SMEC

Member of the Surbana Jurong Group

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Flora & Fauna (Dewatering) Management Plan

Lake Macdonald (Six Mile Creek) Dam Improvement Project

Client Reference No. 05327
Prepared for: Seqwater
22 April 2025

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Important Notice

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Executive Summary

This Adaptive Management Plan, herein referred as the 'plan,' has been prepared to manage potential impacts associated with water lowering for the Lake Macdonald (Six Mile Creek) Dam Improvement Project. Located in the Noosa hinterland, Lake Macdonald (Six Mile Creek) Dam, alternatively referred to as Lake Macdonald, serves as one of two principal raw water sources providing potable drinking water to the residents of Noosa Shire. The dam improvement project will enhance the dam's ability to manage severe weather and earthquake events, improve spillway discharge capacity, and enhance earthquake stability, all while maintaining water supply security.

The improvement works involve removing the existing spillway and embankments, and the construction of a new spillway and embankments on weathered rock. This process necessitates lowering the water level in Lake Macdonald to RL 93 m AHD (~42% of full supply volume) to facilitate construction of a temporary coffer-dam, demolition of the existing structure and construction of its replacement. The reduced water level will be maintained for approximately 48 months, subject to inflows and weather.

This plan, a revision of the 2020 draft, has been updated to accommodate changes in design/methodology, with a significant shift in focus on the lake level. In 2020, the construction methodology necessitated lowering the lake to RL 88.5 m AHD (essentially empty), whereas the updated 2023 methodology maintains 42% of the lake volume, significantly reducing stressors on aquatic fauna and minimising the need for lake de-stocking. Technical studies have been revised to account for the passage of time, incorporating recent aquatic ecology field surveys that inform and update this plan, in addition to revisions made to species management plans.

Two aquatic fauna species listed as Matters of National Environmental Significance (MNES) have been identified in Lake Macdonald and Six Mile Creek: the Mary River cod (*Maccullochella mariensis*) and the giant barred frog (*Mixophyes iterates*). Additionally, three other MNES species may inhabit the area: the Australian lungfish (*Neoceratodus forsteri*), the Mary River turtle (*Elusor macrurus*), and the white-throated snapping turtle (*Elseya albagula*). These species are also recognised as Matters of State Environmental Significance (MSES), with two additional MSES species known to exist in Lake Macdonald: the platypus (*Ornithorhynchus anatinus*) and the tusked frog (*Adelotus brevis*).

This plan aims to mitigate environmental impacts from lowering Lake Macdonald and safeguard MNES and MSES species while facilitating the essential safety upgrades of Six Mile Creek Dam. Its primary goal is to prevent significant harm and manage potential effects on aquatic ecosystems downstream of the dam. Other types of impacts, such as effects on recreational activities, are addressed in the Project's Impact Assessment Report (IAR), which was approved with conditions by the Queensland Coordinator-General on 20 May 2019. The Commonwealth Minister for the Environment approved the Project, with conditions, as a controlled action on 7 November 2019.

This plan has been prepared in accordance with conditions in the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Approval (EPBC 2017/8078) and the Queensland Coordinator-General's evaluation report on the IAR (May 2019). The plan includes:

- A description of how and when the lake will be lowered
- A summary of baseline aquatic ecosystem conditions based on information in the Impact Assessment Report and subsequent surveys
- Discussion of potential impacts associated with the lake lowering
- Environmental objectives, performance criteria, management measures, monitoring and reporting requirements, and corrective actions to minimise potential impacts from the lake lowering, including a fauna salvage and relocation program
- A risk assessment and implementation schedule
- Key roles and responsibilities
- Data management, reporting, and audit requirements
- Required permits and qualifications.

1. Introduction

This plan is a revision of a plan drafted in 2020, updated to reflect a design/method change. Of most importance to this revision is a change to the lake level to be maintained during the improvement project. In 2020, the construction methodology required the lowering of the lake to RL 88.5 m AHD – almost empty. This scenario necessitated the removal of the vast bulk of the biomass from the lake. The revised 2023 methodology provides for maintenance of the lake level at RL 93 m AHD (approximately 42% of full supply), and maintenance of the lake as a live storage (i.e. still contributing to regional potable water supply). Under the new scenario, the stressors on aquatic fauna are greatly reduced and the requirements for de-stocking of the lake significantly diminished.

1.1 Background

Lake Macdonald (Six Mile Creek) Dam, commonly and from herein referred to as Lake Macdonald, is located on the Sunshine Coast. It is one of two principal raw water sources that supply potable drinking water to the residents of Noosa Shire. The dam requires an upgrade to meet modern safety standards and the performance requirements of the Queensland dam safety regulations into the future (the Project).

The improvement of Lake Macdonald Dam will allow the dam to better manage severe weather and earthquake events; it includes improving the spillway discharge capacity and earthquake stability while maintaining water supply security. The Project will not change the scale of the existing water impoundment, with the dam's full supply level and inundation area remaining the same post-upgrade and the proposed dam infrastructure largely occupying the existing footprint.

The Project comprises the removal of the existing spillway and embankments and the construction of a new spillway and embankments on weathered rock. This will require the lowering of water stored in Lake Macdonald to facilitate construction of a temporary coffer dam, demolition of the existing dam and construction of a replacement dam. The water level will be lowered to RL 93.0 m AHD for the duration of construction which will be approximately 3 to 4 years (subject to inflows and weather). Lake Macdonald will continue to be relied upon for water supply during the construction period and further operationally related drawdowns will occur. The indicative program for the Project is shown below in Table 1-1.

Table 1-1: Indicative Program for the Project

Phase	Timing
Supplementary business case and investment approval	End 2023
Construction Contract Award	Early 2024
Community Engagement Action Plan Launch	Early 2024
Mobilise to site and commence early and preparatory works	Q4 2024 to Q2 2025
Construction	2025-2030*

*Weather and construction conditions permitting

1.2 Site Description

Lake Macdonald is located on Six Mile Creek, approximately 10 km from the centre of Cooroy in the Noosa hinterland. The dam was constructed in the early 1960s and raised in 1979. When full it holds 8,018 ML of water, with a surface area of 260 ha and a total catchment area of 49 km^2. Lake Macdonald and its location are shown in Figure 1–1.

Lake Macdonald is primarily a water storage with no flood mitigation objectives; however the dam provides some flood attenuation and the conditions of the water licence for the dam include environmental flow release requirements. The lake is also used as a recreation facility by the community, supporting rowing, paddling, fishing, and foreshore recreation, including the Noosa Botanical Gardens.

A number of protected species are known to occur or potentially occur in and around Six Mile Creek and Lake Macdonald. In particular, five species that are listed as Matters of National Environmental Significance (MNES) and listed as Matters of State Environmental Significance (MSES), may occur in Lake Macdonald and Six Mile Creek: Mary

River cod (*Maccullochella mariensis*), Australian lungfish (*Neoceratodus forsteri*), Mary River turtle (*Elusor macrurus*), white-throated snapping turtle (*Elseya albagula*), and giant barred frog (*Mixophyes iterates*). Two additional MSES species, tusked frog (*Adelotus brevis)* and platypus (*Ornithorhynchus anatinus*), were recorded within Lake Macdonald and the upper reaches of the lake, with the platypus also recorded in Six Mile Creek.

1.3 Purpose and Objectives

The purpose of this plan is to manage the environmental impacts associated with the lowering of Lake Macdonald to facilitate construction of the upgraded Lake Macdonald (Six Mile Creek) Dam, and to protect the Mary River cod, Australian lungfish, Mary River turtle, white-throated snapping turtle, giant barred frog, tusked frog, and platypus. The primary objective of the plan is to minimise the risk of material environmental harm due to the lowering. As the water level in Lake Macdonald will need to be lowered to undertake the construction of the Project, the plan has been developed to manage potential impacts on aquatic ecosystems in:

- Lake Macdonald
- Six Mile Creek downstream of Lake Macdonald.

Other types of impacts, such as impacts to recreational activities, are addressed in the Project's Impact Assessment Report (IAR).

This plan has been prepared in accordance with conditions in the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Approval (EPBC 2017/8078) and the Queensland Coordinator-General's evaluation report on the IAR (May 2019) – noting that the design/methodology has evolved over that period.

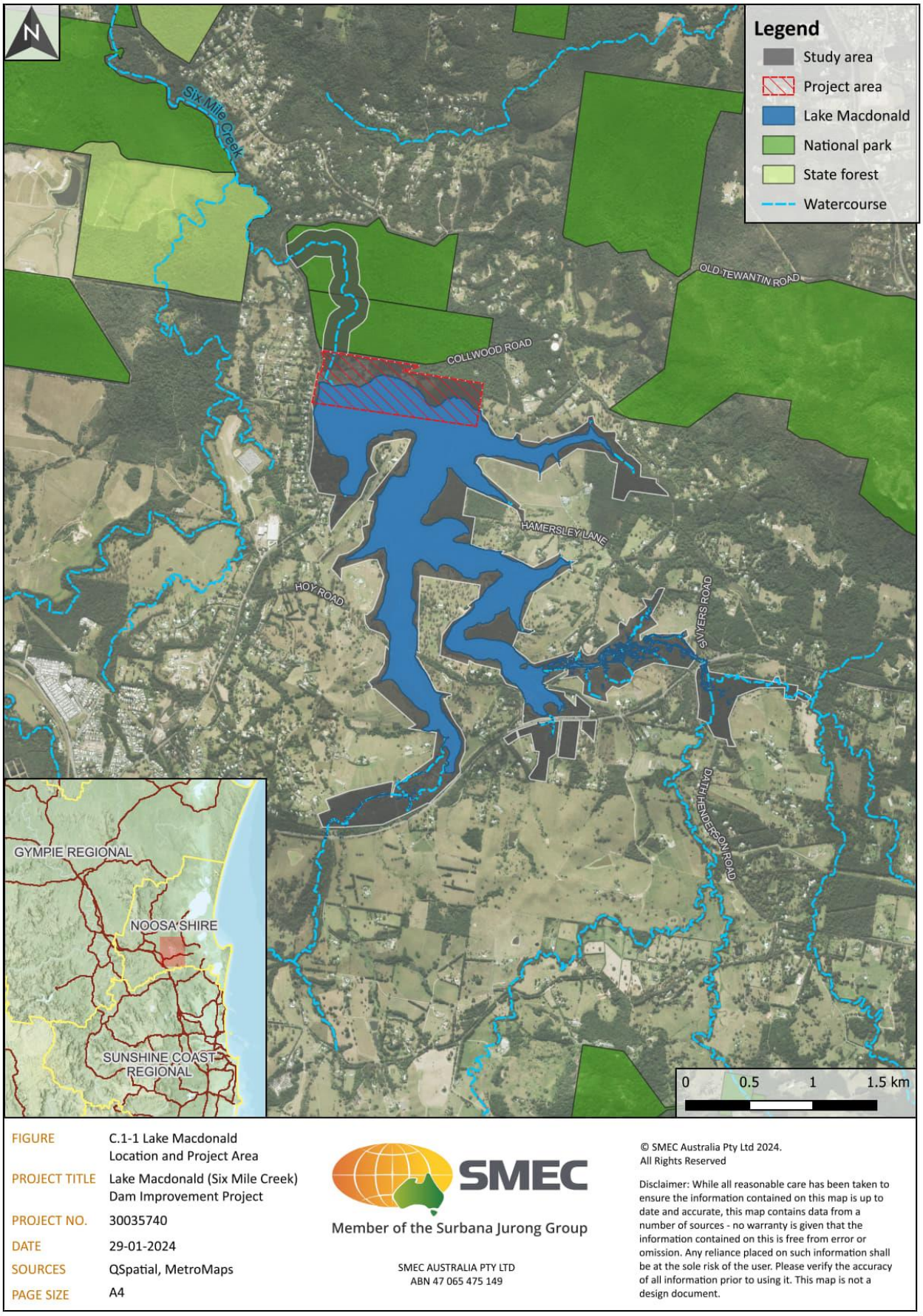


Figure 1–1: Lake Macdonald location and Project area

1.4 Plan Preparation

This plan was originally prepared in 2019/2020 by the following suitably qualified persons:

- Steven Cox
  - Senior Planning Approvals Advisor, Seqwater
  - Bachelor of Applied Science (Chemistry – Honours), Queensland University of Technology, 2006
  - 14+ years' experience in environmental science and planning roles
- Nirvana Searle
  - Associate Environmental Scientist, SMEC
  - Bachelor of Applied Science (Environmental Science - Honours), University of Canberra 1997
  - 18+ years' experience in aquatic ecologist roles
  - Certified Environmental Practitioner, Environment Institute of Australia and New Zealand
- Dr Ben Cook
  - Senior Principal Ecologist, frc environmental
  - Doctor of Philosophy (PhD), Aquatic Biology, Griffith University 2006
  - Bachelor of Science (Environmental Science - Honours), Griffith University 2000
  - Bachelor of Applied Science (Environmental Management), University of Queensland 1998
  - 20+ years' experience in academic and applied aquatic ecologist roles
- Dr Ben Pearson
  - Geomorphologist, Hydrobiology
  - Doctor of Philosophy (PhD), Geomorphology, James Cook University 2006
  - Bachelor of Applied Science (Environmental Management), James Cook University 1999
  - 20+ years' experience in academic and applied aquatic ecologist roles.

This plan was revised between 2023 and 2025 with major changes to the detailed design by the following suitably qualified persons:

- Kylie Mill
  - Senior Advisor Planning Approvals, Seqwater
  - Bachelor of Built Environment (Distinction) Urban and Regional Planning (Queensland University of Technology)
  - 25+ years' experience in major projects and planning roles.
- CP Soin
  - Manager Environment, SMEC
  - Bachelor of Environmental Management (Major in Sustainable Development), University of Queensland 2007
  - Master of Development Practice (Double major in Politics of Global Development and Development Planning), University of Queensland 2010
  - 16+ years' experience in major projects and planning roles
- Jordan Diflo
  - Associate Scientist Environment, SMEC
  - Bachelor of Environmental Science from University of the Sunshine Coast 2013.

  - 10 years' experience in environmental science and planning roles
- Dr James Bone
  - Senior Associate Scientist Ecology, SMEC
  - PhD Environmental Science, Griffith University,
  - Bachelor of Science (First Class Honours), Griffith University
  - 10+ years' experience in applied aquatic ecologist roles
- Craig Thamm
  - Bachelor of Engineering (Environment) Hons, Advanced Diploma WH&S
  - 29+ years' experience
- Kris Pitman
  - Principal Fish Ecologist, Fishology Consulting
  - Bachelor of Science (Hons) Southern Cross University
  - 21+ years' experience
- Dr Ben Cook
  - Senior Principal Ecologist, frc environmental
  - Doctor of Philosophy (PhD), Aquatic Biology, Griffith University 2006
  - Bachelor of Science (Environmental Science - Honours), Griffith University 2000
  - Bachelor of Applied Science (Environmental Management), University of Queensland 1998
  - 20+ years' experience in academic and applied aquatic ecologist roles.

In addition to the principal plan preparers, the development of the plan has been informed by representatives of the construction team to ensure that the methods and measures described herein are able to be implemented.

1.5 Content Relevant to EPBC Act Approval Conditions

EPBC Act approval conditions relevant to the lake lowering are identified in Table 1-2 , along with where these are addressed in this plan and a summary of key commitments.

Supporting information for this plan is provided in the Six Mile Creek Dam Safety Upgrade Project Impact Assessment Report (IAR), the IAR supplementary document, and the Project's Environmental Management Plan and High Risk Species Management Program.

Table 1-2: EPBC Act approval conditions and location addressed in plan

Condition Reference	Condition Requirement	Report Reference	Summary of Key Commitments
Department of the Environment and Energy – Approval Decision (EPBC 2017/8078)			
Part A	**CONDITIONS SPECIFIC TO THE ACTION**		
1	The approval holder must:		
	a) not undertake construction outside the project area	Refer to Construction Environmental Management Plan for Project	No construction will occur outside the Project area.
	b) not undertake clearing outside the clearing extent	Refer to Impact Assessment Report (IAR) Table 5-3 Table 6-1	Clearing of riparian vegetation will be restricted to the footprint approved under the IAR
	c) not undertake the lake drawdown between 1 September and 28 February	Section 2.2	Lake drawdown will not occur between 1 September and 28 February.
	d) not undertake the lake drawdown in a manner that exceeds bank-full height.	Section 2.4 Table 5-2 Table 3-1	Discharge during dewatering will not exceed 5 m^3/s with initial dewatering being undertaken over a period of not less than 4 weeks (assuming lake full at commencement).
2	Prior to the commencement of the action, and to inform the Adaptive Management Plan required under condition three (3), the approval holder must:		
	a) identify and map habitat of protected matter(s) within Lake Macdonald and downstream in Six Mile Creek	Appendix G	Habitat assessment and mapping was completed in July 2020.
	b) develop trigger levels and specify limits, at which to initiate adaptive management of the lake drawdown and construction activities, for water quality parameters including (but not limited to) temperature, pH, dissolved oxygen, turbidity, total suspended solids, nitrogen and phosphorus.	Section 3.3 Table 3-1	Water quality trigger levels (low and high) and limits have been identified based on baseline data and water quality objectives defined in the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019*. Compliance with these triggers will be used to initiate adaptive management of Project activities and management measures.
Adaptive Management Plan			
3	For the protection of protected matter(s) within Lake Macdonald and downstream in Six Mile Creek, the approval holder must submit an Adaptive Management Plan, prepared by a suitably qualified and	This plan Section 1.7	This document will be submitted to DCCEEW for approval by the Minister before implementation. This plan will be implemented for the duration of the Project.

Condition Reference	Condition Requirement	Report Reference	Summary of Key Commitments
	experienced person, for the Minister's approval. The approval holder must not commence the action until the Adaptive Management Plan has been approved by the Minister in writing. The approved Adaptive Management Plan must be implemented for the duration of the action.		
4	The Adaptive Management Plan must be reviewed by an independent expert in relation to each of the protected matter(s). The review must be provided to the Department at the time the Adaptive Management Plan is submitted for the Minister's approval	Section 13 Table 13-1 Table 13-2	This document has been reviewed by independent experts for each of the protected matters (i.e. Mary River cod, Australian lungfish, giant barred frog, Mary River turtle, and white-throated snapping turtle).
5	The Adaptive Management Plan must be consistent with the Department's Environmental Management Plan Guidelines (2014), and must include:		
	a) details of how the construction and lake drawdown (during both the gradual 12-week lowering scenario and the rapid release scenario) will be managed to avoid, mitigate, and manage:	Section 2 risks associated with water quantity Section 3 risks associated with water quality Section 4 risks associated with erosion and sediment Section 5.3	The initial lake lowering will be undertaken over a period of not less than 4 weeks with release rates determined by lowering requirement and inflow into the storage at the time. Performance criteria for habitat have been set and if exceeded will trigger a review of releases and management measures. Adjustments to drawdown releases (reduce or cease) may be made if a potential impact is detected. The requirement for, and the nature of, the adjustment will be dependent on the identified impact.
	i. negative impacts on the habitat of protected matter(s) identified and mapped as required under condition two (2)		
	ii. the exceedance of trigger levels to initiate adaptive management, and exceedance of specified limits to initiate a flow reduction or pause of the lake drawdown or construction until a solution is identified and implemented, for water quality parameters as required to be developed under condition two (2))	Section 3.3 Table 3-1 Table 5-2 Table 6-1	Performance criteria for water quality have been set and if exceeded will trigger a review of releases and management measures. Adjustments to drawdown releases (reduce or cease) will be made if a potential impact associated with the release is detected. The requirement for, and the nature of, the adjustment will be dependent on the identified impact and affected parameter.
	iii. injury and mortality of protected matter(s), including from (but not limited to) lake drawdown equipment and the temporary cofferdam.	Table 5-2	Performance criteria for aquatic flora and fauna have been set, including MNES species, along with aquatic habitat criteria. Where the flora and fauna, and habitat, triggers are exceeded, a review of releases and management measures will be implemented. Adjustments to drawdown releases (reduce or cease) will be made if a potential impact associated with the release is detected. The requirement for, and the nature of, the adjustment will be dependent on the nature of the impact.
	b) details of how proposed management measures take into account relevant approved conservation advice and are consistent with the	Section 5.4 Table 5-3	This plan was developed with regard to relevant advice, key threats and management actions for the MNES species that potentially occur in the

Condition Reference	Condition Requirement	Report Reference	Summary of Key Commitments
	measures contained in relevant recovery plans and threat abatement plans.		project area. Table 5-3 demonstrates how management measures are consistent with the advice.
	c) details of habitat remediation measures, including (but not limited to) the remediation and establishment of habitat for protected matter(s) within Lake Macdonald and downstream in Six Mile Creek.	Section 9	Where impacts to habitat for MNES species are identified, aquatic habitat will be re-established or supplemented (e.g. through replacement of woody debris or snags, bank or bed stabilisation, replacement of bed materials). Seqwater will also investigate opportunities to improve aquatic habitat in Lake Macdonald for a variety of species (e.g. addition of root balls and other fish friendly structures, if needed).
	d) measures to review and update the Adaptive Management Plan if protected matter(s), not previously identified, are found within Lake Macdonald or downstream in Six Mile Creek within 10 km of the project area	Section 1.7	If protected matters not previously identified are found within 10 km of the Project, the plan will be reviewed and updated.
	e) a monitoring program, which must include:		
	i. the timing, frequency, and location of monitoring within Lake Macdonald and downstream in Six Mile Creek, during the lake drawdown and construction, to detect potential impacts on the habitat for protected matter(s) and the exceedance of trigger levels and specified limits for water quality	Section 3.3 Table 3-1 Section 1 Section 6.3	Monitoring to assess potential impacts to MNES species habitat and water quality in relation to the specified performance criteria will occur before and during drawdown, and during construction. The monitoring frequency will range from continuous logging to every six months depending on the parameter and the location. Three downstream sites, two control sites, and one Lake Macdonald sites will be monitored.
	ii. the timing, frequency, and location of monitoring within Lake Macdonald and downstream in Six Mile Creek, post lake drawdown and construction, to detect potential impacts on protected matter(s)	Section 3.3 Table 3-1 Section 5.4 Table 5-2 Section 5.5.11	Monitoring to assess potential impacts to MNES species' habitat and water quality in relation to the specified performance criteria will occur after drawdown and construction. The monitoring frequency will range from continuous logging to quarterly depending on the monitoring outcomes. Three downstream sites, two control sites, and one Lake Macdonald site will be monitored.
	iii. the details and timing of adaptive management measures and corrective action, if negative impacts on habitat for protected matter(s) are detected, including (but not limited to) reducing or ceasing the lake drawdown and construction	Table 5-2 Table 6-1 Appendix F	Where the performance criteria defined for MNES species' habitat are not met, drawdown releases will be reduced or paused (depending on the potential impact detected). Management measures will be reviewed and revised if required. Where adjustments are not effective, alternative mitigation measures will be reviewed (e.g. habitat improvements). The duration of adjustments to releases and management measures will depend on the timing and severity of the potential impact.
	iv. the details and timing of adaptive management measures and corrective actions, if threshold trigger levels for water quality are exceeded, including (but not limited to) reducing or ceasing the lake drawdown and construction	Section 3.3 Table 3-1 Appendix F	Where the performance criteria defined for water quality are exceeded, review and corrective actions will be undertaken. If the low trigger is exceeded, a review of mitigation measures and the potential for environmental harm will be undertaken. If the high trigger value is exceeded, drawdown releases will be reduced or paused (depending on the parameter

Condition Reference	Condition Requirement	Report Reference	Summary of Key Commitments
			and magnitude of potential impact), and a review of management measures and the potential for environmental harm will be undertaken. The adjustments to releases and management measures will depend on the parameter, timing and severity of the potential impact.
6	All monitoring and data analysis required under the Adaptive Management Plan must be undertaken by a suitably qualified and experienced person(s).	Section 3.1.4 Table 3-1 Table 5-2	All monitoring is to be implemented by suitably qualified persons as defined in this plan.
Aquatic Fauna Salvage and Relocation Management Plan			
7	For the protection of protected matter(s) that are subject to salvage and relocation, the approval holder must submit an Aquatic Fauna Salvage and Relocation Management Plan, prepared by a suitably qualified and experienced person, for the Minister's approval. The approval holder must not commence the action until the Aquatic Fauna Salvage and Relocation Management Plan has been approved by the Minister in writing. The approved Aquatic Fauna Salvage and Relocation Management Plan must be implemented for the duration of the action.	Section 5.5	An Aquatic Fauna Salvage and Relocation Management Plan is incorporated in this plan. The project will not commence until this plan has been approved by the Minister in writing.
8	The Aquatic Fauna Salvage and Relocation Management Plan must be reviewed by an independent expert in relation to each of the protected matter(s). The review must be provided to the Department at the time the Aquatic Fauna Salvage and Relocation Management Plan is submitted for the Minister's approval.	Section 13	This document has been reviewed by independent experts for each of the protected matters (i.e. Mary River cod, Australian lungfish, giant barred frog, Mary River turtle, and white-throated snapping turtle).
9	The Aquatic Fauna Salvage and Relocation Management Plan must be consistent with the Department's Environmental Management Plan Guidelines (2014), and must include:		
	a) details of how proposed management measures take into account relevant approved conservation advices and are consistent with the measures contained in relevant recovery plans and threat abatement plans.	Table 5-5	This plan was developed with regard to relevant approved conservation advice for the MNES species that potentially occur in the project area. Table 5-3 demonstrates how management measures are consistent with the advice.
	b) details of risk assessments and risk management measures to be undertaken and implemented for protected matter(s) at each proposed relocation site prior to the commencement of the lake drawdown (including but not limited to the risk of disease, translocation of aquatic weeds and pests, and risks to the health and safety of aquatic fauna during capture and transport)	Section 10 Table 5-2 Appendix H	A risk workshop and risk assessment were completed for the lake lowering, and incorporated fauna salvage and relocation. A detailed assessment of relocation sites was undertaken to determine their suitability, and visual monitoring of these sites will be undertaken. If new sites are required this will be discussed with DPI prior to relocation of fauna. Fauna capture, handling and transport will be done in accordance with relevant State and Commonwealth guidelines.

Condition Reference	Condition Requirement	Report Reference	Summary of Key Commitments
	c) detailed methodologies for the salvage and relocation operations, including (but not limited to) associated equipment for each species, which demonstrate the application of best practice and species specific methods for the salvage and relocation of the protected matter(s).	Section 5.5	A pre-salvage evaluation survey will be completed in Lake Macdonald to familiarise personnel with the lake and proposed salvage methods. The salvage and relocation operations will be completed by electrofishing, trapping (fyke), and transport teams. Fauna will be held in suitable receptacles before transport to suitable relocation sites (a total time of 3-4 hours). Fauna will be transported using suitable vehicles containing aerated water from Lake Macdonald. Handling of all MNES fauna will be in accordance with relevant Commonwealth and State guidelines.
	d) details of surveys and monitoring, including:	Water Quality: Sections 3.1.4 and 3.3 Erosion and Sediment Control: Sections 4.1.2 and 1 Aquatic flora and fauna: Sections 5.1.2 and 5.4 Aquatic fauna salvage and relocation: Section 5.5.11 Aquatic habitat: Section 6.3 Biosecurity: Section 7.3	Details of baseline monitoring and management and monitoring for water quality, erosion and sediment control, aquatic flora and fauna. Salvage and relocation monitoring of aquatic fauna. Aquatic habitat and biosecurity management and monitoring.
	i. to assess the suitability and carrying capacity of all proposed relocation sites prior to the lake drawdown	Appendix H	Surveys of relocation sites were undertaken in December 2019 and January 2020 assess to assess their suitability. Sites will be re-surveyed prior to the commencement of relocation to ensure continued viability. Survey methods are provided in Appendix H.
	ii. on a monthly basis at all relocation sites for 12 months after week four (4) of the lake drawdown schedule, to assess the long-term success of the salvage and relocation operation	Section 5.5.11	Monitoring of the relocation sites will occur for 12 months post completion of salvage.
	iii. on a monthly basis at Lake Macdonald for 12 months commencing on the final date of the salvage and relocation of the protected		Quarterly monitoring of fish and fish condition in Lake Macdonald during construction and for one year post-construction. There will be no temporary

Condition Reference	Condition Requirement	Report Reference	Summary of Key Commitments
	matter(s) back into Lake Macdonald (Mary River Cod only), to assess the long-term success of the salvage and relocation operation		relocation of Mary River cod, all cod will be relocated to suitable sites (as listed in Table 5-4) and will not be returned back into lake Macdonald at a later date. Efforts will be made to re-stock Mary River cod into Lake Macdonald on project completion as a mitigation action.
10	During salvage and relocation of protected matter(s), the approval holder must ensure that:		
	a) no protected matter(s) other than the Australian Lungfish, Mary River Cod, Mary River Turtle, and White-throated Snapping Turtle are relocated	Table 5-1 Section 5.5.2 Table 5-4	No protected matters (MNES species) other than those identified will be relocated.
	b) the Department is notified within three (3) business days if any Mary River Turtle or White throated Snapping Turtle individuals are identified during salvage and relocation operations	Section 5.5.12	Any MNES species caught and relocated will be reported to Seqwater on the same day. Seqwater will notify DCCEEW of any Mary River turtle and white-throated snapping turtle caught and relocated within three days.
	c) no Mary River Cod or Australian Lungfish are relocated to Tinana Creek or Obi Obi Creek.		No aquatic fauna will be relocated to the Tinana Creek or Obi Obi Creek sub-catchments.
	d) the Mary River Cod is the only protected matter that may be temporarily relocated (until Lake Macdonald is deemed suitable for restocking by a suitably qualified and experienced person). All other protected matter(s) including (but not limited to) the Australian Lungfish, must be permanently relocated		All other MNES species will be permanently relocated.
	e) temporary relocation of the Mary River Cod can only be to the Gerry Cook Fish Hatchery, or other location that is approved by the Queensland Department of Agriculture and Fisheries prior to the commencement of the lake drawdown		All other MNES species will be permanently relocated.
	f) no Australian Lungfish is relocated to farm dams		Australian lungfish will only be relocated to the sites identified in this plan, which exclude farm dams.
Residual Significant Impacts			
11	Within six (6) months after the completion of all monitoring required under both conditions five (5) and nine (9), the approval holder must undertake a Significant Impact Assessment (in accordance with the Significant Impact Guidelines 1.1) to determine if there are any residual significant impacts to each protected matter(s) as a result of the lake drawdown, construction and relocation operations. The assessment must be undertaken by a suitably qualified person(s) and reviewed by an independent expert. The assessment must have regard to approved conservation advices, recovery plans and threat abatement plans, and also include an assessment and evaluation of:		
	a) the effectiveness and success of the Adaptive Management Plan and of the lake drawdown and construction to avoid, mitigate and manage impacts to protected matter(s)	Section 13	A report on the effectiveness and success of this plan, including an assessment of residual significant impacts on MNES species, will be prepared by a suitably qualified and experienced person within six months of the completion of the monitoring.

Condition Reference	Condition Requirement	Report Reference	Summary of Key Commitments
	b) the effectiveness and success of the Aquatic Fauna Salvage and Relocation Management Plan, and salvage and relocation activities to avoid, mitigate and manage impacts to protected matter(s).	Section 13	A report on the effectiveness and success of the fauna salvage and relocation plan, including an assessment of residual significant impacts on MNES species, will be prepared by a suitably qualified and experienced person within six months of the completion of the monitoring.
12	The Significant Impact Assessment and independent review required under condition 11 must be made publicly available on the website within nine (9) months after the completion of monitoring required under both conditions five (5) and nine (9) and be provided to the Minister within five (5) business days of being published.	Section 13	The report will be made publicly available within the specified time frame.

1.6 Content Relevant to Coordinated Project Approval Conditions

Coordinated project approval conditions relevant to the lake lowering in the Coordinator-General's Evaluation Report on the IAR are identified in Table 1-3, along with where these are addressed in this plan and a summary of key commitments.

Table 1-3: Coordinated project approval conditions and location addressed in plan

Condition Reference	Condition Requirement	Report Reference	Summary of Key Commitments
Imposed Conditions			
Schedule 1	**MANAGEMENT OF ENVIRONMENTAL IMPACTS**		
1	Site environmental management plan	Refer to Environmental Management Plan for Project	
5	Flora and fauna management plan: The purpose of this condition is the development and delivery of an adaptive management plan for managing and minimising impacts on terrestrial and aquatic ecology habitat, including fish species, pest species, and MSES species likely to occur in Lake Macdonald, its tributaries. and in Six Mile Creek.		
	a) The purpose of this condition is the development and delivery of an adaptive management plan for managing and minimising impacts on terrestrial and aquatic ecology habitat, including fish species, pest species, and MSES species likely to occur in Lake Macdonald, its tributaries and in Six Mile Creek.	This plan (in part)	This adaptive management plan has been developed to minimise impacts associated with the lowering of Lake Macdonald and will be reviewed periodically.
	b) The plan must include effective management measures (including fauna salvage and relocation program and remediation) to reduce impacts for all other aquatic MSES species.	Table 3-1 Table 5-2 Table 6-1	Management measures to reduce potential impacts to aquatic flora and fauna associated with the lowering of Lake Macdonald, including a salvage and relocation program (Section 5.5) have been identified, along with performance criteria and monitoring requirements.

Condition Reference	Condition Requirement	Report Reference	Summary of Key Commitments
		Table 7-1	
	c) The plan must:		
	(i) include aquatic habitat management measures for the management of water quantity and quality released downstream from the dam, both during dam drawdown and during construction activities, including:	Section 3 Table 3-1	Management measures for the release of water from Lake Macdonald. Water quality and aquatic habitat are provided.
	(A) monitoring of water level, water quality, velocity and bed and bank stability downstream of the dam	Section 2.5	Monitoring of water level and velocity, water quality, and bed and bank stability will be undertaken before, during and after drawdown.
	(B) performance criteria and trigger levels to detect potential impacts to initiate adaptive management measures, corrective action, or remediation as appropriate	Table 3-1 Table 5-2 Table 6-1 Table 7-1 Table 7-2	Performance criteria are identified for water quality, bed and bank erosion, and aquatic habitat.
	(C) upper threshold limits for water quality that would initiate emergency response measures, including immediate reduction or temporary ceasing of water release	Section 3.3 Table 3-1	Performance criteria (low and high trigger values) are identified and response measures will be undertaken if these trigger values are exceeded.
	(D) detail corrective measures and how they would be implemented if trigger levels are exceeded	Section 3.3 Table 3-1 Table 5-2 Table 6-1 Table 7-1 Table 7-2	Corrective measures / actions have been identified for water quality, bed and bank erosion, and aquatic habitat, including immediate reduction or temporary ceasing of water release
	(E) the requirement for site photographs to record vegetation and stream structure before, during, and immediately after dam lowering to monitor effects of discharge rates on aquatic ecosystems	Appendix F	Photo monitoring will be undertaken before, during and after the drawdown of Lake Macdonald.
	(ii) clearly set out monitoring and reporting requirements on the success of the management measures against performance criteria and trigger levels to meet the environmental flow requirements under the *Water Plan (Mary Basin) 2006*, and if necessary, how the plan has been amended to address exceedances.	Table 3-1 Table 5-2 Table 6-1 Table 7-1 Table 7-2	Monitoring and reporting requirements are identified for environmental flow requirements and water quality.
Stated Conditions			

Condition Reference	Condition Requirement	Report Reference	Summary of Key Commitments
Schedule 1	***PLANNING ACT 2016***		
Part A	Waterway Barrier Works		
1	(a) Drawdown of Lake Macdonald and fish salvage operations must not occur between 1 September and 28 February.	Section 2.2	Drawdown will not occur between 1 September and 28 February.

1.7 Review of Plan

This plan has been prepared based on the best available information at the time of the current revision. It is based on desktop and field data compiled for the IAR and subsequent assessments completed in 2020 and 2023. It is acknowledged that this data is a representation of ecosystem conditions at the time of the assessments and does not account for all ecosystem conditions, or flora and fauna, that may occur in areas relevant to the plan. Consequently, the plan is intended to be adaptive and will evolve over the course of the Project in response to changing conditions and expert advice.

The plan will be implemented for the duration of the Project. Periodic technical review of the plan will be undertaken by the Construction Contractor within three months of completing drawdown and subsequently every six months until the Project is complete. In addition, at any point of the Project, the approved plan may need to be amended in response to changes in potential impacts, increased or decreased risks, and greater or less uncertainty. The plan must be reviewed and updated if:

- Protected matters not identified previously within the project area or a 10 km radius of the project area are found within Lake Macdonald or downstream in Six Mile Creek within 10 km of the Project area
- Project activities change from those described in the current version of the plan
- Performance criteria are not met (as indicated by monitoring)
- Management measures or monitoring requirements are found to be ineffective
- Corrective actions stipulate a review is required
- An environmental incident occurs.

As per conditions 26 to 31 of the EPBC Act approval, if action taken in accordance with the revised plan is unlikely to result in a new or increased impact, the plan can be revised without approval from the Australian Government Minister administering the EPBC Act including any delegate thereof (the Minister). If the plan is revised without approval, Seqwater must notify the Department of Climate Change, Energy, the Environment and Water (DCCEEW) in writing and provide an electronic copy of the plan showing tracked changes, an explanation of the differences between the approved and revised plan, justification as to why the amendments would not be likely to create a new or increase existing impacts, and written notice of the date on which the revised plan will be implemented. The written notice must occur at least 20 business days before the implementation of the revised plan. If the Minister believes the amendments will result in a new or increased impact, the approval holder must implement the action management plan specified by the Minister.

Any proposed changes to the plan can be revoked by Seqwater at any time by notifying DCCEEW and implementing the previous action management plan.

2. Lowering Lake Macdonald

2.1 Water Quantity

Full supply level (FSL) in Lake Macdonald is at an elevation of RL 95.3 m AHD. The corresponding full supply volume (FSV) is 8,018 ML. Water in Lake Macdonald will be lowered to RL 93.0 m AHD to facilitate the construction of a temporary cofferdam with a spillway crest at RL 93 m AHD. Upon completion the temporary cofferdam will control the lake and demolition of the existing dam spillway and embankment will commence. The cofferdam will then maintain the maximum water level at RL 93.0 m AHD for the duration of construction of the new spillway and embankments (36 to 48 months). This equates to retaining approximately 3,368 ML (42% of FSV) of water in Lake Macdonald. The water level during construction will be subject to inflows, evaporation and operational drawdown, and so fluctuation in water level during construction is expected, noting that it is possible for the lake to lower to 91.5 m AHD (15% of FSL) under a worst case (and unlikely) scenario where water extraction for potable use is not replenished by inflows.

Assuming Lake Macdonald is full at the time water lowering begins, a minimum of approximately 4,650 ML of water (plus inflows) will be removed from the lake before the temporary cofferdam can be installed.

2.2 Drawdown Schedule

The initial lowering of Lake Macdonald must not be undertaken between 1 September and 28 February of any year, per conditions of approval for the Project (EPBC 2017/8078). This is to reduce impacts of lowering on breeding seasons of threatened species listed under the EPBC Act[1]. This schedule also avoids breeding seasons of other threatened and common species.

The initial lowering of Lake Macdonald will occur over a period of not less than 4 weeks. The drawdown schedule ensures the lake is lowered in a controlled manner to minimise adverse effects on aquatic fauna and to allow for capture (salvage) and relocation of aquatic fauna. The controlled and gradual drawdown will also minimise adverse effects of released flows in Six Mile Creek downstream and limit the rate of lakebed exposure.

It is to be noted that it is possible that during the drawdown, natural inflow into the storage may increase the lake level. In this circumstance, the lake would be re-lowered at a more rapid rate in an effort to achieve the preferred 4 week program overall.

2.3 Drawdown Rate

The drawdown will target approximately 11% of the lake full supply volume each week. The volume of water discharged downstream will be set by the sum of:

- the lake lowering requirement, plus
- inflow, minus
- operational demand, minus
- evaporation and other losses

The practical limitation on release rate of the siphon system is around 5 m^3/s. Hydraulic modelling indicates that the bankfull rate of Six-Mile Creek is 10 m^3/s. As per Condition 1-d) of the EPBC Approval the lake drawdown must be undertaken in a manner that does not exceed the bankfull height.

2.4 Drawdown Method

Pumps and/or siphons will be used to achieve the drawdown of Lake Macdonald. These will enable variable release rates during the drawdown. Some drawdown equipment may also remain throughout the Project to manage lake levels, if required.

[1] The giant barred frog calling season includes March and potentially April in this area, so the drawdown period may overlap with the breeding season and the presence of tadpoles, but that this is not expected to significantly impact the breeding of the downstream population where water quality and stream flows mimic natural hydrological patterns, as far as it is possible.

Screening requirements for intakes are outlined in Table 5-2. The drawdown release point/s will be installed with suitable energy dissipation to minimise bed and bank erosion (for example, by discharging onto the concrete apron of the existing spillway). This requirement is stipulated in Table 3-1. Discharged water will then flow downstream through Six Mile Creek.

