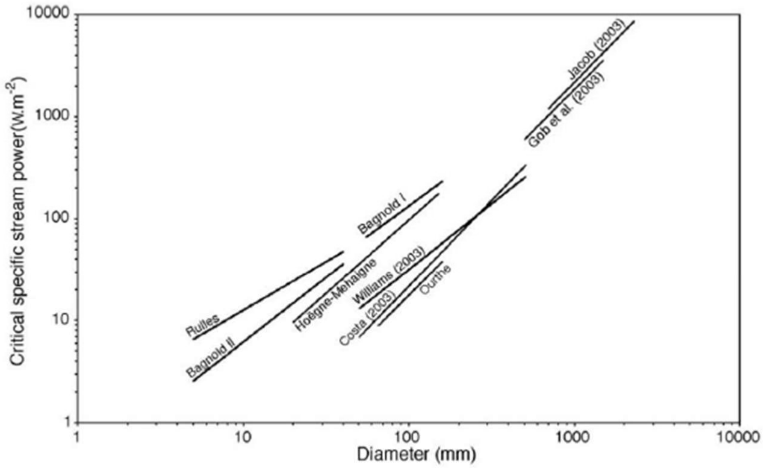


Fig. 3. Relations linking the critical specific stream power and the material size (D_{50} in mm) in Belgian gravel bed rivers and mountainous boulder rivers of southern France and Colorado. Bagnold I is the Bagnold's equation (Eq. (4)) with the Ourthe parameters (D_i=55–160 mm and d=2 m) and Bagnold II is Eq. (4) with the Rulles parameters (D_i=5–40 mm and d=1 m).

Figure 1. Critical stream power and sediment diameter, excerpted from Petit et al. (2005) as quoted by Gartner (2016)

For stream bank erosion, reference was made to Streamology 2021, where a relationship between shear stress and erosion threshold was provided for size from 0.065 to 64 mm (sands and gravel). Shear stress was correlated to unit stream power using modelling results for the HNR, and the results correlated well with Gartner in the range where they overlapped. Bank material sizes were obtained from field visits undertaken in July 2022 as part of the bank stability assessment. The parameters used are presented in Table 1. While these values could be debated, sensitivity testing in the finer fractions showed little change in effect as it relates to lower flow rates where the scenarios are similar, and the precise selection is less important in comparing analysis for relative effects of flood flow changes.

Table 1. Erosion threshold – unit stream power

Sediment size (mm)	64	5	2	0.5	0.05
Description	Coarse gravel	Fine gravel	Coarse sand	Fine/medium sand	Silt
Erosion threshold (W/m^2)	39	1.1	0.33	0.048	0.002

3.3 Sediment transport assessment

Further to the above method, which is sensitive to exponent selected, we have also undertaken an estimate of sediment carrying capacity for each event and scenario using the Engelund & Hansen method. This was selected as it is appropriate to sand-size sediment, and all the required parameters are available from the modelling results supplied. The formula as used is:

$$Q_{Ts} = 0.05\rho_s B V^2 \left(\frac{d_{50}}{\Delta g}\right)^{0.5} \left[\frac{\tau_0}{(\rho_s - \rho) g d_{50}}\right]^{1.5}$$

Where

Q_{Ts} is total sediment load in kg/s

B is surface width

V is velocity

d_{50} is representative material size available for transport

$\Delta = (\rho_s - \rho)/\rho$

τ_0 is shear stress

This formula will overestimate actual load, as it reflects carrying capacity ignoring any sediment supply constraints. In the case of the HNR, the presence of the Warragamba Dam significantly reduces the supply of sediment in the river system immediately downstream, and this influence is still significant through the reaches where geomorphic affects have been assessed. The formula is also sensitive to particle size, but does provide a basis for relative assessment of the project effects on potential sediment transport capacity.

The analysis includes shear stress, which takes hydraulic gradient into account, so the sediment transport capacity recognises the effect of a difference between transport capacity on the rising limb of the hydrograph, and a reduction on the lower limb. However, it does not model the sedimentation process, or the passage of sediment through the system, and therefore does not predict where and how much sedimentation might occur on the falling limb of the hydrograph. That would be a major study in itself, well beyond the scope of an assessment of relative effects for the project.

3.4 Sediment supply from upstream and from tributaries

The sediment transport capacity assessment outlined above can generate very high potential sediment loads, potentially much greater than the sediment supply from upstream and probably also from most downstream tributaries. In the event that the project results in a reduced sediment transport capacity, but this still exceeds the expected supply, the effects of the project may not be significant. As such, we have made an estimate of sediment load with the HNR for use in a comparative assessment against changes to transport capacity.

We have been unable to locate reliable data on sediment loads currently experienced in the HNR, even for average annual loads. In the absence of downstream data, we have relied on data from literature about the catchments upstream of Lake Burragorang. There has been quite a lot of work done on sediment loads for tributaries to Lake Burragorang, and this has been used as an indication of possible flood event loads for the HNR, although there is still significant variability in estimates. We have particularly drawn on Armstrong et al (2002) for sediment loads and concentrations, although other references supported the general range of values we have used. This data is not ideal, because while it will reflect load characteristics from some of the western and northern hill catchments flowing direct to the HNR, it will be less applicable to the urban and semiurban catchments in the south and east of the HNR catchment. Further, it is mostly collected in small catchments, with significant variability depending on catchment condition, whereas at a larger catchment level this variability will not be as great. However, it appears to be the best indication available of potential sediment loads.

The range of loads identified varies from 20 to 400 t/km^2/year. Some sources suggest between 40 and 200, and these are what we have considered as a low-end rate and high end of 200 rate respectively for this study. We have also assumed that there is no sand discharged from Lake Burragorang. Table 2 shows the results for the relevant reaches of the river, reflecting node points where significant tributaries join the main stem.

Table 2. Indicative sediment loads

Catchment increment	River reach	Estimated annual average sediment load (t/year)	
		Low	High
Lake Burragorang	Warragamba River	nil	nil
Upper Nepean	Penrith weir	77,000	386,000
local	Penrith to Richmond	101,000	503,000
Grose	Richmond to Windsor	128,000	640,000
South Creek	Windsor to Cattai Creek	149,000	743,000
Cattai Creek	Cattai Creek to Sackville	156,000	779,000
local	Sackville to Colo	182,000	909,000
Colo River	Downstream Colo	370,000	1,851,000

Similarly, Armstrong et al (2002) quoted 90^{th} percentile sediment concentrations between 200 and 4200 g/m^3 depending on the amount of gullying in the subcatchment. The upper 10% of samples varied up to 49,000 g/m^3, although the highest were exceptional and possibly related to severely degraded subcatchments. We would expect event mean concentrations from our modelling to be much lower than the upper extreme values measured.

We have applied the sediment load data (Table 2) in the following ways:

- The lower end of the annual average sediment load is used as a guide to possible loads in the smaller (5 to 10 year ARI) floods
- The upper end of the annual average sediment loads is used as a guide to possible loads in the larger (20 to 100 year ARI) floods
- We have calculated the event mean concentration for each event and scenario analysed, and we have used this as a further check on where calculated transport capacity might be higher than expected, or where the calculated capacity might be low enough to reflect an effect of the project.

It is not known how much additional sediment load is being contributed by river bank erosion, and the data from Armstrong et al (2002) is not applicable to the river bank and flow conditions on the lower HNR. At an upper end, for the 26 km section from North Richmond to Cattai Creek, if there was 1 m thickness of bank loss over typically 15 m high river banks both sides, this would amount to 780,000 m^3 of sediment contribution. However, in any one flood event the erosion would not be so widespread along a reach. Such high loads from river bank erosion are unlikely to occur upstream of Penrith weir, but downstream, from North Richmond, large contributions from bank loss could occur. From the site visits and available literature, these sediment contributions from bank erosion with be in the medium sand to silt size range, which is easily transported by the river during elevated flow.

3.5 Sites and data

Eighteen sites along the HNR were chosen to give a representation of the different hydrological changes and river geology, to assess effects on downstream sediment transport and erosion. These sites are illustrated in maps in Attachment A. Time series datasets for each site were obtained from WMAwater (the hydrologic and hydraulic modellers for the project) for analysis. These datasets contained the water depth, flow rate, water surface width, average velocity, stream power, and unit stream power for each site for both the ‘Existing’ and ‘with Project’ dam scenarios over a full flood event duration. The time series for hydraulic grade and stream power were post-processed by WMAwater from the model output data.

Representative events for 5, 10, 20, 50 and 100 year ARI[1] were supplied by WMAwater with the same rainfall event being used for both the 'Existing' and the 'with Project' time series.

We analysed the flow data for the sites for each scenario and each event to obtain a total runoff volume for each combination of event and site. These volume results are provided in Attachment B. They are useful in understanding the nature of the hydraulic effects, as they illustrate the effects of the project on flow volume conveyed through the channel in different reaches of the river. In confined reaches the volume of flow through the channel is the same between 'Existing' and 'with Project' scenarios, as all flow from upstream remains within the channel. In areas where there is significant flood plain, the volume of flow through the channel in the 'Existing' scenario can be much less than the total event volume, as there is considerable flow across the flood plain, but with the 'with Project' scenario with lower and longer peaks, a greater proportion of the total event volume is confined to the channel. Example hydrograph plots are shown with explanatory annotation in Figure 2, and are included for every site and event in Attachment E. Attachment B shows the relative volumes passing through each section during 'Existing' and 'with Project' scenarios, and these are the flows and volumes that have driven the erosion and sediment transport analysis.

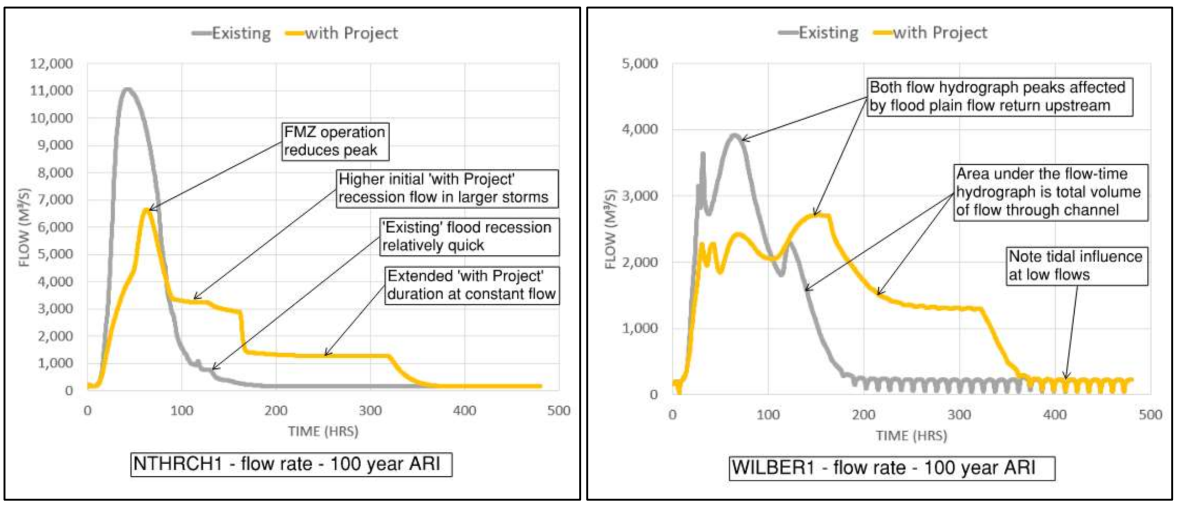


Figure 2 – Flow hydrographs – annotated examples

Relative cumulative erosion potential was assessed for each site, event and scenario. The results are set out in Attachment C and summarised in Sections 5.1 and 5.2.

Sediment transport capacity was assessed for each site, event and scenario. The results are set out in Attachment D and summarised in Section 5.3.

The cumulative work done within the channel, both before and after the proposed dam raising, were plotted on a single time-series graph. This was replicated for the 5-year, 10-year, 20-year, 50-year, and 100-year ARI storm events. This same approach was also used for cumulative sediment transport capacity. Flow hydrographs for each ARI flood event are also plotted to illustrate the differences in hydrological conditions between 'Existing' and 'with Project' scenarios. This allowed for a direct comparison of cumulative erosion work done and cumulative sediment transport capacity with the

[1] Average recurrence interval – the frequency with which the flowrate is equalled or exceeded on a long term average basis.

'Existing' and the 'with Project' dam scenarios, for the range of flood events. These data are plotted for each site and each event in Attachment E.

4 River description

4.1 General morphology

A full description of the existing environment is provided in SMEC (2021), including rapid geomorphological assessment field sheets and site data. River styles are also referenced and mapped in SMEC (2021).

For the purposes of this assessment, reaches have been delineated based on a range of factors, including NSW river styles, consideration of geology, confluence of major tributaries, channel for hydraulic behaviour. The range of factors specifically reflects that the purpose of the assessment is to consider the effects of a change of operation of the Warragamba Dam on sediment transport and erosion. Of note is that further downstream, with tributary inflows, the relative contribution of the Dam discharges to peak flow reduces, and the uncontrolled flows from tributaries has more effect on the flood behaviour. Also, changes in flood plain flow patterns have a big influence on effects. Therefore, the reaches defined for erosion and sediment transport assessment differ from the River Styles reaches, and from those selected for bank stability assessment, to better reflect differing effects on these aspects.

Table 3. General description of river reaches

Reach	Description
Upstream Penrith Weir	This reach has been limited to downstream of the Fairlight Gorge area. The river channel is confined, has low hydraulic gradient due to effects of weir, and a mixed gravel and sand bank and bed. It is most directly affected by the Dam operation, as the dam discharge dominates flows and the only other contributing catchment is the upper Nepean.
Penrith to Grose River	The river channel is quite variable, but mostly confirmed. There is a much steeper gradient in the upper portion of the reach compared to the balance of the assessment area. Gravel dominates in bed and bank. There is some additional local inflow below Penrith Weir, but not significant.
Grose River to Windsor	This reach is dominated by sand bed and silty sand banks, although there is some shale evident in the left bank for about 3.5 km downstream of North Richmond. Hydraulic gradients are very flat. The river is not confined, and significant flow leaves the channel to flow over the banks and through the flood plain in events of about 10 year ARI and greater, reducing the peak flows and volumes that the channel experiences under existing conditions. It will therefore potentially be more affected hydraulically by reduced flow peaks from the Dam, which will reduce out-of-channel flow and increase the total volume flowing through the channel. The total flow from upstream is slightly increased by inflows from the Grose River.

Reach	Description
Windsor to Cattai Creek	The channel form in this reach is similar to the reach immediately upstream. The main difference is that much of the flood plain flow from the upstream reach returns to the river through this reach, particularly in the general vicinity of Windsor, although the reach does still have significant out-of-channel flow. Additional inflow comes primarily from South Creek, which joins just downstream of Windsor.
Cattai Creek to Colo River	This reach is dominated by sand bed and silty sand banks. Hydraulic gradients are very flat, and at lower flows tidal influence is evident. The river is confined, so all flow from upstream remains in-channel or in minor adjacent flood plain areas. There is a small additional flow contribution from Cattai Creek, and also from other local inflows.
Colo River to Wiseman's Ferry	This reach has a mix of rock banks and areas of localised sand flood plain and banks. Bed material is sand. The hydraulic gradient is low, and there is a strong tidal influence at low flows. The Colo River is a significant tributary, affecting total flows, flood peaks and the relative affects of changes to Dam operation.

4.2 Recent floods and erosion / bank failures

There have been a number of floods recently, notably in March 2021 and March 2022, and significant bank erosion and collapse as a result. These events, and the context in terms of bank stability and failures, are outlined in Beca's technical note on Downstream Bank Stability.

4.3 Sites assessed

The analysis has drawn on hydraulic modelling data for specific cross-sections within the model. The specific model sections listed in Table 4 have been selected for analysis to represent the different reaches, with a particular focus on more sites in areas of known erosion and instability.

Table 4. Specific sites for which model data was extracted and analysed

Reach	Sites assessed
Upstream Penrith Weir	REGENT1
Penrith to Grose River	MINNA2, DEVLINSRD
Grose River to Windsor	NTHRICH1, THORNHAMPK, RESERVOIR, TERRACEPK2, FREEREACH, ARGYLE
Windsor to Cattai Creek	WILBREACH, WILBER1, BURDKNRD3
Cattai Creek to Colo River	CATTAICK3, HOPEFARM1, HILLCREST, SACKVILLE1, TEATREESW
Colo River to Wiseman's Ferry	LIVERPOOL

5 Results

The following sections set out a summary of results for each reach, for different effects analysed.

5.1 Erosion risk - banks

The detailed results from the erosion analysis for banks are presented in tabular form in Attachment C, and in graphical form in Attachment E. They are summarised by reach in Table 5. Example plots are shown with explanatory annotation in Figure 3.

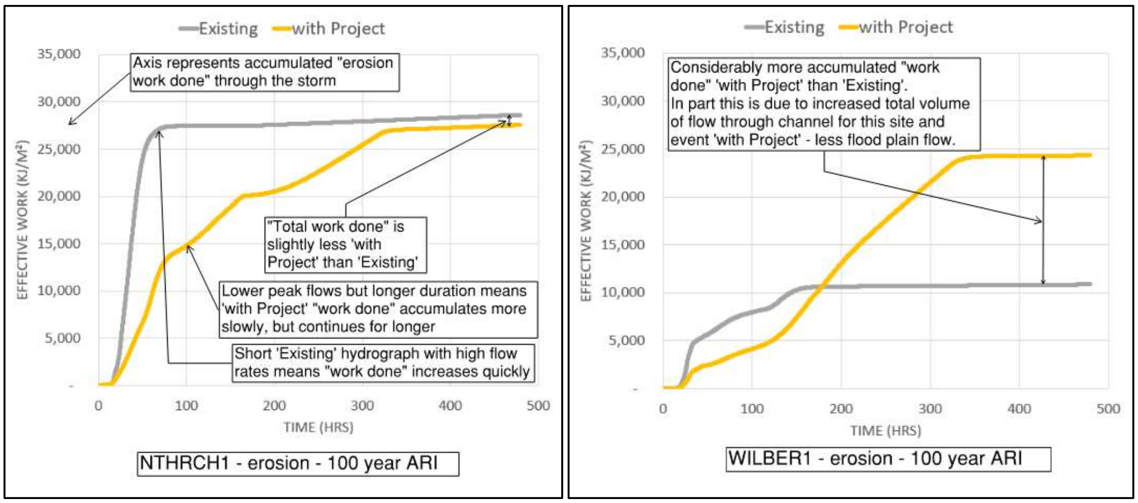


Figure 3 – Erosion plots – annotated examples

The assessment is based on banks being sand / fine sand, with a relatively low threshold of movement. The outcome is relatively insensitive to whether it is coarse sand, fine sand or silt. With fine gravel the total effective work done is reduced, but the relative effect of the project reduces even further.

These results illustrate the potential changes to bank erosion, which can take many forms (e.g. toe erosion, frittering / notching of the banks at higher fixed flow levels, general hydraulic erosion). The analysis is not able to explicitly separate these out, but does provide a guide to relative effects in an already highly susceptible river bank system. The Technical Note on Bank Stability takes these results and interprets them in the context of potential for increased mass failure of the river banks.

Table 5. Bank erosion assessment summary – fluvial scour

Reach	Comments
Upstream Penrith Weir	Erosion risk is reduced in this reach.
Penrith to Grose River	Erosion risk generally reduced, or neutral.
Grose River to Windsor	The results in this reach are affected by low hydraulic gradients due to hydraulic backwater from downstream near Windsor. Some sites show reduced erosion risk, while others show a possibility of some increase. Overall, this could be a reach where there might be increased bank erosion in places.
Windsor to Cattai Creek	This reach consistently shows a risk of increased erosion.
Cattai Creek to Colo River	This reach shows a risk of increased erosion in the upper reach – Cattai Creek to Hope Farm. In the lower reach there is a possibility of some erosion increase in some sites and events, but the risk would be low.
Colo River to Wiseman's Ferry	Erosion risk is reduced in this reach.

5.2 Erosion risk - bed

The principal difference between erosion risk at the bed and on the banks is the difference in material. Field observations in SMEC (2021) suggested there was fine gravel present in the bed from Penrith through to the Grose River. Downstream from there it was mostly sand and fine sand. Given that as a basis, the conclusions regarding bed erosion would be similar to those for bank erosion. However, they also need to be considered in the context of sediment movement through the HNR system. If, as outlined in Section 5.3, the sediment transport capacity is reduced in most reaches, then it is likely that the general trend would be to increased sedimentation rather than erosion.

5.3 Sediment transport capacity

The detailed results from the sediment transport capacity analysis are presented in tabular form in Attachment D, and in graphical form in Attachment E. They are summarised by reach in Table 6. Example sediment transport capacity plots are shown with explanatory annotation in Figure 4.

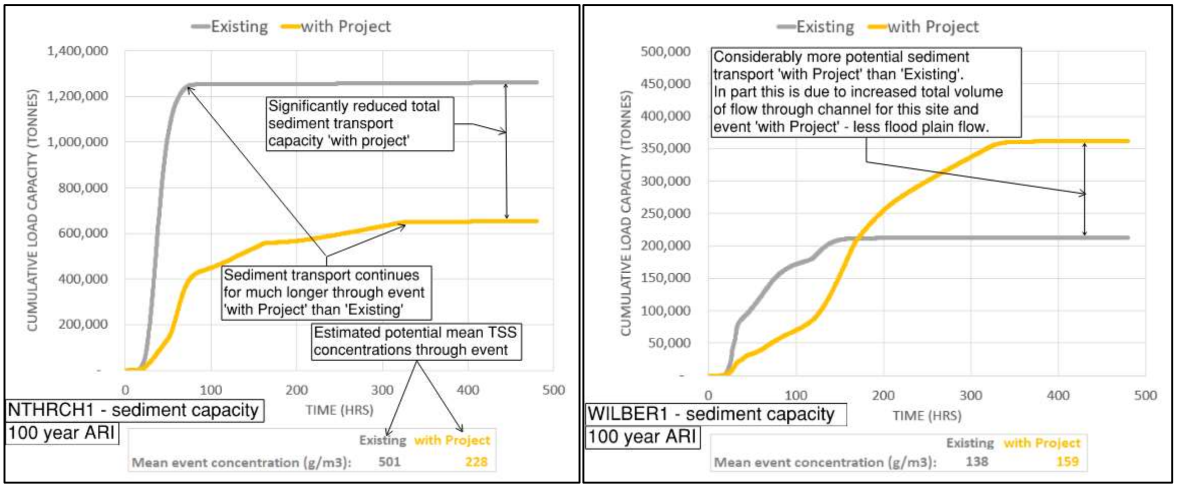


Figure 4 – Sediment transport capacity plots – annotated examples

The assessment is based on transport of sand / fine sand / silt in the ratio 40% : 50% : 10%, with each size calculated separately and the loads added.

In addition to load calculation for each site, event and scenario, we have calculated the potential event mean concentration of sediment, by dividing the sediment load by the event runoff volume. These values are provided for each analysis on the plots of sediment transport capacity in Attachment E, and provide a further context check for the analysis.

In preparing the assessment of change in sediment transport capacity set out in Attachment D, the possible sediment supply in each reach has been considered against the potential transport capacity under the 'with Project' scenario. It is important to recognise that in the absence of good data on current sediment loads in the HNR downstream of the Dam, results are indicative only, and reductions in sediment transport capacity may not mean an increase in sediment deposition if supply is limiting.

There is sensitivity to the selection of sediment size distribution in the modelling, in the sense that larger capacity occurs when the particle sizes are smaller. However, the selection of particle size distribution does not appear to significantly affect the relative outcome of 'with Project' transport versus 'Existing' in the analysis – reduced capacity is typical particularly in smaller flood events. The focus in this analysis is towards sand, as that is reflective of the bed and bank materials through the main areas of interest.

Table 6. Sediment transport capacity assessment summary

Reach	Comments
Upstream Penrith Weir	Potential for reduced capacity leading to sedimentation, particularly in 5 - 10 year ARI events. Larger events still have reasonable capacity under 'with Project'.
Penrith to Grose River	In the upper steeper portion transport capacity remains adequate, but in the lower gradient reach towards Devlins Road there is a risk of reduced capacity and increased sedimentation in 5 – 10 year ARI events.
Grose River to Windsor	Potential for reduced capacity leading to sedimentation, particularly in 5 - 20 year ARI events. Larger events still appear to have good transport capacity, even though less under 'with Project' than 'Existing'. The issue in this reach is that while there will be a larger volume of flow through the reach the backwater from downstream reduces hydraulic gradient and transport capacity.
Windsor to Cattai Creek	Potential for reduced capacity leading to sedimentation, particularly in 5 - 10 year ARI events. Larger events have greater transport capacity under 'with Project' than 'Existing' because more flow is conveyed within the channel than under 'Existing'.
Cattai Creek to Colo River	Potential for reduced capacity leading to sedimentation, particularly in 5 - 10 year ARI events. Larger events still have reasonable capacity under 'with Project'.
Colo River to Wiseman's Ferry	Potential for reduced capacity leading to sedimentation, particularly in 5 - 20 year ARI events. Larger events may also result in sedimentation.

It should also be noted that this analysis on an event basis does not provide the full picture of sediment transport in the river, which is a much more complex process than just the transport capacity in individual events. Sediment supply and conveyance load is typically larger in floods than dry weather flows, but transport does occur even in small floods occurring several times per year. Deposition occurring on the recession of a larger flood will continue to be reworked by these smaller floods, which will not be as affected by the FMZ operation. A more comprehensive study of the overall sediment supply and transport behaviour of the river system is beyond the scope appropriate for a relative assessment of effects of the FMZ operation.

6 Assessment

The results from the above tables have been combined into an overall assessment in Table 7. Further, the erosion findings are summarised in map form in Figure 5. This only covers the reaches where an increase in erosion could be expected. The results for sediment transport do not readily lend themselves to presentation in map form.

Because the river is already subject to significant flooding, sedimentation in some reaches, and bank erosion and instability, the baseline is already a compromised environment. This assessment compares the effects with the raised dam and FMZ operation against a baseline of current conditions, and seeks to identify the potential incremental effects of the proposed project.

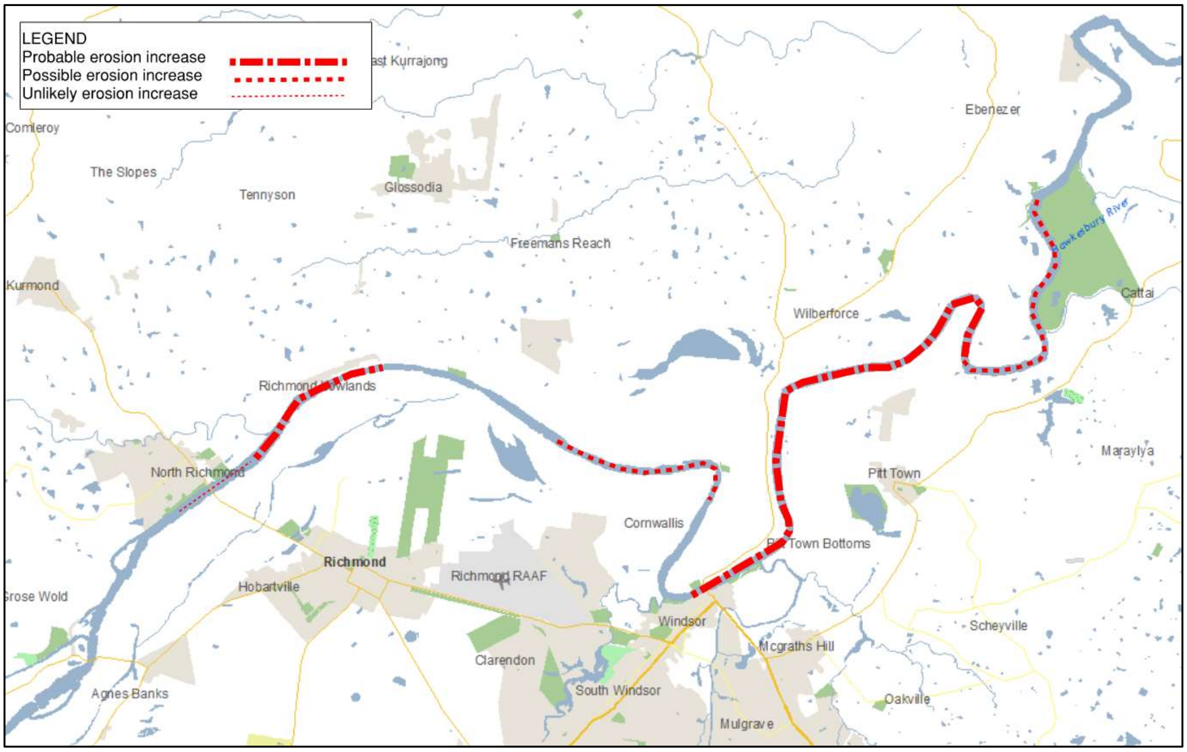


Figure 5 – Map of areas where erosion might increase

Table 7. Assessment of Effects Summary

Description	Erosion potential	Sediment transport capacity
Upstream Penrith Weir		
"Ponded" due to weir. Flood mostly confined. Rock / gravel bed, also some cohesive sediments.	Cumulative work done significantly reduced in all FMZ events. Bed and bank erosion potential reduced.	Sand transport potential capacity significantly reduced in FMZ events. Despite this, 50 and 100 year ARI capacity remains adequate to transport the expected load, while in 5, 10, possibly 20 ARI events might not be adequate to transport all the expected load.
Penrith Weir to Grose River		
Steeper gradient than downstream reaches. Flood mostly confined. Bed gravel to sand.	Cumulative work done significantly reduced in all FMZ events. Bed and bank erosion potential reduced.	Upstream section has steeper grade and good sediment transport capacity. Lower section at Devlins Road has much less capacity – may not transport expected load in 5, 10 year ARI, and possibly not the 20 and 50 year ARI.
Grose River to Cattai Creek		
Significant out-of-channel flood plain flow in 'Existing', but much reduced in 'with Project'. Flat hydraulic grades. Return flow from flood plain around Windsor affects hydraulic grades upstream, even some backflow in 'Existing'. This reduces erosion potential and lowers sediment transport capacity in 50 – 100 year ARI.		
North Richmond – Windsor Bed and banks sandy.	Increased total event flow volume through the channel for 50 and 100 year ARI in 'with Project' results in similar erosion potential to 'Existing' for North Richmond, but by Thornham Park erosion potential in 20 to 100 year ARI is nearly doubled, which could affect the right bank (left is shale). From Reservoir to Windsor the backwater affects stream power and erosion is reduced for 'with Project', although locally at Freereach there is a slight increase in all events.	Low hydraulic grade means reduced transport in all events, even up to 100 year ARI. Increased sedimentation likely.

Description	Erosion potential	Sediment transport capacity
Windsor to Cattai Creek Bed and banks sandy.	For this reach there is again an increase in erosion potential from the 20 year ARI event and above, under the 'with Project' scenario, with the effects up to or slightly more than double.	Improved hydraulic grade and increased flow in channel means mostly increased transport, with limited effects in some areas in smaller events.
Cattai Creek to Colo River		
Bed and banks sandy. Flood mostly confined.	Effects on erosion potential are variable, with some locations being slightly reduced for 'with Project', and some slightly increased, but on average similar to 'Existing'. The greatest increase occurs in the 50 and 100 year ARI events in the vicinity and immediately downstream of Cattai Creek.	Reduced capacity in all events, but still enough residual capacity in larger events (50, 100 year ARI). Expect reduced capacity and possible increased sedimentation in smaller events (particularly 5 to 10 year ARI).
Colo River to Wisemans Ferry		
Bed and banks sandy. Flood mostly confined.	Erosion potential reduced under 'with Project' compared to 'Existing'.	Generally reduced capacity, may not be able to transport expected sediment load.

7 Recommendations - potential mitigation

7.1 General approach to mitigation

The potential effects of the ‘with Project’ scenario on erosion and sediment transport are variable and come on top of an already challenging river management environment. It is therefore difficult to split out the relative contribution of future effects coming from the FMZ operation, and to target mitigation solely to those effects. Rather, the potential mitigations are similar to what could be considered appropriate for mitigation and management of the rivers current condition, and existing operating regime at Warragamba Dam.

Mitigation in this context is intended to modify or address any possible adverse effects under the ‘with Project’ scenario (where practicable) so as to return the river to conditions similar to the ‘Existing’ scenario.

Mitigation for erosion (reducing the erosion power of the flow) and for sediment transport (increasing transport capacity to avoid increased sedimentation) potentially leads to conflicting objectives, since the former could require reduced “power” in the river, while the latter requires increased “power” in the river. However, there is potential to undertake measures that address both (e.g. improved riparian vegetation in critical reaches) and further optimisation of the FMZ operation. These are explained below.

Potential mitigation related to refinement of the FMZ operation will need to reflect the primary objectives of the project in regard to protection of life and property, and also any other constraints related to potential project effects, and any limits on the duration of storage.

7.2 Mitigation relating to erosion risks

Given the numerous and varied influences on the river environment, it is envisaged that this would require a whole-of-government approach. The future management of the river environment should probably be centred around remediation and reinforcement of critical sites and more at-risk reaches, and could primarily be via active planting of vegetation. Riparian planting will strengthen banks to resist collapse as a result of erosion (as further described in the Technical Note on Bank Stability) and can reduce near-bank velocity and shear stress if planting is dense and within the flood zone. To be effective this might require some bank re-profiling in places, where erosion has already led to them being over-steep and inherently unstable. Routine maintenance of planting, and monitoring, would be required to support such management.

Spatially, such mitigations, if intended to address effects of the FMZ operation, should be focussed on the reach from North Richmond to Cattai Creek and a little downstream (refer to Figure 5), as that is where the greatest change in erosion (and also potentially increased risk of bank failure resulting from FMZ operation) might occur.

There may also be potential to optimise the FMZ operation to reduce the risk of erosion undercutting of the banks leading to block failure. This could include a progressive recession rather than flat-lining, to avoid holding flow rate at a fixed level, which can lead to wave action causing frittering or notching of the bank at that level.

7.3 Mitigation relating to sediment transport risks

Whether there is a need to improve sediment transport would require a much more comprehensive whole of government response to assessing sediment supply, transport capacity and deposition. This would facilitate the maintenance of flood capacity, and potentially treating the sediment in the whole river system as a resource to be managed. The relative effects of the FMZ operation on that overall management would fit within that wider consideration.

However, there may be some responses directly available to mitigate the potential effects of reduced sediment transport on localised deposition in the river, amendments to the operation of the FMZ might assist. In 5 to 10 year ARI events, the approach would be to minimise the amount of flow peak reduction applied while still achieving appropriate downstream flood management outcomes. This would assist in moving sediment through without exacerbating erosion risk in these more frequent flood events.

In larger events, 20 year ARI and above, the objective would be to retain higher downstream flows on the hydrograph recession, while still achieving appropriate downstream flood management outcomes. This could include using a more progressive reduction of flows in the latter part of the recession rather than a more abrupt steps.

In the context of potential reduced sediment transport capacity, reduction of sediment supply would be the most effective physical mitigation action. While the upstream sediment supply is not affected by the FMZ operation or within the scope of this assessment, reducing the contribution to sediment load from river bank erosion would be a potential tool. This is best achieved with targeted riparian planting focusing on highest risk areas, as outlined above for erosion mitigation.

Finally, a method for river sediment management commonly used elsewhere is to assess total loads coming through the river system over time, and understanding where and in what quantities they deposit. A managed amount can then be extracted at suitable controlled locations through dredging, with the potential for beneficial use of the dredged material to meet demands of the construction industry. This approach would address the wider sediment management needs of the river system, over and above any specific mitigation needed to address potential effects of the project.

8 Limitations statement

This report has been prepared by Beca on the specific instructions of our Client. It is solely for our Client’s use for the purpose for which it is intended in accordance with the agreed scope of work. Any use or reliance by any person contrary to the above, to which Beca has not given its prior written consent, is at that person's own risk.

9 Approvals

Prepared by:	Reviewed by:	Approved by:
Melissa Halligan Environmental Engineer **Graham Levy** Technical Director – Water Resources Engineering	**Mark Megaughin** Senior Associate – Water	**Graham Levy** Technical Director – Water Resources Engineering
		on behalf of Beca Pty Ltd

10 References

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Attachments

Attachment A – Site Location Maps

Attachment B – Main Channel Runoff Volumes

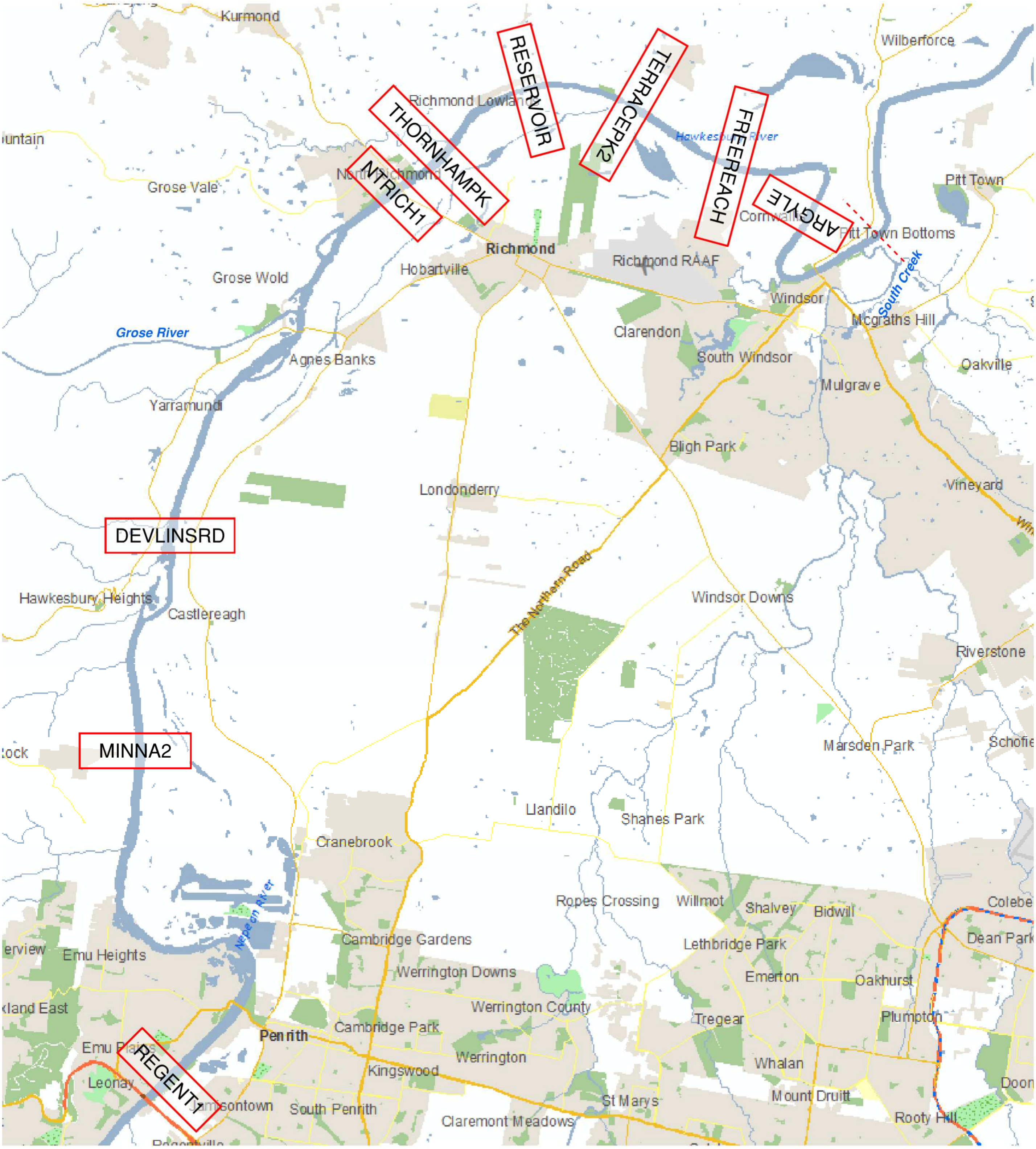
Attachment C – Bank Erosion Assessment

Attachment D – Sediment Transport Capacity Assessment

Attachment E – Results Plots

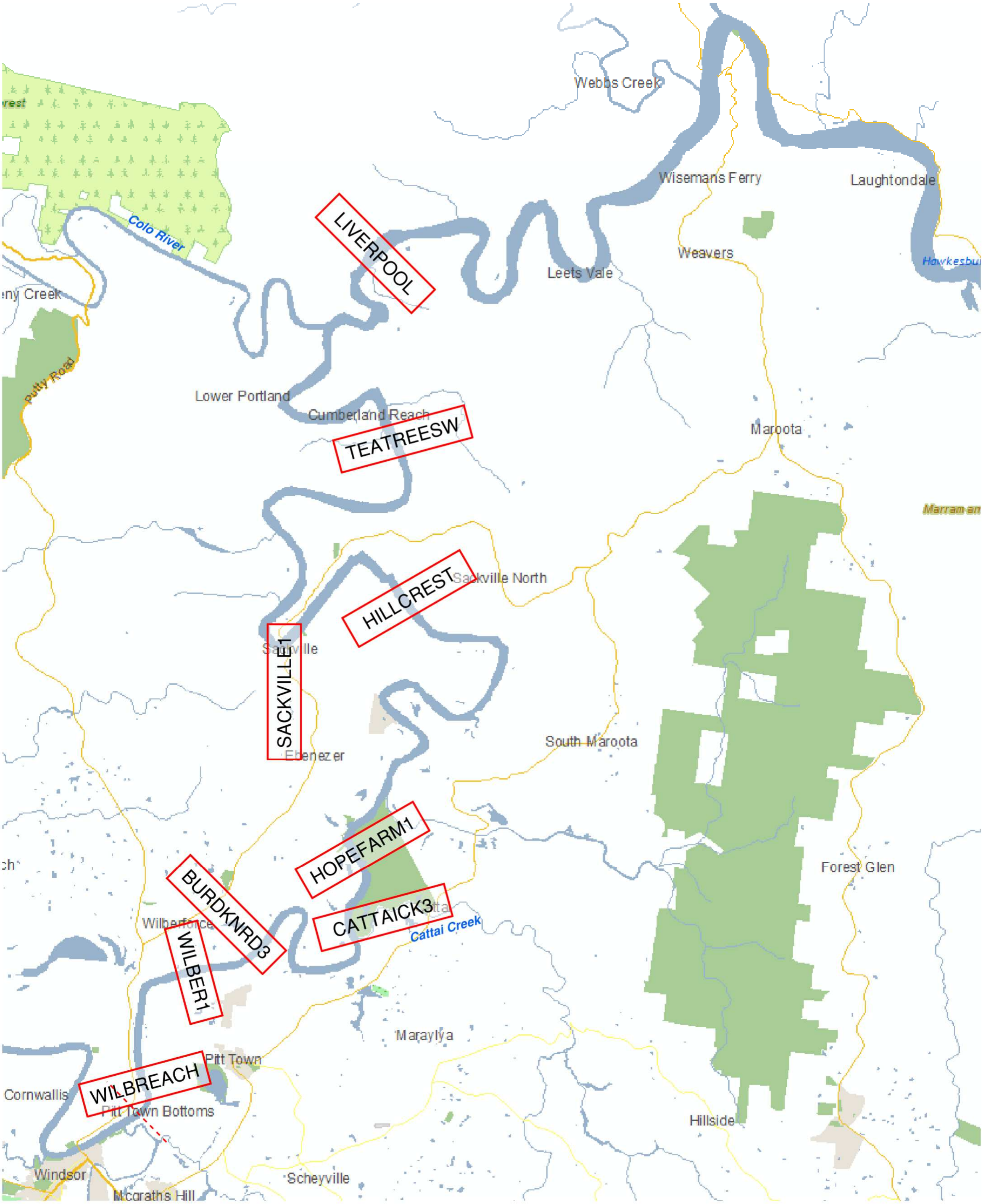
Attachment A - SITE LOCATION MAPS

SOUTHERN REACHES - Penrith to Windsor



Attachment A - SITE LOCATION MAPS

NORTHERN REACHES - Windsor to Wisemans Ferry



Attachment B - MAIN CHANNEL RUNOFF VOLUMES

Note - flow volumes are those within the main river channel, not including any flood plain flow

	Event (ARI - years)	Existing - channel flow volume (m^3)	with Project - channel flow volume (m^3)	Volume increase (%)	Comments
REGENT1	**5**	661,026	664,217	0%	Includes Nepean and Warragamba upper catchments. Confined channel.
	10	1,095,982	1,100,682	0%	
	20	1,528,099	1,509,066	-1%	
	50	2,458,746	2,434,989	-1%	
	100	2,710,164	2,693,309	-1%	
MINNA2	**5**	673,453	677,406	1%	Confined channel.
	10	1,106,367	1,112,817	1%	
	20	1,536,368	1,520,668	-1%	
	50	2,452,463	2,443,020	0%	
	100	2,634,042	2,699,022	2%	
DEVLINSRD	**5**	689,513	692,623	0%	Confined channel.
	10	1,128,403	1,133,074	0%	
	20	1,563,961	1,544,900	-1%	
	50	2,499,303	2,475,779	-1%	
	100	2,758,725	2,742,371	-1%	
NTRICH1	**5**	761,805	765,180	0%	Includes inflow from Grose River. Confined channel up to 50 year ARI.
	10	1,232,848	1,246,315	1%	
	20	1,669,369	1,684,921	1%	
	50	2,438,194	2,633,463	8%	
	100	2,518,457	2,872,557	14%	
THORNHAMPK	**5**	751,266	764,969	2%	Reduced overbank flow under Raised scenario for 50 and 100 year ARI - increased flow volume through channel.
	10	1,203,452	1,242,401	3%	
	20	1,628,419	1,678,536	3%	
	50	2,158,221	2,581,943	20%	
	100	2,071,874	2,804,629	35%	
RESERVOIR	**5**	741,148	762,921	3%	Reduced overbank flow under Raised scenario for 50 and 100 year ARI - increased flow volume through channel.
	10	1,181,500	1,227,657	4%	
	20	1,582,574	1,658,214	5%	
	50	1,714,322	2,523,241	47%	
	100	1,596,555	2,741,948	72%	
TERRACEPK2	**5**	728,146	753,992	4%	Reduced overbank flow under Raised scenario for 50 and 100 year ARI - increased flow volume through channel.
	10	1,158,029	1,202,085	4%	
	20	1,463,851	1,621,894	11%	
	50	1,644,518	2,460,255	50%	
	100	1,601,561	2,658,736	66%	
FREEREACH	**5**	723,120	747,344	3%	Reduced overbank flow under Raised scenario for 20, 50 and 100 year ARI - increased volume through channel.
	10	1,138,462	1,192,531	5%	
	20	1,194,152	1,608,403	35%	
	50	1,296,497	2,412,333	86%	
	100	1,244,294	2,441,771	96%	
ARGYLE	**5**	722,339	746,544	3%	Reduced overbank flow under Raised scenario for 20, 50 and 100 year ARI - increased flow volume through channel.
	10	1,069,988	1,191,263	11%	
	20	922,705	1,606,841	74%	
	50	779,682	2,336,149	**200%**	
	100	655,370	2,178,613	**232%**	

Attachment B - MAIN CHANNEL RUNOFF VOLUMES

Note - flow volumes are those within the main river channel, not including any flood plain flow

	Event (ARI - years)	Existing - channel flow volume (m^3)	with Project - channel flow volume (m^3)	Volume increase (%)	Comments
WILBREACH	**5**	827,541	857,788	4%	Increased inflow from South Creek. Reduced overbank flow under Raised scenario for all events except 5 year ARI - increased flow volume through channel.
	10	1,078,017	1,362,363	26%	
	20	1,021,318	1,777,694	74%	
	50	1,135,077	2,390,243	**111%**	
	100	1,117,343	2,210,321	98%	
WILBER1	**5**	830,134	861,972	4%	Reduced overbank flow under Raised scenario for all events except 5 year ARI - increased flow volume through channel.
	10	1,067,770	1,368,768	28%	
	20	1,150,813	1,786,879	55%	
	50	1,478,270	2,375,038	61%	
	100	1,549,221	2,269,378	46%	
BURDKNRD3	**5**	858,369	862,322	0%	Reduced overbank flow under Raised scenario for 20, 50 and 100 year ARI - increased flow volume through channel.
	10	1,271,857	1,377,396	8%	
	20	1,459,024	1,802,572	24%	
	50	1,966,470	2,670,098	36%	
	100	2,077,849	2,741,193	32%	
CATTAIK3	**5**	891,449	894,727	0%	Includes inflow from Cattai Creek. Confined channel.
	10	1,405,783	1,409,643	0%	
	20	1,851,864	1,833,439	-1%	
	50	2,846,632	2,823,473	-1%	
	100	3,177,894	3,162,339	0%	
HOPEFARM1	**5**	891,159	894,530	0%	Confined channel.
	10	1,405,688	1,409,510	0%	
	20	1,851,675	1,833,298	-1%	
	50	2,846,286	2,823,262	-1%	
	100	3,177,678	3,162,183	0%	
HILLCREST	**5**	904,472	907,839	0%	Confined channel.
	10	1,424,214	1,428,171	0%	
	20	1,870,299	1,852,026	-1%	
	50	2,869,294	2,846,430	-1%	
	100	3,209,995	3,193,231	-1%	
SACKVILLE1	**5**	904,088	907,465	0%	Confined channel.
	10	1,424,005	1,427,972	0%	
	20	1,869,889	1,851,613	-1%	
	50	2,869,054	2,846,162	-1%	
	100	3,209,736	3,192,978	-1%	
TEATREESW	**5**	920,934	924,615	0%	Confined channel.
	10	1,450,281	1,454,709	0%	
	20	1,904,632	1,887,306	-1%	
	50	2,912,292	2,890,161	-1%	
	100	3,260,249	3,243,913	-1%	
LIVERPOOL	**5**	1,020,968	1,024,650	0%	Includes inflow from Colo River. Confined channel.
	10	1,802,031	1,806,482	0%	
	20	2,337,325	2,320,009	-1%	
	50	3,455,033	3,432,921	-1%	
	100	4,179,403	4,163,048	0%	

Attachment C - BANK EROSION ASSESSMENT

Site	Flood event (years ARI)	Erosion - cumulative work done (KJ/m^2/event)		Percent change	Comments - potential effect on bank erosion
		Existing	with Project		
REGENT1	5	29,000	7,000	-76%	Likely reduced erosion
	10	87,000	19,000	-78%	Likely reduced erosion
	20	221,000	31,000	-86%	Likely reduced erosion
	50	556,000	141,000	-75%	Likely reduced erosion
	100	718,000	211,000	-71%	Likely reduced erosion
MINNA2	5	61,000	39,000	-36%	Likely reduced erosion
	10	135,000	80,000	-41%	Likely reduced erosion
	20	312,000	122,000	-61%	Likely reduced erosion
	50	811,000	254,000	-69%	Likely reduced erosion
	100	268,000	318,000	19%	Possible increased erosion
DEVLINSRD	5	10,000	9,000	-10%	Likely reduced erosion
	10	21,000	11,000	-48%	Likely reduced erosion
	20	61,000	14,000	-77%	Likely reduced erosion
	50	195,000	31,000	-84%	Likely reduced erosion
	100	268,000	44,000	-84%	Likely reduced erosion
NTHRCH1	5	10,000	7,000	-30%	Likely reduced erosion
	10	17,000	13,000	-24%	Likely reduced erosion
	20	23,000	19,000	-17%	Likely reduced erosion
	50	31,000	28,000	-10%	Likely reduced erosion
	100	29,000	28,000	-3%	Unlikely effect
THORNHAMPK	5	6,000	5,000	-17%	Likely reduced erosion
	10	8,000	9,000	13%	Possible increased erosion
	20	8,000	12,000	50%	Probable increased erosion
	50	9,000	15,000	67%	Probable increased erosion
	100	8,000	13,000	63%	Probable increased erosion
RESERVOIR	5	11,000	3,000	-73%	Likely reduced erosion
	10	34,000	8,000	-76%	Likely reduced erosion
	20	103,000	12,000	-88%	Likely reduced erosion
	50	107,000	40,000	-63%	Likely reduced erosion
	100	93,000	58,000	-38%	Likely reduced erosion
TERRACEPK2	5	12,000	4,000	-67%	Likely reduced erosion
	10	36,000	9,000	-75%	Likely reduced erosion
	20	118,000	13,000	-89%	Likely reduced erosion
	50	121,000	41,000	-66%	Likely reduced erosion
	100	108,000	56,000	-48%	Likely reduced erosion
FREEREACH	5	6,000	7,000	17%	Possible increased erosion
	10	7,000	8,000	14%	Possible increased erosion
	20	9,000	12,000	33%	Probable increased erosion
	50	9,000	10,000	11%	Possible increased erosion
	100	9,000	9,000	0%	Unlikely effect
ARGYLE	5	13,000	5,000	-62%	Likely reduced erosion
	10	26,000	11,000	-58%	Likely reduced erosion
	20	49,000	17,000	-65%	Likely reduced erosion
	50	51,000	29,000	-43%	Likely reduced erosion
	100	45,000	21,000	-53%	Likely reduced erosion

Attachment C - BANK EROSION ASSESSMENT

Site	Flood event (years ARI)	Erosion - cumulative work done (KJ/m^2/event)		Percent change	Comments - potential effect on bank erosion
		Existing	with Project		
WILBREACH	5	8,000	4,000	-50%	Likely reduced erosion
	10	8,000	10,000	25%	Probable increased erosion
	20	7,000	13,000	86%	Probable increased erosion
	50	7,000	18,000	157%	Probable increased erosion
	100	6,000	13,000	117%	Probable increased erosion
WILBER1	5	11,000	9,000	-18%	Likely reduced erosion
	10	11,000	19,000	73%	Probable increased erosion
	20	10,000	26,000	160%	Probable increased erosion
	50	12,000	32,000	167%	Probable increased erosion
	100	11,000	24,000	118%	Probable increased erosion
BURDKNRD3	5	7,000	8,000	14%	Possible increased erosion
	10	10,000	16,000	60%	Probable increased erosion
	20	10,000	23,000	130%	Probable increased erosion
	50	11,000	29,000	164%	Probable increased erosion
	100	10,000	25,000	150%	Probable increased erosion
CATTAIK3	5	12,000	9,000	-25%	Likely reduced erosion
	10	18,000	18,000	0%	Unlikely effect
	20	20,000	16,000	-20%	Likely reduced erosion
	50	27,000	42,000	56%	Probable increased erosion
	100	26,000	40,000	54%	Probable increased erosion
HOPEFARM1	5	14,000	9,000	-36%	Likely reduced erosion
	10	16,000	17,000	6%	Possible increased erosion
	20	20,000	24,000	20%	Probable increased erosion
	50	33,000	40,000	21%	Probable increased erosion
	100	34,000	35,000	3%	Possible increased erosion
HILLCREST	5	13,000	12,000	-8%	Likely reduced erosion
	10	18,000	21,000	17%	Possible increased erosion
	20	30,000	33,000	10%	Possible increased erosion
	50	61,000	50,000	-18%	Likely reduced erosion
	100	68,000	53,000	-22%	Likely reduced erosion
SACKVILLE1	5	13,000	9,000	-31%	Likely reduced erosion
	10	20,000	17,000	-15%	Likely reduced erosion
	20	34,000	26,000	-24%	Likely reduced erosion
	50	72,000	51,000	-29%	Likely reduced erosion
	100	80,000	58,000	-28%	Likely reduced erosion
TEATREESW	5	8,000	5,000	-38%	Likely reduced erosion
	10	10,000	8,000	-20%	Likely reduced erosion
	20	18,000	13,000	-28%	Likely reduced erosion
	50	37,000	29,000	-22%	Likely reduced erosion
	100	42,000	32,000	-24%	Likely reduced erosion
LIVERPOOL	5	5,000	3,000	-40%	Likely reduced erosion
	10	15,000	9,000	-40%	Likely reduced erosion
	20	24,000	12,000	-50%	Likely reduced erosion
	50	41,000	28,000	-32%	Likely reduced erosion
	100	56,000	39,000	-30%	Likely reduced erosion

Attachment D - SEDIMENT TRANSPORT ASSESSMENT

Site	Flood event (years ARI)	Sediment transport capacity (tonne per event)		Potential catchment load (tonne/year)		Comments - potential effect on sediment transport
		Existing	with Project	Low	high	
REGENT1	5	464,000	76,000	77,000	390,000	Probable reduction - with Project < yield
	10	1,561,000	229,000			Possible reduction - with Project similar to yield
	20	4,703,000	378,000			Unlikely effect
	50	12,969,000	2,339,000			OK - with Project still > yield
	100	17,303,000	3,817,000			OK - with Project still > yield
MINNA2	5	890,000	421,000	101,000	503,000	Unlikely effect
	10	2,284,000	917,000			OK - with Project still > yield
	20	6,714,000	1,426,000			OK - with Project still > yield
	50	20,816,000	3,793,000			OK - with Project still > yield
	100	25,042,000	5,298,000			OK - with Project still > yield
DEVLINSRD	5	690,000	100,000	101,000	503,000	Probable reduction - with Project < yield
	10	428,000	148,000			Probable reduction - with Project < yield
	20	1,549,000	220,000			Possible reduction - with Project similar to yield
	50	5,778,000	602,000			Unlikely effect
	100	8,404,000	933,000			OK - with Project still > yield
NTHRCH1	5	202,000	87,000	101,000	503,000	Probable reduction - with Project < yield
	10	431,000	173,000			Probable reduction - with Project < yield
	20	877,000	256,000			Possible reduction - with Project similar to yield
	50	1,327,000	560,000			Unlikely effect
	100	1,262,000	654,000			OK - with Project still > yield
THORNHAMPK	5	153,000	66,000	128,000	640,000	Probable reduction - with Project < yield
	10	297,000	128,000			Probable reduction - with Project < yield
	20	580,000	190,000			Probable reduction - with Project < yield
	50	649,000	388,000			Possible reduction - with Project similar to yield
	100	555,000	433,000			Possible reduction - with Project similar to yield
RESERVOIR	5	172,000	35,000	128,000	640,000	Probable reduction - with Project < yield
	10	604,000	86,000			Probable reduction - with Project < yield
	20	3,517,000	135,000			Probable reduction - with Project < yield
	50	3,906,000	619,000			Unlikely effect
	100	3,471,000	1,129,000			OK - with Project still > yield
TERRACEPK2	5	164,000	38,000	128,000	640,000	Probable reduction - with Project < yield
	10	534,000	91,000			Probable reduction - with Project < yield
	20	2,182,000	141,000			Probable reduction - with Project < yield
	50	2,314,000	543,000			Possible reduction - with Project similar to yield
	100	2,076,000	809,000			Unlikely effect
FREEREACH	5	182,000	84,000	128,000	640,000	Probable reduction - with Project < yield
	10	273,000	139,000			Probable reduction - with Project < yield
	20	440,000	203,000			Probable reduction - with Project < yield
	50	459,000	292,000			Possible reduction - with Project similar to yield
	100	411,000	231,000			Possible reduction - with Project similar to yield
ARGYLE	5	281,000	57,000	128,000	640,000	Probable reduction - with Project < yield
	10	687,000	139,000			Probable reduction - with Project < yield
	20	1,666,000	219,000			Probable reduction - with Project < yield
	50	1,761,000	603,000			Possible reduction - with Project similar to yield
	100	1,523,000	413,000			Possible reduction - with Project similar to yield