2.5 Post-Drawdown Maintenance of Water Level

Following the drawdown and during the construction of the new spillway and embankments, water levels will be maintained at a temporary FSL of RL 93.0 m AHD (42% of normal FSV) by a cofferdam. The cofferdam will incorporate a 150 m long crest at RL 93.5 m AHD. Noting this, the current cofferdam design only contains a small low-flow slot section which has limited freeboard (relative to the remaining 150 m of the structure). As designed, this is the only section at 93.0 m AHD, therefore the remaining 150 m of cofferdam will have a freeboard greater than 0.5 m, limiting fauna interactions. A section of the existing dam spillway will be cut and lowered to 89.5 m AHD. When this occurs, the main waterbody of the dam will be retained by the coffer dam. Throughout the construction period the temporary FSL will be actively managed by diverting inflows, up to a practical upper limit of 5 m^3/s around the work area through a diversion system comprised of pumps and siphons. The diversion rate will approximately match inflow rate when the storage level gets close to the temporary FSL. Where inflows are larger than 5 m^3/s and the storage level increases above the cofferdam crest, water will discharge downstream through the existing dam spillway. Any active management of water levels will aim to mimic natural flow regimes by reducing the frequency and extending the intervals between release pulses, thereby minimising disruptions to the behavioural patterns of sensitive species.

As preparation for wet weather, the Contractor may drawdown the lake water level through bypass releases no greater than 0.5 m below the coffer dam low-flow crest level.

It must be noted that it is essential that the lake remain operational (i.e. subject to consumptive water extraction) throughout construction to ensure regional and water security. Water levels in the lake will therefore depend on inflows, consumption and other losses.

A small body of water will be retained in between the cofferdam and the existing dam / construction site, referred to herein as the stilling basin, that will need to be lowered or fully dewatered from time to time. Likely conditions of the stilling basin include:

- relatively large surface area (approximately 14,000 m^2 or 1.4 HA)
- depth of 2 – 3 m, depending on thickness of placed rock and accuracy of bathymetry model
- regular pass through of water with water received over cofferdam spillway and discharged through a slot in the existing / partially reconstructed dam
- periodically poor water quality, and therefore moderate risk of fish kill.

Consequently, water quality monitoring and management (e.g. periodic dewatering), and aquatic fauna monitoring and management (e.g. salvage), with respect to the stilling basin will be key aspects of environmental management for the project. To facilitate effective access for environmental management and construction purposes, the design of the cofferdam and adjacent areas will need to accommodate safe access and working conditions.

2.6 Average Monthly Outflows

The operation of the Southeast Queensland Bulk water supply system was simulated under 10,000 stochastics climate replica for two scenarios being the 95.3 m AHD (100% FSV) and 93.0 m AHD (42% FSV) using the Regional Stochastic Model and a Spills Analysis. The simulation was conducted over a period of 10 years starting from the 1st July 2023, and based on a temporary 3-year Lake Macdonald construction lowering that began in March 2024. The statistics obtained from the first three years of the simulation illustrate the average monthly outflow from Lake Macdonald, and provide insight into the impact of lowering the FSL on the average monthly outflow. The average monthly outflows are detailed in Table 2-1: Average Monthly Outflows; and indicate that after the drawdown a limited increase to the average monthly outflows is expected, with variations ranging from 1 to 28%. These increases can be largely attributed to the fact that during normal operating conditions at 100% FSL, the lake will only spill when lake levels are at 100% or above therefore most of the year minor inflows are absorbed into the reservoir without spilling downstream. During construction however most inflows will be diverted directly downstream through the siphon system. Only when the siphon system reaches capacity will flows spill over the UCD and working platform. Other

environmental factors such as evaporation and groundwater seepage would also expect to increase water losses during the normal operating conditions of a larger reservoir.

To maintain the lowered lake level, it is anticipated that a monthly increase in water outflow will be necessary. It is assumed that allowing 100 mm of water to flow over the cofferdam spillway will encourage fish to move downstream from the cofferdam area. This 100 mm overflow was used to assess outflow for the current design. The design also aims to prevent fish from passing downstream (with the exception of significant flow events) by maintaining the cofferdam water level at 93 m AHD. A siphoned system is used to maintain this water level and restrict downstream fish passage, except during significant flow events. These outflows are modelled on the use of siphons pipe to facilitate release from Lake Macdonald and reduce the number of days that would have been considered to queue downstream movement of fish (i.e. <100 mm) over the low-flow section of the cofferdam. Currently the siphon design for outflow reduces potential downstream movement of fish via the spillway (at >100 mm) and is modelled at an average of five (5) days per year.

Table 2-1: Average Monthly Outflows

Month	Average Monthly Outflow Volume (ML) FSL 95.32	Average Monthly Outflow Volume (ML) FSL 93.0	Percentage Change (%)
January	3,595	3,771	4.91%
February	6,281	6,368	1.38%
March	5,278	6,774	28.34%
April	3,173	3,373	6.32%
May	2,756	2,911	5.62%
June	2,243	2,294	2.26%
July	1,455	1,519	4.38%
August	312	353	13.19%
September	270	303	11.98%
October	526	590	12.09%
November	1,024	1,084	5.81%
December	1,479	1,637	10.71%

2.7 Management of Environmental Flow Requirements

The impoundment of water by Six Mile Creek is authorised under *Water Act 2000*, by a Water Licence granted to Queensland Bulk Water Supply Authority (Seqwater). The water licence is subject to conditions, which include releases for environmental flow from Lake Macdonald (Six Mile Creek) Dam.

The Water Licence conditions require releases from Lake Macdonald (Six Mile Creek) Dam based on inflow rules. That is, inflows to the dam trigger certain daily releases downstream, whether by manual release or spillway overtopping. These conditions will remain in force during the Project construction, with no change from the existing situation.

During construction, the majority of lake inflows will be diverted downstream through the siphon system, allowing the environmental flows to be achieved with no intervention. If inflows trigger an environmental flow requirement under the Water Licence and temporary cofferdam overtopping does not occur, manual releases from the lake by pump or another means will be required.

It should be noted that the intended outcomes of environmental flows under the Water Licence are not in Seqwater's purview and their intent is not to provide constant downstream flows. Seqwater is not the responsible entity for determining environmental flow requirements to maintain downstream ecosystem health. Nevertheless, in the event of an extended dry or hot period, the feasibility of additional releases may be investigated for the benefit of downstream ecology.

3. Water Quality Management Plan

3.1 Baseline Conditions

3.1.1 Water Quality Objectives

Six Mile Creek, including Lake Macdonald has defined waterway Environmental Values (EVs) and Water Quality Objectives (WQOs) under the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP(Water)). The WQOs for parameters listed in the EPP (Water) for the protection of the aquatic ecosystem EV in Lake Macdonald and Six Mile Creek are provided in Appendix B.

3.1.2 Water Quality in Lake Macdonald

Median water quality results from Seqwater long term monitoring data for Lake Macdonald are provided in Appendix B. These are based on data available from a variety of routine and non-routine surface water quality sampling sites located, within and upstream of, Lake Macdonald (refer to Appendix B). A review of the results shows that regional WQOs for nutrient parameters are typically not achieved within Lake Macdonald; with nitrate, total nitrogen and oxidised nitrogen median values exceeding default WQOs. Dissolved oxygen for Lake Macdonald was generally lower than the WQOs. Previous studies also indicated that the regional WQO for chlorophyll-a is not achieved in the lake. All other median values for each parameter were within regional WQO range across Lake Macdonald.

Long-term water quality monitoring data (2011-2017) supplied by Seqwater and previously assessed for the IAR also indicated that:

- Dissolved aluminium in Lake Macdonald was often higher than the Default Guideline Value (DGV) (ANZG, 2018) for the 95% protection level of aquatic ecosystems
- Total aluminium, zinc and cobalt in Lake Macdonald were sometimes higher than the DGV
- Total aluminium, chromium, copper, mercury and zinc, and dissolved aluminium in the Lake Macdonald tailwater were higher than the DGV[2].

The *Water Monitoring Data Collection Standards* (DNR, 2007) defines a reservoir as stratified if the temperature difference between surface and basement layers exceeds 5°C. A review of monthly depth profile measurements in Lake Macdonald (mid-lake) from November 2011 to November 2017 indicated that Lake Macdonald rarely stratifies, and when it does it is only weakly stratified. Further information on stratification is provided in Appendix B.

3.1.3 Water Quality within Six Mile Creek (downstream of Lake Macdonald)

Median water quality results and site-specific water quality trigger values from Seqwater long term monitoring data for Six Mile Creek downstream are provided in Appendix B. These are based on data available from a variety of routine and non-routine surface water quality sampling sites located at the tailwater, and further downstream, of Lake Macdonald (within Six Mile Creek) (refer to Appendix B). A review of the results shows that median values for both pH and turbidity parameters were within regional WQO range across Six Mile Creek. Dissolved oxygen for Six Mile Creek was generally lower than the regional WQOs. Previous assessments also indicated that the tailwater typically fails to achieve WQOs for total suspended solids, and ammonia. This is expected to continue through the construction period as the non-achievement of WQOs is principally related to releases from the dam rather than external factors.

[2] ANZECC & ARMCANZ (2000) guidelines were applicable at the time the IAR was completed. If sampling is required, any future monitoring results for metals will be compared to the Australian & New Zealand Guidelines for Fresh & Marine Water Quality (2018).

3.1.4 Water Quality Monitoring

3.1.4.1 Site-specific water quality triggers

As dam improvement works and associated measures are proposed to deal with a reduced (42% full supply level) impoundment, the following sites have been identified for inclusion (as collated data) for the calculation of triggers:

Lake Macdonald:

- Seqwater active sampling:
    - Lake Macdonald Dam Wall Offtake
    - Lake Macdonald Mid-Lake at Confluence
- Seqwater passive sampling:
    - Lake Macdonald (Inflow passive)
- Virid IFC sample point:
    - Lake Macdonald (I1 and I3)

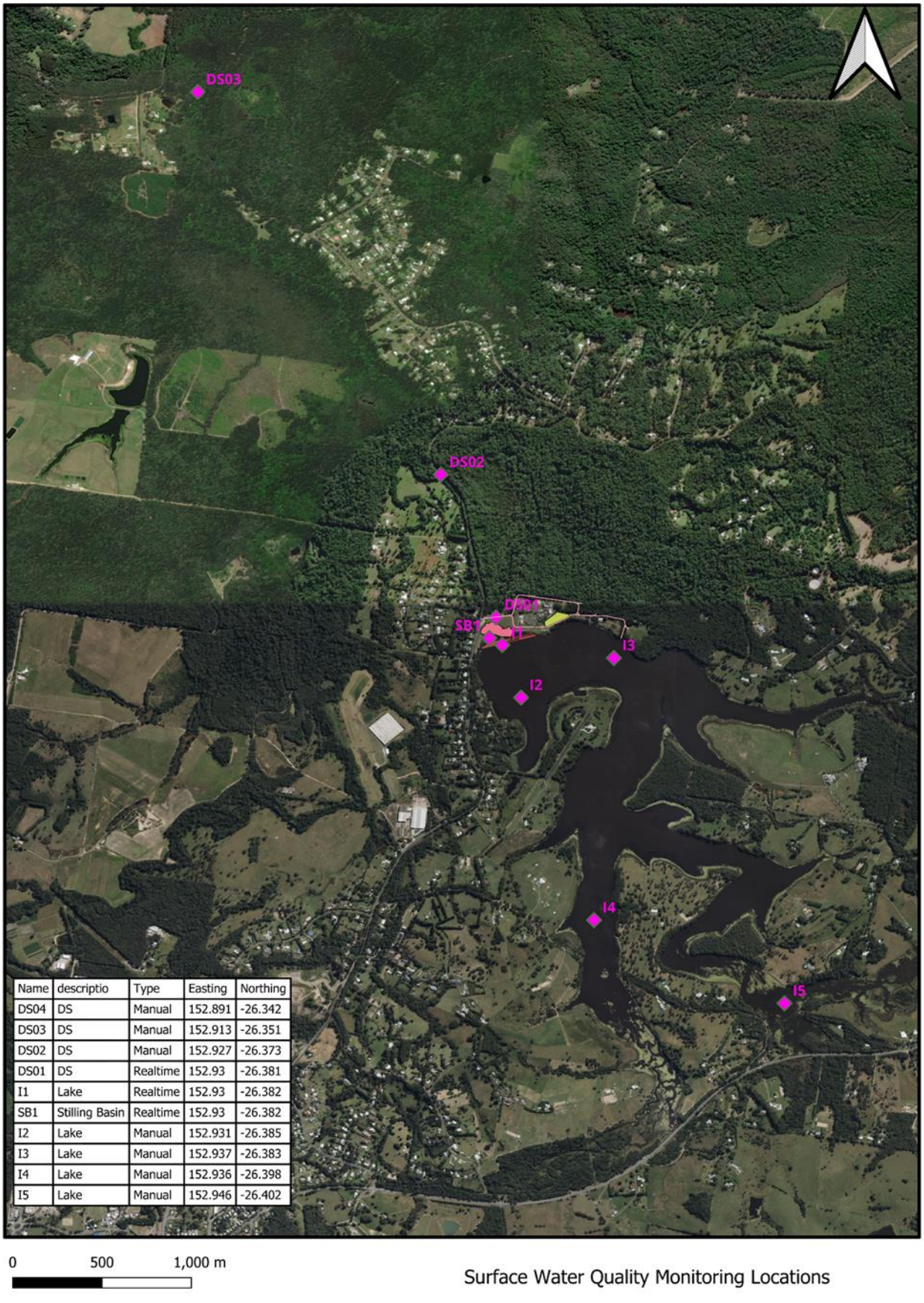
Six Mile Creek:

- Seqwater active sampling:
    - Lake Macdonald Tailwater below Dam Wall
- Seqwater passive sampling:
    - Six Mile Creek (Tailwater passive)
- Virid IFC sample point:
    - Six Mile Creek (DS01 and DS02)

Further description of site locations and coordinates are presented in the *LMDIP site specific water quality objectives 2024* report (*LMDIP-05762-RES-ENV-REP-00001*) (SMEC, 2024). Due to the proximity of the current sites; Lake Macdonald Dam Tailwater and Six Mile Creek (DS01 and DS02), these have been combined to provide data for lake Macdonald Tailwater management triggers.

3.1.4.2 Baseline Monitoring

All baseline water quality monitoring will be undertaken by suitably qualified persons in accordance with the Queensland *Monitoring and Sampling Manual – Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (DES 2018). The monitoring is described in Table 3-1 and the proposed monitoring sites are shown in Figure 3-1**Error! Reference source not found.**. Note that locations are indicative and may be varied for logistical reasons. Additional monitoring will be completed during the month before the lake lowering to record and assess water quality conditions immediately before the Project begins.



Name	descriptio	Type	Easting	Northing
DS04	DS	Manual	152.891	-26.342
DS03	DS	Manual	152.913	-26.351
DS02	DS	Manual	152.927	-26.373
DS01	DS	Realtime	152.93	-26.381
I1	Lake	Realtime	152.93	-26.382
SB1	Stilling Basin	Realtime	152.93	-26.382
I2	Lake	Manual	152.931	-26.385
I3	Lake	Manual	152.937	-26.383
I4	Lake	Manual	152.936	-26.398
I5	Lake	Manual	152.946	-26.402

Figure 3-1 Monitoring and survey sites

3.2 Potential Impacts of Lowering Lake Macdonald

3.2.1 Within Lake Macdonald

The IAR indicated that the risk of adverse impact to water quality in the lake is low, especially considering that the magnitude of drawdown (i.e. from RL 95.3 m AHD to RL 93.0 m AHD) is limited, meaning the maximum and average depth of water in the lake, and area of water coverage, will not be reduced to the extent that water quality and aquatic ecology impacts are likely. While the quality of water in the stilling basin (i.e. body of water in between cofferdam and permanent structure) may periodically deteriorate, this will not affect the lake. Nonetheless, a conservative approach towards environmental management of the drawdown and construction phases of the Project will be implemented. Mitigations and monitoring for the following potential sources of adverse impact will be implemented:

- Increasing turbidity and total suspended solids via disturbance of bed sediments and / or the erosion of bed and banks
- Reducing pH by exposing or disturbing acid sulphate soils[3] and / or decomposing organic material (e.g. aquatic plants)
- Reducing dissolved oxygen, through eutrophication and mobilisation of iron in the lake sediment, which may consume dissolved oxygen when mobilised into oxygenated water
- Eutrophication of Lake Macdonald following the drawdown resulting in an increased occurrence of agal blooms, specifically Blue-green algae
- Reducing dissolved oxygen and pH through decomposition of algae and aquatic plants during and following drawdown (refer to section 5.3.1)
- Contaminating water through spills of fuels, oils or other chemicals from pumping equipment or other machinery / vehicles
- Contaminating water within the stilling basin (e.g. contamination from construction dust and other contaminants).

3.2.2 Within Six Mile Creek (Downstream of Lake Macdonald)

Water quality in Six Mile Creek downstream of the dam is also unlikely to change significantly from current condition given the relatively limited magnitude of drawdown. The main water quality risk relates to an event whereby a significant volume of poor water quality from the stilling basin released downstream. This would only happen in the event of a spill over the cofferdam spillway and hence likely to be a transitory condition that rapidly reverts to water quality consistent with lake water quality. Mitigation and monitoring will be implemented for the following potential sources of adverse impact:

- Poor water quality within the stilling basin
- Increasing turbidity and total suspended solids via disturbance of bed sediments, the erosion of bed and banks, and/or the discharge of turbid water
- Reducing pH if the discharged water has a lower pH than occurs in the creek
- Reducing dissolved oxygen if the discharged water has low dissolved oxygen
- Increasing nutrient concentrations if the discharged water has high nutrient concentrations (or is allowed to eutrophy)
- Contaminating water if there are spills of fuels, oils or other chemicals from pumping equipment or other machinery / vehicles to the creek or the water discharged into the creek.

[3] Testing indicates that although there is some acidity in the soils at lake Macdonald, this is non-sulfuric (i.e. acid sulfate soils are unlikely to be present).

3.3 Management and Monitoring

Potential risks to water quality are overall low, with the exception of poor water quality in the stilling basin, especially if this water was to be released to the downstream Six Mile Creek. However, it is expected that potential sources of adverse impact will be mitigated by implementing the measures outlined in Table 3-1. Where appropriate, the detailed management measures will be adapted over the course of the Project in response to changing conditions and expert advice.

Management objectives for water quality are identified in Table 3-1. These management objectives were derived from water quality monitoring data for Lake Macdonald and Six Mile Creek collected between 2019 and 2024, in accordance with the methods in the Queensland Water Quality Guidelines 2009 (DEHP 2013, see also DES 2022 and ANZG 2018). Therefore, the established management objectives reflect the water quality conditions supporting aquatic fauna (including MNES) in the Project area. For water quality parameters that do not have management objectives, values, historical and baseline data will be used to evaluate monitoring results. The triggers have been updated to incorporate baseline monitoring data prior to the drawdown commencing.

As detailed in Table 3-1, monitoring will be conducted in Lake Macdonald at least 30 days before the drawdown begins to obtain a contemporary water quality data set to be used to inform acute water quality issues from the drawdown. Noting this, this water quality data will also be assessed against developed site-specific water quality trigger values derived from comprehensive background data collected by Seqwater active and passive sampling between 2019 to 2024, and a VIRID IFC between 08/03/2024 and 16/05/2024 (refer to Appendix B). This will be used to identify longer term issues from drawdown (rather than acute issues to physico-chemical water quality parameters associated with the drawdown). Noting the fortnightly monitoring to be conducted within Lake Macdonald before the drawdown, this is proposed for laboratory analytes while physico-chemical parameters are proposed to be undertaken daily. During the drawdown, there are a number of monitoring event timeframes and these are commensurate with the risk of drawdown across various site activities i.e. physico-chemical parameters to be monitored daily (in Lake Macdonald proper and in the cofferdam), laboratory analytes weekly in the stilling basin and monthly in Lake Macdonald proper. The aim of the pre-drawdown monitoring is linked to the performance criteria for minimising the impact of lowering on water quality in Lake Macdonald and Six Mile Creek which indicates water quality will be assessed against the low and high trigger values of recently collected (over the last 5 year period) water quality data (Appendix B). The background water quality data included in Appendix B has been generated from long-term Seqwater data (for all Lake Macdonald dam management) and from sampling undertaken (non-continuous) between 2019 and 2024 by Seqwater and VIRID IFC.

Table 3-1: Management of water quality during the lowering of Lake Macdonald

Environmental objective:
Minimise impact of lowering on water quality in Lake Macdonald and Six Mile Creek.

Performance criteria

Daily monitoring for field parameters and weekly/monthly for laboratory parameters will be undertaken. Investigations will be undertaken if monitoring identifies that levels have exceeded the high and low risk trigger values developed from recent years of water quality data collected by Seqwater and contractors which represents what it typically observed.

Should trigger values be identified during water quality testing associated with this adaptive management plan the following measures will be undertaken (refer to Appendix B for more information):

- Low risk trigger – Implementation of adaptive scenario management measures where increased water quality sampling is undertaken alongside assessing the effectiveness of current mitigation measure controls.
- High risk trigger – Implementation of intervention control management measures (i.e. fish salvage exercises, increased aeration, management of erosion and sediment control devices.

Adaptive management actions will be triggered when multiple samples (at least 2) exceed the performance criteria.

Water Quality Parameter	Unit	Low risk trigger value		High risk trigger value	
		Min low risk value	Max low risk value	Min high risk value	Max high risk value
Lake Macdonald (freshwater lakes/reservoirs)					
pH	log {H+}	6.41	6.64	5.73	7.30
Turbidity	NTU	-	9.75	-	42.60
Dissolved Oxygen	%	>74.10 (6.1 mg/L)	-	31.80 (2.62 mg/L)	-
Total suspended solids	mg/L	-	5	-	9
Total nitrogen	mg/L	-	0.59	-	0.78
Nitrate	mg/L	-	0.0142	-	0.020
Nox	mg/L	-	0.0116	-	0.040
Ammonia	mg/L	-	0.0528	-	0.110
Total phosphorus	mg/L	-	0.034	-	0.048
Six Mile Creek (lowland freshwater)					
pH	log {H+}	6.25	6.65	5.70	7.13
Turbidity	NTU	-	4.13	-	6.69

Environmental objective: Minimise impact of lowering on water quality in Lake Macdonald and Six Mile Creek.								
		Dissolved Oxygen	%	>98.02 (8.07 mg/L)	-	56.96 (4.69 mg/L)	-	
Management measures	**Lake Macdonald** <u>During drawdown</u>: • Arrange dewatering equipment intakes so that suction does not disturb sediments on the bed of Lake Macdonald. • Arrange intakes of dewatering equipment to extract from within top half of water column. • For any mechanical equipment biodegradable oils/lubricants will be used, refuelling will preferentially be undertaken on land and with suitable containment. Where refuelling needs to occur proximate to the lake, appropriate spill kits will be in place to contain any spill. • Ensure that fuels, oils and other chemicals are stored in bunded areas in accordance with Australian Standard 1940 (2004) – *The storage and handling of flammable and combustible liquids.* • The existing bubble plume destratification unit will be maintained and will run continuously for the life of the project, providing aeration of the water in Lake Macdonald. If the trigger values for relevant parameters are identified and it appears that the destratification unit is not working or there are insufficient inflows, additional measures to restore water quality will be investigated. This will include additional proven aeration devices or methods. • Implement risk-based assessment of any exceedances of water quality trigger values to determine the potential for environmental harm, and if so then implement additional mitigations (e.g. implement additional proven aeration devices or methods in Lake Macdonald if the concentration of dissolved oxygen becomes low and of concern). • Where the current median (50th percentile) exceeds the low risk trigger value but remains below the high risk trigger value, monitoring and management will continue under existing processes. In this case, low risk trigger management measures will not apply to parameters where the median already exceeds the low risk trigger value. This approach acknowledges that if a parameter's median was already above the low risk trigger before the drawdown, the system is naturally operating under those conditions. Trigger values will be reassessed as more data becomes available. If a parameter's median does not meet the existing regional water quality objectives for aquatic ecosystems, the relevant trigger thresholds will be applied. See Appendix B for details. <u>During construction</u>: • For any mechanical equipment biodegradable oils/lubricants will be used, refuelling will preferentially be undertaken on land and with suitable containment. Where refuelling needs to occur proximate to the lake, appropriate spill kits will be in place to contain any spill. • Ensure that fuels, oils and other chemicals are stored in bunded areas in accordance with Australian Standard 1940 (2004) – *The storage and handling of flammable and combustible liquids.* • Comply with the construction erosion and sediment control plan, and stormwater management plan. • Regular dewatering and treatment of poor water quality, when detected, in the stilling basin. • The existing bubble plume destratification unit will be maintained and will run continuously for the life of the project, providing aeration of the water in Lake Macdonald. If the trigger values for relevant parameters are identified and it appears that the destratification unit is not working or there are insufficient inflows, additional measures to restore water quality will be investigated. This will include additional proven aeration devices or methods. • Implement risk-based assessment of any exceedances of water quality trigger values to determine the potential for environmental harm. If potential for environmental harm is identified additional mitigations will be implemented (e.g. implement additional proven aeration devices or methods in Lake Macdonald if the concentration of dissolved oxygen becomes low and of concern). • Where the current median (50th percentile) exceeds the low risk trigger value but remains below the high risk trigger value, monitoring and management will continue under existing processes. In this case, low risk trigger management measures will not apply to parameters where the median already exceeds the low risk							

Environmental objective: Minimise impact of lowering on water quality in Lake Macdonald and Six Mile Creek.	
	trigger value. This approach acknowledges that if a parameter's median was already above the low risk trigger before construction, the system is naturally operating under those conditions. Trigger values will be reassessed as more data becomes available. If a parameter's median does not meet the existing regional water quality objectives for aquatic ecosystems, the relevant trigger thresholds will be applied. See Appendix B for details. **Six Mile Creek Downstream** During drawdown and construction: • Release rates must comply with mitigations measures outlined in Table 4-1 (under Six Mile Creek Downstream – During drawdown and construction). • Provide aeration of water and mitigate erosion through energy dissipation as water is discharged downstream, such as through armoured discharge points or sprays. • Undertake refuelling or chemical use away from Six Mile Creek, in accordance with the relevant construction environmental management plan. • Ensure that fuels, oils and other chemicals are stored in bunded areas in accordance with Australian Standard 1940 (2004) – *The storage and handling of flammable and combustible liquids.* • Comply with the construction erosion and sediment control plan, and stormwater management plan.
Monitoring	• All monitoring must be implemented by suitably qualified persons in accordance with the Queensland Monitoring and Sampling Manual – Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (DES, 2018). **In Lake Macdonald** Before drawdown: • At least 30 days before lake drawdown begins, conduct monitoring at least daily of temperature, pH, dissolved oxygen, electrical conductivity (EC) and turbidity at one lake site upstream of the cofferdam). • In the month before lake drawdown begins, fortnightly monitoring of chemical oxygen demand (COD), suspended solids, nitrate, ammonia, total phosphorus, and visual observations for oil slicks During drawdown and construction: • Conduct monitoring at least daily of temperature, pH, dissolved oxygen, EC, and turbidity at the lake monitoring location upstream of the cofferdam. • Daily visual observations for oil slicks in the lake immediately upstream of the cofferdam. • Daily monitoring of water quality for pH, dissolved oxygen and turbidity in the stilling basin. • Monthly monitoring of COD, suspended solids, nitrate, ammonia, total phosphorus and total recoverable hydrocarbons (laboratory analysed) at one site in the lake (upstream of the cofferdam). • Weekly monitoring of COD, suspended solids, nitrate, ammonia, total phosphorus and total recoverable hydrocarbons (laboratory analysed) within the stilling basin. Post construction • Quarterly (for 1-year post-construction) in conjunction with habitat monitoring (refer to Appendix F) monitoring of temperature, pH, dissolved oxygen, EC, and turbidity COD, suspended solids, nitrate, ammonia, total phosphorus and total recoverable hydrocarbons (laboratory analysed) at the lake monitoring site (upstream of the cofferdam). Routine Seqwater monitoring of water quality in Lake Macdonald maybe used where requirements overlap. **Six Mile Creek Downstream Sites and Control Sites** Before drawdown:

Environmental objective: Minimise impact of lowering on water quality in Lake Macdonald and Six Mile Creek.	
	• In the month before lake drawdown begins, install a logging device for real-time monitoring of temperature, pH, dissolved oxygen, EC, and turbidity at downstream monitoring site SMCDS02. • In the month before lake drawdown begins, fortnightly monitoring of COD, nutrients (nitrate, ammonia and total phosphorus) and suspended solids, and visual observations for oil slicks, at the downstream monitoring sites SMCDS01, SMCDS02 and SMCDS04. • In the month before lake drawdown begins, fortnightly monitoring of temperature, pH, dissolved oxygen, EC, and turbidity at downstream monitoring sites SMCDS01 and SMCDS04. • In the month before lake drawdown begins, fortnightly monitoring of temperature, pH, dissolved oxygen, EC, and turbidity, nutrients (nitrate, ammonia and total phosphorus), suspended solids, temperature, pH, dissolved oxygen, EC and turbidity, and visual observations for oil slicks at upstream control sites SMCUS01 and CU02. <u>During drawdown:</u> • Real-time monitoring of temperature, pH, dissolved oxygen, EC, and turbidity at the downstream monitoring site SMCDS02. • Fortnightly monitoring of nutrients (nitrate, ammonia and total phosphorus), suspended solids, and visual observations for oil slicks, at the downstream monitoring sites SMCDS01, SMCDS02 and SMCDS04. • Fortnightly monitoring of temperature, pH, dissolved oxygen, EC, and turbidity at downstream monitoring sites SMCDS01 and SMCDS04. • Fortnightly monitoring of temperature, pH, dissolved oxygen, EC, and turbidity nutrients (nitrate, ammonia and total phosphorus), suspended solids, temperature, pH, dissolved oxygen, EC and turbidity, and visual observations for oil slicks at upstream control sites SMCUS01 and CU02. <u>During construction:</u> • Real-time monitoring of temperature, pH, dissolved oxygen, EC, and turbidity at downstream monitoring site SMCDS02. • Monthly monitoring of nutrients (nitrate, ammonia and total phosphorus), suspended solids, and visual observations for oil slicks, at the downstream monitoring sites SMCDS01, SMCDS02 and SMCDS04. • Weekly monitoring of temperature, pH, dissolved oxygen, EC, and turbidity at the downstream sites SMCDS01 and SMCDS04. • Weekly monitoring of temperature, pH, dissolved oxygen, EC, and turbidity at the upstream control sites SMCUS01 and CU02. • Monthly monitoring of nutrients (nitrate, ammonia and total phosphorus), suspended solids, temperature, pH, dissolved oxygen, EC and turbidity, and visual observations for oil slicks at the upstream control sites SMCUS01 and CU02. <u>Post construction:</u> • Quarterly (for 1-year post-construction) in conjunction with habitat monitoring (refer to Appendix F), monitoring of temperature, pH, dissolved oxygen, EC, and turbidity COD, suspended solids, nitrate, ammonia, total phosphorus (laboratory analysed) at downstream sites SMCDS01, SMCDS02 and SMCDS04, and upstream control sites SMCUS01 and CU02.
Reporting	• A succinct baseline (before drawdown) water quality memorandum will be provided to the Seqwater Project Manager and regulatory agencies (if requested). • Daily reporting during drawdown and construction will be provided to Seqwater Project Manager where exceedances are recorded by loggers, with reports provided via a brief summary email and MS Excel spreadsheet. • Weekly reporting during drawdown and construction will be provided to Seqwater Project Manager where no exceedances are recorded via a brief summary email and spreadsheet.

Environmental objective: Minimise impact of lowering on water quality in Lake Macdonald and Six Mile Creek.	
	• A summary report will be provided to regulatory agencies where monitoring indicates ongoing exceedances of any high trigger value for more than 3 consecutive monitoring events. • Quarterly reports will be provided during drawdown and construction to regulatory agencies summarising compliance and monitoring results.
Responsibility	Contractor – Site Supervisor or representative Monitoring to be implemented by suitably qualified persons.
Corrective actions	• Low trigger exceeded: – Compare water quality results against control site, historical and baseline results and evaluate for non-Project related influences. – Determine if additional monitoring of non-compliant parameter(s) in Lake Macdonald and Six Mile Creek is required, as relevant to the situation. – Check control measures are operational. – Assess the risk of environmental harm as a result of the low trigger being exceeded; assessment to be completed by a suitably qualified person, using an accepted risk framework. – If the risk for environmental harm is determined to be anything other than low, review management measures, including rate of release, and revise if appropriate. – Increase frequency of monitoring data review to prevent or prepare for high trigger exceedance. Increase monitoring frequency if relevant (i.e. non-real-time parameters). • High trigger exceeded: – Compare water quality results against control site, historical and baseline results and evaluate for non-Project related influences. – Assess the risk of environmental harm as a result of the high trigger being exceeded; assessment to be completed by a suitably qualified person, using an accepted risk framework. – If the risk for environmental harm is determined to be anything other than low, take corrective actions as per below: – Reduce the release rate if the relationship with the exceedance is uncertain or pause the release if there is a clear or likely relationship with the exceedance – only reinstate the release to the initial rate if the cause of the exceedance has been identified and is not associated with the release rate. – Check relevant control measures (e.g. sediment controls if turbidity is high) are operational and, if required, reduce or pause releases until measures are reinstated/repaired. – Review management measures relevant to the exceedance, including scheduled rate of release, and revise if appropriate (i.e. if existing measures are insufficient or not functioning as expected). – Attempt to identify cause of non-compliance with trigger value (if not clearly related to existing control and management measures). – Implement incidental fauna salvage as per section 5.5.4.1 if deemed necessary by the Seqwater representative and suitably qualified persons (based on a risk assessment for aquatic fauna). – Undertake additional monitoring of non-compliant parameter(s) in Lake Macdonald and Six Mile Creek, as relevant to the situation. Assess if water quality monitoring sites should be extended downstream temporarily to understand the spatial distribution of poor water quality.

Environmental objective: Minimise impact of lowering on water quality in Lake Macdonald and Six Mile Creek.	
	• Implement temporary shutdown of releases where automated monitoring results indicate the high trigger threshold has been exceeded for more than 24 consecutive hours, until cause or likely cause for exceedance has been determined, and appropriate controls have been implemented. • If a particular non-compliance is an ongoing occurrence, review the suitability of monitoring parameters and trigger thresholds with respect to risk of environmental impacts. Changes are not to be implemented without sound evidence and agreement of the Seqwater representative, and with relevant consideration of change management in Project regulatory approvals. • If after all the above mitigation measures and corrective actions have been implemented yet the high trigger threshold has been exceeded for more than 3 consecutive days then construction works must stop. Construction can only restart once the cause of the exceedance has been confirmed and a suitable control measure implemented.

4. Erosion and Sediment Control Management Plan

4.1 Baseline Conditions

4.1.1 In Lake Macdonald and Six Mile Creek

Surface geology mapping indicates that Lake Macdonald and Six Mile Creek are within a drainage channel composed of Quaternary Alluvium overlying Upper Triassic-Jurassic aged Myrtle Creek Sandstone. Triassic Kin Kin Beds outcrop to the east of Lake Macdonald and host a Tertiary aged rhyolite intrusion, and the Jurassic aged Tiaro Coal Measures outcrop further east.

Bore logs show that Lake Macdonald is positioned on top of clay that reaches a depth between 3 m and 21 m below ground level. The alluvium is thought to be largely comprised of fine-grained overbank sediments, rather than coarser channel deposited materials. Field surveys conducted by frc environmental noted that the substrate in Lake Macdonald was dominated by silt with some sand near the banks, while in Six Mile Creek downstream of the dam the substrate was dominated by clay and silt, with gravel and occasional bedrock. Silt and sand are highly mobile sediments.

Sediment quality has not been assessed in detail for the Project, as geology and soils are not expected to be affected. However, the potential for acid sulphate soils to occur in Lake Macdonald was assessed and determined to be unlikely (refer to section 15 of the IAR).

Geomorphic processes have created pool-riffle habitat sequences throughout Six Mile Creek. Pool features in the creek are likely subject to natural bed scour that maintains their channel form (if these events do not occur naturally then over time the pools become shallower, assuming continued sediment supply). Coarse sediment scoured from pool features is typically deposited immediately downstream on riffle features (these are natural deposition processes during floods), while fine sediments are transported further downstream.

4.1.2 Baseline Monitoring

Baseline monitoring of erosion will be completed in Six Mile Creek in the month before lake drawdown begins to establish existing conditions (e.g. areas of scouring and / or deposition) downstream of the dam. The monitoring location will be located at demonstrably representative areas of Six Mile Creek, as a basis for comparison with potential changes during the lake drawdown.

No additional baseline monitoring of sediment in Lake Macdonald is proposed.

4.2 Potential Impacts of Lowering Lake Macdonald

4.2.1 Within Lake Macdonald

The drawdown process for Lake Macdonald could potentially lead to erosion and sedimentation in the lake area, particularly in areas with mobile sediments such as silt and sand. Erosion and sedimentation may also occur after the drawdown, during the 36-48-month period that the lake is lowered. However, the current magnitude of drawdown is limited to approximately the top 2.3 m of the storage. This is within the normal operating range of the storage, and therefore risks associated with erosion and sedimentation are low. Drawdown rates are targeted for approximately 11% of the lake FSL each week (relative to inflows and operational demand). This loss is proposed to occur over a minimum of 4 weeks and as such, roughly allows for a drop of water level of approximately 0.58 m per week (~10 cm/day). Noting this, water quality monitoring will be continually assessed to determine if the lake drawdown it causing erosion issues across the exposed bed & banks within Lake Macdonald.

It is possible that minor erosion of the bed and banks of Lake Macdonald may be caused by wind and / or rainfall events, and associated surface runoff, while the lake is lowered.

Lake Macdonald contains extensive beds of Cabomba (*Cabomba carolina*), along with other aquatic plants. The presence of these aquatic plants will minimise the potential for erosion in the areas where they occur as their roots

help bind the sediment and, when the water level is lower, the dying plants will cover sediment that would otherwise be exposed.

Visual inspections of the lake's exposed banks will be undertaken to determine if any unforeseen erosion issues are becoming apparent. Active stabilisation efforts can then be deployed if such occurrences become apparent. Such efforts would include stabilizing exposed sediments with erosion control sprays and non-invasive grasses, and in more significant erosion areas developing a site-specific ESCP and remediation plan.

4.2.2 Downstream of Lake Macdonald (Six Mile Creek) Dam

The drawdown of Lake Macdonald may potentially lead to erosion and sedimentation in Six Mile Creek through the release of water from the lake into the creek. In particular, there is a risk of erosion if the water is not discharged with suitable scour protection in place at the discharge location. Sedimentation may also occur in Six Mile Creek if there is a high sediment load in the water being discharge from the lake.

There is also a risk of erosion and/or movement of woody debris through the flow of water in the drawdown phase; however, this has low likelihood as drawdown rates will be well below naturally occurring flow rates. Based on fluvial geomorphology assessment, there appears to be enough roughness along Six Mile Creek, both on the channel bed and banks, to limit boundary shear stress and provide resistance to fluvial entrainment and mass wasting processes. However, minor fluvial entrainment of the bank and bed or reorganisation of instream wood may still occur. This would also be expected during natural events of similar magnitude. These minor fluvial entrainment processes include entrainment and transport of unconsolidated fine sediments on the bed of Six Mile Creek until natural bed armouring occurs, whereby entrainment of bed sediments will cease until reactivated by a higher boundary stress.

Where erosion occurs, or the discharged water has a high sediment load, the mobilised sediment may be carried downstream and deposited over the substrate and aquatic plants in Six Mile Creek. This has potential implications for water quality and habitat condition and could subsequently affect aquatic fauna, noting risks associated with this are low. Sedimentation associated with releases is likely to be temporary, as subsequent high flow events will entrain and transport the deposited sediments to locations further downstream. Six Mile Creek experiences frequent flow events and so the turnaround is expected to be in the order of weeks under a typical flow regime. Sedimentation may be more prolonged under low flow conditions or if substantial volumes of sediment are deposited, noting this is not expected to occur.

4.3 Management and Monitoring

Table 4-1: Management of erosion and sediment during the lowering of Lake Macdonald

ENVIRONMENTAL OBJECTIVE: **Minimise environmental impact by preventing soil loss and erosion.**	
Performance criteria	**Lake Macdonald** • The risk of erosion within Lake Macdonald after drawdown is managed and mitigated. • No establishment of head-cut erosion. • No detrimental change in structure of lake margin while exposed (from erosion). • Gully erosion locations within exposed bed and banks are identified and managed. **Six Mile Creek Downstream** • Geomorphic impacts on Six Mile Creek as a result of the drawdown and construction phase activities are managed and mitigated. • Achieve monitoring limits identified in Appendix F (Habitat Monitoring Program, Table 16-6) – bank height, substrate composition, and bank and bed erosion.
Management measures	**General** • Engage a suitably qualified person to monitor and advise on planned and responsive mitigations measures through the drawdown and construction phases. **Lake Macdonald** During drawdown and construction:

ENVIRONMENTAL OBJECTIVE: Minimise environmental impact by preventing soil loss and erosion.	
	• Place intake pipes for drawdown equipment in top half of water column, to minimise disturbance of bed sediments and organic matter, for example by using a pontoon-based pump station or floating intake structure. • If it does not interfere with works or cause a hazard, allow Cabomba and other exposed aquatic plants to decompose in situ. • Where appropriate for the site conditions and drawdown timing, use erosion control sprays to stabilise exposed sediment. The scope for use of erosion control will be limited by constraints, such as safe access, and will be focused on high-risk areas susceptible to erosion (e.g. gullies): – An assessment of high-risk areas susceptible to erosion shall be undertaken by a suitably qualified person and reviewed at intervals suitable to the changing conditions. – Any erosion control sprays must be suitable for use in aquatic ecosystems, as well drinking water sources (noting that Lake Macdonald will not be used to supply water during construction, but any risks relating to return to service must be assessed). • Comply with the construction erosion and sediment control plan, and stormwater management plan. **Six Mile Creek Downstream** During drawdown and construction: Drawdown to occur over not less than 4 weeks. Discharge drawdown releases in a manner that dissipates energy and prevents scour at the discharge point. For example, discharge onto the concrete apron on the downstream side of the Lake Macdonald spillway, use diffusers or spray nozzles, and / or energy dissipation methods such as riprap to slow water flow. Comply with the construction erosion and sediment control plan and stormwater management plan. Ensure releases do not exceed bankfull height of Six Mile Creek.
Monitoring	**Lake Macdonald** • Weekly inspection of sediment and erosion control structures and measures. In wet weather more frequent monitoring will be necessary. • Daily monitoring of turbidity in Lake Macdonald (refer to Table 3-1). • Monthly visual monitoring of any potential erosion & sediment issues occurring throughout the lake edges. These inspections would be incorporated into the monthly fauna inspections described in Table 5-2. **Six Mile Creek Downstream Sites and Control Sites** Before drawdown: • Undertake baseline phase monitoring of erosion at the downstream monitoring locations and the upstream control sites, as outlined in (Habitat Monitoring Program). During drawdown: • Undertake drawdown phase monitoring of erosion at the downstream monitoring sites and upstream control sites, as outlined in Appendix F Habitat Monitoring Program. During construction: • Undertake construction phase monitoring at the downstream monitoring sites and upstream control sites, as outlined in Appendix F Habitat Monitoring Program. Post-construction: • Undertake post-construction phase monitoring at the downstream monitoring sites an upstream control sites, as outlined in Appendix F Habitat Monitoring Program.
Reporting	• Weekly report to Seqwater Project Manager via email that includes details of monitoring, audits, non-compliances, complaints, and incidents. • Report any erosion issues to the Supervisor immediately. • Quarterly report provided to regulatory agencies summarising compliance and monitoring results.
Responsibility	Seqwater – Project Manager or representative (in relation to the lake lowering). Contractor – Site Supervisor or representative (in relation to the lake lowering).
Corrective actions	• If sedimentation or erosion exceeds the triggers defined in Habitat Triggers (Habitat Monitoring Program) and in Table 6-1, review management measures, including rate of drawdown release (slow or pause if needed), and implement additional control measures where required.

ENVIRONMENTAL OBJECTIVE: Minimise environmental impact by preventing soil loss and erosion.	
	• Where turbidity thresholds in Table 3-1 are exceeded, review management measures, including rate of drawdown release (slow or pause if needed), and implement additional control measures where required. • Amend erosion and sediment control management measures to account for changes in site conditions or treatment methods in the case of failure. • Revise erosion and sediment control plan where required.

5. Aquatic Flora and Fauna Management Plan

5.1 Baseline Conditions

The aquatic flora and fauna in Lake Macdonald and Six Mile Creek are described in detail in Section 5.1.1, including detailed descriptions of aquatic MNES and MSES species (Table 5-6). Brief summaries of aquatic flora and fauna in Lake Macdonald and Six Mile Creek downstream of the dam are provided below.

5.1.1 Flora and Fauna in Lake Macdonald and Six Mile Creek Downstream

5.1.1.1 Aquatic Plants

Lake Macdonald contains a dense cover of Cabomba, which is a restricted biosecurity matter, scattered native water snowflake (*Nymphoides indica*), and isolated occurrences of other native aquatic plants. Hygrophila (*Hygrophila costata*), which is also a restricted biosecurity matter, occurs along the margins of the lake. No threatened aquatic plant species is known to occur in Lake Macdonald.

There are few aquatic plants in Six Mile Creek downstream of Lake Macdonald, due to extensive shading by riparian vegetation, though there are isolated occurrences of Cabomba and water snowflake.

5.1.1.2 Fish

Approximately 26 native fish species are known or likely to occur in Lake Macdonald and Six Mile Creek downstream. Of these, several do not occur upstream of the Lake Macdonald (Six Mile Creek) dam wall (e.g. Pacific blue eyes) or were stocked in Lake Macdonald (e.g. saratoga, yellow belly).

Three previous surveys of the lake in 2016, 2023 and 2024 have not recorded any Mary River cod or lungfish from Lake Macdonald. All previous surveys used boat electrofishing, a method that is considered the most effective for catching these species. Records indicate that at least 112,730 Mary River cod fingerlings were released to Lake Macdonald between 1983 and 2015, with 6,430 released to Six Mile Creek (MRCCA 2016). Six Mile Creek is considered to harbour an important relict population of Mary River cod (Simpson & Jackson 2000), and the high stocking rate suggest that this species has the potential to occur in Six Mile Creek and Lake Macdonald. There are no records of Australian lungfish being stocked in Lake Macdonald or Six Mile Creek. Additionally, there have been no confirmed sightings of lungfish by long-term Seqwater ranger staff within the lake. Lungfish routinely gulp air at the surface of the water and are regularly observed in sites where they occur. Large numbers of yellow belly and Australian bass have also been stocked to Lake Macdonald. This suggests that the abundance of large bodied fish in Lake Macdonald could be high.

Five pest fish are known from the area: eastern Gambusia (*Gambusia holbrooki*), platy (*Xiphophorus maculatus*), swordtail (*Xiphophorus hellerii*), guppy (*Poecilia reticulata*) and tilapia (*Oreochromis mossambicus*). Gambusia and tilapia are restricted biosecurity matters. No tilapia has been recorded upstream of the dam wall.

5.1.1.3 Turtles

Four species of turtle have been recorded from Six Mile Creek and Lake Macdonald, with diversity and abundance higher upstream of the dam wall than in Six Mile Creek downstream. These are: Krefft's river turtle (*Emydura macquarii*), saw-shelled turtle (*Wollumbinia latisternum*), eastern long-necked turtle (*Chelodina longicolis*) and broad-shelled river turtle (*Chelodina expansa*). Krefft's river turtle, and possibly saw-shelled turtle, are abundant in Lake Macdonald. White-throated snapping turtle and Mary River turtle, which are MNES, have not been caught in Six Mile Creek or Lake Macdonald. Field surveys and literature review suggest that these species may occur in low abundance in the lower reaches of Six Mile Creek, but it is considered unlikely that these species would be present in Lake Macdonald.

5.1.1.4 Other Fauna

Platypus are known to occur within Lake Macdonald, in the upper reaches of the lake, in Six Mile Creek upstream of the lake, and Six Mile Creek downstream of the dam (SMEC, 2023). This species is listed as Special Least Concern in Queensland's *Nature Conservation (Wildlife) Regulation 2006*, but is not a threatened species.

5.1.1.5 Amphibians

Six amphibian species are known to occur in the vicinity of Lake Macdonald, including two threatened species and four least concern species. Giant barred frogs were heard calling downstream along Six Mile Creek; however, field survey results suggest that only a low density population is present. No giant barred frogs were identified around Lake Macdonald; however, while the habitat around the lake was considered largely unsuitable for this species, it was not possible to survey the entire extent of the lake and there is some potential for the giant barred frog to be present. There is also potential for this species to occur in Six Mile Creek upstream of the Lake Macdonald full supply level.

Field surveys conducted in 2018 and 2023 recorded the tusked frog along Collwood Road, in the upper reaches of Lake Macdonald and within the ponds of the Noosa Botanical Gardens.

Other least concern species observed include sedgefrog (*Litoria fallax*), graceful treefrog (*Litoria gracilenta*) and striped marshfrog (*Limnodynastes peronii*). Cane toads (*Rhinella marina*), which are a restricted biosecurity matter, occur in the Project area.

5.1.2 Baseline Monitoring

Determining baseline populations of fauna typically requires long-term study. Additional baseline monitoring will not be undertaken in Six Mile Creek downstream to supplement existing information. Instead, it has been assumed that threatened fauna (i.e. MNES and MSES) are present in Six Mile Creek downstream of the dam wall and suitable management measures will be implemented accordingly.

Baseline survey of fish biomass in Lake Macdonald was completed by InfoFish (2019, Appendix I) using hydroacoustic monitoring and advanced data processing. Results indicated that the maximum number of large bodied fish (i.e. >200 mm total length) in Lake Macdonald was 17,671 (±1,300), and the maximum number of small bodied fish was 37,698 (± 3,209). The baseline biomass surveys indicated that Australian bass was the most abundant large bodied species in Lake Macdonald.

Additional baseline monitoring in Lake Macdonald to supplement biomass with species composition will not be undertaken. It has been assumed that threatened fauna (i.e. MNES and MSES) are present in Lake Macdonald and suitable management measures will be implemented. An evaluation survey in Lake Macdonald will be completed before the drawdown, as outlined in section 5.5.3 and Table 5-5, to familiarise teams with the site and the proposed salvage methods. The evaluation survey will also allow for targeted survey to estimate potential presence of threatened fauna in the upper reaches of the lake.

5.2 Matters of National and State Environmental Significance

MNES are protected under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC). MSES species are protected under Queensland's *Nature Conservation Act 1992* (NCA). NCA and EPBC species that have the potential to occur within Lake Macdonald and Six Mile Creek are listed in Table 5-1. The identified habitat for these species within the study area is provided in Section 6.

Table 5-1: Species listed under the NCA and EPBC

Species	Key habitat	Known Locations (as of October 2023)	Likelihood of occurrence in Lake Macdonald and Six Mile Creek
Australian lungfish (*Neoceratodus forsteri*)	Wide, slow flowing or still permanent reaches with deep pools (1 m – 3 m). Low flow conditions above 10 cm. Prefer areas with submerged logs, high	The closest record is in Six Mile Creek near the tailwater pool.	Moderate. Minimal suitable habitat is present in Lake Macdonald and Six Mile Creek. One individual has been recorded in Six Mile Creek near the tailwater pool, but an important population of this species does not occur in Six Mile Creek.

Species	Key habitat	Known Locations (as of October 2023)	Likelihood of occurrence in Lake Macdonald and Six Mile Creek
	aquatic plant cover and underwater crevices.		
Mary River cod (*Maccullochella mariensis*)	Shaded pools within complex in-stream structures (i.e. woody debris, crevices). Water depths of 1 m – 3 m. Slow flowing water	The closest record is within 20 m of the Dam wall in Lake Macdonald and also in Six Mile Creek near the tailwater pool.	High. Suitable habitat is present in Lake Macdonald and Six Mile Creek. Three individuals recorded in Six Mile Creek near the tailwater pool, spawning Mary cod recorded in the creek downstream of the dam (Dunlop 2016), and large numbers stocked to Lake Macdonald and Six Mile Creek.
Giant barred frog (*Mixophyes iterates*)	Rainforest and wet sclerophyll forest, occasionally adjacent farmland Moist riparian habitats with deep leaf litter	The closest record is 185 m downstream of Six Mile Creek.	High. Suitable habitat is present in the downstream tributaries of Six Mile Creek and is likely to be present upstream of the dam full supply level. Individuals were recorded downstream during the site survey in 2018.
Tusked frog (*Adelotus brevis*)	Wet eucalypt forest, rainforest, and occasionally dry eucalypt forest. Occur near slow moving sections of streams, stagnant ponds, and dams.	Recorded along Collwood Road, in the upper reaches of Lake Macdonald and within the ponds of the Noosa Botanical Gardens.	High. Wet eucalypt forest has been identified in the vicinity of Six Mile Creek and Lake Macdonald. Two individuals were recorded during the site survey in 2018 and an additional two were recorded during the 2023 survey.
Mary River turtle (*Elusor macrurus*)	Permanent streams and large pool habitats. Sparsely vegetated, north-facing sloping sandy river banks.	Six Mile Creek has not been identified as a Mary River tributary known to contain a significant population of this species. Indeed, the MNES search did not predict the species to occur within 10 km of the Study area and there are no locality records of the species.	Low. Minimal sparsely vegetated sloping sandy river banks present. No individuals were recorded during the site survey and no records within 10 km.
White-throated snapping turtle (*Elseya albagula*)	Permanent, clear, well oxygenated flowing water. Complex habitat structures (i.e. woody debris and undercut banks). Sandy- gravel substrates	Six Mile Creek has not been identified as a Mary River tributary known to contain a significant population. There are no locality records within 10 km of Study area.	Low. Minimal suitable habitat present, with no apparent breeding habitat. No individuals have been recorded in Lake Macdonald or Six Mile Creek downstream of the dam.
Platypus (*Ornithorhynchus anatinus*)	Permanent water surrounding stable earthen banks, held by native overhanging vegetation. Woody debris and cobbled habitats.	Recorded within Lake Macdonald, in the upper reaches of the lake, in Six Mile Creek upstream of the lake, and Six Mile Creek downstream of the dam.	High. Suitable habitat is present in the downstream and upstream tributaries of Six Mile Creek. Observed in the downstream extent of Six Mile Creek around Site 2 and recorded in 2023 surveys upstream of Site 7 entering the water from a burrow. Platypus records obtained from WildNet, the Australian Conservancy Foundation Platy-Project and the Australian Platypus Foundation, show records within the upper reaches of Lake Macdonald, upstream and downstream of Six Mile Creek and within Lake Macdonald adjacent to the water treatment plant.

5.3 Potential Impacts of Lowering Lake Macdonald

5.3.1 Within Lake Macdonald

The drawdown of Lake Macdonald and construction phase of the Project, may impact aquatic flora and fauna in the lake via:

- Impacts to water quality in the lake (see section 3.2.1)
- Lowering the lake level will cause submerged and floating vegetation to die in areas where the water is no longer sufficient to support them, which may result in the following impacts:
  - If algae or aquatic plants die quickly and sink to the bottom of a body of water, decomposition increases, accelerating oxygen consumption resulting in lowered dissolved oxygen levels.
  - Humic acid forms when organic material decomposes which can lead to a decrease in the pH of the water.
  - Decomposing vegetative matter produces methane in an anaerobic setting (where there is an absence of oxygen i.e. under water), which can result in objectionable odours. Conversely, in areas that become completely dry following the drawdown, organic material will be decomposing in the presence of oxygen, i.e. aerobically. Aerobic decomposition uses oxygen, resulting in the production of carbon dioxide instead of methane. Therefore, decomposition of organic matter on areas of dry lake bed will not produce an objectionable odour.
- The spread of aquatic biosecurity matters such as pest species, weeds, and disease (see section 7)
- Stranding of biota in workspace created by the coffer dam waterbody, and exposure to poor water quality.
- Risk of injury or mortality to fauna due to machine strike / crush injuries if fauna move into the construction areas.
- Injury or mortality of fauna from pumping equipment which could result in individuals becoming susceptible to pathogens and disease. Alternatively, aquatic fauna may become fatally injured by pumping equipment or be trapped within pumping equipment and consequently drown. The mitigations described below ensure risk is low.
- Stranding of fauna in shallow isolated pools or burrows as water levels decline as Lake Macdonald is lowered, which may increase predation (e.g. predation of smaller fish by larger fish and / or birds), and / or competition leading to crowding. Inflows may also wash fauna, in particular small fish and tadpoles, into the lake during drawdown and construction. Crowding may result in reduced dissolved oxygen concentrations in water, reduced food supply, and increased stress on fauna. As small, isolated pools evaporate, or in areas that are dewatered rapidly, there is a risk that aquatic fauna could become stranded on dry areas. However, the risk associated with this source of potential impact is low because the rate and magnitude of dewatering is limited.
- After the drawdown phase, catchment inflows may refill the lake above RL 93 m AHD. This may result in re-flooding of areas which were subject to the aquatic fauna salvage operation conducted prior to the drawdown, creating new isolated pools which pose a risk to stranding of fauna. This scenario would only present a risk in the period between completing drawdown and demolition of the spillway.
- Loss of riparian and in-stream vegetation due to potential changes in livestock access.

Injury and mortality of turtles in construction workspaces, and on the spillway of the existing dam which may be utilised by turtles for basking. Similarly, turtles may be injured or killed on the spillway as they move downstream during spilling events. Current observations of turtles within the dam at 100% FSL indicate limited interaction (i.e. basking behaviour) on the dam spillway when access is expected to be facilitated through water level. Turtles are rarely seen on the spillway and few observations (i.e. 2-3) of turtles under the spillway have occurred within the last 15 years. Noting this, the low-flow slot section of the coffer design (with limited freeboard) will have continuous visual monitoring and any turtle interactions (i.e. basking/passage) can be addressed by the site environmental officer to remove or relocate fauna. If significant turtle interactions are noted to be occurring with the low-flow slot section of the cofferdam or the spillway then an investigation of potential solutions may be undertaken as a corrective action (i.e. exclusion engineering solution). Therefore, while turtles may access the spillway section cut to 89.5 m AHD, the majority of the water will be maintained by the cofferdam allowing observation of interactions with the turtle at the low-flow slot section of the cofferdam as a proxy for specific management of turtles at the existing spillway. As such,

the current risk is considered low due to the restriction of access to a small section of the cofferdam and limited evidence of current use of the spillway for basking or passage.

The release of water downstream to Six Mile Creek may impact aquatic flora and fauna via:

- Impacts to downstream water quality (see section 3.2.2)
- Changes in the downstream flow conditions during drawdown, which could affect breeding success and habitat conditions
- The spread of aquatic biosecurity matters such as pest species, weeds, and disease (see section 7).

The release of water into Six Mile Creek during the drawdown of Lake Macdonald may impact aquatic fauna through the creation of a high flow event that could transport fauna downstream or trigger behaviour that would usually occur at another time (e.g. breeding migration). However, limiting the drawdown to a minimum 4 week period ensures that this source of potential impact has low risk.

The release of contaminated water from the stilling basin could adversely impact aquatic biota in the downstream Six Mile Creek.

Habitat condition and availability may also be impacted where water released from Lake Macdonald leads to:

- Erosion or sedimentation (refer to section 4), which has ow level of risk
- Disturbance of physical habitat structures (refer to section 6.2.2), which has low level of risk
- High flows or prolonged inundation at times when they would not otherwise occur.

5.4 Management and Monitoring

Potential risks to aquatic flora and fauna will be mitigated by implementing the measures identified in Section 5.3. Where appropriate, the management measures contained in Table 5-2 will be adapted over the course of the Project in response to changing conditions and expert advice.

In addition to the measures described in Table 5-2, monitoring of aquatic habitat, including key habitat features that support MNES and MSES, will be undertaken as a preliminary indicator of potential impacts to aquatic fauna. This monitoring is described in 5.1.2 and Table 6-1.

Management measures for flora and fauna and aquatic habitat have been developed with regard to the relevant recovery and threat abatement plans for MNES species potentially affected by the project. The management measures are designed to:

- Salvage large bodied fish from Lake Macdonald during drawdown, and periodically during construction if required
- Salvage aquatic biota from the stilling basin on an as needed basis (e.g. prior to all waterbody dewatering events, and when poor water quality is detected)
- Protect existing habitat present in and downstream of the project area through the implementation of habitat management measures
- Protect or rehabilitate breeding habitat, where present
- Maintain a variable flow regime downstream of the lake, determined by inflows
- Reduce potential impacts to water quality in Six Mile Creek downstream of the dam
- Avoid breeding periods for MNES species know to occur in the lake and Six Mile Creek downstream
- Not facilitating the spread of pest species
- Support the on-going operation of the Mary River cod hatchery during the project
- Rehabilitate habitat, where appropriate, and restock Mary River cod in Lake Macdonald.

A summary of the advice, key threats, and abatement / management actions, and where this has been incorporated in the plan is provided in Table 5-3.

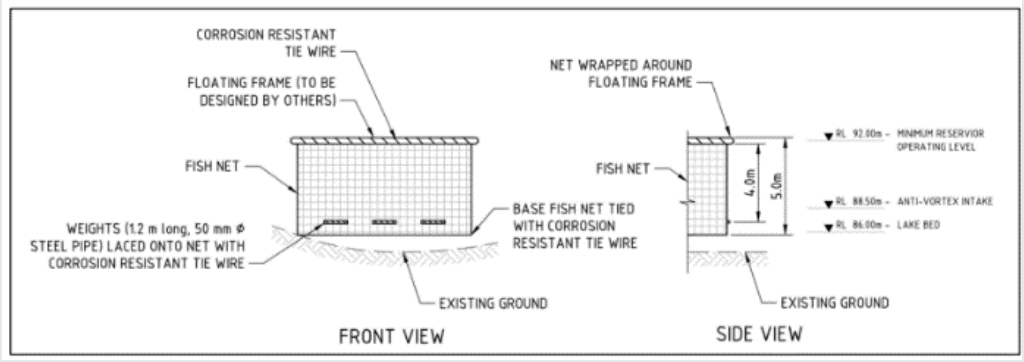
Table 5-2: Management of aquatic flora and fauna during the lowering of Lake Macdonald

ENVIRONMENTAL OBJECTIVE: **Minimise impact of lake drawdown on aquatic flora and fauna.**	
Performance criteria	**Lake Macdonald** • Prevent or minimise potential impacts to aquatic fauna in Lake Macdonald, in particular listed threatened species, where minimise means the impact is temporary and reversible. • Achieve the aquatic habitat performance criteria identified in Table 6-1. • 95% survival rate* for any MNES fauna captured during salvage and fauna relocation activity (based on advice from the QLD Department of Agriculture and Fisheries Animal Ethics Committee, where a 5% attrition rate is acceptable during fish sampling and research activity). No increased mortality of all MNES fauna remaining in Lake Macdonald. **Six Mile Creek Downstream** • Prevent or minimise potential impacts to aquatic fauna in Six Mile Creek, in particular listed threatened species, where minimise means the impact is temporary and reversible. • Achieve the aquatic habitat performance criteria identified in Table 6-1.
Management measures	**Lake Macdonald** Before drawdown: • Undertake an evaluation survey using methods identified in Table 5-5, with a focus on the upper reaches, for: • Large-bodied fish – specifically MNES species (including salvage of these species). • Small bodied fish – recording species and their abundance. • Platypus – Initially undertake eDNA sampling. Use results to inform locations for setting up camera traps in and around active burrows to monitor ongoing presence. • Turtles – MNES listed and common species, using methods outlined in DSEWPC (2011). • Tadpoles – identify and record abundance of barred frog tadpoles (genus *Mixophyes*) caught incidentally using fish and turtle survey methods. If *Mixophyes* tadpoles are detected, species determination should be undertaken. • The evaluation survey may be modified to include activities such as evaluation of biomass and pre-drawdown commencement of aquatic fauna salvage and relocation. • Seqwater will work with individual landholders to ensure stock movements are prevented from moving outside their existing properties. During drawdown: • Gradual initial lowering of lake from FSL (RL 95.3 m AHD) to ~42% FSL (RL 93 m AHD) over a period of no less than a four-week period to allow fauna to adapt to reduced water level. • Begin the drawdown program outside of platypus breeding season (August to October). • Avoid undertaking initial lake drawdown in hot conditions (e.g. summer months). • Manage water quality as described in section 3. • Siphon inlets have been nominated with bell mouth style designs with anti-vortex plates attached to reduce head losses and minimise inlet flow velocities. Diamond mesh nylon netting (9 mm x 9 mm apertures) has been designed to attach to a float around the inlets at a distance where the geometric design of the fish frame ensures flow velocities do not exceed 0.1m/s to prevent fish attraction. These sizing calculations are based on a 60% blockage factor. The geometry of the fish net frame is such that it needs to be finally connected in the water with the assistance of divers, specifically to ensure a fully connected net between the pipes and under the anti-vortex plate. All pipe welding of the frame pieces will be assembled in the laydown and moved into the lake. The net will also be assembled in five pieces four vertical sides and the piece around the bottom making a complete seal, complete with lower weights. The divers will complete the connection of the frame to the siphon pipes as well as the final stitching of the nets together, ensuring the correct clearance and that the net is not snagged on

ENVIRONMENTAL OBJECTIVE:

Minimise impact of lake drawdown on aquatic flora and fauna.

the lakebed.



- To reduce harm to downstream moving fish and turtles the syphon system will be used to reduce the extent of overtopping flow events during construction. This will divert flows around construction site and reduce rates of spilling. Hydraulic modelling shows that the cofferdam spillway will have a flow depth >100 mm only 5 days per year.
- During any drawdown activity in construction phase use intake exclusion screens of suitable design (9 mm x 9 mm aperture) to prevent fish and turtles from being entrained into syphon system.
- To reduce harm to any downstream moving fish and turtles during spilling events, the cofferdam has been designed to reduce risks to both fish and turtles. The design includes maintaining a 30% tailwater depth to spillway height, use of non-abrasive surfaces, eliminating potential impact points and a spillway design with no freefall sections.'
- Implement an aquatic fauna salvage plan to prevent crowding and stranding (see section 5.5) – platypus will not be relocated unless absolutely necessary (as noted in section 8.2.6).
- The existing bubble plume destratification unit will be maintained and will run continuously for the life of the project, providing aeration of the water in Lake Macdonald. If the trigger values for relevant parameters or signs of fish distress are identified and it appears that the destratification unit is not working or there are insufficient inflows, additional measures to restore water quality will be investigated. This will include additional proven aeration devices or methods.
- Do not handle frogs unless relocation is necessary or they appear stranded. If handling is necessary, follow the protocols in section 8.2.5.
- Manage biosecurity matters as described in section 7.
- Manage aquatic habitat as described in section 6.

During construction:

- Implement aquatic biota salvage from the stilling basin as needed.
- The presence of turtles basking in the work space and dam spillway areas will be monitored and if deemed to present an issue specialist advice will be sought on how to best manage their exclusion. Refer to Section 5.3.1.
- Do not handle frogs unless relocation is necessary or they appear stranded. If handling is necessary, follow the protocols in section 8.2.5.
- Monitoring is to be undertaken of areas in the lake which have been re-inundated following a significant inflow (after the initial fish salvage program) to identify if fauna has been stranded in new isolated pools.
- If catchment inflows result in the lake refilling above RL 93 m AHD, the temporary FSL will be actively managed by diverting inflows up to a practical upper limit of 5 m^3/s with drawdown potentially occurring as within 11 days (from FSL to RL93.0) post drawdown. This will allow fauna to adapt to the reduced water level.
- Manage biosecurity matters as described in section 7.
- Manage aquatic habitat as described in section 6.

Six Mile Creek Downstream

During drawdown:

- Release rate tailored to achieve drawdown over a period of not less than four weeks to minimise artificial impacts associated with elevated flow velocity and depth.

ENVIRONMENTAL OBJECTIVE: Minimise impact of lake drawdown on aquatic flora and fauna.	
	• Ensure releases do not exceed bankfull height of Six Mile Creek. • The drawdown is to avoid releases during the breeding seasons for Mary River cod, platypus and giant barred frog, which are known to be in Six Mile Creek downstream of the dam, by conducting drawdown between March and October (refer to section 2.2). • Implement an aquatic fauna salvage plan to prevent stranding (see section 5.5) following high flow pulses – platypus will not be relocated unless absolutely necessary (as noted in section 8.2.6). Do not handle frogs unless relocation is necessary or they appear stranded. If handling is necessary, follow the protocols in section 8.2.5. • Manage water quality as described in section 3. • Manage aquatic habitat as described in section 6. During construction: • Allow inflows to pass downstream. • Manage water quality as described in section 3. • Manage aquatic habitat as described in section 6. **Fauna Relocation Sites** During drawdown: • Weekly visual monitoring of sites where fauna have been relocated during the relocation program (e.g. observations of mortality) and measurement of in situ water quality (focusing on dissolved oxygen). **All Project Areas** All project stages: • All employees working on site to attend induction training sessions. Induction training sessions to include awareness of operating plan for Lake Macdonald during the works, in particular the proposed operating levels. Site inductions should also include protocols in the event of turtles being seen on the cofferdam crest or spillways and in the event of aquatic fauna being seen injured, in distress or dead at the worksite.
Monitoring	**Lake Macdonald** During drawdown: • Daily visual inspection of intake screens – ensure screens are functional, water approach velocity is at or below the limit noted as a mitigation, and no aquatic fauna are trapped against the screens. • Divers will perform an inspection and clean of the intake exclusion device. Initially this will be performed monthly. If weed build up and fauna entanglement is found to be negligible / insignificant then this activity will be scaled back in consultation with the project aquatic ecology expert. During construction: • Camera trap survey of platypus in upper dam reaches (continuous), and eDNA surveys quarterly. • Monthly visual monitoring of fauna in the lake to assess potential for fauna stress and need for adaptive management. • Daily visual monitoring of fauna in the stilling basin to assess potential for fauna stress. • Bi-annual turtle monitoring during September to April for the duration of the project construction period of turtle condition in lake using length weight measurements compared to baseline and evaluation survey data. All captured Mary River turtles and White-throated snapping turtles are to be marked using an approved method by DES prior to release. Measurements to be taken for each turtle are straight carapace length (CL), straight plastron length (PL) and mass (g). • Monthly visual monitoring and water quality measured in situ (dissolved oxygen) of the relocation sites six months after relocations efforts have finished (per schedule provided in Table 5-5) to assess potential for fauna stress and need for adaptive management. • Quarterly monitoring of fish condition in the lake, using length weight measurements compared to baseline and evaluation survey data. • Bi-annual turtle monitoring of turtle condition in lake using length weight measurements compared to baseline and evaluation survey data. Post Construction

ENVIRONMENTAL OBJECTIVE: Minimise impact of lake drawdown on aquatic flora and fauna.	
	• Quarterly monitoring (for one year post construction) of fish condition in the lake, using length weight measurements compared to baseline and evaluation survey data, and aquatic habitat monitoring (Appendix F) • Bi-annual turtle monitoring (for one year post construction) of turtle condition in lake using length weight measurements compared to baseline and evaluation survey data. All captured Mary River turtles and White-throated snapping turtles are to be marked using an approved method by DES prior to release. Measurements to be taken for each turtle are straight carapace length (CL), straight plastron length (PL) and mass (g). • Post construction platypus monitoring in the lake and in upstream reaches (12 months post construction). Undertake final eDNA and associated surveys to assess platypus recovery compared to evaluation survey baseline data. • Post construction monitoring to record abundance of barred frog tadpoles (genus Mixophyes) caught incidentally during fish and turtle survey projects outlined above. If Mixophyes tadpoles are detected, species determination should be undertaken. **Six Mile Creek Downstream Sites and Control Sites** To assess the impacts of flow releases during the project, Giant barred frog habitat quality assessments, fish community surveys and water quality monitoring will be undertaken before, during and after the lake drawdown period. Where possible these surveys should be conducted to minimise the impacts and handling of Mary River cod and avoid the breeding season where possible. These surveys should include existing monitoring sites (SMCDS01, SMCDS02, SMCDS04) where practical, or include additional alternative sites. Data to be readily available to mitigate any adverse impacts of flow releases. <u>During drawdown:</u> • Weekly aquatic habitat monitoring as described in Section 6 (and Appendix F), and observations of aquatic fauna for signs of stress, at downstream sites SMCDS01 and SMCDS04, and control sites SMCUS01 and CU02. • Following high flow pulses during drawdown visual monitoring surveys will be conducted at monitoring sites SMCDS01, SMCDS02, and SMCDS04 for potential stranding of fauna. <u>During Construction:</u> • Quarterly aquatic habitat monitoring as described in Section 6 (and Appendix F), and observations of aquatic fauna for signs of stress, at downstream sites SMCDS01 and SMCDS04, and control sites SMCUS01 and CU02. <u>Post construction:</u> • Quarterly (for one year) aquatic habitat monitoring as described in Section 6 (and Appendix F), and observations of aquatic fauna for signs of stress, at downstream sites SMCDS01 and SMCDS04, and control sites SMCUS01 and CU02. **Fauna Relocation Sites** <u>During drawdown:</u> • Weekly visual monitoring of sites where fauna have been relocated during the relocation program (e.g. observations of mortality) and measurement of in situ water quality (focusing on dissolved oxygen). <u>During construction:</u> • Monthly visual monitoring of sites for six months where fauna have been relocated during the construction phase (e.g. observations of mortality) and measurement of in situ water quality (focusing on dissolved oxygen). • From the completion of the drawdown phase until the dam construction is complete, bi-annual surveys will be conducted at relocation sites. These surveys, following the methodology outlined in the Freshwater Ecology (2020) report, will assess the survivorship of relocated MNES species, such as the Mary River cod.
Reporting	• DCCEEW will be notified within three (3) business days if any Mary River turtle or white-throated snapping turtle individuals are identified during salvage and relocation operations. • Weekly email to Seqwater Project Manager if there are no identified issues with fauna, water quality or aquatic habitat. • Daily email to Seqwater Project Manager if there are identified issues with fauna, water quality or aquatic habitat.

ENVIRONMENTAL OBJECTIVE: Minimise impact of lake drawdown on aquatic flora and fauna.	
	• Quarterly report provided to regulatory agencies summarising compliance and monitoring results. • DESI will be notified within three (3) business days if any MSES are identified during salvage and relocation operations. Notification will include species and the number of individuals identified.
Responsibility	Contractor – Site Supervisor or representative, using suitably qualified persons
Corrective actions	• Implement adaptive measures incorporated in the salvage plan (refer to section 5.5). • Review management measures if performance criteria are exceeded and amend if required. • Adjust lowering system intake screens if approach velocity criteria are not met. • If all the above mitigation measures and corrective actions are implemented and the habitat triggers in Appendix F Table 16-6 continue to be exceeded then the project needs to reduce or cease the lake drawdown and stop construction until an investigation confirms the cause of impacts and suitable remediation or mitigation measures are implemented to prevent ongoing impacts.

Table 5-3: Compliance with Conservation Advice, Recovery Plans and Threat Abatement Plans

Species	Key recovery plan/advice	Key threats relevant to the project	Key management actions	Compliance with this advice
Australian lungfish	Approved Conservation Advice for *Neoceratodus forsteri* (Australian lungfish) (11 April 2014)	Dams and impoundments (habitat loss, disturbance, movement barriers)	• Incorporation of fish passage devices (fishways) at dams and weirs. • Manage disruptions to water flows so water levels are not changing erratically. • Manage changes to hydrology.	• Offsite mitigation provided through construction of fauna biopassage at Gympie Weir – refer to IAR. • Drawdown releases will be relatively low tailored to achieve drawdowns in not less than 4 weeks (i.e. – refer to section 2. • Management measures will be implemented to minimise impacts to water quality and sedimentation, with flushing flows released if required – refer to sections 3.3 and 4.3.
		Exotic fish species	• Develop and implement a management plan for exotic fish, including tilapia and Gambusia.	• Management measures will be implemented to manage the potential spread of pest fish species – refer to section 5.5.9 and Table 7-1.
		Recreational fishing	• Ensure that impacts from recreational fishing are minimised. • Raise awareness of the conservation values of the species within the fishing community.	• Some recreation areas and activities at Lake Macdonald will remain open during construction: – The boat ramp at Lake Macdonald Park, next to the Noosa Botanic Gardens – Fishing, stand up paddle boarding, canoeing
		Clearing of riparian vegetation	• Engage with landholders responsible for land adjacent to waterways.	• Seqwater owns the adjacent land and clearing of riparian vegetation will be restricted to the footprint approved under the IAR – refer to Table 6-1 and the IAR.
Giant barred frog	Conservation Advice *Mixophyes iteratus* giant barred frog (Threatened Species Scientific Committee 13/07/2017) Recovery plan for stream frogs of south-east	Clearing of riparian and upstream vegetation	• Ensure active maintenance and restoration of riparian vegetation is undertaken to benefit stream flows and water quality. • Monitor and prevent clearing and erosion. • Rehabilitate riparian vegetation. • If present, relocate to another location in Six Mile Creek.	• Clearing of riparian vegetation will be restricted to the footprint approved under the IAR – refer to Table 6-1 and the IAR. • Management measures will be implemented to minimise impacts to water quality and erosion – refer to sections 3.3 and 4.3. • Temporary areas of disturbance will be rehabilitated – refer to IAR and section 9.
		Changes to flow regime	• Ensure active maintenance and restoration of riparian vegetation is undertaken to benefit stream flows and water quality.	• Drawdown releases will be relatively low tailored to achieve drawdowns in not less than 4 weeks – refer to section 2. • Ensure releases do not exceed bankfull height of Six Mile Creek.

Species	Key recovery plan/advice	Key threats relevant to the project	Key management actions	Compliance with this advice
	Queensland 2001-2005 (Harry Hines, Queensland Parks and Wildlife Service)		• If found in a work area or stranded, relocate to another location in Six Mile Creek.	
		Degradation of water quality	• Ensure active maintenance and restoration of riparian vegetation is undertaken to benefit stream flows and water quality.	• Management measures will be implemented to minimise impacts to water quality and erosion – refer to sections 3.3 and 4.3.
		Invasive weeds	• Assess and manage the impact of mistflower and crofton weed on habitat.	• Clearing of riparian vegetation will be restricted to the footprint approved under the IAR and remediation undertaken where required, which will minimise the potential spread of invasive weeds – refer to Table 6-1 and the IAR.
		Disease	• Minimise the spread of the chytrid fungus by implementing suitable hygiene protocols.	• Frogs will not be targeted during salvage, with no direct interaction anticipated (refer to Appendix G and section 5.5.1). If handling is necessary, hygiene protocols will be implemented.
Mary River Cod	Conservation Advice *Maccullochella mariensis* Mary River Cod (16/12/2016) The Mary River Cod Research and Recovery Plan (Queensland Department of Primary Industries – Fisheries Group)	Dams and impoundments (habitat loss, disturbance, movement barriers)	• Install fishways at barriers to Mary River Cod movement. • Improve management of stream flows and water quality.	• Offsite mitigation provided through construction of fauna biopassage at Gympie Weir – refer to IAR. • Drawdown releases will be relatively low tailored to achieve drawdowns in not less than 4 weeks – refer to section 2. • Management measures will be implemented to minimise impacts to water quality and sedimentation, with flushing flows released if required – refer to sections 3.3 and 4.3.
		Loss of riparian and in-stream vegetation	• Protect existing riparian vegetation and restore riparian vegetation. • Control livestock in riparian zones.	• Seqwater owns the adjacent land and clearing of riparian vegetation will be restricted to the footprint approved under the IAR – refer to Table 6-1 and the IAR. • Seqwater will work with individual landholders to ensure stock movements are prevented from moving outside their existing properties – refer to Table 5-2. • Cabomba, a restricted weed species that is abundant in the lake, will be left in situ during the Project as a biosecurity management measure – refer to section 7 (Table 7-2); other aquatic plants are sparse (refer to section 6.1.1).
		Exotic and non-indigenous	• Avoid translocating invasive fish species.	• Management measures will be implemented to manage the potential spread of pest fish species – refer to section 5.5.9 (Table 7-1).

Species	Key recovery plan/advice	Key threats relevant to the project	Key management actions	Compliance with this advice
		native fish species		• Pest fish species encountered will be euthanised – refer to section 5.5.9 (Table 7-1). • Non-indigenous native fish species will be left in situ or relocated to a different site than Mary River cod – refer to section 5.5.9.
		Overfishing	• Restock throughout its historic distribution. • Prohibit fishing/taking of this species where not stocked.	• Some recreation areas and activities at Lake Macdonald will remain open during construction: – The boat ramp at Lake Macdonald Park, next to the Noosa Botanic Gardens – Fishing, stand up paddle boarding, canoeing • Lake Macdonald is stocked with Mary River cod and restocking will recommence after the Project – refer to sections 5.4, 8.4 and 9.2.
Mary River Turtle	Approved Conservation Advice for *Elusor macrurus* (Mary River Turtle) (26/03/2008)	Dams and weirs – changes in hydrology and barriers to movement	• Ensure infrastructure activities do not adversely impact populations. • Devices to move aquatic animals upstream of dam walls and weirs (fishways). • Manage disruptions to water flows.	• Offsite mitigation provided through construction of fauna biopassage at Gympie Weir – refer to IAR. • Drawdown releases will be relatively low tailored to achieve drawdowns in not less than 4 weeks – refer to section 2.
		Decline in water quality	• Ensure infrastructure activities do not adversely impact populations.	• Management measures will be implemented to minimise impacts to water quality and sedimentation, with flushing flows released if required – refer to sections 3.3 and 4.3.
		Increased predation and loss of nesting areas	• Predator control. • Protection of eggs and nesting areas. • Identify and protect areas critical to the survival of the species.	• Management measures will be implemented to protect nesting habitat – refer to sections 5.4 and 6.3.
		Decline in food quality and availability	• Ensure infrastructure activities do not adversely impact populations.	• Management measures will be implemented to protect habitat (including habitat of food resources) – refer to sections 5.4.
White-throated snapping turtle	Approved Conservation Advice for *Elseya albagula*	Loss of eggs and nesting areas	• Maintain functional turtle nesting banks throughout the catchments. • Improve recruitment of hatchlings. • Manage water levels so as to avoid inundation of nesting banks.	• Management measures will be implemented to protect nesting habitat – refer to sections 5.4 and 6.3. • There will be no change to the current full supply level of the lake – refer to Section 2.1.