Attachment D - SEDIMENT TRANSPORT ASSESSMENT

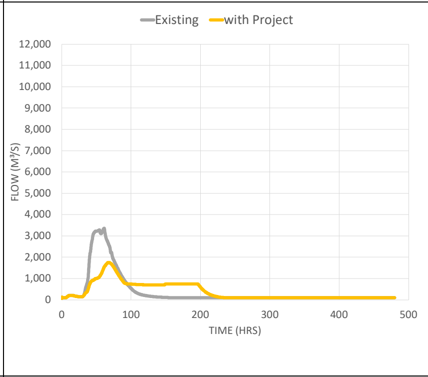
Site	Flood event (years ARI)	Sediment transport capacity (tonne per event)		Potential catchment load (tonne/year)		Comments - potential effect on sediment transport
		Existing	with Project	Low	high	
WILBREACH	5	101,000	35,000	149,000	743,000	Probable reduction - with Project < yield
	10	130,000	86,000			Possible reduction - with Project similar to yield
	20	109,000	118,000			OK - with Project > Existing capacity, though < yield
	50	110,000	249,000			OK - with Project > Existing capacity, though < yield
	100	101,000	184,000			OK - with Project > Existing capacity, though < yield
WILBER1	5	162,000	92,000	149,000	743,000	Possible reduction - with Project similar to yield
	10	181,000	200,000			OK - with Project > Existing capacity, though < yield
	20	179,000	273,000			OK - with Project > Existing capacity, though < yield
	50	232,000	454,000			OK - with Project > Existing capacity, though < yield
	100	213,000	362,000			OK - with Project > Existing capacity, though < yield
BURDKNRD3	5	249,000	125,000	149,000	743,000	Probable reduction - with Project < yield
	10	348,000	279,000			Possible reduction - with Project similar to yield
	20	343,000	376,000			OK - with Project > Existing capacity, though < yield
	50	448,000	808,000			OK - with Project still > yield
	100	398,000	701,000			OK - with Project > Existing capacity, though < yield
CATTAIK3	5	202,000	84,000	149,000	743,000	Probable reduction - with Project < yield
	10	464,000	189,000			Probable reduction - with Project < yield
	20	797,000	217,000			Possible reduction - with Project similar to yield
	50	1,434,000	919,000			Unlikely effect
	100	1,478,000	1,146,000			OK - with Project still > yield
HOPEFARM1	5	175,000	89,000	156,000	779,000	Probable reduction - with Project < yield
	10	520,000	187,000			Probable reduction - with Project < yield
	20	892,000	260,000			Possible reduction - with Project similar to yield
	50	1,791,000	959,000			Unlikely effect
	100	2,048,000	1,291,000			OK - with Project still > yield
HILLCREST	5	337,000	156,000	156,000	779,000	Probable reduction - with Project < yield
	10	685,000	331,000			Probable reduction - with Project < yield
	20	1,171,000	475,000			Possible reduction - with Project similar to yield
	50	2,481,000	1,490,000			OK - with Project still > yield
	100	2,778,000	1,846,000			OK - with Project still > yield
SACKVILLE1	5	283,000	125,000	156,000	779,000	Probable reduction - with Project < yield
	10	640,000	257,000			Probable reduction - with Project < yield
	20	1,206,000	379,000			Possible reduction - with Project similar to yield
	50	2,706,000	1,363,000			OK - with Project still > yield
	100	3,062,000	1,798,000			OK - with Project still > yield
TEATREESW	5	229,000	72,000	182,000	909,000	Probable reduction - with Project < yield
	10	481,000	156,000			Probable reduction - with Project < yield
	20	916,000	236,000			Possible reduction - with Project similar to yield
	50	1,889,000	1,154,000			Unlikely effect
	100	2,085,000	1,562,000			OK - with Project still > yield
LIVERPOOL	5	113,000	51,000	370,000	1,851,000	Probable reduction - with Project < yield
	10	561,000	211,000			Probable reduction - with Project < yield
	20	1,190,000	335,000			Probable reduction - with Project < yield
	50	2,492,000	923,000			Possible reduction - with Project similar to yield
	100	3,465,000	1,859,000			Unlikely effect

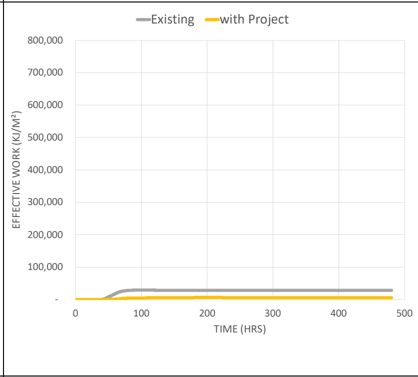
Attachment E - RESULTS PLOTS

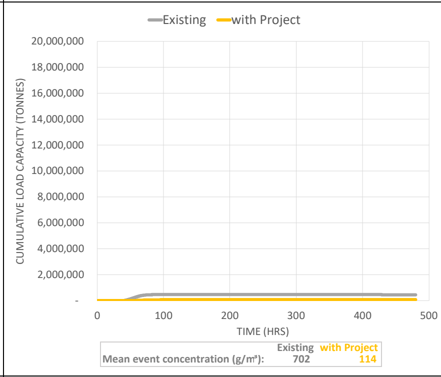
Site location:	**Downstream Western Motorway Bridge**	**Bank material size:**	0.5 mm	**Coarse Sand:**	2.00 mm	**Proportion:**	40%
Cross-section name:	**REGENT1**	**Erosion threshold USP:**	0.05 W/m²	**Fine sand:**	0.50 mm	**Proportion:**	50%
		Erosion equation exponent:	1.5	**Silt:**	0.05 mm	**Proportion:**	10%

	Flow hydrograph	**Erosion risk - cumulative effective work done**	**Cumulative transport load**

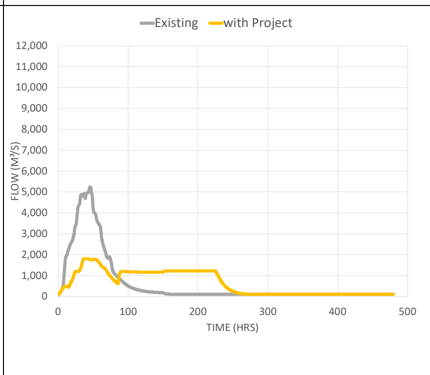
ARI 5

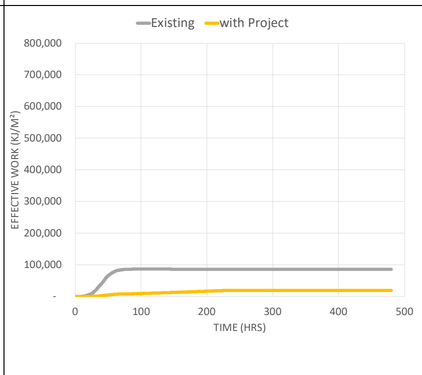


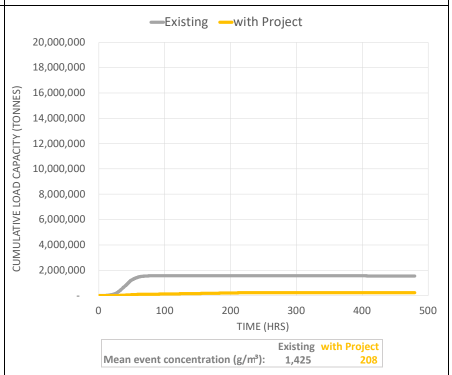




ARI 10







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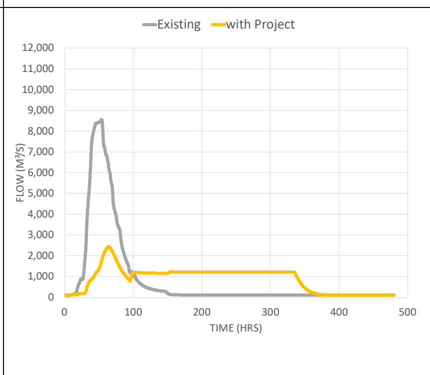

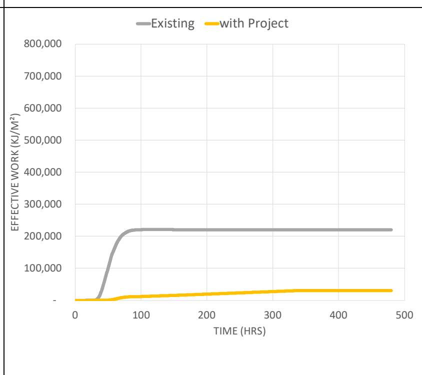

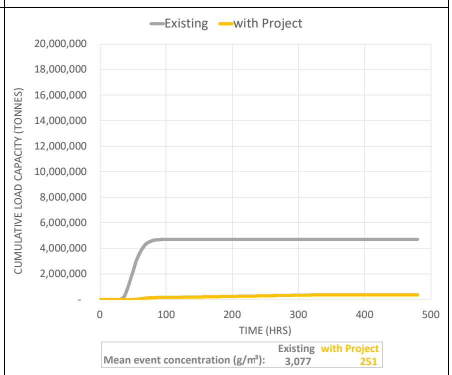

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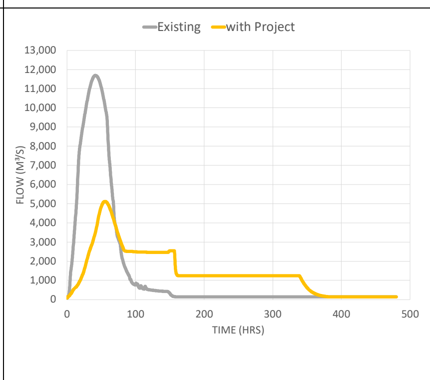

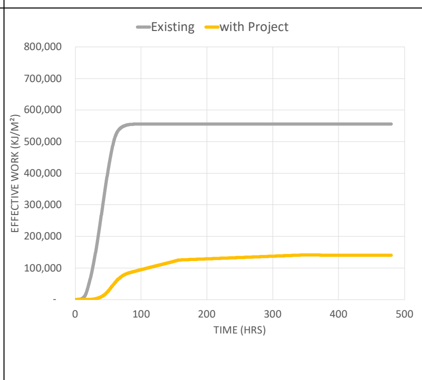

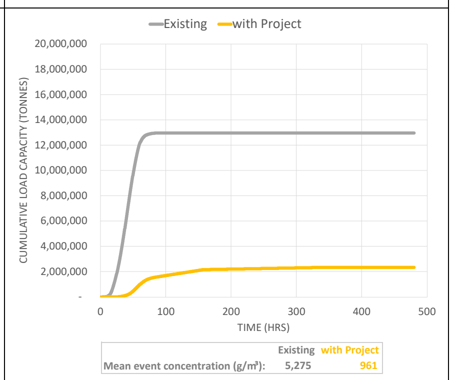

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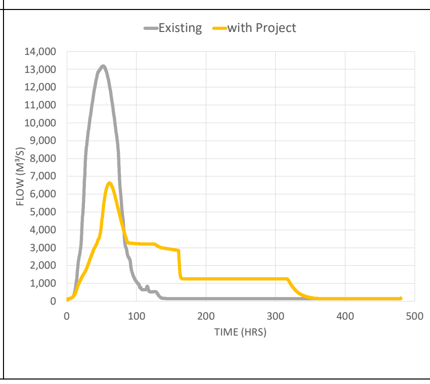
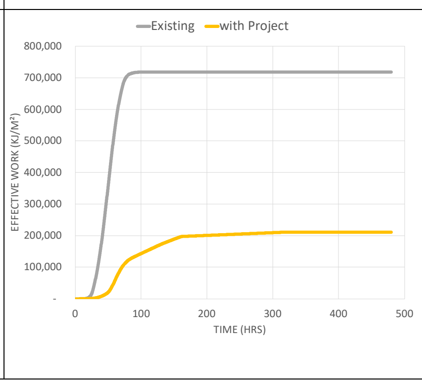
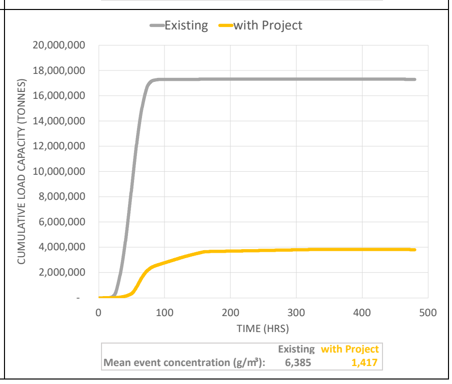


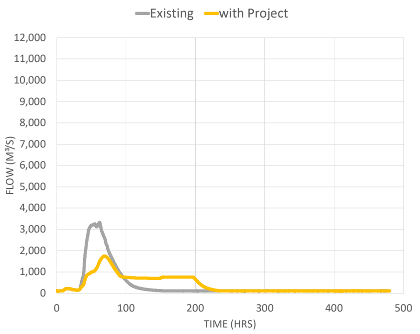


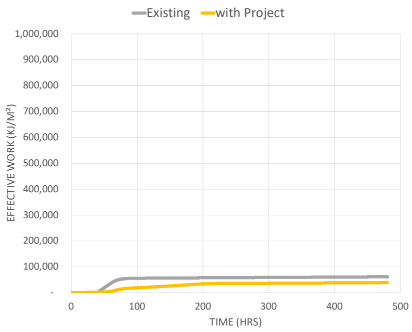


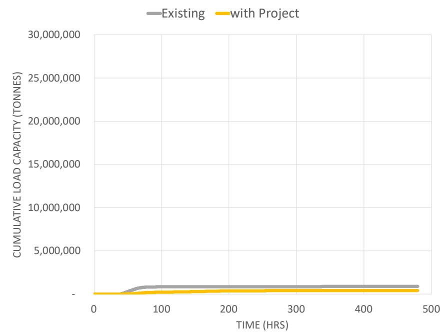
Site location:	**Yellow Rock**	**Bank material size:**	0.5 mm	**Coarse Sand:**	2.00 mm	**Proportion:**	40%
Cross-section name:	**MINNA2**	**Erosion threshold USP:**	0.33 W/m²	**Fine sand:**	0.50 mm	**Proportion:**	50%
		Erosion equation exponent:	1.5	**Silt:**	0.05 mm	**Proportion:**	10%

	Flow hydrograph	**Erosion risk - cumulative effective work done**	**Cumulative transport load**

ARI 5

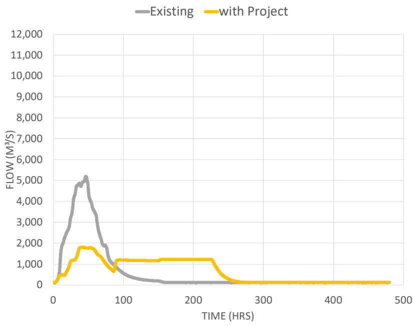


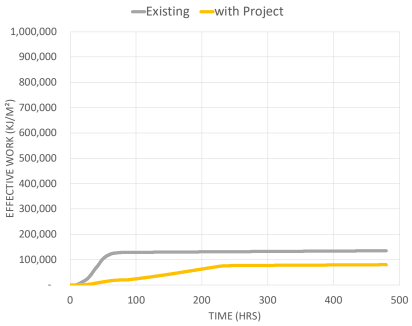


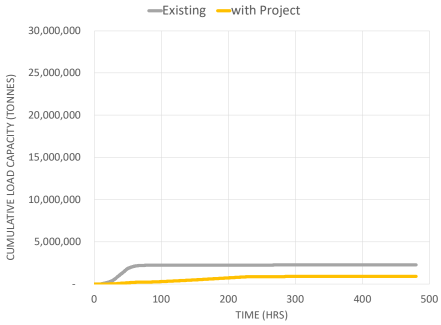


	Existing	with Project
Mean event concentration (g/m³):	1,322	621

ARI 10

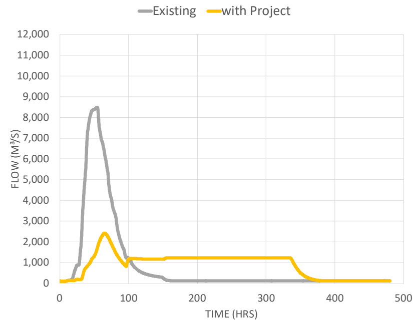


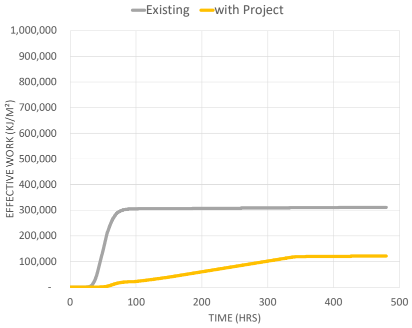


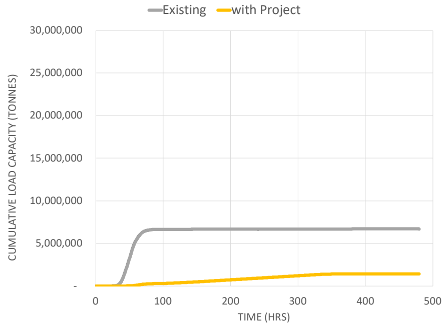


	Existing	with Project
Mean event concentration (g/m³):	2,064	824

ARI 20

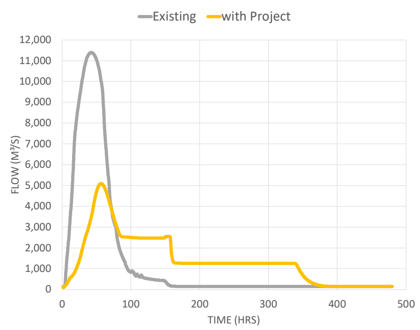


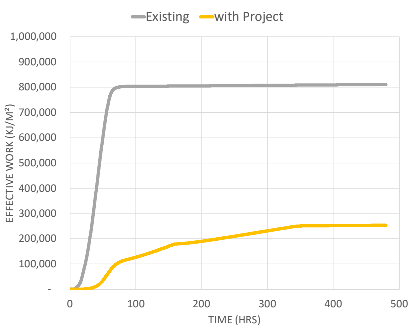


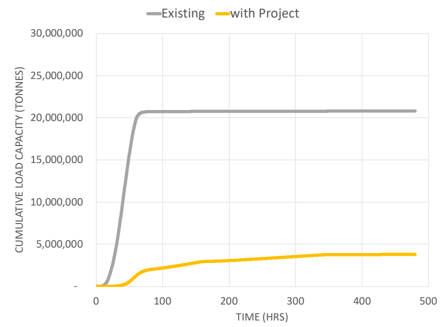


	Existing	with Project
Mean event concentration (g/m³):	4,370	938

ARI 50

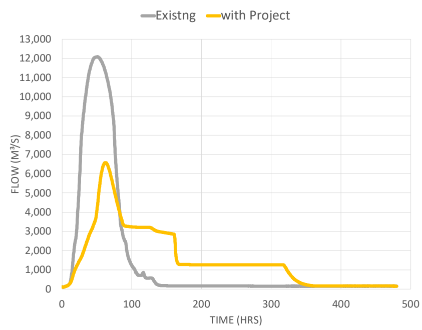


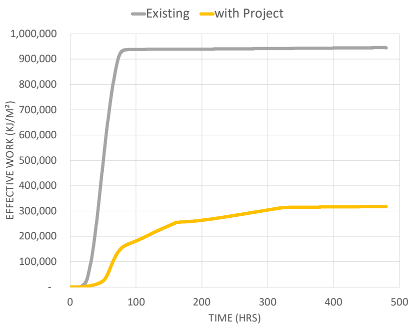


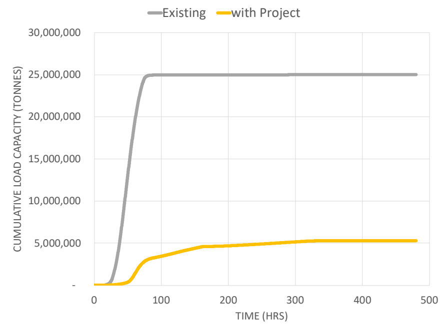


	Existing	with Project
Mean event concentration (g/m³):	8,488	1,553

ARI 100





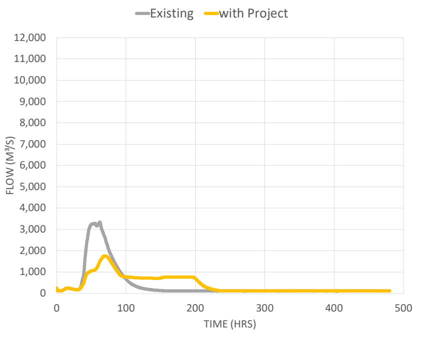


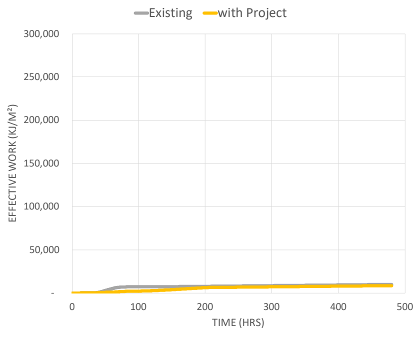
	Existing	with Project
Mean event concentration (g/m³):	9,507	1,963

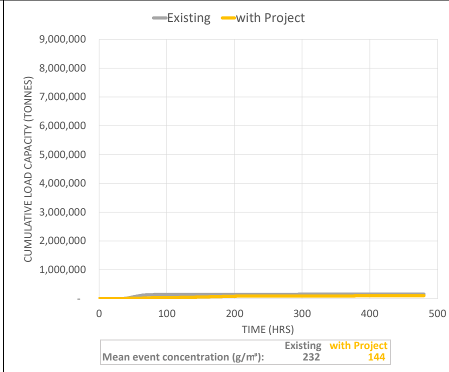
Site location:	**Upstream of Yarramundi**	**Bank material size:**	0.5 mm	**Coarse Sand:**	2.00 mm	**Proportion:**	40%
Cross-section name:	**DEVLINSRD**	**Erosion threshold USP:**	0.05 W/m²	**Fine sand:**	0.50 mm	**Proportion:**	50%
		Erosion equation exponent:	1.5	**Silt:**	0.05 mm	**Proportion:**	10%

	Flow hydrograph	Erosion risk - cumulative effective work done	Cumulative transport load

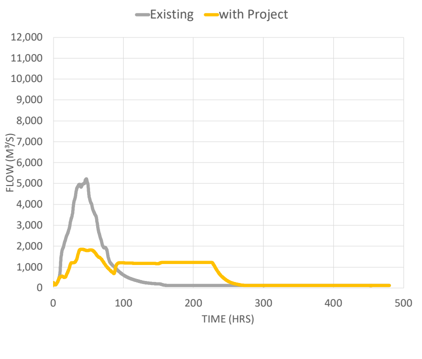
ARI 5

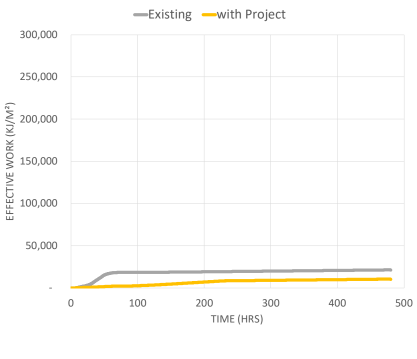


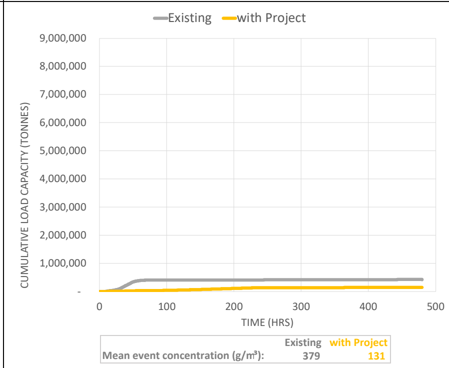




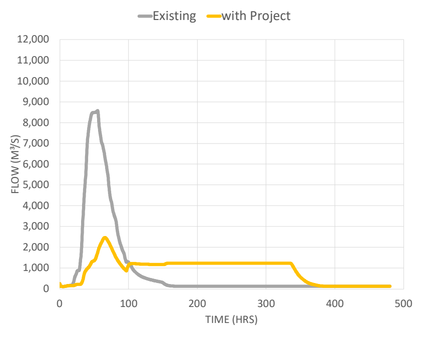
ARI 10

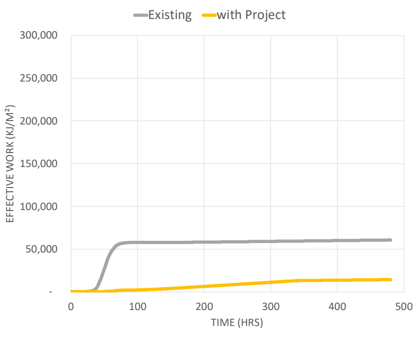


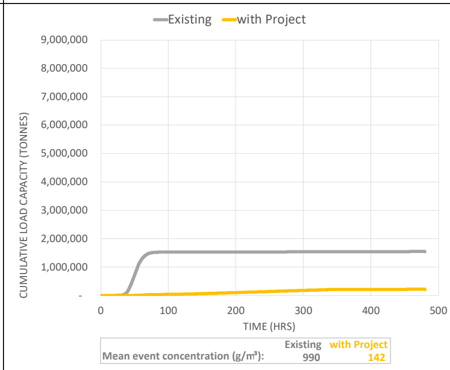




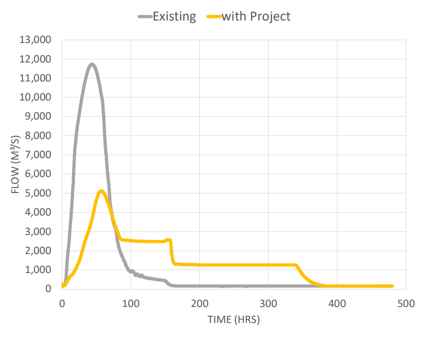
ARI 20

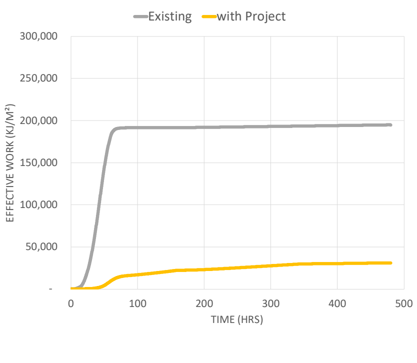


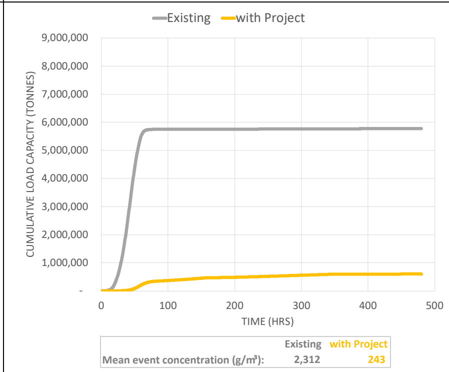




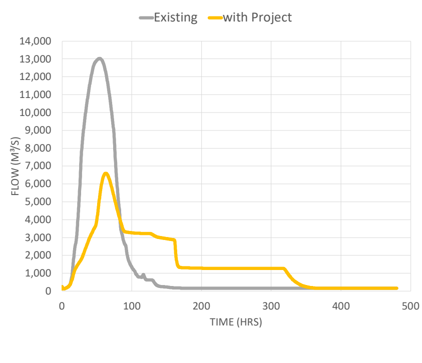
ARI 50

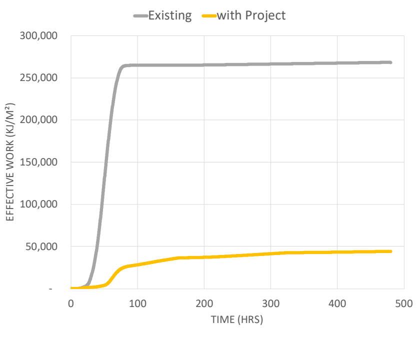


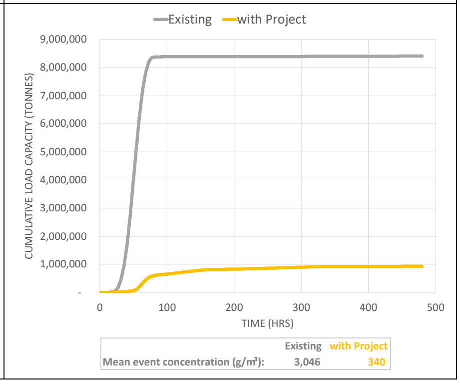




ARI 100



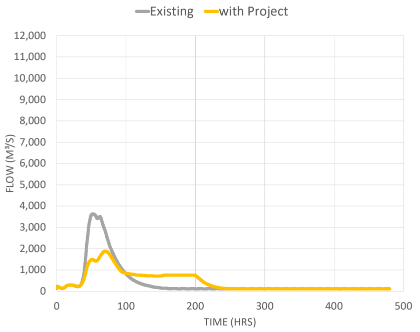


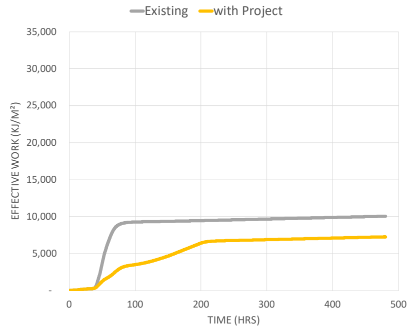


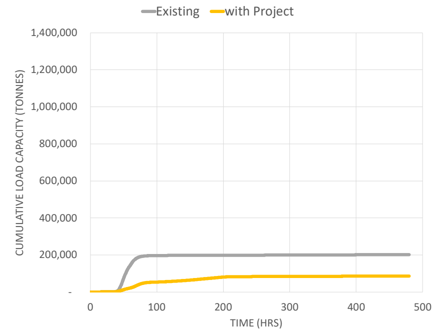
Site location:	**North Richmond**	**Bank material size:**	0.5 mm	**Coarse Sand:**	2.00 mm	**Proportion:**	40%
Cross-section name:	**NTHRICH1**	**Erosion threshold USP:**	0.05 W/m²	**Fine sand:**	0.50 mm	**Proportion:**	50%
		Erosion equation exponent:	1.5	**Silt:**	0.05 mm	**Proportion:**	10%

	Flow hydrograph	Erosion risk - cumulative effective work done	Cumulative transport load

ARI 5

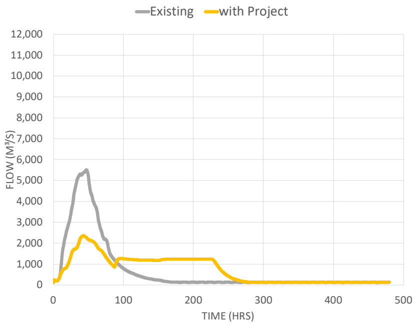


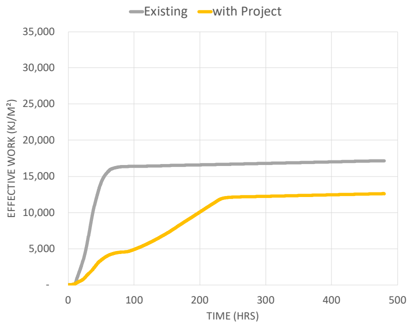


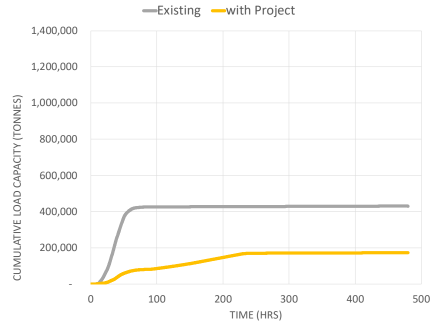


	Existing	with Project
Mean event concentration (g/m³):	266	113

ARI 10

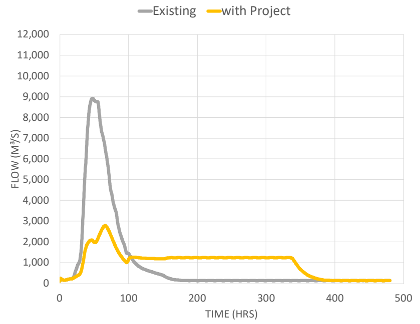


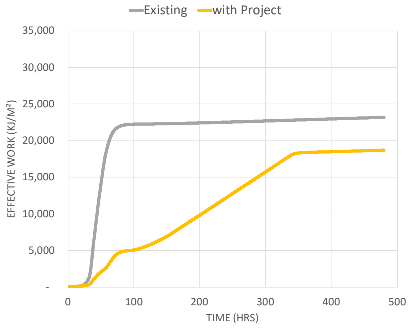


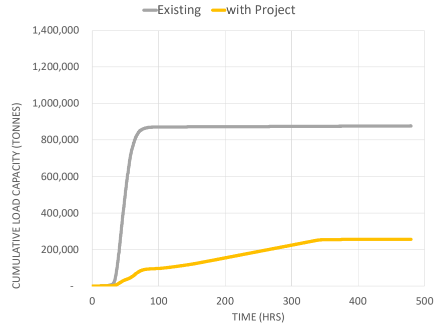


	Existing	with Project
Mean event concentration (g/m³):	350	139

ARI 20

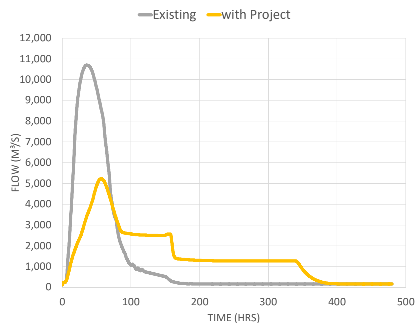


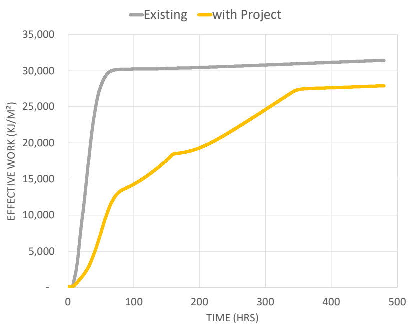


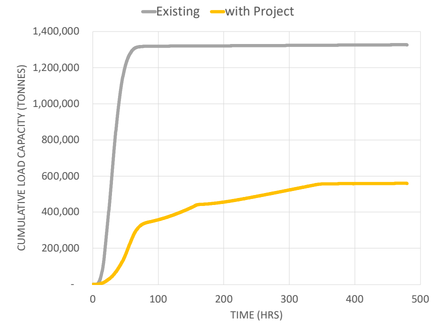


	Existing	with Project
Mean event concentration (g/m³):	525	152

ARI 50

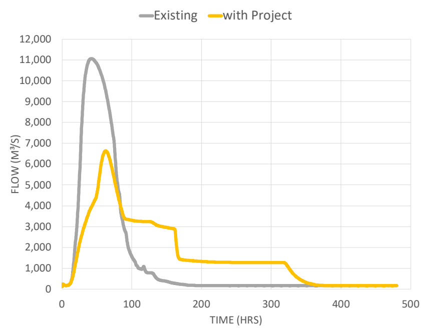


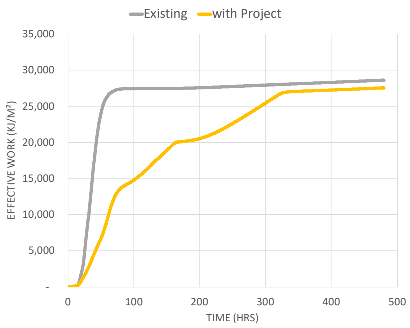


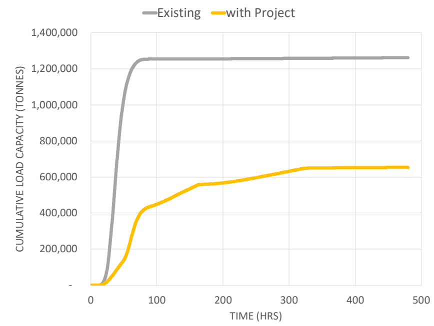


	Existing	with Project
Mean event concentration (g/m³):	544	213

ARI 100





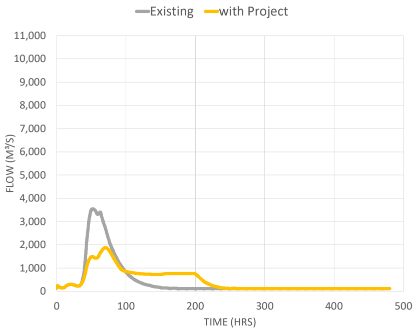


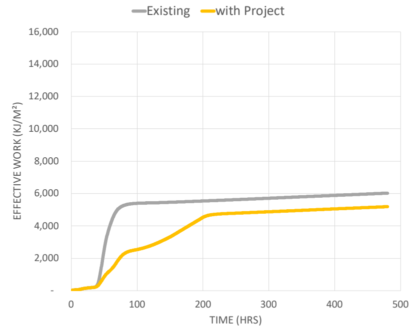
	Existing	with Project
Mean event concentration (g/m³):	501	228

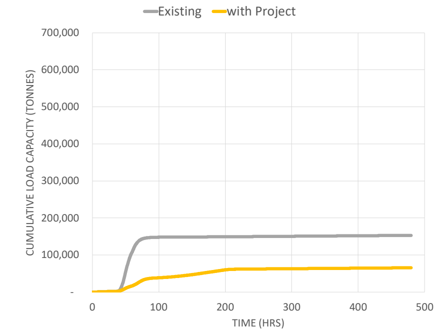
Site location:	**Downstream of North Richmond**	**Bank material size:**	0.5 mm	**Coarse Sand:**	2.00 mm	**Proportion:**	40%
Cross-section name:	**THORNHAMPK**	**Erosion threshold USP:**	0.05 W/m^2	**Fine sand:**	0.50 mm	**Proportion:**	50%
		Erosion equation exponent:	1.5	**Silt:**	0.05 mm	**Proportion:**	10%

Flow hydrograph	Erosion risk - cumulative effective work done	Cumulative transport load

ARI 5

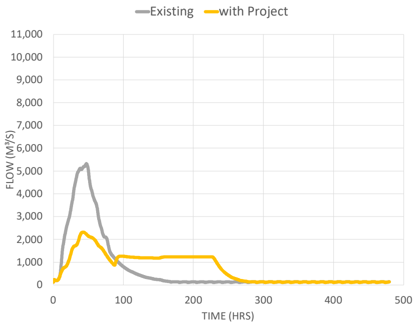


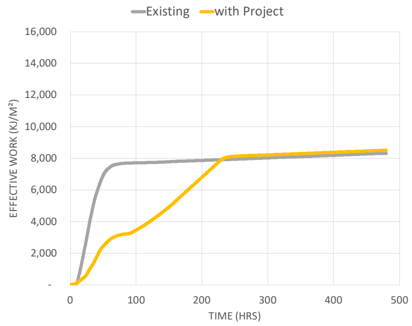


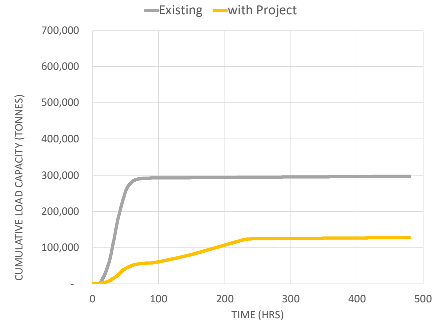


	Existing	with Project
Mean event concentration (g/m³):	204	86

ARI 10

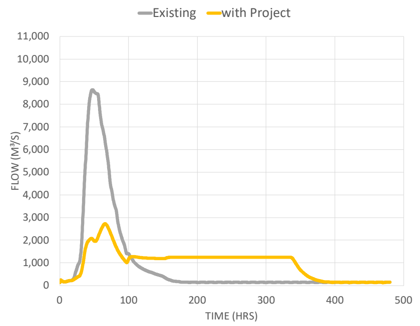


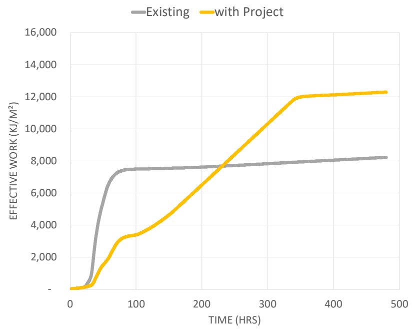


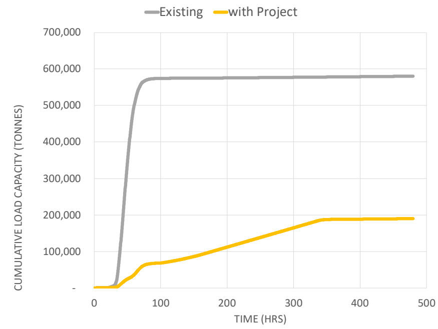


	Existing	with Project
Mean event concentration (g/m³):	247	103

ARI 20

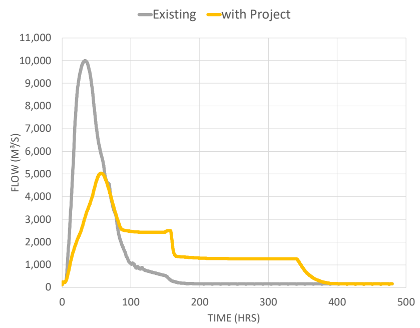


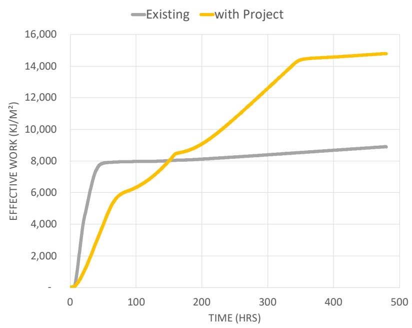


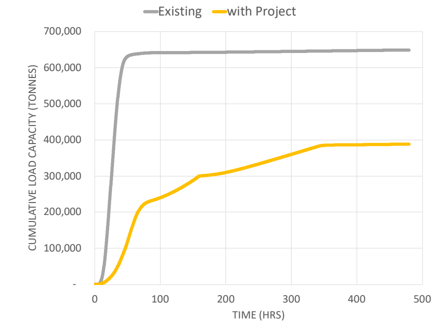


	Existing	with Project
Mean event concentration (g/m³):	356	113

ARI 50

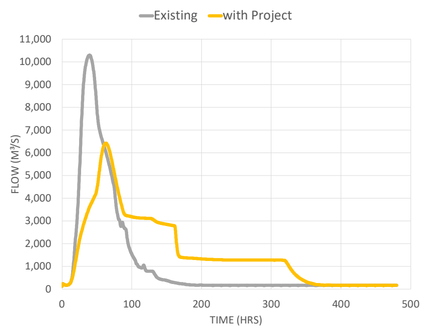


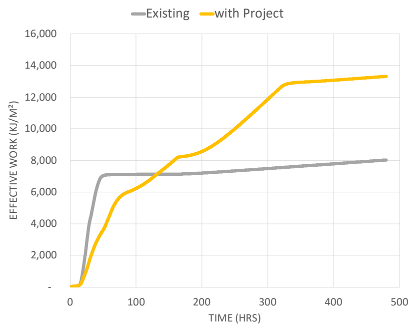


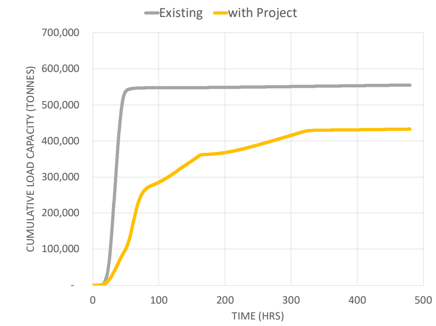


	Existing	with Project
Mean event concentration (g/m³):	301	150

ARI 100





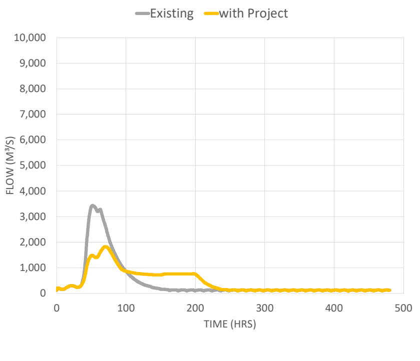


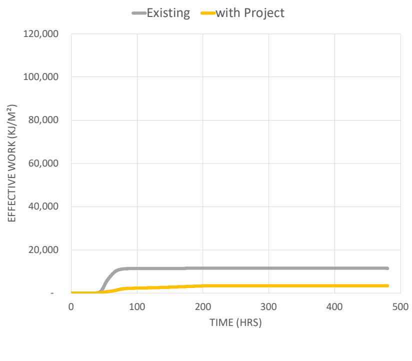
	Existing	with Project
Mean event concentration (g/m³):	268	154

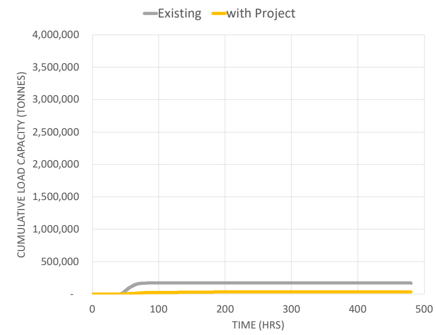
Site location:	**Richmond Lowlands**	**Bank material size:**	0.05 mm	**Coarse Sand:**	2.00 mm	**Proportion:**	40%
Cross-section name:	**RESERVOIR**	**Erosion threshold USP:**	0.05 W/m²	**Fine sand:**	0.50 mm	**Proportion:**	50%
		Erosion equation exponent:	1.5	**Silt:**	0.05 mm	**Proportion:**	10%

Flow hydrograph | **Erosion risk - cumulative effective work done** | **Cumulative transport load**

ARI 5

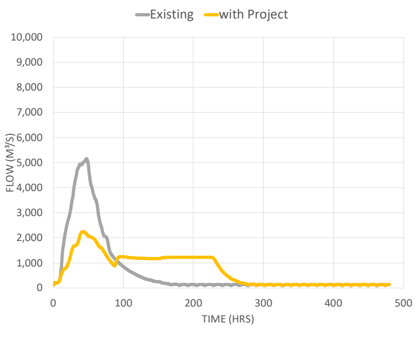


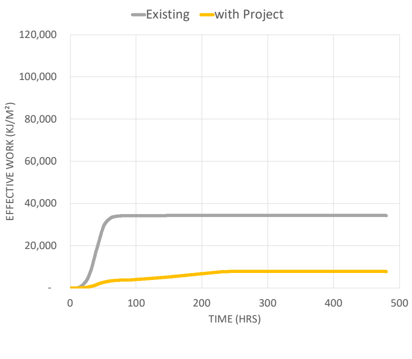


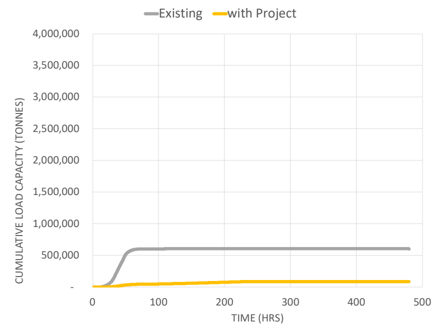


	Existing	with Project
Mean event concentration (g/m³):	232	45

ARI 10

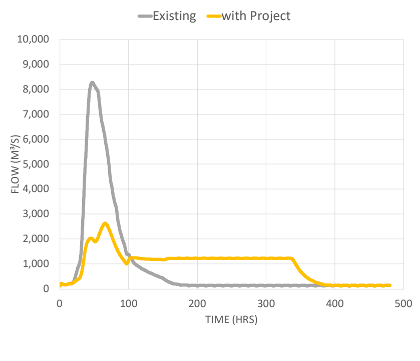


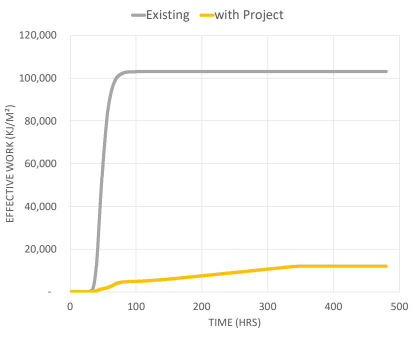


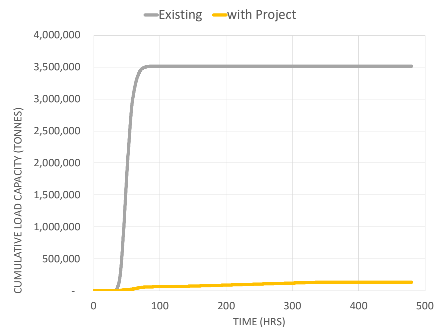


	Existing	Raised
Mean event concentration (g/m³):	511	70

ARI 20

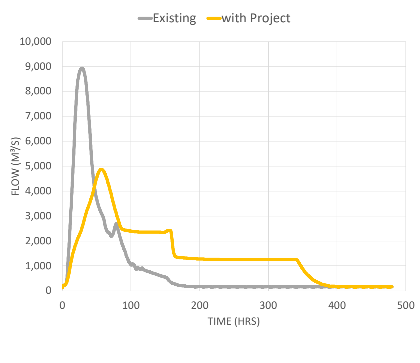


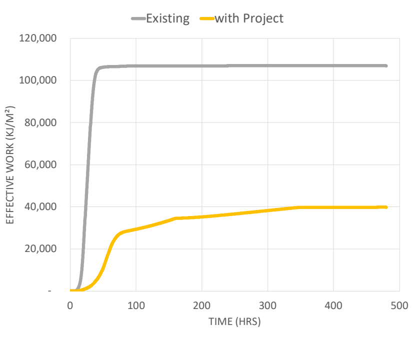


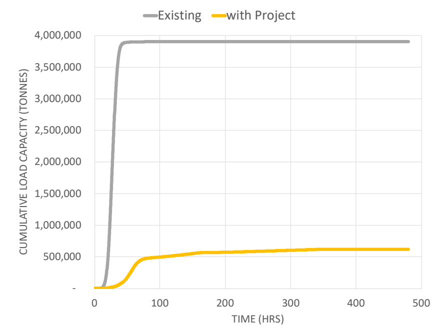


	Existing	with Project
Mean event concentration (g/m³):	2,222	81

ARI 50

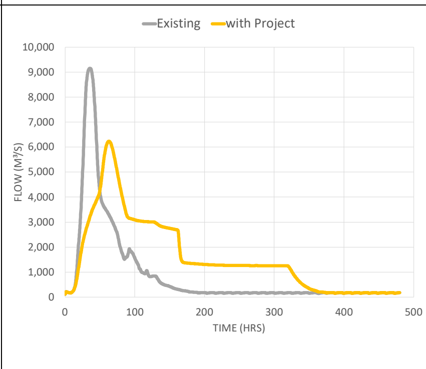


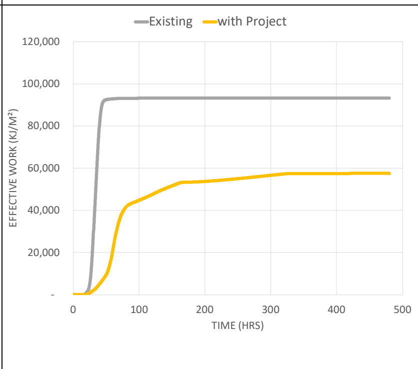


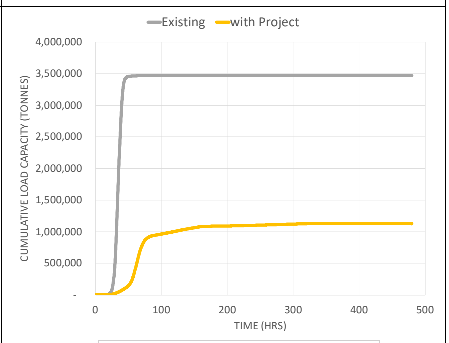


	Existing	with Project
Mean event concentration (g/m³):	2,278	245

ARI 100





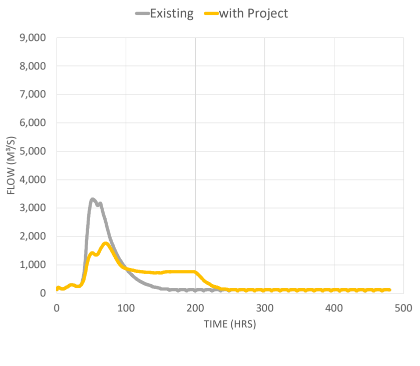


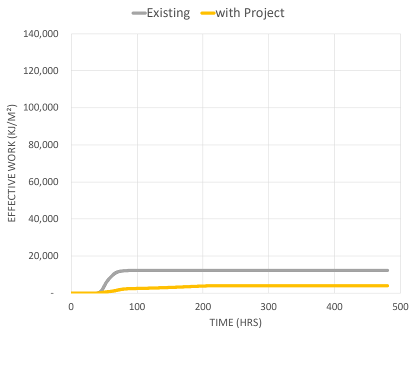
	Existing	with Project
Mean event concentration (g/m³):	2,174	412

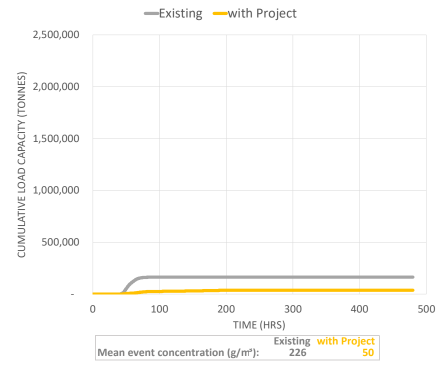
Site location:	**Terrace Road**	**Bank material size:**	0.05 mm	**Coarse Sand:**	2.00 mm	**Proportion:**	40%
Cross-section name:	**TERRACEPK2**	**Erosion threshold USP:**	0.05 W/m²	**Fine sand:**	0.50 mm	**Proportion:**	50%
		Erosion equation exponent:	1.5	**Silt:**	0.05 mm	**Proportion:**	10%

Flow hydrograph | **Erosion risk - cumulative effective work done** | **Cumulative transport load**

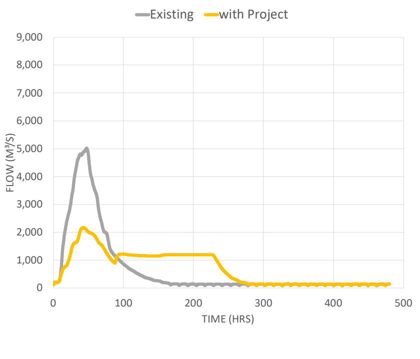
ARI 5

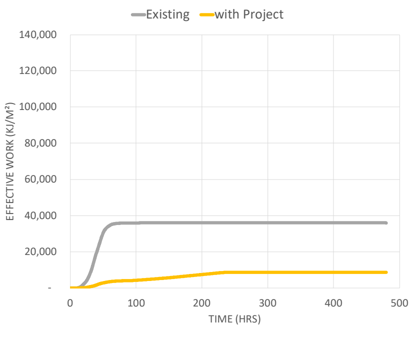


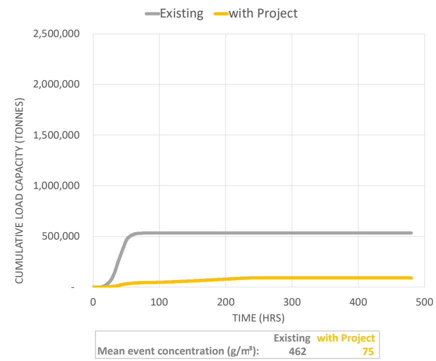




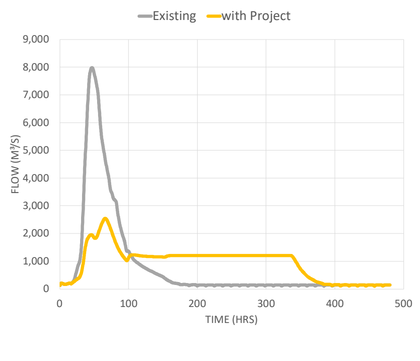
ARI 10

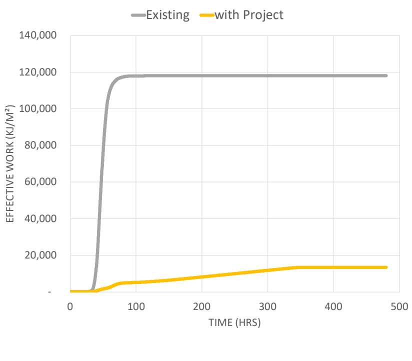


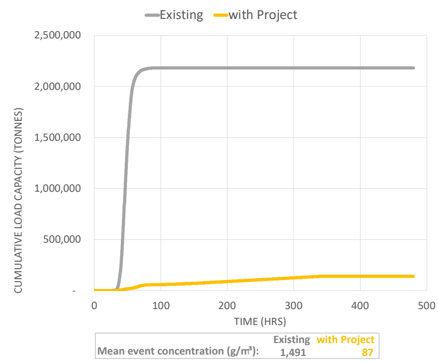




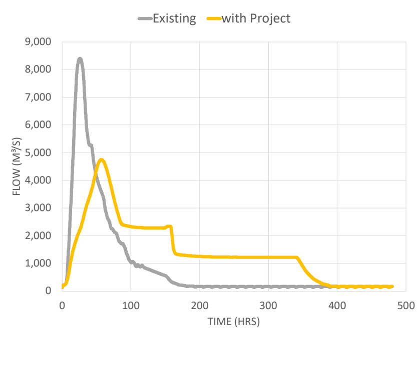
ARI 20

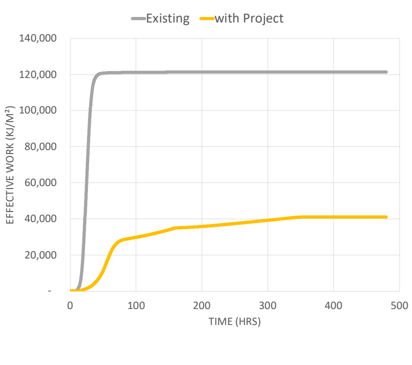


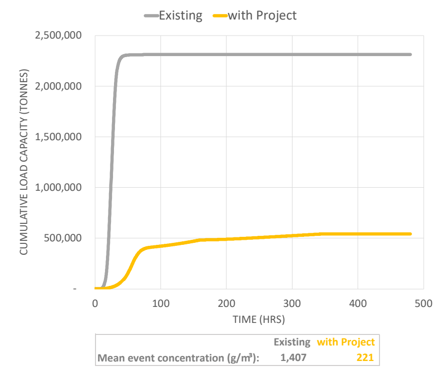




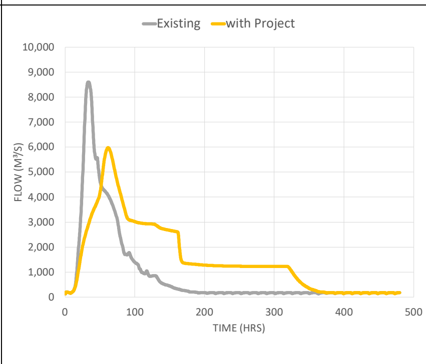
ARI 50

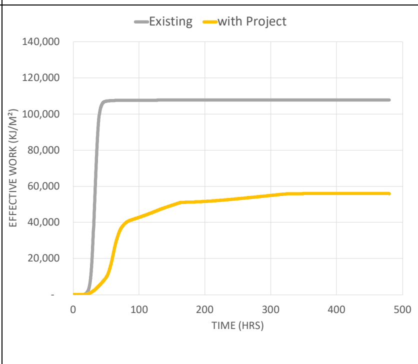


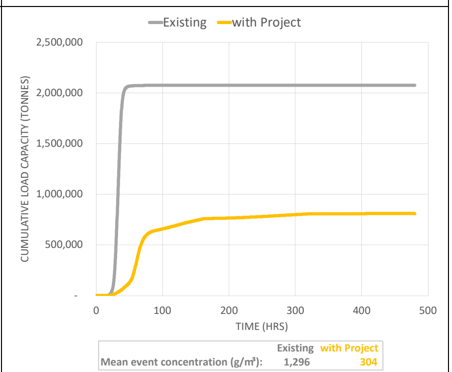




ARI 100



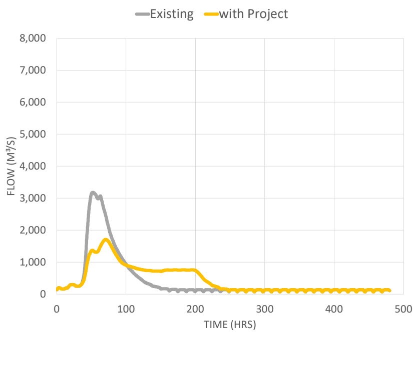


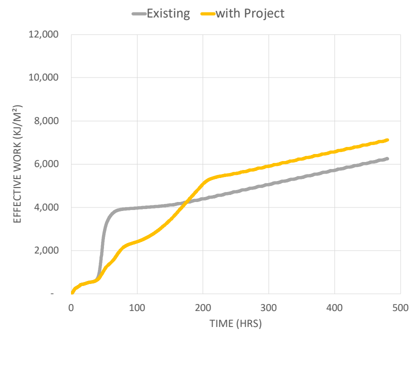


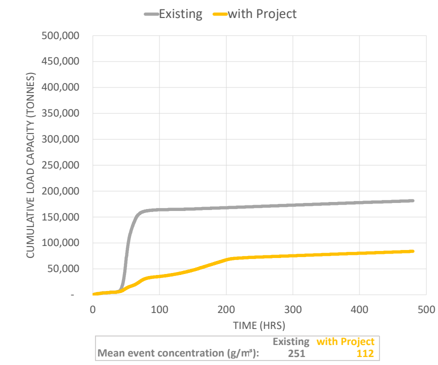
Site location:	**Freemans Reach**	**Bank material size:**	0.5 mm	**Coarse Sand:**	2.00 mm	**Proportion:** 40%
Cross-section name:	**FREEREACH**	**Erosion threshold USP:**	0.05 W/m²	**Fine sand:**	0.50 mm	**Proportion:** 50%
		Erosion equation exponent:	1.5	**Silt:**	0.05 mm	**Proportion:** 10%