Species	Key recovery plan/advice	Key threats relevant to the project	Key management actions	Compliance with this advice
	(White-throated snapping turtle) (07//11/2014)	Dams and weirs – changes in hydrology, barriers to movement, fragmentation of habitat	• Reduce the incidence of death and physical injury of turtles at existing and future impoundment structures. • Maintain stream flow and high quality in-river habitat between impoundments.	• Offsite mitigation provided through construction of fauna biopassage at Gympie Weir – refer to IAR. • Drawdown releases will be relatively low tailored to achieve drawdowns in not less than 4 weeks – refer to section 2.
		Clearing of riparian vegetation	• Engage with landholders responsible for land adjacent to waterways.	• Seqwater owns the adjacent land and clearing of riparian vegetation will be restricted to the footprint approved under the IAR – refer to Table 6-1 and the IAR.
		Recreational fishing and fish stocking	• Manage recreational fishing and boating activities in impoundments to be compatible with the maintenance of sustainable turtle populations.	• Some recreation areas and activities at Lake Macdonald will remain open during construction: – The boat ramp at Lake Macdonald Park, next to the Noosa Botanic Gardens – Fishing, stand up paddle boarding, canoeing

5.5 Aquatic Fauna Salvage and Relocation Management Plan

5.5.1 Purpose

The purpose of the planned aquatic fauna salvage and relocation is to minimise stranding and crowding of aquatic fauna (in particular large bodied fish) in Lake Macdonald during the Project (i.e. during the lake drawdown and the subsequent construction period). While the modest extent of drawdown has low risk to aquatic fauna, a conservative approach to environmental management will be adopted and fauna salvage will be used to avoid any possibility of crowding in the reduced dam during the construction phase. Aquatic Fauna salvage will also ensure welfare of any fish or turtle species that become stranded in the stilling basin.

5.5.2 Approach

The overall approach to aquatic fauna salvage and relocation is:

- Targeted capture and relocation of large bodied fish (e.g. saratoga, bass, yellow belly), with particular focus on threatened fish species, (i.e. Mary River cod) noting that the occurrence of these threatened species is expected to be low).
- As needed capture and relocation of Australian lungfish as determined by suitably qualified and or experienced personnel under exceptional circumstances (i.e. Lake Macdonald water supply reduces to critical levels as a result of severe drought) and observed fish condition (length weight relationship) has deteriorated (as identified by routine quarterly fish monitoring). If drought is occurring relocation sites must be carefully considered as the conditions at these sites may be worse than the condition of Lake Macdonald. Drought conditions are assumed when the lake level reaches 30% FSL or less. Refer to Table 5-5.
- Opportunistic capture and relocation of small bodied aquatic fauna, if determined to be necessary during the course of the salvage operation.
- As needed salvage of small and large bodied fish, and turtles, from the stilling basin following high flow events during the construction phase, or if stressed fauna are observed, poor water quality is detected or a dewatering event is planned, with salvaged biota to be returned to the lake upstream of the cofferdam.
- Turtle salvage and relocation will only occur should unforeseen circumstances require. Any reference to turtle salvage or relocation in this document is a contingency plan only.

The salvage and relocation plan has been developed with regard to:

- the EPBC Translocation of Listed Species Policy (DSEWPC)
- DPI's Fish Salvage Guidelines (DPI, 2004)
- DPI's Guidelines for Fish Salvage fact sheet (DAF, 2018)
- conservation advice for relevant MNES species
- independent expert advice (through review of plan).

The EPBC *Translocation of Listed Species Policy* identifies information relevant to using translocation (i.e. relocation) as a mitigation for potential impacts to MNES species and their habitat. In particular, potential impacts of translocation and the factors critical to successful translocation identified in the policy have been considered in the development of this plan. No MNES species other than those identified above will be relocated.

The DPI guidelines present principles and guidance for aquatic fauna salvage operations in Queensland and are summarised in Appendix E. Due to scale of the activity and the relatively long period of drawdown modifications to the DPI guidelines will be required; these are described in Section 5.5.4.

As identified in section 14, all salvage will be performed by an adequate number of suitably qualified and or experienced personnel in accordance with required permits.

Note that relocation of turtles, platypus, giant barred frog and tusked frog is not proposed. For platypus, it is proposed to maintain refugial habitat in the upper reaches of Lake Macdonald (Six Mile Creek) for the duration of the Project, where physical conditions in the lowered lake allow (i.e. there are suitable refugial pools or it is possible to deepen the

channel). However, contingencies for platypus relocation are provided in section 8. Giant barred frog and tusked frog are expected to relocate in response to changing water levels, both upstream and downstream, and return once the Project is complete, or following drawdown in the case of downstream water fluctuations.

5.5.3 Evaluation Survey

Before the lake drawdown commences, a hydroacoustic evaluation survey of fish abundance in the lake will be implemented, as will a targeted survey of turtles. Additionally, electrofishing will be implemented to provide an indication of the likely catch rates of the species to be salvaged. Preliminary salvage during the evaluation survey will target upstream reaches of the lake as these will be the first areas exposed once drawdown commences and also evaluate the presence of key species in Lake Macdonald. The evaluation survey will initially use eDNA surveys for platypus. The results of these surveys will inform platypus searches (timed transects) searches for active burrows. The results will inform the placement of camera traps for ongoing monitoring. The evaluation survey is identified as a mitigation measure in 5.5.3 and Table 5-2.

The evaluation survey will be used to familiarise personnel with Lake Macdonald and the proposed salvage methods, and focus on:

- Large-bodied fish – specifically MNES species in Lake Macdonald (including preliminary salvage of large-bodied species).
- Small bodied fish – recording species, abundance and health (i.e. length-weigh relationships).
- Platypus – camera trap and eDNA surveys.
- Turtles – MNES listed and common species, using methods including trapping (e.g. fyke nets and baited cathedral traps), as outlined in DSEWPC (2011).
- Tadpoles – identify and record abundance of barred frog tadpoles (genus Mixophyes) where they are caught in other salvage activities. If Mixophyes tadpoles are detected, species determination should be undertaken.

5.5.4 Salvage and Relocation Targets

For the purposes of salvage and relocation of aquatic fauna, the general phases of work can be outlined as:

- **Evaluation Survey Phase** – Lake Macdonald at 100% FSV (or lower natural level at the time)
- **Drawdown Salvage Phase** – Lake Macdonald between 100% and 42% FSV
- **Post-Drawdown Salvage Phase** – Lake Macdonald at 42% FSV.
- **Stilling Basin Salvage Phase** – Monthly salvage of aquatic fauna and transfer of native fish downstream, and following high-flow events, and if stressed fauna are observed, and when poor water quality is detected and if a dewatering event is planned.

The evaluation survey phase has no salvage target. It is for preliminary evaluation and familiarisation and will be completed using the methods identified in Table 5-5.

The drawdown salvage phase has a target for aquatic fauna salvage of at least an equivalent percentage of large bodied fish as the percentage of drawdown that has occurred. This is provisionally assumed to occur over 4 weeks of salvage effort. Salvage will commence within 4 weeks of drawdown commencing and will continue on a week-on week-off basis until the target percentage has been achieved or for 8 weeks of salvage effort – whichever is the sooner. Once the target has been reached, salvage will move to the post-drawdown phase.

The overall fish salvage target during the first stage of salvage will be 55% of large bodied fish compared to evaluation survey result. This percentage may be refined from evaluation survey, depending on catch rates and characteristics of the fish community within the lake. If the fish salvage target set has not been achieved by end of the 4th week of salvage effort, the salvage program will be reviewed and if deemed necessary refined with the objective of maintaining the health of aquatic fauna in the lake.

If water levels decline further than RL 92.0 m AHD during the construction phase or if regular monitoring indicates an unacceptable level of stress on the aquatic fauna, additional salvage will be implemented under the guidance of a suitable qualified and experienced person until the conditions in the storage are sustainable.

The salvage of small and large bodied fish, from the stilling basin following high flow events, or if stressed fauna are observed, poor water quality is detected or a dewatering event is planned, during the construction phase has no specific target. However, the objective will be to salvage as many individuals as is practical. The design of access and the works space will need to provide for effective fish salvage and relocation – specifically, the lowest point of the works space should be positioned where access by salvage crews is easy and have an earthen (i.e. no rock armouring) basement so that seine nets can effectively salvage benthic fish. Typically, fish salvaged from the stilling basin will be returned to the main lake as opposed to one of the off-site relocation areas.

A biomass baseline survey done in November 2024 which estimated 16,850 large bodied fish (>200mm) reside in the lake. This sets a 55% target of 9,268 fish to remove.

The 2025 evaluation survey has found that 81.6% of large-bodied fish captured were bony bream (see section 5.5.4.2). Additionally, 8.5% of large-bodied fish captured were banded grunter which are also unsuitable for relocation as they're not native to SEQLD and would be euthanized. Therefore potentially 90% of large bodied fish captured will be unsuitable for relocation. If salvage efforts result in significantly lower catch rates then more realistic targets may need to be adopted in consultation with DPI and the fish biologist.

This represents a significant change to the overall fish community within the lake which can be rationalised by the fact that no stocking has occurred since 2018. Since 2018 there have been several significant wet seasons where migrating fish species would have had many opportunities to leave the lake to spawn in the downstream estuaries. In 2022 the lake spilled for 8-months straight and there have been many regular spilling events since.

Over 12 days the 2025 evaluation survey caught a total of 5,042 large bodied native fish species representing six species, however of these only 490 were suitable for relocation. If similarly low catch rates occur during the project drawdown targets may need to be revised.

Consideration must also be given to the potential benefits of leaving larger predatory fish such as Australian bass, saratoga, eels and freshwater catfish within the dam as these are likely to assist in regulating populations of bony bream and abundant small bodied fish communities.

5.5.4.1 Comparison of Target with DPI Fish Salvage Guideline

The proposed drawdown and fauna salvage program (i.e. the matched percentage approach) broadly aligns with the DPI guidelines. However, the size and bathymetry of the water body also dictate deviations from a strict approach of salvage at 25% drawdown intervals.

The matched percentage approach to salvage is intended to give confidence to all stakeholders that salvage will be effective in mitigating potential impacts of lowered water levels on aquatic fauna (i.e. demonstrating that collection of fauna has been successful), and have clear points where salvage is no longer needed (i.e. has achieved the target mitigation).

It is anticipated that the water retained in Lake Macdonald during the construction period will be sufficient for the remaining aquatic fauna to survive during the construction period, noting that monitoring measures will be implemented and incidental salvage undertaken if required.

5.5.4.2 Fish Sensitive to Handling

Handling of all fish species will be in accordance with the DPI Fish Salvage Guidelines (DPI, 2004), and Commonwealth Survey Guidelines for Australia's Threatened Fishes (DSEWPaC, 2011).

Bony bream have a biology that makes them well suited to impoundments such as Lake Macdonald. Bony bream are fast growing with males maturing at 1-2 years of age and females at 2 years, they are also have high levels of egg production with between 33,000 and 880,000 eggs being produced per fish depending on size (Lintermans, 2023). The species feeds on detritus, microalgae and microcrustaceans, all food sources that are commonly available in lake environments (Lintermans, 2023). Bony bream are generally a hardy fish species, tolerating high temperatures (up to 38^{o}C), high salinity and low dissolved oxygen (Pusey et al., 2004). Despite this bony bream are highly sensitive to capture and handling.

The 2025 evaluation survey results have indicated that there are large numbers of bony bream (*Nematalosa erebi*) within the lake accounting for approximately 82% of large bodied fish captured. Attempts to salvage and relocate these fish could result in high mortality of this species. Efforts to move these fish are also likely to foul water while in transport and potentially affect other fish being transported at the time.

Release of captured Australian lungfish back into the body of water from which they were captured should be prioritised to minimise stress and discomfort. Immediate release into their original habitat is likely to yield better health and welfare outcomes than relocation if Lake Macdonald is experiencing typical conditions.

With this information in mind, there will be need for flexibility in the salvage approach in the field, notwithstanding the general approach for targeted aquatic fauna salvage (section 5.5.1).

For example, a common native species of large bodied fish may be excluded from salvage and relocation where injury and/or mortality in transport is likely, or where health and welfare outcomes are likely to be better within Lake Macdonald. This flexibility will be managed such that the population remaining within Lake Macdonald following drawdown is sustainable, based on the professional judgement of aquatic ecologists and suitable monitoring. In an unlikely situation of an overabundance (unsustainable population) of common fish sensitive to handling/transport, consultation with DPIF regarding management options will occur. Options may include attempted salvage and relocation of the population or in an extreme fish kill scenario euthanasia be considered if recommended by the fish biologist.

5.5.4.2.1 Management of Mary River cod and lungfish

As per EPBC approvals for the project the following management actions will apply to Australian lungfish and Mary River cod.

- No Mary River cod or Australian Lungfish will be relocated to Tinana Creek and Obi Obi Creek.
- During the fish salvage operation the following actions and steps will be taken to prioritise release sites for Mary River cod:
  - Prior to any fish relocation from Lake Macdonald all of the potential relocation sites for Mary River cod within the Mary River and Yabba Creek will be re-assessed. The results of this assessment will confirm (or modify) the current site priorities from Freshwater Ecology (2020).
  - A strategic release regime based on the numbers of cod expected to be relocated will be refined after the baseline survey, where catch rates of cod will be better understood.
  - Mary River cod caught initially (approximately 8-10 fish) will be equally distributed between the two highest priority sites (currently sites 12 and 37).
  - After the initial catch, fish (3-4 per site) will be released into secondary sites (currently 17, 33, 18 and 31).
  - After this, the above schedule of fish release will be repeated.
- There will be no temporary relocation of Mary River cod, all cod will be relocated to suitable sites (as listed in Table 5-4) and will not return back into lake Macdonald at a later date. Efforts will be made to re-stock Mary River cod into Lake MacDonald on project completion as a mitigation action.
- Captured Australian lungfish to be released back into the body of water from which they were captured, unless relocation is deemed required by a suitably qualified and or experienced personnel as stipulated in Section 5.5.2).
- No Australian lungfish will be relocated to farm dams.

The 2025 evaluation survey did not find any MNES or MSES species living in the lake.

5.5.5 Fauna Relocation Sites

The proposed fauna relocation sites are identified in Table 5-4. The primary relocation sites are described in more detail in Appendix H.

Table 5-4: Proposed fauna relocation sites

Fauna	Primary relocation sites	Contingency relocation sites
Mary River cod	Four Mary River sites – permanent Two Yabba Creek sites – permanent	Mary River downstream of Gympie Weir
Australian lungfish (if required, as stipulated in Section 5.5.2)	Four Mary River sites – permanent Two Yabba Creek sites – permanent	Mary River downstream of Gympie Weir
Large-bodied native fish	Cooloolabin Dam – permanent[4]	Nil

5.5.6 Assessment of relocation sites and carrying capacity

As per EPBC approvals for the project an assessment of the suitability and carrying capacity of potential relocation sites was undertaken in January 2020. The site assessment (Freshwater Ecology, 2020) was very thorough and included an assessment of 38 potential sites. These sites included areas within the main stem of the Mary River, several Mary River tributaries and Cooloolabin Dam in the South Maroochy River. 12 assessment criteria were used to create a short list of 18 sites which were then subject to further detailed assessments (travel times, habitat quality, water quality, macrophyte & macroinvertebrates abundance, fish and turtle surveys). Out of these 18 sites 4 Mary River and 2 Yabba Creek sites were chosen for threatened species and Cooloolabin Dam was selected for other large bodied fish species (Table 5-4). The Freshwater Ecology (2020) report included:

- Desktop review.
- Rapid field assessment and screening of a long list of potential relocation sites.
- Field assessment of a consolidated long list.
- Final screening to produce a short list of relocation sites.
- Logistics – site access, duration of travel to site, safety considerations
- Assessment of fauna communities comprising:
  - diversity and abundance of fish and turtle species, using quantitative or semi-quantitative methods (e.g. electrofishing) that enable calculation of CPUE and estimates of biomass.
  - community composition based on length, weight, life history stage (as appropriate for species).
  - presence of platypus and burrows, using semi-quantitative methods such as timed observations and estimates of size.
- Habitat suitability – assessment of structure, condition and suitability for fauna, with an estimate or calculation of the area of optimal habitat for MNES and MSES species (if present).
- Availability of food resources – quantitative surveys of aquatic macroinvertebrates and aquatic plants (macrophytes).
- The relocation sites recommended by this report are presented in Table 5-4.

It is noted that habitat conditions and carrying capacity status of sites may have changed since this assessment that was completed in 2020. To address this all sites will be revisited prior to any fauna being relocated and if new sites are required this will be discussed with DPI prior to relocation of fauna. If turtles need to be salvaged and relocated and new sites are required, the appropriateness of any proposed turtle relocation sites will also be discussed with DETSI biodiversity experts (via the EIA team) and DCCEEW (where relevant).

Fishology are planning to undertake relocation site surveys as soon as the lake drawdown date has been confirmed. As per the freshwater ecology report (Freshwater Ecology, 2020) it was recommended that visual assessment will be undertaken immediately prior to commencement of any potential relocation activities. This will include an assessment of the streamflow conditions at the time and how this would influence the potential aquatic fauna carrying capacity (e.g. flow, water quality, submerged macrophytes and connectivity).

[4] Cooloolabin Dam is located mostly within a forest reserve making the shoreline mostly inaccessible to vehicles. Where possible, multiple sites will be used for fish release during the project. This will be dependent on lake levels, Seqwater access requirements, and accessibility for vehicles towing a trailer.

It is likely that habitat quality and carrying capacity of these sites would have improved since 2020. The original assessment was undertaken following low rainfall and riverine flow conditions within the catchment. Since the report was written the region has experienced several subsequent wet years that are likely to have increased habitat quality and conditions within the riverine and lake relocation sites. Additionally, several successful riverine stabilisation and habitat improvement projects have been undertaken by MRCCC in partnership with Seqwater during this time.

5.5.7 Salvage Schedule and Resourcing

The drawdown salvage phase has a target for aquatic fauna salvage of at least an equivalent percentage of large bodied fish as the percentage of drawdown that has occurred. This is provisionally assumed to occur over 4 weeks of salvage effort. Salvage will commence within 4 weeks of drawdown commencing and will continue on a week-on week-off basis until the target percentage has been achieved or for 8 weeks of salvage effort – whichever is the sooner.

If the fish salvage target (i.e. 55% of large bodied fish compared to evaluation survey result, to be refined based on biomass estimates undertaken during the baseline survey) has not been achieved by end of the 4th week of salvage effort, the salvage program will be reviewed and if deemed necessary for the health of aquatic fauna, extended for up to 4 additional weeks of salvage effort.

If water volume in the lake reduces beyond the planned construction phase volume of 3,368 ML, then additional salvage will be implemented at the following triggers:

- 2,405 ML, with the fish salvage target becoming 70% of large bodied fish compared to evaluation survey result
- 1,640 ML, with the fish salvage target becoming 80% of large bodied fish compared to evaluation survey result

Hydroacoustic surveys will be used to confirm achievement of salvage target post dewatering phase.

Salvage of aquatic biota from the stilling basin will occur on a frequency required to prevent welfare concerns, determined by the results of visual observations of fauna stress and water quality monitoring. Additionally, aquatic biota will be salvaged before and during all cofferdam dewatering events. Aquatic biota salvaged from the cofferdam space will be released to the upstream lake.

Table 5-5: Indicative pre-construction aquatic fauna salvage schedule

Phase	Week	Lake Volume* (ML)	Indicative Effort
Evaluation Survey	0	8,018 (full)	Hydroacoustic survey of fish Survey of platypus using eDNA and camera traps Salvage using: • 2 boat electrofishing teams • 1 fyke netting team • 1 turtle trapping team • 2 transport teams
Drawdown / Lowering	1-4	8,018 reducing to 4,410 (42%)	Salvage on a 1 week on 1 week off schedule using: • 2 boat electrofishing teams • 1 fyke netting team • 2 transport teams
	4-8	Maintained at 4,410	
Cofferdam Construction	32	Maintained at 4,410	If salvage target has not been achieved, then continue salvage on a fortnightly basis from week 11 onwards until target is achieved, using: • 1 boat electrofishing teams • 1 fyke netting team • 1 transport teams Repeat hydroacoustic survey if further validation of salvage target is required
Construction	–	2,405 (30% FSL,	Contingency salvage if lake volume reduces to 2,405 ML; new salvage target is 70% of large bodied fish compared to evaluation survey result:

Phase	Week	Lake Volume* (ML)	Indicative Effort
		considered drought conditions)	• 1 boat electrofishing teams • 1 fyke netting team • 1 transport teams
	–	1,604 (20% FSL, considered drought conditions)	Contingency salvage if lake volume reduces to 1,604 ML; new salvage target is 80% of large bodied fish compared to evaluation survey result: • 2 boat electrofishing teams • 1 fyke netting team • 2 transport teams

*Assumes no inflow into storage.

5.5.8 Capture Methods

Active salvage will be implemented, with regular monitoring of traps and nets (e.g. twice daily).

The following capture methods will be used (also refer to section 5.5.7 for scheduling and resourcing information):

- Boat electrofishing: large units (7.5 GPP), and potentially small units (3.5 GPP), each operated by a team of suitably qualified persons
- Fyke nets (up to 20, mesh size 10 mm): set in upper reaches of Lake Macdonald for fish by a team of suitably qualified persons from a boat
- Seine net: on an as-needed basis, such as to catch stranded fish from shallow isolated pools.

The species, the number of each species, the apparent health and the total length and weight of all Mary River cod and Australian lungfish individuals that are captured will be recorded. The mark and recapture of these species over the life of the project will assist with determining population size and fish condition over time. It will not be practical, nor in the interests of fish welfare, to record measurements for any other species.

5.5.8.1 Fish Salvage

Fish salvage will be principally undertaken through electrofishing and fyke netting.

Boat electrofishing will be undertaken with purpose-built (industry standard) vessels that contain a generator powered electrofishing unit. These vessels use a pulsed direct current (DC) waveform to immobilise fish, which are then netted and placed in a live well located on the electrofishing vessel. Holding of fish on vessels is outlined below in section 5.5.9. All electrofishing boats will be operated in accordance with the Australian Code of Electrofishing Practice, as per Queensland General Fisheries Permit requirements, and all drivers will be trained in electrofishing and hold senior operator status.

Double winged fyke nets will be set during the day and retrieved the following morning. Setting fyke nets overnight is normal practice and approved by the relevant animal ethics committee and in accordance with Queensland General Fisheries Permit requirements. To avoid harm to air breathing animals (i.e. platypus) the cod end of the net will be kept afloat in case any air breathing animals were caught. Each net will be set out from the bank with wooden stakes used to keep the fyke net wings and cod end in place. The netting team will use standard nets and traps, operated by suitably qualified aquatic ecologists.

It should be noted that no MNES or MSES fish species were recorded in the lake during the 2025 Fishology Biomass Surveys.

5.5.8.2 Turtle Salvage

No turtle salvage activity is planned to occur as part of the project. Lake conditions during the construction phase of the project are likely to be suitable for the turtle population. Furthermore, turtles are likely play an important role in ecosystem functioning within the lowered lake. Turtle communities will be monitored bi-annually during the construction phase, to ensure that the health of this community is not compromised. Note that turtle salvage and relocation will only occur if monitoring suggests it is necessary, or if other unforeseen circumstances occur (i.e. overland turtle migrations).

It should be noted that no MNES or MSES turtle species were recorded in the lake during the 2025 Fishology Biomass Surveys.

5.5.9 Holding Methods

A salvage and relocation holding area will be established, featuring an access jetty from the lake to the shoreline. This area will include two temporary storage tubs, each with a 2,000 L capacity, equipped with shading and aeration. These tubs will be available for emergency use or for isolating fish when necessary. Storage tubs will be positioned to ensure they are under shade for the entirety of the salvage operation.

At the time of capture on each vessel, all fish will be carefully placed in sufficiently large receptacles (either purpose built recirculating live wells and/or sufficiently large tubs to house fish) containing Lake Macdonald water, with dissolved oxygen concentrations of the water maintained using aerator units.

Where possible, threatened species will be housed separately from other fish within a separate aerated tub. This measure will be adapted to suit the occurrence and catch rate of threatened species in the field.

Prior to and during salvage operations, assessments will be undertaken on all fauna housing and aeration systems to ensure they are capable of providing adequate conditions.

The holding capacity of each holding receptacle will be pre-determined in accordance with DPI's Fish Salvage Guidelines (DPI, 2004). Once the capacity of the holding receptacle is reached or two hours since catching the first individual has passed (whichever comes first), fish in all holding receptacles on the vessel will be moved to the salvage and relocation holding area. Equipment, such as pumps and tanks, will be repurposed for the salvage and relocation activity. The salvage and relocation holding area will be used as the principal transfer location of fauna from salvage vessels to land-based transports, and as a holding facility as required. With the exception of emergencies or if fish need to be isolated, fish will be moved straight from the salvage vessels into the land-based transports.

Any pest fish caught will be euthanised using ethics committee-approved methods and disposed of appropriately (e.g. in plastic bags at an appropriate refuse facility or buried on site a minimum of 20 m from the water's edge).

It is expected that the average time from capture to release will be less than three hours for Mary River cod, Australian lungfish, and four hours for other species. Detailed planning and work instructions for salvage and relocation will include the maximum timeframes identified for capture, transport and relocation for MNES, non-MNES and pest species.

5.5.10 Transport and Release Methods

Land-based transports (suitable vehicles with purpose-built trailers) will be used to transport native fauna to the pre-determined release locations and released according to the DPI Fish Salvage Guidelines.

Three specialised fish transport trailers with aerated water tanks will be used for transport with one spare all times for keeping fish, this will reduce handling where possible. Two transport trailers will be fitted with 1700 L capacity (single tub), which will be used for general fish salvage capability. One transport trailer fitted with 2 separate holding tanks (500 L each) will be available for general fish transport as well as transport for sensitive species such as Mary River cod (ability to separate fish where required). The trailers will rely on compressed air for aeration with a backup compressed oxygen system. Tanks will be fitted with lids to prevent fish jumping out prior to intentional release.

Assessments of stocking rates, aeration and water volume in tanks will be made prior to any transfer from holding to land-based transports.

Handling of fish will be minimised as far as practical and will be in accordance with the DPI Fish Salvage Guidelines, and Commonwealth Survey Guidelines for Australia's Threatened Fishes (DSEWPaC, 2011) and Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC, 2011).

Details of the fauna relocation sites are provided in section 5.5.5. Details of monitoring of relocation sites during the salvage and relocation activity is provided in section 5.5.11.

5.5.11 Monitoring of Relocation Success

Weekly visual monitoring of sites where fauna have been relocated during the relocation program (e.g. observations of mortality) and measurement of in situ water quality (focusing on dissolved oxygen).

On a monthly basis at all relocation sites for 12 months after week four (4) of the lake drawdown schedule, to assess the long-term success of the salvage and relocation operation. This will involve visual monitoring of sites where fauna have been relocated during the relocation program (e.g. observations of mortality) and measurement of in situ water quality (focusing on dissolved oxygen).

Before relocation, all MNES fish species salvaged from Lake Macdonald will be tagged with Passive Integrated Transponder (PIT) tags and surveys will subsequently be undertaken at all sites where MNES species were released. These surveys will occur every six months from the completion of the drawdown salvage phase until the completion of dam construction. The surveys will use the same methods used in the relocation site assessment (Appendix H), and any MNES species caught will be scanned with a hand-held PIT tag reader to estimate the proportion of relocated MNES fauna recaptured as an indication of potential survivorship. Results will be compared to mark-recapture data for both species from the Mary River collected by DR, which will serve as a reference for recapture rates.

5.5.12 Reporting

A count of each species caught for relocation will be made at the time of capture on the boat. In addition, for MNES, size and health/condition shall be measured and recorded per the relevant industry practice. The total catch across all fishing teams will be recorded and reported on a fortnightly basis to track progress and to keep project managers informed. Any MNES species caught and relocated will be reported to Seqwater on the same day. Seqwater will notify DCCEEW of any Mary River turtle and white-throated snapping turtle caught and relocated within three days.

A detailed salvage and relocation report will be prepared at the completion of the Drawdown Salvage Phase (and following verified achievement of the drawdown fish salvage target via the hydroacoustic survey). The report will include but not be limited to:

- Salvage effort
- Trends in catch rates
- Breakdown of relocated fauna by species and relocation site
- Health of MNES species
- Any incidents or mortality
- Observations of fauna and in situ water quality at relocation sites.

Additional compliance reporting and audits are outlined in section 13, specifically relating to residual significant impacts with respect to the project EPBC approval.

5.5.13 Salvage of MNES Species

Table 5-6 provides a summary of the methods for salvage and relocation of MNES species from Lake Macdonald. It also identifies relocation sites, guidance documents, and where further information is provided in this plan.

No MNES species other than those identified in this plan and Table 5-6.

The 2025 evaluation survey did not find any MNES or MSES species living in the lake.

Table 5-6: Salvage details for MNES species

MNES Species	Salvage Methods	Holding Methods	Transport and Release Methods	Estimated Time – Capture to Release	Relocation Sites	Guidance Documents
	Details in section 5.5.8	*Details in section 5.5.9*	*Details in section 5.5.10*	*Details in section 5.5.10*	*Details in section 5.5.5 and Appendix G*	
Australian lungfish (if required, as stipulated in Section 5.5.2)	Boat electrofishing (7.5 GPP and 3.5 GPP) – multiple pass where conditions allow. Fyke netting – up to 20 set overnight, checked every 4-6 hours. Handling of fish will be minimised as far as practical	All fish will be placed in large receptacles with a pre-determined holding capacity, containing aerated water from Lake Macdonald. MNES fish species will be held separately from other fish/ where possible. When the capacity of the holding receptacle is reached or two hours have passed since the first individual was caught, the fish will be moved to the salvage and relocation hub. Handling of will be minimised as far as practical. Tag all individuals with PIT tags and record details.	MNES fish species will be moved in a specialised transport trailer with an aerated water tank (1,500-2,000 L approx.). Tanks will be fitted with lids. Assessments of stocking rates, aeration and water volume in tanks will be made prior to any transfer from holding. Handling of fish will be minimised as far as practical.	< 3 hours	4 Mary River sites 2 Yabba Creek sites	DPI's Fish Salvage Guidelines (DPI, 2004) DPI's Guidelines for Fish Salvage fact sheet (DAF, 2018) Survey Guidelines for Australia's Threatened Fishes (DSEWPaC, 2011)
Mary River cod				< 3 hours	4 Mary River sites 2 Yabba Creek sites	
Giant barred frog	No salvage – expected to move independently from affected areas					

6. Aquatic Habitat

6.1 Baseline Conditions

6.1.1 Aquatic Habitat in Lake Macdonald

Aquatic habitat in Lake Macdonald comprises a large pool, with a high abundance of submerged aquatic flora, predominantly *Cabomba caroliniana* and *Nymphoides indica*, and beds of emergent *Persicaria* spp. near lake margins. The substrate is dominated by silt, with some sand near banks, and there is limited large woody debris. Habitat in the lake does not provide suitable breeding locations for Mary River cod and Australian lungfish, and there is no suitable nesting habitat for Mary River turtle and white-throated snapping turtle on the banks.

6.1.2 Aquatic Habitat in Six Mile Creek

Six Mile Creek downstream of the dam is a low-gradient, low energy stream, with notophyll vine forest the dominant native riparian vegetation (DNRM, 2004). Extensive deposits of large woody debris are a common habitat element along with medium length pools (i.e. between 6 and 12 channel widths in length) that are less than 2 m deep (DNRM 2004). Riffles and shallow glides over sand also present.

Habitat surveys were undertaken in Six Mile Creek downstream of the dam from 2013 to 2018, using methods that developed to specifically assess suitability of aquatic habitat for Mary River cod, Australian lungfish, Mary River turtle and white-throated snapping turtle. The habitat surveys found:

- A well-defined channel with high steep banks and undercut banks was common
- The substrate was dominated by clay and silt, with gravel riffles and some bedrock present
- High variation in hydraulic habitat types, with riffles, runs and shallow and deep pools all variously occurring
- Low abundance of submerged aquatic flora, except immediately downstream of the dam
- Abundant large woody debris and leaf packs
- The riparian vegetation is in good condition, providing shade and a supply of fine and large woody material
- There are some suitable breeding locations for Mary River cod, but very limited breeding habitat for Australian lungfish
- No suitable turtle nesting habitat was recorded.

In general, the habitat was similar regardless of proximity to the dam, which suggests that the existing flow regime does not have a substantial influence on habitat structure between the dam and the Mary River. There was also little evidence of change in the aquatic habitat condition between surveys despite a number of high flow events occurring during these time periods.

Further assessment of habitat, including habitat mapping for relevant species, was undertaken in July 2020, the details of which are provided in Appendix G.

6.2 Potential Impacts of Lowering Lake Macdonald

6.2.1 Within Lake Macdonald

Aquatic habitat in the lake will be minimally affected by the planned magnitude of water lowering during the drawdown phase, with the amount of aquatic habitat (i.e. volume of water) reduced to approximately 42% of FSL volume, and maximum depth decreasing by 22% compared to FSL. The reduced lake will have a maximum depth of 8.2 m during the construction phase and continue to hold water over most of the impoundment area. Only the upstream extremities of the lake will be temporarily lost during the construction phase, during which time these areas will revert to waterway habitat (rather than impounded / lake habitat). It is likely that pools in these waterways will be retained by inflows and groundwater throughout the duration of the project.

6.2.2 Downstream of Lake Macdonald (Six Mile Creek) Dam

Potential adverse impacts to aquatic habitat in Six Mile Creek downstream of the dam during drawdown may occur due to changes in:

- Water quality – as described in section 3.1.3
- Erosion and sedimentation – as described in 0
- Hydrology – sustained moderate flow for the duration of the dewatering phase that would naturally have a lower median flow and higher variability.

Fine sediments accumulate on the bed of reservoirs (e.g. >90% of sediment is captured in Lake Macdonald Dam - DNRM 2014), which could be mobilised during the drawdown and construction phases and deposited downstream. This has potential to smother benthic habitats, including in-filling pools and interstitial spaces of coarse substrate (e.g. gravels and cobbles), and subsequently affect primary producers (i.e. aquatic plants and benthic algae), macroinvertebrates and fish (Wood and Armitage, 1997). As described in section 4, thus potential impact pathway has low risk, and should some level of sedimentation occur downstream the effect would be temporary in nature, whereby flows following deposition events would further entrain and transport unconsolidated fine sediments to re-establish the creek's natural features and substrates. Six Mile Creek experiences frequent flow events and so the turnaround is expected to be in the order of weeks to months.

Changes in flow conditions have the potential to cause changes in fauna behaviours, including breeding success, that are triggered by flow. Changes in flow conditions may also lead to loss of, or deterioration in, habitat condition through scouring of the substrate, disturbance of physical habitat (e.g. woody debris, leaf packs, aquatic plants, bank erosion) and altered flow habitat (e.g. riffle to pool). Where these potential impacts are not managed or mitigated, further impacts, such as declines in fauna populations and breeding, may also occur.

6.3 Management and Monitoring

Potential impacts to aquatic habitat will be mitigated by implementing the measures identified in Table 6-1. Where appropriate, the management measures contained in table 6-1 will be adapted over the course of the Project in response to changing conditions and expert advice.

Due to the importance of aquatic habitat in supporting aquatic fauna, including MNES and MSES species, monitoring of aquatic habitat will be undertaken not only to assess direct impacts, but also as a preliminary indicator for potential impacts to aquatic fauna.

Table 6-1: Management of aquatic habitat during the lowering of Lake Macdonald

ENVIRONMENTAL OBJECTIVE: **Minimise impact of lake drawdown on aquatic habitat in the lake and Six Mile Creek downstream.**	
Performance criteria	**Lake Macdonald** • Prevent or minimise potential impacts to aquatic habitat in Lake Macdonald, where minimise means the impact is temporary and reversible. • Maintain water quality within the current variability for Lake Macdonald, as identified in Appendix B. • Achieve the erosion and sediment control performance criteria identified in Table 4-1. **Six Mile Creek Downstream** • Achievement of downstream flows where inflows are recorded during the construction phase. • Prevent or minimise potential impacts to aquatic habitat in Six Mile Creek, in particular habitat for listed threatened species, where minimise means the impact is temporary and reversible. • No exceedance of habitat monitoring triggers, as identified in Appendix F (Habitat Monitoring Program, Table 16-6).
Management measures	**Lake Macdonald** • Implement management measures for water quality (Table 3-1), erosion and sediment control (Table 4-1), and aquatic fauna (Table 5-2). • Do not clear vegetation outside of the clearing extent defined in the IAR.

ENVIRONMENTAL OBJECTIVE: Minimise impact of lake drawdown on aquatic habitat in the lake and Six Mile Creek downstream.	
	• Do not disturb bed or banks (e.g. clear vegetation or excavate) until a suitably qualified person has checked the area for threatened fauna and breeding habitat. If any are identified, implement a 3 m x 3 m exclusion zone with flagging tape until approval to impact the area has been granted by the suitably qualified person. • After construction is completed, and where disturbance or visual assessment indicates this is required, re-establish or supplement aquatic habitat (as per section 9) if it is safe to do so. **Six Mile Creek Downstream** • Implement management measures for water quality (Table 3-1), erosion and sediment control (Table 4-1), and aquatic fauna (Table 5-2). • Control the drawdown release rate as outlined in Section 2 of this plan. • Do not clear vegetation outside of the clearing extent defined in the IAR or other relevant approvals. • Do not complete drawdown of lake in less than 4 weeks. • Ensure releases do not exceed bankfull height of Six Mile Creek. • Avoid changes to hydrology during the breeding seasons for MNES and MSES species known to be in Six Mile Creek downstream of the dam, with drawdown not being permitted between 1 September and 28 February of any year (per section 2.2). • Do not clear vegetation or excavate banks until a suitably qualified person has checked the area for threatened fauna and breeding habitat (e.g. burrows). If any are identified, implement a 3 m x 3 m exclusion zone with flagging tape until approval to impact the area has been granted by the suitably qualified person. • Re-establish or supplement aquatic habitat (as per section 9.1), where monitoring indicates this is required.
Monitoring	**Lake Macdonald** • Quarterly assessment of aquatic habitat at the lake monitoring site (450 m upstream of the dam) during the construction phase, and quarterly for one year post construction, in accordance with Appendix F. • Where possible aerial drone surveys will be used to monitoring of the upper reaches of Lake Macdonald before (baseline), during and after the drawdown (i.e. at 42% FSL) to document the rate of exposure and assess the location, variety and abundance of fish habitats across various water levels and seasons. Surveys should encompass a range of fish habitats, including (but not limited to) macrophyte beds, boulders, riffles, woody debris, and identifiable breeding sites, such as eel-tailed catfish (*Tandanus tandanus*) nests. **Six Mile Creek Downstream Sites and Control Sites** <u>Before drawdown (baseline):</u> • Undertake baseline monitoring of habitat condition at the three downstream monitoring sites and two control sites, as outlined in Appendix F (Habitat Monitoring Program). <u>During drawdown:</u> • Undertake drawdown phase monitoring at the three downstream monitoring sites and two control sites, as outlined in Appendix F (Habitat Monitoring Program). • Daily flow volume recorded at State Government gauging station at Cooran compared to long-term flow percentiles; flow data accessed and assessed monthly. <u>During construction:</u> • Undertake construction phase monitoring of habitat condition at the three downstream monitoring sites and two control sites, as outlined in Appendix F (Habitat Monitoring Program). • Daily flow volume recorded at State Government gauging station at Cooran compared to long-term flow percentiles; flow data accessed and assessed monthly. <u>Post-construction:</u> • Undertake post-construction phase habitat monitoring at the three downstream monitoring sites and two control sites, as outlined in Appendix F (Habitat Monitoring Program).
Reporting	• Monitoring results provided to Seqwater Project Manager and Contractor's environmental representative via email, where performance criteria are not met. • Quarterly report provided to regulatory agencies summarising compliance and monitoring results. • A brief monitoring data summary report, as outlined in Appendix F (Habitat Monitoring Program), will be provided to the Seqwater Project Manager and regulatory agencies (if requested).

ENVIRONMENTAL OBJECTIVE: Minimise impact of lake drawdown on aquatic habitat in the lake and Six Mile Creek downstream.	
Responsibility	Contractor – Site Supervisor or representative, using suitably qualified persons
Corrective actions	• Where the performance criteria are not met, reduce or pause releases and investigate as outlined in Appendix F (Habitat Monitoring Program). • Review management measures and adjust to prevent further impact if required. Update the plan and, if required, provide notification as described in section Appendix F. • If impacts are noted and reducing the drawdown releases is not effective, review alternative mitigation options, including habitat improvements, through Seqwater's existing relationship with MRCCC and Noosa and District Landcare. – Note: in-stream actions to manage stream flows are not considered appropriate (e.g. checks or armouring) due to safety considerations and are likely to have greater impact on the ecosystem compared to the release activities. • Where downstream flow requirements are not achieved, release bypass flows or investigate alternative options. • Re-establish or supplement aquatic habitat (as per section 9.1)

7. Biosecurity Management Plan

7.1 Baseline Conditions

7.1.1 Biosecurity Matter in Lake Macdonald and Six Mile Creek Downstream

The *Biosecurity Act 2014* (Bio Act) identifies two types of biosecurity matters: prohibited matters, which are not yet present in Queensland, and restricted matters, which are currently present in Queensland.

Eight restricted biosecurity matters are known to be present in Six Mile Creek:

- Pest fish: eastern gambusia (*Gambusia holbrooki*) and tilapia (*Oreochromis mossambicus*) – all are listed as restricted noxious fish under the Bio Act
- Aquatic plants: salvinia (*Salvinia molesta*), water hyacinth (*Eichhornia crassipes*), Hygrophila (*Hygrophila costata*), and Cabomba (*Cabomba caroliniana*) – all listed as category 3 restricted invasive plants under the Bio Act
- Amphibians: cane toad (*Rhinella marina*) – not listed as a prohibited or restricted invasive animal under the Bio Act

There are extensive beds of Cabomba within Lake Macdonald and the upstream tributaries of Six Mile Creek. Small populations of Cabomba have also been identified downstream in Six Mile Creek. Restricted matters from the lake (e.g. gambusia and Cabomba) are likely transported downstream when the dam overtops, which occurs frequently.

In 2010 it was estimated that Lake Macdonald was home to 86% of Australia's Hygrophila. Since then Seqwater Operations staff estimate that 99% of the plant has been removed from the lake.

Surveys in 2015, 2020 and 2023 identified eastern gambusia populations in Lake Macdonald. To date, tilapia have only been recorded downstream of Lake Macdonald in Six Mile Creek. It is not known if the species is present in Lake Macdonald, though it is considered unlikely.

Cane toads were identified around lake Macdonald during amphibian surveys conducted in 2018 and 2023, including the upstream and downstream tributaries of Six Mile Creek.

It is not known whether frogs present in Lake Macdonald and Six Mile Creek are infected with chytridiomycosis, the infectious disease that affects amphibians across the world. Chytridiomycosis mostly affects species associated with permanent water and appears to be confined to the relatively cool and wet areas of Australia, including along the Great Dividing Range and adjacent coastal areas in Queensland (DSEWPaC, 2013). While it is widespread, with very few suitable host areas remain uninfected in Australia, there are also some disease-free pockets within infected regions. Chytridiomycosis is caused by the Chytrid fungus (*Batrachochytrium dendrobatidis*), a fungus capable of

causing occasional deaths in some amphibian populations and complete mortality in others. Chytrid fungi typically live in water or soil and have spores that 'swim' through the water.

7.2 Potential Impacts of Lowering Lake Macdonald

Potential impacts associated with biosecurity matters that could occur by lowering Lake Macdonald are:

- Spread of biosecurity matter (aquatic weeds, aquatic pest species, disease)
- Introduction of new biosecurity matter.

7.2.1 Lake Macdonald

Certain hydrological conditions may potentially allow upstream movement of pest fish such as tilapia into Lake Macdonald dam during the proposed works.

7.2.2 Downstream of Lake Macdonald Dam

There may be a slight increase in the transport of restricted matter downstream, notably Cabomba and Gambusia, from the lake to Six Mile Creek during the lowering process. Water pumped from Lake Macdonald to Six Mile Creek may contain a greater concentration of restricted matter than is present during overtopping events, and this could place pressure on the downstream aquatic communities.

If Chytrid fungus is present in Lake Macdonald or the surrounding area, it is also likely to be in Six Mile Creek downstream of the dam. While not considered likely given the widespread nature of Chytrid fungus, if it is not present, it could also be transferred to the creek on muddy equipment and machinery brought in for the Project, on the boots of workers, or in water trucked in for construction after Lake Macdonald is lowered.

7.2.3 Fauna Relocation Sites

There is potential for the spread of biosecurity matter from Lake Macdonald to relocation sites as a result of the fauna salvage and relocation program. Pest fish species (e.g. Gambusia) and aquatic weeds (e.g. Cabomba) could be inadvertently transported in water from Lake Macdonald used to transport and hold fauna, and on the fauna being transported. If the biosecurity matter being transported is not already present at the relocation sites, there is the potential to introduce a new biosecurity matter to an area.

Relocation of fauna from Lake Macdonald also has the potential to introduce pathogens and diseases (e.g. Chytrid fungus, parasites) to relocation sites. These may be present in the water from Lake Macdonald used for holding and transport of fauna, or on fauna. However, given the widespread nature of Chytrid fungus, it is unlikely that it is not already present at relocation sites.

7.3 Management and Monitoring

Potential impacts of fauna biosecurity matters will be mitigated by implementing the management measures in Table 7-1 and Table 7-2. Where appropriate, the management measures contained in table 7-1 and 7-2 will be adapted over the course of the Project in response to changing conditions and expert advice.

Seqwater plans to implement opportunistic programs to manage pest species in Lake MacDonald. The dam upgrade project team will coordinate with operational staff to make the most of opportunities arising from the temporary lowering of the lake to allow for ongoing pest management activities during the construction period.

Table 7-1: Management of pest animal biosecurity matters during the lowering of Lake Macdonald

ENVIRONMENTAL OBJECTIVE – PEST MANAGEMENT: **Distribution of pests does not increase due to the Project and existing populations of pest fauna do not increase.**	
Performance criteria	**Lake Macdonald and Six Mile Creek Downstream** Obligations under the Queensland *Biosecurity Act 2014* are met. No new pest infestations, or increase in distribution of pests, as a consequence of the lake lowering activities, including fauna relocation.

ENVIRONMENTAL OBJECTIVE – PEST MANAGEMENT:

Distribution of pests does not increase due to the Project and existing populations of pest fauna do not increase.

Management measures

Lake Macdonald and Six Mile Creek Downstream

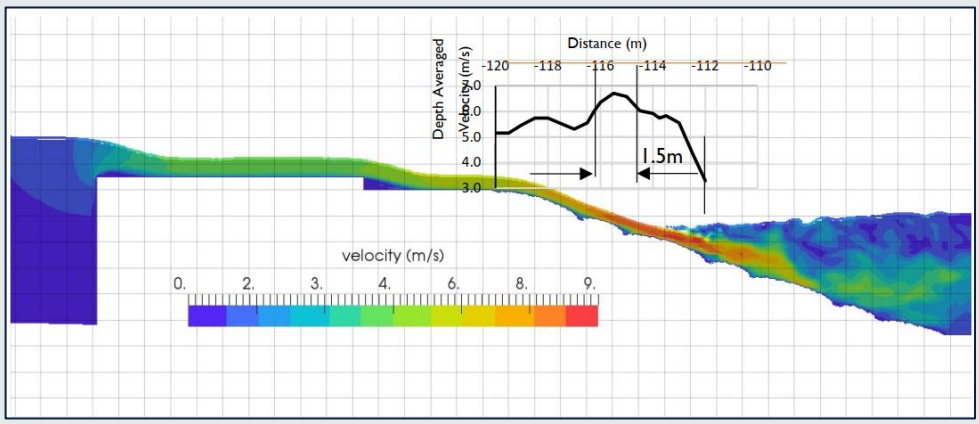
Before drawdown:

- Hydrological modelling conducted prior to the drawdown indicates that the current cofferdam retains 3000 mm during significant inflow events (up to a 1 in 1000 AEP) of freeboard between headwaters and tailwaters, mitigating impact of potential pest fish migration into Lake Macdonald and upstream environments.

Property	Elevation (m AHD)		
	AEP 1 in 1000	AEP 1 in 100	AEP 1 in 10
Headwater	95.2	94.9	94.5
Stilling Pond	92.4	92.1	91.5
Tailwater	92.15	91.45	90.63
Difference Stilling Pond to Tailwater	0.25	0.65	0.87

Extract from the Cofferdam Design Report

Flow velocities over the cofferdam would also be prohibitive to tilapia migrating over the structure. As seen below velocities for a 1 in 100 AEP peak at 6.7m/s across a 1.5m distance. The maximum swimming speed of tilapia is known to be approximately 4.9m/s. For a 1 in 10 AEP event the flow velocities peak at 5.6m/s however as seen in the table above the vertical distance between headwater and tailwater is further increased thereby removing the possibility of upstream fish passage.



Extract from the Cofferdam Design Report for a 1 in 100 AEP event.

- The Lake Macdonald spillway and dam abutment upgrade (including temporary works) has been designed to avoid the spread of pest fish such as tilapia into the lake. No fish passage facilities have been included in the dam upgrade program and the new spillway will exclude fish migration.

During drawdown and construction:

- Manage the water level in the lake to reduce the potential for drown-out / overtopping (i.e. via active releases), where possible (i.e. where weather conditions are favourable).
- If drown-out of the temporary cofferdam occurs, implement a fish salvage event targeting tilapia when conditions are suitable and access is safe. This may include lower the lake level to consolidate biomass density for effective sampling.
- Euthanise pest fish humanely during aquatic salvage or sampling activities.
- Do not use water from Six Mile Creek downstream of the dam for construction purposes, if the purpose presents a credible risk of transferring biosecurity matters (tilapia) into Lake Macdonald.
- All vehicles (including boats) and plant to have weed hygiene certification before entering Lake Macdonald.
- Ensure all relevant personnel complete pest identification training.

Salvage and Relocation

- Ensure all relevant personnel complete pest identification training.

ENVIRONMENTAL OBJECTIVE – PEST MANAGEMENT: Distribution of pests does not increase due to the Project and existing populations of pest fauna do not increase.	
	• During fauna salvage and relocation, euthanise any pest fish or turtles caught using ethics approved methods and dispose of appropriately (e.g. in plastic bags at an appropriate refuse facility or buried on site a minimum of 20 m from the water's edge). • Filter (screen) all water to be used to hold and transport fauna for relocation to reduce potential transport of tadpoles. • Assess fauna condition and do not relocate individuals with impaired condition or visible parasites, lesions or fungi. With the exception of MNES species, fauna with impaired condition should be returned to the lake or euthanised. MNES species should be placed in a suitable receptacle and transported to a suitably qualified wildlife carer. • Wash down fauna relocation vehicles and equipment in accordance with weed washdown protocols before returning to the Project area to remove any attached sediment or mud. • Clean and disinfect footwear, or change footwear, used for fauna relocation in accordance with the Hygiene protocols for the control of diseases in Australian frogs (Murray et al, 2011).
Monitoring	**Lake Macdonald** • During construction, monitor presence of pest species in the lake as part of quarterly fish and turtle monitoring. **Six Mile Creek Downstream** • During construction, monitor presence of pest species as part of quarterly fish and turtle monitoring. **Relocation Sites** • During salvage and relocation, record the number of pest species observed and euthanised (e.g. in a register) during relocation activities.
Reporting	• Immediately report any tilapia in Lake Macdonald to the Seqwater Project Manager. • Fortnightly report submitted to the Seqwater Project Manager via email with details of monitoring results and incidents. • Quarterly report provided to regulatory agencies summarising compliance and monitoring results.
Responsibility	Contractor – Site Supervisor or representative Seqwater – Project Manager or representative
Corrective action	• Where infestations of pest species are identified, implement appropriate treatment / control measures, on a case by case basis. • Regularly review existing control measures to identify potential improvements. • If any biosecurity issues are identified, review and adapt management measures as appropriate.

Table 7-2: Management of pest plant biosecurity matters during the lowering of Lake Macdonald

ENVIRONMENTAL OBJECTIVE – WEED MANAGEMENT: **Restricted invasive plants not present in Lake Macdonald are not introduced.** **Restricted invasive plants already present in Lake Macdonald are not spread to new areas.**	
Performance criteria	• Obligations under the Queensland *Biosecurity Act 2014* are met. • All vehicles and plant working in the lake have weed hygiene certificates. • No additional weed infestations or increase in distribution in the lake or at relocation sites due to construction activities. • All employees working on site attend induction training sessions to identify weeds.
Management measures	**Lake Macdonald, Six Mile Creek Downstream, and Salvage and Relocation** During drawdown: • Relocate fauna only to the specified relocation sites for each species, which have been selected with consideration to the presence of restricted biosecurity matter that occur in Lake Macdonald. • Filter (screen) all water to be used to hold and transport fauna for relocation to reduce potential of transport of weeds. • All vehicles used for fauna relocation to be inspected and washed before leaving site if they have entered Lake Macdonald or margin areas where aquatic plants are exposed. During construction: • All vehicles (including boats) and plant to have weed hygiene certification before entering Lake Macdonald. • Undertake aquatic and terrestrial weed control in the lake area as required, based on monitoring stipulated below. This may include areas where Hygrophila is likely to establish on exposed banks that have previously been controlled or eradicated. Weed control methods and substances shall be selected based on avoidance of impacts on water quality and aquatic fauna. • The temporary lowering of the lake will allow more direct access to the lake edges by ARGO (mud buggy) from which the remaining plants can be more readily targeted and either manually removed or spot-sprayed with approved herbicides.
Monitoring	**Lake Macdonald** Before drawdown Baseline monitoring of the lake (and lake margins) to establish a baseline understanding of the species and distribution of restricted aquatic or semi-aquatic plants. During drawdown and construction: • Spot checks of weed hygiene certifications and inspection and wash down records. • Weekly monitoring of the lake (and lake margins) for outbreaks of not previously established restricted aquatic or semi-aquatic plants (noting that new growth of Cabomba will not be prevented in the lake to provide food for aquatic species). **Six Mile Creek Downstream** During drawdown and construction: • Record visual observations of aquatic and semi-aquatic weed species as part of aquatic habitat monitoring. Post-construction: • Record visual observations of aquatic and semi-aquatic weed species as part of aquatic habitat monitoring. **Relocation Sites** • Record visual observations of aquatic and semi-aquatic weed species as part of relocation site monitoring.
Reporting	• Personnel to notify the Seqwater Project Manager of weed outbreaks or potential contamination immediately. • Monthly report via email to Seqwater that includes details of monitoring and audits. • Quarterly report provided to regulatory agencies summarising compliance and monitoring results.
Responsibility	Contractors – Site Supervisor or representative Seqwater – Project Manager or representative

ENVIRONMENTAL OBJECTIVE – WEED MANAGEMENT: Restricted invasive plants not present in Lake Macdonald are not introduced. Restricted invasive plants already present in Lake Macdonald are not spread to new areas.	
Corrective action	• If an outbreak of a restricted weed is observed in Lake Macdonald, Six Mile Creek or a relocation site: – where practical and safe, treat weed(s) to control outbreak using appropriate methods (e.g. herbicide approved for use in waterways, physical removal) – increase monitoring of weed hygiene measures, if relevant – review mitigation and adapt the management measures, as appropriate.

8. Incident and Contingency Planning

This section describes proposed measures to manage unforeseen events and incidents that may occur during the drawdown process and construction period. The described management measures are indicative only, and will be adapted in response to an event, and in response to changing conditions and expert advice.

8.1 Drawdown of Lake Macdonald

During the drawdown phase, gradual releases will aim to lower the water level for aquatic fauna salvage and for minimising potential for downstream habitat changes. Nevertheless, there are likely to be rainfall events in the drawdown phase that disrupt the drawdown schedule. Where the drawdown release rate is exceeded by catchment inflows, the drawdown release will be temporarily increased to reinstate the drawdown schedule.

Monitoring for downstream geomorphic and habitat impacts shall be undertaken as per the drawdown phase frequency outlined in Appendix F. Where increased release rate is required, the frequency of downstream aquatic habitat monitoring will increase for that period.

If issues are detected during monitoring, the release rate will be slowed or stopped to enable appropriate management measures, to be implemented. The management measures will be similar to those described in this plan but adapted as needed in response to the conditions at the time.

8.2 Aquatic Fauna Salvage and Relocation

8.2.1 High Fauna Abundance

During the baseline evaluation survey and during the fish salvage operation, multiple biomass assessments will be undertaken so the biomass of fauna in the lake can be validated. This will allow informed choices regarding fish management during the project.

Should the abundance of fauna in Lake Macdonald be higher than expected, to the extent that the active salvage teams are unable to safely capture and relocate adequate numbers of aquatic fauna, then additional salvage teams will be mobilised to assist in the salvage and relocation effort. The contingency relocation sites discussed in sections 5.5.5 and 8.2.3 may also need to be used to accommodate any additional fauna.

Additionally, salvage will prioritise fauna species as follows:

- 1st Priority – MNES and MSES species (i.e. Mary River cod, Australian lungfish (if required, as stipulated in Section 5.5.2), Mary River turtle, white-throated snapping turtle)
- 2nd Priority – other large-bodied native fish species.

Where fauna abundance is higher than anticipated, holding facilities will be prioritised for MNES and MSES species. Additional common fauna will be returned to the lake for later management, either in the lake or during later salvage phases.

8.2.2 Unable to Achieve Salvage Targets

The 2025 evaluation survey found that 81.6% of large-bodied fish captured were bony bream which are unsuitable for relocation (see section 5.5.4.2). Additionally, 8.5% of large-bodied fish captured were banded grunter which are also unsuitable for relocation as they're not native to SEQLD. Therefore potentially 90% of large bodied fish captured will be unsuitable for relocation. If salvage efforts result in significantly lower catch rates then more realistic targets may need to be adopted in consultation with DPI and the fish biologist.

If after 2 weeks of salvage effort catch rates are <25% of the targets specified in Section 5.5.4 then the salvage program will be modified to substitute salvage and relocation for additional monitoring of WQ and aquatic fauna health. The monitoring program will be expanded from what's described in Table 3-1 to include WQ sampling profiling the various depth ranges at each sampling location. This will give the fish biologist a clearer picture of lake health.

8.2.3 Relocation Sites

As described in section 5.5.5, a suite of suitable relocation sites has been identified, which includes contingency sites that will be utilised if the conditions at primary relocation sites change or more fauna than anticipated are caught during salvage activities.

8.2.4 Fauna Injury or Death

All salvage will be implemented in accordance with DPI's Fish Salvage Guidelines to protect the welfare of fish during capture, transport and release. Seqwater will liaise with wildlife parks, carers and veterinarians in the region before the lake drawdown begins in order to develop:

- Awareness of the Project and the potential need for care and treatment of injured fauna
- A network that can provide support if required.

In the event that an aquatic animal is injured during the salvage operation:

- If the species is a Mary River cod or Australian lungfish, it will be transported as quickly as possible in an appropriately sized receptacle with aerated water for assessment by a qualified wildlife carer as nominated in the Construction Contractor's Flora and Fauna Management Plan
- If it is any other native fish species (e.g. yellow belly or Australian bass), then it will be:
  - placed in holding tank of suitable size with aerated water to allow for recovery and subsequent relocation
- If at the end of the day recovery has not been achieved, the fish will be humanely euthanised using methods approved under an ethics permit. If the species is a turtle, it will be transported as quickly as possible to a qualified wildlife carer
- If the species is a platypus, it will be transported as quickly as possible to a qualified wildlife carer, as nominated in the Construction Contractor's Flora and Fauna Management Plan.

8.2.5 Giant Barred Frog

While giant barred frogs are expected to adapt to the lower lake level or relocate of their own accord in response to changing water levels. They may be encountered during fauna salvage activities, and construction. Where the frogs are unable to voluntarily relocate, they will be relocated to Six Mile Creek downstream of the dam at locations with suitable habitat that are not affected by construction or drawdown releases.

All handling and relocation of frogs will be done in accordance with the following protocols, as per the *Survey Guidelines for Australia's Threatened Frogs* (DCCEEW, 2010), *Hygiene protocols for the control of diseases in Australian frogs* (Murray et al 2011), and Queensland *Technical Manual, Wildlife Management, Interim Hygiene Protocol for Handling Amphibians* (DEHP, 2016):

- Minimise handling as much as possible – have a transport bag/container ready to put the frog in before catching it
- Wear non-powdered vinyl or nitrile gloves whenever handling frogs

- Use soft cloth bags or a suitable container to hold frogs for transport, with only one frog per bag / container, and only use the bag / container once
- Release the frog as soon as possible and hold for no more than one hour.

The release of frogs to sites downstream of the lake is not expected to facilitate the spread of Chytrid fungus, as the fungus will be present downstream if it is present in the lake.

8.2.6 Platypus

It is not planned to relocate platypus during the Project. However, if maintaining suitable habitat conditions becomes difficult/impractical or a platypus is in distress, relocation will be necessary. If circumstances require the care and/or relocation of platypus, the following steps are proposed:

- A qualified wildlife carer will be contacted to assess the platypus condition and take it into care
- If the platypus is considered to be in healthy condition, and suitable habitat is present in the vicinity of where it was found, it will be returned to the habitat in this location by a suitably qualified person (i.e. carer or aquatic ecologist) and monitored using camera traps for two weeks.
- If the platypus is considered to be in healthy condition, and no suitable habitat is present in the vicinity of where it was caught, the platypus will be relocated to an appropriate location further upstream or downstream on Six Mile Creek. It will be relocated by a suitably qualified person and monitored using camera traps for two weeks.

If a platypus is relocated to a holding facility (as opposed to a waterway site) due to unavailability of suitable release locations, it will be returned to Lake Macdonald once conditions in the lake are suitable and monitored using camera traps.

8.2.7 Traffic Assessment

A traffic assessment should be undertaken prior to each day (or individual transfer) of fish capture and relocation activity. This will assist in determining the best routes to the relocation sites to avoid delays to fish relocation. Ongoing team communication during each day will allow the capture and transport of fish to be streamlined and avoid any transport delays.

8.2.8 Unforeseen Situations During Salvage and Relocation

In the event that unforeseen situations arise during salvage and relocation operations, the following contingencies will be implemented:

- In an emergency, the temporary storage tubs set up at the salvage and relocation holding area can be used to store fish.
- The relocation operation will be undertaken by two transport teams using two transport trailers, with a third spare trailer available if delays occur for any reason.
- Two oxygen bottles will be available in each trailer in the event one runs out. A back up air blower will be also available.
- A communication plan will be in place, along with a fish relocation coordinator at the lake to manage risks of traffic delays etc.
- Welfare checks on fish will be made at set points along the route in the event aeration system fails. Oxygen testing and recording will be included in routine transfers.

8.3 Aquatic Habitat and Fauna in Lake Macdonald

While Lake Macdonald is lowered it is possible, but unlikely given the modest drawdown magnitude proposed, for the remaining aquatic habitat to become unsuitable for fauna. If monitoring indicates aquatic fauna are in distress or dying, the following actions will be taken:

- Review of water quality monitoring results. If monitoring indicates that water quality in the lake is not meeting the objectives identified in section 3.1.1, the following actions will be taken:

  - Low dissolved oxygen – assess and implement additional aeration measures, including effective and proven aeration devices or methods.
  - Low pH – dose with appropriate agent, with consideration of potential impacts to fauna
  - High turbidity – investigate and manage potential erosion sources, institute additional or alternative erosion controls.
- Construction phase salvage if reduced water volume targets are exceeded, to reduce potential crowding and pressure on resources.

8.4 Aquatic Habitat and Fauna in Six Mile Creek

Where monitoring indicates a potential impact to aquatic habitat in Six Mile Creek downstream of the dam (i.e. performance criteria are not met), the following actions will be taken:

- Drawdown releases will be reduced or paused
- Targeted monitoring of habitat and/or fauna will be undertaken to identify the cause and extent of the impact, with the monitoring design to be determined on a case by case basis, but consistent with the routine monitoring described in this plan
- Review of management measures and additional or alternative measures implemented to prevent further impact.

If a reduction in flow release rates, or pauses in releases, are not effective the following alternative mitigation options will be investigated and implemented where appropriate:

- Appropriate habitat improvements after lowering (based on impacts identified during monitoring and the affected fauna), through Seqwater's existing relationship with MRCCC and Noosa and District Landcare
- Restocking of Mary River cod after lowering
- Physical protection of aquatic habitat (e.g. increase in energy dissipation measures).

8.5 Protected Matters (Flora and Fauna) not Previously Identified

Where flora and fauna species classified as protected matters (MNES and MSES) that were not previously identified in the IAR are encountered in the project area or downstream, the following actions will be taken:

- Drawdown releases will be reduced or paused.
- Works in the area where the species was found will cease.
- Seqwater and the relevant regulatory agencies will be notified.
- A targeted survey of the species and its habitat will be undertaken in the project area and Six Mile Creek downstream. The survey design will be determined on a case by case basis but be consistent with relevant threatened species survey guidelines and the routine monitoring described in this plan (where applicable).
- Management measures will be reviewed and, if required, additional or alternative measures implemented within the AMP to prevent impact. These will have regard to the recovery and threat abatement plan for the species identified, where available. The revised AMP will then be reviewed by an independent expert and submitted for approval by DCCEEW as per Condition 27 of the EPBC approval, prior to the reissue and re-commencement of works.

9. Remediation of Lake Macdonald

Based on Seqwater water balance modelling for Lake Macdonald Dam (GoldSim simulation over a period of 1890-2011), mean annual inflow and direct rainfall for Lake Macdonald is 33,732 ML/y. The full supply volume of Lake Macdonald on completion of the Project will remain unchanged compared with the existing dam, at 8,018 ML. Under

typical rainfall conditions Lake Macdonald is expected to return to its full supply level within approximately one year of the completion of the Project.

9.1 Aquatic Habitat

Where the monitoring described in section 6.3 and Appendix F indicates that aquatic habitat in Lake Macdonald has been negatively impacted, or project activities have disturbed the bed or banks of Lake Macdonald, habitat remediation measures will be implemented. The remediation measures will be contingent on the identified impact, but may include revegetation and stabilisation of banks, replacement of substrate materials, and the reestablishment of any habitat removed for works (e.g. woody debris and snags).

The lowering of Lake Macdonald may also provide an opportunity to improve aquatic habitat in the lake for some fauna (e.g. native fish in general, MNES species, turtles). Seqwater will investigate these opportunities in the lead up to and during construction. Seqwater plans to implement opportunistic programs to manage pest species in Lake MacDonald. The dam upgrade project team will coordinate with operational staff to make the most of opportunities arising from the temporary lowering of the lake to allow for ongoing pest management activities during the construction period. Depending on the target species (to be identified during the investigation), fish habitat structures could be created through the strategic placement of:

- Broken concrete slabs from existing dam spillway structure
- Leftover concrete from pours during construction, which may be redirected into moulds designed to produce fish habitat structures
- Root balls and hollow logs from vegetation cleared for the Project
- Objects resembling hollow logs such as concrete culverts.

The project will set aside Coarse Woody Debris (large rootballs / hollow logs etc) in a separate stockpile to be inspected by the project fish ecologist who will identify and mark-up pieces suitable for aquatic ecology enhancement projects. The project will endeavour to install as many of these as possible throughout the lake during rehabilitation or offer them to local environmental groups like MRCCC for beneficial reuse.

A targeted instream woody habitat (IWH) survey will be conducted prior to any introduction of structures to ensure that the most effective use of resources is achieved in Lake Macdonald and in any other locations. The following information will be recorded to describe the implemented structures for any future monitoring or research purposes:

- Location (latitude and longitude)
- date of installation
- area of timber in square meters
- complexity and description of IWH.

In addition, the opportunity to facilitate the growth of native aquatic plant species and increase competitive pressure on Cabomba through the seeding and planting of native plants will also be investigated and considered.

Where the monitoring described in section 6.3 and Appendix F indicates that aquatic habitat in Six Mile Creek downstream has been affected or removed by flows associated with the lake lowering, the habitat will be rehabilitated at the completion of the lake lowering. Remediation will include the reestablishment of snags, large woody debris and aquatic vegetation, and replacement of banks and substrate materials, as required.

Habitat Remediation will be the responsibility of the Contractor, reporting to Seqwater. The Contractor is to produce a Rehabilitation Management Plan that covers remediation works required in Lake Macdonald as well as any impacted areas of downstream Six Mile Creek. The plan needs to be submitted to DCCEEW for approval prior to implementation.

9.2 Aquatic Fauna

Quarterly fish and turtle monitoring data collected during the construction phase will be compared to baseline data, including species, abundance and condition (length weight relationships). Where review of this data at the completion

of the construction phase indicates habitat augmentation or stocking should be considered as management options, then further investigation will be undertaken at that time.

Seqwater will collaborate with local stakeholders, including MRCCC and the Freshwater Fishing and Stocking Association of Queensland (FFSAQ), to identify the most effective approach for restoring the lake to its pre-construction condition.

9.3 Water Quality

The water quality data logging meters will be kept in place after completion of construction until the lake has refilled to at least 80% FSL. Where turbidity is found to be higher than baseline condition, then visual surveys for erosion hotspots and sources of turbid runoff will be implemented in the inflow areas and upper margins of the dam and stabilised using appropriate sediment and erosion control.

9.4 Removal of Project Infrastructure

At the completion of the Project, equipment and facilities associated with construction, including erosion and sediment controls, will be demobilised and removed from the Project site. Areas of ground disturbance will be seeded with suitable grasses or re-vegetated with locally sourced plants.

10. Risk Assessment

A risk based approach to the management of Lake Macdonald and Six Mile Creek downstream of the dam during the project has been undertaken. A risk workshop for the lake lowering was held on 29 August 2018 and attended by a range of stakeholders including Seqwater, MRCCC, Aquatic Biopassage (Andrew Berghuis) and frc environmental. Following the workshop, a preliminary version of this lowering plan was developed and reviewed as part of the IAR process. A subsequent risk workshop for the lake lowering to RL93m AHD was held on 14 December 2023 and attended by a range of stakeholders including Seqwater, Fishology (Kris Pitman), Virid IFC (Craig Thamm), John Holland.

Issues considered in the workshop held on 14 December 2023 included:

- The cofferdam and construction process
- Timing of and approach to lake drawdown
- Impacts to water quality
- Erosion and sediment control
- Impacts to flora and fauna
- Potential management measures
- Fauna salvage and relocation
- Maintenance and remediation.

A qualitative risk assessment was subsequently completed for the plan in accordance with the risk framework described in the DCCEEW Environmental Management Plan Guidelines (2014). This risk assessment is provided in Table 10-3. The risk framework is provided in

Table 10-1, with the likelihood and consequence categories defined in

Table 10-2.

Table 10-1: Risk framework

		CONSEQUENCE				
LIKELIHOOD		Minor	Moderate	High	Major	Critical
	Highly Likely	Medium	High	High	Severe	Severe
	Likely	Low	Medium	High	High	Severe
	Possible	Low	Medium	Medium	High	Severe
	Unlikely	Low	Low	Medium	High	High
	Rare	Low	Low	Low	Medium	High

Table 10-2: Likelihood and consequence

QUALITATIVE MEASURE OF LIKELIHOOD (how likely is it that this event/circumstances will occur after management actions have been put in place/are being implemented)	
Rare	May occur in exceptional circumstances
Unlikely	Could occur period of EPBC approval but considered unlikely or doubtful
Possible	Might occur during the period of EPBC approval
Likely	Will probably occur during the period of EPBC approval
Highly likely	Is expected to occur
QUALITATIVE MEASURE OF CONSEQUENCES (what will be the consequence/result if the issue does occur)	
Minor	Minor risk of failure to achieve the plan's objectives. Results in short term delays to achieving plan objectives, implementing low cost, well characterised corrective actions.
Moderate	Moderate risk of failure to achieve the plan's objectives. Results in short term delays to achieving plan objectives, implementing well characterised, high cost/effort corrective actions.
High	High risk of failure to achieve the plan's objectives. Results in medium-long term delays to achieving plan objectives, implementing uncertain, high cost/effort corrective actions.
Major	The plan's objectives are unlikely to be achieved, with significant legislative, technical, ecological and/or administrative barriers to attainment that have no evidenced mitigation strategies.
Critical	The plan's objectives are unable to be achieved, with no evidenced mitigation strategies.

Table 10-3: Risk assessment and management

Environmental Attribute	Management Objective	Main Potential Impact Pathways	Management Measures	Residual risk			Monitoring and Corrective Actions
				Likelihood	Consequence	Risk	
Water Quality	Minimise impact of lake lowering on water quality in Lake Macdonald and Six Mile Creek	Poor water quality results from low inflows and evaporation of the lake.	As per Table 3-1, which includes the existing bubble plume destratification unit being maintained and run continuously for the life of the project, providing aeration of the water in Lake Macdonald. If the trigger values for relevant parameters are identified and it appears that the destratification unit is not working or there are insufficient inflows, additional measures to restore water quality will be investigated. This will include additional proven aeration devices or methods.	**Unlikely**	**Moderate**	**Low**	Table 3-1
		Increasing turbidity and total suspended solids via disturbance of bed sediments and / or the erosion of bed and banks.	As per Table 3-1, which includes standard controls such as arranging dewatering intakes to extract from within the top half of water column and so that suction does not disturb sediments on the bed of Lake Macdonald, and implementing sediment and erosion control.	**Possible**	**Moderate**	**Medium**	Table 3-1
		Reducing pH by exposing or disturbing acid sulphate soils	As per Table 3-1, which includes standard controls such as arranging dewatering intakes to extract from within the top half of water column and so that suction does not disturb sediments on the bed of Lake Macdonald. As stated in Section 8.3, if low pH is identified dosing will be undertaken with an appropriate agent, with consideration of potential impacts to fauna.	**Unlikely**	**Moderate**	**Low**	Table 3-1
		Eutrophication of Lake Macdonald following the drawdown resulting in an increased occurrence of agal blooms, specifically Blue-green algae.	As per Table 3-1 the existing bubble plume destratification unit will be maintained and run continuously for the life of the project, providing aeration of the water in Lake Macdonald. Implement risk-based assessment of any exceedances of water quality trigger values to determine the potential for environmental harm, and if so, then implement additional mitigations (e.g. implement additional proven aeration devices or methods in Lake Macdonald if the concentration of dissolved oxygen becomes of concern).	**Possible**	**Moderate**	**Medium**	Table 3-1
		Reduced water quality and/or drought conditions leading to reduced inflows resulting in stratification of the lake.	As per Table 3-1, the existing bubble plume destratification unit will be maintained and will run continuously for the life of the project, providing aeration of the water in Lake Macdonald. If the trigger values for relevant parameters are identified and it appears that the destratification unit is not working or there are insufficient inflows, additional measures to restore water quality will be investigated immediately. This will include additional proven aeration devices or methods. If before additional measures can be implemented it is identified that fish are showing signs of serious distress indicating they cannot remain within the lake then incidental fauna salvage as per section 5.5.4.1 is to be undertaken.	**Unlikely**	**Moderate**	**Low**	Table 3-1
		Reducing dissolved oxygen and pH through decomposition of organic matter (e.g. algae and aquatic plants) during and following drawdown.	As per Table 3-1, which includes standard controls such as arranging dewatering intakes to extract from within the top half of water column and so that suction does not disturb sediments on the bed of Lake Macdonald. Additionally, the existing bubble plume destratification unit will be maintained and will run continuously for the life of the project, providing aeration of the water in Lake Macdonald. If the trigger values for relevant parameters are identified and it appears that the destratification unit is not working or there are insufficient inflows, additional measures to restore water quality will be investigated. This will include additional proven aeration devices or methods. As stated in Section 8.3, if low pH is identified dosing will be undertaken with an appropriate agent, with consideration of potential impacts to fauna.	**Possible**	**Moderate**	**Medium**	Table 3-1
		Contaminating water through spills of fuels, oils or other chemicals from pumping equipment or other machinery / vehicles.	As per Table 3-1, which includes standard controls such as the use of biodegradable oils/lubricants, refuelling to be preferentially undertaken on land, appropriate spill kits to be in place, storage of hydrocarbons and chemicals in bunded areas, and compliance with the construction erosion and sediment control plan.	**Unlikely**	**Moderate**	**Low**	Table 3-1
		Contaminating water within the stilling basin (e.g. contamination from construction dust and other contaminants).	As per Table 3-1, which includes standard controls such as the use of biodegradable oils/lubricants, refuelling to be preferentially undertaken on land, appropriate spill kits to be in place, storage of hydrocarbons and chemicals in bunded areas, and compliance with the construction erosion and sediment control plan.	**Unlikely**	**Minor**	**Low**	Table 3-1
		Release of poor-quality water from the stilling basin to the downstream Six Mile Creek.	As per Table 3-1, regular monitoring of water quality in the stilling basin, and regular dewatering and treatment of poor-quality water from the stilling basin, will effectively mitigate this risk. Additionally, aeration of water and mitigation of erosion through energy dissipation as water is discharged downstream is to be provided, such as through armoured discharge points or sprays.	**Possible**	**Minor**	**Low**	Table 3-1

Environmental Attribute	Management Objective	Main Potential Impact Pathways	Management Measures	Residual risk			Monitoring and Corrective Actions
				Likelihood	Consequence	Risk	
Geomorphology	Minimise impact of lake lowering by preventing soil loss and erosion	Erosion of exposed bed sediments in upper lake areas.	As per Table 4-1, primarily engaging a suitably qualified person to undertake ongoing monitoring and implementation of the Erosion and Sediment Control Plan approved by a Certified Profession in Erosion & Sediment Control (CPESC). Additionally, if it does not interfere with works or cause a hazard, allow Cabomba and other exposed aquatic plants to decompose in situ as the dying plants will cover sediment that would otherwise be exposed.	**Unlikely**	**Minor**	**Low**	Table 4-1
		Bed and bank erosion of Six Mile Creek downstream.	As per Table 4-1, engaging a suitably qualified person to undertake ongoing monitoring and implementation of the Erosion and Sediment Control Plan approved by a CPESC, release rates complying with mitigations measures outlined in Table 4-1 (under Six Mile Creek Downstream – During drawdown and construction), as well as discharge drawdown releases in a manner that dissipates energy and prevents scour at the discharge point. For example, discharge onto the concrete apron on the downstream side of the Lake Macdonald spillway, use diffusers or spray nozzles, and / or energy dissipation methods such as riprap to slow water flow.	**Unlikely**	**Minor**	**Low**	Table 4-1
		Increase in chance of construction rubble and gravel being washed downstream during demolition of spillway and embankment structures.	As per Table 4-1, primarily engaging a suitably qualified person to undertake ongoing monitoring and implementation of the Erosion and Sediment Control Plan approved by a CPESC.	**Rare**	**Moderate**	**Low**	Table 4-1
Flora and Fauna	Minimise the impact of lake drawdown on aquatic flora and fauna in Lake Macdonald	Stranding of fauna in isolated pools in upper dam areas and overcrowding of fauna in the reduced lake.	Undertake an evaluation survey, with a focus on the upper reaches, to assess species presence and abundance (refer to Table 5-2 and section 5.5.3). Control the drawdown release rate as outlined in section 2 of this plan to allow fauna to move away from potential isolated pools to minimise the need for intervention. Do not complete drawdown of lake in less than 4 weeks. Implement contingency planning for incidental fauna salvage, where required (see section 8).	**Rare**	**Minor**	**Low**	Table 5-2
		During the period between completing the drawdown and demolition of the spillway, catchment inflows may refill the lake above RL 93 m AHD. This may result in re-flooding of areas which were subject to the aquatic fauna salvage operation conducted prior to the drawdown, creating new isolated pools which pose a risk to stranding of fauna.	Following the drawdown and during the construction of the new spillway and embankments, water levels will be maintained at a temporary FSL of RL 93.0 m AHD (42% of normal FSV) by a cofferdam. Undertake an evaluation survey, with a focus on the upper reaches, to assess species presence and abundance (refer to Table 5-2 and section 5.5.3). Implement contingency planning for incidental fauna salvage, where required (see section 8).	**Rare**	**Minor**	**Low**	Table 5-2
		Stranding of fauna in stilling basin, and exposure to potentially poor-quality water.	As per Table 5-2, diligence in monitoring fauna in the stilling basin and implementing a fauna salvage program to prevent overcrowding in the stilling basin on an as needed basis. As per Table 3-1, regular monitoring of water quality in the stilling basin, and regular dewatering and treatment of poor-quality water from the stilling basin. Additionally, aeration of water and mitigation of erosion through energy dissipation as water is discharged downstream is to be provided, such as through armoured discharge points or sprays.	**Likely**	**Minor**	**Low**	Table 5-2
		The stilling basin will need to be lowered or fully dewatered from time to time meaning aquatic fauna within the stilling basin will be impacted.	As per Table 5-2, daily visual monitoring of fauna in the stilling basin to assess potential for fauna stress and salvage aquatic biota from the stilling basin on an as needed basis (e.g. prior to all waterbody dewatering events, and when poor water quality is detected).	**Likely**	**Minor**	**Low**	Table 5-2
		Risk of injury or mortality to fauna due to machine strike / crush injuries if fauna move into the construction areas.	As per Table 5-2, primarily having a fauna salvage program to remove fauna from the construction area, and diligence in monitoring and salvaging fauna on an as needed basis from the construction area. The presence of turtles basking in the construction areas will be monitored and if deemed to present an issue specialist advice will be sought on how to best manage their exclusion.	**Unlikely**	**Moderate**	**Low**	Table 5-2
		Injury and mortality of turtles in construction workspaces, and on the spillway of the existing dam which may be utilised by turtles for basking.	As per Section 5.3.1, the low-flow slot section of the coffer design (with limited freeboard) will have continuous visual monitoring and any turtle interactions (i.e. basking/passage) can be addressed by the site environmental officer to remove or relocate fauna. If significant turtle interactions are noted to be occurring with the low-flow slot section of the cofferdam or the spillway then an investigation of potential solutions may be undertaken as a corrective action (i.e. exclusion engineering solution). Therefore, while turtles may access the spillway section cut to 89.5 m AHD, the majority of the water will be maintained by the cofferdam allowing observation of interactions with the turtle at the low-flow slot section of the cofferdam as a proxy for specific management of turtles at the existing spillway. As such, the current risk is considered low due to the restriction of access to a small section of the cofferdam and limited evidence of current use of the spillway for basking or passage.	**Unlikely**	**Moderate**	**Low**	Table 5-2