	Flow hydrograph	Erosion risk - cumulative effective work done	Cumulative transport load

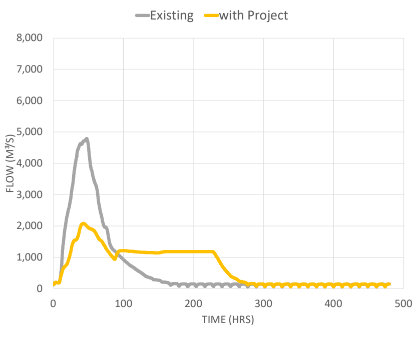
ARI 5

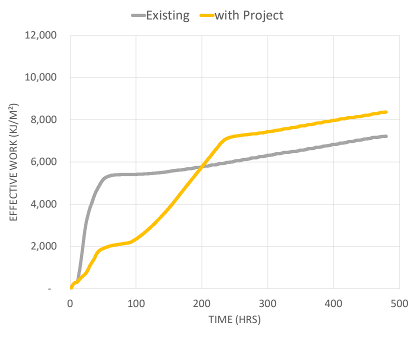




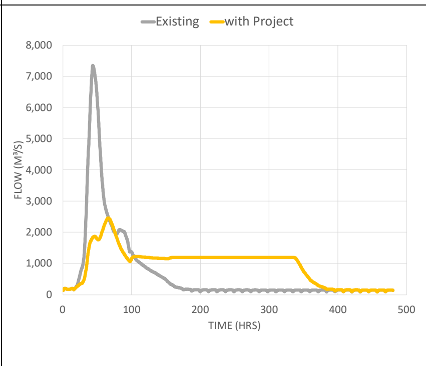


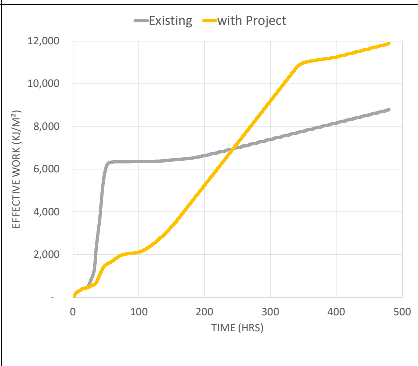
ARI 10

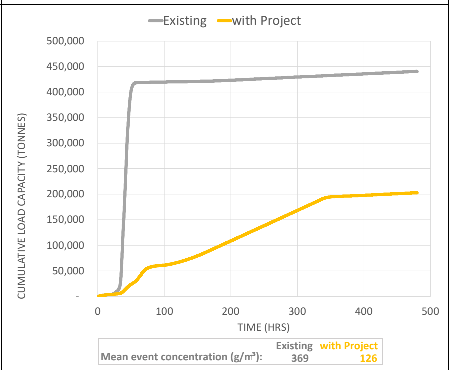




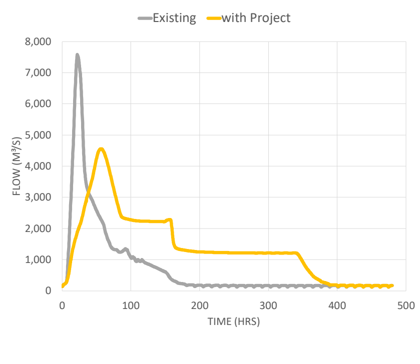
ARI 20

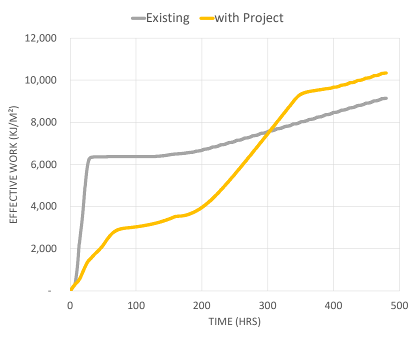




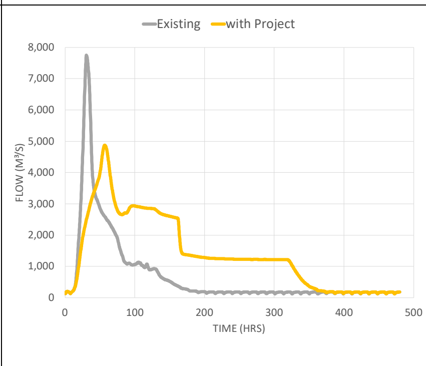


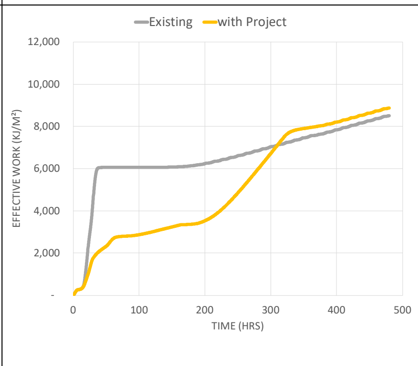
ARI 50

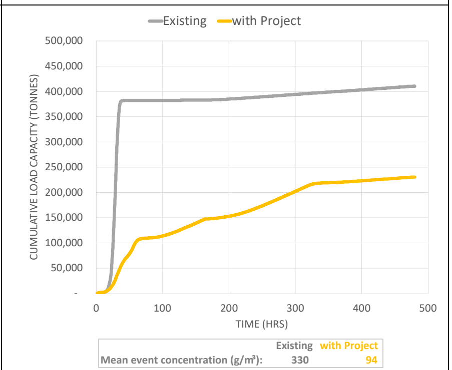




ARI 100



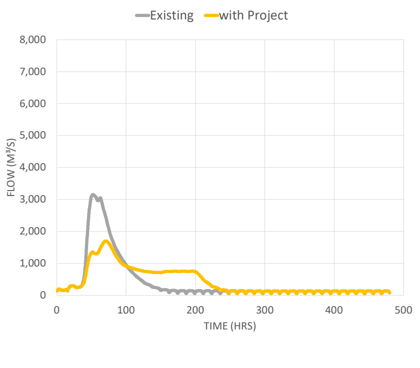


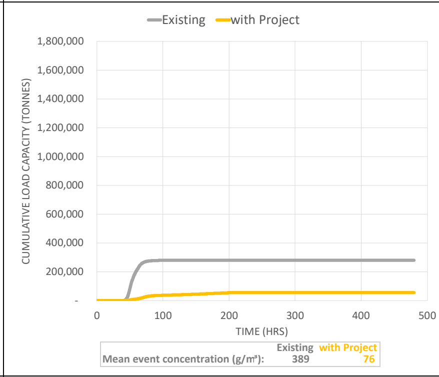


Site location:	**Cornwallis**	**Bank material size:**	0.5 mm	**Coarse Sand:**	2.00 mm	**Proportion:**	40%
Cross-section name:	**ARGYLE**	**Erosion threshold USP:**	0.05 W/m²	**Fine sand:**	0.50 mm	**Proportion:**	50%
		Erosion equation exponent:	1.5	**Silt:**	0.05 mm	**Proportion:**	10%

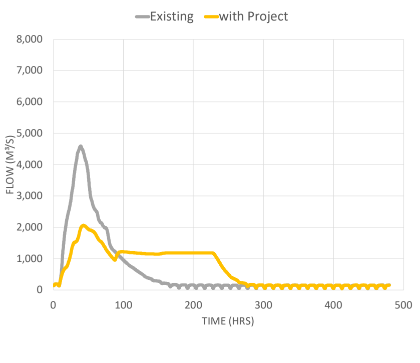
	Flow hydrograph	Erosion risk - cumulative effective work done	Cumulative transport load

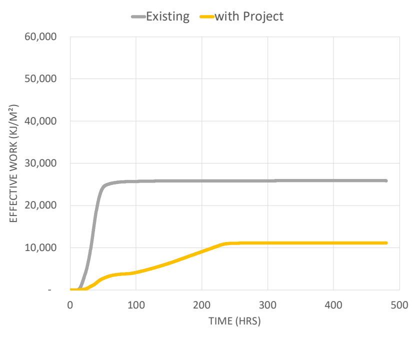
ARI 5

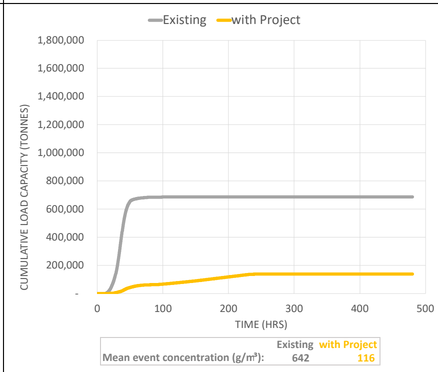




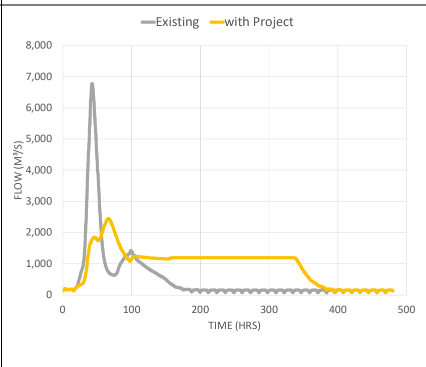
ARI 10

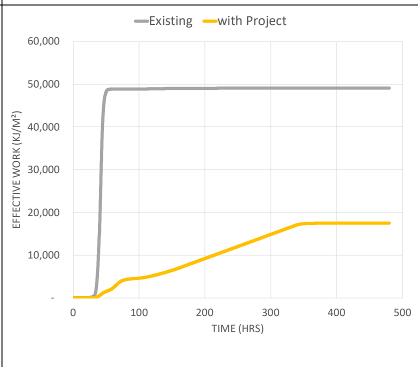


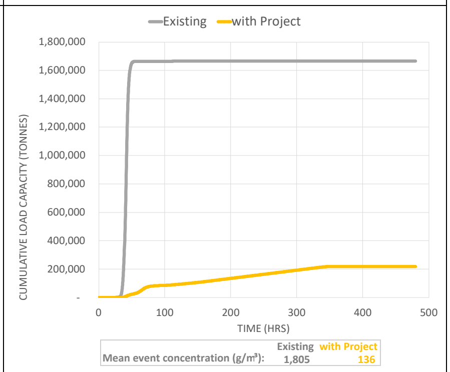




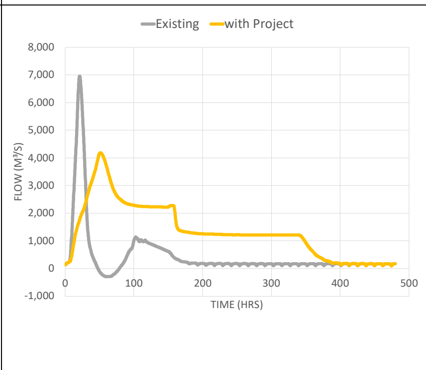
ARI 20

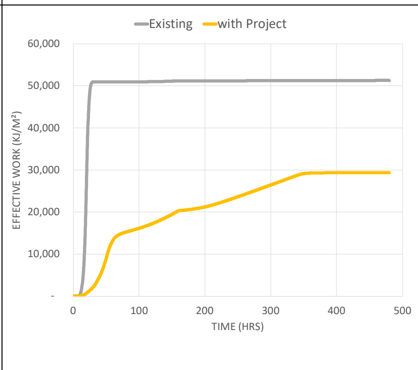


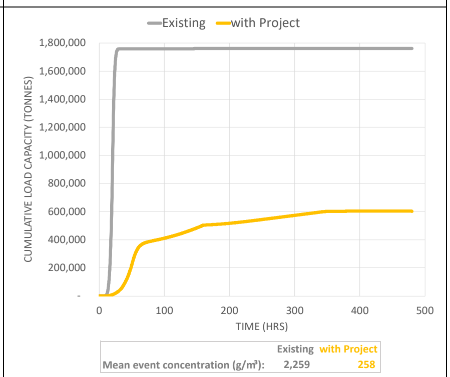




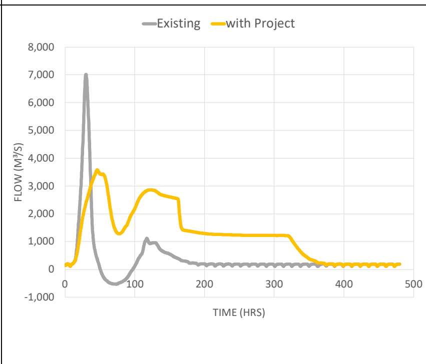
ARI 50

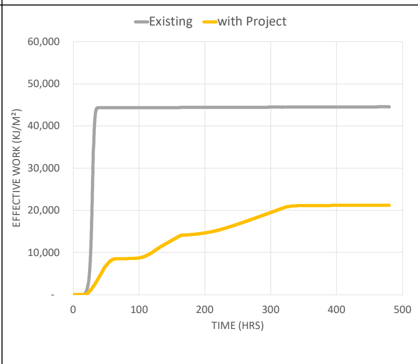


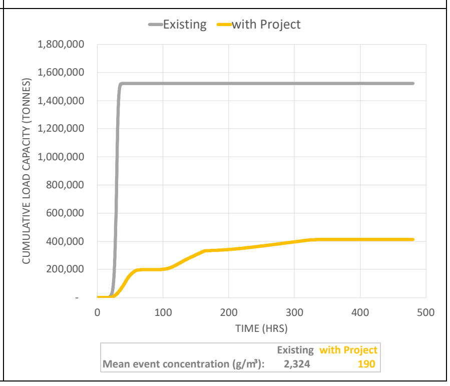




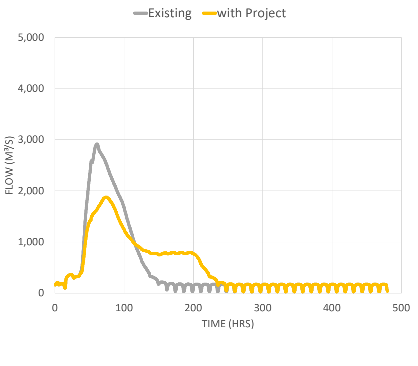
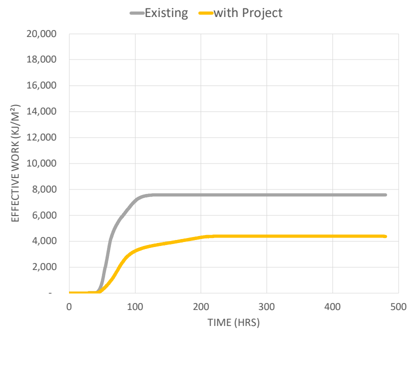
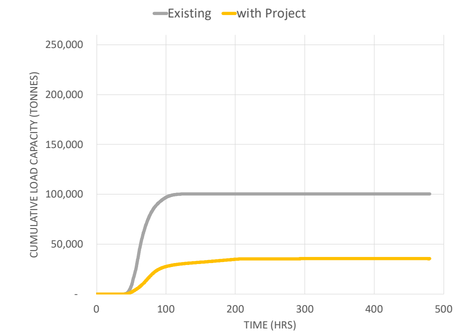
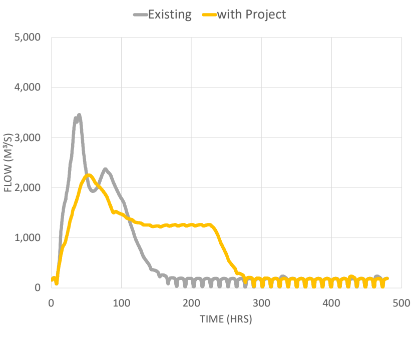
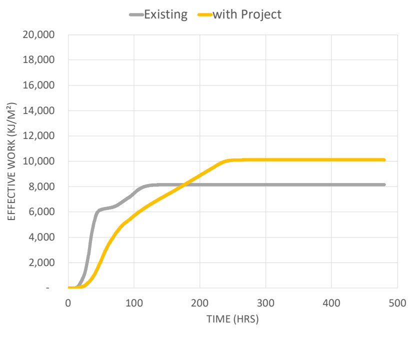
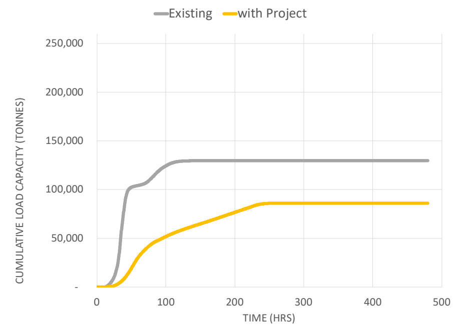
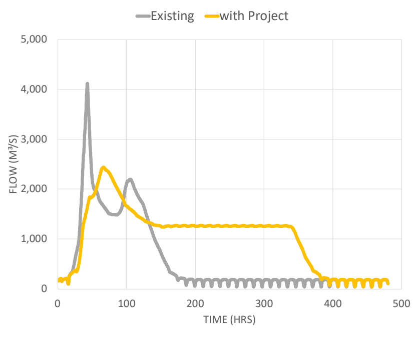
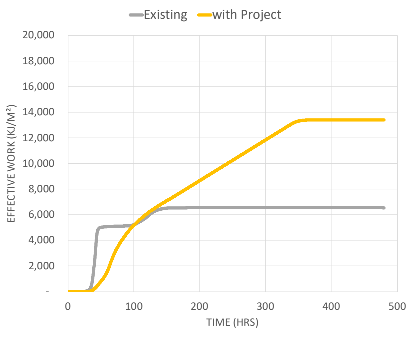
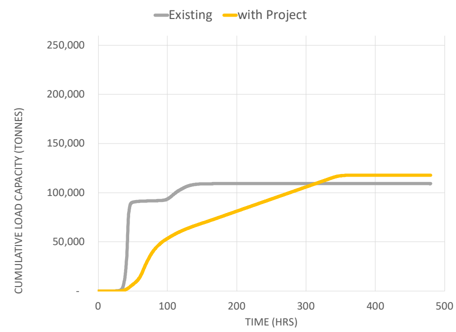
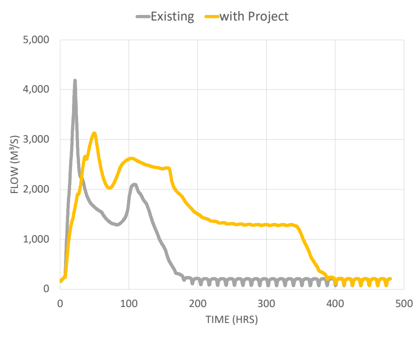
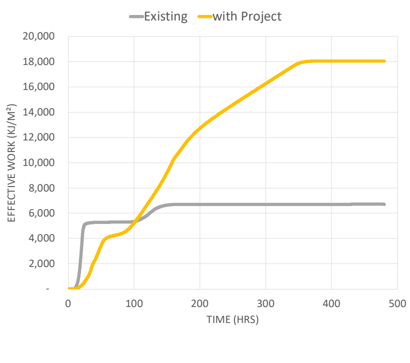
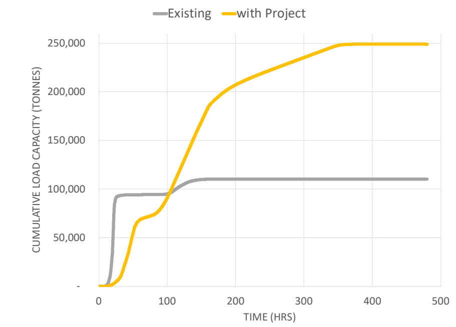
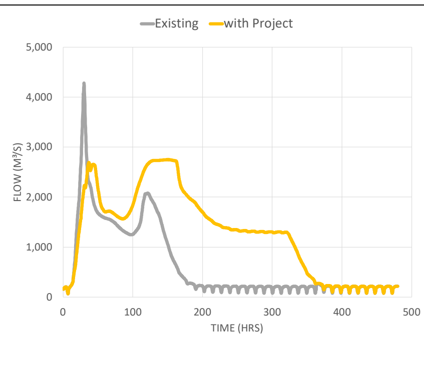
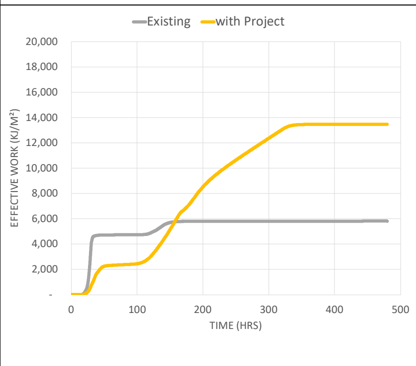
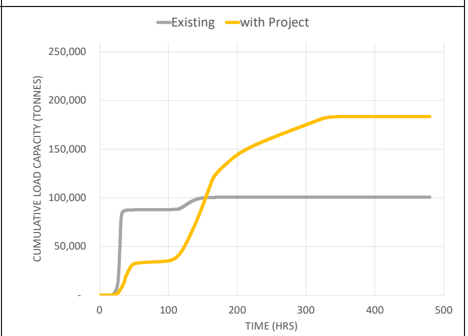
ARI 100







Site location:	**Downstream of South Creek confluence**	**Bank material size:**	0.5 mm	**Coarse Sand:**	2.00 mm	**Proportion:**	40%
Cross-section name:	**WILBREACH**	**Erosion threshold USP:**	0.05 W/m²	**Fine sand:**	0.50 mm	**Proportion:**	50%
		Erosion equation exponent:	1.5	**Silt:**	0.05 mm	**Proportion:**	10%

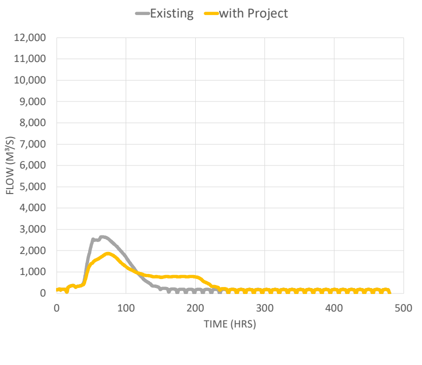
	Flow hydrograph	**Erosion risk - cumulative effective work done**	**Cumulative transport load**
ARI 5			
ARI 10			
ARI 20			
ARI 50			
ARI 100			

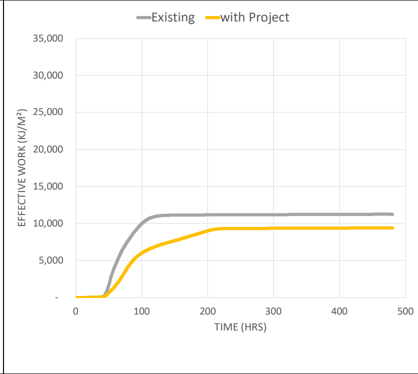
Mean event concentration (g/m³):	Existing	with Project
ARI 5	122	41
ARI 10	120	63
ARI 20	107	66
ARI 50	97	104
ARI 100	90	83

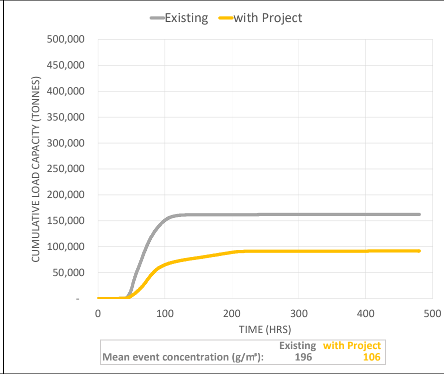
Site location:	**Wilberforce**	**Bank material size:**	0.1 mm	**Coarse Sand:**	2.00 mm	**Proportion:**	40%
Cross-section name:	**WILBER1**	**Erosion threshold USP:**	0.05 W/m²	**Fine sand:**	0.50 mm	**Proportion:**	50%
		Erosion equation exponent:	1.5	**Silt:**	0.05 mm	**Proportion:**	10%

	Flow hydrograph	**Erosion risk - cumulative effective work done**	**Cumulative transport load**

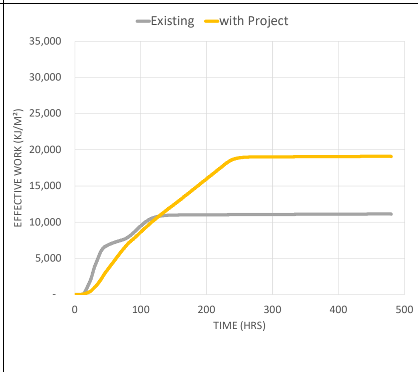
ARI 5

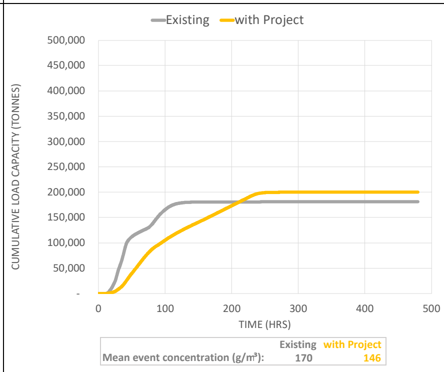




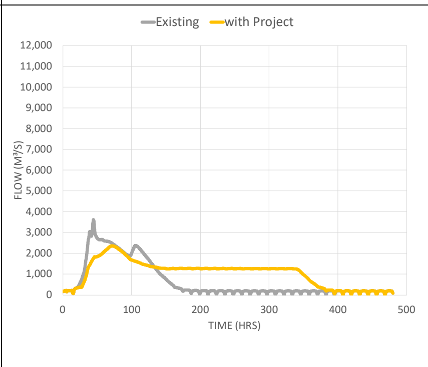


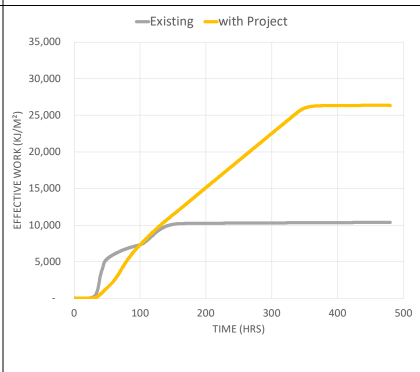
ARI 10

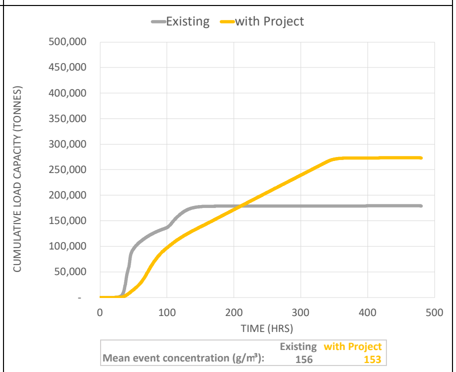




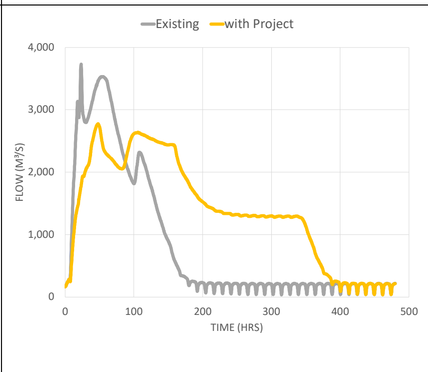
ARI 20

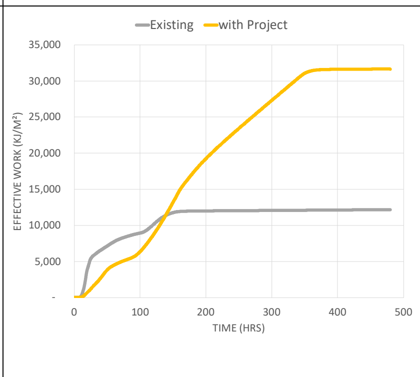


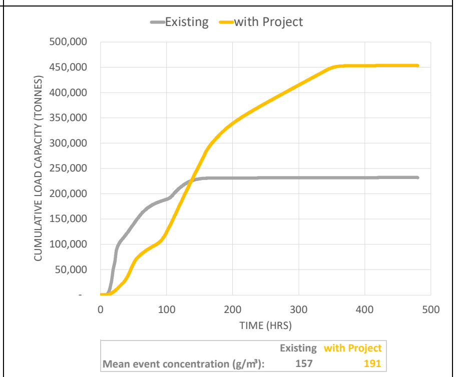




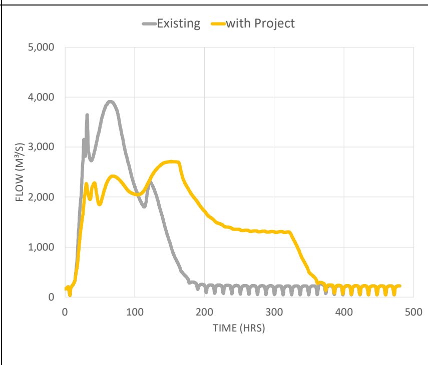
ARI 50

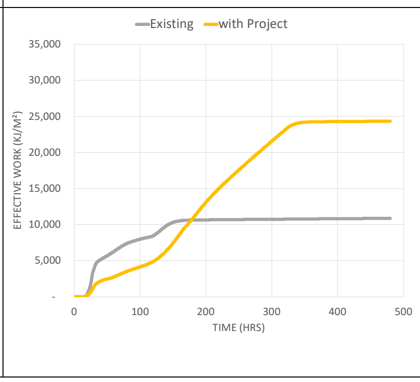


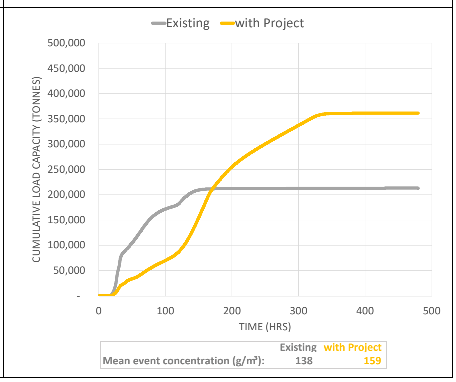




ARI 100



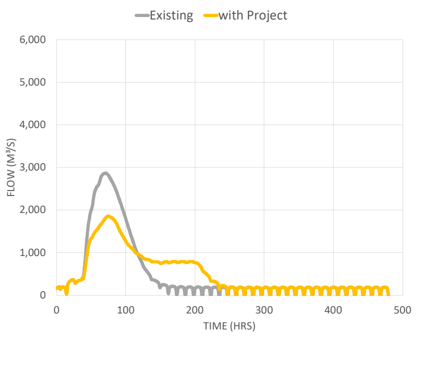


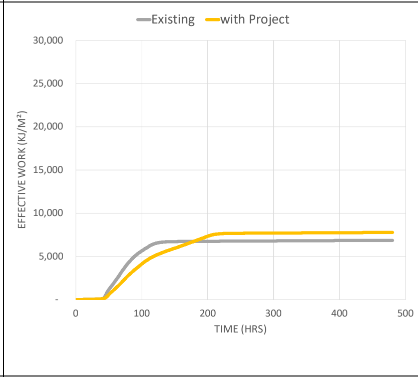


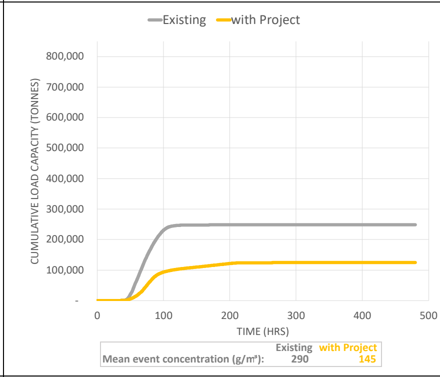
Site location:	**Burdeken Road**	**Bank material size:**	0.1 mm	**Coarse Sand:**	2.00 mm	**Proportion:**	40%
Cross-section name:	**BURDKNRD3**	**Erosion threshold USP:**	0.05 W/m²	**Fine sand:**	0.50 mm	**Proportion:**	50%
		Erosion equation exponent:	1.5	**Silt:**	0.05 mm	**Proportion:**	10%

	Flow hydrograph	Erosion risk - cumulative effective work done	Cumulative transport load

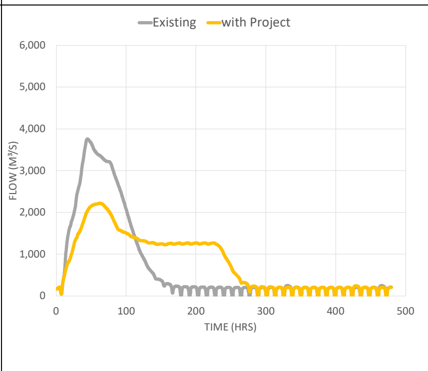
ARI 5

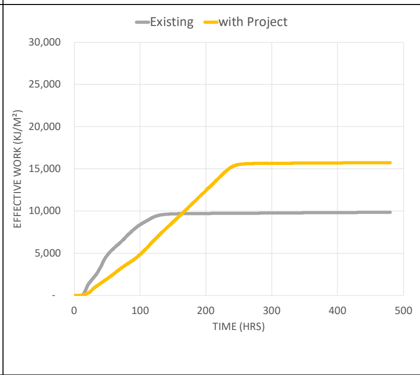


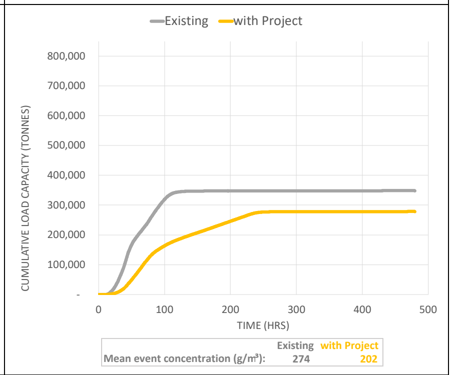




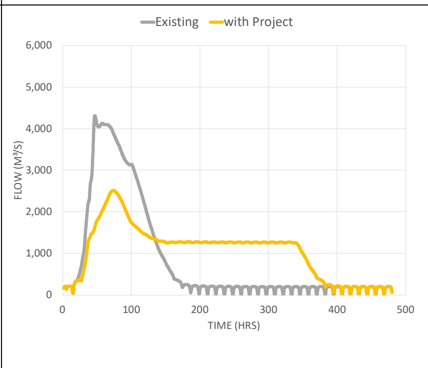
ARI 10

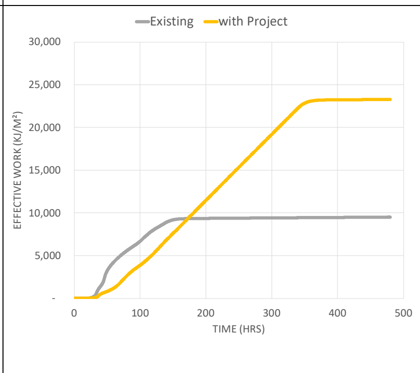


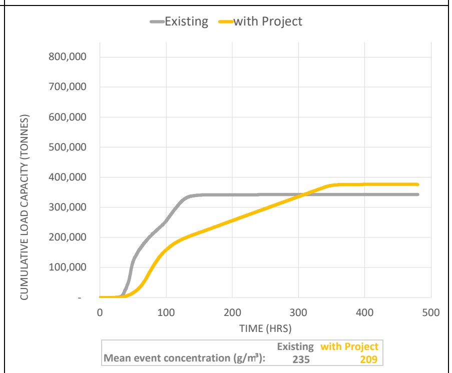




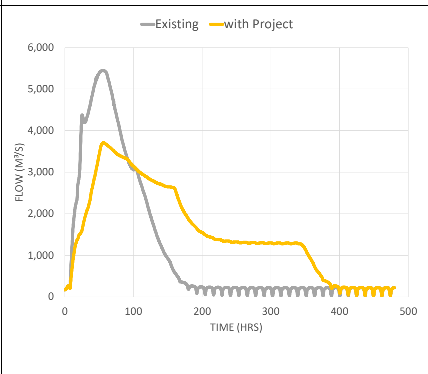
ARI 20

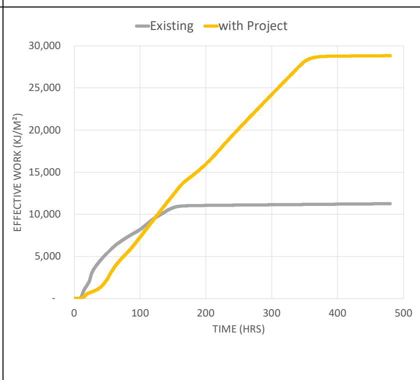


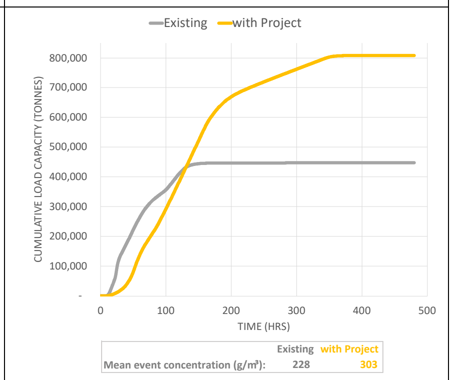




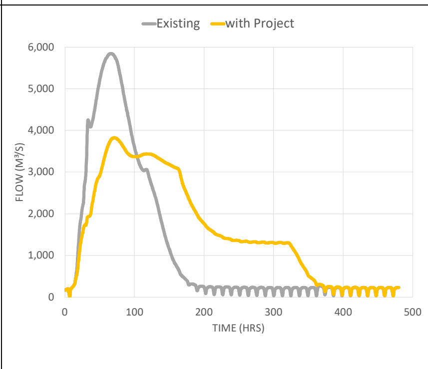
ARI 50

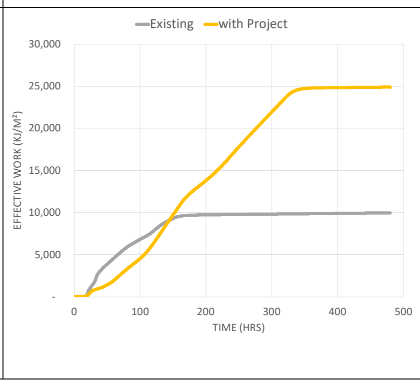


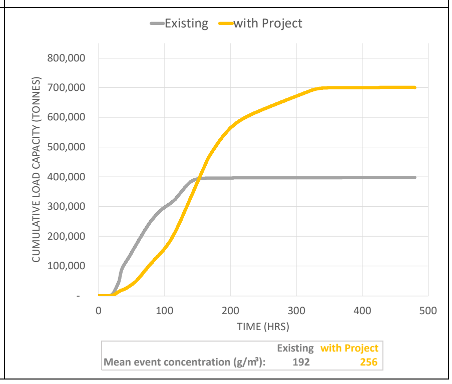




ARI 100



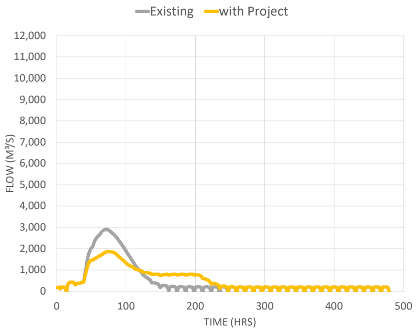


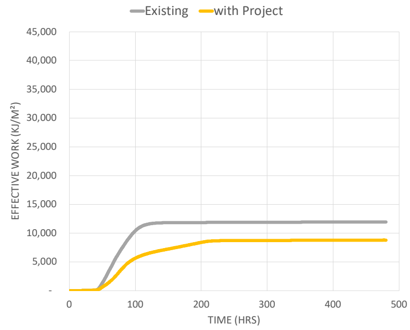


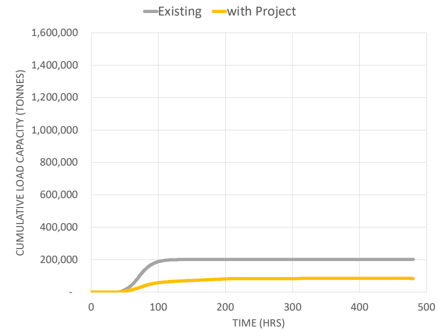
Site location:	**Downstream of Cattai Creek confluence**	**Bank material size:**	0.5 mm	**Coarse Sand:** 2.00 mm	**Proportion:** 40%
Cross-section name:	**CATTAIK3**	**Erosion threshold USP:**	0.05 W/m²	**Fine sand:** 0.50 mm	**Proportion:** 50%
		Erosion equation exponent:	1.5	**Silt:** 0.05 mm	**Proportion:** 10%

	Flow hydrograph	Erosion risk - cumulative effective work done	Cumulative transport load

ARI 5

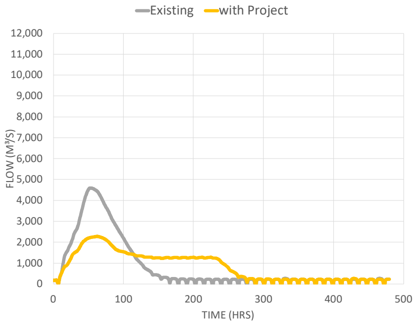


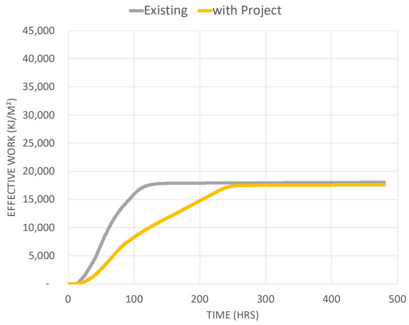


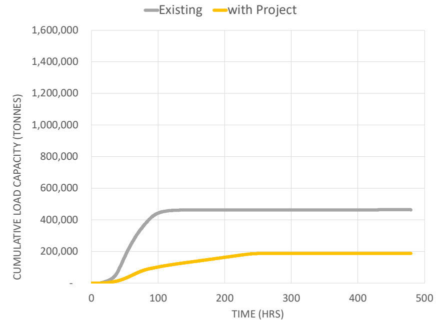


	Existing	with Project
Mean event concentration (g/m³):	227	94

ARI 10

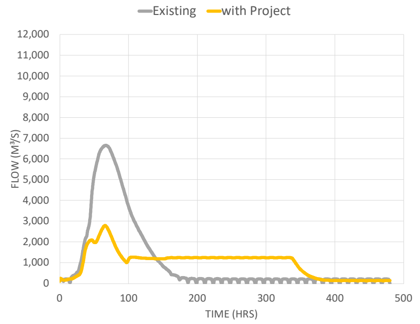


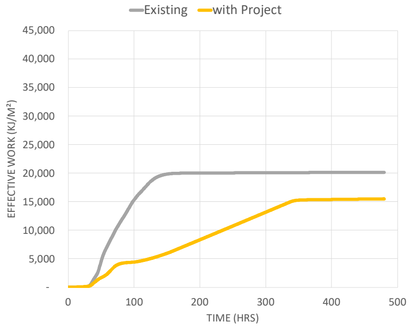


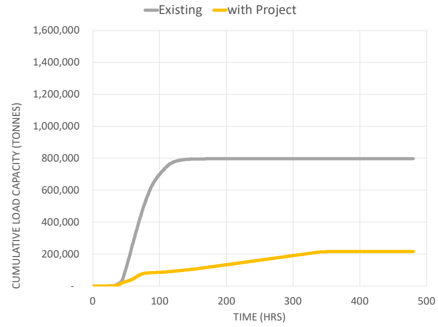


	Existing	with Project
Mean event concentration (g/m³):	330	134

ARI 20

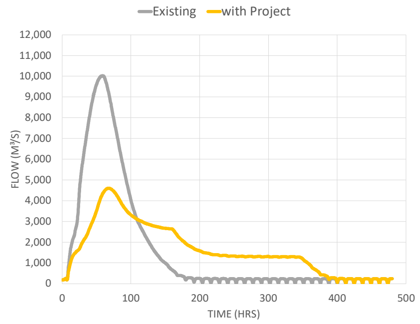


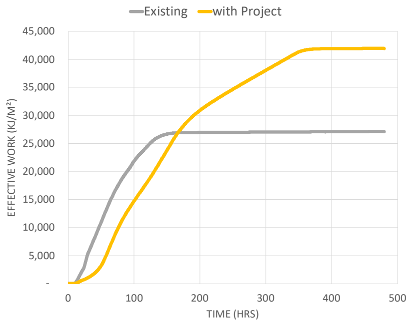


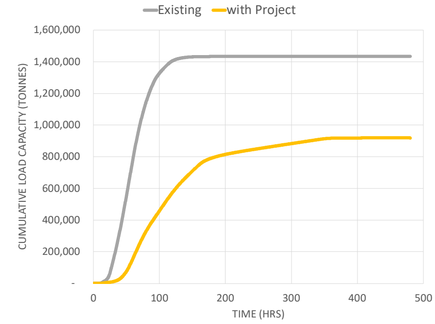


	Existing	with Project
Mean event concentration (g/m³):	430	129

ARI 50

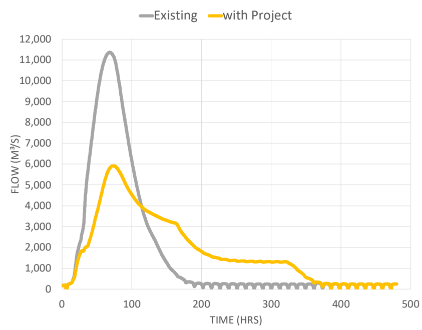


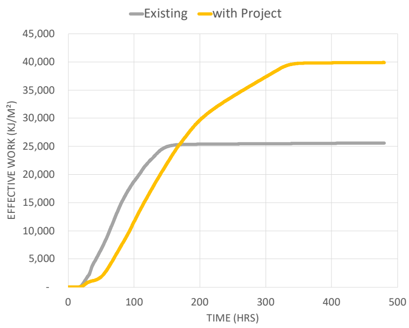


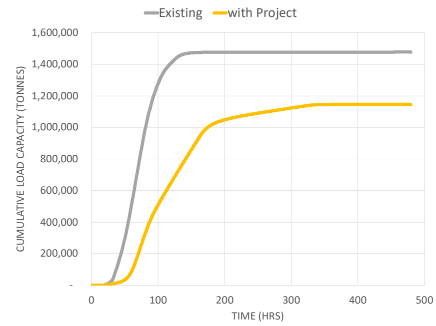


	Existing	with Project
Mean event concentration (g/m³):	504	325

ARI 100





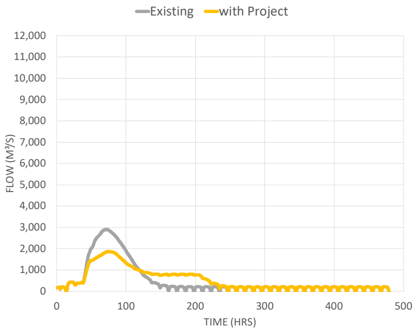


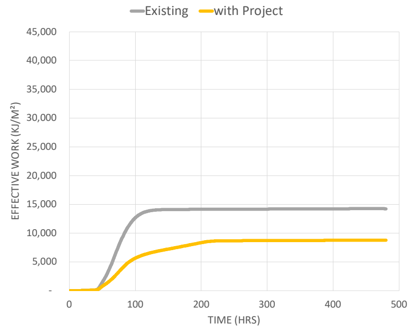
	Existing	with Project
Mean event concentration (g/m³):	465	362

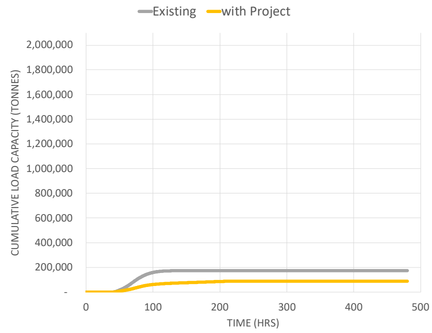
Site location:	**Hope Farm**	**Bank material size:**	0.5 mm	**Coarse Sand:**	2.00 mm	**Proportion:**	40%
Cross-section name:	**HOPEFARM**	**Erosion threshold USP:**	0.05 W/m²	**Fine sand:**	0.50 mm	**Proportion:**	50%
		Erosion equation exponent:	1.5	**Silt:**	0.05 mm	**Proportion:**	10%

Flow hydrograph	Erosion risk - cumulative effective work done	Cumulative transport load

ARI 5

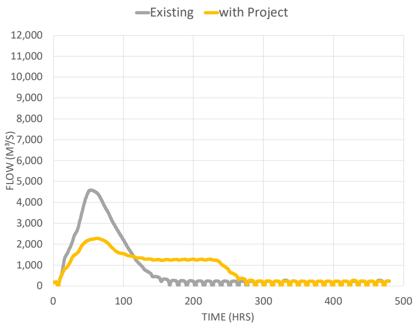


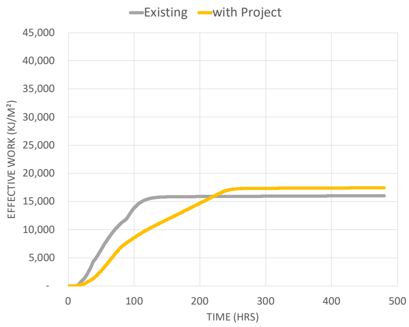


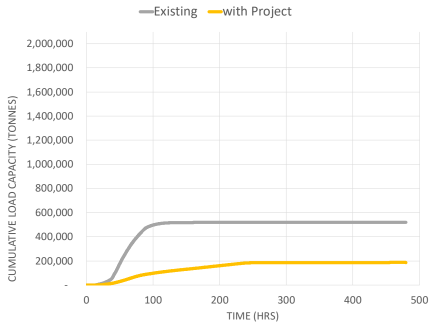


	Existing	with Project
Mean event concentration (g/m³):	196	100

ARI 10

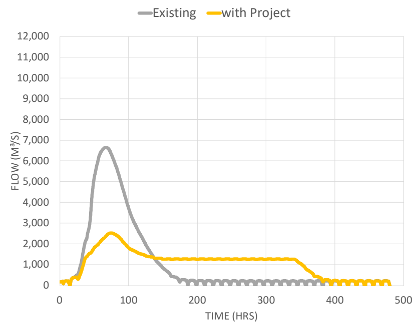


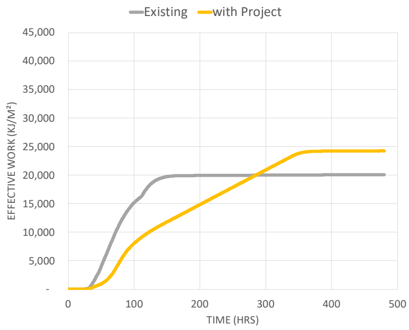


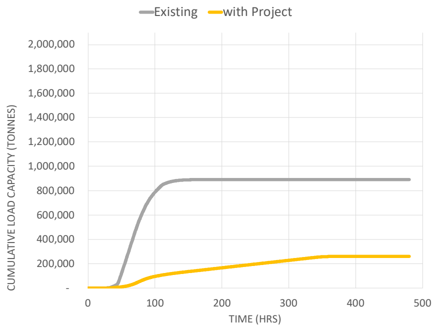


	Existing	with Project
Mean event concentration (g/m³):	370	133

ARI 20

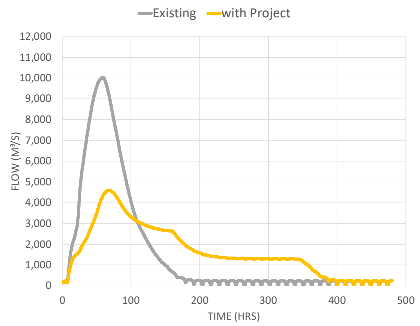


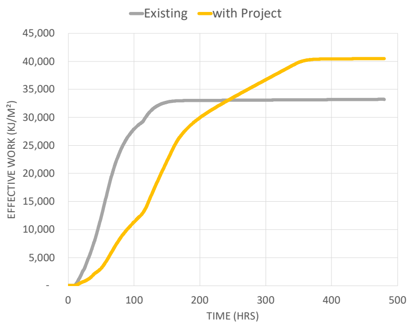


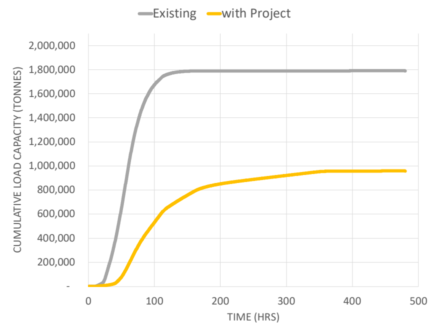


	Existing	with Project
Mean event concentration (g/m³):	482	142

ARI 50

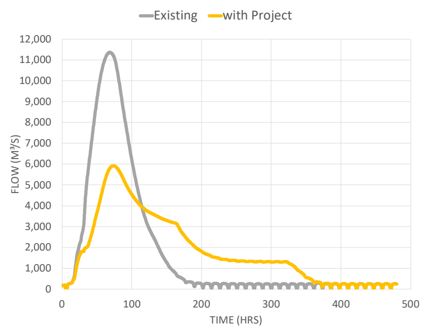


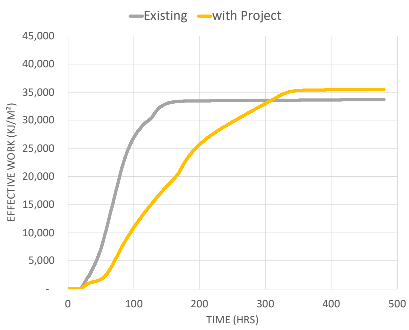


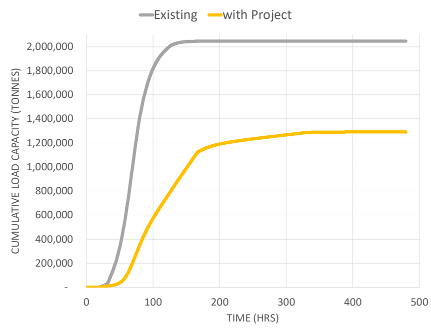


	Existing	with Project
Mean event concentration (g/m³):	629	340

ARI 100





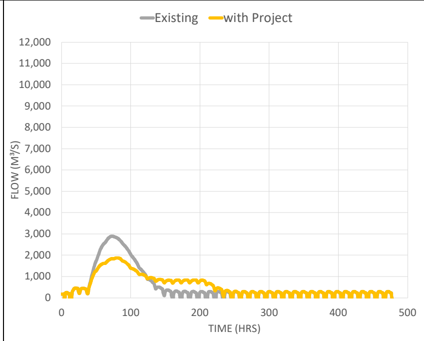


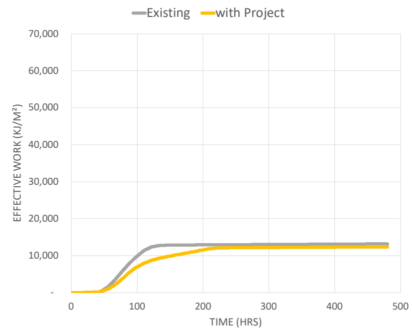
	Existing	with Project
Mean event concentration (g/m³):	644	408

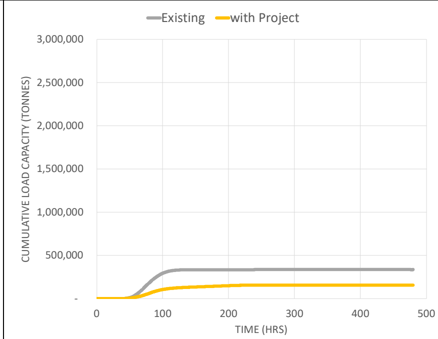
Site location:	**Upstream of Sackville**	**Bank material size:**	0.5 mm	**Coarse Sand:**	2.00 mm	**Proportion:**	40%
Cross-section name:	**HILLCREST**	**Erosion threshold USP:**	0.05 W/m²	**Fine sand:**	0.50 mm	**Proportion:**	50%
		Erosion equation exponent:	1.5	**Silt:**	0.05 mm	**Proportion:**	10%

	Flow hydrograph	Erosion risk - cumulative effective work done	Cumulative transport load