Environmental Attribute	Management Objective	Main Potential Impact Pathways	Management Measures	Residual risk			Monitoring and Corrective Actions
				Likelihood	Consequence	Risk	
		Risk of lake lowering impacting fauna breeding activities in downstream environments.	Control the drawdown release rate as outlined in Section 2 of this plan. Do not complete drawdown of lake in less than 4 weeks. Avoid changes to hydrology during the breeding seasons for MNES and MSES species known to be in Six Mile Creek downstream of the dam by conducting drawdown between March and October of any year (refer to Section 2.2).	**Unlikely**	**Moderate**	**Low**	Table 5-2
		Possible injury to downstream moving fish and turtles during a spill event due to barotrauma or strike with hard surfaces.	• In accordance with State code 18: Constructing or raising waterway barrier works in fish habitats, the temporary coffer dam will be designed, constructed and maintained to avoid and minimise impacts on matters of national and state environmental significance. The drownout characteristics of the waterway barrier works will be designed in consultation with a suitably qualified person (fish biologist) and constructed to not result in adverse impacts to fish passage. • To reduce harm to downstream moving fish and turtles the syphon system will be used to reduce the extent of overtopping flow events during construction. This will divert flows around construction site and reduce rates of spilling. • During any drawdown activity in construction phase use intake exclusion screens of suitable design (9mm x 9mm aperture) to prevent fish and turtles from being entrained into syphon system. • To reduce harm to any downstream moving fish and turtles during spilling events, the cofferdam has been designed to reduce risks to both fish and turtles. The design includes maintaining a 30% tailwater depth to spillway height, use of non-abrasive surfaces, eliminating potential impact points and a spillway design with no freefall sections.	**Likely**	**Moderate**	**Medium**	State code 18: Constructing or raising waterway barrier works in fish habitats and Table 5-2
		Entrainment, entrapment, injury and mortality of aquatic fauna in the screens and siphons during the dam lowering and bypassing of any inflows.	• During any drawdown activity in construction phase use intake exclusion screens of suitable design (9mm x 9mm aperture) to prevent fish and turtles from being entrained into syphon system. The mesh aperture and type that will be used is the same as the aperture and type previously proposed, assessed by DPI, accepted, and implemented for a siphon arrangement on another Seqwater project (Ewen Maddock). Performance for this project indicated there were no issues with fish/fauna entanglement or weed blockages. The mesh specified is diamond mesh aquaculture netting that is soft and has no knots (knotless nylon netting) which minimises harm to aquatic fauna. • Daily visual inspection of intake screens – ensure screens are functional, water approach velocity is at or below the limit noted as a mitigation, and no aquatic fauna are trapped against the screens. • Divers will perform an inspection and clean of the intake exclusion device. Initially this will be performed monthly. If weed build up and fauna entanglement is found to be negligible / insignificant then this activity will be scaled back in consultation with the project aquatic ecology expert.	**Likely**	**Moderate**	**Medium**	Table 5-2
Fauna Salvage and Relocation	Minimise the stranding and crowding of aquatic fauna in Lake Macdonald due to lake drawdown	Salvage and handling of fauna from lake results in injury or mortality to MNES species.	Undertake fauna salvage in accordance with the methodology in section 5.5.	**Unlikely**	**Moderate**	**Low**	Section 5.5
		Transport and handling of fauna results in injury or mortality.	Undertake fauna salvage in accordance with the methodology in section 5.5.	**Unlikely**	**Moderate**	**Low**	Section 5.5

Environmental Attribute	Management Objective	Main Potential Impact Pathways	Management Measures	Residual risk			Monitoring and Corrective Actions
				Likelihood	Consequence	Risk	
		Relocation sites are not suitable, leading to illness or mortality of relocated fauna or fauna already present at relocation sites.	As discussed in section 5.5.6, all sites will be revisited prior to any fauna being relocated and if new sites are required this will be discussed with DPI prior to relocation of fauna. Fishology are planning to undertake relocation site surveys as soon as the lake drawdown date has been confirmed. As per the freshwater ecology report (Freshwater Ecology, 2020) it was recommended that visual assessment will be undertaken immediately prior to commencement of any potential relocation activities. This will include an assessment of the streamflow conditions at the time and how this would influence the potential aquatic fauna carrying capacity (e.g. flow, water quality, submerged macrophytes and connectivity). As discussed in section 5.5, weekly visual monitoring of sites where fauna have been relocated during the relocation program (e.g. observations of mortality) and measurement of in situ water quality (focusing on dissolved oxygen) will be undertaken. Monitoring will also be undertaken on a monthly basis at all relocation sites for 12 months after week four (4) of the lake drawdown schedule, to assess the long-term success of the salvage and relocation operation. This will involve visual monitoring of sites where fauna have been relocated during the relocation program (e.g. observations of mortality) and measurement of in situ water quality (focusing on dissolved oxygen). Before relocation, all MNES fish species salvaged from Lake Macdonald will be tagged with Passive Integrated Transponder (PIT) tags and surveys will subsequently be undertaken at all sites where MNES species were released. These surveys will occur every six months from the completion of the drawdown salvage phase until the completion of dam construction. The surveys will use the same methods used in the relocation site assessment (Appendix H), and any MNES species caught will be scanned with a hand-held PIT tag reader to estimate the proportion of relocated MNES fauna recaptured as an indication of potential survivorship. Results will be compared to mark-recapture data for both species from the Mary River collected by DR, which will serve as a reference for recapture rates.	**Unlikely**	**Moderate**	**Low**	Section 5.5
		Fauna salvage efforts are unable to achieve the specified targets	Undertake additional WQ and aquatic fauna health monitoring. WQ monitoring described in Table 3-1 will be expanded to include sampling various profile depths at each monitoring site.	**Likely**	**Moderate**	**Medium**	Section 8.2.2
Aquatic Habitat	Minimise impact of drawdown on aquatic habitat in Lake Macdonald and Six Mile Creek downstream of the dam	Physical disturbance to downstream aquatic habitat.	As per Table 6-1, including: • Implement management measures for water quality (Table 3-1), erosion and sediment control (Table 4-1), and aquatic fauna (Table 5-2). • Control the drawdown release rate as outlined in section 2 of this plan. • Do not clear vegetation outside of the clearing extent defined in the IAR or other relevant approvals. • Do not complete drawdown of lake in less than 4 weeks. • Ensure releases do not exceed bankfull height of Six Mile Creek. • Avoid changes to hydrology during the breeding seasons for MNES and MSES species known to be in Six Mile Creek downstream of the dam, with drawdown not being permitted between 1 September and 28 February of any year (per section 2.2). • Do not clear vegetation or excavate banks until a suitably qualified person has checked the area for threatened fauna and breeding habitat (e.g. burrows). If any are identified, implement a 3 m x 3 m exclusion zone with flagging tape until approval to impact the area has been granted by the suitably qualified person. • Re-establish or supplement aquatic habitat (as per section 9.1), where monitoring indicates this is required.	**Unlikely**	**Moderate**	**Low**	Table 6-1
		Changes in flow conditions that lead to decline in habitat condition through scouring, disturbance of physical habitat (e.g. woody debris, leaf packs, aquatic plants) and altered flow habitat (e.g. riffle to pool).	As per Table 6-1, including: • Control the drawdown release rate as outlined in section 2 of this plan. • Avoid changes to hydrology during the breeding seasons for MNES and MSES species known to be in Six Mile Creek downstream of the dam, with drawdown not being permitted between 1 September and 28 February of any year (per section 2.2).	**Unlikely**	**Moderate**	**Low**	Table 6-1

Environmental Attribute	Management Objective	Main Potential Impact Pathways	Management Measures	Residual risk			Monitoring and Corrective Actions
				Likelihood	Consequence	Risk	
		Disturbance of banks and riparian vegetation during construction.	As per Table 6-1, including: • Implement management measures for erosion and sediment control (Table 4-1). • Do not clear vegetation outside of the clearing extent defined in the IAR. • Do not disturb bed or banks (e.g. clear vegetation or excavate) until a suitably qualified person has checked the area for threatened fauna and breeding habitat. If any are identified, implement a 3 m x 3 m exclusion zone with flagging tape until approval to impact the area has been granted by the suitably qualified person. • After construction is completed, and where disturbance or visual assessment indicates this is required, re-establish or supplement aquatic habitat (as per section 9) if it is safe to do so.	**Unlikely**	**Moderate**	**Low**	Table 6-1
		Temporary decrease in available habitat for aquatic flora and fauna during construction.	As per Table 6-1, including: • Implement management measures for water quality (Table 3-1), erosion and sediment control (Table 4-1), and aquatic fauna (Table 5-2). • Do not clear vegetation outside of the clearing extent defined in the IAR. • Do not disturb bed or banks (e.g. clear vegetation or excavate) until a suitably qualified person has checked the area for threatened fauna and breeding habitat. If any are identified, implement a 3 m x 3 m exclusion zone with flagging tape until approval to impact the area has been granted by the suitably qualified person. • After construction is completed, and where disturbance or visual assessment indicates this is required, re-establish or supplement aquatic habitat (as per section 9) if it is safe to do so.	**Unlikely**	**Moderate**	**Low**	Table 6-1
		Loss of riparian and in-stream vegetation due to potential changes in livestock access.	As per Table 5-2, Seqwater will work with individual landholders to ensure stock movements are prevented from moving outside their existing properties.	**Unlikely**	**Minor**	**Low**	Table 5-2
Biosecurity	Restricted invasive plants already present in Lake Macdonald are not spread to new areas	The spread or introduction of aquatic weeds on vehicles, machinery and personnel.	As per Table 7-1 and Table 7-2, primarily having weed hyenine protocols, and designing the cofferdam with fish biologist input to ensure tilapia cannot pass upstream under drownout conditions.	**Possible**	**Moderate**	**Medium**	Table 7-1 and Table 7-2
	Restricted invasive plants not present in Lake Macdonald are not introduced						
	Distribution of pests does not increase due to the Project and existing populations of pest fauna do not increase	The upstream spread of tilapia at the edges of the coffer dam during spilling events.	Risk of tilapia migrating upstream has been reduced due to physical barrier of cofferdam.	**Unlikely**	**Moderate**	**Low**	Table 7-1
	Distribution of aquatic diseases and pathogens does not increase due to the project	Spread of aquatic diseases and pathogens to Lake Macdonald, Six Mile Creek, and/or fauna relocation sites.	As per Table 7-1: • Do not use water from Six Mile Creek downstream of the dam for construction purposes, if the purpose presents a credible risk of transferring biosecurity matters (tilapia) into Lake Macdonald. • Assess fauna condition and do not relocate individuals with impaired condition or visible parasites, lesions or fungi. With the exception of MNES species, fauna with impaired condition should be returned to the lake or euthanised. MNES species should be placed in a suitable receptacle and transported to a suitably qualified wildlife carer. • Wash down fauna relocation vehicles and equipment in accordance with weed washdown protocols before returning to the Project area to remove any attached sediment or mud. • Clean and disinfect footwear, or change footwear, used for fauna relocation in accordance with the Hygiene protocols for the control of diseases in Australian frogs (Murray et al, 2011).	**Unlikely**	**Moderate**	**Low**	Table 7-1

11. Key Roles and Responsibilities

The persons responsible for implementing and reviewing this plan are identified in Table 11-1. Note that this table will be updated once a construction contractor is appointed, and the roles and contact information are finalised.

Table 11-1: Key roles and responsibilities

Role	Responsibilities	Contact information
Contractor – Senior Project Manager	• Management of lake lowering • Implementation of plan • Internal compliance audits • Compliance reporting • Site and habitat remediation • Ensuring design and operational elements are sourced (e.g. from experts in the field) and incorporated into the works to minimise the likelihood of injury and mortality of aquatic fauna	Name: Phone: Email:
Contractor – Environmental Representative	Implementation of management measures and monitoring	Name: Phone: Email:
Contractor – Suitably Qualified Persons	• Water quality monitoring • Flora and fauna salvage and relocation program • Flora and fauna surveys • Aquatic habitat monitoring • Technical review of plan	Name: Phone: Email: Name: Phone: Email:
Seqwater – Project Manager	• Direction of erosion and sediment control measures • Direction of biosecurity management • Internal compliance audits	Name: Phone: Email:
Seqwater – Planning and Approvals Advisor	Periodic review of plan	Name: Phone: Email:

Role	Responsibilities	Contact information
Seqwater – Rangers	Visual monitoring of lake for stranded fauna during routine duties	Name: WTP Rangers - TBC Phone: Email:
Independent Auditor	External compliance audits	Name: Phone: Email:
Independent Expert Reviewer	Review of Plan	Name: Phone: Email:

12. Data Handling and Storage

All monitoring data, quality control documents (e.g. laboratory reports) and site photographs are to be stored electronically, and with appropriate documentation to outline the data captured, storage location, type and any other relevant information.

All monitoring data are to be stored in a suitable database, spreadsheet(s), or software, which is to be kept up to date, secure and backed up. Integrity of monitoring data is to be ensured through suitable quality control processes, and access control as required.

13. Compliance Reporting and Audits

A report on residual significant impacts will be prepared within six months of the completion of the monitoring described in section 5.4. The report will include a Significant Impact Assessment (in accordance with the Significant Impact Guidelines 1.1) to determine if there are any residual significant impacts to MNES as a result of the lake drawdown, construction, and salvage and relocation operations.

The report will be prepared by suitably qualified and experienced persons, reviewed by an independent expert (refer to definitions provided in EPBC approval – EPBC 2017/8078), and made publicly available within nine months of the completion of monitoring. It will have regard to approved conservation advices, recovery plans and threat abatement plans and include an assessment of the effectiveness and success of the:

- Adaptive Management Plan and of the lake drawdown and construction to avoid, mitigate and manage impacts to protected matter(s)
- Aquatic Fauna Salvage and Relocation Management Plan, and salvage and relocation activities to avoid, mitigate and manage impacts to protected matter(s).

Compliance and non-compliance reporting and independent audits for the lake lowering will be undertaken in accordance with the Construction Environmental Management Plan. Reporting requirements for the EPBC Approval are identified in Table 13-1 and an audit schedule is provided in Table 13-2.

Reporting requirements for the different aspects managed under this plan are provided in the relevant management sections (1, 3.3, 5.4, 6.3, and 7.3 Table 6-1, Table 7-1, and Table 7-2).

Seqwater will notify DCCEEW of any Mary River turtle and white-throated snapping turtle caught and relocated within three days.

Table 13-1: EPBC reporting requirements

Report type	Content	Schedule	Person responsible	Recipient
Notification of commencement	Notification of commencement of action in accordance with Condition 14 of Part B.	Within 10 business days after the date of commencement of the action.	Seqwater Project Manager	DCCEEW
Compliance records	Electronic copies of compliance records in accordance with Conditions 16 and 17 of Part B.	As requested	Seqwater Project Manager	DCCEEW
Compliance reporting	Evidence of compliance with plan and monitoring data in accordance with Condition 20 of Part B.	Annually	Seqwater Project Manager and Contractor	DCCEEW
Non-compliance / incident reporting	Information on any incident, non-compliance with the conditions, or non-compliance with the commitments in this plan in accordance with Conditions 21 and 22 of Part B.	Notification – within 2 business days Detailed – within 10 business days	Seqwater Project Manager and Contractor	DCCEEW

Report type	Content	Schedule	Person responsible	Recipient
Audit report	Outcomes of independent compliance audits in accordance with Conditions 23, 24 and 25 of Part B.	Annually	Seqwater Project Manager and Contractor	DCCEEW
Plan revision	Details of any changes to this plan in accordance with Conditions 26 to 31 of Part B.	20 days before the implementation of the revised plan	Seqwater Project Manager and Contractor	DCCEEW
Completion notification	Notification of completion of the action in accordance with Condition 32 of Part B.	Within 30 business days of completion of the action.	Seqwater Project Manager	DCCEEW
Significant residual impact report	Significant Impact Assessment in accordance with Conditions 11 to 13 of Part A	Within nine months of the monitoring required under Conditions 5 and 9 of Part A.	Seqwater Project Manager, or representatives	DCCEEW

Table 13-2: Audit Schedule

Audit	Trigger / Subject	Frequency	Person responsible	REPORTING
Independent audit	Routine – compliance with plan in accordance with Conditions 23 to 25 of Part B.	Annually	Independent auditor	Compliance report to Seqwater and Contractor
Internal audit	Routine or in response to non-compliance – compliance with mitigation and monitoring measures.	Monthly or when triggered by a non-compliance	Contractor Site Supervisor, or representative	Compliance report to Seqwater

14. Permits and Qualifications

14.1 Permits and Approvals

The necessary permits and approvals required for the lake lowering and fauna relocation include:

- Remediation Permit (Spotter Catcher) in conjunction with a Species Management Program (SMP)
- SMP – required to tamper with the breeding place of a protected animal under the *Nature Conservation Act 1992*
- General Fisheries Permit
- Animal Ethics Permit is needed only for monitoring but not salvage.

14.2 Qualifications

The qualifications required of individuals managing and undertaking monitoring and the fauna salvage and relocation may include:

- Training, skills, and/or experience surveying and/or handling aquatic fauna
- A remediation permit issued under the *Nature Conservation Act 1992*.

15. References

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SMEC (2024. LMDIP site specific water quality objectives 2024 (LMDIP-05762-RES-ENV-REP-00001).

16. Glossary, Acronyms and Abbreviations

Abbreviations

Term	Definition
AHD	Australian Height Datum
AMP	Lake Macdonald Water Lowering – Adaptive Management Plan (this document)
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
COD	Chemical oxygen demand
CPUE	Catch per Unit Effort
DAF	Department of Agriculture and Fisheries
DCCEEW	Department of Climate Change, Energy, the Environment and Water (formally Department of Sustainability, Environment, Water, Populations and Communities)
DC	Direct Current
DES	Department of Environment and Science
DETSI	Department of Environment, Tourism, Science and Innovation (formally Department of Environment and Science)
DNRM	Department of Natural Resources and Mines
DR	Department of Resources (formally Department of Natural Resources and Mines)
DPI	Department of Primary Industries (formerly DAF)
DSEWPC	Department of Sustainability, Environment, Water, Populations and Communities
EC	Electrical Conductivity
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPP (Water)	*Environmental Protection (Water and Wetland Biodiversity) Policy 20109*
EVs	Environmental values
FSL	Full supply level
FSV	Full supply volume
GPP	Generator Powered Pulsator
HMP	Habitat Monitoring Program
IAR	Impact Assessment Report
MNES	Matters of National Environmental Significance
MRCCA	Mary River Catchment Coordination Association
MRCCC	Mary River Catchment Coordinating Committee
MSES	Matters of State Environmental Significance
NCA	*Nature Conservation Act 1992*

Term	Definition
SMP	Species Management Program
WQO	Water Quality Objectives
WTP	Water Treatment Plant

Glossary of Terms

Term	Definition
Abundance	Number of individuals per species.
Action	Any specified activity associated with the action including clearing, lake drawdown, construction and salvage and relocation.
Acid sulfate soils	Naturally occurring soils that contain iron sulphides.
Bankfull height	The water level at which a stream, river or lake is at the top of its banks, and any further increase in water level would result in water flowing into the flood plain.
Bathymetry	The study and mapping of a waterbody floor.
Baseline surveys	Surveys undertaken before the drawdown.
Benthic	An ecological region at the lowest level of a body of water, including the sediment surface and some sub-surface layers.
Destratification unit	Mechanism to prevent the lake from stratifying.
Baffle	A device (plate, wall or screen) to deflect, check, or regulate flow or passage.
Biomass	Amount of living matter in a given habitat.
Bypass arrangement	A pumping, siphoning or drainage arrangement that allows for bypassing of the low flow channel through the construction site.
Carapace	A bony or chitinous shield or shell covering some or all of the dorsal part of an animal.
Catchment	The area of land, which collects and transfers rainwater into a waterway.
Catch Per Unit Effort	The total catch divided by the total amount of effort used to harvest the catch.
Clearing	The cutting down, felling, thinning, logging, removing, killing, destroying, poisoning, ringbarking, uprooting or burning of vegetation (but not including weeds – see the Australian weeds strategy 2017 to 2027 for further guidance).
Cofferdam	A watertight structure, usually made of sheet piling, which encloses an area usually under water, so that it can be pumped dry to facilitate construction.
Common species	Species that are listed under the EPBC Act and/or the NCA as 'least concern.'
Compliance reports	Means written reports: providing accurate and complete details of compliance, incidents, and non-compliance with these approval conditions and commitments in the plans details of contingency measures or corrective actions that have been or will be implemented; consistent with the Department's Annual Compliance Report Guidelines (2014). include a shapefile of any clearance of any protected matter(s), or their habitat, undertaken within the relevant 12-month period; and annexing a schedule of all plans prepared and in existence in relation to the conditions during the relevant 12 month period.
Conservation advice	Conservation advice means a conservation advice approved by the Minister under the EPBC Act.
Controlled action	An action (including a project, development, undertaking, activity, or series of activities) that is likely to have a significant impact on a Matter of National Environmental Significance.

Term	Definition
Construction	The erection of a building or structure that is or is to be fixed to the ground and wholly or partially fabricated on-site; the alteration, maintenance, repair or demolition of any building or structure; preliminary site preparation work which involves breaking of the ground (including pile driving); the laying of pipes and other prefabricated materials in the ground, and any associated excavation work; but excluding the installation of temporary fences and signage.
Defined waterway	A defined waterway has one or more of the following attributes (Fisheries Act 1994): Defined bed and banks An extended, if non-permanent, period of flow Flow adequacy Fish habitat at, or upstream of the site
Department	The Australian Government agency responsible for administering the EPBC Act.
Discharged water	Water that is transported through a cross-sectional area. This includes any suspended solids, dissolved chemicals or biologic material in addition to the water itself.
Dissolved oxygen (DO)	The amount of oxygen dissolved in water.
Diversity	The variety of a particular factor.
Downstream	Means within Six Mile Creek and within 10 km down gradient of the project area.
Environment	The total of all the external conditions that act upon an organism.
Environmental flow	Freshwater flow that is maintained solely for environmental reasons, e.g. flows to act as an environmental cue, to deliver nutrients and sediment downstream etc.
Environmental Management Plan	Environmental Management Plans describe how an action might impact on the natural environment in which it occurs and sets out clear commitments from the person taking the action on how those impacts will be avoided, minimised and managed.
Erosion	The process by which rocks are loosened, worn away and removed from parts of the Earth's surface. Seven processes of erosion discussed separately; in practice they overlap and it is often difficult to isolate the net effects of any one process. Rain splash erosion: the detachment and removal of soil and debris by raindrop impact. Overland flow OR surface runoff: water flowing over the surface before being concentrated into definite streams. Sheet erosion, sheet wash, or slope wash: the combined effect of overland flow and rain splash. Gully erosion: the rapid development of gullies, usually in first- or second-order tributaries of streams, BUT also in situations unrelated to an integrated drainage system (e.g. highly dispersive soils) Mass Movement: downhill movement of debris en masse rather than as individual particles. It can occur slowly (creep), or rapidly (rock falls, slumps, landslides). Surface rock creep: the movement of stones down sloping surfaces. Fluvial erosion: the detachment and removal by streams of material in solution, suspension, or as bed load. Includes removal of debris supplied to the streams by slope wash, mass movement, and gullies.
Euthanise	The act or practise of causing or permitting the death of hopelessly sick or injured individuals in a relatively painless way and in accordance with animal ethics permits and guidelines.
Eutrophication	The process in which a body of water becomes enriched in dissolved nutrients that stimulate the growth of aquatic plant life, usually resulting in the depletion of dissolved oxygen.
Evaporation	The process that changes a liquid or a solid into a gas. In the tropical hydrological cycle, this involves the conversion to water vapor and the return to the atmosphere of the precipitation (rainfall) that has reached the earth's surface.

Term	Definition
Fauna	The collective animals of a given region.
Flora	The collective plants growing in a geographic area.
Flow regime	The variation in flow characteristics, such as volume, for a particular stream over time.
Fluvial	The river system.
Full supply level (FSL)	The maximum normal operating water surface level of a reservoir (Lake Macdonald is 95.3 AHD).
Full supply volume (FSV)	The volume of the lake at full supply.
Geomorphic processes	The formation and deformation of landforms on the surface of the earth,
Habitat	The biophysical medium or media occupied (continuously, periodically or occasionally) by an organism or group of organisms.
Hydrology	The study of the movement, distribution and management of water.
Incident	Any event which has the potential to, or does, impact on one or more protected matter(s).
Incidental catch	A catch that was not originally targeted but was caught and retained regardless.
Incidental salvage	Fauna salvage undertaken in response to flow and/or stranding event.
Independent audit	Audit conducted by an independent and suitably qualified person as detailed in the Environment Protection and Biodiversity Conservation Act 1999 Independent Audit and Audit Report Guidelines (2019).
Independent expert	A person that: does not have, an individual or by employment or family affiliation, any conflicting or competing interests with the approval holder; the approval holder's staff, representatives or associated persons; or the project, including any personal, financial, business or employment relationship, other than receiving payment for undertaking the role for which the condition requires an independent expert. has professional qualifications relevant to the protected matter(s) is a recognised expert, supported by relevant peer reviewed publications, regarding the protected matter(s) has at least 7 years of experience designing and undertaking surveys relevant to the protected matter(s).
Inflows	Water moving into Lake Macdonald due to inclement weather.
Inundation area	The area that will be flooded with water above the existing water level, from raising of the dam.
Lake drawdown	Intentional draining of water from within Lake Macdonald to facilitate construction.
Lake drawdown equipment	Lake drawdown equipment means equipment required to undertake the lake drawdown, including (but not limited to) pumping equipment.
Lake Macdonald	Means the area designated as 'Lake Macdonald' coloured in dark blue on the map at Figure 1–1.
Listed species	A plant or animal included in a schedule of endangered, vulnerable, or near threatened biota, such as the schedules in the Environment Protection and Biodiversity Conservation Act 1999 (Cth) or the Nature Conservation (Wildlife) Regulation 2006 (Qld).
Low flow channel	The low flow channel is the section of channel within the waterway that holds water during periods of low flow.
Macroinvertebrate	Organisms without a backbone which are large enough to be seen with the naked eye.
Macrophyte	An aquatic plant that is large enough to be seen with the naked eye.

Term	Definition
Matter of national environmental significance (MNES)	The matters of national environmental significance include: listed threatened species and communities listed migratory species Ramsar wetlands of international importance the Commonwealth marine environment World heritage properties National heritage places Nuclear actions
Mesohabitat	Medium sized habitat
NATA accredited laboratory	A laboratory in which independent authorities have assured the technical competence through a network of best practise industry experts.
Native species	A species that is indigenous to Australia or an external Territory, or periodically or occasionally visits.
Overtop	Where inflows will flow over the temporary cofferdam.
Performance criteria	The measurable standard set to which an activity is to perform.
pH	Measure of the acidity or alkalinity of a substance, with 1 being the most acidic, 7 being neutral and 14 being the most alkaline.
Population	Occurrence of a species or ecological community in a particular area.
Project area	The proposed construction and ancillary works area necessary to safely undertake the demolition and construction of the dam and embankments.
Protected matters	A matter protected under a controlling provision in Part 3 of the EPBC Act for which this approval has effect, including: Mary River Cod Australian Lungfish Mary River Turtle White-throated Snapping Turtle Giant Barred Frog.
Published	Means made publicly available on the approval holders website.
Recovery plans	Recovery Plans set out the research and management actions necessary to stop the decline of, and support the recovery of, listed threatened species or threatened ecological communities.
Regulatory agencies	Independent governmental body established by legislative act in order to set standards in a particular field of activity or operations.
Remediation	Making the land useful again after a disturbance. It may involve the recovery of ecosystem functions and processes in a degraded habitat.
Release rates	The rate at which the water in Lake Macdonald is released.
Relocation sites	A site used to relocate any protected matter(s) during salvage and relocation activities.
Reservoir	A natural or artificial place where water is collected and stored for use.
Riffle	A shallow landform in a flowing channel.
Riparian	Pertaining to, or situated on the bank of, a body of water, especially a watercourse such as a river.
Risk	Future uncertainty about deviation from an expected outcome.
Risk controls	Measures to minimise the risk.
Risk treatments	Measures taken if risk is realised.

Term	Definition
Risk workshop	A workshop designed to identify risks and give stakeholders a better understanding of what the risks are and how they can affect the Project.
Run	An area in a stream that is characterised by moderately straight channels and medium water flow.
Salvage and relocation	Means capturing any protected matter(s) from one area of habitat and transferring it to another area of habitat.
Sediment	A naturally occurring material that is broken down by processes of weathering and erosion and is subsequently transported by the action of wind, water or gravity.
Six Mile Creek	Means the watercourse designated as 'Six Mile Creek' as shown in Figure 1–1.
Six Mile Creek Dam	Dam on Six Mile Creek that forms Lake Macdonald.
Species	A group of biological entities that (a) interbreed to produce fertile offspring; or (b) possess common characteristics derived from a common gene pool.
Spotter/catcher	An ecologist who is accredited by the Queensland Parks and Wildlife Service (QPWS) to capture and relocate fauna (mainly mammals) from trees prior to vegetation clearance.
Stratification	When water masses with different properties – salinity, oxygenation, density and temperature – to form layers that act as barriers to water mixing.
Suitably qualified person(s)/Suitably qualified and experienced person(s)	Means a person who has professional qualifications, training, skills and experience related to the nominated subject matter and can give authoritative independent assessment, advice and analysis on performance relative to the subject matter using the relevant protocols, standards, methods and/or literature.
Suspended solids	Small solid particles which remain in suspension in water as a colloid.
Tailwater	Waters located immediately downstream from a hydraulic structure.
Telemetry	The in-situ collection of measurements or other data at remote points and their automatic transmission to receiving equipment for monitoring.
The Department	The Department of Climate Change, Energy, the Environment and Water
the Minister	Australian Government Minister administering the EPBC Act including any delegate thereof
The Project	The Lake Macdonald (Six Mile Creek) Dam upgrade, including all phases of the project (pre-construction, construction and operational) and temporary and permanent works
Threat abatements plans	Threat abatement plans provide for the research, management, and any other actions necessary to reduce the impact of a listed key threatening process on native species and ecological communities.
Threatened species	Species listed under the EPBC Act and/or the NCA.
Translocation	The act, process or instance of changing location or position
Tributary	A stream that flows into a larger stream or other body of water.
Turbidity	The clarity of a waterbody; depends on the concentration of particles that are suspended in the water column.
Velocity	The speed at which water is moving.
Zooplankton	The aggregate of animal or animal like organisms in plankton.

Appendix A

Declaration of Accuracy

Appendix A Declaration of Accuracy

DECLARATION OF ACCURACY

I declare that:

To the best of my knowledge, all the information contained in, or accompanying the Lake Macdonald Water Lowering – Adaptive Management Plan, Rev 12, 18 February 2025 is complete, current and correct.

I am duly authorised to sign this declaration on behalf of the approval holder.

I am aware that:

Section 490 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) makes it an offence for an approval holder to provide information in response to an approval condition where the person is reckless as to whether the information is false or misleading.

Section 491 of the EPBC Act makes it an offence for a person to provide information or documents to specified persons who are known by the person to be performing a duty or carrying out a function under the EPBC Act or the Environment Protection and Biodiversity Conservation Regulations 2000 (Cth) where the person knows the information or document is false or misleading.

The above offences are punishable on conviction by imprisonment, a fine or both.

Signed

Full name (please print)

Nathan Carruthers

Organisation (please print)

SEQWATER

Date: 2/05/2025

Appendix B

Background Information – Water Quality

Appendix B Background Information – Water Quality

Environmental Values and Water Quality Objectives

The Queensland Department of Environment, Tourism, Science and Innovation (DETSI) has published a report relevant to the Project alignment listing relevant environmental values (EVs) and WQOs, as:

- *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* Mary River environmental values and water quality objectives Basin No. 138, including all tributaries of the Mary River (Department of Environment and Resource Management, 2010).

The EPP (Water) supports the achievement of the objectives of the *Environmental Protection Act 1994* (EPA 1994) in relation to Queensland waters. This document relevant to the catchment areas of the Mary River form part of the EPP (Water) subordinate to the EPA 1994. The WQOs most relevant to the Project are those within the EPP (Water and Wetland) relating to moderately disturbed and high-ecological value waters (as identified by the current condition within Schedule 1 of EPP (Water) surface water ecosystems).

Default *Australian and New Zealand Guidelines for Fresh and Marine Water Quality Guidelines 2018* (ANZG) for pesticides, heavy metals and other toxic contaminants are used where the regional EPP (Water) guidelines are less applicable. Within the WQOs relevant to the Project, thresholds for the protection of aquatic ecosystems were selected for assessment of current environmental conditions.

Water bodies within the project area are in the following:

- Mary River catchment – Lake Macdonald (freshwater lakes/reservoirs)
- Mary River catchment - Six Mile Creek (moderately disturbed - lowland streams)

All waterbodies associated with this Flora and Fauna (Dewatering) Management Plan are considered moderately disturbed. All sample points, depending on the waterbody in which they are located, have been assigned to one of the above categories to derive WQOs.

Water Quality

Table 16-1 provides the initial median values of the collected datasets prior to normalisation, compared against the relevant default regional EPP (Water) or ANZG WQOs for each parameter. Data was used from a variety of routine and non-routine surface water quality sampling sites located upstream, within and downstream of Lake Macdonald. Data was collected across a five (5) year timeframe from 2019-2024. The water quality data was collected from the following sites:

Lake Macdonald:

- Seqwater active sampling:
    - Lake Macdonald Dam Wall Offtake
    - Lake Macdonald Mid-Lake at Confluence
- Seqwater passive sampling:
    - Lake Macdonald (Inflow passive)
- Virid IFC sample point:
    - Lake Macdonald (I1 and I3).

Six Mile Creek:

- Seqwater active sampling:
    - Lake Macdonald Tailwater below Dam Wall
- Seqwater passive sampling:
    - Six Mile Creek (Tailwater passive)

- Virid IFC sample point:
    - Six Mile Creek (DS01 and DS02).

Site locations and further details are discussed in the *LMDIP site specific water quality objectives 2024* report (*LMDIP-05762-RES-ENV-REP-00001*) (SMEC, 2024).

Critical analysis of median values for each parameter indicates regional WQOs for nutrient parameters are typically not achieved within Lake Macdonald; with nitrate and total and oxidised nitrogen values exceeding default WQOs. Both Lake Macdonald and Six Mile Creek did not achieve regional WQOs for dissolved oxygen. All other median values for each parameter were within Regional WQO range across Lake Macdonald and Six Mile Creek.

Previous long-term monitoring and assessment of Seqwater water quality data (from 2011-2017) also indicated that:

- dissolved aluminium was commonly higher than the National Water Quality Guideline (ANZECC & ARMCANZ 2000) for the 95% protection level of aquatic ecosystems in Lake Macdonald
- total aluminium, zinc and cobalt were sometimes higher than the National Water Quality Guideline in Lake Macdonald, and
- total aluminium, chromium, copper, mercury, zinc, and dissolved aluminium were higher than the National Water Quality Guideline in the Lake Macdonald tailwater.

The *Water Monitoring Data Collection Standards* (DNR 2007) defines a reservoir as stratified if the temperature difference between surface and basement layers exceeds 5ºC. Depth profile measurements of water temperature through the depth profile in Lake Macdonald (mid-lake) were summarised on a monthly basis between November 2011 and November 2017 (i.e. 70 months), with measurements for 69 of these months indicating no stratification. Stratification was detected in only one month (January 2015). Overall, these results indicate that Lake Macdonald rarely stratifies, and when it does it is only weakly stratified. Seqwater operates a 24hr aeration system located close to the WTP intake which ensures more stable conditions within the lake and is likely playing a role in minimising stratification events.

Table 16-1: Summary statistics for Lake Macdonald and Six Mile Creek

Water quality parameter	Unit	Water quality objective for Aquatic Ecosystems	Median (50th percentile) value
Lake Macdonald (2019 – 2024)			
pH	log {H+}	6.5 – 8.0	6.51
Turbidity	NTU	1 – 20	8
Dissolved Oxygen	%	90 - 110	49 (4.32mg/L)
Total suspended solids	mg/L	-	3
Total nitrogen	mg/L	<0.35	0.52
Nitrate	mg/L	2.4[a]	0.01
N_{ox}	mg/L	<0.01	0.04
Ammonia	mg/L	<0.010	0.016
Total phosphorus	mg/L	<0.03	0.03
Six Mile Creek (2019 - 2024)			
pH	log {H+}	6.50 – 8	6.61
Turbidity	NTU	<50 NTU	2.57
Dissolved Oxygen	%	90 -110	75.49 (6.4 mg/L)

[a] Trigger values for freshwater (based on 95% level of protection for surveillance nitrate concentrations

Site Specific water quality objective values

Data normalisation was adopted to further reduce skew between values collected from each site. Interquartile ranges identified non-normal distributions and exceedances within each data set. A 1.5 sensitivity scale was used to detect extreme outliers to follow Gaussian distribution. The method dictates that any data point that's 1.5 basis points below the lower bound quartile or above the upper bound quartile is an outlier. Outliers were removed from the dataset after identification if a deviation existed from 1.5 interquartile range limits, grouped by site.

Trigger values in water quality management refer to specific thresholds that indicate whether the water quality is acceptable or requires further investigation and potential action. These values help in assessing the health of aquatic ecosystems and the safety of water for human consumption, recreational use, and ecological health.

Low Trigger Values

- Definition: Low trigger values represent acceptable minimum thresholds below which water quality may be compromised. These values help ensure that the ecosystem remains healthy and that water quality meets regulatory standards.

High Trigger Values

- Definition: High trigger values are thresholds that, when exceeded, indicate a potential problem with water quality. They signal that the water may be unsafe or unsatisfactory for its intended use, necessitating immediate action or further monitoring.

Importance of Trigger Values

Trigger values are crucial for:

- Water Quality Monitoring: They guide regular assessments and help identify trends in water quality over time.
- Regulatory Compliance: They ensure that water bodies meet legal standards set by environmental agencies.
- Conservation Efforts: They inform management decisions aimed at protecting aquatic ecosystems and public health.

Overall, effectively using high and low trigger values in water quality assessments helps in the proactive management of water resources, safeguarding both human health and ecological integrity. Seqwater aims to avoid both low and high trigger values as these would indicate a potential issue with water quality management measures.

Triggers were then calculated the normalised data for each trigger (excluding dissolved oxygen) as below:

• Low trigger – based on either > 20th or < 80th percentile (depending on the parameter)

• High trigger - based on either the maximum or minimum recorded values (depending on the parameter).

Due to specific management of dissolved oxygen concentrations within waters (i.e. prevention of hypoxic conditions and adherence to key ranges of dissolved oxygen concentrations), the 20th and 80th percentile were used to calculate the high and low triggers, respectively.

All reference sample point sites within the Mary River basin are classified as moderately disturbed waters. For moderately disturbed waters the 20th and 80th percentiles of reference site values are used to derive site-specific objectives. Whilst ANZG 2018 Guidelines recommends 24 data points, in accordance with the QWQG 2009, for the 20th and 80th percentile values, error values diminish at an estimated 15-20 data values. As a result, the majority of data values within this range were considered sufficient to merit inclusion and acceptable to provide a statistically sound estimate of the true percentile values. Refer to the *LMDIP site specific water quality objectives 2024* report (*LMDIP-05762-RES-ENV-REP-00001*) (SMEC, 2024) for more information regarding requirements for deriving site-specific objectives and methodologies of data normalisation.

Implementation of low risk and high risk triggers were calculated from data obtained from routine and passive monitoring conducted by Seqwater and a monitoring campaign conducted by Virid IFC. Data was collated for sites from various periods across 2019 to 2024. This data was normalised prior to broad data summaries and calculation of triggers.

- The low risk triggers are presented in Table 16-2
- The high risk triggers are presented in Table 16-3**.**

These triggers will be used as a performance criterion for the management of the impact of lowering on water quality within Lake Macdonald and within Six Mile Creek. These results are to be read in conjunction with the *LMDIP site specific water quality objectives 2024* report (*LMDIP-05762-RES-ENV-REP-00001*) (SMEC, 2024).

The implementation of the below water quality objectives is to be considered as an assessment of management measures rather than a compliance tool. Management is based around mitigating significant impact to ecological receptors within Lake Macdonald and within Six Mile Creek and will inform ongoing management rather than as a compliance reporting tool. As such, the trigger values identified here are not intended as assessment triggers (for compliance) but rather indicators of adequacy of implemented management measures at time of sampling. Should trigger values be identified during water quality testing associated with this adaptive management plan the following measures will be undertaken:

- Low risk trigger – Implementation of an active watch scenario where increased water quality sampling is undertaken alongside identification of effectiveness of current mitigation measure controls (as per the Lake Macdonald (Six Mile Creek) Dam Improvement Project adaptive management plan)
- High risk trigger – Implementation of intervention control (i.e. fish salvage exercises, increased aeration, management of erosion and sediment control devices (Lake Macdonald (Six Mile Creek) Dam Improvement Project adaptive management plan).

Where the current median (50^{th} percentile) exceeds the low risk trigger value but remains below the high risk trigger value, monitoring and management will continue under existing processes. In this case, low risk trigger management measures will not apply to parameters where the median already exceeds the low risk trigger value. This approach acknowledges that if a parameter's median was already above the low risk trigger before the drawdown, the system is naturally operating under those conditions. Trigger values will be reassessed as more data becomes available. If a parameter's median does not meet the existing regional water quality objectives for aquatic ecosystems, the relevant trigger thresholds will be applied.

Low-risk trigger values

The low-risk trigger values are presented in Table 16-2.

Table 16-2 Low-risk trigger values

Water Quality Parameter	Unit	WQO for Aquatic ecosystem EV	Low risk trigger value[a]	
			Min trigger value	Max trigger value
Lake Macdonald (freshwater lakes/reservoirs)				
pH	log {H+}	6.50 – 8.00	6.41	6.64
Turbidity	NTU	1 – 20	-	9.75
Dissolved Oxygen[b]	%	90 – 110%	>74.1 (6.1 mg/L)	-
Total suspended solids	mg/L	-	-	5
Total nitrogen	mg/L	<0.35	-	0.59
Nitrate[c]	mg/L	2.4000	-	0.0142
Nox	mg/L	<0.0100	-	0.0116
Ammonia	mg/L	<0.0100	-	0.0528
Total phosphorus	mg/L	<0.030	-	0.034
Six Mile Creek (lowland freshwater)				
pH	log {H+}	6.50 – 8.00	6.25	6.65
Turbidity	NTU	<50 NTU	-	4.13
Dissolved Oxygen[b]	%	90-110	>98.02 (8.07 mg/L)	-

[a] Where a range is presented for a specific parameter, low risk trigger is outside of range identified.

[b] Dissolved Oxygen concentrations triggers require concentration to remain above identified percentile.

[c] Nitrate's calculated trigger value acts as an interim, low-risk, site specific WQO.

High-risk trigger values

The high-risk trigger values are provided in Table 16-3.

Table 16-3 High-risk trigger values

Water Quality Parameter	Unit	WQO for Aquatic ecosystem EV	High risk trigger value[a]	
			Normalised minimum recorded values	Normalised maximum recorded values
Lake Macdonald (freshwater lakes/reservoirs)				
pH	log {H+}	6.50 – 8.00	5.73	7.30
Turbidity	NTU	1 – 20	-	42.6
Dissolved Oxygen[b]	%	90 - 110	31.80 (2.62 mg/L)	-
Total suspended solids	mg/L	-	-	9
Total nitrogen	mg/L	<0.35	-	0.78
Nitrate	mg/L	2.40	-	0.02[c]
N_{ox}	mg/L	<0.01	-	0.04
Ammonia	mg/L	<0.01	-	0.11
Total phosphorus	mg/L	<0.030	-	0.048
Six Mile Creek (lowland freshwater)				
pH	log {H+}	6.50 – 8.00	5.70	7.13
Turbidity	NTU	<50 NTU	-	6.69
Dissolved Oxygen[1]	%	90-110	56.96 (4.69 mg/L)	-

[a] Where a range is presented for a specific parameter, high risk trigger is outside of range identified.

[b] Dissolved Oxygen concentrations triggers require concentration to remain above identified percentile.

[c] Nitrate's calculated trigger value acts as an interim, low-risk, site specific WQO.

Appendix C

Background Information – Aquatic Flora and Fauna

Appendix C Background Information – Aquatic Flora and Fauna

Aquatic Plants

The aquatic plant community of Lake Macdonald is characterised by a dense cover of the 'restricted biosecurity matter' Cabomba (*Cabomba carolina*), scattered occurrence of the native water snowflake (*Nymphoides indica*), and isolated occurrences of other native aquatic plants, such as Javan pondweed (*Potamogeton javanicus*), water primrose (*Ludwigia peploides*), spike rush (*Eleocharis* sp.), and bull rush (*Typha* sp.). There are few aquatic plants in Six Mile Creek downstream of Lake Macdonald, although there are isolated occurrences of Cabomba and water snowflake. A range of native aquatic plants grow on the banks of Lake Macdonald and Six Mile Creek, including sedges (*Carex* spp. and *Cyperus* spp.), knot weeds (*Persicaria* spp.) and mat rushes (*Lomandra* sp.). The 'restricted biosecurity matter' *Hygrophila* (*Hygrophila cosata*) occurs in high cover along the margins of the lake.

Relatively high concentrations of chlorophyll a, and blue-green algae cell counts, for water samples taken from Lake Macdonald indicate an abundant phytoplankton community.

No threatened species of aquatic plant is known from the Project area. Several aquatic plants known from the Project area are biosecurity matters, including notable infestations of *Cabomba* and *Hygrophila.*

Aquatic Macroinvertebrates

A range of aquatic macroinvertebrates are known from Lake Macdonald and Six Mile Creek, including crustaceans (e.g. river prawns, glass shrimp and crayfish), insects (e.g. aquatic beetles, various aquatic bugs, mayflies, caddisflies and true flies), molluscs (e.g. snails and mussels) and worms.

While the *abundance* of macroinvertebrates is variable but relatively high overall, the overall *diversity* of macroinvertebrates is lower than the biological WQO for macroinvertebrates presented in the EPP(Water) (DERM 2010). The diversity of sensitive taxa, and the abundance of sensitive taxa, also tended to be lower than the biological WQO presented in the EPP(Water) (DERM 2010).

No threatened species of aquatic macroinvertebrate is known from the Project area, and none of the macroinvertebrate species known from the Project area are biosecurity matters.

Fish

The native fish community of the Project area comprises approximately 26 species that are known or likely to occur in Six Mile Creek. The community was numerically dominated by small bodied species, such as Agassiz's glassfish (*Ambassis agassizii*), unspecked hardyhead (*Craterocephalus fulvus*), common gudgeons (*Hypseleotris* spp.), purple spotted gudgeon (*Mogurnda adspersa*), flat head gudgeones (*Philypnodon* spp.), crimson-spotted rainbowfish (*Melanotaenia duboulayi*), Pacific blue-eye (*Pseudomugil signifer*), and Australian smelt (*Retropinna semoni*). Medium-sized native fish included bony bream (*Nematolosa erebi*), spangled perch (*Leiopotherapon unicolor*), eel-tailed catfish and mouth almighty (*Glossamia gillii*); and large bodied species included eels (*Anguilla* spp.), saratoga (*Scleropages leichardti*), Australian lungfish (*Neoceratodus forsteri*), Australian bass (*Percalates novemaculeata*), yellow belly (*Macquaria ambigua*) and Mary River cod (*Maccullochella mariensis*). Mary River cod is endemic to the Mary River Basin.

A number of diadromous species expected to occur in Six Mile Creek have not been recorded (e.g. striped gudgeon (*Gobiomorphius australi*) and Empire gudgeon (*Hypseleotris compressa*), potentially reflecting cumulative impacts from barriers to fish passage in the lower Mary River between the estuary and Six Mile Creek.

Of the native species occurring in the Project area, several of them:

- occur in Six Mile Creek downstream of Lake Macdonald but do not occur upstream of the Lake Macdonald (Six Mile Creek) dam wall (e.g. Pacific blue eyes)
- have been stocked and although native to Australia, do not occur naturally in Six Mile Creek (e.g. saratoga, yellow belly), and

- are threatened species under the *Environmental Protection and Biodiversity Conservation Act 1999* (i.e. are Matters of National Environmental Significance):
  - Mary River cod, listed as endangered, and
  - Australian lungfish, listed as vulnerable.

Surveys have recorded Mary River cod and Australian lungfish only from Six Mile Creek downstream of Lake Macdonald, although records indicate that at least 112,730 Mary River cod fingerlings were released to Lake Macdonald between 1983 and 2015, with 6430 released to Six Mile Creek (MRCCA, 2016). There are no records that Australian lungfish have been stocked in Lake Macdonald or Six Mile Creek, and while this species is known from the Project area, Six Mile Creek is not likely preferred habitat for the Australian lungfish and it is consequently considered that this species would be in relatively low abundance in the Project area. In contrast, Six Mile Creek is considered to harbour an important relict population of Mary River cod (Simpson & Jackson 2000), and the high stocking rate suggest that this species has the potential to occur in relatively high numbers, especially in Lake Macdonald. Large numbers of yellow belly and Australian bass have also been stocked to Lake Macdonald, suggesting that the abundance of large bodied fish in Lake Macdonald could be relatively high.

Five pest fish are known from the Project area: eastern Gambusia (*Gambusia holbrooki*), platy (*Xiphophorus maculatus*), swordtail (*Xiphophorus hellerii*), guppy (*Poecilia reticulata*) and tilapia (*Oreochromis mossambicus*), with this latter species only recently recorded for the first time in Six Mile Creek downstream of the Lake Macdonald (Six Mile Creek) dam wall. It is currently unknown if tilapia occur in Lake Macdonald, or if the dam wall has prevented this species extending further upstream. Eastern gambusia and tilapia are restricted biosecurity matters.

Two threatened species of fish (Mary River cod and Australian lungfish) occur in the Project area. Two species of fish (Eastern gambusia and tilapia) that are biosecurity matters occur in the Project area.

The 2025 evaluation survey did not identify any MNES or MSES species living in the lake.

Turtles

Recent surveys found that four species of turtle (i.e. Krefft's river turtle (*Emydura macquarii*); saw-shelled turtle (*Wollumbinia latisternum*); eastern long-necked turtle (*Chelodina longicolis*); and broad-shelled river turtle (*Chelodina expansa*) occur in the Project area, with the diversity and abundance of turtles higher upstream of the Lake Macdonald (Six Mile Creek) dam wall than in Six Mile Creek downstream of Lake Macdonald. It is possible that white-throated snapping turtle (*Elseya albagula*) and Mary River turtle (*Elusor macrurus*), both of which are endemic to the Mary River Basin, also occur in the lower reaches of Six Mile Creek, with white-throated snapping turtle likely occurring further upstream than Mary River turtle. These two species of turtle are threatened species under the EPBC Act 1999, with:

- White-throated snapping turtle listed as critically endangered, and
- Mary River turtle listed as endangered.

Platypus

Platypus (*Ornithorhynchus anatinus*) is known from Six Mile Creek, Lake Macdonald, and the tributaries upstream of Lake Macdonald. This species is listed as Special Least Concern in Queensland's *Nature Conservation (Wildlife) Regulation 2006* but is not a threatened species.

Aquatic Matters of National Environmental Significance

Matters of National Environmental Significance (MNES) are matters that are protected under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC). This section considers in greater detail, aquatic species that are MNES: Mary River cod, Australian lungfish Mary River turtle and white-throated snapping turtle.

Mary River cod

Status

The Mary River cod (*Maccullochella mariensis*) is listed as endangered under the EPBC Act and is a 'no take' species under the Queensland *Fisheries Act 1994* except from specific impoundments nominated by DPI to which the species has been stocked.

Distribution

The Mary River cod is endemic to the Mary River system. Through the 1950's to the 1970s, the Mary River cod became very rare in the main channel of the Mary River, Yabba Creek, Munna Creek and Booloumba Creek. Currently, only three tributaries of the Mary River (i.e. Tinana-Coondoo creek, Six Mile creek and Obi Obi Creek) contain relatively abundant numbers of Mary River cod. The approximate area of occupancy across these three creeks is between 5 – 7.5 km^2, with the population size estimated to be fewer than 600 individuals (Simpson & Jackson 1996). In Six Mile Creek, Mary River cod have been caught at the confluence with the Mary River (SKM 2007) and occur in the creek for approximately 40 km upstream to Lake Macdonald. Historically, the Six Mile Creek population has been considered to be in a stable condition (Simpson & Jackson 1996). In Tinana-Coondoo Creek, Mary River cod occur up to seventy kilometres upstream of the confluence with the Mary River, of which only 25-30% is considered suitable habitat. In Obi Obi creek, the species range extends approximately 10 km upstream from the confluence with the Mary River (Simpson & Jackson 1996). A number of impoundments have been stocked with Mary River cod for recreational fishing (DoE SPRAT Profile).Preferred Habitats

The pool habitats within Obi Obi, Six Mile and Tinana-Coondoo creeks are known strong-holds for Mary River cod. These pools are not particularly deep (up to 3 m) and usually occur along pool and shallow riffle or run sequences (Simpson & Jackson 1996). The in–stream habitat features preferred by Mary River cod include submerged large woody debris, undercut banks, rock ledges and boulders (SKM 2007; DoE SPRAT profile). Reaches of creek with intact riparian vegetation are also favoured by the species as it provides shade and a supply of woody debris (GHD 2012). Woody debris and other complex submerged habitat features (e.g. boulders, undercut banks) are utilised by the species for foraging, shelter and nesting (SKM 2007; DoE SPRAT profile). Of the three creeks inhabited by Mary River cod, preferred habitat for the species is most common in Tinana–Coondoo Creek. This creek flows through areas of low human population density (Simpson & Jackson 1996). Larval and juvenile fish habitat preferences are relatively unknown.

Water Quality

The reported water quality tolerances of Mary River cod are:

- pH = 6.0 – 7.3
- conductivity (µS/cm) = 100 – 800
- temperature (°C) = 15.7 – 29.0, and
- dissolved Oxygen (mg/L) = 3.9 – 9.7 (Hydrobiology 2008a).

Of the listed water quality parameters, temperature and dissolved oxygen are the most important, as high temperatures and low dissolved oxygen levels can be lethal to the species (DNRM, pers. Com.)

Flow Requirements

Adults of the species typically prefer low flowing water of suitable depth (i.e. 1 – 3 m) and generally avoid shallow (<1 m) areas. During periods of high flow, they shelter amongst woody debris and undercut banks which act to baffle and reduce flow velocities (GHD 2012). Mary River cod have been observed dispersing from 10 km to 70 km over several months following high flows (Simpson & Jackson 1996). Juvenile Mary River cod utilise shallow water habitats, including runs and pools margins, where sufficient cover in the form of trailing root masses or rocky substrates occurs. Spawning is triggered by light episodic rainfall (up to 20 mm) and associated flows, when it coincides with a water temperature of at least 19 ºC and the full moon phase (R Manning 2014, pers. comm.).

Foraging and Movement

Mary River cod typically have relatively narrow home ranges, and have been reported to occupy a particular pool for extended periods (Simpson & Jackson 1996). Within their ranges, movement tends to be upstream during the summer months when rainfall and flows are higher, connecting pools, and downstream or into larger tributaries during the winter months (DoE SPRAT profile). Murray River cod disperse widely as larvae drifting at night for approximately one to two weeks (DoE SPRAT profile), suggesting larval drift could be important for dispersal of Mary River cod.

Mary River cod are predatory and generally feed on smaller fish and crustaceans, most commonly during dawn and dusk; but the species is also known to consume waterbirds and other fauna (DoE SPRAT Profile ; MRCCC ; Aurecon 2013). The species often forages on prey immediately downstream of riffles, presumably due to a constriction of the watercourse and the concentration of prey items (SKM, 2007). This suggests that shallow riffle habitat is important for Mary River cod, although this habitat may not be commonly occupied by the species.

Breeding

Mary River cod mature at approximately 38 cm and are considered to be a large, slow growing, long-lived fish with relatively low fecundity (DoE SPRAT Profile; Aurecon, 2013). The cod is presumed to spawn more than once a year, initiated by a rise in water temperature to 20 °C during spring and into early summer (Simpson & Jackson, 1996). Eggs are typically deposited inside a nest formed by a hollow log or similar habitat features (e.g. submerged open pipe) (Simpson & Jackson 1996). The male will subsequently guard the eggs until they begin to hatch towards the end of the fourth day at 20°C (Aurecon 2013). The male will continue to guard the brood until they are ready to search for food between seven and nine days after hatching (Aurecon 2013; Simpson & Jackson 1996). In the event that conditions do not coincide i.e. water temperature of at least 19ºC, moon phase at full and light episodic rainfall up to 20 mm, female Mary River cod will reabsorb their eggs and will not spawn (DoE SPRAT Profile).

Threats

There are a number of threats facing the Mary River cod, including:

- Overfishing - overfishing during the late 1800's and early 1900's saw the removal of large numbers of fish (Simpson & Jackson 1996). Currently, fishing for Mary River cod is prohibited in the Mary River, however there is evidence that illegal capture of the Mary River cod still occurs (Simpson & Jackson 1996).
- habitat degradation – specifically clearing of riparian zones, which exposes bank soil to erosion and leaded to sedimentation of pool habitats (Simpson and Jackson 1996). Loss of riparian vegetation also reduced input of branches and other habitat elements that are preferred by Mary River cod.
- dams and weirs – impose barriers to movement; while long-range dispersal by cod is not frequent as they generally have relatively small home ranges, periodic movement over longer distances is likely important for the long-term survival of the species (Simpson & Jackson 1996). Cold-water releases from dams and altered flows downstream of dams may also impact breeding and / or survival of larvae (DoE SPRAT Profile)
- pollution – various sources of pollution may impact the suitability of water quality for Mary River cod, with increased nutrients and reduced dissolved oxygen known water quality issued for Mary River cod (Simpson & Jackson 1996), and
- introduced species – may increase competition for food or habitat resources or may prey on larval and juvenile cod (Simpson & Jackson 1996).

Australian lungfish

Status

Australian lungfish (*Neoceratodus forsteri*) is listed as vulnerable under the EPBC Act, and as a 'no take' species under the Queensland *Fisheries Act 1994*.

Distribution

Australian lungfish is known to occur in the Mary River and several of its tributaries between Conondale (220 km from the mouth of the river) and the Mary River Tidal Barrage (59.3 km from the mouth of the river) (DoE SPRAT profile). It has previously been caught at Coles Crossing and near the confluence of the Mary River and Six Mile Creek (LinkWater Projects 2008). The natural distribution of Australian lungfish also includes the Burnett River system. It has been stocked into several other rivers (e.g. Brisbane River). It is estimated that the Australian lungfish population consists of less than 10,000 individuals (DoE SPRAT Profile).

Preferred Habitats

Generally, Australian lungfish require riparian vegetation comprising eucalypt woodland, native grasslands or minimally modified pastures in moderate to good condition, although the species has been reported from reaches with moderately cleared riparian zones (Smith et al., 2012).

Australian lungfish are generally found in wide, slow-flowing or still permanent reaches with deep pools (i.e. 1 – 3 m) and shallower sections (i.e. 1 – 2 m deep) with abundant aquatic plant cover. Riffles or runs may also be present along a reach (DCCEEW, 2009). Open water with an absence of complex in-stream structures is not preferred habitat of the species (DoE SPRAT profile).

Australian lungfish tend to inhabit reaches with structurally complex submerged habitat, including submerged logs, high aquatic plant cover and underwater crevices formed by rock scouring and / or undercut banks (SKM 2007; Hydrobiology 2008a; Arthington 2009). Aquatic plant species associated with Australian lungfish habitat include *Vallisneria* sp.*, Hydrilla vertillata, Egeria densa, Ludwigia peploides* and *Nymphoides* sp. (DoE SRPAT profile).

Water Quality

The water quality tolerances of Australian lungfish are:

- pH = 7.0 – 9.1
- conductivity (µS/cm) = 421 – 1165
- temperature (^{o}C) = 10 – 30, and
- dissolved Oxygen (mg/L) = 6.9 – 15.6 (Hydrobiology 2008a).

Flow Requirements

The specific flow requirements for lungfish are only partly understood. Adults of the species are found mostly in permanent still or slow flowing deep pools, or in shallow pools with high cover of submerged aquatic plants. Breeding and recruitment occurs under low flow conditions (i.e. water levels between 10 and 30 cm above cease to flow levels) (Hydrobiology 2008b).

Foraging and Movement

Lungfish are largely sedentary, having home ranges of less than 2 km, although long-term recoding of movement patterns shows that some individuals may move up to 5 km over a number of years (Kind 2002). Most movement is reported to occur during the summer months (Kind 2002).

Lungfish feed on benthic invertebrates, amphibian larvae and aquatic plants (e.g. *Vallisneria* spp. and *Hydrilla* spp.) (Aurecon 2013; DoE SPRAT profile). Lungfish tend to forage at night with adults utilising shallow macrophyte beds and juveniles employing ambush tactics (Aurecon 2013; DoE SPRAT Profile).

Breeding

Male Australian lungfish begin breeding at approximately 15 years of age while females first breed at approximately 20 years of age (Aurecon 2013, DoE SPRAT profile). Australian lungfish spawn over a variety of habitats (e.g. woody debris, rocks, boulders and aquatic plants), however, under slow-flow conditions they tend to spawn more commonly among aquatic plants e.g. ribbon weed (*Vallisneria* sp.) (Department of the Environment 2013). Spawning tends to occur at night from August to December and is triggered by increasing day length (Bunn 2008; Espinoza et al. 2012; DoE SPRAT profile). If spawning habitat is disturbed, Australian lungfish will either delay breeding or skip breeding

entirely (DoE SPRAT profile). After spawning the Australian lungfish thrash their tail to disperse eggs that then adhere to submerged surfaces (DoE 2014). A single clutch consists of 50 to 100 eggs (DoE SPRAT profile). Hatching of eggs occurs approximately one month after fertilisation (McGrouther 2013). Juvenile lungfish are almost exclusively found in dense submerged aquatic plant beds (DoE SPRAT profile). Recently hatched lungfish are poor swimmers, and tend to rest on their sides on the stream bed while they digest their yolk and avoid daylight (DoE SPRAT profile).

Threats

The main threats to Australian lungfish are:

- Dams - impoundments act as a physical barrier to breeding sites; lungfish will migrate to find suitable areas for breeding. However, if they are unable to reach appropriate breeding habitat due to obstructions, spawning will not occur that year (Arthington 2009; DoE SPRAT profile). Repeated failure to breed may cause lungfish populations to decline substantially in a small number of generations (Aurecon 2013; DoE SPRAT profile). Furthermore, fluctuations of water levels in impoundments can result in stranding of lungfish and mortality of lungfish eggs (Arthington 2009; DoE SPRAT profile); and some reservoirs are known to undergo periods where lungfish density is very high (i.e. crowding of lungfish), which reduces the health and condition of lungfish at these times (DoE SPRAT profile).
- Fishing - recreational fishers are known to unintentionally catch the Australian lungfish. While some are returned to the water and survive others are unaccounted for (DoE SPRAT profile).
- Exotic fish species - predation on lungfish eggs and juveniles by exotic and native translocated fish species has also put pressure on the lungfish population, and alien fish also compete with adults for breeding habitat (Arthington 2009; DoE SPRAT profile), and
- Habitat degradation – specifically clearing of riparian zones, which exposes bank soil to erosion and leads to sedimentation of pool habitats.

Mary River turtle

Status

The Mary River turtle (*Elusor macrurus*) is listed as endangered under the EPBC Act and endangered under the NC Act.

Distribution

The Mary River turtle has been recorded in the Mary River and several of its tributaries (e.g. Yabba Creek and Tiana Creek) between Kenilworth (260 km from the river mouth) and the Mary River tidal barrage at Tiaro (Limpus 2007; SKM 2007 and references cited therein; Red Leaf Projects 2013; DoE 2014a). Individuals of the species have well defined home ranges and show strong site fidelity (Cann & Legler 1994; DCCEEW 2008; Kuchling 2008; Limpus 2008; Micheli-Campbell et al. 2013).

Preferred Habitats

Much of the Mary River turtle habitat is surrounded by cleared grazing and agricultural land, although in such reaches, the species has been caught in areas where the river is wide and there is trailing vegetation and in-stream habitat (Cann & Legler 1994). Some areas of Mary River turtle habitat retain some riparian and catchment vegetation, especially in upper catchment areas and along several tributaries.

The species is regularly associated with areas of submerged habitat, including sparse to dense aquatic plant coverage, woody debris and rock crevices (SKM 2007 and references cited therein). Similar to other reptiles, the Mary River turtle often basks on emerging rocks and logs within the waterbody or along its banks (Cann & Legler 1994).

Water Quality

There are no specific water quality tolerances that have been published for Mary River turtle, however, they are known to prefer flowing water with high concentrations of dissolved oxygen (Thomson et al. 2006). It would be reasonable to assume that their preferences for other water quality parameters (e.g. temperature, electrical conductivity, turbidity and pH) would be similar to that of the Mary River cod, given that both species are endemic to

the Mary River. Declines in water quality may reduce the efficiency of cloacal respiration by Mary River turtle, which can reduce foraging efficiency and more frequently expose juveniles to predators at the water surface.

Flow Requirements

The Mary River turtle prefers habitats characterised by shallow, fast-flowing streams with riffle zones and well-oxygenated water, and reaches with deep connected pools (depth ranging from approximately 1 m – 5 m) (DCCEEW 2008; Flakus & Connell 2008). During flooding, the Mary River turtle takes refuge in backwaters until flow decreases to pre-flood levels (Sadlier et al. 2004). They are also known to swim upstream during moderate to high flow events, returning to the same pool once water levels recede (Flakus & Connell 2008).

Foraging and Movement

The Mary River turtle is omnivorous and feeds on aquatic plants (including algae) and invertebrates (including bivalves) (Cann & Legler 1994). Juvenile Mary River turtles eat aquatic insect larvae, supplemented by freshwater sponges, aquatic plants including green algae, and fruits of some terrestrial trees (Flakus 2002; Micheli-Campbell et al. 2013). During the winter months movement is generally limited to within a particular reach; however, movement up to 2 km in search of breeding sand banks have been recorded during the early summer months (Sadlier et al. 2004).

Breeding

Mary River turtles live for between 30 and 80 years of age and do not breed until between 15 and 25 years of age (Limpus 2008). Sparsely vegetated sandy river banks in close proximity to riffles and pools are preferred nesting habitats, with these sites revisited across decades by the same individual (Flakus 2002; Limpus 2008). Breeding occurs only once every year with a clutch size of approximately 13 eggs (Flakus et al 2008). Successful hatching is dependent on 50 consecutive days of non-inundation after nesting. For this reason, nests are typically located 5 m above the water level and up to 30 m inland from the watercourse. Nesting occurs in late October to December after the first significant summer rain (Cann & Legler 1994; Flakus & Connell 2008; Limpus 2008). Depending on sand temperature, eggs have an incubation period of 50 – 56 days (Cann & Legler 1994).

Threats

Major threats to the Mary River turtle include:

- Nest predation and reduced success of recruitment - for twelve years during the 1960's and 1970's large numbers of Mary River turtle eggs were collected for commercial purposes (DoE SPRAT Profile; Bunn 2008; Limpus 2008). As a result, little to no recruitment occurred during this time and this has resulted in poor breeding success of Mary River turtle for four decades (DoE SPRAT profile). Furthermore, pressure from predation in nesting areas by foxes, goannas and wild dogs has meant the hatching success of the Mary River turtle continues to be very low (DoE SPRAT Profile; Flakus et al 2008; Limpus 2008).
- Dams - impoundments do not provide suitable habitat for the Mary River turtle, having typically still water with low levels of dissolved oxygen that reduces the efficiency of cloacal respiration (DoE SPRAT profile). There is also a decline in types and quality of food available for Mary River turtles in impoundments due to fluctuating water levels; aquatic plants and terrestrial fruiting trees do not tolerate inundation and will consequently die back. Dams also lack the insect larvae of flowing water habitats comprise part of the diet of the Mary River turtle (DoE SPRAT profile). Lastly, dams reduce the availability of suitable nesting habitat, as they do not support suitable sandy banks, and dams act as a physical barrier preventing females from reaching nesting sites (DoE SPRAT profile).
- Habitat degradation - including clearing of the riparian zone, which exposes bank soil to erosion and leaded to sedimentation of pool habitats, and sand and gravel mining which results in the destruction of sand banks that are used as nesting sites. The Mary River turtle may increase territorial behaviour with reduced habitat and breeding area, leading to a decrease in population size (DoE SPRAT profile).

White-throated snapping turtle

Status

White-throated snapping turtle (*Elseya albagula*) is listed as critically endangered under the EPBC and endangered under the NC Act.

Distribution

The white-throated snapping turtle is restricted to the Fitzroy, Mary and Burnett river catchments in Queensland (Threatened Species Scientific Committee 2014). The species has also been recorded in:

- adjacent small coastal river basins, including the Kolan and Gregory-Burrum systems (Hamann et al. 2007)
- impoundments upstream of weirs such as Eden Bann Weir and Glebe Weir (Limpus et al. 2007), and
- the spring-fed pools of the Dawson River (Hamann et al. 2007; frc environmental 2008).

White-throated snapping turtle is widely distributed in the Mary River and its major tributaries, including Tinana, Wide Bay, Obi Obi and Yabba creeks (Limpus et al. 2008).

Preferred Habitats

White-throated snapping turtles are habitat specialists that prefer permanent, clear, well oxygenated water that is flowing and contains shelter (e.g. large woody debris and undercut banks) (Limpus et al. 2008; Todd et al. 2013). The species has also been recorded in non-flowing waters, such as impoundments (e.g. Borumba Dam, Imbil Weir, Mary River Barrage) but only in low numbers (Limpus et al. 2008; Threatened Species Scientific Committee 2014). Within the greater Fitzroy, Burnett and Mary river catchments, this species has been recorded almost exclusively in close association with permanent flowing stream reaches that are typically characterised by a sand-gravel substrate with submerged rock crevices, undercut banks and / or submerged logs and fallen trees, and are rarely found in reaches without such refuge (Hamann et al. 2007; Limpus et al. 2007). Across its distribution, individuals have been recorded from both shallow and deep, slow flowing pools (Hamann et al. 2007).

White-throated snapping turtles are rarely present in water bodies that are isolated from flowing streams, such as farm dams or sewage treatment ponds, suggesting that the species does not move extended distances over dry land (Hamann et al. 2007; Limpus et al. 2008). However, white-throated snapping turtles have been observed walking short distances from drying waterholes to nearby water bodies (Limpus et al. 2007).

Water Quality

There are no published water quality tolerances for white-throated snapping turtle, although they are known from flowing streams with generally clear, well-oxygenated water.

Flow Requirements

Flowing streams with clear water, in both shallow or deep pools. Uncommon in non-flowing waters and isolated waterbodies that are not connected to flowing water habitats. As the species is a cloacal ventilating species, it is thought that it would not function well in deeper habitats of larger pools where dissolved oxygen concentrations are low, such as dry season conditions in standing water bodies (Limpus et al. 2008), although could be in shallow upper reaches of impoundments where there are inflows.

Foraging and Movement

White-throated snapping turtles feed primarily on aquatic plants along with fruits and leaves from overhanging riparian vegetation (Limpus et al. 2007). They may also eat periphyton, freshwater bivalves and insects, particularly when plant food resources are limited (Limpus et al. 2007). The diet of juveniles is dominated by invertebrates, whereas the diet or larger individuals (i.e. standard carapace length < 6 cm) is dominated by plant material (Limpus et al. 2008).

Little is known of the movement patterns of these turtles in the greater Fitzroy River catchment. However, in the Burnett River they generally have small home ranges of less than 500 m and have limited spatial and temporal movements (Hamann et al. 2007).

Breeding

The life history of white-throated snapping turtles is characterised by a long life span and slow growth to maturity (Threatened Species Scientific Committee 2014). The age at first breeding is approximately 15 to 20 years (Limpus et al. 2011). Breeding occurs once per year, mostly during autumn and winter, with adult females breeding in each successive year unless the turtle has been injured or debilitated, or riverine habitat has been altered (e.g. water extraction, drought or weeds) (Threatened Species Scientific Committee 2014). Females generally nest on sandy banks, although nests have been observed on loose gravels and soils. Females lay a single clutch of eggs during the breeding season, with an average of 14 eggs per clutch (Hamann et al. 2007; Limpus et al. 2011). Nests are generally laid in areas of low canopy cover and in areas of dense grass cover; however, dense weeds at the water's edge may limit suitability of potential nesting banks (Hamann et al. 2007; Limpus et al. 2011). Nests are an average of 16.6 m from the water's edge, with eggs laid in deep chambers (greater than 20 cm in depth) and on banks with a slope of up to 26.5º (Hamann et al. 2007; Limpus et al. 2011). However, nests have been recorded up to 60 m from the water (Hamann et al. 2007). White-throated snapping turtles will repeatedly use specific areas of banks over multiple years (Limpus et al. 2007).

There is no parental care, and egg and small juvenile survival is typically low (Heppell et al. 1996; Hamann et al. 2007). There is abundant evidence of nesting in all three river basins (i.e. Fitzroy, Burnett and Mary River Basins), but most eggs are lost to predation or trampling by stock (Hamann et al. 2007; Limpus et al. 2011). The population growth or decline rate is highly responsive to changes in adult survivorship, rather than changes in egg or juvenile survivorship (Heppell et al. 1996). Nonetheless, where egg predation rates are high, population growth rate will be constrained.

Threats

The principal threat to white-throated snapping turtles in all three catchments is the excessive loss of eggs and hatchlings due to predation (Threatened Species Scientific Committee 2014). Primary predators include feral (e.g. foxes, dogs, pigs and cats) and native (e.g. water rats and lizards) animals. Trampling of nests by cattle is also a major threat.

An additional threat to this species includes limited suitable habitat, which is highly fragmented across its distribution range due to dams and weirs. Waterway impoundments, such as dams, barrages and weirs, also form significant barriers to the passage of freshwater turtles. The number of dead and injured turtles can be much greater in pools immediately downstream of weirs than in pools distant from weirs, presumably a result of turtles being swept downstream and over impoundments during major and sudden water releases (Hamann et al. 2007).

Other threats to this species are:

- stocking of fish into dam impoundments for recreational fishing
- recreational fishing resulting in hook injuries
- boat strike
- loss of nesting habitat to weed infestation in the riparian zone
- dense aquatic weeds in the waterways, and
- water extraction for agriculture and irrigation (Limpus et al. 2011).

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16.1.1.1 Additional Studies of Relevance

Below are additional references that provide information on the ecological requirements, status and threats to Mary River cod and/or Australian lungfish, if required:

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Appendix D

Background Information – Drawdown Release Hydraulic and Geomorphic Assessment

Appendix D Background Information – Drawdown Release Hydraulic and Geomorphic Assessment

Assessment and Recommendations – Undertaken by Hydrobiology for Seqwater

It is noted that the proposed magnitude of lake lowering is significantly lower than that proposed at the time this hydraulic and geomorphic assessment was undertaken. Consequently, the results of the below assessment reflect a significantly worse case scenario than the currently proposed approach to dewatering.

The WMA Water (2018) hydraulic modelling of flood impacts report concluded that the constant release of 10 $m^3.s^{-1}$ would result in little to no out of bank flooding in the downstream reaches of Six Mile Creek (Figure D-3) and so was considered an appropriate maximum release volume. However, to understand what potential impacts the above release strategy (including the maximum 10 $m^3.s^{-1}$ flow) may have on downstream geomorphology, a number of hydraulic analyses were undertaken on data provided by Seqwater, as described below:

- Lake Macdonald (Six Mile Creek) Dam discharge and level data (1999-2019) (Figure D-1) were analysed using the River Analysis Package (RAP) software to analyse flow events and to determine the frequency and nature of 2-3 $m^3.s^{-1}$ events (proposed constant release over the 12-week period) and 10 $m^3.s^{-1}$ events (maximum release rate). This was undertaken to understand potential impacts that may occur from these events and to recommend a duration and frequency of releases for the Lowering Plan based on such past events. The analysis found:
  - Flows of less than or equal to 3 $m^3.s^{-1}$ occurred 7,165 times in the 21-year record, whereas flows of greater or equal to 3 $m^3.s^{-1}$ occurred 212 times in the record. However, flows of exactly 2 $m^3.s^{-1}$ occurred 86 times in the record and flows of exactly 3 $m^3.s^{-1}$ occurred 66 times in the record. This suggested that these flows were relatively frequent in the record.
  - Flows of less than or equal to 10 $m^3.s^{-1}$ occurred 7,320 times in the 21-year record, whereas flows of greater or equal to 10 $m^3.s^{-1}$ occurred 56 times in the record. Flows approximating 10 $m^3.s^{-1}$, occurred 33 times in the record, which was equivalent to about the 1 in 1.58 AEP event. Such flows typically lasted, on average, a duration of 1.697 days (and up to six days for total rise and fall of that sized event), with a mean rising limb of 1.751 days and a mean falling limb of 0.677 days. Hence, these types of events are relatively short in duration, with steep rising and falling limbs that occur over a matter of days. Examples of hydrographs of these types of flow events are shown in Figure D-2.
- Once the frequency had been developed, velocity hydraulic modelling outputs for the 10 $m^3.s^{-1}$ drawdown rate were analysed in ArcGIS and compared to DNRM (2019) guidelines. DNRM (2019) provide guidelines for any works that interfere with water in a watercourse for a resource activity and relate to watercourse diversions authorised under the *Water Act 2000*. Although specific to diversions and developed using one-dimensional hydraulic modelling, these were deemed useful in the absence of any other legislated guidelines. Given that the frequency identified above for 10 $m^3.s^{-1}$ peak flow events (1 in 1.58 AEP) roughly equated to the 50% AEP, the modelling outputs were compared to DNRM (2019) guidelines for a 50% AEP. DNRM (2019) recommends for a 50% AEP scenario (vegetated) that velocities should be <1.5 $m.s^{-1}$. The analyses showed the following:
  - Figure D-3 shows the output of the hydraulic analysis, displaying spatially where flows fall below or above the 1.5 $m.s^{-1}$ guideline. It shows that, for most of the creek, velocities fall within the DNRM (2019) guidelines, apart from the odd location where it is exceeded. These exceedance occurrences are likely to be associated with small local changes in bed level and are relatively minor. Given this, 10 $m^3.s^{-1}$ is considered an appropriate maximum drawdown rate.
  - At a release rate of 10 $m^3.s^{-1}$, it would take approximately 8.5 days to lower the lake from Full Supply Level if the release is constant. Although 10 $m^3.s^{-1}$ flows are frequent, they occur about twice a year and only for a short duration.

Given these analyses, and upon consultation with Seqwater, Hydrobiology notes and recommends the following:

- It is considered that a release at a rate of 2-3 m3.s-1 will be of limited concern from a geomorphic perspective. However, it is recommended that the planned five-day releases and two-day cessation will involve a slow rise

and ebb (i.e. over the duration of a day), rather than sudden stop-starts. This will minimise the potential for rapid drawdown of water in the banks and resulting bank failures.

- In the case that the lake re-fills after an event and a larger release of up to 10 m3.s-1 is required to lower water levels, it is recommended that such releases aim to mimic the hydrographs presented in Figure D-2, and that the duration is no more than two days at the 10 m3.s-1 rate.
- In the circumstance that a large event occurs towards the end of the release schedule, it is recommended that at Week 10, the contingency plan is initiated to release at the maximum 10 m3.s-1. As outlined above, the original contingency plan involved releasing at this rate for between 8-10 days. Based on the assessment of hydrographs outlined above, this should be altered slightly to incorporate two releases with a peak of 10 m3.s-1 over five days with a two day break in between each release. As per the other releases and cessations, this should involve a slow rise and ebb (i.e. over the duration of a day) to minimise impacts to bank stability.
- It is important that any other releases (such as those during construction to maintain water levels) are also restricted to this release rate and duration design, to minimise potential geomorphic impacts within the creek.