ARI 5

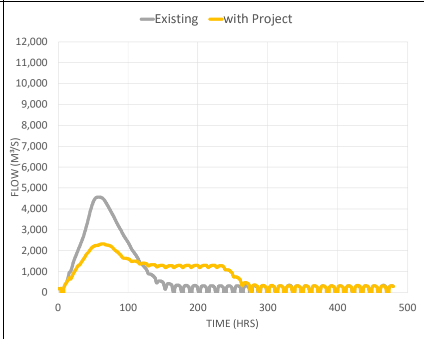


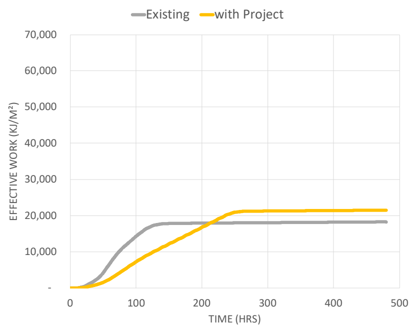


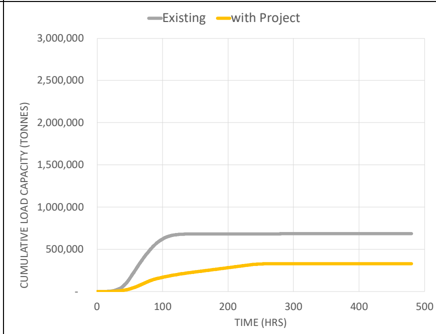


	Existing	with Project
Mean event concentration (g/m³):	372	172

ARI 10

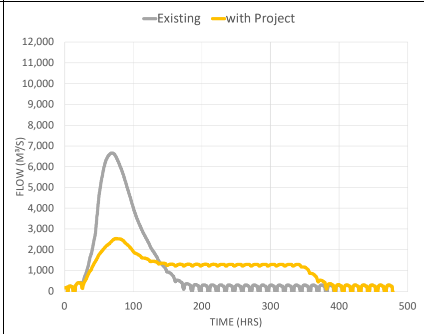


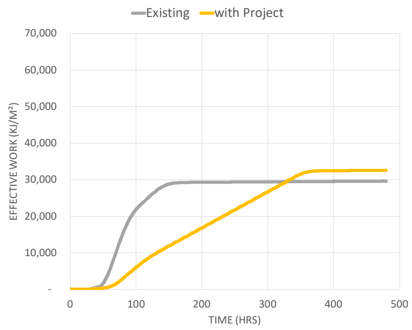


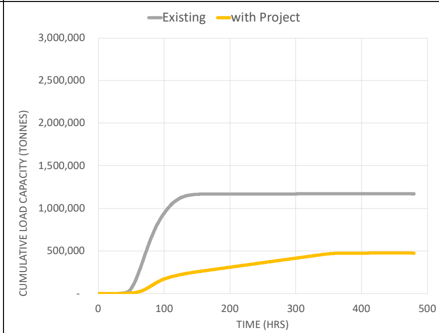


	Existing	with Project
Mean event concentration (g/m³):	481	232

ARI 20

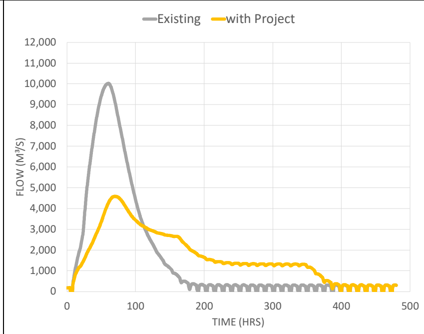


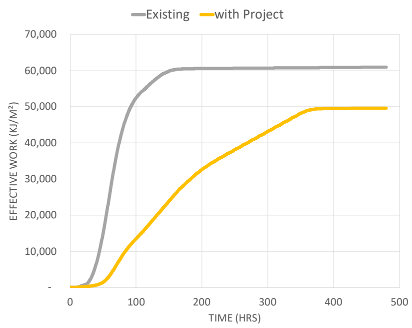


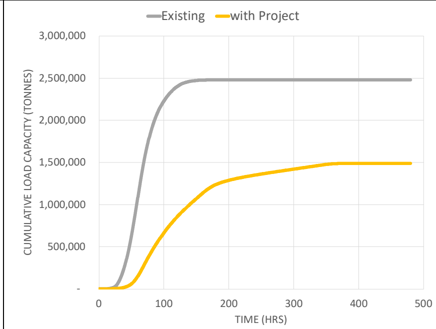


	Existing	with Project
Mean event concentration (g/m³):	626	257

ARI 50

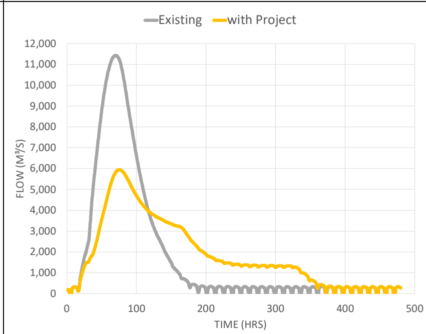


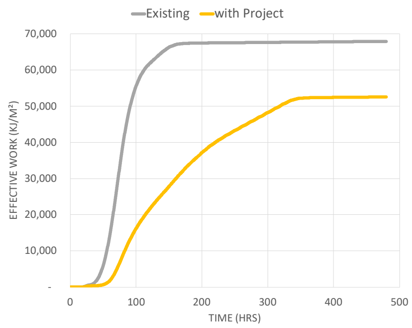


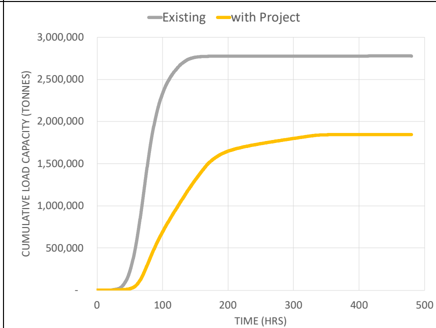


	Existing	with Project
Mean event concentration (g/m³):	865	524

ARI 100





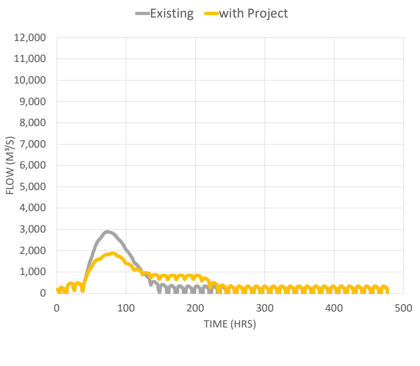


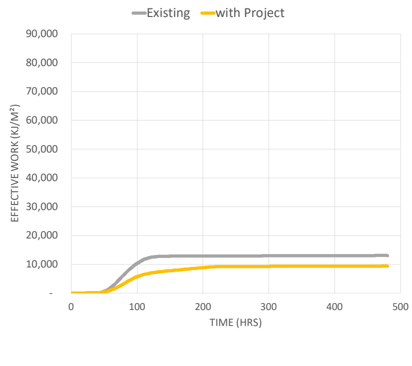
	Existing	with Project
Mean event concentration (g/m³):	866	578

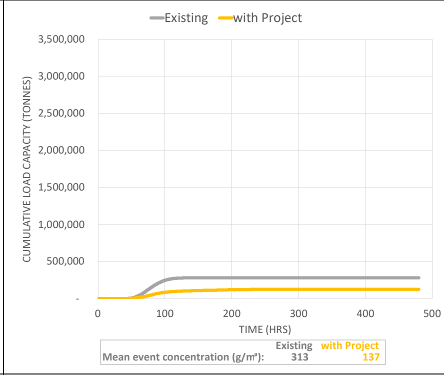
Site location:	**Sackville Ferry**	**Bank material size:**	0.5 mm	**Coarse Sand:**	2.00 mm	**Proportion:**	40%
Cross-section name:	**SACKVILLE1**	**Erosion threshold USP:**	0.05 W/m²	**Fine sand:**	0.50 mm	**Proportion:**	50%
		Erosion equation exponent:	1.5	**Silt:**	0.05 mm	**Proportion:**	10%

Flow hydrograph | **Erosion risk - cumulative effective work done** | **Cumulative transport load**

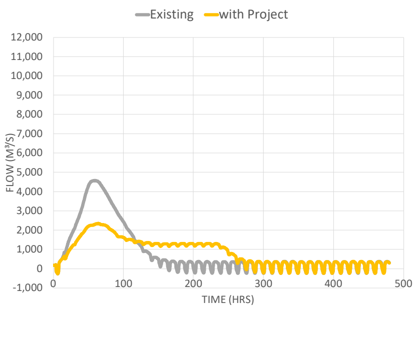
ARI 5

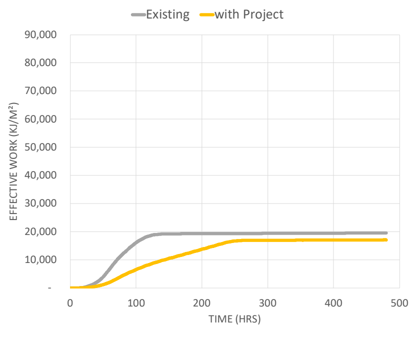


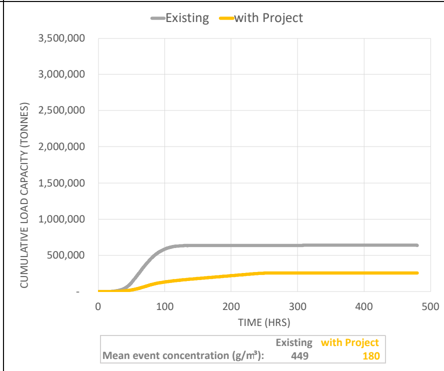




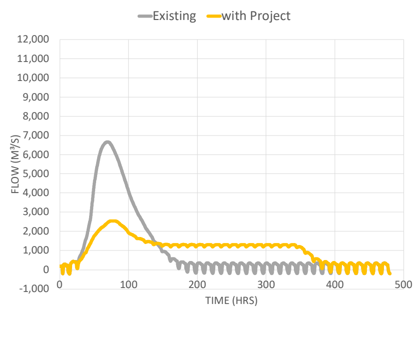
ARI 10

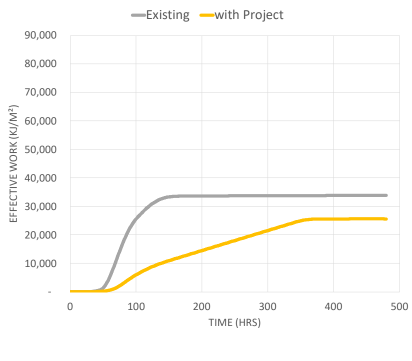


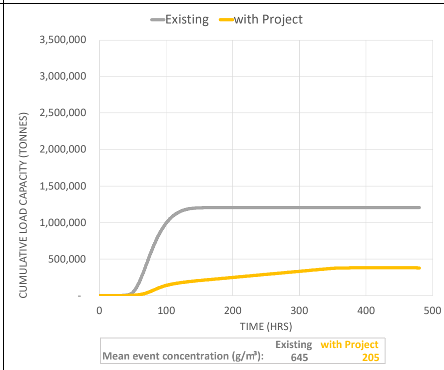




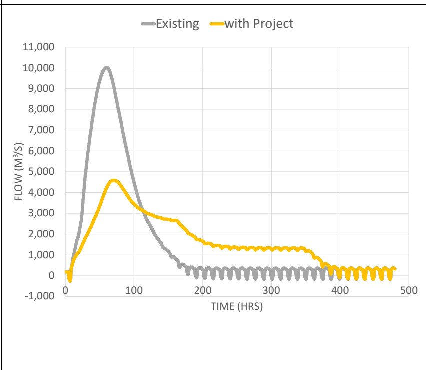
ARI 20

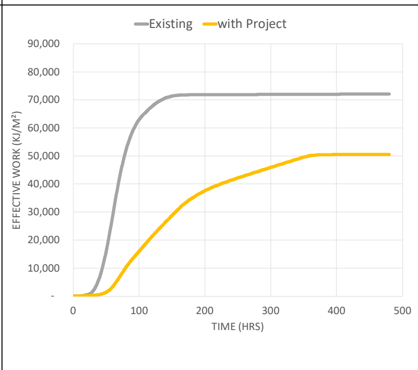


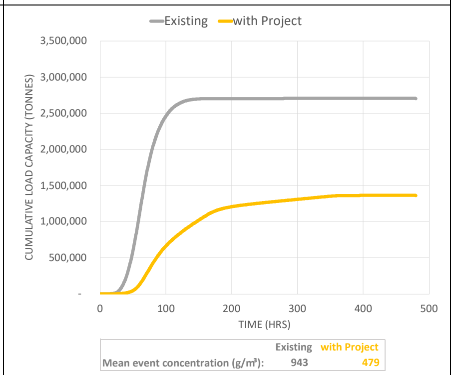




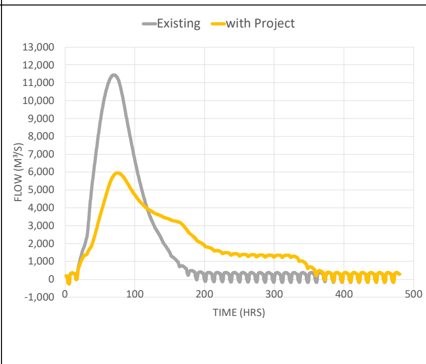
ARI 50

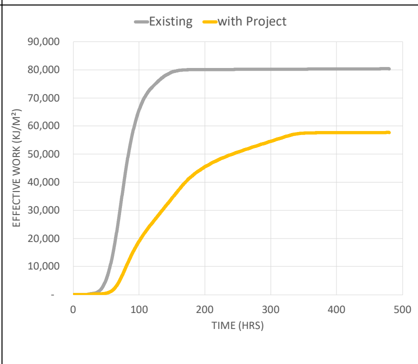


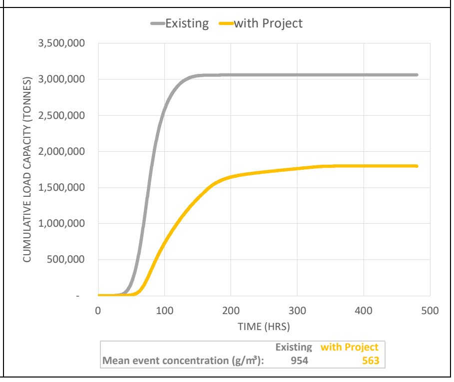




ARI 100



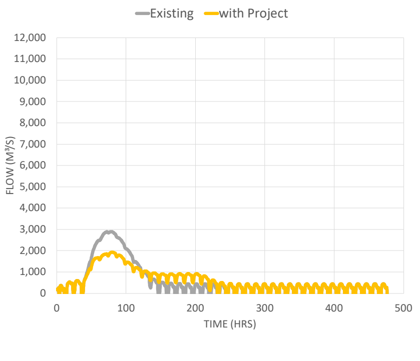


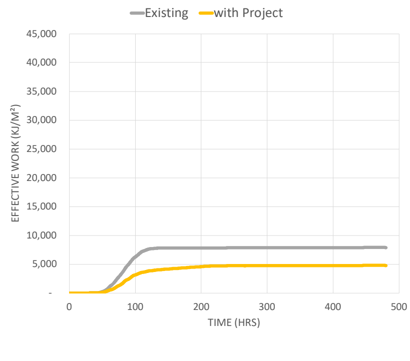


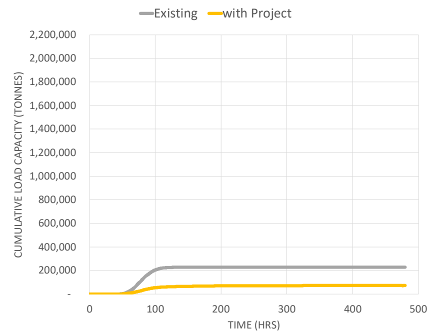
Site location:	**Upstream of Colo River confluence**	**Bank material size:**	0.5 mm	**Coarse Sand:**	2.00 mm	**Proportion:**	40%
Cross-section name:	**TEATREESW**	**Erosion threshold USP:**	0.05 W/m²	**Fine sand:**	0.50 mm	**Proportion:**	50%
		Erosion equation exponent:	1.5	**Silt:**	0.05 mm	**Proportion:**	10%

Flow hydrograph | **Erosion risk - cumulative effective work done** | **Cumulative transport load**

ARI 5

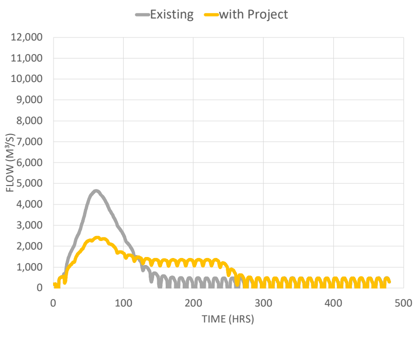


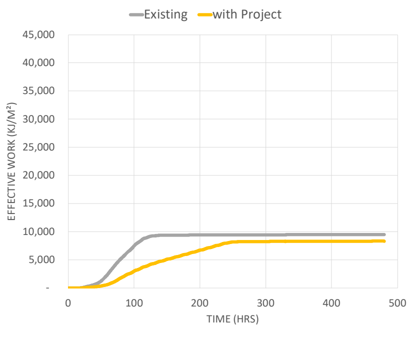


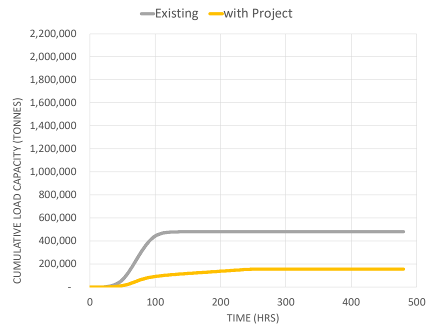


	Existing	with Project
Mean event concentration (g/m³):	248	78

ARI 10

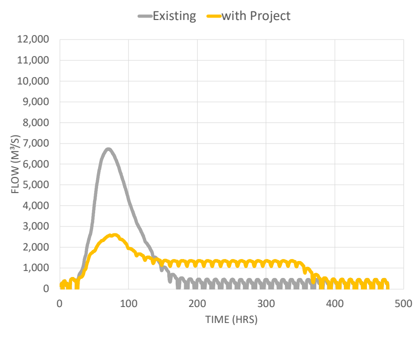


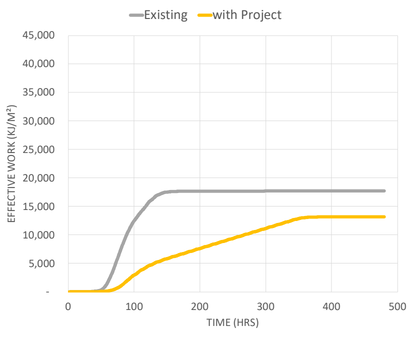


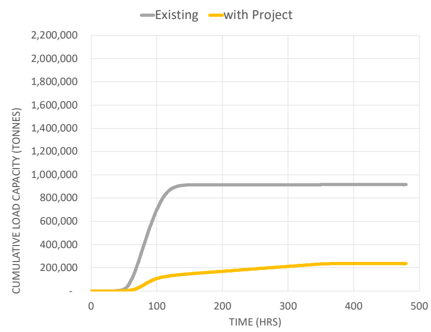


	Existing	with Project
Mean event concentration (g/m³):	332	107

ARI 20

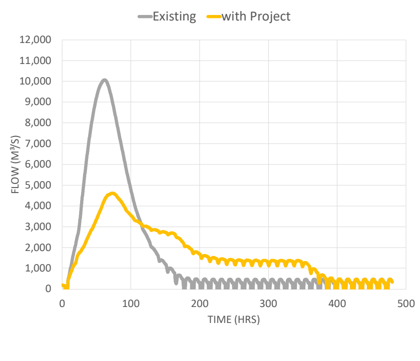


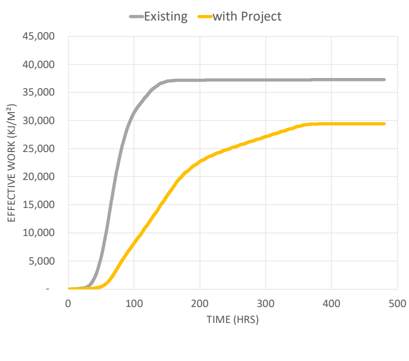


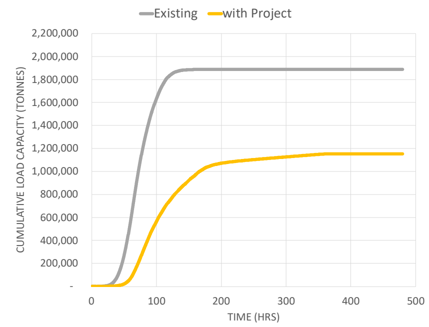


	Existing	with Project
Mean event concentration (g/m³):	481	125

ARI 50

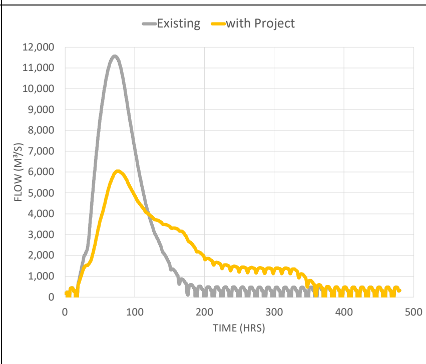


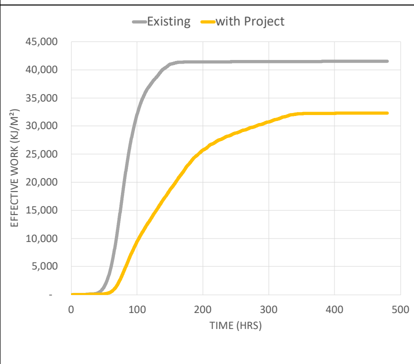


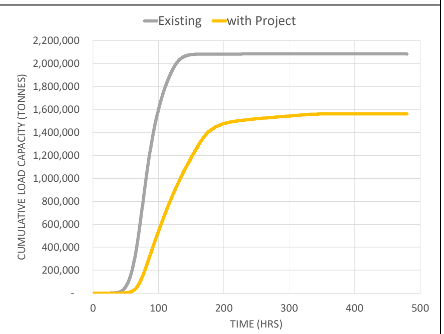


	Existing	with Project
Mean event concentration (g/m³):	649	399

ARI 100





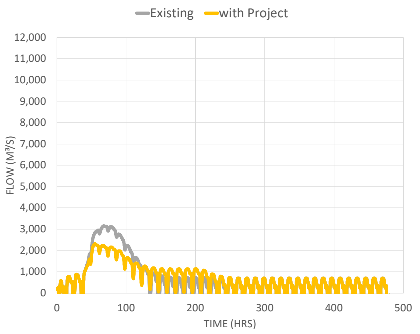


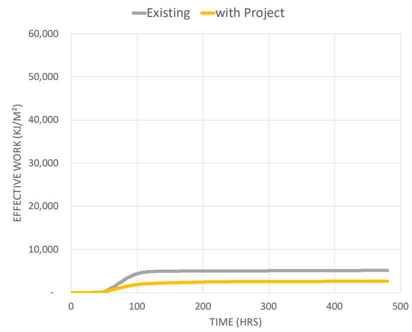
	Existing	with Project
Mean event concentration (g/m³):	640	482

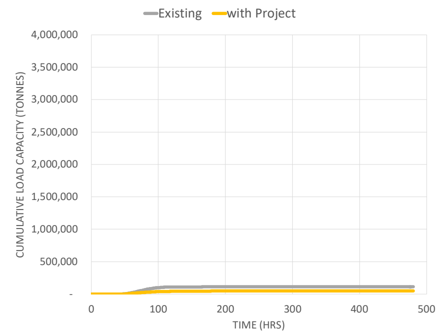
Site location:	**Downstream of Colo River confluence**	**Bank material size:**	0.5 mm	**Coarse Sand:**	2.00 mm	**Proportion:**	40%
Cross-section name:	**LIVERPOOL**	**Erosion threshold USP:**	0.05 W/m²	**Fine sand:**	0.50 mm	**Proportion:**	50%
		Erosion equation exponent:	1.5	**Silt:**	0.05 mm	**Proportion:**	10%

	Flow hydrograph	Erosion risk - cumulative effective work done	Cumulative transport load

ARI 5

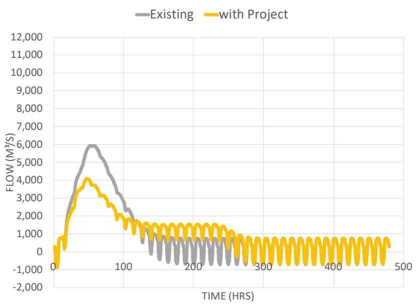


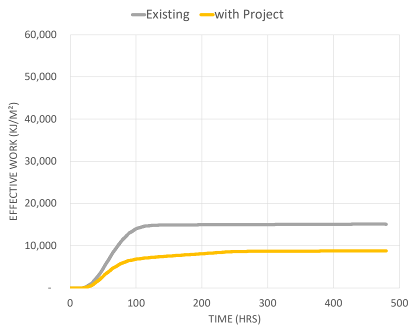


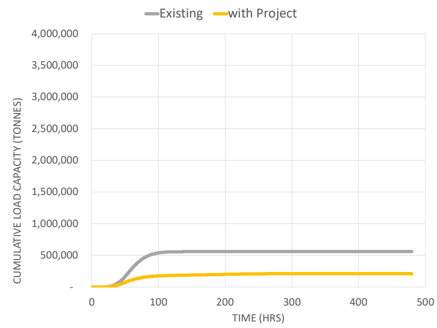


	Existing	with Project
Mean event concentration (g/m³):	111	50

ARI 10

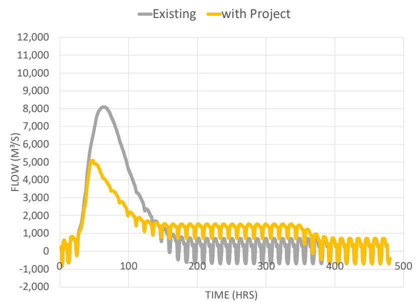


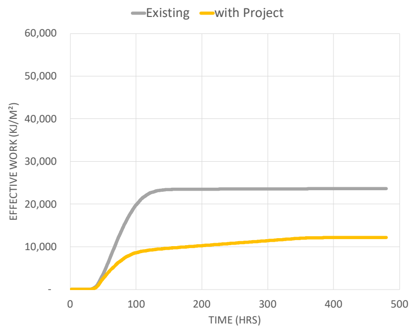


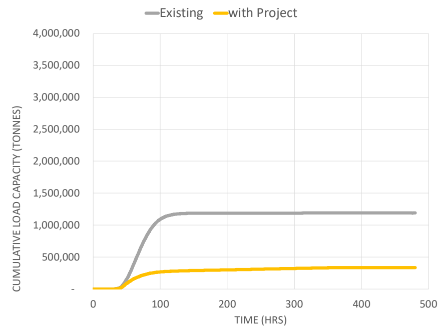


	Existing	with Project
Mean event concentration (g/m³):	311	117

ARI 20

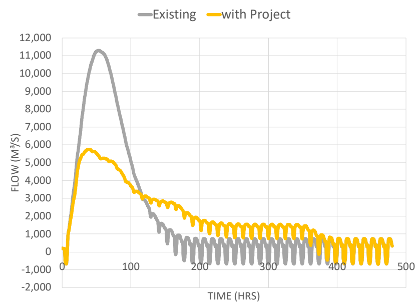


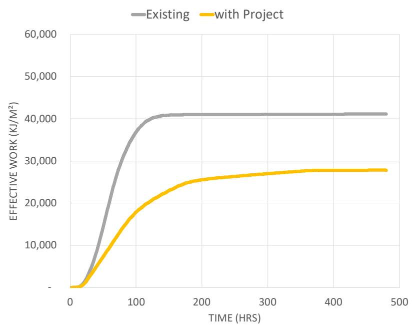


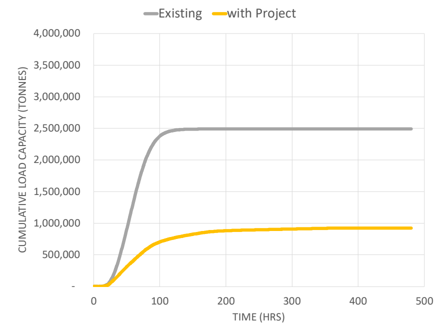


	Existing	with Project
Mean event concentration (g/m³):	509	144

ARI 50

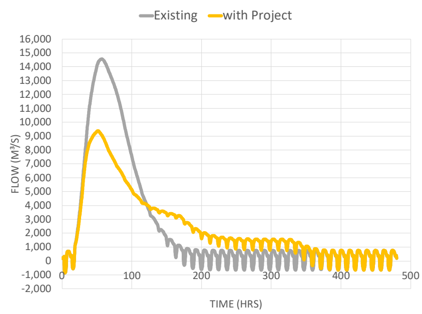


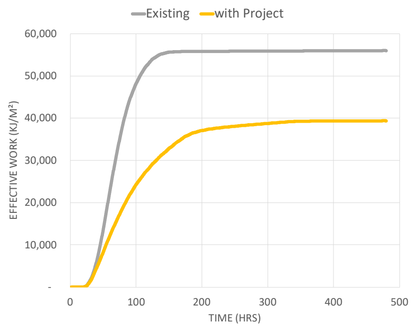


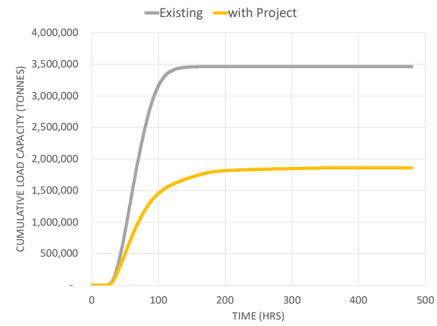


	Existing	with Project
Mean event concentration (g/m³):	721	269

ARI 100







	Existing	with Project
Mean event concentration (g/m³):	829	446

Technical Note

By:	Mark Megaughin	**Date:**	9 September 2022
Subject:	**Warragamba Dam Raising –**	**Our Ref:**	4512987-194045299-49
	Environmental Impact Submissions Response for upstream watercourses		
		ABN: 85 004 974 341	

1 Purpose

As part of the Environment Impact Assessment (EIS) for the Warragamba Dam Raising Project, Beca prepared a Geomorphology Technical Assessment (SMEC, 2021a) which became Appendix N2 of the EIS (referred to in this note as "EIS N2"). This assessed potential geomorphological effects of the project both upstream of the dam, and in the downstream waterways of the Hawkesbury and Nepean Rivers (HNR).

Following the public exhibition process the former Department of Planning, Industry and Environment (DPIE), and the Natural Resources Access Regulator (NRAR) have raised several issues which require a response.

This technical note provides the technical background to our response to questions relating to the upstream tributaries of Lake Burragorang under the *'with Project'* scenario.

2 Background

In our assessment we have relied upon the 'Existing' and 'with Project' peak water level outlines developed as part of the work documented in Chapter 15: Flooding and hydrology of the Warragamba Dam Raising Environmental Impact Statement, along with the associated information on water depth and duration of inundation.

We have used the above information to show how the inundation of Lake Burragorang's tributaries changes between 'Existing' and 'with Project' and what the likely geomorphic effects of these changes could be.

We have considered the following main tributaries (Figure 1):

- Wollondilly River
- Nattai River
- Coxs River
- Kowmung River.

We have also undertaken an assessment of the other tributaries, these being (Figure 1):

- Brimstone Creek
- Butchers Creek
- Cedar Creek
- Green Wattle Creek
- Jooriland River
- Kedumba River
- Lacys Creek

- Little River
- Reedy Creek
- Tonalli River
- Werriberri Creek.

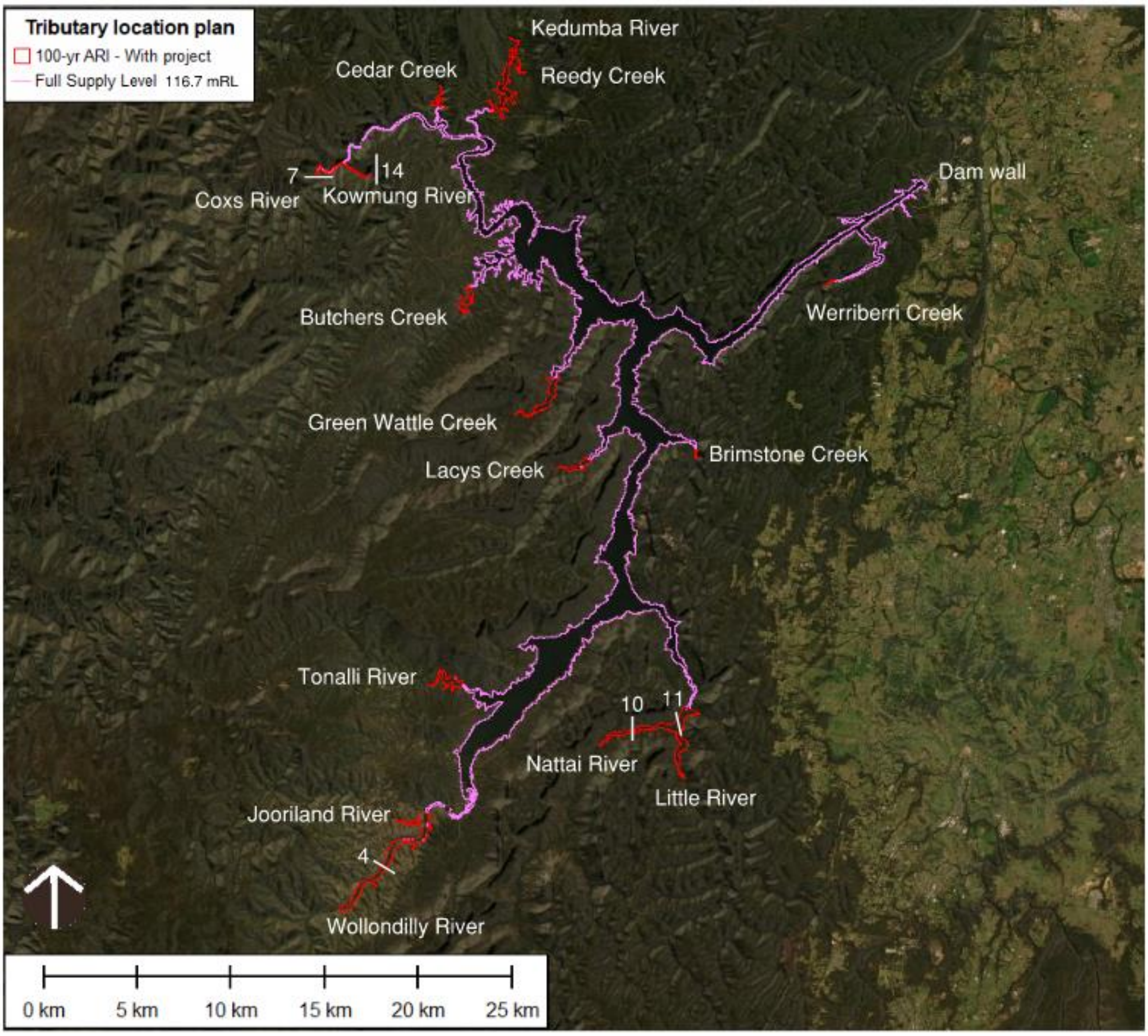


Figure 1. Tributary locations

3 Method

3.1 Main tributaries

We have assessed changes in the main tributaries using information from Chapter 15: Flooding and hydrology of the Warragamba Dam Raising Environmental Impact Statement (SMEC, 2021b) (Table 1).

Table 1. Main tributary data sources

No.	Data	Events
1	Peak water level outlines	5-yr, 10-yr, 20-yr, and 100-yr ARI
2	Peak water depths taken from hydraulic model cross-sections	
3	Inundation durations taken from hydraulic model cross-sections	

Our approach is to undertake an assessment of quantitative data, and then draw on qualitative studies to support the assessment. We consider three quantitative variables in our assessment of effects, these being:

1. Length of tributary inundated
2. Area of tributary inundated, both within the active channel and on adjacent riparian fringes
3. The depth and duration of flooding

Our assessment of these variables was undertaken between the Full Supply Level (FSL) and the truncation point. It is based on the assumption that the lake is at FSL at the start of the event (the basis for the EIS Chapter 15 data) (SMEC, 2021b). Given the nature of historical supply storage at Lake Burragorang this is a highly conservative assumption.

The reservoir's FSL is 116.7 mAHD and for the purposes of this assessment we have taken this point to represent where the upstream tributaries end and the reservoir starts.

The truncation point identified in SMEC (2021b) marks the furthest upstream point on the tributaries where differences between the 'Existing' and 'with Project' scenarios are observed. This point was determined using thresholds (called truncation thresholds) for differences in inundation depth (<0.5 m) and inundation duration (<0.5 days) to truncate the extents of the 'with Project' inundated areas. Any depths or durations below these thresholds were removed as they were judged to have no effects.

SMEC (2021b) have supplied peak water-level outlines for each of the events we have considered, and these have been used to define the length and areas inundated.

3.1.1 Length

To determine the area of channel inundated in the scenarios (Section 2.1.2) we estimated the lengths of each tributary inundated between the FSL and the truncation point for each ARI. These were estimated by measuring inundation extents supplied as outlines in GIS.

3.1.2 Area

We measured the area of inundation in GIS for the 'Existing' and 'with Project' scenarios between the FSL and the truncation point for each ARI using the inundation outlines supplied by SMEC (2021b).

We spilt the inundated area into two categories – channel, and overbank. This distinction is important as any sediment deposited in the channel can be expected to be reworked by small flood events over time and is unlikely to smother areas of vegetation. Inundation of the overbanks could cause sediment to be deposited which will not be easily reworked and removed by future small events.

To estimate the increase in flooded channel area, we multiplied the increase in flooded watercourse length by an estimated channel width. We estimated the average channel width using aerial imagery. We defined overbank area as the difference in area between the total inundated area and the inundated channel area.

3.1.3 Depth-duration

Alongside our length and area flood extent analysis, we have presented depth-duration information from EIS N2. This information indicates the scale of inundation occurring in the areas identified, and how this differs between 'Existing' and 'with Project' scenarios, from which potential geomorphic effects of the project can be inferred.

3.1.4 Sediment load

Information on the comparative and total sediment loads for each main tributary is limited. EIS N2 presents loads from two separate studies (Table 2).

Table 2. Sediment Loads, taken from EIS N2

Table 11 Estimated suspended sediment loads for rivers in the Lake Burragorang catchment (Estimates from Rustomji P (2006) provided in brackets)

River	Suspended sediment load (tonnes / annum)	Catchment area (km^2)	Catchment factored load (tonnes / annum / km^2)
Cox's	54,822 (60,800)	2,630	21 (23)
Nattai	154 (15,000)	446	0.3 (34)
Wollondilly	496,983 (123,000)	2,699	184 (45)

For Coxs River and Wollondilly River there are order of magnitude differences between the loadings. The reason for this is not clear. For consistency we have used the published values from Rustomi P (2006) as the basis for our analysis.

3.2 Other tributaries

For 11 other tributaries we undertook the same analysis, with the following modifications:

- No depth-duration data is available to inform the scale of potential effects resulting from the inundated lengths and areas observed. Where possible we have inferred these effects from the main tributaries.
- The truncation process has not been applied to these sites and as such the length and area of inundation is overstated, relative to the main tributaries. The results presented therefore include areas of low inundation depth and/or short inundation duration which are unlikely to have a material effect on the geomorphic functioning of the tributary.
- We were not able to use the FSL as the downstream boundary for tributaries that end above the FSL (e.g., Little River). Where this was the case, we use the downstream confluence as the downstream boundary instead (e.g. where Little River intersects Nattai River).

4 Results

The outcome of our assessment is presented in tabular form (Table 3, Table 4) and maps for each tributary (Appendix A, Appendix B).

These results show the scale and extent of inundation change between the ‘Existing’ and ‘with Project’ scenarios. Without interpretation, these results are of limited use in informing the geomorphic functioning of the tributaries under the ‘with Project’ scenario. We have provided this interpretation in Section 4. In this assessment the length of Main Tributary does not change between scenarios because truncated data has been used. We have assumed that this would also be the case for the Other Tributaries, in lieu of actual truncation data being available.

Table 3. Main tributaries inundation summary

Watercourse	Event ARI (years)	Change to inundated area between ‘Existing’ and ‘with Project’ scenarios		
		Channel (ha)	Overbank (ha)	Total (ha)
Coxs River	5	0.8	1.2	2.0
	10	0.0	0.2	0.2
	20	0.0	0.4	0.4
	100	0.0	1.1	1.1
Kowmung River	5	0.0	0.0	0.0
	10	0.0	0.0	0.0
	20	0.0	0.0	0.0
	100	0.0	0.2	0.2
Nattai River	5	0.0	8.8	8.8
	10	0.0	24.4	24.4
	20	0.0	37.5	37.5
	100	0.0	48.8	48.8
Wollondilly River	5	0.0	5.9	5.9
	10	0.0	6.5	6.5
	20	0.0	20.7	20.7
	100	0.0	42.3	42.3

Table 4. Other tributaries inundation summary

Watercourse	Event ARI (years)	Change to inundated area* between 'Existing' and 'with Project' scenarios		
		Channel (ha)	Overbank (ha)	Total (ha)
Brimstone Creek	5	0.3	0.2	0.5
	10	0.5	0.4	0.9
	20	0.7	0.9	1.6
	100	0.7	2.3	3.0
Butchers Creek	5	0.9	2.7	3.6
	10	1.4	7.0	8.4
	20	2.6	14.2	16.8
	100	3.6	21.1	24.7
Cedar Creek	5	1.3	1.4	2.7
	10	1.6	3.5	5.1
	20	3.0	5.3	8.3
	100	3.9	7.9	11.8
Green Wattle Creek	5	1.2	8.4	9.6
	10	1.3	16.1	17.4
	20	2.9	28.2	31.1
	100	4.2	46.5	50.7
Jooriland River	5	0.1	0.2	0.3
	10	0.4	0.9	1.3
	20	0.9	3.3	4.2
	100	1.3	9.0	10.3
Kedumba River	5	3.0	7.9	10.9
	10	5.8	20.1	25.9
	20	8.9	46.7	55.6
	100	9.2	109.3	118.5
Lacys Creek	5	0.4	4.0	4.4
	10	0.7	7.2	7.9
	20	1.2	12.2	13.4
	100	2.0	17.6	19.6
Little River	5	0.9	1.9	2.8
	10	1.5	9.1	10.6
	20	2.6	24.4	27.0
	100	3.8	42.4	46.2

Watercourse	Event ARI (years)	Change to inundated area between 'Existing' and 'with Project' scenarios		
		Channel (ha)	Overbank (ha)	Total (ha)
Reedy Creek	5	0.0	0.0	0.0
	10	0.0	0.0	0.0
	20	0.5	0.1	0.6
	100	2.4	19.0	21.4
Tonalli River	5	1.1	4.7	5.8
	10	2.1	11.4	13.5
	20	3.7	21.5	25.2
	100	4.4	34.2	38.6
Werriberri Creek	5	0.1	0.0	0.1
	10	1.0	0.1	1.1
	20	1.4	0.9	2.3
	100	1.9	2.0	3.9

** The areas presented in this table are not truncated as the Main Tributary inundation areas are (Table 3). These areas are therefore conservative, and not directly comparable with the areas in Table 3.*

5 Assessment

5.1 Context

EIS N2 states that the main risk to tributaries of Lake Burragorang (called Upstream Zone watercourses in EIS N2 was from elevated erosion of terrace deposits during inundation events with a ‘medium’ residual risk. EIS N2 also stated that there is a risk of sediment deposition as a result of higher reservoir levels, however these were not considered to be of particular concern and were rated as ‘negligible’.

5.2 Conceptual model

The tributaries flowing into the lake form the **transportation zone** for sediment, linking the upper catchments (the **source zones**) with the lake (the **deposition zone**).

The **source zones** are unchanged by the project, and so the same volume and rate of sediment movement occurs under the ‘Existing’ and the ‘with Project’ scenarios. This may vary naturally through land use change or because of wildfires, but this change is not related to the project.

Likewise, the **deposition zone** is also unchanged, this being the lake. In our analysis we define the deposition zone, or lake, as everything below 116.7 mAHD, the Full Supply Level. This remains the ultimate destination of sediment generated by the upstream tributaries, and we assume that the lake is at FSL prior to considering any of the effects discussed. We do not expect any changes to the sediment budget of the lake in the ‘with Project’ scenario and for the deposition features to remain generally unchanged.

Due to the stream morphology, and due to the ‘Existing’ operation of the reservoir, the **transportation zone** is a dynamic environment through which sediment passes in pulses, often over multiple events.

Transport of sediment through the transportation zone is currently governed by (1) the size of floods in the tributary, and (2) the level of the lake at the time of the flood. Sediment will be transported through this zone by flood flows, with larger floods carrying greater volumes of sediment. Sediment is generally mobilised and carried during the rising limb of the flood, and will be moved towards the lake. As the flood peak passes and the flow reduces sediment which hasn’t made it to the lake will be deposited within the transportation reach. For smaller floods this deposition will occur within the channel and the sediment will be available for remobilisation during the next flood. In larger floods, sediment may be deposited in the overbank area in which case resuspension becomes limited due to revegetation binding the sediment.

If sediment passes through the transportation zone and enters the lake it will be deposited on the lake bed. If deposition occurs when the lake is at FSL, and the lake subsequently falls below FSL the deposited material will be visible on the surface. This is seen throughout the lake around each tributary termination point at present. This sediment will generally not be remobilised, except for that in the channel cut by the river as it follows the reservoir level down. A very large flood in the river could rework some of this sediment but in general it will form a delta-like structure.

The above pattern of erosion and deposition will continue in the ‘with Project scenario’, and the location at which some of these dynamic processes occur will change.

5.3 Functioning of transportation zone in the 'with Project' scenario

Sediment from the source zone can be carried straight through the transportation zone during the rising limbs and peak of floods, or in the case of smaller floods or falling limbs, sediment can be deposited temporarily in the transportation zone until it is remobilised by subsequent storms to continue its journey to the lake. This temporary storage can be seen throughout the tributaries in the form of sand and gravel bars forming in low points along the tributaries, and near the interface with the reservoir.

On the falling limb of larger floods sediment may also be deposited on the overbank areas of the transportation zone channel, and this sediment would be stored over a longer timeframe than the in-channel deposits. Once sediment is deposited on the overbank areas it is unlikely that velocities in future flood events would be sufficient to remobilise it and therefore the sediment would be stored in the area. Depending upon the gradient of local slopes and vegetation coverage following inundation events there may be some localised erosion by rainfall which could remobilise the deposited sediment, but in general this material will become part of the overbank morphology.

There will be a general pattern of finer silts and sands being deposited on the overbanks, with coarser sediment deposited in and around the main channel.

For the sediment deposited in the channel, the higher lake levels in the 'with Project' scenario will result in sediment pulses settling further upstream in the transportation zone, and the pulses may take longer to travel through the zone to the lake.

Changes to sediment deposition and erosion in the 'with Project' scenario will include upstream migration of in-channel sediment deposition features, increasing the length over which these features occur. They will remain transitional features which move over time. Changes will also include occasional deposition of sediment on the overbanks. Such material (which is likely to be finer sand and silt) may be remobilised in future floods, or by runoff from surrounding land, however much of this material will be incorporated into the soil layers of the riparian areas.

Our analysis of the data on flood extent, depth, and duration shows that such effects will be limited in extent and frequency.

5.4 Main tributary analysis

5.4.1 Coxs River

The Coxs River represents 27% of the lake's total catchment area. It has the highest TSS value recorded at any upstream tributary, at 514 mg/L (peak recorded). This equates to 21 tonnes/year/km^2 of catchment.

Additional overbank inundation in the 'with Project' scenario is a maximum of 1.1 ha in the 100-year event (Appendix A, Table A4, Figure A4). This inundation occurs for less than 1 additional day, and increases flood depth by 0.5 m (Appendix A, Table A5). It should be noted that the maximum increase in flood depth (0.5 m) would not occur for the full duration of the additional day. For all other events the inundation which occurs is below the truncation thresholds for depth and duration.

There will therefore be a limited increase in the area affected by sediment deposition in Coxs River. Given the effects occur at the 100-year event they are not likely to modify the normal geomorphic functioning of the river.

5.4.2 Kowmung River

The Kowmung River is a tributary of the Coxs River. No sediment load data is available for this tributary. Under the 'with Project' scenario there are no changes to the inundated area except in the 100-year ARI event, where there is a change of 0.16 ha of overbank area inundated (Appendix A, Table A9 and Figure A8).

The small increase in overbank inundated area for the 100-year ARI event is below the truncation depth threshold, and occurs for an additional 2 days (Appendix A, Table A10). There are no changes to inundated area in events smaller than the 100-year ARI.

The limited area and depth/duration suggests that there will be no noticeable effects on the geomorphic functioning of the Kowmung River.

5.4.3 Nattai River

The Nattai River catchment represents 7% of the total lake catchment. It is estimated that suspended sediment load is similar to the Coxs River and Wollondilly River, at 34 tonnes/year/km^2.

Changes to the inundated overbank area under the 'with Project' scenario are between 8.8 ha (5-year event) and almost 50 ha (100-year event) (Appendix A, Table A13).

Cross-section 11 (Appendix A, Figure A11) is representative of the channel in the affected reach. This cross-section shows a change to the inundation duration and depth in the 5-year event of 2.4 days and 0.5 m. In the 100-year event the cross section is inundated for 8.3 days longer and by an additional 10 m. The relatively flat longitudinal and cross-valley grades contribute to this large change in inundated area.

The flat grades that allow a large area of sediment to be deposited will also restrict the potential for erosion of the deposited material by subsequent runoff from surrounding land. We would expect the sediment deposited over bank to be recolonised by vegetation, reducing the risk of erosion into the stream further.

Deposition within the stream channel will remain until subsequent flood events with sufficient velocity/power to move sediment transports the material towards the reservoir. It is likely that the sand and gravel bars currently seen in downstream reaches will migrate upstream in the affected reach, serving as temporary storage for material on its way to be deposited in the reservoir.

5.4.4 Wollondilly River

The Wollondilly River is the largest catchment contributing to the lake (55% by area). As with the Coxs River the Wollondilly has high recorded TSS concentrations, of up to 436 mg/L. This equates to a sediment load of 45 tonnes/year/km^2. This load would not be changed by the project.

Given the wide valley floor associated with the Wollondilly River the amount of overbank area inundation in the 'with Project' scenario in the 20-year and 100-year events increases by 20.7 ha and 42.3 ha respectively (Appendix A, Table A18). At cross-section 4 (Appendix A, Figure A15) the inundation occurs for 3.2 and 3.6 days extra respectively but for both events the duration of inundation is below the truncation threshold (0.5 days) which will limit the effects (Appendix A, Table A19).

Under less extreme events the area of inundation is around 6 ha (5-10-year ARI), however at these events the changes to depth and duration are below the truncation thresholds and as such no effects are anticipated.

In summary, whilst the area of additional overbank inundation appears large in the 100-year flood, areas are much smaller in more common floods and the majority of the inundation is below the truncation threshold for depth and/or duration. Therefore, there is a low likelihood of large amounts of sediment being deposited.

Deposition within the stream channel will continue, and is likely that the sand and gravel bars currently seen in downstream reaches will migrate upstream, serving as temporary storage for material on its way to deposition in the reservoir.

5.5 Other tributaries analysis

The increase in inundated area under the ‘with Project’ scenario for the other tributaries is shown Table 4, and presented in detail in Appendix A. In general the other tributaries are steeper than the main tributaries, and therefore the inundation changes occur over a shorter length of river. Due to a lack of cross-section information, a depth-duration analysis has not been undertaken for these tributaries, however we expect these to follow a similar pattern to the main tributaries.

This means that the changes in inundation (Table 4, and Appendix A) can be expected to be upper estimates. Were truncation thresholds to be applied to these areas they would likely reduce in size.

5.6 Summary

The above work confirms the statement in the geomorphology report that the effects in the ‘with Project’ scenario will be a limited increase in the extent and lateral width of deposition in all upstream rivers.

This will see translocation of current in-channel deposition features up the rivers within the affected reaches. As with the ‘Existing’ scenario these depositional features will be transient in the ‘with Project’ scenario.

It will also see deposition of sediment on the overbank areas, some of which will be permanently stored on the overbanks, with the remained being reworked by subsequent floods in the tributary, or by runoff from surrounding land. Again, this general process occurs under the ‘Existing’ scenario.

The above will have little to no impact on the sediment budget of the system. It will have a limited impact on the rate at which sediment passes through the transport zone, which will result in temporary instream and overbank sediment storage.

6 Limitations Statement

This report has been prepared by Beca on the specific instructions of our Client. It is solely for our Client’s use for the purpose for which it is intended in accordance with the agreed scope of work. Any use or reliance by any person contrary to the above, to which Beca has not given its prior written consent, is at that person's own risk.

7 Approvals

Prepared by:	Reviewed by:	Approved by:
Monica Hoetjes Environmental Engineer **Mark Megaughin** Senior Associate – Wate Resources	**Mark Megaughin** Senior Associate – Water	**Graham Levy** Technical Director – Water Resources Engineering
		on behalf of Beca Pty Ltd

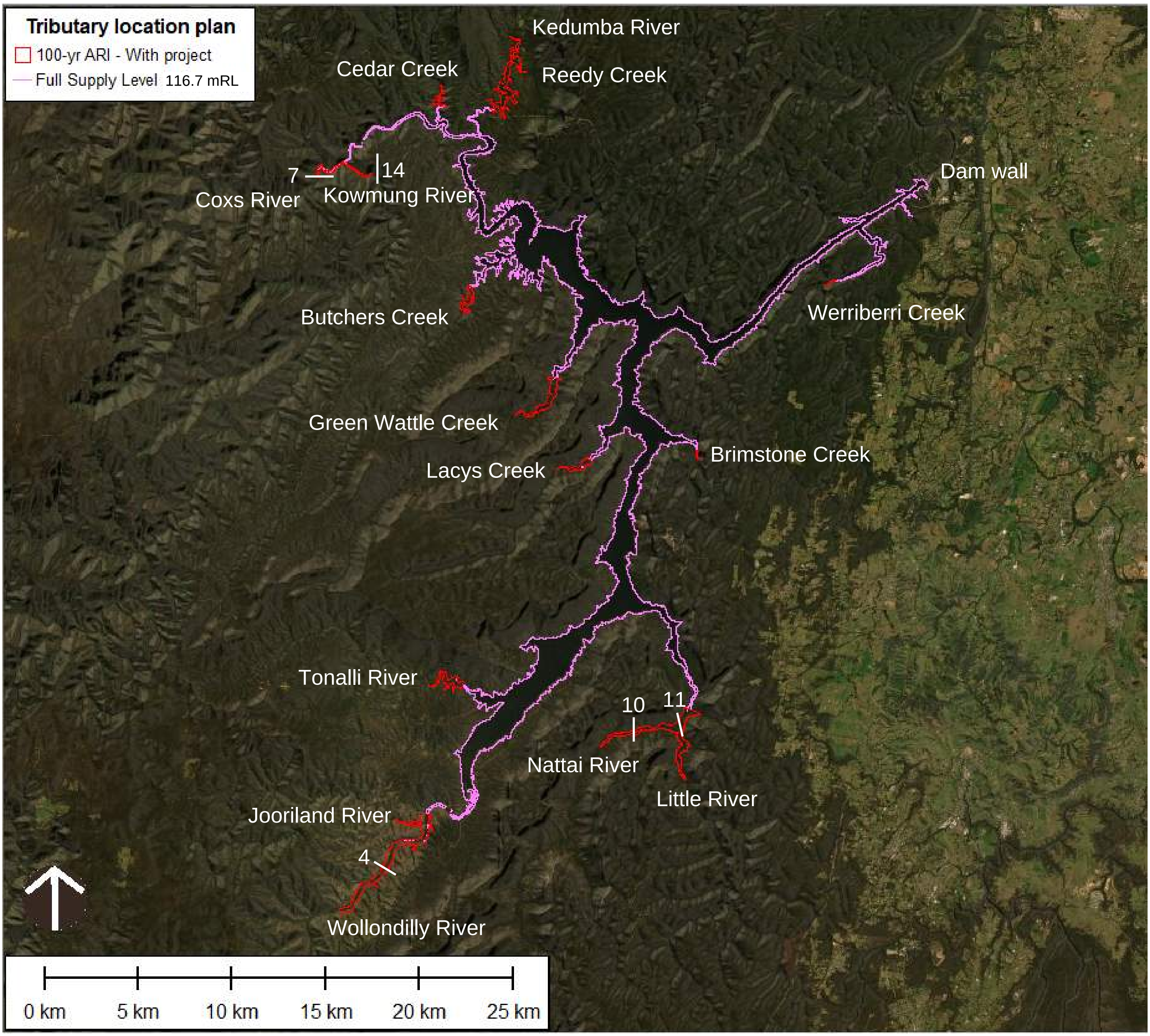
8 References

SMEC. (2021a). Warragamba Dam Raising: Environmental Impact Statement – Appendix N2: Geomorphology Technical Assessment. Beca.

SMEC. (2021b). Warragamba Dam Raising: Environmental Impact Statement – Chapter 15: Flooding and Hydrology.

Appendix A – Main tributary analysis

Overview - Upstream Locations



Brimstone Creek

Table A1. Comparison of inundation extent for Brimstone Creek

	INUNDATED CHANNEL AREA			INUNDATED OVERBANK AREA		
	Area inundated (ha)		Change with project (ha)	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project		Existing	Project	
5	0.50	0.78	0.28	0.04	0.19	0.15
10	0.54	1.01	0.47	0.08	0.46	0.38
20	0.57	1.26	0.69	0.11	1.05	0.94
100	0.89	1.61	0.72	0.28	2.53	2.25

	TOTAL INUNDATED AREA		
	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project	
5	0.54	0.97	0.43
10	0.62	1.47	0.85
20	0.68	2.31	1.63
100	1.17	4.14	2.97

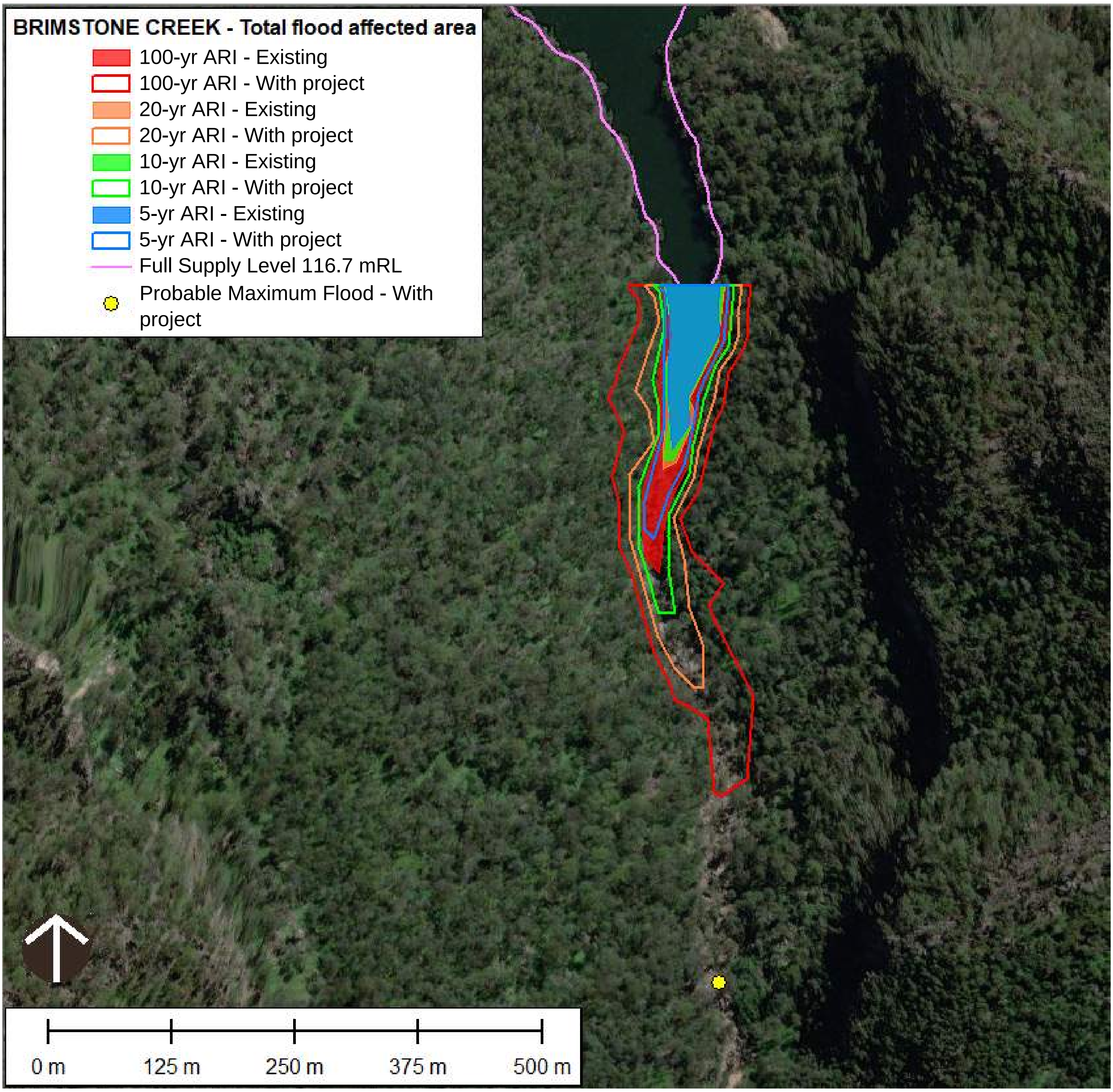


Figure A1. Brimstone Creek inundation extent

Butchers Creek

Table A2. Comparison of inundation extent for Butchers Creek

	INUNDATED CHANNEL AREA			INUNDATED OVERBANK AREA		
	Area inundated (ha)		Change with project (ha)	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project		Existing	Project	
5	2.40	3.26	0.86	2.05	4.72	2.66
10	2.63	4.03	1.40	2.53	9.49	6.96
20	2.91	5.46	2.55	2.98	17.20	14.22
100	3.74	7.29	3.56	6.61	27.71	21.10

	TOTAL INUNDATED AREA		
	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project	
5	4.46	7.98	3.52
10	5.15	13.52	8.36
20	5.89	22.66	16.77
100	10.34	35.00	24.65

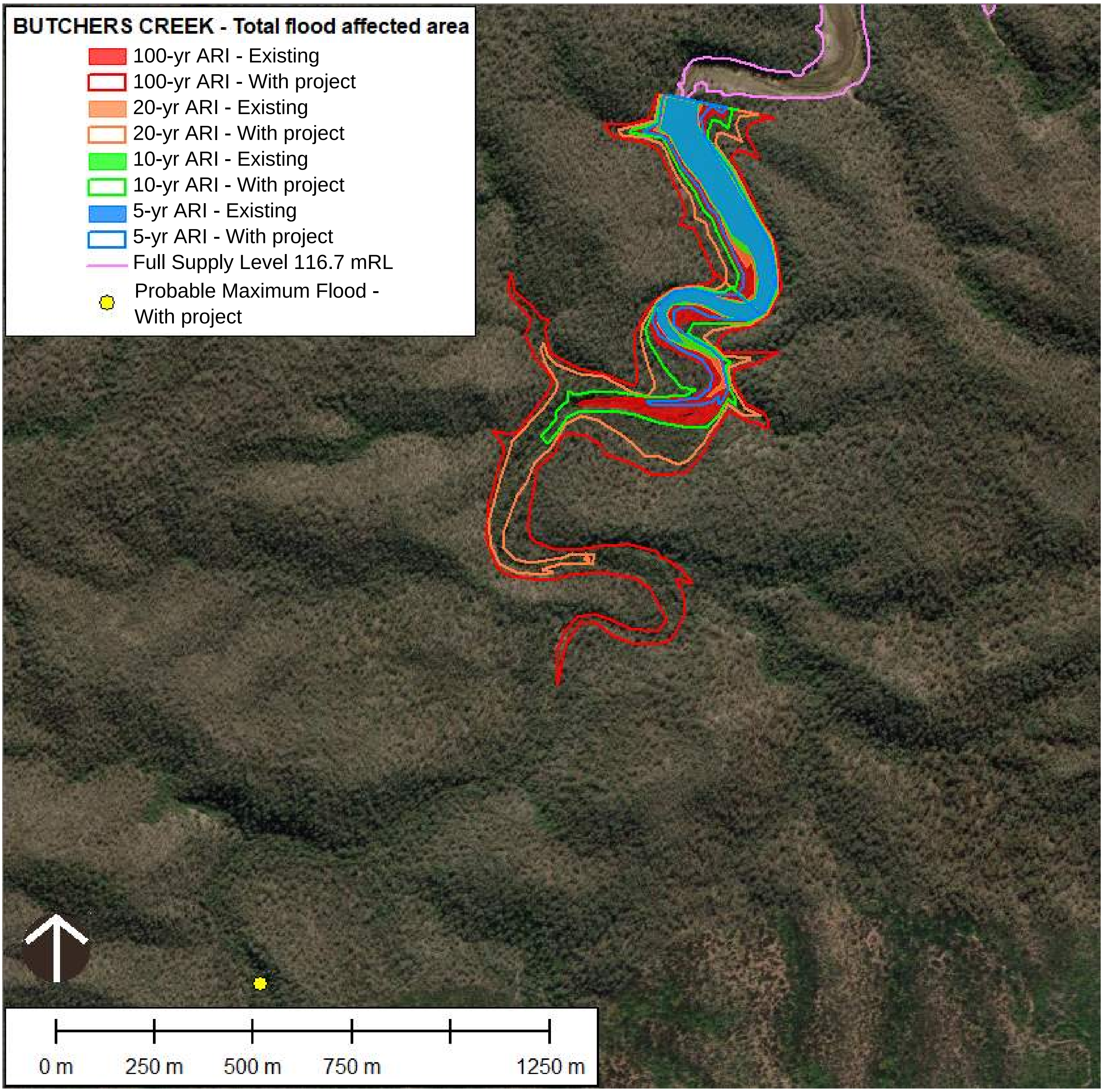


Figure A2. Butchers Creek inundation extent

Cedar Creek

Table A3. Comparison of inundation extent for Cedar Creek

	INUNDATED CHANNEL AREA			INUNDATED OVERBANK AREA		
	Area inundated (ha)		Change with project (ha)	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project		Existing	Project	
5	3.26	4.51	1.25	0.00	1.44	1.44
10	3.62	5.22	1.60	0.25	3.74	3.49
20	4.01	7.00	2.98	0.57	5.82	5.25
100	5.02	8.97	3.94	2.40	10.33	7.93

	TOTAL INUNDATED AREA		
	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project	
5	3.26	5.94	2.68
10	3.87	8.96	5.09
20	4.58	12.82	8.24
100	7.43	19.30	11.87

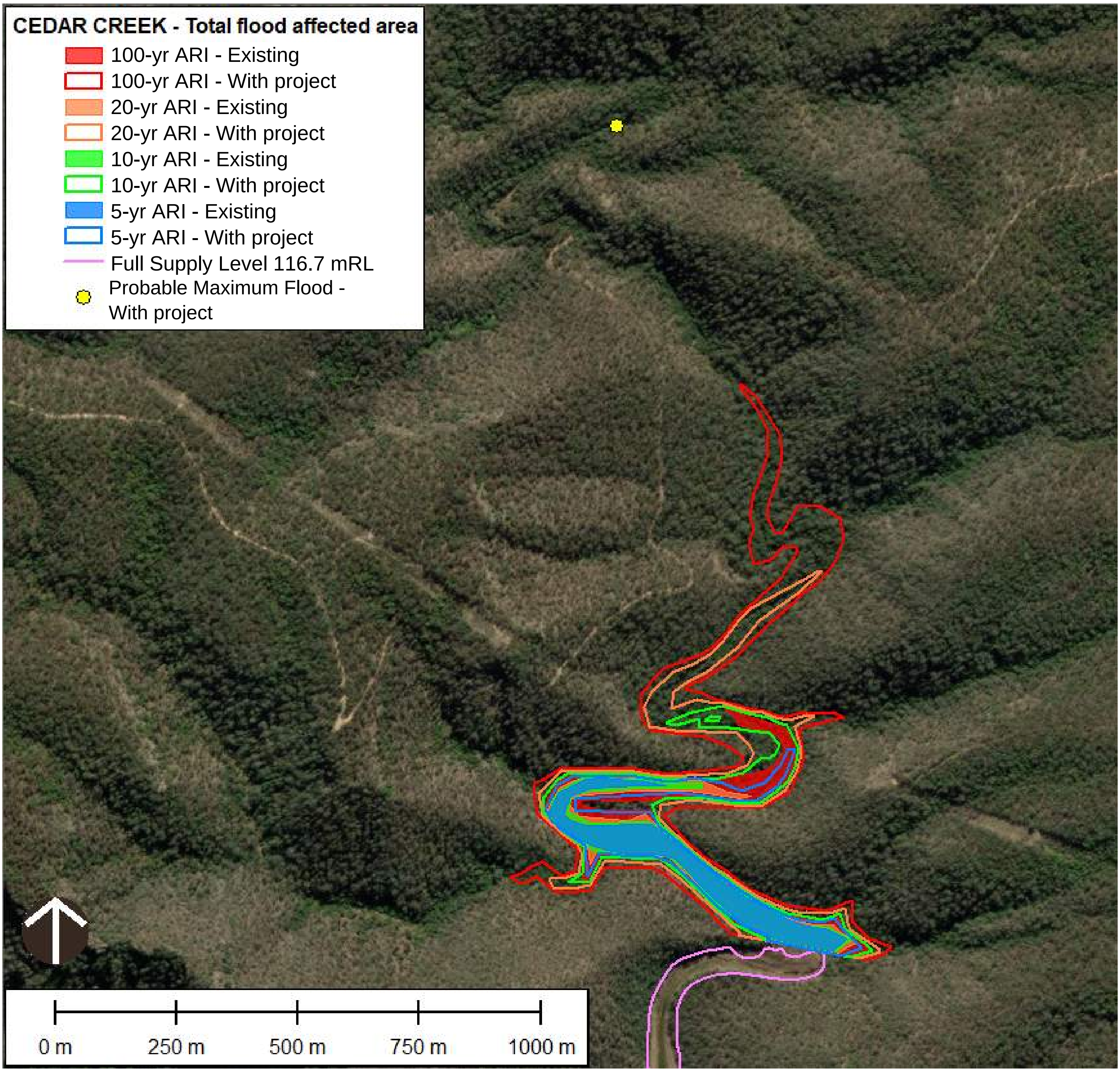


Figure A3. Cedar Creek inundation extent

Coxs River

Table A4. Comparison of inundation extent for Coxs River. Kowmung River (white dashed polygon) is excluded from analysis

	INUNDATED CHANNEL AREA			INUNDATED OVERBANK AREA		
	Area inundated (ha)		Change with project (ha)	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project		Existing	Project	
5	4.82	5.58	0.76	9.59	10.76	1.17
10	5.58	5.58	0.00	13.55	13.80	0.24
20	5.58	5.58	0.00	15.04	15.45	0.41
100	5.58	5.58	0.00	17.43	18.51	1.08

	TOTAL INUNDATED AREA		
	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project	
5	14.42	16.34	1.93
10	19.13	19.38	0.24
20	20.62	21.03	0.41
100	23.01	24.09	1.08

Table A5. Comparison of inundation depth and duration for Coxs River (depth in brackets)

	DURATION AND DEPTH INCREASE
	Location 7: Cox_US_9985
Event ARI (yrs)	Change with project
5	-
10	-
20	-
100	0.7 days (0.5 m)

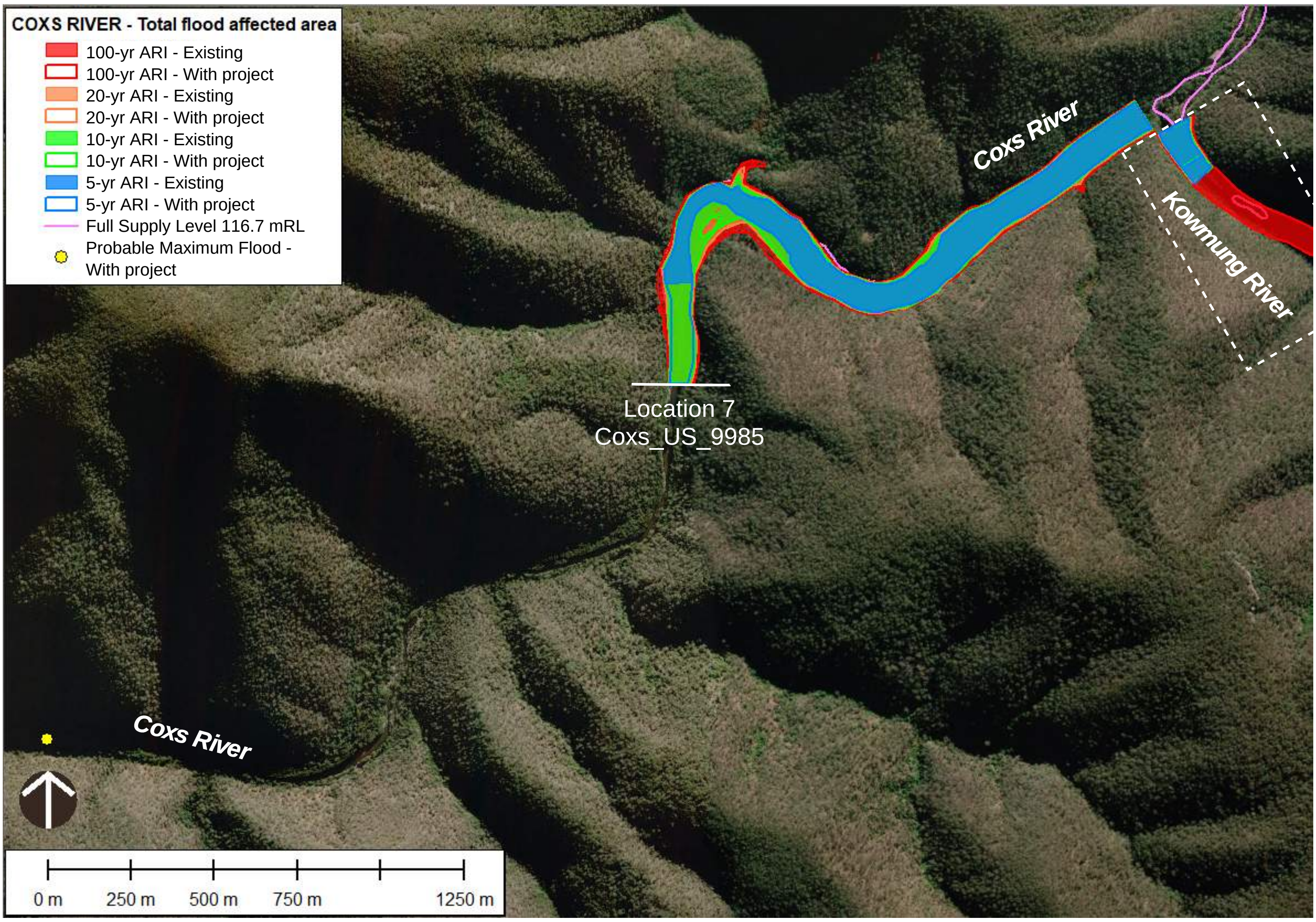


Figure A4. Coxs River inundation extent

Green Wattle Creek

Table A6. Comparison of inundation extent for Green Wattle Creek

	INUNDATED CHANNEL AREA			INUNDATED OVERBANK AREA		
	Area inundated (ha)		Change with project (ha)	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project		Existing	Project	
5	3.59	4.76	1.17	14.01	22.38	8.38
10	3.93	5.19	1.26	15.22	31.30	16.08
20	4.07	6.94	2.87	17.27	45.42	28.16
100	5.33	9.49	4.16	25.42	71.96	46.53

	TOTAL INUNDATED AREA		
	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project	
5	17.60	27.14	9.54
10	19.15	36.48	17.34
20	21.34	52.36	31.03
100	30.75	81.44	50.69

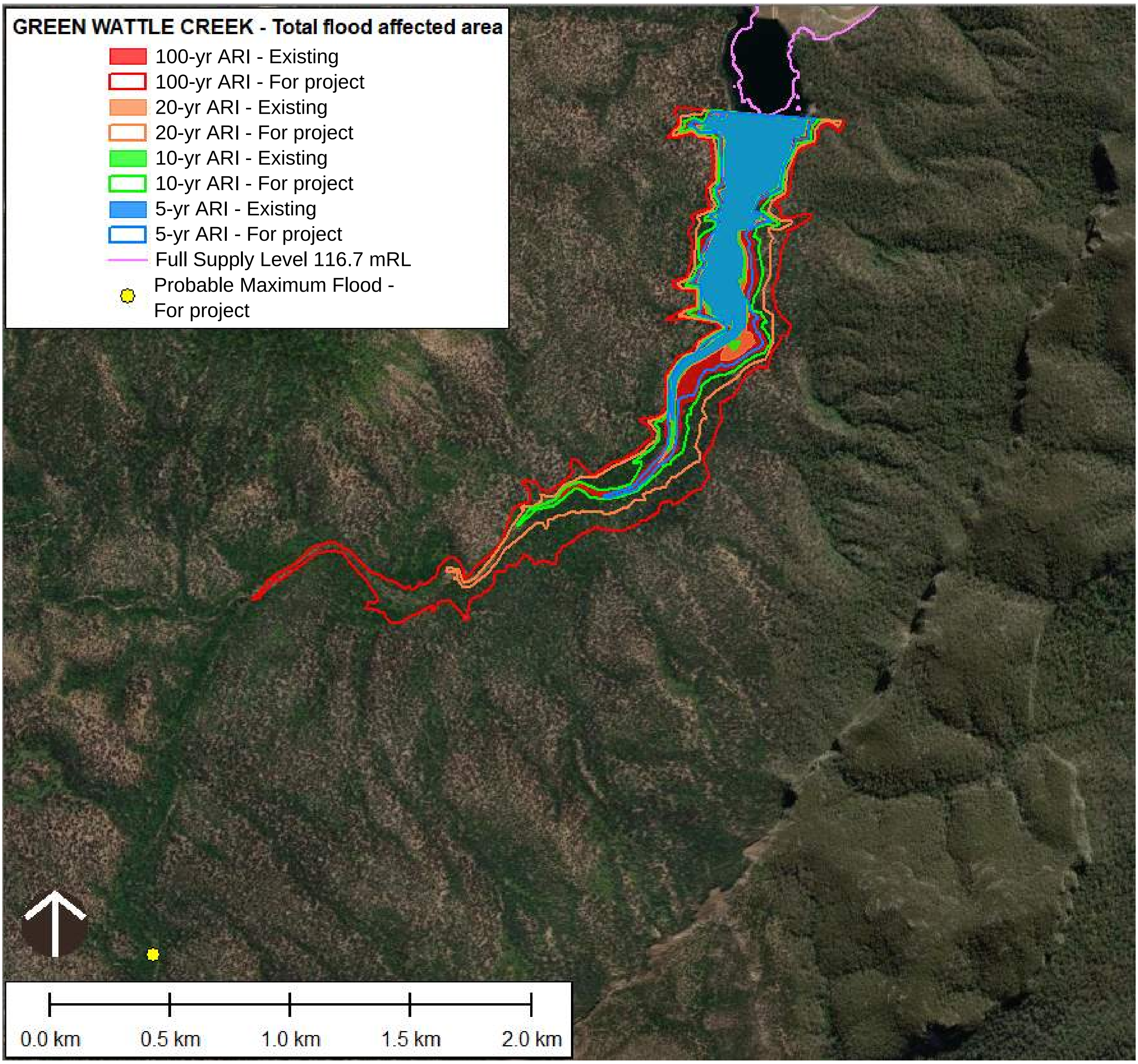


Figure A5. Green Wattle Creek inundation extent

Jooriland River

Table A7. Comparison of inundation extent for Jooriland River. Wollondilly River (white dashed polygon) is excluded from analysis

	INUNDATED CHANNEL AREA			INUNDATED OVERBANK AREA		
	Area inundated (ha)		Change with project (ha)	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project		Existing	Project	
5	0.50	0.64	0.14	0.28	0.52	0.23
10	0.71	1.11	0.41	0.63	1.50	0.88
20	0.83	1.70	0.87	1.10	4.41	3.32
100	1.34	2.64	1.31	2.78	11.78	9.00

	TOTAL INUNDATED AREA		
	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project	
5	0.79	1.16	0.37
10	1.33	2.61	1.28
20	1.93	6.12	4.19
100	4.11	14.42	10.31

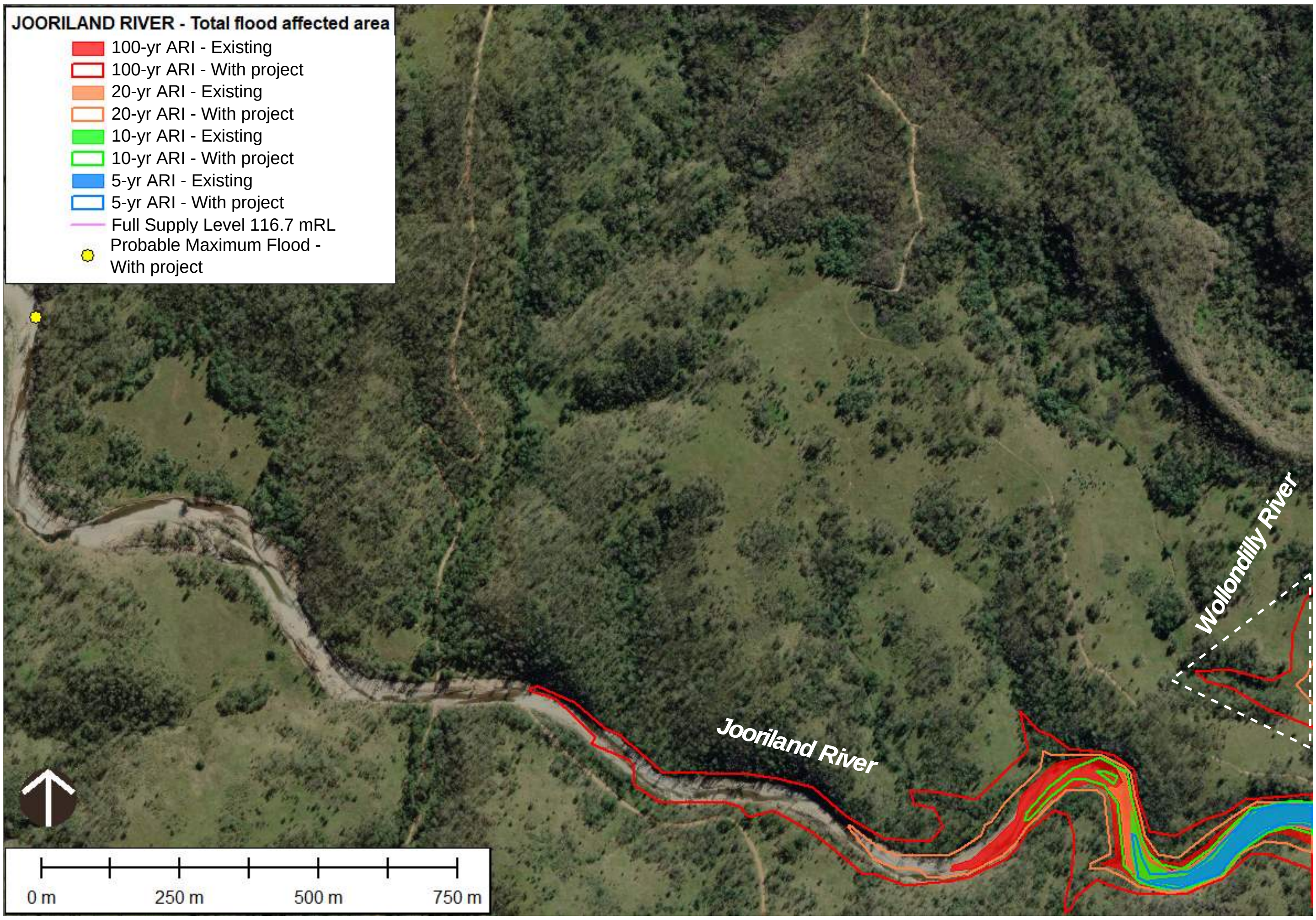


Figure A6. Jooriland River inundation extent

Kedumba River

Table A8. Comparison of inundation extent for Kedumba River. Reedy Creek (white dashed polygon) is excluded from analysis

	INUNDATED CHANNEL AREA			INUNDATED OVERBANK AREA		
	Area inundated (ha)		Change with project (ha)	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project		Existing	Project	
5	6.82	9.82	3.00	1.27	9.13	7.85
10	7.18	12.96	5.78	2.56	22.63	20.07
20	7.37	16.24	8.87	4.23	50.93	46.70
100	11.01	20.17	9.16	14.23	123.50	109.27

	TOTAL INUNDATED AREA		
	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project	
5	8.09	18.94	10.86
10	9.74	35.58	25.85
20	11.60	67.17	55.57
100	25.24	143.67	118.43

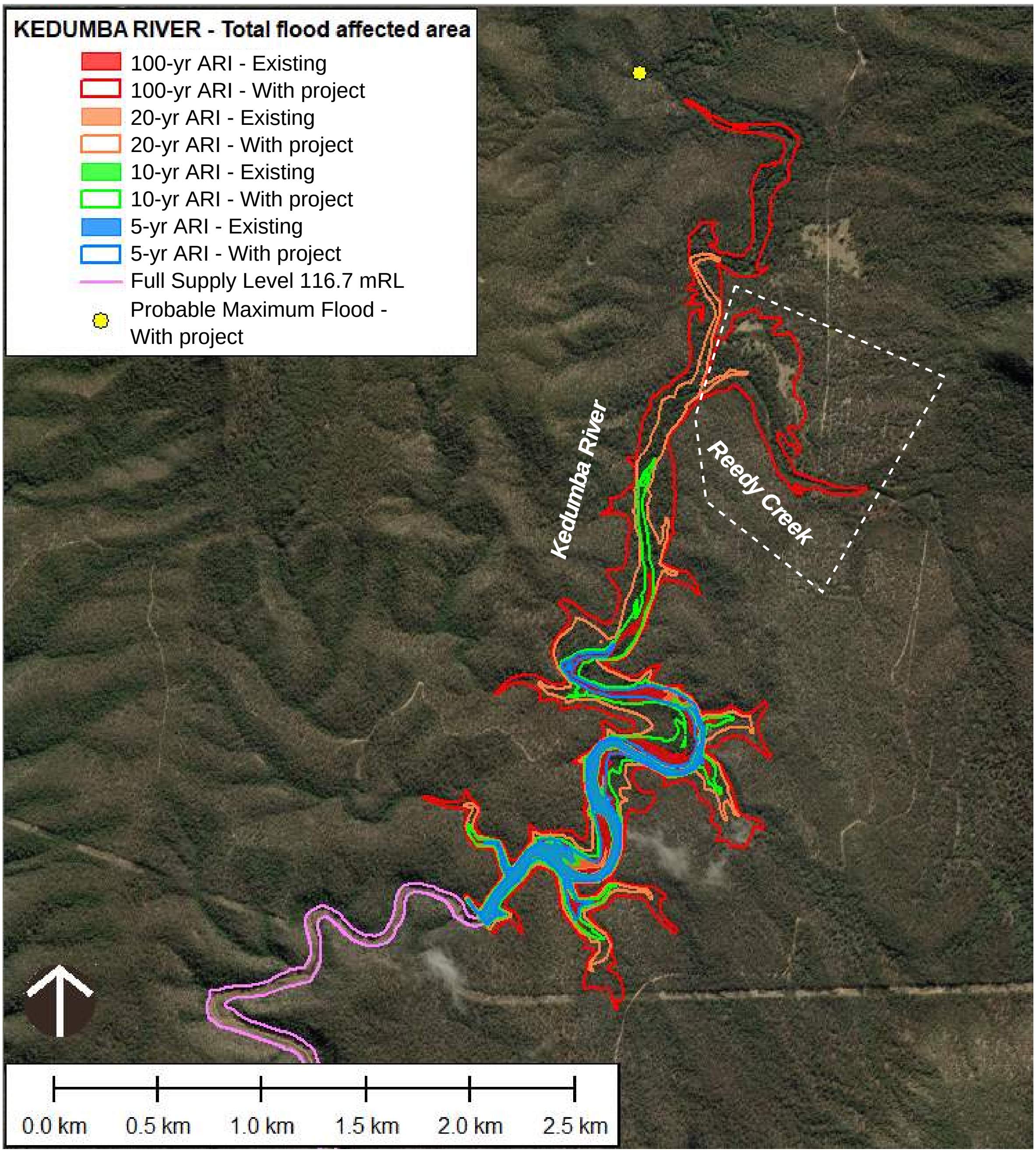


Figure A7. Kedumba River inundation extent

Kowmung River

Table A9. Comparison of inundation extent for Kowmung River. Coxs River (white dashed polygon) is excluded from analysis

	INUNDATED CHANNEL AREA			INUNDATED OVERBANK AREA		
	Area inundated (ha)		Change with project (ha)	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project		Existing	Project	
5	0.10	0.10	0.00	0.25	0.25	0.00
10	0.10	0.10	0.00	0.28	0.28	0.00
20	0.10	0.10	0.00	0.29	0.29	0.01
100	3.14	3.14	0.00	7.98	8.14	0.16

	TOTAL INUNDATED AREA		
	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project	
5	0.35	0.35	0.00
10	0.38	0.38	0.00
20	0.39	0.39	0.01
100	11.13	11.29	0.16

Table A10. Comparison of inundation depth and duration for Kowmung River (depth in brackets)

	DURATION AND DEPTH INCREASE
	Location 14 : Kowmung_13130
Event ARI (yrs)	Change with project
5	-
10	-
20	1.3 days (<0.5 m)
100	2.0 days (<0.5 m)

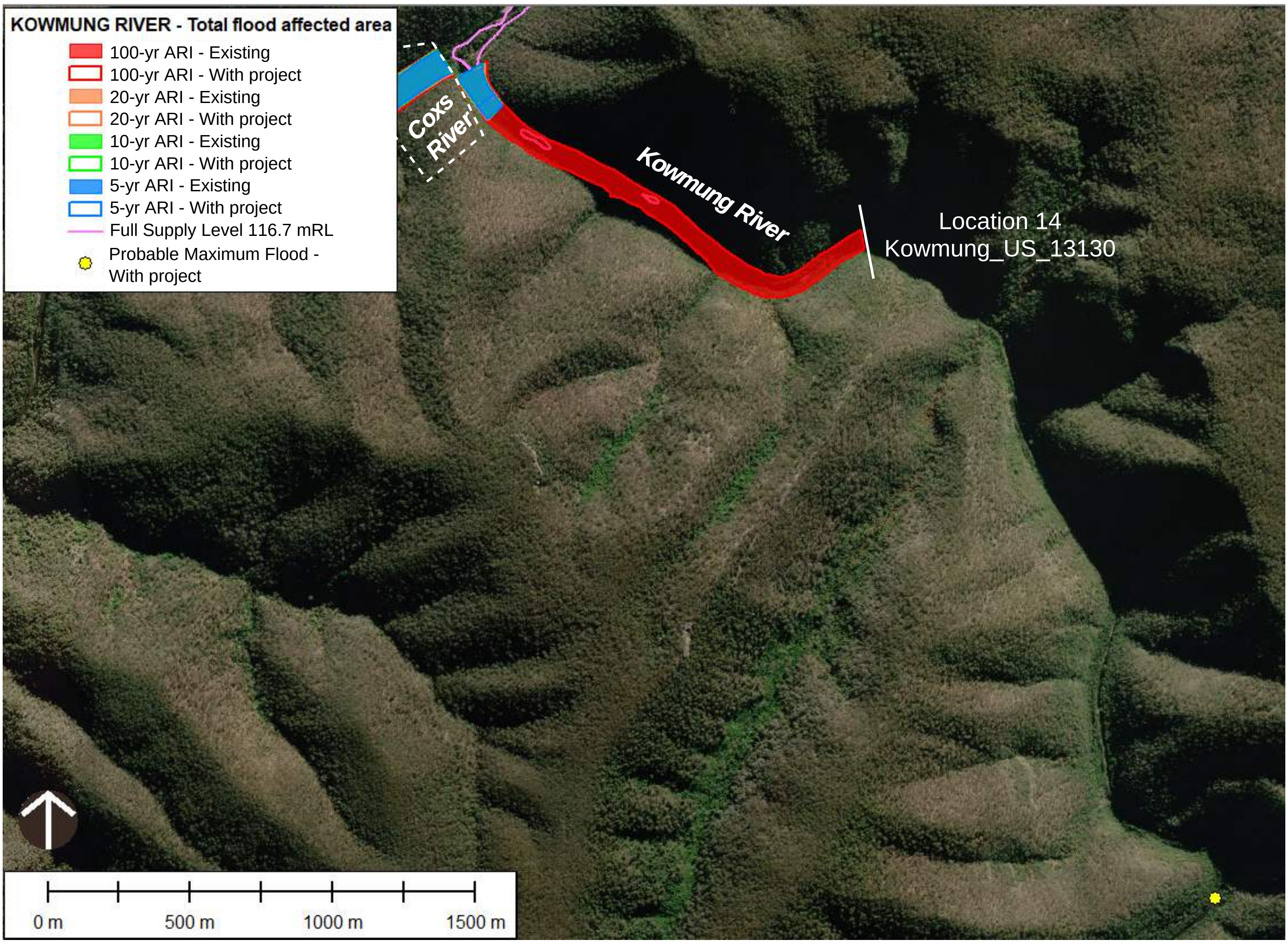


Figure A8. Kowmung River inundation extent

Lacys Creek

Table A11. Comparison of inundation extent for Lacys Creek

	INUNDATED CHANNEL AREA			INUNDATED OVERBANK AREA		
	Area inundated (ha)		Change with project (ha)	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project		Existing	Project	
5	1.87	2.32	0.44	6.97	11.00	4.04
10	1.93	2.62	0.69	7.85	15.04	7.19
20	2.01	3.23	1.23	8.60	20.83	12.23
100	2.47	4.53	2.06	12.67	30.26	17.59

	TOTAL INUNDATED AREA		
	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project	
5	8.84	13.32	4.48
10	9.78	17.66	7.88
20	10.61	24.06	13.45
100	15.14	34.79	19.65

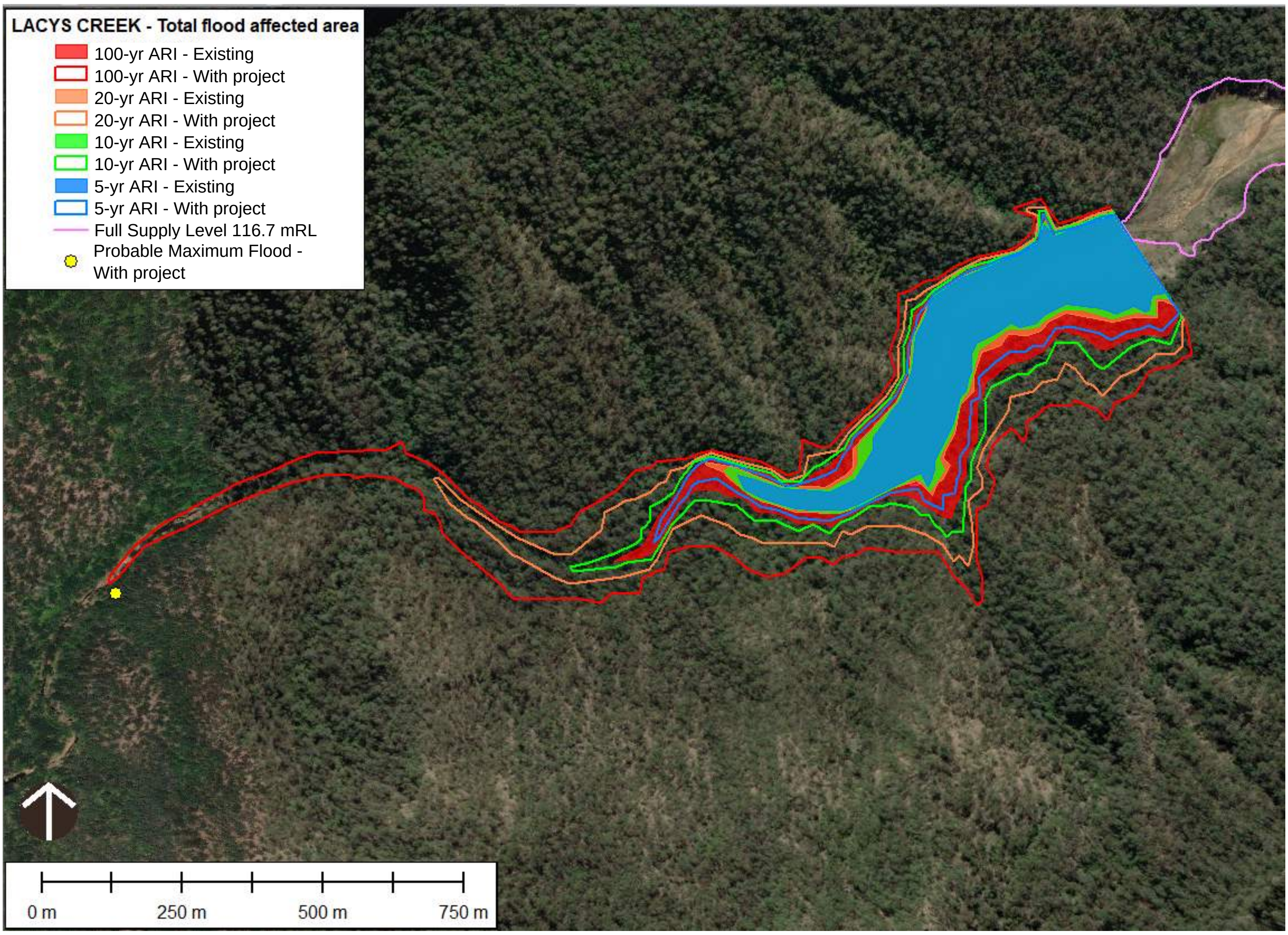


Figure A9. Lacys Creek inundation extent

Little River

Table A12. Comparison of inundation extent for Little River. Nattai River (white dashed polygon) is excluded from analysis.

	INUNDATED CHANNEL AREA			INUNDATED OVERBANK AREA		
	Area inundated (ha)		Change with project (ha)	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project		Existing	Project	
5	4.17	5.03	0.86	1.05	2.98	1.93
10	4.28	5.79	1.52	2.47	11.53	9.06
20	5.09	7.68	2.60	3.60	27.95	24.35
100	5.74	9.54	3.80	9.36	51.72	42.36

	TOTAL INUNDATED AREA		
	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project	
5	5.22	8.00	2.79
10	6.75	17.32	10.57
20	8.69	35.63	26.95
100	15.10	61.26	46.16

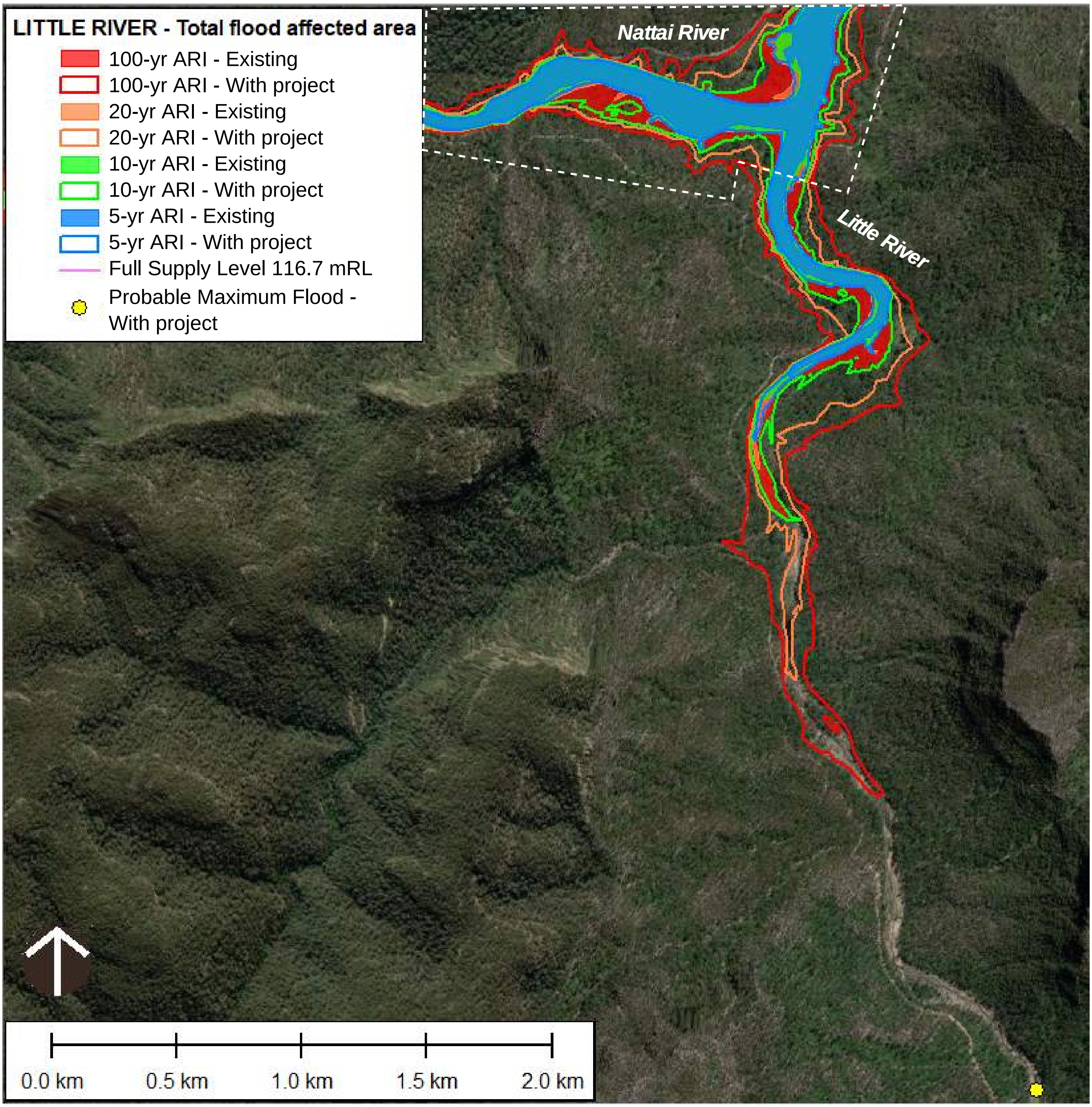


Figure A10. Little River inundation extent

Nattai River

Table A13. Comparison of inundation extent for Nattai River. Little River (white dashed polygon) is excluded from analysis

	INUNDATED CHANNEL AREA			INUNDATED OVERBANK AREA		
	Area inundated (ha)		Change with project (ha)	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project		Existing	Project	
5	11.65	11.65	0.00	23.33	32.10	8.77
10	16.28	16.28	0.00	32.22	56.60	24.38
20	16.28	16.28	0.00	38.53	75.98	37.45
100	20.91	20.91	0.00	72.03	120.82	48.79

	TOTAL INUNDATED AREA		
	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project	
5	34.98	43.75	8.77
10	48.50	72.88	24.38
20	54.81	92.26	37.45
100	92.94	141.73	48.79

Table A14. Comparison of inundation depth and duration for Nattai River (depth in brackets)

	DURATION AND DEPTH INCREASE
	Location 11: Nattai_1880
Event ARI (yrs)	Change with project
5	2.4 days (0.5 m)
10	3.8 days (3.2 m)
20	8.0 days (7.4 m)
100	8.3 days (10.0 m)

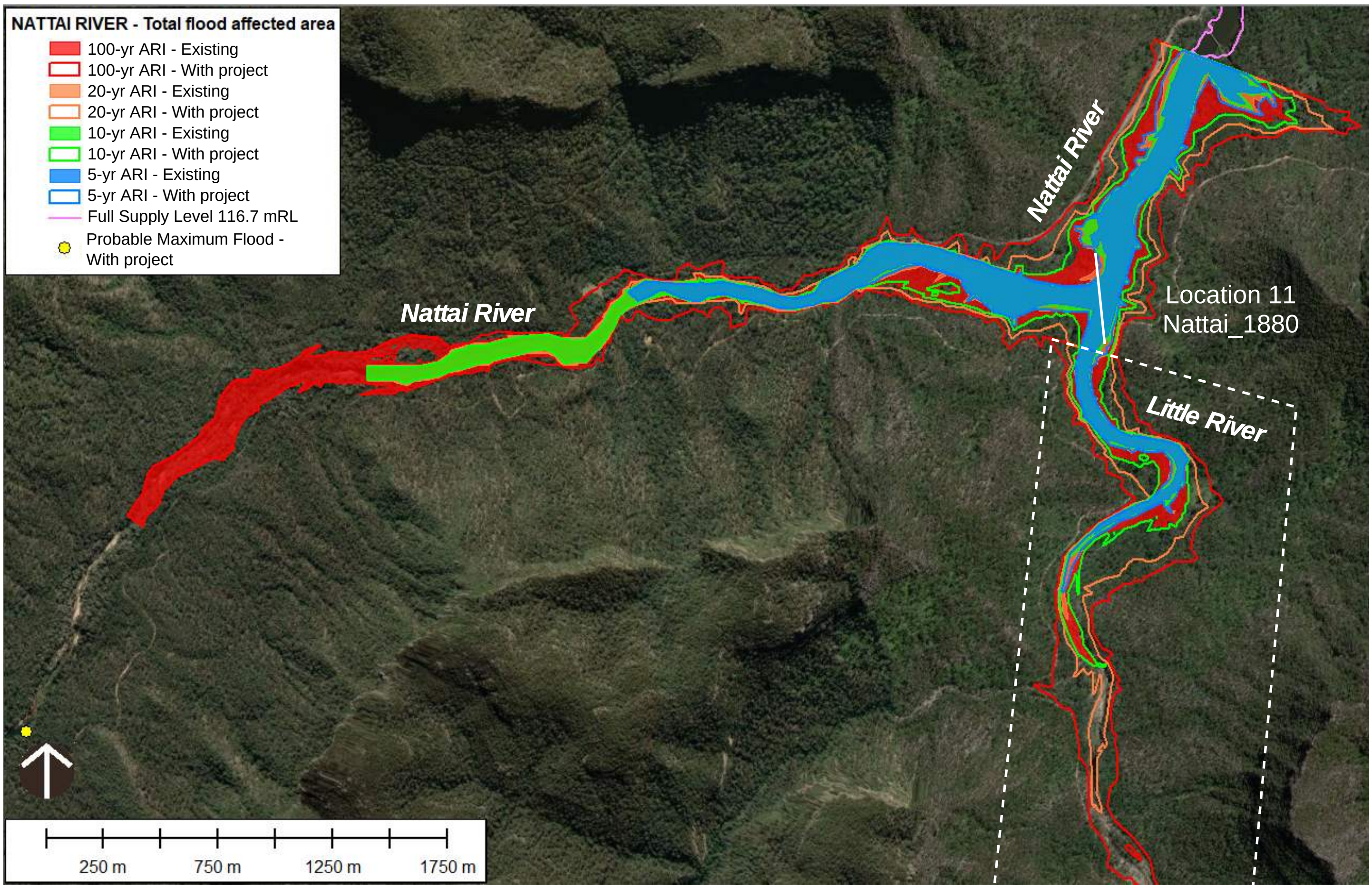


Figure A11. Nattai River inundation extent

Reedy Creek

Table A15. Comparison of inundation extent for Reedy Creek. Kedumba River (white dashed polygon) is excluded from analysis

	INUNDATED CHANNEL AREA			INUNDATED OVERBANK AREA		
	Area inundated (ha)		Change with project (ha)	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project		Existing	Project	
5	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.49	0.49	0.00	0.05	0.05
100	0.00	2.40	2.40	0.00	18.93	18.93

	TOTAL INUNDATED AREA		
	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project	
5	0.00	0.00	0.00
10	0.00	0.00	0.00
20	0.00	0.54	0.54
100	0.00	21.33	21.33

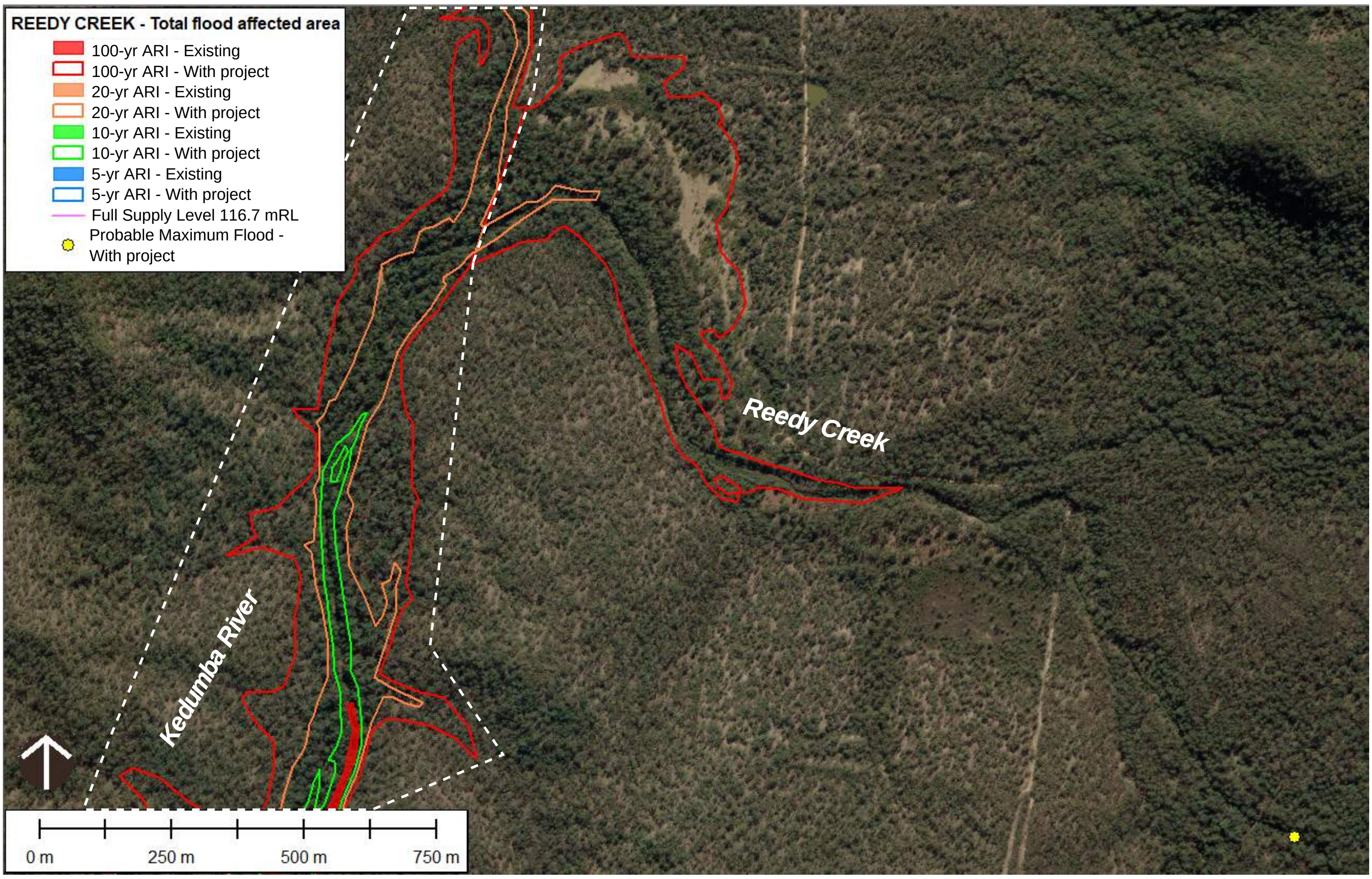


Figure A12. Reedy Creek inundation extent

Tonalli River

Table A16. Comparison of inundation extent for Tonalli River

	INUNDATED CHANNEL AREA			INUNDATED OVERBANK AREA		
	Area inundated (ha)		Change with project (ha)	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project		Existing	Project	
5	3.44	4.51	1.07	3.30	8.03	4.74
10	3.75	5.81	2.07	4.03	15.45	11.42
20	3.79	7.51	3.72	4.96	26.48	21.52
100	4.95	9.32	4.37	11.03	45.18	34.16

	TOTAL INUNDATED AREA		
	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project	
5	6.74	12.54	5.80
10	7.77	21.26	13.49
20	8.75	33.99	25.24
100	15.98	54.50	38.52

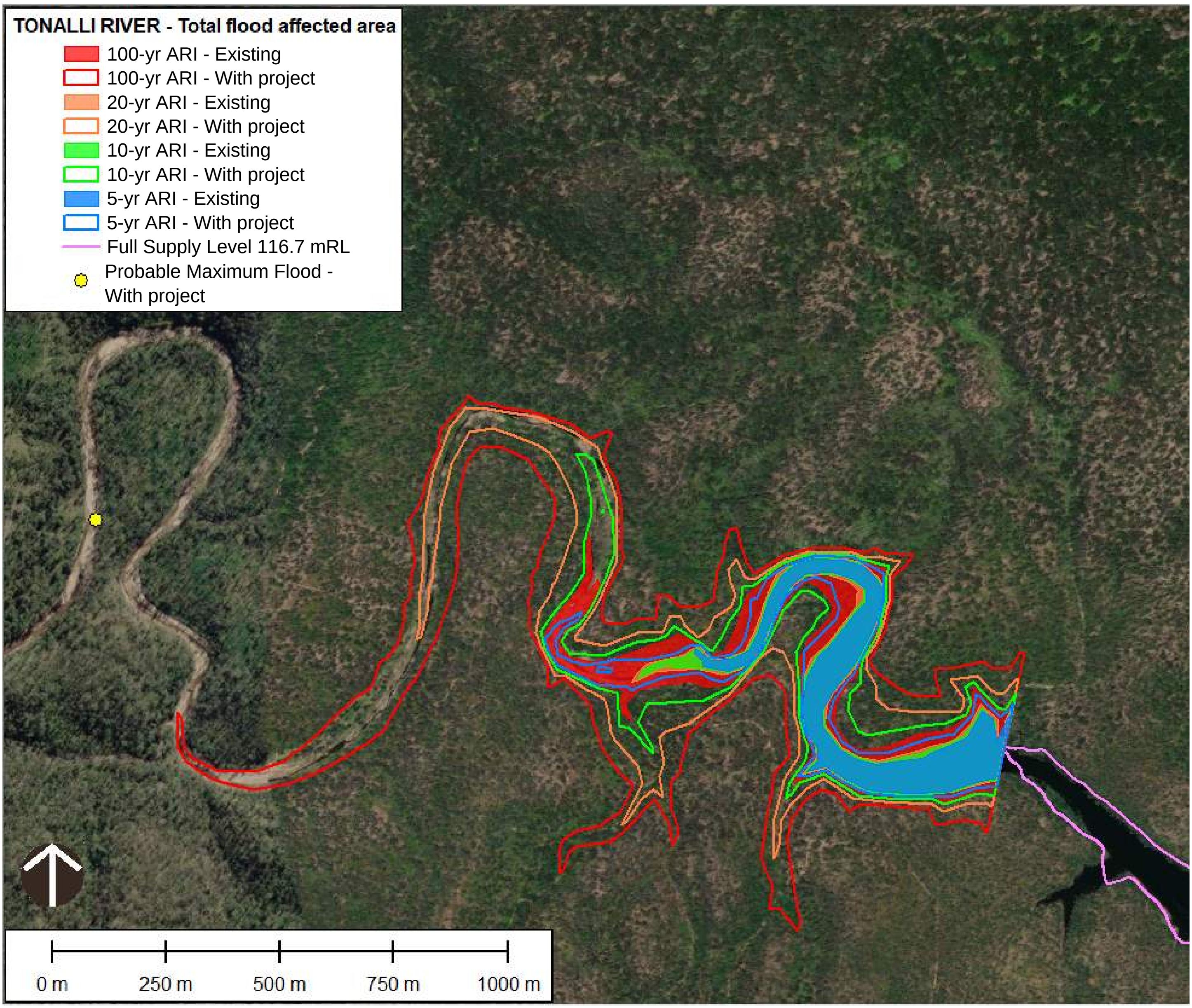


Figure A13. Tonalli River inundation extent

Werriberri Creek

Table A17. Comparison of inundation extent for Werriberri Creek

	INUNDATED CHANNEL AREA			INUNDATED OVERBANK AREA		
	Area inundated (ha)		Change with project (ha)	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project		Existing	Project	
5	0.00	0.10	0.10	0.00	0.00	0.00
10	0.00	0.99	0.99	0.00	0.08	0.08
20	0.00	1.37	1.37	0.00	0.90	0.90
100	0.23	2.10	1.86	0.00	2.02	2.02

	TOTAL INUNDATED AREA		
	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project	
5	0.00	0.10	0.10
10	0.00	1.06	1.06
20	0.00	2.27	2.27
100	0.23	4.11	3.88

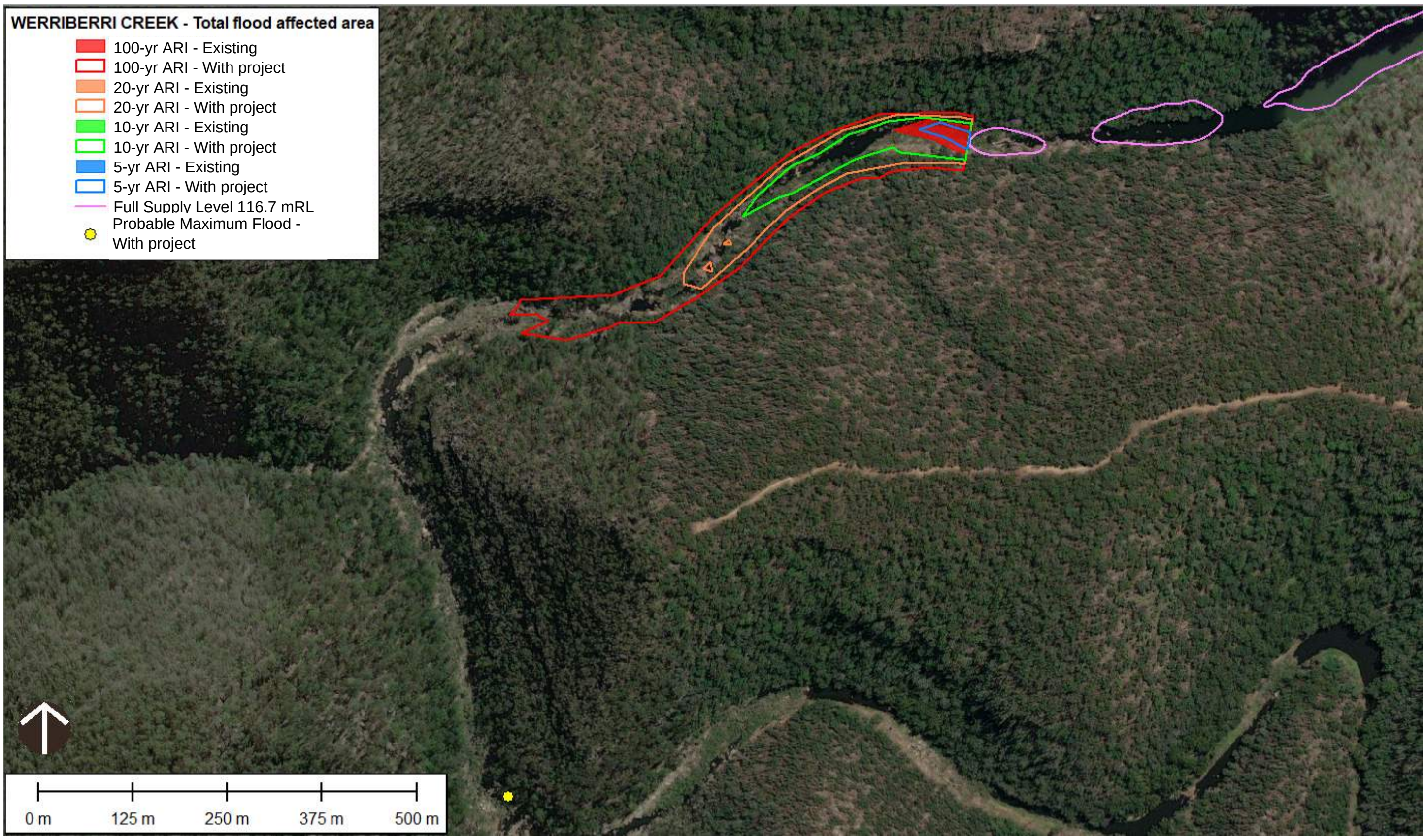


Figure A14. Werriberri Creek inundation extent

Wollondilly River

Table A18. Comparison of inundation extent for Wollondilly River. Jooriland River (white dashed polygon) is excluded from analysis.

	INUNDATED CHANNEL AREA			INUNDATED OVERBANK AREA		
	Area inundated (ha)		Change with project (ha)	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project		Existing	Project	
5	12.99	12.99	0.00	26.00	31.92	5.92
10	25.40	25.40	0.00	81.59	88.10	6.51
20	25.40	25.40	0.00	98.42	119.07	20.65
100	32.68	32.68	0.00	160.22	202.52	42.30

	TOTAL INUNDATED AREA		
	Area inundated (ha)		Change with project (ha)
Event ARI (yrs)	Existing	Project	
5	38.98	44.90	5.92
10	106.99	113.50	6.51
20	123.82	144.47	20.65
100	192.90	235.20	42.30

Table A19. Comparison of inundation depth and duration for Wollondilly River (depth in brackets)

	DURATION AND DEPTH INCREASE
	Location 4 : Wollondilly_3380
Event ARI (yrs)	Change with project
5	-
10	-
20	3.2 days (<0.5 m)
100	3.6 days (<0.5 m)

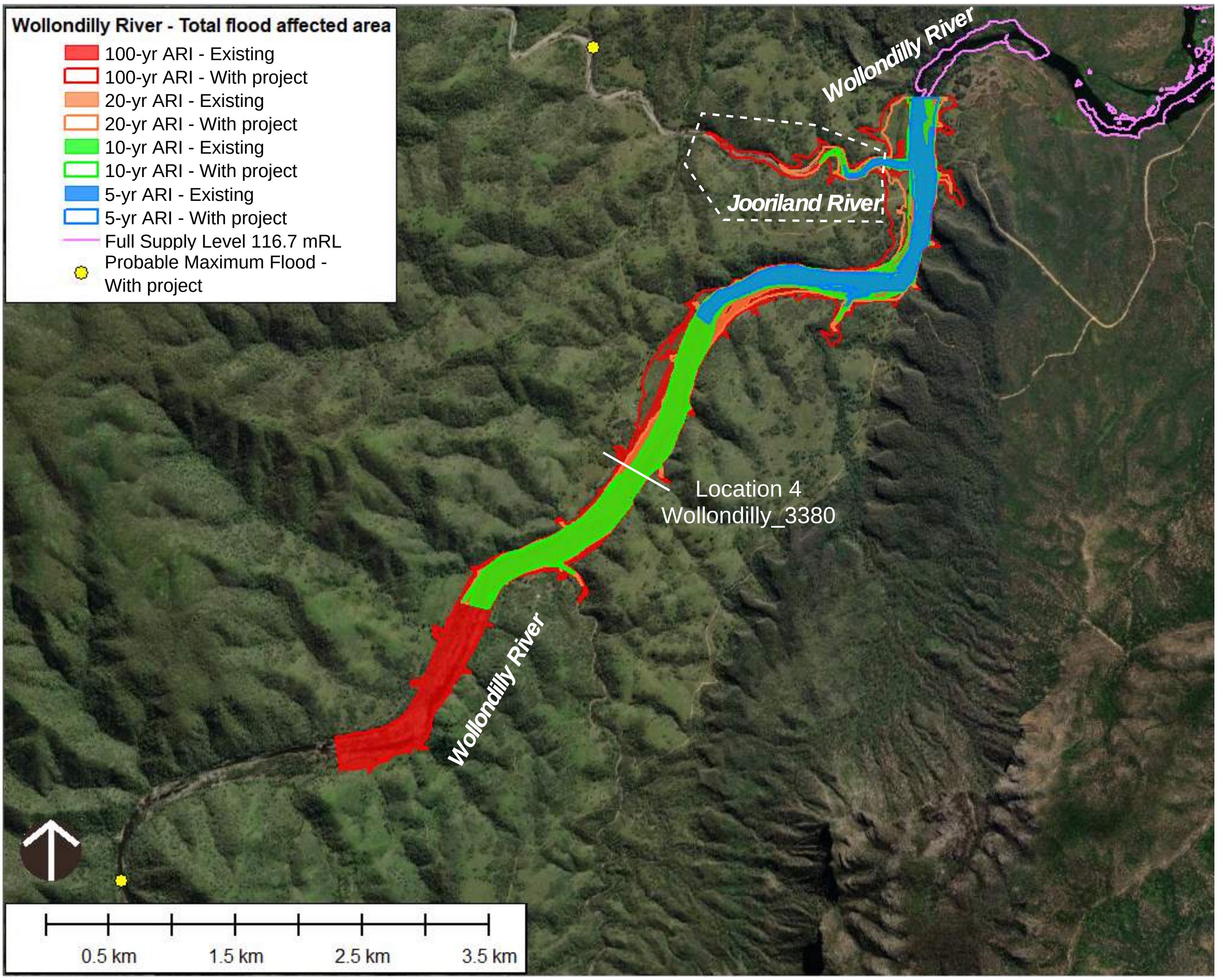


Figure A15. Wollondilly River inundation extent

Appendix H

Supplementary contaminated land assessment

Appendix I

Supplementary non-Aboriginal heritage assessment

Warragamba Dam Wall Raising Project

Non-Aboriginal Heritage
Supplementary Report to the
Environmental Impact Statement

Final Report to SMEC for WaterNSW
August 2022

artefact

Artefact Heritage

ABN 73 144 973 526
Suite 56, Jones Bay Wharf
26-32 Pirrama Road
Pyrmont NSW 2009
Australia

+61 2 9518 8411
office@artefact.net.au

EXECUTIVE SUMMARY

WaterNSW, a New South Wales (NSW) state owned corporation, is seeking environmental planning approval for the Warragamba Dam Raising Project (the project). The Project requires approval from the NSW Minister for Planning under Division 5.2 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act). To support the project approval application, an Environmental Impact Statement (EIS) was prepared for public exhibition in 2021. This report is a Supplementary Report as part of the next stage in the assessment process for the Response to Submissions Report. This report has been prepared to assess the project's impact on four non-Aboriginal sites listed on the National Parks and Wildlife Service (NPWS) Section 170 Heritage and Conservation Register (S170 Register) and a separate assessment for the State Heritage Register (SHR) listed Megarittys Bridge (ID #01367).

The project is also a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and therefore requires concurrent assessment under the EPBC Act. In accordance with the Bilateral Agreement reached between the NSW and Commonwealth Governments, an EIS under the EP&A Act for State Significant Infrastructure (SSI) can also be used for an EIS under the EPBC Act for a controlled action, where directed by the Federal Minister. The direction was given for the project to be assessed under the Bilateral Agreement on 17 July 2017.

This Supplementary Report has assessed the four S170 heritage sites as being in poor condition and that the project would result in a continued disintegration of their condition or a complete loss of fabric due to the increased duration of temporary inundation at each of the sites for the 1 in 5 chance in a year event and larger flood events.

The separate assessment for the State Heritage Register listed Megarritys Bridge builds on the findings within the impact assessment supporting the EIS and has concluded that no impacts are expected to the State heritage values of the item.

Overview of findings

The findings of this Supplementary Report are summarised in the below table.

Summary of significance and impacts to the four Section 170 sites and the SHR listed Megarritys Bridge

Site name	Listing	Significance grading	Impacts
Megarritys Bridge	State Heritage Register ID 01367	**State**	**Neutral** impacts
Orange Tree Flat House	National Parks and Wildlife Services Section 170 ID 12805	Does not fulfil criteria for a Local listing	**Minor - moderate** physical impacts **Neutral** visual and setting impacts **Neutral** archaeological impacts

Site name	Listing	Significance grading	Impacts
Stone Hut Ruins	National Parks and Wildlife Services Section 170 ID 12804	**Local**	**Minor - moderate** physical impacts **Neutral** visual and setting impacts **Neutral** archaeological impacts
Murphy's Flat Yards	National Parks and Wildlife Services Section 170 ID 13367	Does not fulfil criteria for a Local listing	**Minor-moderate** physical impacts **Neutral** visual and setting impacts **Neutral** archaeological impacts
Managers Cottage Group Joorilands	National Parks and Wildlife Services Section 170 ID 3817	**State**	**Neutral** physical impacts **Neutral** visual and setting impacts **Neutral** archaeological impacts

Changes to temporary inundation duration (days) for potentially affected S170 sites

Location	Flood event (1 in x chance in a year)							
	1 in 5		1 in 10		1 in 20		1 in 100	
	Existing	Project	Existing	Project	Existing	Project	Existing	Project
Jooriland	NA*	NA	NA	NA	NA	NA	NA	NA
Murphy's Flat Yards	NA	NA	NA	10	NA	13	8	16
Stone Hut Ruins	NA	8	7	10	8	13	8	16
Orange Tree Flat House	NA	8	NA	10	NA	13	NA	16

* Not affected by flood event

Mitigation measures

The following mitigations apply to the project in relation to the four heritage items assessed in this Supplementary Report.

- WaterNSW should conduct an Archival Recording of the four S170 sites prior to the operation of this project. The archival recording should be conducted by an appropriately qualified heritage specialist and must be conducted in accordance with Heritage Office guidelines (see *How to Prepare Archives Records of Heritage Items and Guidelines for Photographic Recording of Heritage Sites, Buildings and Structures*) and should lodge the record with the State Library and the local Council library. The report should be shared with National Parks and Wildlife Service and Heritage NSW for their records. A copy could also be shared with the Wollondilly Heritage Centre & Museum out of courtesy.
- WaterNSW should conduct inspections of these four S170 sites following any major flood event where one or more sites is affected by backwater flooding attributable to the Project, and shall consult with NPWS with regard to any required measures relating to additional temporary inundation from the Project.
- No specific mitigations are required for the State Heritage listed Megarritys Bridge as no heritage impacts are expected.
- WaterNSW to prepare a Management Plan for the locally significant Stone Hut Ruins in consultation with NPWS. This Management Plan would focus on fabric management post-inundation, general conservation post-inundation and opportunities for heritage interpretation, such as through digital archival recording to enable public engagement with the heritage values of the item offsite. This plan should be produced by a suitably qualified heritage specialist with heritage architect and engineer input. The plan can be produced post approval but should be implemented prior to completion of construction.
- WaterNSW to prepare a condition assessment in consultation with NPWS and provide advice on stabilisation and minimisation of moisture ingress and damage to the Stone Hut Ruins. This should be provided to the project prior to construction by a suitably qualified engineer with heritage experience. Findings and recommendations from this reporting must be implemented and considered prior to completion of construction of the project.

CONTENTS

FIGURES

TABLES

1.0 INTRODUCTION

WaterNSW, a New South Wales (NSW) state owned corporation, is seeking environmental planning approval for the Warragamba Dam Raising Project (the project). The Project requires approval from the NSW Minister for Planning under Division 5.2 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act). Under the project approval application, an Environmental Impact Statement (EIS) was prepared for public exhibition in 2021. This report is a Supplementary Report as part of the next stage in the assessment process for the Response to Submissions Report. The agency advice from the Environment, Energy and Science Group (EES) within the Department of Planning and Environment (DPE) noted that impacts to some sites on the National Parks and Wildlife Service (NPWS) Section 170 Heritage and Conservation Register (S170 Register) had not been addressed in the EIS. Advice provided by Heritage NSW included a general comment that additional information is required to assessment of impacts to Megarittys Bridge. This report has been prepared to assess the project's impact on four non-Aboriginal sites listed on the NPWS Section 170 Register and a separate assessment for the State Heritage Register (SHR) listed Megarittys Bridge (ID #01367).

The project is also a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and therefore requires concurrent assessment under the EPBC Act. In accordance with the Bilateral Agreement reached between the NSW and Commonwealth Governments, an EIS under the EP&A Act for State Significant Infrastructure (SSI) can also be used for an EIS under the EPBC Act for a controlled action, where directed by the Federal Minister. The direction was given for the project to be assessed under the Bilateral Agreement on 17 July 2017.

Artefact Heritage has been engaged by SMEC Australia Pty Ltd (SMEC) to undertake further investigations into the potential impacts associated with the proposed flood mitigation works at Warragamba Dam (the project) to four Section 170 (S170) listed sites and to provide a separate assessment for the SHR listed Megarittys Bridge, building off the assessment previously provided in the EIS. The raised dam would provide an airspace (called a Flood Mitigation Zone) to temporarily capture up to around 1,000 gigalitres of water during a rainfall or inflow event. The aim of this Supplementary Report is to identify the five listed heritage items and any potential archaeological remains which may be impacted by the project, determine the level of heritage significance of each item, assess the potential impacts to those items, recommend mitigation measures to reduce or avoid heritage impacts and identify other management or statutory obligations.

Artefact Heritage note that impact assessment of the World and National heritage listed Greater Blue Mountains World Heritage Area (GBMWHA), including the Greater Blue Mountains Area – Additional Values, has been assessed in a separate report provided as Appendix J to the EIS with additional information provided in the Submissions Report. Artefact Heritage also note that the Managers Cottage Group Joorilands (item #3817) listed on the NPWS S170 Register and the SHR listed Megarritys Bridge (item #01367) were assessed as part of the Non-Aboriginal Heritage Impact Assessment for the EIS however this report offers further information about the impact assessment.

1.1 Project location

The overall project area is located approximately 65 km west of the Sydney Central Business District in the Wollondilly Local Government Area (LGA). To the west of the project area are the Blue Mountains, various National Parks and State Conservation Areas and the GBMWHA which make up part of the catchment of Lake Burragorang – the water storage formed by Warragamba Dam. To the east of the project area is the Warragamba and Silverdale townships and surrounding rural residential areas.

1.1.1 Study area

The study area has been separated from the overall project area for targeted assessment of the project on the S170 sites in question (see Figure 1-1). Megarritys Bridge is located within the vicinity of the Construction Footprint for the project and has been illustrated in Figure 1-1 although it is noted that this assessment largely focuses on the S170 sites.

The study area comprises an area along the tributaries of Lake Burragorang, specifically Wollondilly River and the Little River. Two of the S170 listed sites are along the Wollondilly River at Colemans Bend, roughly 1.5 km from Smiths Lagoon. One of the S170 sites is further upstream along the Wollondilly, roughly 6 km from Smiths Lagoon. The other S170 listed site is along the Little River, roughly 4 km from Lake Burragorang and 500 m from where the Little River and the Nattai River meet. To the west of this study area is the Yerranderie State Conservation Area, to the north is the Nattai State Conservation Area, and to the east/south is the Nattai National Park.

See Figure 1-2 to Figure 1-5 for the locations of the four S170 sites.

Megarritys Bridge is located approximately 2 km east of Warragamba Dam. The bridge site is located at the base of the Warragamba Chlorine Dosing Plant in Wallacia, and crosses over Megarritys Creek, a tributary of Warragamba River. The bridge can also be accessed off Weir Road in Warragamba.

See Figure 1-6 for the location of the SHR listed Megarritys Bridge.

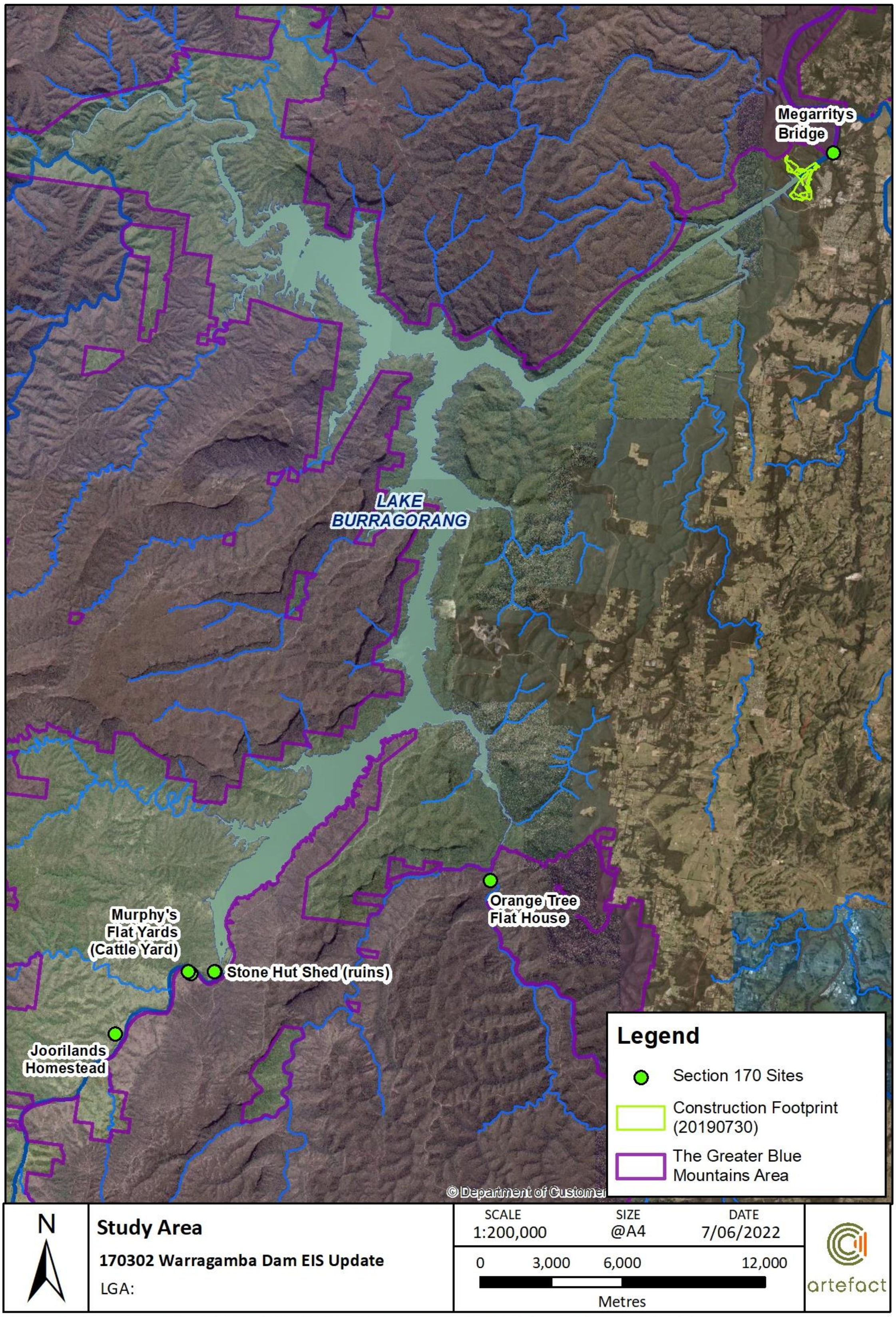


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Figure 1-1: Regional location of the S170 sites in relation to the World Heritage area and the construction footprint

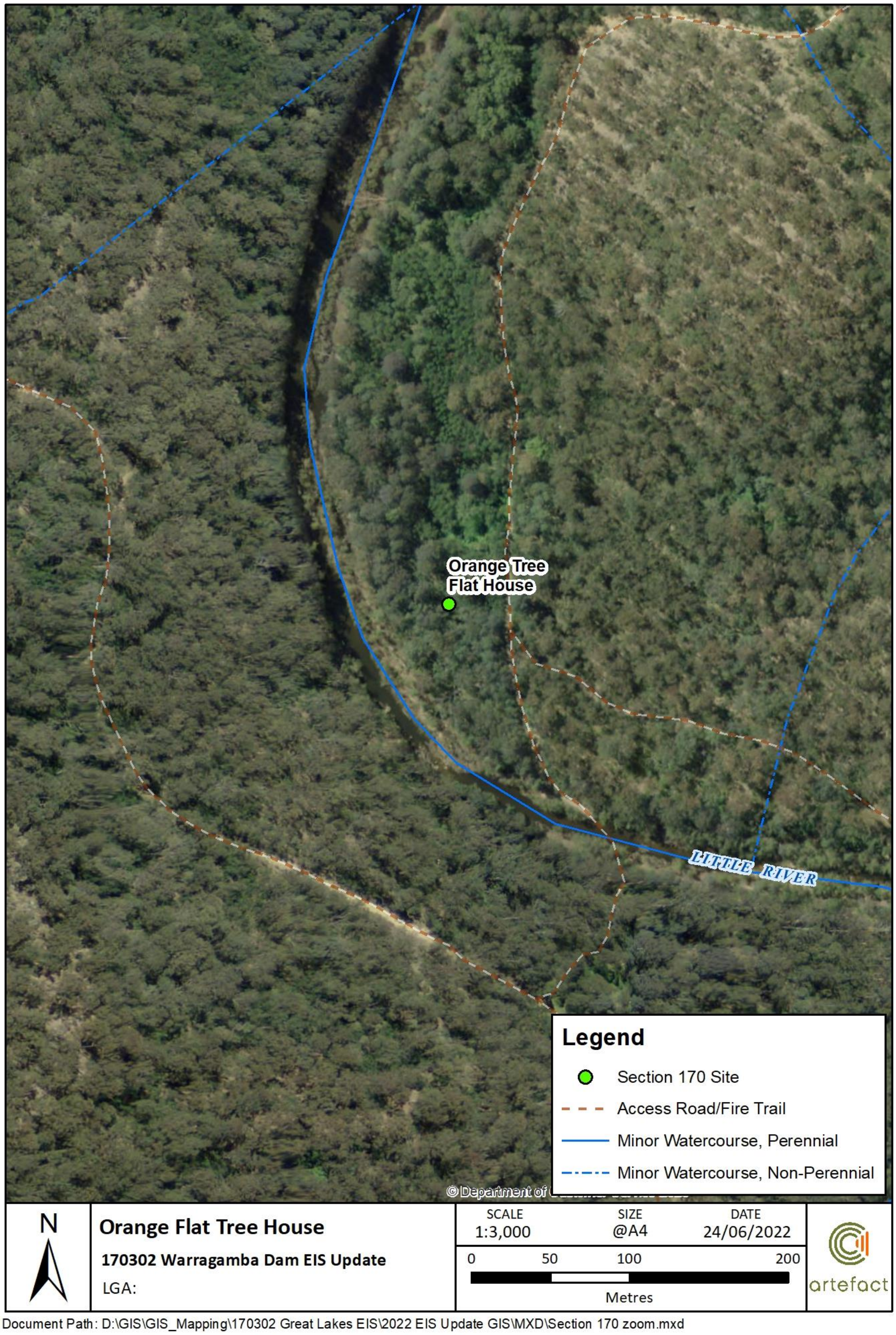

Figure 1-2: Location of the Orange Tree Flat House site

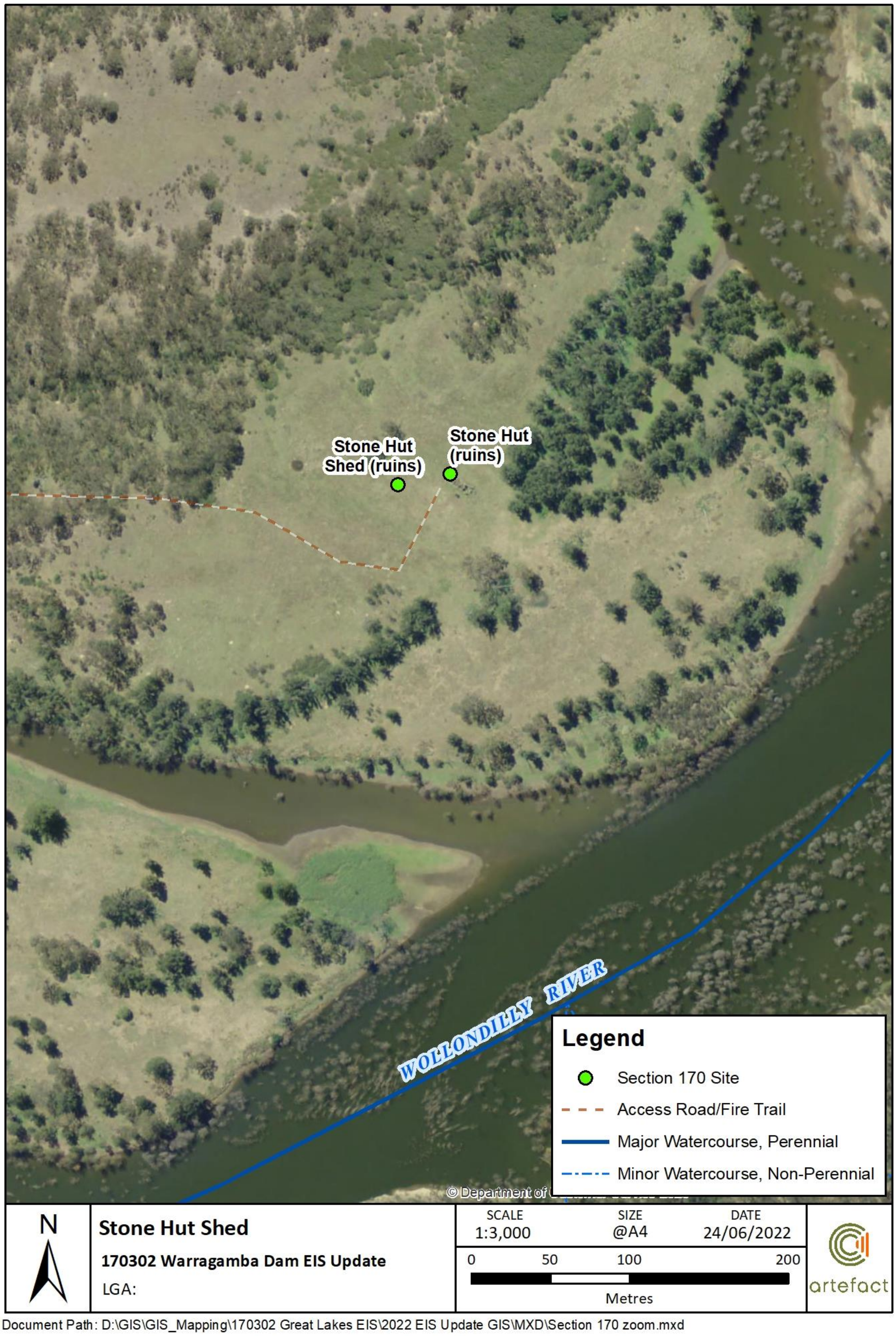

Figure 1-3: Location of the Stone Hut Ruins site

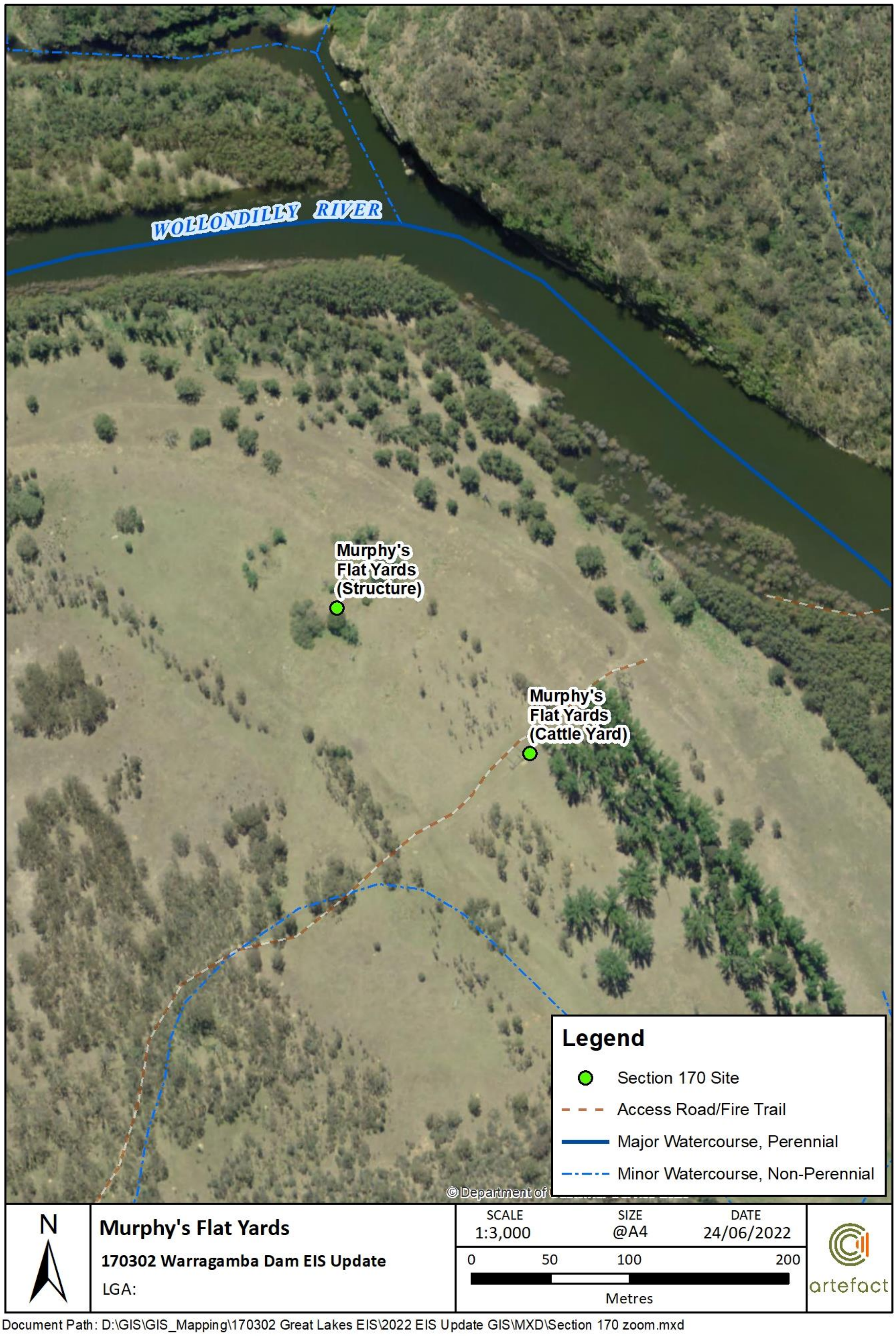

Figure 1-4: Location of the Murphy's Flat Yards site

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Figure 1-5: Location of the Joorilands Homestead site

Figure 1-6: Location of the Megarritys Bridge site

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Figure 1-7: Location of the Megarritys Bridge site in relation to the construction footprint

1.2 Methodology

The scope of this Supplementary Report is to prepare a non-Aboriginal heritage assessment for the project in accordance with the EPBC Act and the *Heritage Act 1977* (Heritage Act). This report contains targeted assessment of five heritage items as part of the Submissions Report stage of the EIS for the project. The heritage impact assessment is consistent with the methodology used in the EIS report (refer Appendix I *Non-Aboriginal Heritage Assessment Report*, Section 7.1).

Construction impacts associated with raising the dam wall to create a Flood Mitigation Zone, and impacts from the operation of the project will be assessed. The Supplementary Report will assess the site areas as shown in Figure 1-2 to Figure 1-6.

This Supplementary Report has been informed by the *NSW Heritage Manual* (NSW Heritage Office and NSW Department of Urban Affairs and Planning 1996) and the *Australia ICOMOS Charter for Places of Cultural Significance, The Burra Charter*, 2013 (Burra Charter). In addition, this report has been prepared in accordance with the following heritage guideline and policy documents:

- Heritage Council of NSW *Statements of Heritage Impact* (updated 2002)
- Heritage Council of NSW *Assessing Heritage Significance: NSW Heritage Manual* (updated 2002)
- Heritage Branch, Department of Planning, *Assessing Significance for Archaeological Sites and 'Relics'* (2009)

1.3 Limitations

Overall, the following limitations apply to the assessment:

- No Aboriginal heritage values were assessed in this report.
- No sub-surface investigations were undertaken. The assessment of archaeological potential is based on knowledge of similar sites and site formation processes, the historical background and predicted robustness of potential archaeological remains
- This assessment relies on publicly available digital mapping data. No additional mapping has been carried out to map the curtilage of items that do not have publicly available digital mapping data (i.e. items on Section 170 Heritage and Conservation Registers)
- No identification or assessment of unlisted items of potential heritage significance not included on statutory registers or lists was undertaken due to the extensive potential study area. The identification of unlisted heritage items was therefore beyond the scope of this assessment.
- Site inspection of the Jooriland Homestead S170 item and the Megarritys Bridge SHR item were not completed as part of this assessment. All information related to the significance, historical context and impact assessment for this site has been extracted from previous assessments.
- No community consultation was undertaken in the production of this assessment. Social and associative significance assessments for heritage listed items and potential archaeological resources were based predominantly on existing studies and data included on the State Heritage Inventory (SHI) for individual items.

1.4 Authorship

This assessment was prepared by Jess Mauger (Senior Heritage Consultant). Section 5.0 was prepared by Sam Sammut (Heritage Consultant) and reviewed by Jenny Winnett (Principal). Dr Sandra Wallace (Managing Director) provided management input and review.

2.0 HERITAGE LISTINGS

2.1 Legislative context

The legislative context of the planning approval and listings is discussed in detail in the EIS assessment, see Section 2 of Appendix I Non-Aboriginal Heritage Assessment. The below legislative context relates to the additional items assessed for this supplementary report.

2.1.1 State Heritage Register

The State Heritage Register listed Megarritys Bridge (ID #01367) has been included in this assessment and the curtilage is shown below in Figure 2-1.

Figure 2-1: State Heritage curtilage of Megarritys Bridge #01367

2.1.2 Section 170 Heritage and Conservation Registers

The Heritage Act requires all NSW government agencies to identify and manage heritage assets under their ownership and control. Under Section 170(3) of the Heritage Act, government instrumentalities must establish and keep a register which includes all places of environmental heritage listed on the SHR, environmental planning instruments, or which may be subject to an interim heritage order that are owned, occupied, or managed by that government body. Government agencies must also ensure that all places entered on its register are maintained with due diligence in accordance with State Owned Heritage Management Principles approved by the Minister on advice of the NSW Heritage Council. These principles serve to protect and conserve the heritage significance of identified sites, places and objects and are based on relevant NSW heritage legislation and statutory guidelines.

There are **four** places listed on State Agency Section 170 Heritage and Conservation Registers located within the study area. As mapped, Section 170 Heritage and Conservation Registers curtilages are not available for many items on the State Heritage Inventory (SHI) database and the items within the study area have not been mapped in this Supplementary Report.

Of the four sites, the Managers Cottage Group Joorilands has a Conservation Management Plan (prepared by Christo Aitken & Associates for National Parks and Wildlife Services, August 2006) but it is understood that there are no existing management plans for the other three sites.

Table 2-1: Section 170 Heritage and Conservation Register listings within the study area

Heritage Item	Section 170 Heritage and Conservation Registers No.	Location
Orange Tree Flat House	National Parks and Wildlife Services Section 170 ID 12805	Zone: GDA 56 Easting: 264612 Northing: 6218580
Murphy's Flat Yards	National Parks and Wildlife Services Section 170 ID 12804	Zone: GDA 56 Easting: 251979 Northing: 6214619
Stone Hut Ruins	National Parks and Wildlife Services Section 170 ID 13367	Zone: GDA 56 Easting: 253016 Northing: 6214729
Managers Cottage Group Joorilands	National Parks and Wildlife Services Section 170 ID 3817	Zone: GDA 56 Easting: 248805 Northing: 66212090

3.0 HISTORICAL CONTEXT

This chapter provides additional historical information relating to the items assessed in this Supplementary Report. The history of the broader study area has not been reproduced as it is included in the EIS assessment.

3.1 Orange Tree Flat House

The Orange Tree Flat House is located just off the Orange Tree Flat Trail, close to the bend of Little River and in the basin of a steep valley formed by the Nattai Tablelands. Early European settlement in the Wollondilly region was predominantly rural. The rich soil of the riverside land was ideal for crop cultivation, and the tall native forests provided plenty of work for timber-getters.

The subject site is located on a 100-acre (40-hectare) lot of land in the Parish of Burragorang that belonged to James O'Brien prior to 1900, according to the earliest available Parish maps (Figure 3-2). James O'Brien was born in Menangle, Wollondilly, in September 1842 and died in 1900, although the estate appears to have remained in his name into the 1930's.[1] The year of O'Brien's land grant is unknown, however, it was likely allotted at a similar time to neighbouring grants. The lot of land immediately north of the subject site was owned by ex-convict Thomas Maxwell, who died by drowning in the Wollondilly River in 1843.[2] It can be assumed that the land in and around the subject site was granted to O'Brien sometime before Maxwell's death.[3]

Early parish maps indicate that the large "Mount Burragorang" estate immediately to the east of the O'Brien estate was set aside for the "preservation and growth of timber," (Figure 3-2) and it is likely that O'Brien's estate was used for the same purpose. A 1933 tourist map of the Burragorang Valley (Figure 3-1) places an 'old farm' and 'sawmill and camp' at the subject site. The map notes that ex-convict and local constable James Reilly (who served in the area from 1828) named Orange Tree Flat as the point at which the first white man – Francis Louis Barrallier in 1802 – entered the Burragorang Valley. The Orange Tree Flat property was one of the earliest settled areas in the Burragorang Valley, and likely consisted of a homestead, timber-getter's campsite, and sawmill. It is probable that the Orange Tree Flat House used purely for the purposes of timber cultivation, and is a representation of the early timber-getting industry in Wollondilly.

Significant clearing along the north and western edge of the property is evident on aerial images from 1962, which also indicates that the property was primarily a timber-getting site (Figure 3-3). Tree and bush regrowth are apparent in aerial photography from 1977 (Figure 3-4) and 1990 (Figure 3-5). A road through the subject site that accommodated a single vehicle is marked on parish maps from 1900 and now forms the Orange Tree Flat trail. The house is not visible on the earliest available aerial maps (from 1962) to present (see Figure 3-3 to Figure 3-5), and the exact date of its construction is unknown, however, it probably pre-dates O'Brien's death in 1900.

1 Find a Grave, "James O'Brien, 1842-1900," accessed 10 May 2022 via: <https://www.findagrave.com/memorial/145158709/james-o'brien>.
2 NSW State Archives, Convict Index. "MAXWELL, Thomas: 4/4303; Reel 986" accessed on 10 May 2022 via: <https://www.records.nsw.gov.au/archives/collections-and-research/guides-and-indexes/node/1616/browse>.
3 Ibid.

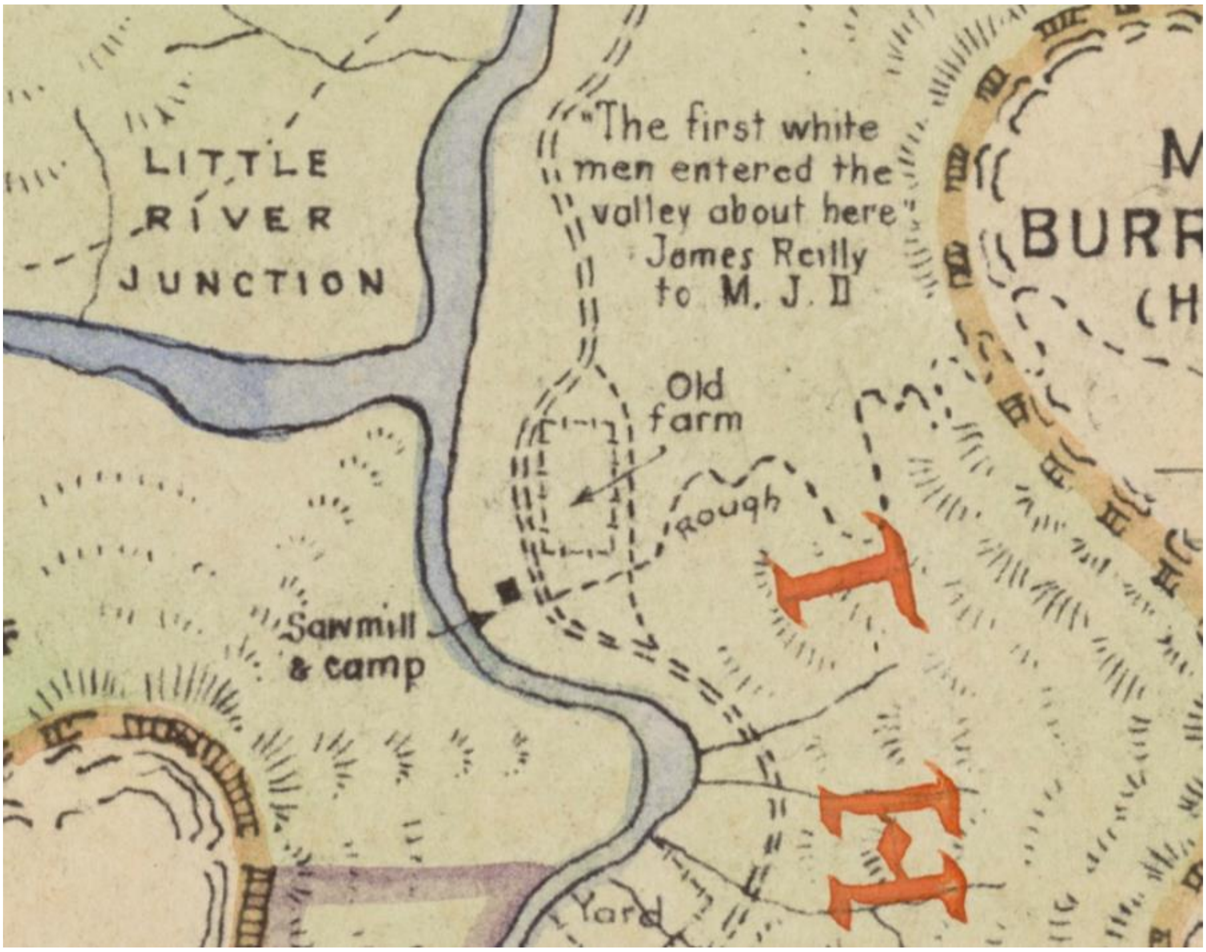

Figure 3-1. 1933 Map of the Picton Lakes, Blue Gum & Little River Canyons, lower Nattai Valley and central Burragorang, including the country between Buxton, Picton and The Oaks. (Source: State Library of NSW, 74VvVVEZgXvA)

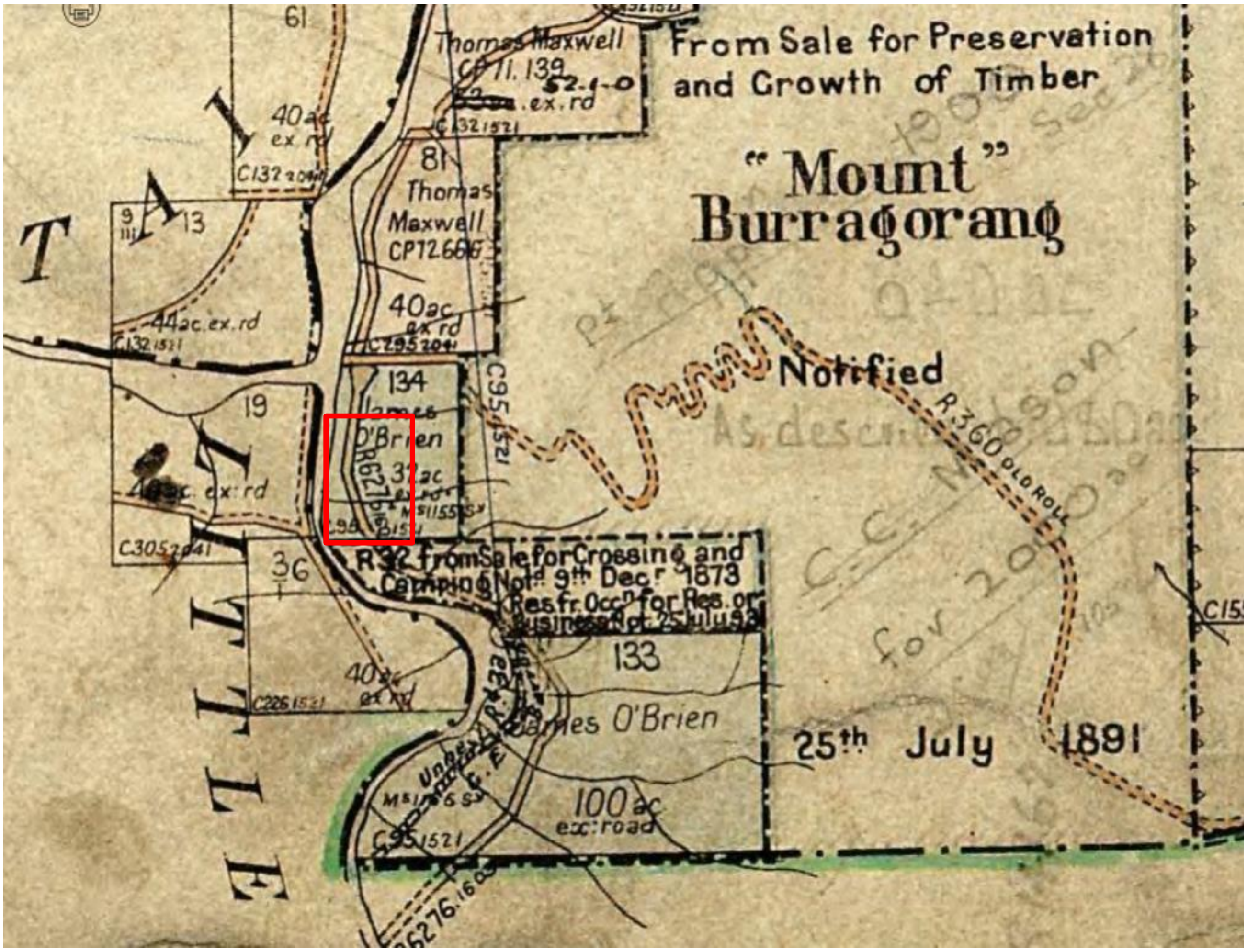

Figure 3-2. 1900 Parish of Wollondilly map, approximate subject site marked in red (Source: Historic Land Records Viewer)

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Figure 3-3. 1962 Aerial image, approximate site location (Source: NSW Spatial Services)

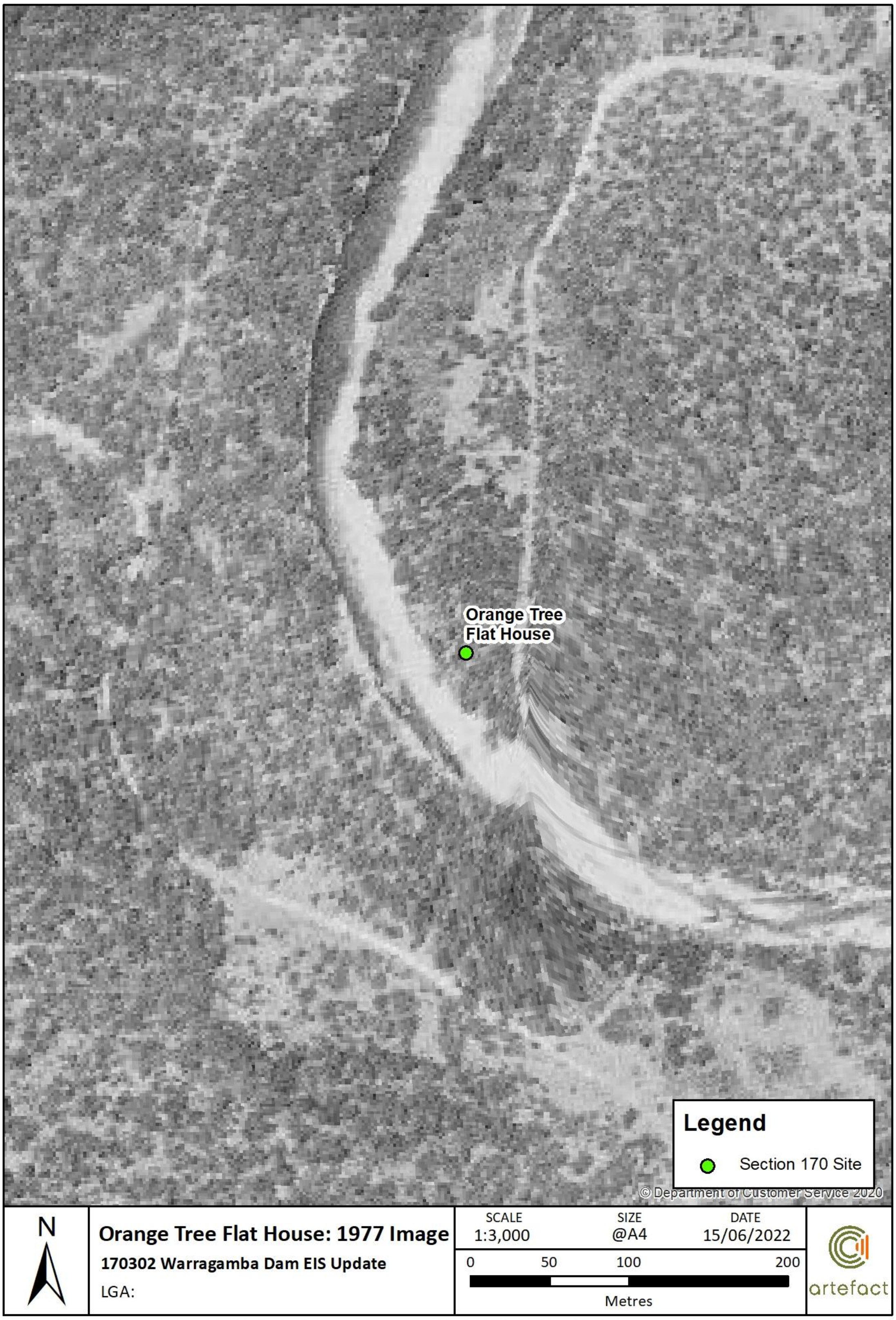

Figure 3-4. 1977 Aerial image, approximate site location (Source: NSW Spatial Services)

Figure 3-5. 1990 Aerial image, approximate site location (Source: NSW Spatial Services).

3.2 Stone Hut Ruins

The stone hut ruins are located on a 100-acre lot of land at Colemens Bend on the Wollondilly River. The land was purchased in 1838 by Richard Hunt and Samuel Barber, who jointly owned 1,000 acres of land in Burragorang.[4] Like many early settlers to the region, Hunt and Barber probably used their land for grazing cattle and sheep, a popular industry in the area west of the Wollondilly River.[5] Unlike fellow pastoralists residing in the valley at the time, in 1877 Samuel Barber protested the proposed flooding of Burragorang, writing in the Sydney Morning Herald "the only source from whence the city of Sydney and suburbs can be supplied with pure water is from the Nepean."[6] Hunt's descendants lived in the Burragorang Valley until 1933, leaving a decade before the valley was flooded.[7] A small amount of land immediately to the west of the subject site was "put aside for the use of Aborigines" in 1891 according to parish maps. The local Catholic priest, Father John Dillon, had established two Aboriginal reserves in 1878 at Toonali River and Byrnes Creek, and it has been noted that the property west of the ruins was a third reserve.

An image of the house (Figure 3-7) that probably dates to 1900-1910 – prior to the flooding of the Burragorang Valley – indicates that it was likely used as a homestead into the early 20th century; the property is cleared and fenced, and a woman is pictured doing laundry on the veranda. By the 1980s, Hunt and Barber's land had been resumed by the state as a conservation area, and the house was abandoned and in poor condition by 1990. An image from the 1990s shows that much of the structure had crumbled away and the house was overgrown with trees and scrubs (Figure 3-8).

Aerial images from 1977 (Figure 3-10) and 1990 (Figure 3-11) show that the land was largely cleared, with the exception of a line of trees close to the hut and some dispersed trees to the north. This may be the result of human intervention or could be a natural geographical occurrence or self-seeded trees.

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4 *New South Wales Government Gazette No. 331*, 2 May 1838. 'Title Deeds,' pg. 341.

5 Steven Ring and Christo Aitken & Associates, et al. for Sydney Catchment Authority and National Parks and Wildlife Services, June 2001, *Jooriland Sheep Station: Yerranderie State Conservation Area – Draft Conservation Management Plan. Part 3*, pg. 14.

6 *Sydney Morning Herald*, 24 Mar 1877. 'To the editor of the Sydney Morning Herald,' pg. 8.

7 Part 3, pg. 14.

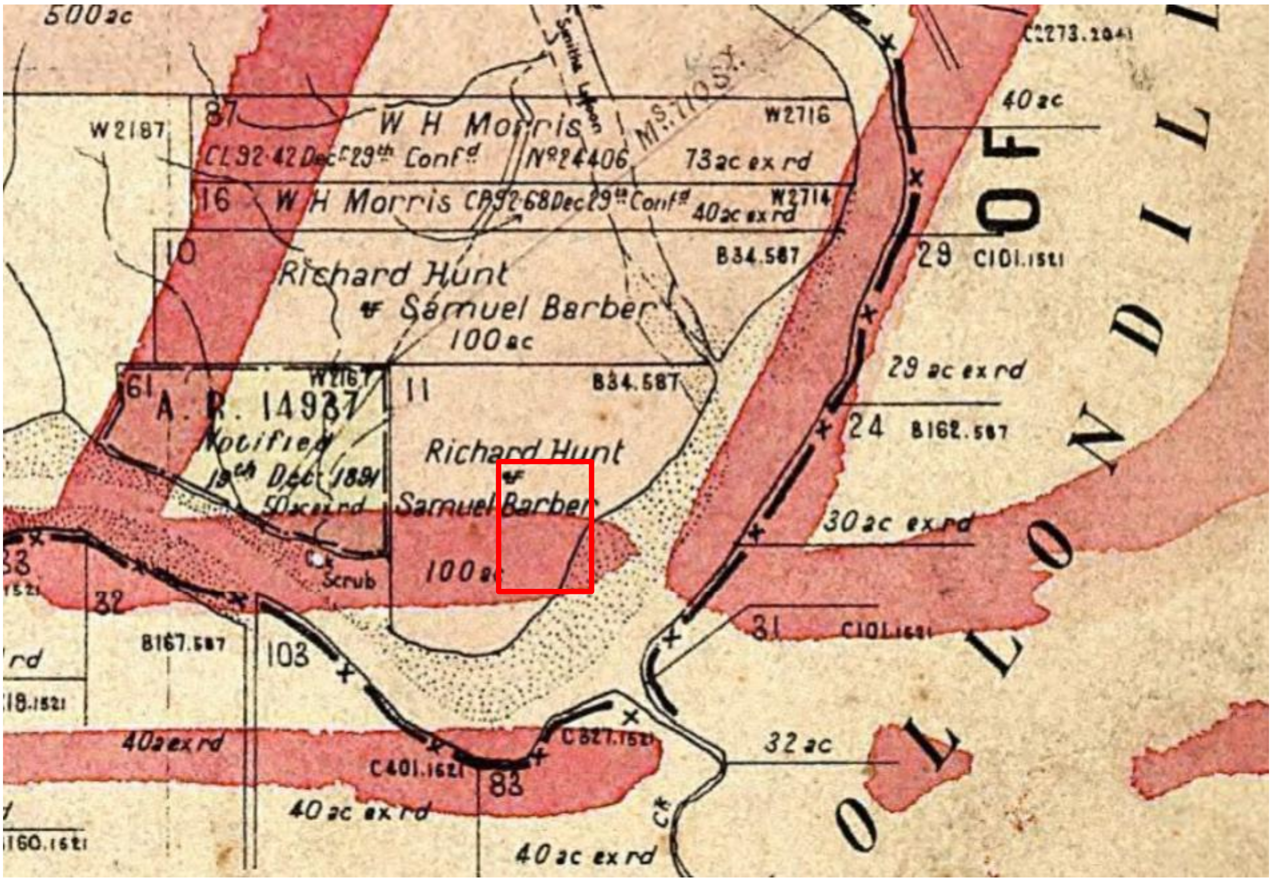

Figure 3-6. 1895 Parish of The Peaks map, subject site in red (Source: Historic Land Records Viewer).

Figure 3-7. Stone Hut Ruins, pre-flooding, date unknown but likely the late 1920s or early 1930s (Source: Trish Hill, Wollondilly Heritage Centre & Museum)

Figure 3-8. Stone hut ruins, c. 1990 (Source: Trish Hill, Wollondilly Heritage Centre & Museum)

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Figure 3-9. 1962 Aerial image, overlayed with approximate site location (Source: NSW Spatial Service)

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Figure 3-10. 1977 Aerial image, overlayed with approximate site location (Source: NSW Spatial Service)

Figure 3-11. 1990 Aerial image, overlayed with approximate site location (Source: NSW Spatial Service)

3.3 Murphy's Flat Yards

The subject site – known the "Murphy's Flat Yards" – is located on a 40-acre lot of land (Figure 3-12) that was owned by Edward Murphy from around 1854.[8] Murphy lived in Burragorang with his wife, Mary, and four daughters.[9] Like most others in the region, the Murphy family was Irish-Catholic and appears to have been highly involved in the local church community – in 1865, the Murphy's hosted the 25-year anniversary celebration of the construction of Burragorang's Catholic church.[10]

Despite the Murphy family's proximity to the coal mines of Yerranderie, their property appears to have been used as a homestead. Upon his death in 1880, Murphy's land was put up for sale, with the notice of sale recording that he owned over 250 acres of cleared, fenced, and cultivated land along the Wollondilly River.[11] The exact nature of the 'cultivation' is not stated, however, nearby properties appeared to have been used for orchards, timber-getting, or grazing. As per Figure 3-13, the notice of sale records a 40-acre lot of land on the Wollondilly that was "partly fenced and ring-barked" and with a "Bush Hut and Stock-yard on this lot" – it is on this lot of land that the subject site is located.[12] The existence of a stockyard indicates that the land was used for grazing for a period in the 19th century and existing stone, brick and concrete remains on the site suggest the "Bush Hut" was upgraded to a more substantial building with surrounding sheds and structures perhaps in the late 19th or early 20th centuries.

There are no further records of sale following this 1881 notice, and Edward Murphy continues to be listed as the land's owner in 1973 parish maps. Aerial photography from 1962 (Figure 3-14) shows that the subject site was almost entirely cleared. The former structures are not visible on aerials until 1977 (Figure 3-15), when the ruins become apparent – this is likely due to advancements in photography rather than an indicator of its construction date. The aerials also show a neat row of trees appearing to the east, which indicates they were possibly planted sometime between 1962 and 1977. It is possible there were occupants of the land up until at least the mid-1960s.

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8 *New South Wales Government Gazette No. 78*, 1 Jul 1854. 'Country Lots,' pg. 1351.
9 *Freeman's Journal*, 6 Apr 1878. 'Death,' pg. 12.
10 *Freeman's Journal*, 23 Dec 1865. 'The Jubilee at Camden,' pg. 807.
11 *Freeman's Journal*, 2 Jul 1881. 'To Farmers and Others – 7 Blocks of Rich Land,' pg. 20.
12 Ibid.

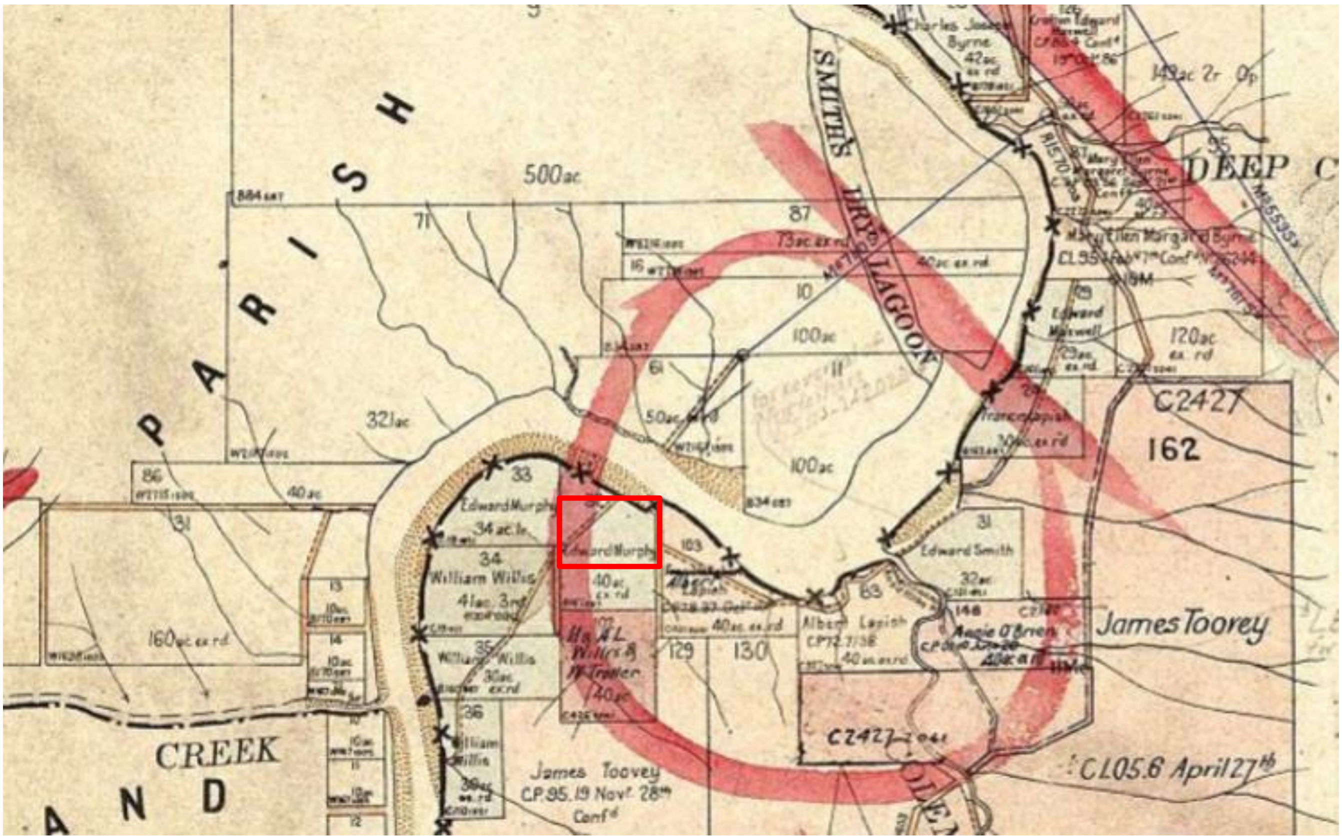

Figure 3-12. 1899 Parish of Nattai map, subject site in red box (Source: Historic Land Records Viewer).

BURRAGORANG,
WOLLONDILLY RIVER.

TO FARMERS AND OTHERS:—
7 BLOCKS OF RICH LAND.

BY ORDER OF THE ADMINISTRATRIX OF THE ESTATE OF THE LATE MR. EDWARD MURPHY.

ELLIS and Co. have received instructions to sell by Public Auction at M'KENRICK'S ROYAL HOTEL, PICTON, on SATURDAY, the 2nd of JULY next, at 2 O'Clock.

The following valuable properties, situated at BURRAGORANG, parish of NATTAI, in the County of CUMBERLAND:—

No. 1.—30 Acres of Land fronting the Wollondilly River. A new line of Road to Camden and Picton passes this Lot.

No. 2.—40 Acres 1 Rood of Land, fenced and ring-barked. A never-failing Supply of Water. Douglass Creek running through this Lot.

No. 3.—40 Acres of Land, fenced and ring-barked. A never-failing Supply of Water. Douglass Creek running through. This Lot joins No. 2.

No. 4.—40 Acres of Land, Free-selection, partly fenced and ring-barked, Bush Hut and Stockyard on this lot.

No. 5.—30 Acres of Land known as Willis's Paddock, frontage to the Wollondelly River, all cleared and fenced, and has been under cultivation.

No. 6.—41½ Acres of Land known as Willis's paddock, frontage to the Wollondilly River, all cleared and fenced, and has been under cultivation. This lot joins No. 5.

No. 7.—30 Acres of Land known as Willis's Paddock, frontage to the Wollondilly River. All cleared and fenced, and has been under cultivation. This Lot joins No. 6.

The above mentioned Properties are for absolute sale.

Figure 3-13. Notice of Sale, 1881 (Source: Freeman's Journal).

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Figure 3-14. 1962 Aerial image, overlayed with approximate site location (Source: NSW Spatial Service).

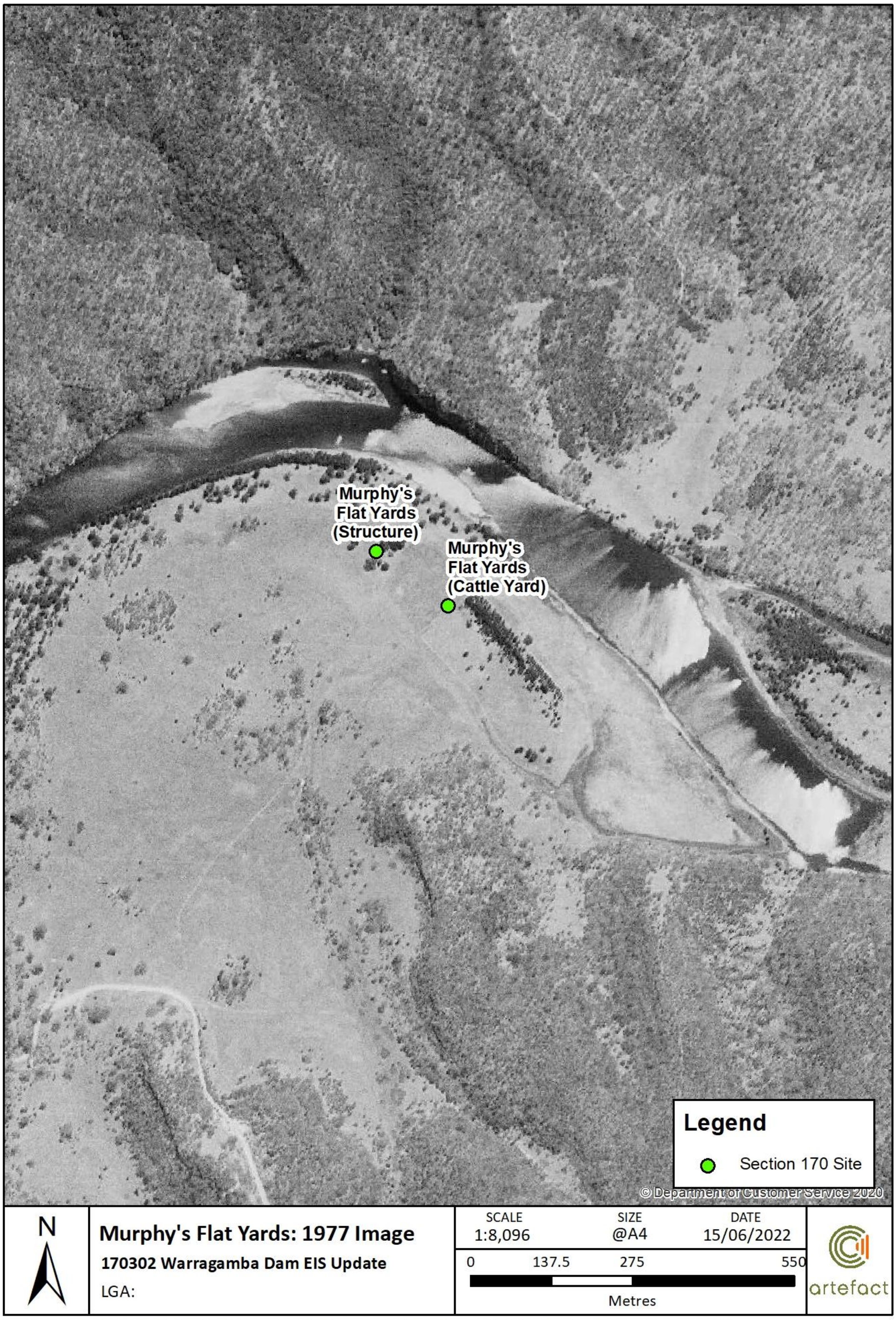

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Figure 3-15. 1977 Aerial image, overlayed with approximate site location (Source: NSW Spatial Service).

Figure 3-16. 1990 Aerial image, overlayed with approximate site location (Source: NSW Spatial Service)

3.4 Jooriland Homestead

The following history of Jooriland has been extracted from previous reporting including the Non-Aboriginal Heritage Impact Assessment prepared by Artefact for the EIS, the *Jooriland Sheep Station: Yerranderie State Conservation Area – Draft Conservation Management Plan* (draft CMP) prepared by Steven Ring and Christo Aitken & Associates, et al. for the Sydney Catchment Authority and NPWS (June 2001) and the *Jooriland Sheep Station Conservation Management Strategy* (CMS) prepared by Christo Aitken & Associates for NPWS (2006).[13] The extent of the structures on the homestead are shown in red on Figure 3-19 and Figure 3-20. The Jooriland Old Homestead building as well as examples of pastoral activities in Burragorang are shown in Figure 3-17.

John Wild – a former government cattle herdsman at Camden – and his wife Emmeline Susannah Wild were granted the land that would become “Jooriland” in 1852. Between 1852 and 1870 the road to Camden is constructed through the station, and the hut and sheepyard are also erected during this time. Following Wild’s death in 1857 the 12 ha riverside block was held by his family until 1875, when it was bought by Edward Moore from Oran Park. Moore obtained additional grants to build “Jooriland” to its final size and erected the timber homestead that still stands, before selling in 1902 to George and Amelia Egan, who held the property until 1925. The Egan’s expanded the Old Homestead and re-constructed the roof. They also established a slab cottage, a woolshed and a new homestead on the property.

Then ensued the first of the property’s two tenures by prominent pastoral families, when it was acquired by Denzil (later Sir Denzil) Macarthur-Onslow – a descendant of Merino pioneer John Macarthur – in 1925 and later sold it to the family-controlled Camden Park Estates in 1932. Camden Park Estates held “Jooriland”, which they ran primarily as a sheep station in conjunction with their Camden dairy interests, until 1936 when it was bought by a Sydney property dealer, Frank Thurech, an investor from Double Bay. In 1936 the property again changed hands, this time to a sibling partnership of the Pye pastoral family. Richard and Henry Pye were both graziers from Sydney. It is between 1936 and 1945 that modifications to the bathroom and kitchen in the Old Homestead occur, electricity was introduced, and a former timber and fibro cottage adjacent to the Old Homestead was likely constructed.

In 1945 Henry and Richard Pye sold “Jooriland” to another brother, Walter Pye, a prominent Sydney businessman and philanthropist (who later donated his historic home, “Lindesay” at Darling Point, to the National Trust). A new shearers quarters was constructed during this time before the land was sold to Frederick Pye in 1948, another relative of the grazier family.

From 1955 the land was purchased by the NSW Water Board (now WaterNSW and Sydney Water) and access became restricted. The area was gazetted as part of the Yerranderie State Recreation Area in the late 20th century and was partially leased to Langs of Bindook Station until 1993. The Old Homestead was not used by Langs from 1972 onwards. Some of the buildings were used by the Water Board and NPWS as a base camp for joint management project, with some burning down in the 1980s. Remnants of these structures were buried on site by the Water Board.

In 2001, Steven Ring and Christo Aitken & Associates were commissioned to draft a Conservation Management Plan for the site, which based some of their assessment on the Australian Water Technologies study conducted by James Stephany for the Water Board in 1994.

[13] Refer to: Artefact Heritage, 2021. ‘Warragamba Dam Raising Environmental Impact Statement, Appendix I,’ report to Water NSW, pg. 73.; Steven Ring and Christo Aitken & Associates, et al. for Sydney Catchment Authority and National Parks and Wildlife Services, June 2001, *Jooriland Sheep Station: Yerranderie State Conservation Area – Draft Conservation Management Plan*. Part 1, pg. 18.

Figure 3-17. Historic images of pastoral activities in Burragorang and the Jooriland Old Homestead (Source: Source: "How 'Jooriland' joined pastoral pyes' stable", *The Land*, 2018)

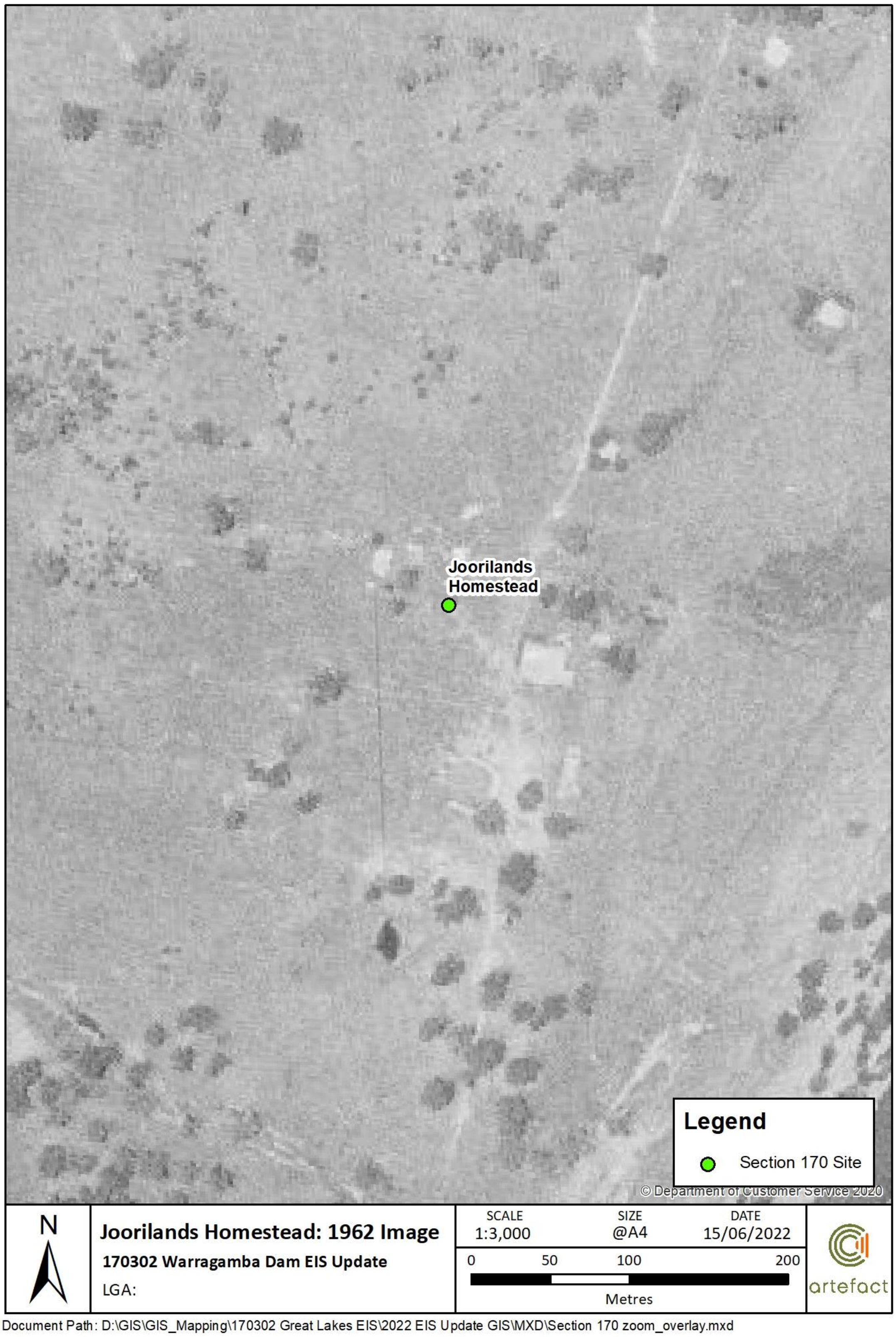


Figure 3-18. 1962 Aerial image, Jooriland Homestead approximate location (Source: NSW Spatial Service)

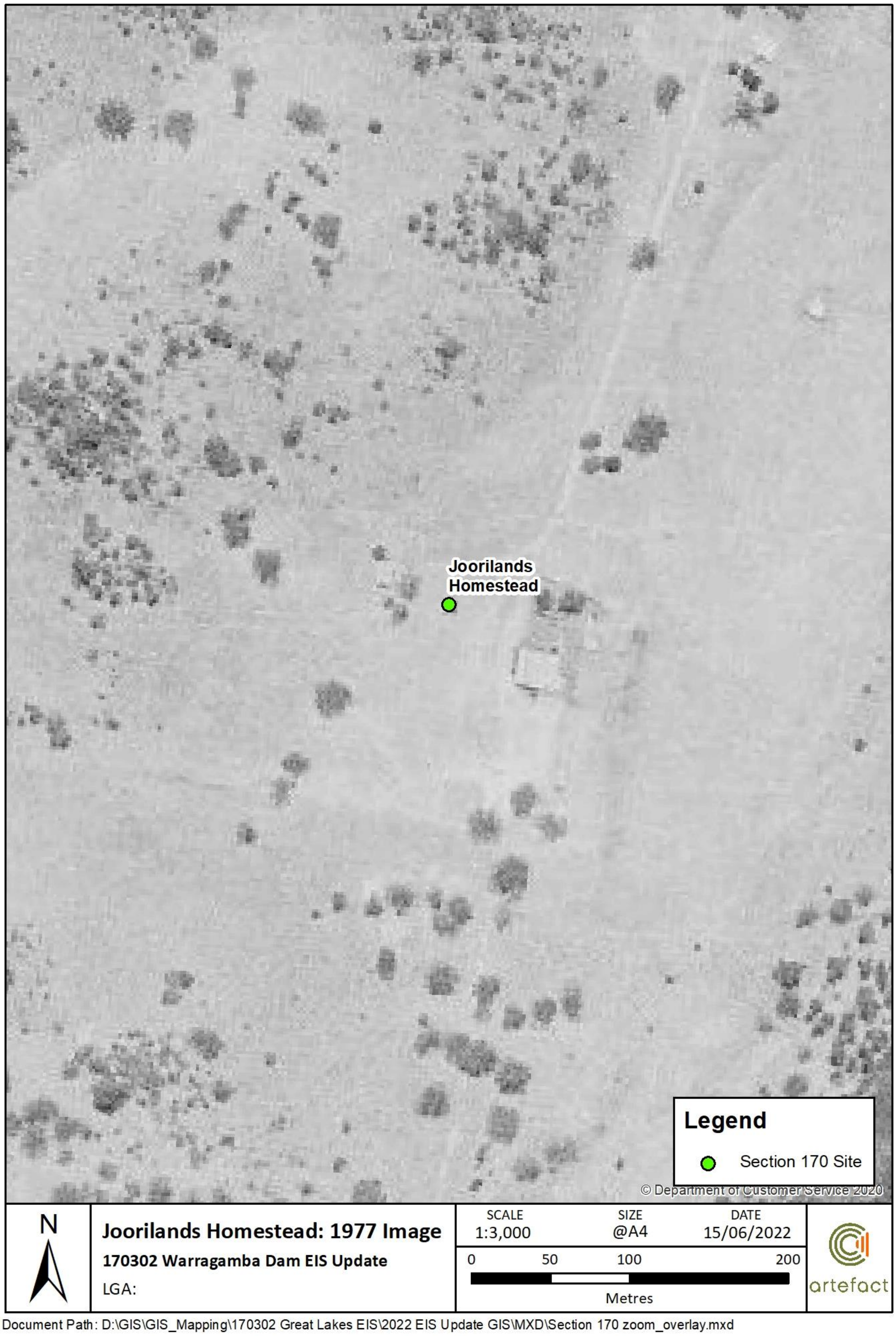
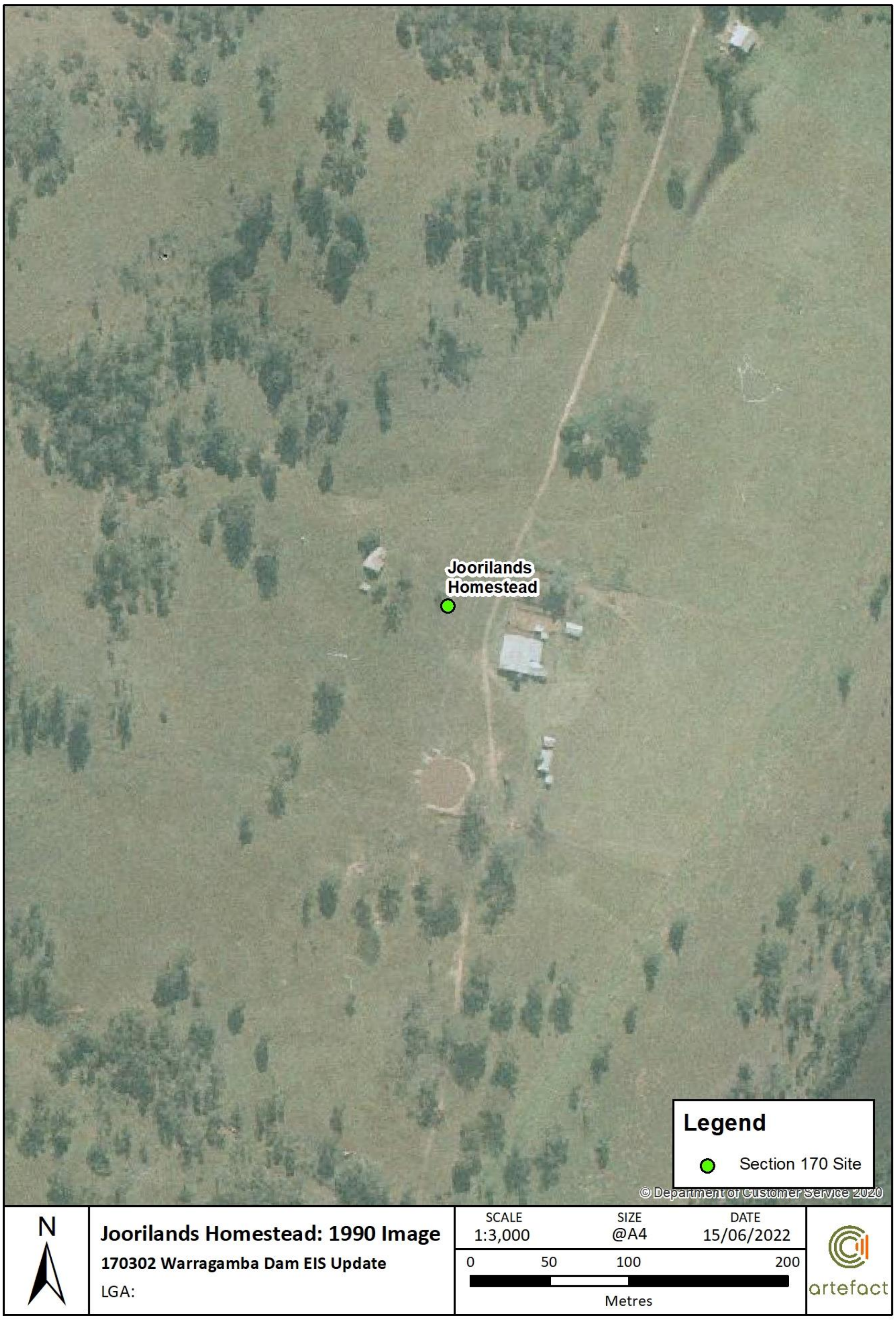


Figure 3-19. 1977 Aerial image, Jooriland Homestead approximate location (Source: NSW Spatial Service)



Document Path: D:\GIS\GIS_Mapping\170302 Great Lakes EIS\2022 EIS Update GIS\MXD\Section 170 zoom_overlay.mxd

Figure 3-20. 1990 Aerial image, Jooriland Homestead approximate location (Source: NSW Spatial Service)

3.5 Megarritys Bridge

The following history is extracted from the State Heritage Inventory (SHI) form for Megarrity's bridge. For detailed historical context for the Upper Nepean Scheme and Warragamba Dam, refer to Chapter 3 of the Non-Aboriginal Heritage Report for the EIS (Appendix I).

> *Megarritys Creek Bridge is a concrete arch bridge spanning Megarritys Creek. The construction of the bridge provided a vital link across the Creek for the operation of the Warragamba Emergency Scheme. While it was designed eventually to carry the No. 1 106" outlet main from Warragamba Dam, for the Emergency Scheme it carried the 48" main from the weir to Prospect Reservoir.*[14]

Figure 3-21: Photograph of Megarittys Bridge, c. 1941. (Source: NLA, PIC/8732/17 LOC Album 562)

[14] State Heritage Inventory form for 'Megarritys Bridge'. Retrieved from: https://www.hms.heritage.nsw.gov.au/App/Item/ViewItem?itemId=5051476

4.0 EXISTING ENVIRONMENT

4.1 Site inspection

Site inspection was undertaken on 16 May 2022 by two of Artefact's consultants Jess Mauger (Senior Consultant – Built Heritage) and Sam Sammut (Heritage Consultant – Historical Archaeology). Due to the targeted nature of this assessment, site inspections were limited to the general area of the four S170 listed items. Jooriland and Megarritys Bridge were not inspected as part of this site inspection. Information for Jooriland and Megarritys Bridge is extracted from previous assessments or the State Heritage Inventory (SHI).

Results of the site inspection are included under the heading for each listed item. The exact locations of each of these items are shown in Figure 1-2 to Figure 1-6.

4.1.1 Orange Tree Flat House

4.1.1.1 Description

The remains of the Orange Tree Flat House primarily consist of an extant, free-standing bluestone chimney and fireplace (see Figure 4-1). The chimney is about 2.5 metres in height with the opening of the fireplace measuring 0.8 metres in height (see Figure 4-6 and Figure 4-9). The structure is located roughly 5 metres west of the Orange Tree Flat trail, and about 10 metres from the water's edge of Little River, up on a steep embankment. The structure is situated in a clearing within relatively thick vegetation and has impeded views towards the Little River and the Orange Tree Flat trail.

The structure is constructed of bluestone with a lime mortar aggregate. It is a typical chimney design, with a wide fire base which narrows to a chimney flue. There is some vegetation growing over the structure but there is no evidence of the vines compromising the chimney (see Figure 4-8). The internal structure of the chimney is clear of vegetation and there is no evidence of collapse. There are areas at the back of the structure which are experiencing cracking or breaking of the lime mortar.

The fireplace is intact with no evidence of obstructions. Within the fireplace there are two iron elements, one steel plate is used as a lintel for the top of the opening to the fireplace and one flat bar which appears to be attached internally to the structure and is aligned vertically inside the chimney (see Figure 4-10 and Figure 4-14). It is possible this was used as a stove hook to hold billies or pots over a fire. Externally there are two steel bolts inserted through the structure on either side, perhaps as a stabilising element or attached to the vertical steel bar within the chimney itself (see Figure 4-11).

Externally on the chimney structure, on both sides, is evidence of the affixing of former walls with lime, which suggests the fireplace and chimney were formally attached to a structure (see Figure 4-12).

Surrounding the chimney structure there are limited scattered remnants of stone, with no evidence of other materials associated with former structures. The thick undergrowth and vegetation did not allow for a thorough survey of any other possible above ground structural remains however in the relatively cleared area surrounding the chimney there is no obvious evidence of a former building or structure.

4.1.1.2 Site survey

Below is a table of site images of the Orange Tree Flat House site taken by Artefact's consultants:

Figure 4-1: Frontal view of the extant stone chimney and fireplace, facing north-east.

Figure 4-2: Side view of the stone chimney, facing north.

Figure 4-3: View of chimney showing surrounding setting.

Figure 4-4: View showing surrounding clearing and vegetation.

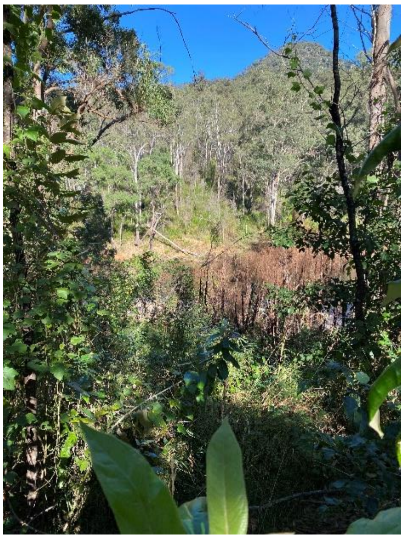


Figure 4-5: View from the clearing towards Little River

Figure 4-6: The chimney structure with scale (1.3 m).

Figure 4-7: Little River, about 10m west of the chimney, facing downstream.

Figure 4-8: View of the chimney showing vegetation growing over the structure.

Figure 4-9: View of the fireplace with scale.

Figure 4-10: Image of the iron lintel above the fireplace.

Figure 4-11: Image of one of the steel bolts protruding from the side of the chimney.

Figure 4-12: Image of one of the external sides of the chimney, showing possible former joint or wall.

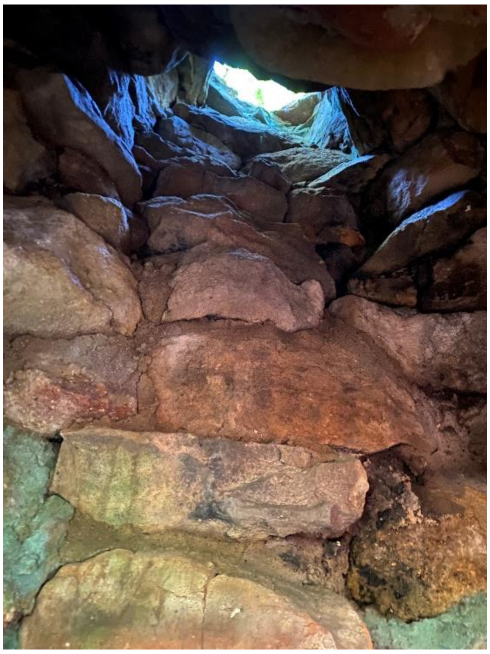


Figure 4-13: View inside the chimney flue.


Figure 4-14: Closer image of the iron bar vertically hanging within the fireplace.

4.1.2 Stone Hut Ruins

4.1.2.1 Description

The Stone Hut Ruins primarily consist of an extant, partially collapsed sandstone house, a corrugated iron water tank, remnant fencing and timber posts, and scattered remains of other stone structures nearby (see Figure 4-15 to Figure 4-38). The ruins are situated on a soft slope, about 240 metres from the Wollondilly River. The ruins are visible from the river however they are partially hidden by overgrown grasses and mature trees lining the banks of the river.

The stone house is constructed of sandstone with a lime aggregate, with larger blocks used as lintels and doorsteps (see Figure 4-18). It is very likely this house is an example of the continuation of the Old Colonial Georgian style into the Victorian era, which is characterised by symmetrical facades, simple rectangular shapes, and general orderliness. This is evidenced in a historic image found of the stone house (see Figure 3-7), which is likely dated to the late 1920s to early 1930s based on the woman's attire on the veranda. This would be before the Hunt family vacated the property in 1933. In this image the house's corrugated iron roof is well intact with a modest veranda held up by timber posts and smaller fencing in the foreground. In the background a structure is held up by four tall timber posts, which may have been a shelter or a platform. What is also illustrated in this photograph is that the room on the righthand side of the image is possibly a later extension to the main house, likely the smallest room on the most westerly side (see Figure 4-22). The image also shows evidence of a timber door and possibly 6-paned glazed windows. On the left hand side of the picture there appears to be a mature tree and possible fencing in the form of a small paddock adjacent to the house. This tree is perhaps the snag shown leaning towards the house, surrounded by younger trees growing inside and around the house, in an image of the site taken in 1990 (see Figure 3-7).

There is evidence of shaped stone around the doorways where former door jams would have been inserted (see Figure 4-20). The house consists of four rooms in a traditional linear layout. The most westerly room is the smallest (see Figure 4-22), which adjoins two moderate sized rooms (see Figure 4-23) which lead into the largest room to the east (see Figure 4-26). The walls of the largest room on the eastern side of the house have collapsed, mostly in a uniform fall (see Figure 4-17). On the northern face of the house, there is evidence of a former veranda, with a mixed stone foundation and possibly concrete surface (see Figure 4-19). This has all subsided inwards. Extant sections of lime are evident on the internal walls of the structure, indicating the internal rooms were finished with a wash (see Figure 4-25, Figure 4-33 and Figure 4-34).

Timber lintels line all six windows, and four external and one internal doorway, which all appear in poor condition (see Figure 4-27). One of the internal timber lintels between the second room and the third room is on the ground having likely fallen when the internal wall collapsed (see Figure 4-23).

The entire house is currently exposed with the roof no longer extant. There is some evidence of the former corrugated iron roof with some metal brackets still nailed (with handcrafted nails) to timber lintels framing the most western doorway (see Figure 4-27, Figure 4-35 and Figure 4-36).

There is no longer evidence of the former flooring in the house with the subfloor completely exposed however there is a clear differentiation between the structure's foundations and where the former flooring would have been located (see Figure 4-30). Internally and externally the ground is experiencing a moderate level of visible moisture in the lower stones and foundations of the walls (see Figure 4-39).

To the west of the stone house is an extant corrugated iron water tank (see Figure 4-32). This appears to be in fair condition. To the west of the tank are remnant timber fence posts, which were found to run along the extent of the property around the house. Separate from the fencing is a larger timber post which has a metal nail or bolt protruding from the top (see Figure 4-37). In the general vicinity of these structures are scattered sandstone blocks completely covered by ground cover and grasses (Figure 4-38). These were likely from smaller stone structures associated with the main house.

4.1.2.2 Site survey

Below is a table of site images of the Stone Hut Ruins site taken by Artefact's consultants:

Figure 4-15: View of the northern façade of the stone hut ruins, showing the collapsed veranda and eastern wall.

Figure 4-16: View of the collapse eastern wall.

Figure 4-17: View of the collapsed easterly wall.

Figure 4-18: Example of a window with timber and sandstone lintels.

Figure 4-19: View of the subsided veranda.

Figure 4-20: Example of a doorway with sandstone and timber lintels.

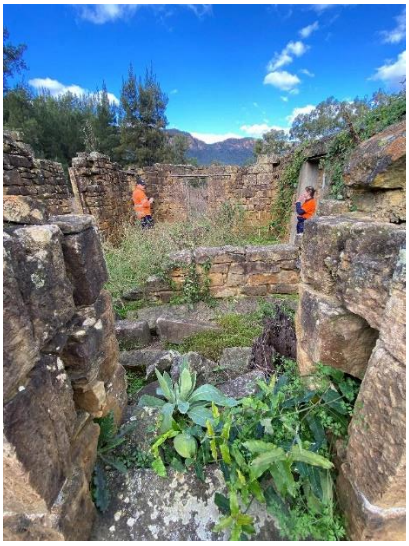


Figure 4-21: View of all four rooms, facing east.

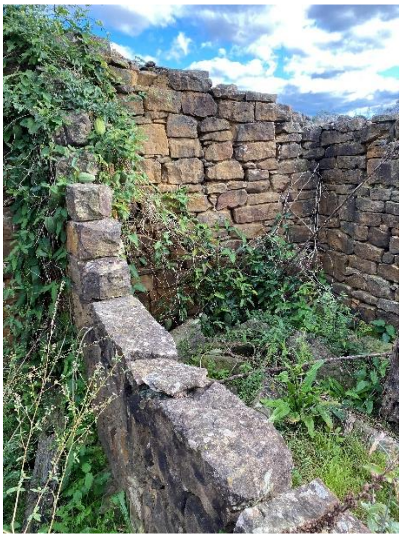


Figure 4-22: View of the first, smallest room, facing south west.

Figure 4-23: View of the two middle rooms, facing south.

Figure 4-24: View from middle rooms facing west towards the smallest room.

Figure 4-25: Example of lime wash on the interior walls and doorways.

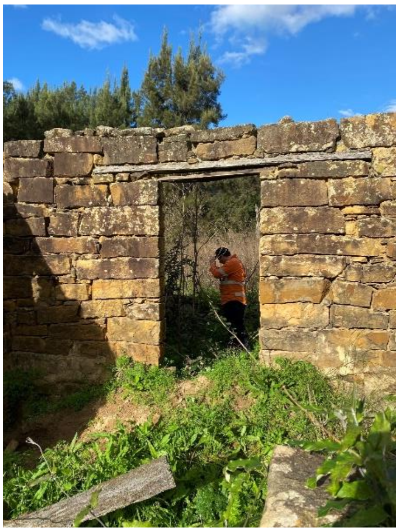


Figure 4-26: View of the doorway from the third room into the fourth room, facing east.

Figure 4-27: Example of timber lintel and timber framing to former roof with evidence of metal bracket nailed to the beam.

Figure 4-28: View of the southerly wall, facing north east.

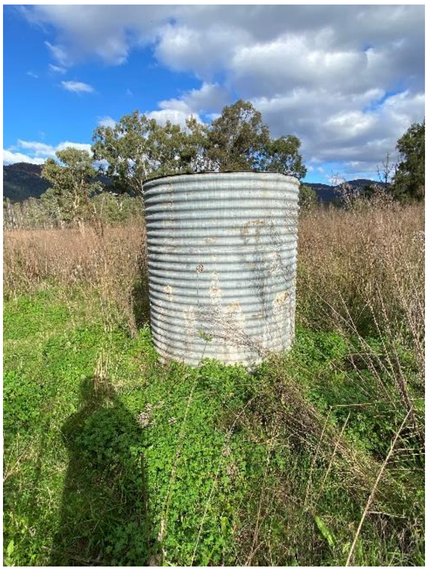


Figure 4-29: Extant corrugated iron water tank.


Figure 4-30: View of the third room showing the former floor level and the subfloor level, shown through colour differentiation in the sandstone.


Figure 4-31: Example of the condition of timber lintels.


Figure 4-32: View of the tank and southern wall, facing north.

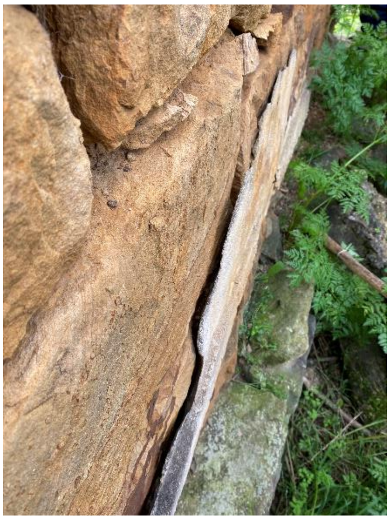


Figure 4-33: Another example of lime wash on the interior walls.


Figure 4-34: Flaked lime wash from the walls, showing sand aggregate.

Figure 4-35: Example of metal bracket from timber beams with a long, handmade nail.

Figure 4-36: Metal bracket nailed into a timber beam.

Figure 4-37: Large timber post and remnant fencing, a few metres beyond the water tank.

Figure 4-38: Example of scattered sandstones in the grass nearby to the stone house.

Figure 4-39: Example of damp ground beneath the foundations.

4.1.3 Murphy's Flat Yards

4.1.3.1 Description

Murphy's Flat Yards is a scattering of timber fencing, a cattle ramp, and former structure footings (see Figure 4-42 to Figure 4-65). The yards and former structures are situated about 210 metres from the Wollondilly River, on a flat plain largely cleared of mature trees but overgrown with grasses. The distance between the livestock ramp and the former structures is roughly 140 metres, with the structures positioned on the top of a minor slope overlooking the yards and the river. A number of different non-native tree species such as peppercorn trees are evident close to the former structures and yards.

The former cattle or sheep ramp, yard and remnant fencing are in poor condition but are largely legible as a sorting and holding yard (see Figure 4-42 and Figure 4-43). The construction is primarily a timber post and rail arrangement with rails tied to the posts with high tensile wire or bolted to the end posts (see Figure 4-47 and Figure 4-48). Some of the fencing also consists of timber posts with belly wire fencing, suggesting rabbit or kangaroo proof fencing was used on the property (see Figure 4-50). There is evidence of both kinds of fencing throughout the general area of these structures, which suggest majority of the property was fenced into paddocks.

An extant corrugated water tank is situated between the former yard and the former structures, a little over halfway between the former structures (see Figure 4-54). The tank is empty and is lined with possibly concrete.

The former structures are in a largely cleared area surrounded by possibly self-seeded non-native trees (see Figure 4-56). More remnant fencing is present which suggests there was fencing around the possible former homestead or sheds in this area. The area has several scattered materials such as red bricks, stone, stone footings with concrete capped foundations as well as fragments of corrugated metal sheeting and other discarded materials (see Figure 4-61). Some of the structure foundations could have been footings for tanks or sheds, with a rounded stone and concrete structure possibly being a septic tank (see Figure 4-58, Figure 4-62 and Figure 4-63). The larger structures have bluestone or concrete foundations and are capped with concrete slabs. It is unknown what these former structures were due to the lack of extant structural elements such as a roof or walls, and their narrowness in size, however some of the foundations were concealed by grasses and were not completely comprehensible. Nearby to these foundations are five tall timber posts standing upright in a circle, which may have previously been a shelter (like the one seen at the stone house) or possibly held a water tank on top or a windmill (see Figure 4-65).

4.1.3.2 Site survey

Below is a table of site images of the Murphy's Flat Yards site taken by Artefact's consultants:

Figure 4-40: View towards Murphy's Flat from the Wollondilly River, facing west.

Figure 4-41: Another view towards Murphy's Flat from the Wollondilly River, facing west.

Figure 4-42:Former livestock ramp and yard, with extant fencing, facing west.

Figure 4-43: View of the livestock ramp and yard, with extant fencing, facing south.

Figure 4-44: View of cleared area looking towards the livestock ramp and yard, facing south-east.

Figure 4-45: Former sorting yard fencing.


Figure 4-46: Former livestock ramp.


Figure 4-47: Example of the high tensile fencing wire used to tie the rails to the posts at the yard.


Figure 4-48: Example of bolted rails to end posts at the yard.


Figure 4-49: Example of remnant timber fencing near to the yard, with fragments of metal sheeting.


Figure 4-50: Example of remnant fencing north of the yard with rabbit proof wire.


Figure 4-51: Another example of the condition of the timber fencing at the yard.

Figure 4-52: Remnant fencing facing the yard, facing south.

Figure 4-53: Remnant fencing facing the yard, facing north.

Figure 4-54: Extant water tank between the yard and former structures.

Figure 4-55: Example of timber posts nearby to the former structures.

Figure 4-56: Setting of the former structures with non-native trees present in the background.

Figure 4-57: Looking back towards the tank and yard from the area of the former structures, facing east.

Figure 4-58: View of former structure foundations, facing west.

Figure 4-59: View of former structure foundations, facing north.

Figure 4-60: Another view of former structure foundations, facing west.

Figure 4-61: Example of rubbish materials around the former structures such as brick.

Figure 4-62: Example of a former structure, possible former septic tank.

Figure 4-63: Example of former structures, one with stone foundations and one with concrete foundations.


Figure 4-64: Example of remnant intact brickwork close to the former structures.


Figure 4-65: Five tall timber posts extant to the west of the former structures, facing west.

4.1.4 Jooriland Homestead

4.1.4.1 Description

Jooriland was not inspected as part of the site inspection conducted by Artefact Heritage on 16 May 2022 as information on the site was available in the existing draft Conservation Management Strategy (CMS). The following description of Jooriland has been summarised from the draft CMS for the site (Christo Aitken & Associates, 2006).[15]

Jooriland is situated on the Wollondilly River, with the junction of Jooriland Creek and the River lying north of the property. The property was formally accessed from Camden until the flooding of Warragamba Dam in the 1950s. It formerly compromised approximately 250 acres of freehold land and was managed as a predominantly pastoral property for over 100 years. Forest regrowth triggered by extensive wildfires which began when the property was abandoned in the 1970s has seen the landscape start to shift back to a natural state on the upper slopes but generally it remains cleared of mature vegetation. Majority of the property is fenced, with a large amount still extant.

Jooriland is typical of many medium sized pastoral working properties in NSW with a number of buildings, sheds, yards, outbuildings and other structures or elements remaining from a range of periods of occupation (Figure 4-66). There is a distinct group of precincts consisting of a shearing group (see Figure 4-67), a slab cottage group, an old homestead (see Figure 4-68) and new homestead group. Some buildings have been demolished and relocated over time or have been burnt in bushfires.

The property once ran 6000 to 7000 sheep together with some cattle and has been surveyed as the largest and most intact of the properties in Burragorang. The homestead retains the range of farming elements including the homestead buildings, managers cottages, a woolshed (Figure 4-69), shearers cottages and associated outbuildings, and infrastructure such as yards, paddocks, water tanks, a generator, overhead lines, a septic tank, and irrigation lines. There has been little change since it was abandoned apart from general issues associated with lack of maintenance such as decay, deterioration and vandalism.

[15] Refer to: Jooriland Sheep Station Conservation Management Strategy (CMS) prepared by Christo Aitken & Associates for National Parks and Wildlife Services (2006), pp. 7 – 15 for more detailed descriptions of the buildings, their condition and further commentary on the site.

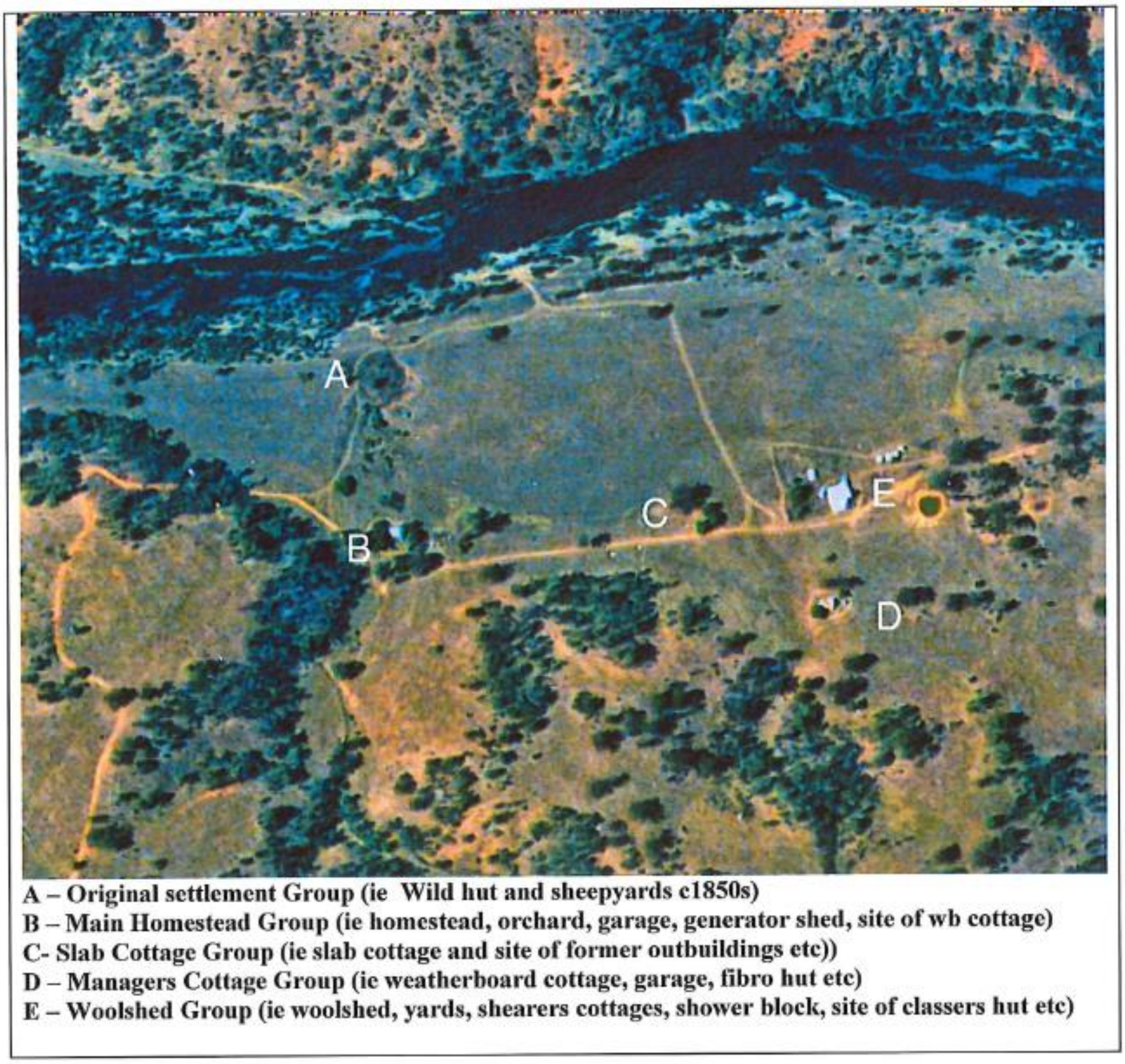


Figure 4-66: A map of the homestead structures (Source: Jooriland Sheep Station CMS, pg 30)

Figure 4-67: Image of the shearer's quarters. (Source: "How 'Jooriland' joined pastoral pyes' stable", *The Land*, 2018).

Figure 4-68: Image of the Jooriland Old Homestead building. (Jooriland Sheep Station CMS, pg 32)

Figure 4-69: Image of the Jooriland woolshed building. (Jooriland Sheep Station CMS, pg 43)

4.1.5 Megarritys Bridge

The following physical description is extracted from the State Heritage Inventory (SHI) form for Megarrity's Bridge. A site inspection was not conducted for this site as part of this assessment. However a site inspection was completed for the inspection of Warragamba Emergency Scheme (SHR No. 01376, LEP No. I270) as the bridge is located within its curtilage. For the information on this site survey refer to Section 4.5 of Appendix I *Non-Aboriginal Heritage Report* supporting the EIS.

> *The construction incorporated an arch formwork design using tubular steel scaffolding. It is believed that this was the first instance in NSW of the use of this material for such load carrying purposes.*
>
> *Substantially as designed, but with an increase in height of the crest of 5.1m with post tensioning anchors undertaken in 1989 as part of interim flood mitigation works.*[16]

4.2 Significance Assessments

The following significance assessments have been prepared in accordance with the following heritage guideline and policy documents:

- Heritage Council of NSW *Statements of Heritage Impact* (updated 2002)
- Heritage Council of NSW *Assessing Heritage Significance: NSW Heritage Manual* (updated 2002)
- Heritage Branch, Department of Planning, *Assessing Significance for Archaeological Sites and 'Relics'* (2009)

In NSW assessments of heritage significance are conducted in accordance with the Heritage Council of NSW guideline document *Assessing Heritage Significance: NSW Heritage Manual* (updated 2002). Assessments and management recommendations should also be made with consideration for the Burra Charter.[17] Both guidelines stipulate that the NSW Heritage Assessment criteria should guide the level of significance assigned to heritage items.

The criteria are as follows:

- Research potential or archaeological research potential (NSW Heritage Assessment Criterion E). Note: archaeological potential and significance is not dealt with in this report or heritage assessment, only research potential of built heritage items.
- Associations with individuals, events or groups of historical importance (NSW Heritage Assessment Criteria A, B & D)
- Aesthetic or technical significance (NSW Heritage Assessment Criterion C)
- Ability to demonstrate the past through archaeological remains (NSW Heritage Criteria A, C, F & G)

[16] State Heritage Inventory form for 'Megarritys Bridge'. Retrieved from: https://www.hms.heritage.nsw.gov.au/App/Item/ViewItem?itemId=5051476
17 NSW Heritage Office 2001; NSW Heritage Branch, Department of Planning 2009; Australia ICOMOS 2013

4.2.1 Orange Tree Flat House significance assessment

The following table outlines the significance assessment for the Orange Tree Flat House remains.

Table 4-1: Orange Tree Flat House significance assessment

Criteria	Discussion
A – Historical Significance	The Orange Tree Flat House remains are an example of mid-to-late-19th century construction techniques of stone chimneys and is indicative of a typical bush-style dwelling of that era. Whilst it is the last extant feature of the former structure which was located at this site, and it represents the era of development in Burragorang prior to the flooding of the valley, it is not of particular importance to the history of the area.
B – Associative Significance	The remains of the Orange Tree Flat House may be associated with the former owners of the land, i.e. James O'Brien and family, however generally this item does not qualify for significance under this criterion.
C – Aesthetic or Technical Significance	The chimney and fireplace structure at the Orange Tree Flat House site is an isolated element within the larger surrounds along the Little River. It is not an exceptional example of its type (particularly as the adjoining structure is no longer present) nor is it easily viewed from any vantage points along the Little River or nearby track. This item does not qualify for significance under this criterion.
D – Social Significance	The house may have some social value to the descendants of the O'Brien family however this item does not qualify for significance under this criterion.
E – Research Potential	The Orange Tree Flat House does illustrate typical housing materiality used by the community along the Little River, utilising local materials and hardier construction techniques compared to a bark or timber dwelling. The remains also assist in the understanding of the dwelling types used in the Burragorang Valley prior to the flooding. Whilst this information is useful, it does not necessarily contribute to the broader understanding of the local area or the wider history of rural development outside of the Sydney area. This item does not qualify for significance under this criterion.
F – Rarity	The remains at the site do demonstrate a masonry construction technique that is slowly becoming lost throughout regional NSW, particularly so close to the Sydney metropolitan area. Also the Burragorang Valley, which was flooded during the creation of Warragamba Dam, lost many of its former homesteads and dwellings so Orange Tree Flat House is one of few which remain above water level. However, it is unlikely to be the only example of its type and it not of exceptional interest as the chimney is the only fabric extant of the former structure. This item does not qualify for significance under this criterion.
G – Representativeness	Orange Tree Flat House may have some representative value for its pristine rural setting and its integrity as an original element to the former dwelling at the site however it does not represent exceptional characteristics of a bluestone chimney and is in poor condition. This item does not qualify for significance under this criterion.

Based on the above heritage assessment, the Orange Tree Flat House has some historic value as early example of a mid-to-late 19th century rural stone chimney and fireplace, but it is not of exceptional value as an individual heritage feature.

The Orange Tree Flat House would not fulfil the criteria to be listed at Local Level.

4.2.2 Stone Hut Ruins significance assessment

The following table outlines the significance assessment for the Stone Hut Ruins.

Table 4-2: Stone Hut Ruins significance assessment

Criteria	Discussion
A – Historical Significance	The land has been identified as belonging to Richard Hunt and Samuel Barber, who jointly purchased the property in 1838. It is believed that Hunt's descendants lived on the property up until 1933. It is likely this house was constructed in the early part of their 95-year history on the land. Being made of sandstone, which has evidently been cut and dressed by an experienced mason, the house demonstrates the skill taken to construct a dwelling of this nature and highlights the moderate wealth of the former occupants. Whilst currently in poor condition, the house and its surrounding remnants are evidence of continued and successful settlement of the land by European families during the 19^{th} and 20^{th} centuries, prior to the flooding of the valley. The house is also a good example of a sandstone dwelling in a rural setting, close to the Sydney metropolitan area. The site fulfils the criteria for local significance.
B – Associative Significance	The remains of the Stone Hut Ruins may be associated with the former owners of the land, i.e. Samuel Barber, Richard Hunt and family, however this item does not qualify for significance under this criterion.
C – Aesthetic or Technical Significance	The Stone Hut Ruins are a good example of a partially intact sandstone house, used as the primary homestead on a rural property in the Burragorang area. The house is an example of the continuation of the Old Colonial Georgian style into the Victorian era, which is characterised by symmetrical facades, simple rectangular shapes, and general orderliness. The Stone Hut Ruins is typical of this style, and this is further evidenced in the photograph of the house intact and in use (see Figure 3-7). The stone house and its surrounds are situated in a picturesque rural setting. The landscape of the house is very pastoral and isolated, with the locality allowing for water and mountain views as well as vantage points across the property. Whilst the house does not exhibit landmark qualities and it is not aesthetically distinctive from others of its type, the Stone Hut Ruins exemplify the orderly nature of an Old Colonial Georgian sandstone dwelling and has positive visual appeal. The site fulfils the criteria for local significance.
D – Social Significance	The house may have some social value to the descendants of the Hunt family however largely this item does not qualify for significance under this criterion.

Criteria	Discussion
E – Research Potential	The stone house does illustrate an atypical housing materiality used along the Wollondilly River, with sandstone uncommonly used for houses in this district (which appear to be mainly constructed of timber). The house therefore assists in the understanding the varying tastes and resources of different agriculturalists in the Burragorang Valley prior to the flooding. Whilst this information is useful, it does not necessarily contribute to the broader understanding of the local area or the wider history of rural development outside of the Sydney area. This item does not qualify for significance under this criterion.
F – Rarity	The ruins are an example of a house completely constructed from sandstone in the Old Colonial Georgian style, which is becoming less common to find in a completely rural setting so close to the Sydney metropolitan area. Also, the Burragorang Valley, which was flooded in the mid-20th century during the creation of Warragamba Dam, lost many of its former homesteads and dwellings, so the Stone Huts Ruins is one of few which remain above water level. However, the house is not the only example of its type and it not of exceptional interest with much of the structure experiencing complete or partial failure, rot, and rising damp. This item does not qualify for significance under this criterion.
G – Representativeness	The Stone Hut Ruins has some representative value as an extant but partially collapsed Old Colonial Georgian or Victorian Georgia stone dwelling. Through its form and the lack of a formal entry, the building hints at the pastoral way of life of the first European settlers of the district. It also has some representative value as one of the few, or perhaps only, sandstone homesteads in the wider Burragorang district.

Based on the above heritage assessment, the Stone Hut Ruins site has historic and aesthetic values, as an early example of an early-to-mid 19th century sandstone homestead. Whilst it is not of extraordinary value as an individual heritage feature, within the context of the Burragorang district, this site does contribute to the course of the local area’s cultural history and provides positive aesthetic characteristics to the local area.

The heritage significance of the Stone Hut Ruins would fulfil the criteria to be listed at Local Level.

4.2.3 Murphy's Flat Yards significance assessment

The following table outlines the significance assessment for the Murphy's Flat Yards remains.

Table 4-3: Murphy's Flat Yards significance assessment

Criteria	Discussion
A – Historical Significance	Murphy's Flat Yard has some historic value as the remnant livestock ramp and sorting yard, the different fencing types and former structure foundations do illustrate that Murphy's Flat was predominantly a sheep or cattle grazing farm, being one of the common agricultural practices in this district. However generally this item does not qualify for significance under this criterion.
B – Associative Significance	The remains of the Murphy's Flat Yard may be associated with the former owners of the land, i.e. Edward Murphy and family, however largely this item does not qualify for significance under this criterion.
C – Aesthetic or Technical Significance	Whilst idyllically situated on a flat plain along the Wollondilly River, the remains are not of particular visual or sensory appeal, so the site does not qualify for significance under this criterion.
D – Social Significance	This item does not qualify for significance under this criterion.
E – Research Potential	The site does not offer any outstanding or extraordinary information which is not readily known about the local district or wider regional development in the Sydney area. This item does not qualify for significance under this criterion.
F – Rarity	This item does not qualify for significance under this criterion.
G – Representativeness	The site is not easily legible as a former homestead with all of the former structures no longer extant. The purpose of existing foundations of former structures are not definitively known. The timber livestock ramp and yard are comprehensible however they are in poor condition and are not completely intact to qualify for representative value.

Based on the above heritage assessment, the Murphy's Flat Yards site has some historic value as an example of an early grazing farm in the Burragorang distract, but it is not of particular interest.

The item would not fulfil the criteria to be listed at Local Level.

4.2.4 Jooriland Homestead significance

The CMP assessed Jooriland as having **Local** significance for Criteria A, B, D and E, and as having **State** significance for Criteria C and G.

The following is the Statement of Significance for Jooriland Homestead as extracted from the CMP for the site:

> *Jooriland is the last intact large pastoral property within the Upper Burragorang Valley north west of Camden. It is located in a dramatic natural setting on the river flats of the Wollondilly River at the foot of the impressive cliffs of the Jooriland escarpment. The property was originally part of an 1852 land grant but the rugged area is likely to have been used as sheep grazing from as early as the 1830s.*
>
> *Subsequent owners (including the Macarthurs and Camden Park Estate) increased the landholding and leased adjoining lands to develop the property's pastoral industry. There are a number of intact buildings including a weatherboard homestead c1890s, a smaller weatherboard and fibro residence c1920s, a larger timber and galvanised iron woolshed c1900 with later Shearer's accommodation c1940s and a number of rustic slab outbuildings that appear to have recycled materials from 19th Century slab buildings. The relative physical intactness of not only the building group but also the individual buildings is rare in the locality although the buildings are only typically representative in form and design.*
>
> *It is the overall rural vista that is unique at Jooriland. The contrast in topography and the contrast between the European buildings and the surrounding bushland is a theme that has been well represented in Australian Art since the 1890s (eg Frederick McCubbin, Tom Roberts, Arthur Streeton) and is now rare. The farm and its setting encapsulates an image of Australia which is an important part of 20th Century Australian culture.*
>
> *It is a rare cultural landscape within the NSW context and as such has state significance due to this aspect. There have been no major changes to the fabric of the place, its landscape or its setting since the mid 1950s with the development of Warragamba Dam. It is an environment trapped in time with little opportunity for alterations to the landscape such as subdivision, new construction, roads, powerlines etc. The incidental statutory protection to the place afforded through its Section 1 Land status provides the unique opportunity for its current cultural landscape to remain unaltered in perpetuity unlike any other place in NSW. The place and its setting can not* (sic) *be further developed.*
>
> *The layering of various improvements to either the fabric of the overall landholding or the fabric of the buildings provides an ability to understand pressures for change in a rural property particularly for the period 1890 to 1950. The site has high archaeological potential as it has been little altered. There are a wide range of research and educational opportunities which could include the study of both its cultural and its natural aspects.*
>
> *It has local social significance as it is the last intact farm on the Upper Burragorang Valley, but it may also develop a social importance from within the broader Australian community, as its existences becomes more widely known; Jooriland has the potential to stimulate the imagination as a result of the mystique surrounding such a place, locked into the past, but which cannot be viewed or visited.*[18]

4.2.5 Megarritys Bridge

The following Statement of Significance is extracted from the SHI for Megarrity's Bridge:

> *Megarritys Bridge is considered to be of high significance as it serves the function of carrying the major Warragamba pipeline across Megarritys Creek. It is historically associated with the Warragamba Emergency Scheme, and at the time of construction, was one of the largest*

[18] Steven Ring and Christo Aitken & Associates, et al. for Sydney Catchment Authority and National Parks and Wildlife Services, June 2001, *Jooriland Sheep Station: Yerranderie State Conservation Area – Draft Conservation Management Plan*. Part 1, pp. 132 – 133.

> *concrete arch bridges to be built in NSW. It is a unique item of engineering heritage as its design is based on an innovative 'bow string' arch design rather than the more common 'decked' arch design.*[19]

The bridge is listed as fulfilling Criterion (F) Rarity at a State level.

> *This item is assessed as historically rare statewide. This item is assessed as scientifically rare statewide.* [20]

[19] State Heritage Inventory form for 'Megarritys Bridge'. Retrieved from: https://www.hms.heritage.nsw.gov.au/App/Item/ViewItem?itemId=5051476
[20] State Heritage Inventory form for 'Megarritys Bridge'. Retrieved from: https://www.hms.heritage.nsw.gov.au/App/Item/ViewItem?itemId=5051476

5.0 ARCHAEOLOGICAL ASSESSMENT

5.1 Archaeological potential

This section discusses the potential of the study area to contain historical archaeological resources. The potential for the survival of archaeological remains is significantly affected by activities which may have caused ground disturbance. This assessment is therefore based on consideration of current ground conditions, and analysis of the historical development of the study area.

'Archaeological potential' refers to the likelihood that an area contains physical remains associated with an earlier phase of occupation, activity or development of that area. This is distinct from 'archaeological significance' and 'archaeological research potential'. These designations refer to the cultural value of potential archaeological remains and are the primary basis of the recommended management actions included in this document.

Excavation works associated with the project are confined to the construction zone only, which was the focus of the archaeological assessment in the EIS. This assessment will focus on the identified S170 sites which will be impacted by the temporary inundation resulting from the works.

5.1.1 Summary of historic land-use

A summary of the historical development of the identified sites is contained with Section 3.0 of this report.

5.1.2 Discussion of archaeological potential

The following section will discuss the potential for the study area to contain archaeological remains associated with the identified sites.

Orange Tree Flat House

The Orange Tree Flat House site appeared significantly dilapidated and overgrown during the site inspection. The site consisted of a stone chimney believed to be part of the homestead, as well as stones that likely formed part of the structure's walls. No alignment for the structure was conclusively determined, although the chimney likely formed part of the structure's easternmost wall. The site has been significantly impacted by environmental processes since its abandonment. During the site inspection, it was noted that the land to the west of the visible remnants of the structure sloped down steeply towards the nearby riverbank. Although the land around the site was heavily vegetated, it was apparent that the river has eroded the land west of the site during flooding events or high tides. Given the position of the structure's remnants, it is predicted that the homestead on the property would have continued westward towards the water. Consequently, it is believed that archaeological resources associated with the site have been displaced or destroyed by fluvial movement. As such, there is **low potential** for archaeological resources associated with the homestead to be present at the Orange Tree Flat House site.

The sawmill and camp associated with the homestead were not identified during the site inspection. However, as they are located west of the homestead on the 1933 Map (Figure 3-1) they are likely to have been impacted by the fluvial movement evidenced in the areas around the river. Their assumed location was also shown to be heavily vegetated, with numerous trees and shrubs whose roots are certain to have disrupted the integrity of any present subsurface deposits. Consequently, there is **nil-to-low potential** for archaeological resources associated with the sawmill and camp to be present.

Stone Hut Ruins

Due to the dilapidation of the Stone Hut structure, it was not possible to accurately assess ground surface conditions within the building. Elements of the structure had collapsed inwards, with numerous stone blocks obstructing the ground surface beneath. Moreover, much of the unobstructed ground surface within the structure was vegetated or showed signs of disturbance caused by wombat burrows. The site visit indicated that any previous flooring treatment was no longer present, having potentially been removed after the site was abandoned. No artefacts were observed during the site inspection, and it is likely that any which may have been present were impacted by the collapse of the structure and exposure to the elements. The site has limited potential to contain intact occupation deposits. Due to impacts caused by bioturbation, there is **low-to-moderate potential** for archaeological resources to be present within the structure and in its vicinity. Extant remains may include the remnants of ancillary structures, such as outhouses or sheds, in-ground cisterns or underground storage, or potential artefact bearing deposits including refuse scatters or rubbish pits. However, there is little information available surrounding the site's layout to indicate the form or location of any such structures or features.

Evidence of a structure, assumed to be the shed seen in Figure 3-7, was observed approximately 30 m southwest of the Stone Hut. However, as the structure was likely a general use shed associated with the property's usage for livestock grazing it is expected that archaeological resources associated with this feature will be limited to minor, subsurface structural elements. No artefact deposits are expected to be associated with this structure, although there is **low-to-moderate potential** for structural elements of the shed to be present beneath the ground surface.

Murphy's Flat Yards

The cattle yard at Murphy's Flat featured extant truncated fence posts around its boundary. While it is possible that postholes from former fenceposts on this alignment are present, it is considered unlikely that any other archaeological resources or artefact deposits associated with the cattle yard will be present at the site. Therefore, there is **nil-to-low potential** for additional archaeological resources related to the cattle yard.

Remains of a structure or structures were identified approximately 100 m west of the cattle yards. These are likely the remnants of the 'Bush Hut' identified within the historical context established in this report. However, the presence of concrete elements suggests that these features were likely installed during the twentieth century and represent a modification to or replacement of the original structure on the site. The construction of these features is likely to have disturbed any evidence of the previous structure. Moreover, the concentrated presence of wooden posts and bricks in certain locations across the site, as well as a small set of stairs could indicate that the structure was built on supports off the ground surface. If so, this would limit the potential for archaeological resources associated with the 'Bush Hut' to be present. Given the site's usage as a temporary residence, there is some potential for artefact bearing rubbish pits to be present. However, as occupation at the site would have been sporadic it is likely that any artefacts would limited to isolated finds rather than substantial deposits. Therefore, it is ultimately considered that there is **low potential** for archaeological resources associated with the 'Bush Hut' to be present at the site.

Joorilands

The Jooriland Homestead features extant pastoral and vernacular structures with truncated fence posts around its boundary, and remnant historic and agricultural elements scattered around the site. While it is possible that slabs from former 19th century structures and postholes from former fenceposts are present, it is considered unlikely that any other archaeological resources or artefact deposits associated with the early colonial development of the site will be present at the site.

Therefore, there is **nil-to-low potential** for additional archaeological resources related to the early phase of development on the site.

The site has seen a number of different phases of development, with extensive upgrades to existing structures and former structures in the early 20th century, with the provision of new amenities such as electricity, water reticulation and sewerage systems. Remains of any earlier structures, such as footings or slabs, were reused to support newer structures. A number of new residential structures were erected during these later phases of development, some of which were burnt down in the 1990s. The construction of these features is likely to have disturbed any evidence of previous structures or earlier farming activity. If so, this would limit the potential for archaeological resources to be present. However given the site's usage as a moderate sized agricultural homestead there is some potential for artefact bearing deposits associated with farming activities but these are likely to be limited to isolated finds rather than substantial deposits. Also it is noted in the draft CMP that many of the known rubbish pits on the site were cleared by the Water Board and the NPWS in the late 20th century. Therefore, it is ultimately considered that there is **low potential** for archaeological resources to be present at the site.

A summary of the archaeological potential for the identified sites is included in Table 5-1.

Table 5-1: Summary of archaeological potential

Phase	Potential archaeological remains	Level of disturbance	Archaeological potential
Orange Tree Flat House	Structural remnants of homestead, remnant of the sawmill and campsite, artefact bearing deposits	High level of disturbance through extensive growth of vegetation and landform erosion caused by flooding events	Nil-to-low
Stone Hut Ruins	Structural remnants of the Stone Hut, artefact bearing deposits, ancillary structures	Disturbance to site through dilapidation of structure, as well as extensive vegetation growth and bioturbation	Low-to-moderate
Murphy's Flat Yards	Fenceposts for cattle yard Structural remnants of the 'Bush Hut', ancillary structures, artefact bearing deposits	Localised disturbance through demolition and later construction activities, extensive vegetation growth and bioturbation	Nil-to-low
Joorilands	Structural remnants, artefact bearing deposits, rubbish pits, ancillary structures	Disturbance to site through dilapidation of structures, as well as extensive bushfires, vegetation growth and bioturbation	Nil-to-low

5.2 Archaeological significance

Archaeological significance refers to the heritage significance of known or potential archaeological remains. As with other types of heritage items, archaeological remains should be managed in accordance with their significance. In situations where development is proposed, this can influence the degree of impact that may be acceptable or the level of investigation and recording that may be required.

While archaeological remains often form an integral component of the overall significance of a heritage place, it is necessary to assess them independently from above ground and other historic elements. Assessing the heritage value of archaeological remains is made more difficult by the fact that their extent and nature is often unknown. It becomes necessary for judgement to be made based on expected or potential attributes. The NSW Heritage Branch document *Assessing Significance for Historical Archaeological Sites and 'Relics'*[21] provides the framework for the following significance assessment. A summary of the criteria is included in Table 5-2.

Table 5-2: Overview of NSW Heritage Branch archaeological significance criteria

Heritage Branch archaeological significance criteria	Meaning
Archaeological Research Potential (NSW Heritage Criterion E)	Archaeological research potential is the ability of the archaeological evidence, through analysis and interpretation, to provide information about a site that could not be derived from any other source, written or otherwise, and which contributes to the archaeological significance of the site and its 'relics'. The integrity of a site, the state of preservation of archaeological material and deposits will also be relevant.
Association with individuals or groups of historical importance (NSW Heritage Criteria A, B and D)	Archaeological remains may have associations with individuals, groups and events which may transform mundane places or objects into significant items through the association with important historical occurrences.
Aesthetic or technical significance (NSW Heritage Criterion C)	Whilst the technical value of archaeology is usually considered as 'research potential' aesthetic values are not usually considered to be relevant to archaeological sites. This is often because until a site has been excavated, its actual features and attributes may remain unknown. It is also because aesthetic is often interpreted to mean attractive, as opposed to the broader send is sensory perception or 'feeling' as expressed in the *Burra Charter*. Nevertheless, archaeological excavations which reveal highly intact and legible remains in the form of aesthetically attractive artefacts, aged and worn fabric ad remnant structures, may allow both professionals and the community to connect with the past through tangible physical evidence.
Ability to demonstrate the past through archaeological remains (NSW Heritage Criteria A, C, F and G)	Archaeological remains have an ability to demonstrate how a site was used, what processes occurred, how work was undertaken and the scale of an industrial practice of other historic occupation. They can demonstrate the principal characteristics of a place or process that may be rare or common. A site may best demonstrate these aspects at the time of excavation. It may also be possible to explain the nature of the site and demonstrate past practises via public interpretation with before, during, or after excavation.

5.2.1 Assessment against the NSW heritage assessment guidelines

The Orange Trail Flat House, Murphy's Flat Yards and Jooriland Homestead sites have been identified as having **nil-to-low** potential, whereas the Stone Hut Ruins site has been assessed as possessing **low-to-moderate** potential to contain archaeological resources.

[21] Heritage NSW, *Assessing Significance for Historical Archaeological Sites and 'Relics'* December 2009 p11-14. Accessed online at: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Heritage/assess-significance-historical-archaeological-sites-relics.pdf.

The assessment of the significance of the potential archaeological resources contained within the identified sites against the NSW heritage assessment criteria is outlined in Table 5-3.

Table 5-3: Consideration against NSW heritage assessment criteria

Criterion	Discussion
A – Historical Significance An item is important in the course or pattern of the local area's cultural or natural history.	Intact subsurface structural elements or artefact bearing deposits located at the Stone Hut Ruins, Joorilands Homestead or Murphy's Flat Yards sites may be able to inform us about the development of the area and yield information about their occupation which is absent in the historical record. **Archaeological resources present at the identified sites, if found to be significantly intact and legible, may meet the threshold for local significance under this criterion.**
B – Associative Significance An item has strong or special associations with the life or works of a person, or group of persons, of importance in the local area's cultural or natural history	The historical context established in this report has not indicated that the identified sites possess any known associative significance. **Archaeological resources located within the identified sites are unlikely to reach the threshold for local significance under this criterion.**
C – Aesthetic Significance An item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in the local area.	The potential archaeological remains within the identified sites have little potential for aesthetic significance. Although it is recognised that exposed *in situ* archaeological remains may have distinctive/attractive visual qualities and have visual characteristics with the ability to connect communities and individuals to the past through tangible remains, any potential archaeological remains at the identified sites are likely to be ephemeral. **Archaeological resources present at the identified sites are unlikely meet the threshold for local significance under this criterion.**
D – Social Significance An item has strong or special association with a community or cultural group in the local area for social, cultural or spiritual reasons	The historical context established in this report has not indicated that the identified sites possess any known social significance. **Archaeological resources located within the identified sites are unlikely to reach the threshold for local significance under this criterion.**
E – Research Potential An item has potential to yield information that will contribute to an understanding of the local area's cultural or natural history	Archaeological remains associated with the identified sites could potentially yield information regarding the development of each site; however, they are unlikely to possess significant research potential on a broader scale. It is necessary to reaffirm that there is a general lack of potential for intact artefact bearing deposits within the sites, which could indicate an inability to respond to research questions or to meaningfully contribute to our knowledge of the previous occupants of the sites. **Archaeological resources located within the identified sites are unlikely to reach the threshold for local significance under this criterion.**

Criterion	Discussion
F – Rarity An item possesses uncommon, rare or endangered aspects of the local area's cultural or natural history	The Orange Tree Flat House and Murphy's Flat Yards sites would not be considered rare, as mixed-use residential and agricultural properties were common in the Burragorang Valley area during the nineteenth and twentieth centuries. However, the Stone Hut Ruins and Jooriland Homestead may be considered rare within the local area due to the structure's relatively intact condition. **Archaeological resources present at the identified sites, if found to be significantly intact and legible, may meet the threshold for local significance under this criterion.**
G – Representative An item is important in demonstrating the principal characteristics of a class of NSW's cultural or natural places of cultural or natural environments (or the cultural or natural history of the local area).	The potential archaeological resources present at the identified sites are unlikely to be important in demonstrating the principal characteristics of their previous occupation or usage, and are unlikely to convey information that is not already available from historical sources. **Archaeological resources located within the identified sites are unlikely to reach the threshold for local significance under this criterion.**

5.2.2 Statement of archaeological significance

The four identified sites were used for a mix of occupational and agricultural purposes prior to their abandonment in the twentieth century. While the Orange Tree Flat House, Murphy's Flat Yards and Jooriland Homestead sites have been assessed as possessing overall nil-to-low potential to possess archaeological resources, the Stone Hut Ruins site possesses low-to-moderate potential for archaeological resources relating to the residential and agricultural usage of the site. If found to be substantially intact, archaeological resources from these sites may reach the local significance threshold for their ability to contribute to our knowledge of the history and development of the site (Criteria A and E) and for their rarity (Criterion F). However, the previous human and environmental processes which have impacted the site are likely to have disturbed any archaeological remains present and, as such, there is little potential for relics here as defined by the *Heritage Act*.

6.0 HERITAGE IMPACT ASSESSMENT

6.1 Methodology

This assessment has been prepared using the Statements of Heritage Impact 2002,[22] prepared by the NSW Heritage Office, contained within the NSW Heritage Manual, as a guideline. A detailed assessment is provided for direct, potential direct, indirect and archaeological impacts. Impact terminology and grading systems are consistent with those used in the Non-Aboriginal Heritage report in the EIS for the project.

6.1.1 Assessing flooding impacts

In any consideration of potential impacts associated with the project, it is important to remember that there is already a potential flooding impact associated with the existing reservoir. The focus of this assessment is on the potential incremental impact associated with the project. Floods are all uniquely different depending on the conditions in place when the event occurs. For example, if a flood occurs during a drought when a dam is half empty, upstream inundation levels would be lower than if the dam had been full. Conversely, if a flood occurs soon after previous rain then greater inflows would occur and with the dam being already quite full, more upstream inundation would result.[23]

6.1.1.1 Existing flooding

Flooding in the upstream catchment is a combination of backwater inundation from Lake Burragorang and local catchment inflows. The latter will not change with the project. The water level in Lake Burragorang increases until the outflow exceeds the inflow, at which time the water level recedes to the full supply level (FSL) which is the maximum operational level of Warragamba Dam. The FSL will not change with the project. The extent and duration of temporary inundation is dependent upon the magnitude of the flood-producing rainfall event, the water level in the dam storage at the time of the inflow event and the rate of release of water from the dam. The extent of inundation is controlled by the peak flood level at the dam wall and the topography across the upstream catchment. Steep terrain extends upstream from the dam wall for at least 20 kilometres, so that the extent of land inundated changes at a relatively small rate with increasing magnitude floods. However, the rate of change and inundated area increases as terrain flattens about where the Wollondilly River and Coxs River enter Lake Burragorang.[24]

For the existing dam, water levels in Lake Burragorang remain elevated for a period of about three to four days up to the 1 in 100 chance in a year flood event. Although lake levels remain elevated for a period of days, the period of inundation for specific locations would vary depending on where they are in the catchment, with depth and duration decreasing with elevation.[25]

The nature of existing flooding for the four S170 sites is summarised as follows:

- Jooriland
  - All structures sit above the 1 in 100 chance in a year flood level
  - The group of three structures within the Woolshed Group (location E in Figure 4-66) nearest the river sit on the existing PMF boundary; all other structures sit above the existing PMF (and

22 NSW Heritage Office 2002
23 *Environmental Impact Assessment – Appendix J: World Heritage Assessment Report Warragamba Dam Raising*. Prepared for WaterNSW by SMEC. 2021. Pg. 61.
24 *Environmental Impact Assessment – Appendix J: World Heritage Assessment Report Warragamba Dam Raising*. Prepared for WaterNSW by SMEC. 2021. Pp. 34 – 36.
25 *World Heritage Assessment Report Warragamba Dam Raising*. Prepared for WaterNSW by SMEC. 2021. Pp. 36 – 37.

it should be noted that the PMF is a very rare event with a less than 0.001 percent chance of it occurring in any given year)
  - The duration of temporary inundation for the PMF event is about six days

- Murphy's Flat Yards
  - The structure and the cattle yard are affected by the 1 in 100 chance in a year flood event but not by more frequent flood events
  - The duration of temporary inundation for the 1 in 100 chance in a year flood event is about seven days

- Stone Hut Ruins
  - Possibly affected by the 1 in 20 chance in a year event; affected by the 1 in 100 chance in a year flood event
  - The duration of temporary inundation for the 1 in 20 chance in a year flood event is about seven days and the same for the 1 in 100 chance in a year flood event

- Orange Tree Flat House
  - Possibly affected by the 1 in 100 chance in a year flood event and larger events; not affected by more frequent flood events
  - The duration of temporary inundation for the 1 in 100 chance in a year flood event is about seven days.

Temporary inundation at these four S170 sites is due principally to backwater from Lake Burragorang with local catchment runoff likely only having a very minor contribution. As such, water velocities at these sites would be generally very low.

6.1.1.2 Project flooding

In general terms, the project would change upstream flooding through an increase in the frequency of floods of a specific magnitude, and the depth, duration and extent of temporary inundation. This will be greatest at the dam wall and in Lake Burragorang but will lessen moving away from the lake up the tributaries.

The nature of flooding with the Project for the four S170 sites is summarised as follows:

- Jooriland
  - All structures sit above the 1 in 100 chance in a year flood level
  - All structures apart from the Manager's Cottage (location D in Figure 4-66) are within the project PMF
  - The duration of temporary inundation for the PMF event is about seven days

- Murphy's Flat Yards
  - The structure and the cattle yard are affected by the 1 in 10 chance in a year flood event and larger (relatively less frequent) flood events
  - The duration of temporary inundation for the 1 in 10, 1 in 20 and 1 in 100 chance in a year flood events is about 10 days

- Stone Hut Ruins
  - The Stone Hut Ruins (but not the Stone Hut Shed ruins) are affected by the 1 in 5 chance in a year flood, while both are affected by the 1 in 10 chance in a year flood event and larger events
  - The duration of temporary inundation for the 1 in 5 chance in a year flood event is about seven days and about 10 days for the 1 in 10 chance in a year flood event

- Orange Tree Flat House
  - Possibly affected by the 1 in 10 chance in a year flood event and affected by larger events
  - The duration of temporary inundation for the 1 in 10 chance in a year flood event is about 10 days.

The additional duration of temporary inundation is the primary impact for the project. The following table illustrates the existing duration extents (in days) at each of the three S170 sites versus the new duration extents for the project As noted previously, some of these locations are not affected by all flood events. Additionally, the PMF event has not been considered in view of its extreme rarity and that incremental impacts would be associated with more frequent flood events.

Table 6-1: Changes to temporary inundation duration (days) for potentially affected S170 sites

Location	Flood event (1 in x chance in a year)							
	1 in 5		1 in 10		1 in 20		1 in 100	
	Existing	Project	Existing	Project	Existing	Project	Existing	Project
Jooriland	NA*	NA	NA	NA	NA	NA	NA	NA
Murphy's Flat Yards	NA	NA	NA	10	NA	13	8	16
Stone Hut Ruins	NA	8	7	10	8	13	8	16
Orange Tree Flat House	NA	8	NA	10	NA	13	NA	16

* Not affected by flood event

Predicted flooding with the project for the four flood events up to the 1 in 100 chance in a year flood event has been overlayed with the locations of the sites to show the extent of temporary inundation on the targeted areas (see Figure 6-1 to Figure 6-5)

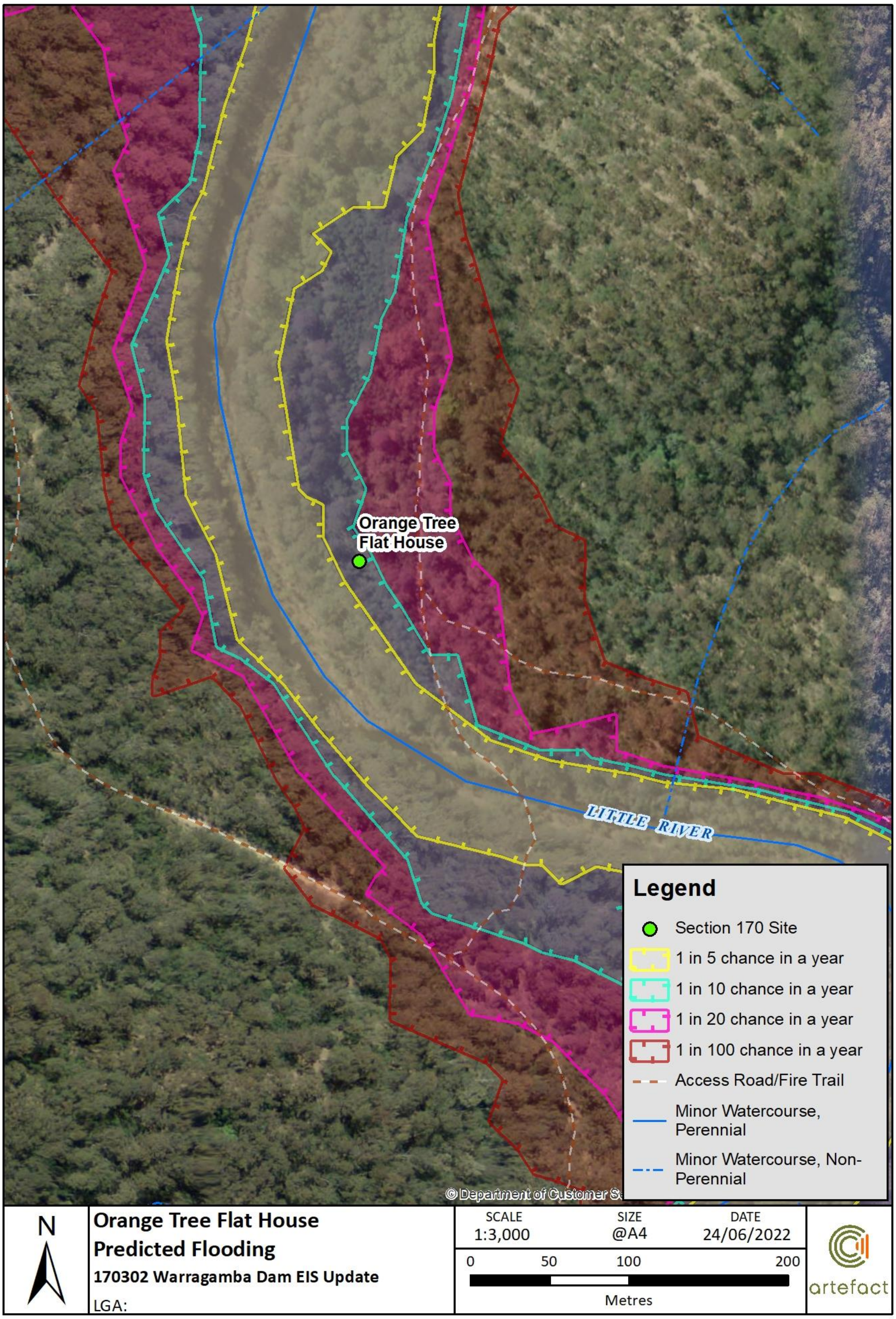


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Figure 6-1: Chance in a year flooding events with the project for the Orange Tree Flat House site (Artefact 2022).

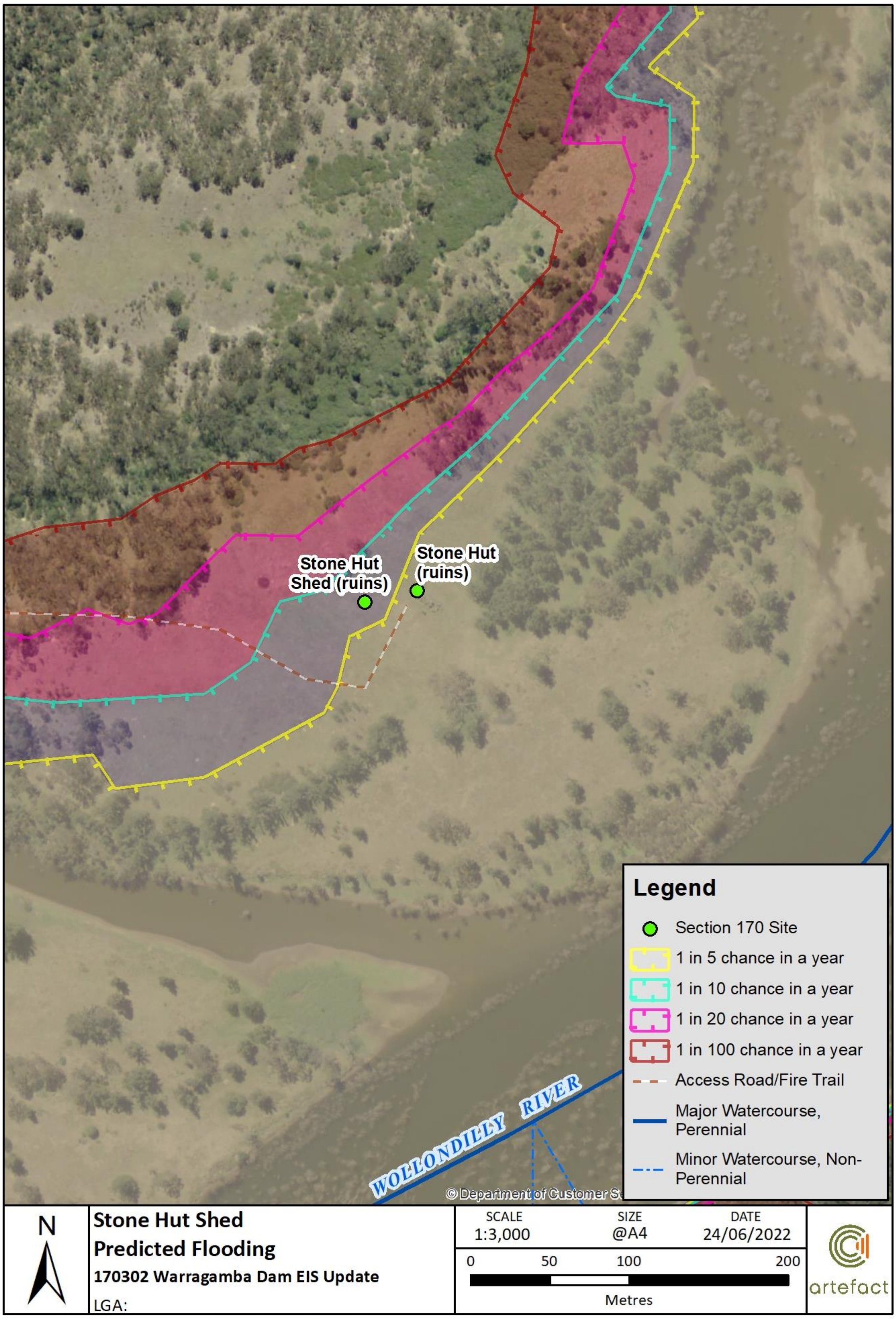

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Figure 6-2: Chance in a year flooding events (in years) for the Stone Hut Ruins site (Artefact 2022).

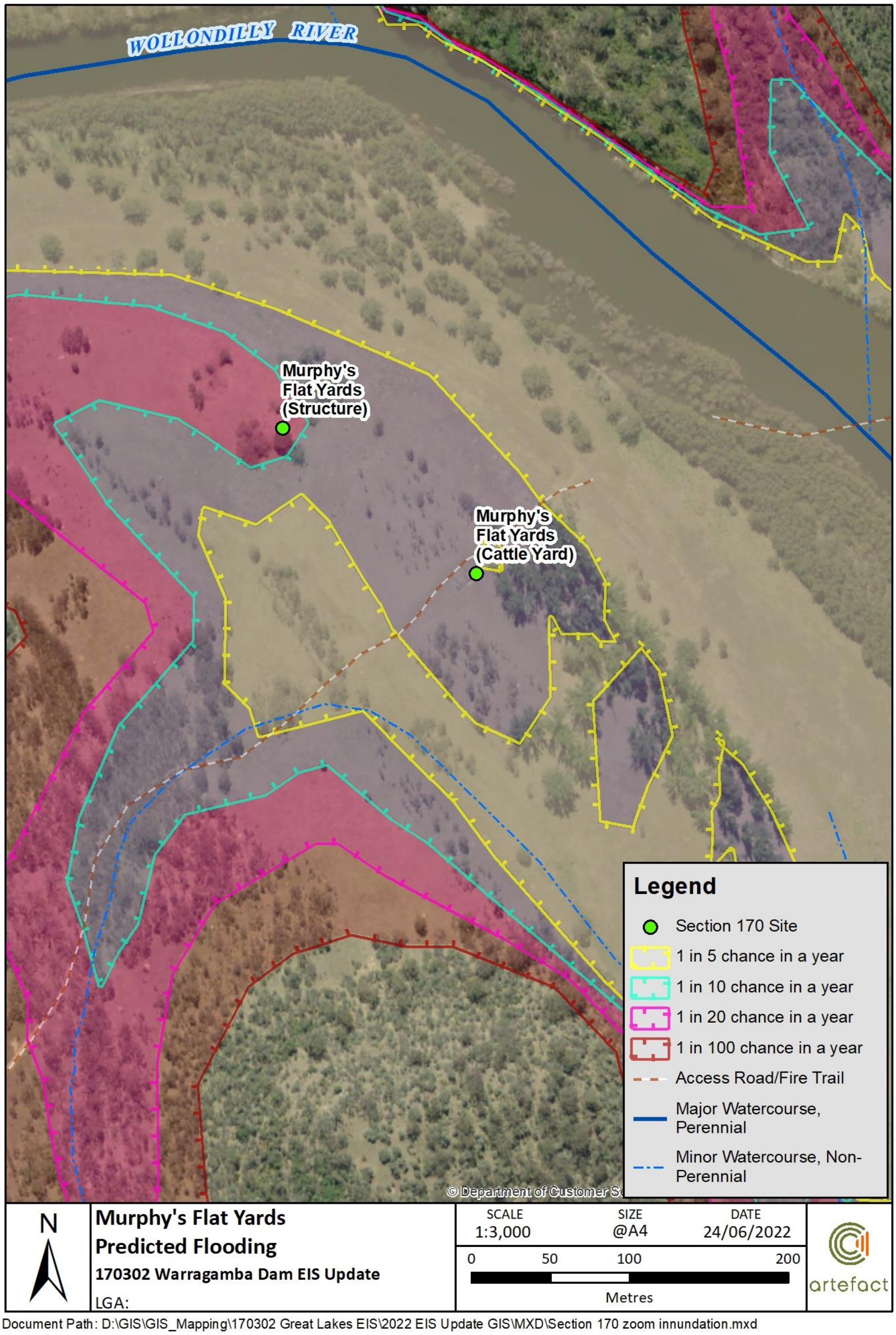

Figure 6-3: Chance in a year flooding events (in years) for the Murphy's Flat Yards site (Artefact 2022).

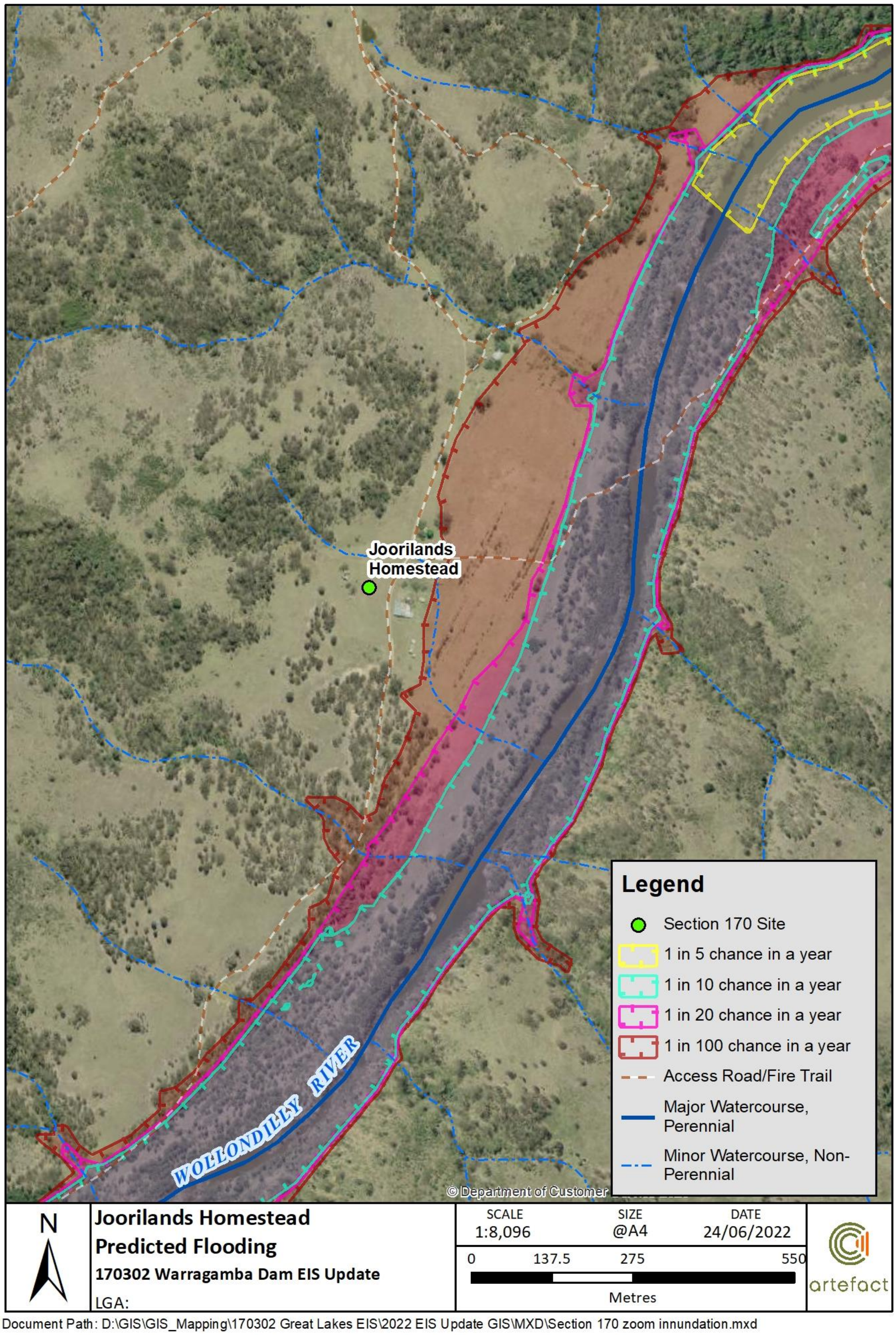

Figure 6-4: Chance in a year flooding events (in years) for the Jooriland Homestead site (Artefact 2022).

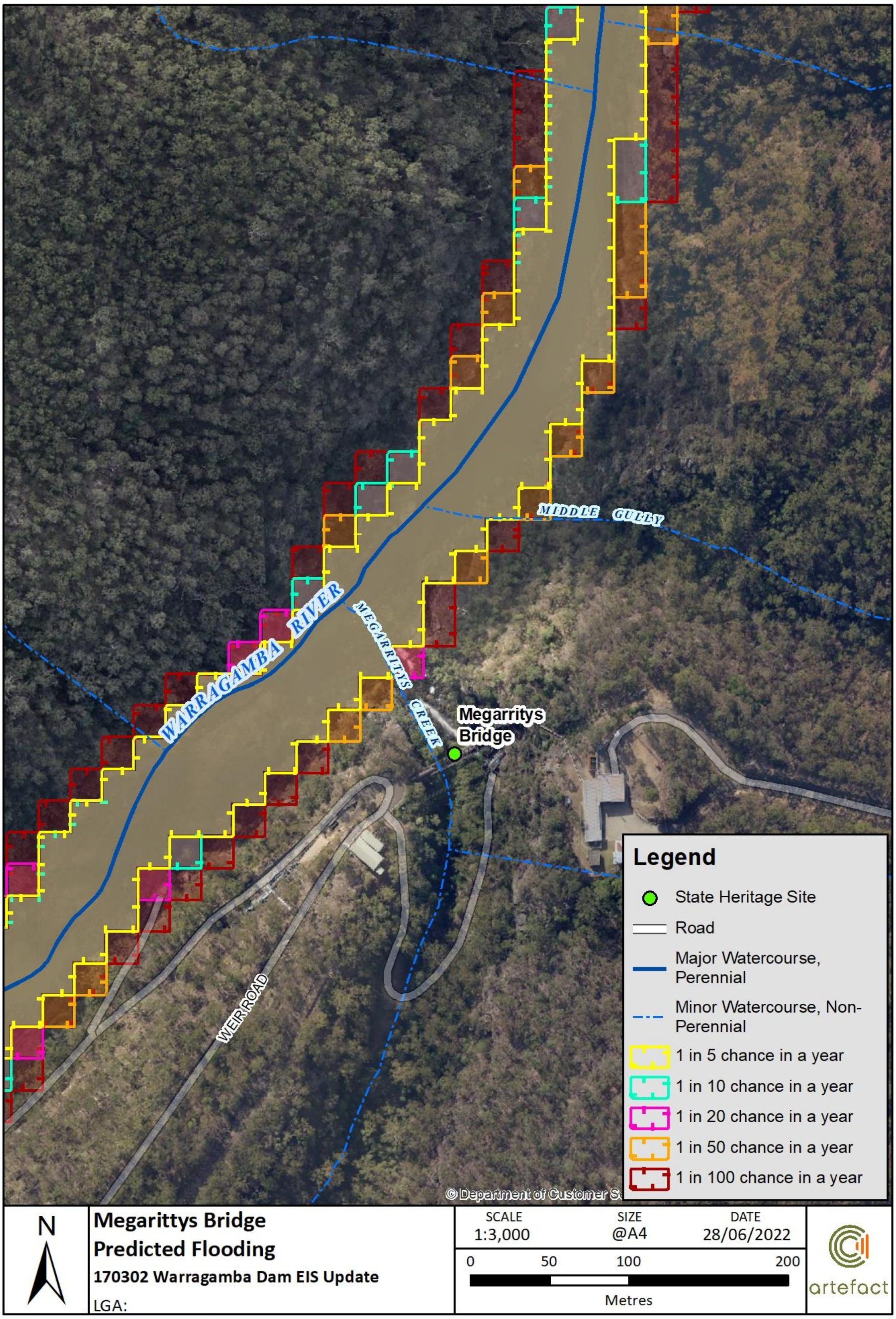

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Figure 6-5: Chance in a year flooding events (in years) for the Megarritys Bridge site (Artefact 2022).

6.2 Potential impacts

This section provides an assessment of impact for the four S170 listed sites and the SHR listed Megarritys Bridge, subject to this Supplementary Report. It provides an overview of the project construction and operational impacts on the five sites.

A detailed impact assessment for the Stone Hut Ruins, the Jooriland Homestead and the Megarritys Bridge site are provided below. Given the Orange Tree Flat House and Murphy's Flat Yards were assessed not meeting the criteria for Local listing no detailed impact assessment was provided.

Potential archaeological impacts as well as direct and indirect cumulative impacts for all four S170 sites are also provided in this section.

The exact locations of the heritage items are shown in Figure 6-1 to Figure 6-5.

6.2.1 Construction impacts

The four S170 sites are over 42 kilometres south-west from the construction footprint of the project. These sites would not be subject to any direct or indirect impacts as a result of the construction works.

Megarritys Bridge is located 853 metres downstream of the construction footprint of the project. It is not expected that any direct or indirect physical or visual impacts would occur to the State heritage values of Megarritys Bridge during the construction of this project.

6.2.2 Operation impacts

The operational impacts of the project on the four upstream sites would involve additional temporary inundation events during any occurrence when Lake Burragorang is above FSL.

The four S170 listed sites are affected to varying degrees by temporary inundation from the existing dam as noted in Section 6.1.1. Three of the four sites are affected by the existing PMF. These existing risks already pose a threat to the conservation of these sites. The raising of the dam has the potential to result in additional periods of inundation to these sites during certain flood events i.e. sites that would not be impacted under an existing 1 in 10 year event would see up to an additional 10 days of temporary inundation whilst some would remain unaffected. These increases are illustrated in Table 6-1. It is noted that the depth and relative velocities of waters backing up and receding during these events would not be very different from the existing situation. Therefore, the primary impacts to these sites would be increased duration of temporary inundation during flooding events. All four of the sites are currently uninhabited and are in poor condition. It is therefore assumed that the potential impact of an extended inundation period would result in some additional deterioration of the structures that remain standing within these sites.

Megarritys Bridge is unlikely to experience physical impacts associated with flood events as the height of water discharged into Warragamba River by the dam would not change as a result of this project. For all events, there would be a reduction in the peak flow discharged by the dam which would lessen any risk of damage to the heritage item. The Bridge is also elevated over a gorge, with Megarritys Creek far below the structure. This height also mitigates any risk for direct or indirect physical impacts to the heritage item.

6.2.3 Impact assessment for the Stone Hut Ruins site

The following table summarises the targeted impact assessment for the Stone Hut Ruins site.

Table 6-2: Impact assessment for the Stone Hut Ruins site

Impact type	Discussion
Physical (direct) impacts	**Minor -moderate** Whilst currently in poor condition, the Stone Hut Ruins site and its surrounding remnants are evidence of continued and successful settlement of the land by European families during the 19th and 20th centuries, prior to the flooding of the valley. The project would see an increase to the duration of temporarily inundation at the site during flood events and additional discharge from the Flood Mitigation Zone. The site already experiences physical impacts from the existing temporary inundation levels of the dam. These consist of periods of up to 7 days of temporary inundation during the 1 in 10 year event and 8 days in a 1 in 50 and 1 in 100 year event but it is currently not effected by a 1 in 5 year event. The relative depth and velocity of flood waters is low at this site during existing flooding events. Direct physical impacts of the existing temporary inundation timeframes have seen the site experience general structural failure. It is noted that the existing condition of the site could be a result of a number of factors, such as lack of occupation and maintenance, weather events, bushfire, as well as vandalism but temporary inundation from flooding events does contribute the site's overall dilapidation. The project's direct physical impacts to this site would consist of an increase in the duration of temporary inundation already experienced at the site (see Table 6-1). The structural integrity of the building has been compromised by the existing flooding, and any lingering flood waters may see additional deterioration of the stonework, timber rot, as well as general structural displacement from rising damp and shifting sediment. It is noted that the site is already exhibiting elements of structural failure as it is no longer occupied and maintained. Given the site is already compromised and has been neglected for a number of decades, it is likely the building would continue to deteriorate which would be contributed to by extended inundation.
Visual and setting (indirect) impacts	**Neutral impact** The site is located on a modestly flat plain, on a soft rise, surrounded by overgrown grasses and ground covering vegetation. It is lined with mature native vegetation to the rear of the property and a mix of potentially non-native and native mature trees closer to the rivers edge. The site overlooks the Wollondilly River to the east as well as the tall escarpments of the Nattai State Conservation Area. The setting of the Stone Hut Ruins is predominantly rural and isolated. However, it has positive visual appeal and is ideally situated for a homestead. The project would not see a change to this pastoral landscape. The surrounding setting would largely remain rural, picturesque and somewhat untouched.
Summary	The Stone Hut Ruins site has been assessed in this report as having significance at a Local level. Overall, the project would have a potential **minor -moderate** impact on the fabric of the Stone Hut Ruins site as an early example of an early-to-mid 19th century sandstone homestead.

6.2.4 Impact assessment for the Managers Cottage Group Joorilands site

The following table summarises the targeted impact assessment for the Joorilands Homestead site.

Table 6-3: Impact assessment for the Managers Cottage Group Joorilands site

Impact type	Discussion
Physical (direct) impacts	**Neutral impact** Whilst currently in fair to poor condition, the Managers Cottage Group Joorilands (Jooriland) site and its surrounding remnants are evidence of continued and successful settlement of the land by European families during the 19th and 20th centuries, prior to the flooding of the valley. It is noted that the site has exhibited elements of structural failure as it is no longer occupied and maintained.[26] Given the site is already seeing elements of termite damage, decay and dilapidation, and has been neglected for a number of decades, it is likely the buildings and remaining elements would continue to deteriorate. This deterioration would not be accelerated by the project as the site is above the 1 in 100 flood level with the project, so inundation is unlikely.
Visual and setting (indirect) impacts	**Neutral impact** The site is located on a wide flat plain and is surrounded by overgrown grasses and ground covering vegetation. It is lined with mature native vegetation to the rear of the property and a mix of potentially non-native and native mature trees closer to the river's edge. The site overlooks the Wollondilly River to the east as well as the tall escarpments of the Nattai and Yerranderie State Conservation Areas. The setting of the homestead is predominantly rural and isolated. However, it has positive visual appeal and encapsulates an image of rural NSW which is often seen as representative of a by-gone era. The project would not see a change to this pastoral landscape. The surrounding setting would largely remain rural and picturesque.
Summary	The Managers Cottage Group Joorilands site has been assessed as having significance at a Local and State level. Overall, the project would see a **Neutral** impact on the historic, aesthetic, research, representative and rarity values assessed for the Managers Cottage Group Joorilands site as an early example of a mid-19th century homestead.

[26] The Managers Cottage Group Joorilands site was not inspected by Artefact for this report. All information pertaining to its current condition have been assumed and based on details contained in the CMP (draft, 1994) and CMS (2006) for the site. Detailed structural and condition assessments are provided in the CMP (see Section 4) and CMS (see Section 1.2) for the site.

6.2.5 Impact assessment for the Megarritys Bridge site

The following table summarises the targeted impact assessment for the SHR listed Megarritys Bridge.

Table 6-4: Impact assessment for Megarritys Bridge

Impact type	Discussion
Physical impacts	**Neutral impact** Megarritys Bridge is located 853 metres downstream of the construction footprint of the project. It is not expected that any direct or indirect physical would occur to the State Heritage values of Megarritys Bridge during the construction or operation of this project. The item is not expected to experience any additional impact as the height of water discharged into Warragamba River by the dam would not change as a result of this project. For most events, there would be a reduction in the peak flow discharged by the dam which would lessen any risk of damage to the heritage item. The bridge is also raised above the gorge of Megarritys Creek so the clearance from the river below also mitigates any risk for direct or indirect physical impacts to the heritage item.
Historic impacts	**Neutral impact** Megarritys Bridge is historically associated with the Warragamba Emergency Scheme, and at the time of construction, was one of the largest concrete arch bridges to be built in NSW. It is a unique item of engineering heritage as its design is based on an innovative 'bow string' arch design rather than the more common 'decked' arch design. The project is not expected to result in any direct or indirect impacts which would jeopardise the State Heritage values of Megarritys Bridge as a rare concrete bow string arch bridge or affect its association to the Warragamba Emergency Scheme.
Visual and setting impacts	**Neutral impact** Megarritys Bridge is located 853 metres downstream of the construction footprint of the project. It is not expected that any direct or indirect visual impacts would occur to the State Heritage values of Megarritys Bridge during the construction or operation of this project.
Summary	Megarritys Bridge is located downstream of the construction footprint of the project, elevated above Megarritys Creek. It is not expected that any direct or indirect would occur to the State Heritage values of Megarritys Bridge.

6.3 Assessment of impact to archaeological remains

The four S170 sites were used for a mix of occupational and agricultural purposes prior to their abandonment in the 20th century. While the Orange Tree Flat House, Murphy's Flat Yards and Joorilands Homestead sites have been assessed as having nil-to-low potential for significant archaeological resources, the Stone Hut Ruins site has a low-to-moderate potential for archaeological resources relating to the residential and agricultural usage of the site. If found to be substantially intact, archaeological resources from these sites may reach the local significance threshold for their ability to contribute to our knowledge of the history and development of the site (Criteria A and E) and for their rarity (Criterion F). However, the previous human and environmental processes which have impacted the site are likely to have disturbed any archaeological remains present and, as such, there is little potential for relics here as defined by the *Heritage Act*.

Given the nil-to-low potential for archaeological resources at the Orange Tree Flat House, Murphy's Flat Yards and Jooriland Homestead sites, and the low likelihood of impacts to these sites from temporary inundation and continued exposure to flooding, the project would see a Neutral level of impact to potential subsurface historical archaeological resources. Whilst there is a low-to-moderate potential for archaeological resources at the Stone Hut Ruins site, the project would not see an increased risk of scouring with velocity of flood waters expected to be low or similar to existing levels. Therefore, the project would not impact subsurface historical archaeological resources at the Stone Hut Ruins site.

6.4 Cumulative impact

The EIS assessment identified that the overall impact of the project across a most flood events would largely be considered positive in most cases downstream from the dam, including SHR listed Megarritys Bridge. However, the four S170 sites which are situated upstream from the project construction area would likely see minor-moderate direct impacts due to the increased duration of temporary inundation at each of the sites and additional discharge from the Flood Mitigation Zone. These impacts would occur for potentially longer extended periods of time across more uncommon flood events.

Each of the sites have been assessed to be in poor to fair condition and are currently experiencing different types of structural failure such as collapse, cracking, and rot. All the sites are overgrown with vegetation which is also compromising the structural integrity of the extant built fabric. Specifically at the Stone Hut Ruins site there is currently evidence of rising damp and possible rising ground water or evidence of standing water following rainfall, which may be exacerbated by the additional days of temporary inundation during any flood event. The cumulative impacts of being inundated for extended periods of time would see the structures continue to experience disintegration, although this would likely occur over a longer period, without project impacts as a result of existing environmental factors.

The visual and archaeological impacts for all five sites assessed in this report have been found to be Neutral therefore no cumulative impacts would occur.

7.0 RECOMMENDATIONS AND MITIGATION

This Supplementary Report has assessed the four S170 heritage sites as being in poor condition and that the project would minor-moderate direct impacts due to increased duration of temporary inundation during all flooding events.

The separate assessment for the SHR listed Megarritys Bridge builds off the findings within the impact assessment supporting the EIS and has concluded that no impacts are expected to the State heritage values of the item.

7.1 Overview of findings

The findings of this Supplementary Report are summarised in the below table.

Table 7-1: Summary of significance and impacts to the four Section 170 sites and the SHR listed Megarritys Bridge

Site name	Listing	Significance grading	Impacts
Megarritys Bridge	State Heritage Register ID 01367	**State**	**Neutral** impacts
Orange Tree Flat House	National Parks and Wildlife Services Section 170 ID 12805	Does not fulfil criteria for a Local listing	**Minor - moderate** physical impacts **Neutral** visual and setting impacts **Neutral** archaeological impacts
Stone Hut Ruins	National Parks and Wildlife Services Section 170 ID 12804	**Local**	**Minor - moderate** physical impacts **Neutral** visual and setting impacts **Neutral** archaeological impacts
Murphy's Flat Yards	National Parks and Wildlife Services Section 170 ID 13367	Does not fulfil criteria for a Local listing	**Minor-moderate** physical impacts **Neutral** visual and setting impacts **Neutral** archaeological impacts
Managers Cottage Group Joorilands	National Parks and Wildlife Services Section 170 ID 3817	**State**	**Neutral** physical impacts **Neutral** visual and setting impacts **Neutral** archaeological impacts

7.2 Mitigation measures

National Parks and Wildlife Services (NPWS) are the asset owner for the listed sites discussed in this report and under the statutory obligations of Section 170 of the NSW *Heritage Act 1977* NPWS are responsible for the ongoing maintenance and conservation of these heritage places. However it is industry best practise to provide standard mitigations for any potential impacts which may occur to these sites attributable to the project. The following mitigation measures have been recommended for WaterNSW to conduct in consultation with NPWS, which would provide standard protection.. WaterNSW will consult with NPWS on any recommendations which result from these mitigation measures that require an action to be considered and implemented for a site by NPWS as the asset owner..

The following mitigations apply to the project in relation to the four heritage items assessed in this Supplementary Report:

- WaterNSW should conduct an Archival Recording of the four S170 sites prior to the operation of this project. The archival recording should be conducted by an appropriately qualified heritage specialist and must be conducted in accordance with Heritage Office guidelines (see *How to Prepare Archives Records of Heritage Items and Guidelines for Photographic Recording of Heritage Sites, Buildings and Structures*) and should lodge the record with the State Library and the local Council library. The report should be shared with National Parks and Wildlife Service and Heritage NSW for their records. A copy could also be shared with the Wollondilly Heritage Centre & Museum out of courtesy.
- WaterNSW should conduct inspections of these four S170 sites following any major flood event where one or more sites is affected by backwater flooding attributable to the Project, and shall consult with NPWS with regard to any required measures relating to additional temporary inundation from the Project.
- No specific mitigations are required for the State Heritage listed Megarritys Bridge as no heritage impacts are expected.
- WaterNSW to prepare a Management Plan for the locally significant Stone Hut Ruins in consultation with NPWS. This Management Plan would focus on fabric management post-inundation, general conservation post-inundation and opportunities for heritage interpretation, such as through digital archival recording to enable public engagement with the heritage values of the item offsite. This plan should be produced by a suitably qualified heritage specialist with heritage architect and engineer input. The plan can be produced post approval but should be implemented prior to completion of construction.
- WaterNSW to prepare a condition assessment in consultation with NPWS and provide advice on stabilisation and minimisation of moisture ingress and damage to the Stone Hut Ruins. This should be provided to the project prior to construction by a suitably qualified engineer with heritage experience. Findings and recommendations from this reporting must be implemented and considered prior to completion of construction of the project.

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artefact

Artefact Heritage

ABN 73 144 973 526
Suite 56, Jones Bay Wharf
26-32 Pirrama Road
Pyrmont NSW 2009 Australia

+61 2 9518 8411
office@artefact.net.au
www.artefact.net.au