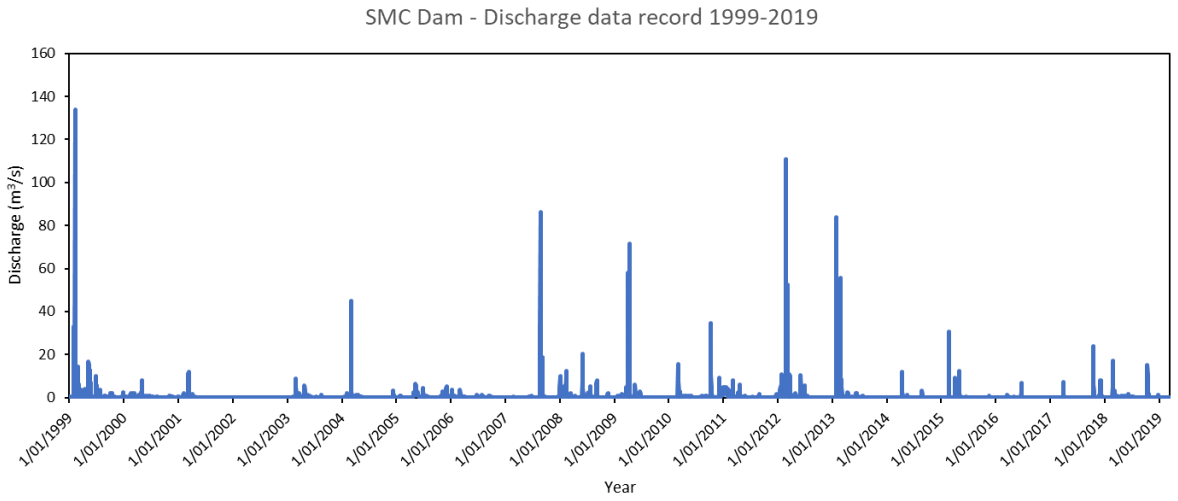

Figure 16-1: Discharge record for Six Mile Creek (SMC) Dam for the period 1999-2019

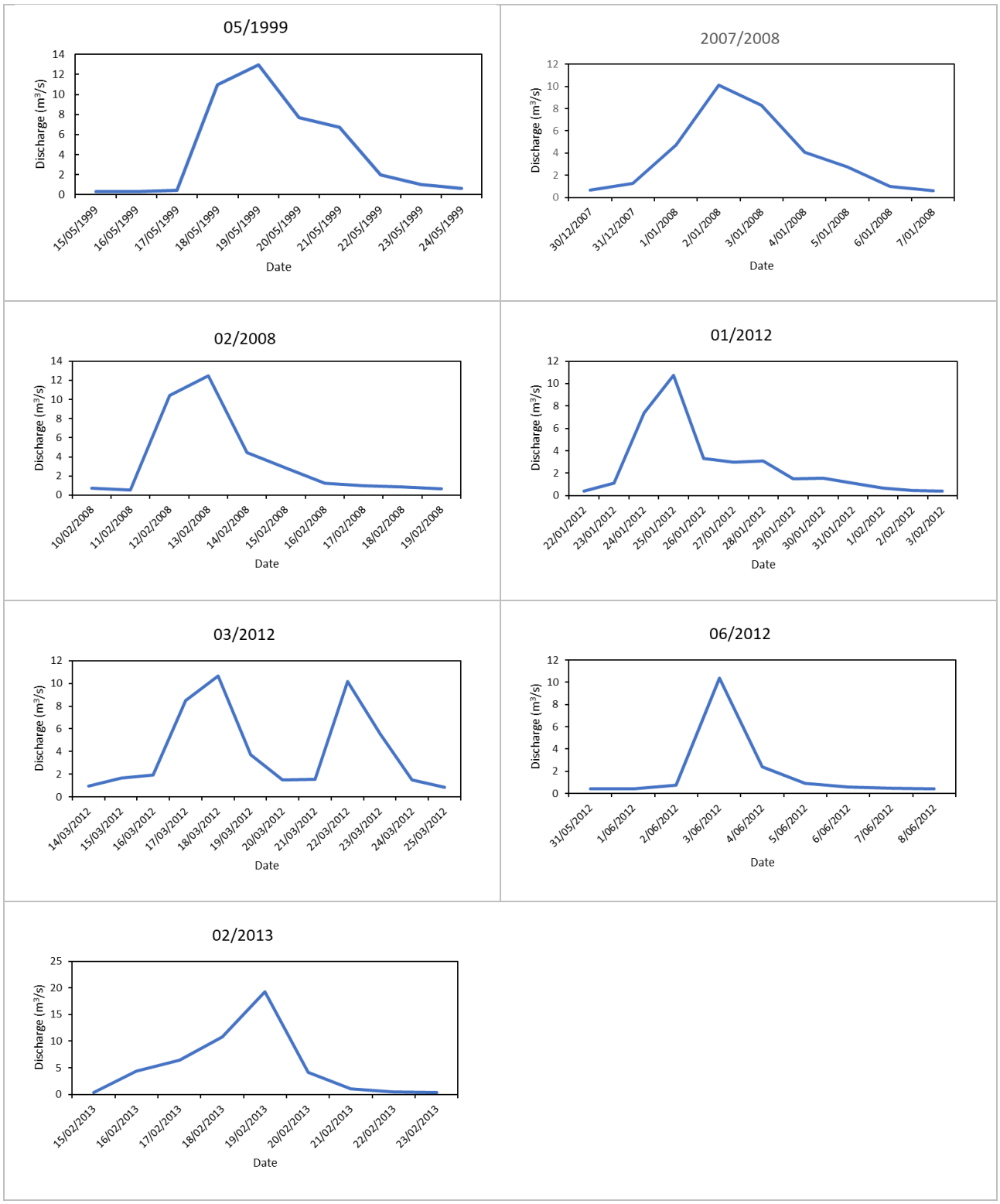

Figure 16-2: Hydrographs showing examples of flow events with peaks of ~10 m3/s that occurred in the Six Mile Creek Dam discharge record period 1999-2019

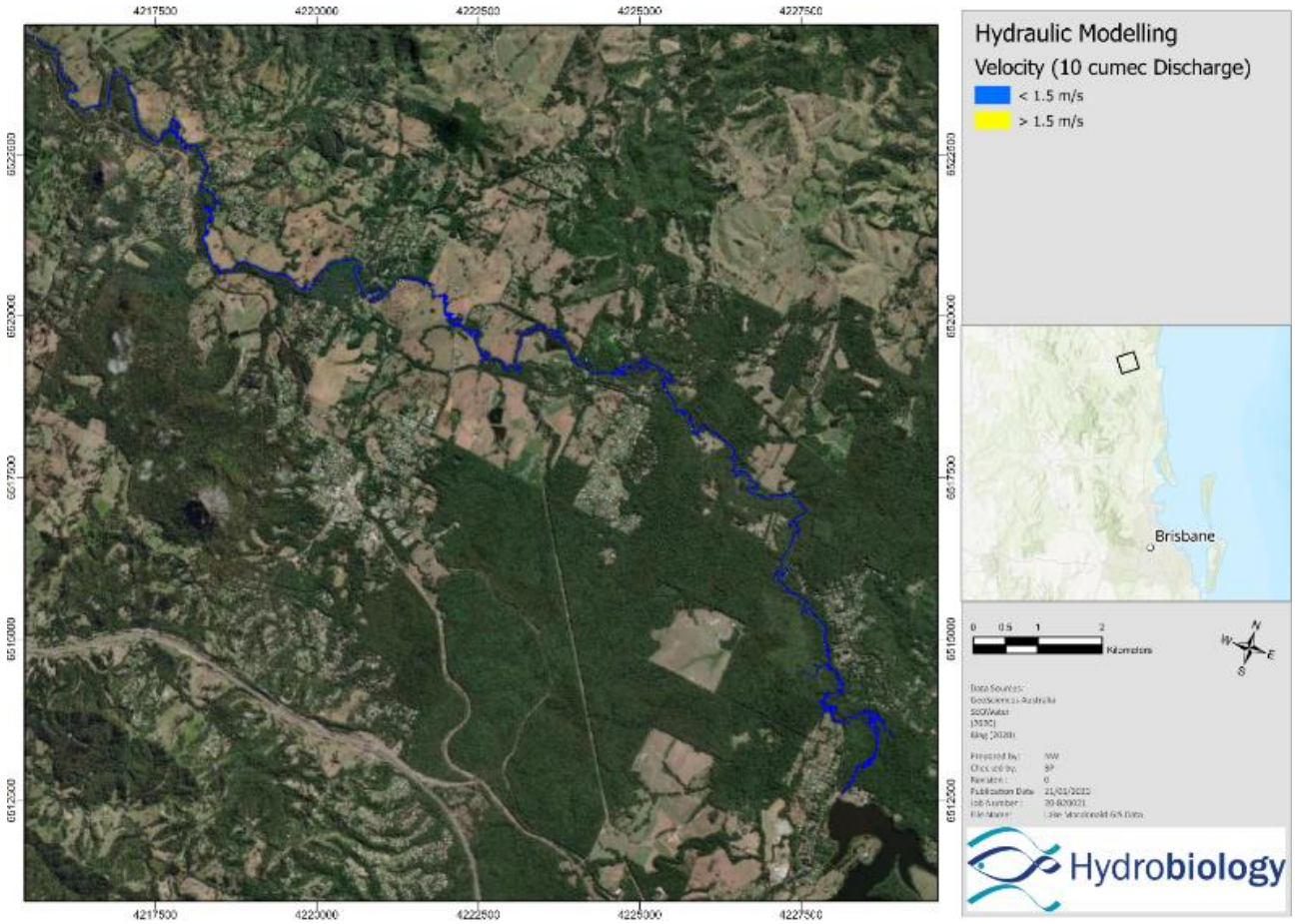

Figure 16-3: Hydraulic Modelling output for a 10 m3/s discharge in Six Mile Creek, representing a sunny day dam release, showing velocities above and below ACARP guidelines of 1.5 m/s for a 50% AEP. Hydraulic modelling data from WMA Water (2019)

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Appendix E

Summary of DPI Fish Salvage Guidelines

Appendix E Summary of DPI Fish Salvage Guidelines

The DPI's Fish Salvage Guidelines (DAF, 2018) present principles that are relevant to the planned aquatic fauna salvage operation. These principles are outlined below:

1. Remove as many fish as possible using appropriate nets.

Note: It is illegal to use certain types of nets, especially in freshwater. A General Fisheries Permit maybe required. Please call DPI for further information.

2. Lower the water level by 25% and remove as many fish as possible. Repeat at each subsequent 25% reduction. Removing fish at each reduction is important as overcrowding can result in a fish kill.

Note: Noxious and non-indigenous fish must be killed immediately with a quick sharp blow to the head, or by placing in an ice slurry. Their bodies must be disposed of away from the waterway in a bin or buried. They are not to be returned to the water. For a list of Noxious Fish species, see the *Biosecurity Act 1994*.

3. The following handling methods lessen damage to fish by reducing the risk of bacterial infections after handling:

- Use nets with a fine, soft, knotless mesh.
- Handle fish with wet hands or a wet towel. Gloves that are wet, open weaved and knotless are good for handling purposes.
- Handle large fish carefully. Fish of 2 kg or more need to be fully supported in a horizontal position with two hands or in a knotless net.

Fish should be placed into suitably sized receptacles as soon as possible to minimise the handling time. The fish holding containers should have good quality, well oxygenated water.

4. Remove, store and release the fish as quickly as possible.

- Use appropriately sized containers with a sufficient water depth to allow for comfortable swimming positions. The container should have soft, rounded surfaces and a lid.
- Size the container depending on the size and number of the fish that will be held. As a guide, 0.2 kg of fish per litre of water is acceptable for oxygen and stress levels.
- Observe fish for signs of stress such as increased gill movements or swimming at the surface.
- Monitor water conditions continuously. Regularly change water, to ensure oxygen levels are maintained, or release fish downstream if suitable conditions exist. As a guide, change 25% to 50% of water hourly, more frequently if conditions are hot. Alternatively, an aerating device that bubbles oxygen at a rate of 2 to 4 litres per second. If possible, keep the containers in the shade while working.
- If pumps are used to exchange water, ensure hoses are screened to prevent fish being injured or sucked through.
- Where practical sluicing fish directly is a better option than transportation. A sluice should:
  - Consist of large diameter PVC pipe with smooth joints or a smooth earthen channel lined with a continuous length of plastic.
  - Be sloped no more than a ratio of 1:10 and must be provided with an auxiliary flow of water.
  - Have a base pool deep enough to cushion the descent of the largest fish. A minimum depth of approximately 1 metre would be suitable for the receiving pool.

5. Release fish carefully by placing the container in the water and allowing the fish to swim away. Drops from height should be avoided. If water temperatures are equal, then a release by scoop net may be possible. Where there is a notable temperature difference water should be exchanged to equalise the temperature before release. These actions will minimise stress.
6. In the event of a fish kill call the hotline number on 1300 130 372.
7. Removing Temporary Bunds

- Remove the most downstream bund first.

- All barrier material to be removed from the waterway.
- Silt fences must be used to prevent erosion.
- Natural stream channel to be reinstated.
- Banks of stream reinstated to natural state, contours and vegetation.
- Aquatic environment similar to the prior state is to be reinstated.

Appendix F

Habitat Monitoring Program

Appendix F Habitat Monitoring Program

The development of the monitoring program was guided by:

- An initial habitat assessment of MNES and MSES species of interest, conducted by Hydrobiology,
- Information presented in the IAR and IAR supplementary report,
- The methods used in baseline aquatic habitat studies completed for the IAR, conducted by frc environmental,
- Advice contained in Seqwater's email correspondence with the Coordinator General's Office and the Department of Natural Resources, Mines and Energy,
- The conditions of the EPBC Act approval (EPBC 2017/8078).

Monitoring Sites

Monitoring sites are presented in Table 16-4. These sites were selected based on:

- Proximity to potential sources of impact
- Inclusion of habitats that would support communities of the listed species.
- Accessibility
- Inclusion of control sites to differentiate between catchment impacts and the dam works impacts.
- Existing baseline sites.

It is noted that the stilling basin is also a key monitoring site for the Project, but not for the purpose of aquatic habitat monitoring.

Six Mile Creek Downstream of the Dam

Monitoring sites to assess Six Mile Creek downstream of the dam are shown in Table 16-4. Three representative sites were selected on Six Mile Creek downstream of the dam. The sites are 200 m long, with coordinates identified for the central point.

Table 16-4: Monitoring sites for the Six Mile Creek downstream study reach

Site	Description	Easting*	Northing*
SMCDS01	Six Mile Creek; directly DS of the Lake Macdonald spillway within the spillway stilling basin	493026	7082149
SMCDS02	Six Mile Creek; approximately 1.5 km DS of the Lake Macdonald spillway	492715	7083047
SMCDS04	Six Mile Creek; approximately 7 km DS of the Lake Macdonald spillway	489171	7086480
Lake site	450 m upstream from dam	493395	7081844
SMCUS01	Upstream Control Site	496073	7079594
CU02	Upstream Control Site	493582	7078933

* Projection – WGS84 (Zone 56J)

Monitoring Components

The monitoring components adopted to assess these potential impacts are:

- Photo point monitoring
- Bank height, relative to water level

- In situ water quality measurements for temperature, pH, EC, dissolved oxygen and turbidity
- Bed substrate composition
- Water velocity
- Cross-sectional depth profiles
- Percent cover of instream aquatic plants
- Percent cover of riffles
- Bank erosion
- Percentage of large woody debris

Monitoring Methods

The habitat monitoring methods are described in Table 16-5.

Table 16-5: Monitoring methods

Monitoring Component*	Method
Photo point monitoring	Take photographs of: downstream view, right bank, upstream view, and left bank, rotating in a clockwise direction a described in the Monitoring and Sampling Manual (DES 2018)
Bank height (m)	Monitor for the duration of the monitoring period and measure height of bank (m) from water surface to top bank. Ensure this measurement coincides with a water depth measurement to normalise bank height measurements.
Velocity (m/s)	Measured using a flow meter
Cross-sectional depth profiles	Cross-section profiles are to be measured at the upstream end, mid-point and downstream end of each site, establish a starting and endpoint. Profiles should be measured perpendicular to the flow and include the entire channel cross-section (i.e. banks included, not just the active bed). Where possible, profiles should be measured using a differential GPS or manual survey techniques (e.g. dumpy level). During drawdown, an ADCP/echosounder can be used in replace of, in conjunction with other techniques to avoid entering high flow conditions. Vertical and horizontal accuracy should be <5 cm. Benchmark stakes should be installed on each bank for the start and end point of each cross-section and tagged with GPS coordinates on the first survey to ensure the same profile is surveyed each time.
Water quality measured in situ	As per *Monitoring and Sampling Manual* (DES 2018). Calibrate meter in accordance with manufacturer's instructions. Wait for reading to stabilise before recording. Take three readings (at least 5 m apart) at each site and take average of the three readings.
Bed substrate composition (percent of size classes)	Visually estimate the percentage of bedrock, boulders (>256 mm), cobble (64-256 mm), pebble (16-64 mm), gravel (4-16 mm), sand (1-4 mm) and silt/clay (<1 mm) along the 200 m site. Percentages of size classes to be documented in a pro forma as per *Monitoring and Sampling Manual* (DES 2018).
Aquatic plant (percent cover)	Visually estimate the percent cover of submerged, floating attached or emergent aquatic plants along the 100 m site Assess only plants rooted in the stream bed (i.e. exclude plants growing on banks and floating plants)
Riffles (percent cover))	Visually estimate the percent cover of riffles (using the definition of riffle presented in DES (2018)) along the 200 m of site.
Bank erosion (percent cover)	Visually record the extent and types of bank erosion (i.e. scour, notch, undercut banks, slump) along the 200 m site. Parameters to be documented in a pro forma and measured at multiple random locations throughout the site to avoid bias. Use cross-section profiles to record actual bank erosion rates at the upstream, mid-point and downstream locations at each site.

Monitoring Component*	Method
Percentage large woody debris	Visual estimation of percentage of large woody debris cover within the 200 m reach at each of the habitat monitoring locations.

* It is noted that high water levels and / or other factors (e.g. turbidity) may preclude the assessment of some indicators (e.g. substrate composition, cross-sectional profiles, aquatic plants and large woody objects) on some sampling occasions.

Habitat Triggers

Trigger values have been developed to provide early warning indicators for either further assessment or management response (e.g. reducing release rate). Non-compliance with the trigger values does not indicate that an impact has occurred.

The trigger values are presented in Table 16-6. However, monitoring results are also to be evaluated with respect to baseline, historical and control site data.

Table 16-6: Habitat Triggers

Monitoring Component	Trigger	Rationale for Trigger
Photo point monitoring	No trigger	Photos taken to aid interpretation of other indicators and as a permanent record of site conditions
Bank height (m)	Bank height must be >5% of water height.	Bank height is approaching bank full capacity.
Velocity (m/s)	At least one velocity reading (i.e. surface or bed at either mid-channel, left bank or right bank) at each site is <0.3 m/s or be comparable with baseline data recorded during similar sized events. Re-assess following *baseline phase*.	Based on prolonged swimming speed water velocity thresholds for native fish known from Six Mile Creek (Kapitzke, 2018)
Cross-sectional depth profile	Mean and maximum water depths at each site to be within baseline range, pending rainfall influences. Mean and maximum bank depths at each site to be within baseline range (top of bank to bed level)	Deep pools likely key habitat for Mary River cod, and important refugia for aquatic fauna during low flow periods.
Water Quality measured in situ	As per low and high triggers	Water quality conditions are maintained in baseline condition
Bed substrate composition (percent of size classes)	Percent cover of each substrate size class no more than 25% beyond baseline range	When substrate composition is >50% different from the baseline range it suggests a notable change in substrate composition.
Aquatic plant (percent cover)	Percent cover of aquatic plants no less than 25% of baseline minimum	Where aquatic plant cover is 25% lower than minimum baseline value, it suggests a notable decrease in aquatic plant cover.
Riffles (percent cover)	Percent cover of riffles no more/less than 25% of baseline range	When riffle extent is >50% different from baseline range it suggests a notable change in riffle extent
Bank erosion	No observed increase in erosion from baseline	Any observed area of new bank erosion requires investigation
Bed erosion	No observed increase in erosion from baseline	Any observed area of new bed erosion requires investigation
Percentage of large wood debris	Presence/cover of LWD within site reduces by >10%	This trigger indicates if the release has potential to change distribution and configuration of instream habitat features

Record Management, Reporting, Notification and Investigations

All monitoring data are to be stored in a suitable database or spreadsheet, which is to be kept up to date. Quality control documents (e.g. calibration records) and digital site photographs are to be stored electronically.

A brief monitoring data summary report is to be prepared on completion of:

- The baseline survey, and the triggers presented in this report are to be reviewed and revised if deemed necessary
- The drawdown phase
- The construction phase
- The post-construction monitoring phase (one-year post-construction), with discussion of post-construction condition compared to baseline conditions.

Post construction monitoring will continue for another year if there have been impacts to habitat that have not returned to baseline condition. If this occurs, another data summary report will be prepared upon completion of the second-year post-construction monitoring and post-construction condition will be compared to baseline conditions.

Appendix G

Habitat Assessment

Appendix G Habitat Assessment

A habitat assessment was undertaken by suitably qualified persons from Hydrobiology (Hydrobiology, 2020). The outcomes of this assessment are summarised below.

Scope

The purpose of the habitat assessment was to provide a better understanding of the habitat within both Six Mile Creek downstream of the dam and within Lake Macdonald to inform the development and design of the HMP, including selection of monitoring sites. Specific focus was placed on the potential for the habitat to support the MNES species of interest. The extent of the survey was limited to a 10 km reach downstream of the dam ('downstream study reach'), extending to the Louis Bazzo Drive crossing, and the Lake Macdonald impoundment ('impoundment study area'). It included both a geomorphology assessment and aquatic habitat assessment.

The scope of the geomorphology assessment was to:

- Review available information to develop a reach breakdown of different geomorphic 'River Styles' to inform monitoring site selection.
- Ground truth the reach breakdown to inform the site selection and describe the geomorphic basis for habitat, specifically in relation to listed species.

The aquatic habitat assessment aimed to demonstrate an adaptive management approach on the presumption of the potential presence of the listed species. This involved a design that focused on potential changes to channel and pool morphology (and in turn, available and suitable habitat) to ensure that it informed monitoring site selection as summarised below:

- Downstream Study Reach
  - Identification, via ground-truthing of potential waterhole traps. This focused on areas where changes to flow and sediment transport regimes will affect habitat connectivity and availability (i.e. riffle and run habitat between pools).
  - Rating different areas along the inspected reach for quality of habitat for each listed MNES species.
  - Use of the above to map good habitat locations and to inform monitoring site selection.
- Impoundment Study Area
  - Use existing data (hydroacoustics, bathymetry, Lidar, aerial imagery, etc.) and collected drone survey data of the lake margins to assess likelihood and quality of habitat for the listed species.

Methods

The methods for the habitat assessment included both a site visit and desktop tasks to inform both the geomorphology and aquatic habitat components, for both the downstream study reach and the impoundment study area. The site visit was conducted by Hydrobiology on 6-9 and 20-21 July. It involved a walk-through of the entire downstream study reach and drone image acquisition of a number of reaches of the dam margin within the impoundment study area.

River Styles Characterisation

The downstream study reach was characterized and split into distinct River Styles, using Stage One of the River Styles Framework, a geomorphic classification tool. Stage One of the framework involves a baseline survey of river character and behaviour, placing river types within their catchment context according to their valley setting, planform, bed material and assemblage of geomorphic units. This involved the analysis of several data sources including:

- Use of aerial photography, LiDAR and Google Earth Imagery to determine valley confinement
- Mapping of preliminary River Styles based on the above assessment

- Verification, adjustment and mapping of River Style boundaries during the site visit.

Morphological Mapping

In addition to River Styles, 'macro-habitat' and 'micro-habitat' were assessed and mapped. Macro-habitat refers to morphological features, such as pools, riffles, glides, and runs, while micro-habitat describes debris, such as leaf litter and large woody debris (LWD). All macro-habitat and LWD were geotagged with a GPS when walking the reaches during the site visit. Specific attention was placed on habitats that would be beneficial for the listed species. At the same time, any evidence of erosion (e.g. notch scour, bank collapse, undercut banks, bank exposures and other prominent scour) was also geotagged. Photographs were also taken. This geodatabase of features was then uploaded into a GIS and mapped to gain an understanding of physical habitat within the creek and the erosion that is currently present.

Downstream Study Reach

In order to determine what habitat was suitable for the species of interest, criteria for assessing the presence of each individual species were developed based on the most recent critical literature (Table 16-7). Field sheets designed to assess and rank the habitat for each species were used during the site visit. Each habitat criterion in the field sheets was assigned a ranking from 0-3 based on the following parameters:

- 0 ranking: 0-25% cover
- 1 ranking: 26-50% cover
- 2 ranking: 51-75% cover
- 3 ranking: 76-100% cover.

Monitoring of available habitat for listed species was conducted whenever a significant change in micro or macro habitat was observed. The scores for each species were then tallied for each site and ranked into potentially "poor", "good" and "excellent" habitat.

Impoundment Study Area

All relevant existing data were loaded into a GIS. Data included:

- Hydroacoustic data provided by Seqwater and collected by Infofish. This included bathymetry and shapefile outputs of LWD presence.
- LiDAR, satellite imagery and aerial imagery.
- Drone-generated orthomosaics collected during the site visit described above. Where access allowed, a Phantom 4 RTK drone was deployed to capture aerial imagery of the impoundment margins. Captured imagery was used to generate recent ortho-mosaics of the margins. Detailed methods of the drone image acquisition are provided in the Hydrobiology assessment report.

The above datasets were used to divide the impoundment into different habitat condition zones, using the same rating system of habitat quality as described above. For fish species, the entire area of the waterbody was categorised into the different habitat condition zones, while for all other species, the impoundment margins were categorised as these species were unlikely to inhabit the deeper open water of the impoundment.

Table 16-7: Habitat requirements of listed species

Species	Australian lungfish	Mary River cod	White-throated snapping turtle	Mary River turtle	Giant Barred Frog	Tusked Frog	Platypus
Still/ low flow water	✓	✓	✓	✓	✓	✓	✓
Permanent water	✓		✓	✓	✓	✓	✓

Species	Australian lungfish	Mary River cod	White-throated snapping turtle	Mary River turtle	Giant Barred Frog	Tusked Frog	Platypus
Submerged/ emergent vegetation	✓		✓	✓			
Overhanging vegetation		✓	✓	✓			
Dense canopy cover					✓	✓	
Low ground vegetation cover					✓	✓	
Unconsolidated banks			✓	✓			✓
Fine sediment							✓
Steep banks					✓	✓	
Leaf litter					✓	✓	
Riffles			✓	✓			
Large boulders			✓	✓			
Large woody debris	✓	✓	✓	✓			
Undercut banks	✓	✓					✓

Results – Geomorphic (Physical) Habitat Assessment

River Styles Characterisation Assessment

A total of four distinct River Styles were identified in the downstream reach in Six Mile Creek (Table 16-8, Figure 16-4). Although most of reaches contained similar geomorphic features (lots of LWD, glides, runs, pools, entrenched channel type), the reaches could be distinguished based on differences in valley confinement, bed material and prominent geomorphic features and channel characteristics. The locations of geomorphic habitat (pools, riffles, runs/glides), LWD, and bank erosion are shown in Figures G-2 to G-4. These were used to assist in the aquatic habitat assessment.

Table 16-8: River Styles characterisation of Six Mile Creek 10 km downstream of the dam

No.	River Style	River Style Full Name	Distance Down Stream (km)	Main features
1	PC_BrMC_FpCab_DcFp_SbedFbed	Partly confined, bedrock margin-controlled, floodplain channel anabranches (secondary or flood channels), discontinuous floodplain, sand and fine-grained bed	0 – 3	Bed material mostly fines with larger concrete blocks and rocks (local influence) that have washed down from the bridge at the dam. Sandy silty bed, long runs. Large clusters of LWD with big logs crossing the channel. Sand bar deposition on the inside of bends. Large bank exposures on the outside of bends with erosion and deep pools on outside of bends. Discontinuous floodplain pockets Flood/secondary chute channels Large sand consolidated vegetated islands that divert flows. Sandy pool-riffle sequences. Deeper incised slot channel with high vertical banks towards mid-reach with high vertical banks – good habitat for platypus. Sandy banks, but trending towards more fine-grained clays and silts towards end of reach.

No.	River Style	River Style Full Name	Distance Down Stream (km)	Main features
2	C_BrMC_Ru_Sbed	Confined, bedrock margin-controlled, runs (glide, plane-bed), sand bed	3 – 4.5	Trending towards more confined valley compared with upstream, with the channel abutting the right bank valley margin, and only occasional floodplain pockets where valley is locally wider. Tributary joins in the upper sections of this reach, resulting in change of bed material, bringing in fine-coarse sands and some gravel. Incised slot channel with high banks. Longer continuous pools and run/glide features. Bed material mostly sands with small bank attached sandy bars. Some fines in the channel. Towards end of reach, the valley becomes fully confined providing constriction– channel occupies the valley floor with only small bank attached bars. Large clusters of LWD.
3	PC_BrMC_f[Ru_DcFp_Fbed	Partly confined, bedrock margin-controlled, runs, discontinuous floodplain, fine-grained bed	4.5 – 6.5	Incised slot channel with long continuous run-glide-pools. Channel widens as confinement changes. High steep banks and deeper cross channel. Channel boundary material comprising mostly fines, including silts, clays and sands. Large clusters of LWD. Occasional secondary/flood channel.
4	PC_PC_LSin_DcFp_FpMCu_Fbed	Partly confined, planform-controlled, low sinuosity, meander cutoff (neck cutoff, billabong), fine-grained bed	6.5 – 10	Incised slot channel with long continuous run-glide-pools. Low sinuosity driven by proximity to valley margins. Channel boundary material comprising mostly fines, including silts, clays and sands. Large clusters of LWD. Occasional secondary/flood channel. Gullying of valley margin.

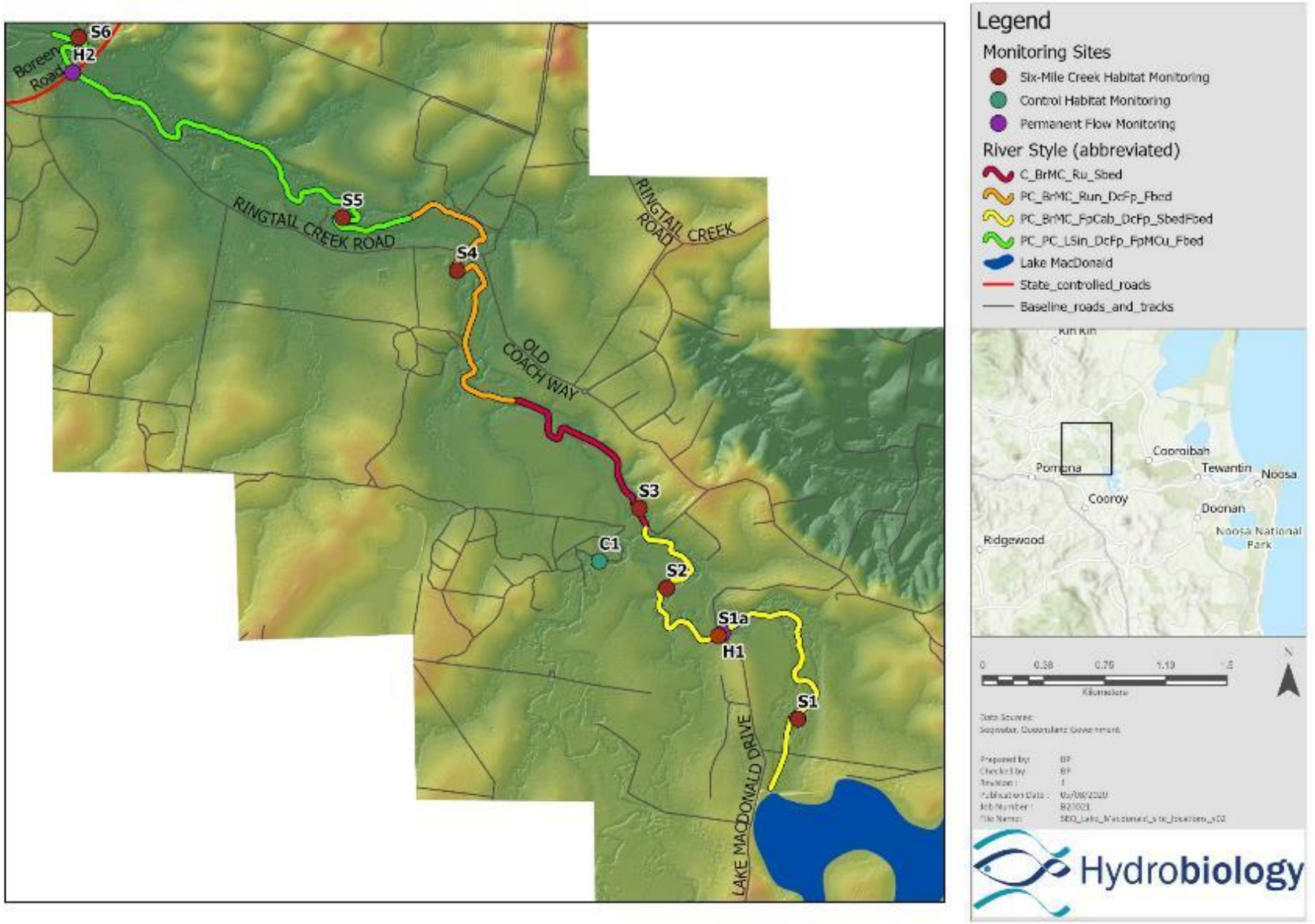

Figure 16-4: River styles and proposed monitoring site locations in the downstream study reach

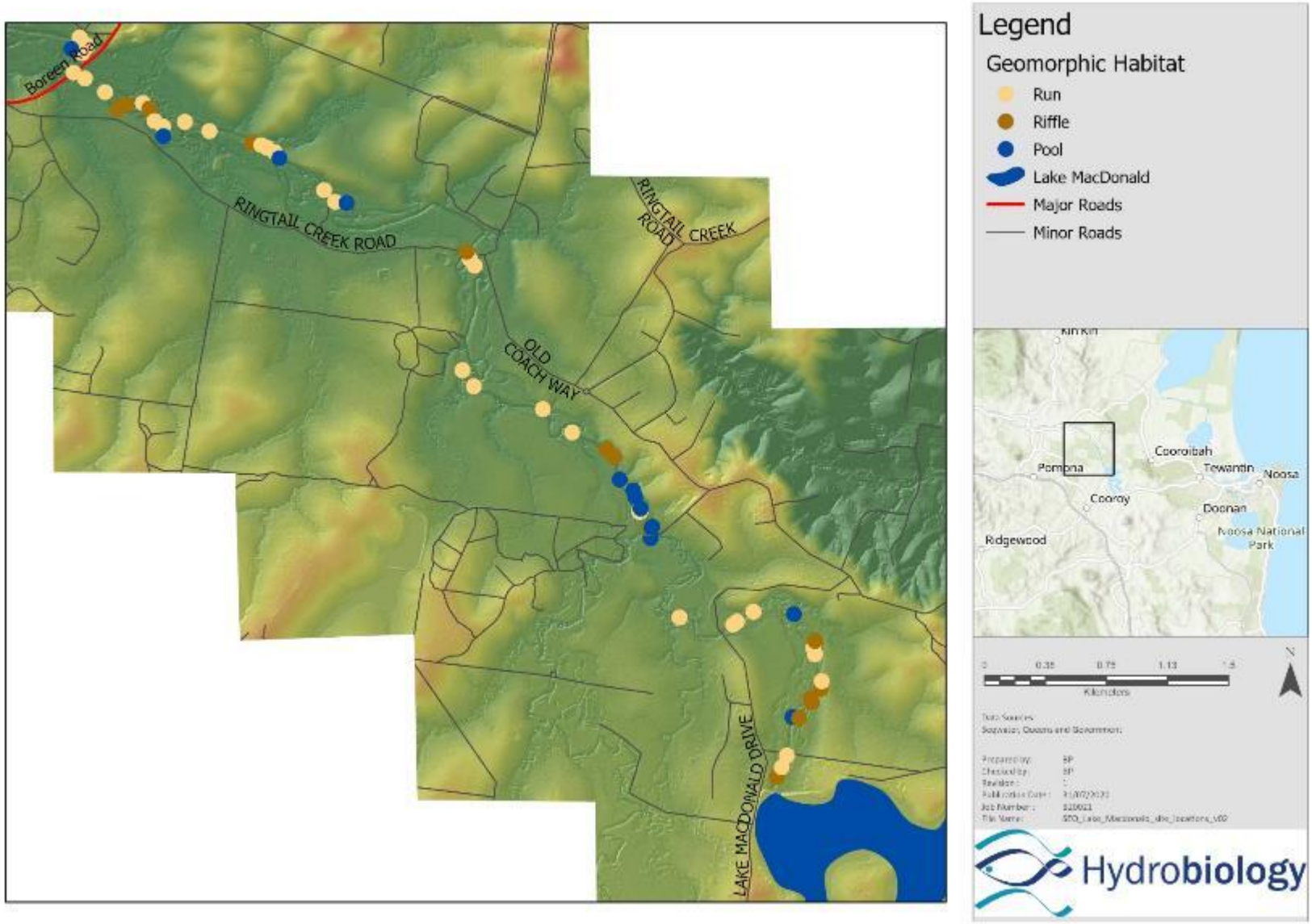

Figure 16-5: Geomorphic habitat features in the downstream study reach. Points indicate habitat until next downstream point

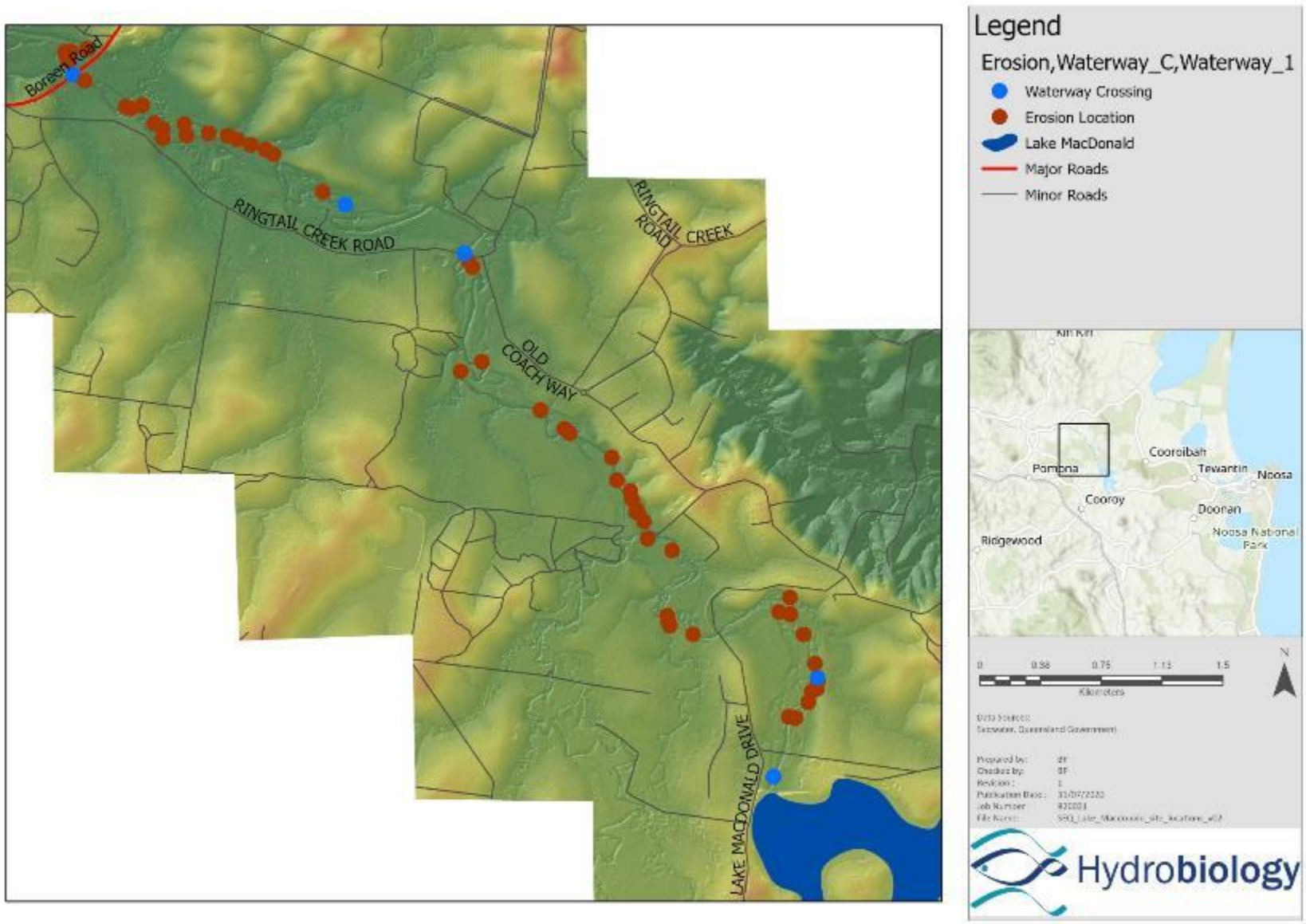

Figure 16-6: Bank erosion in the downstream study reach

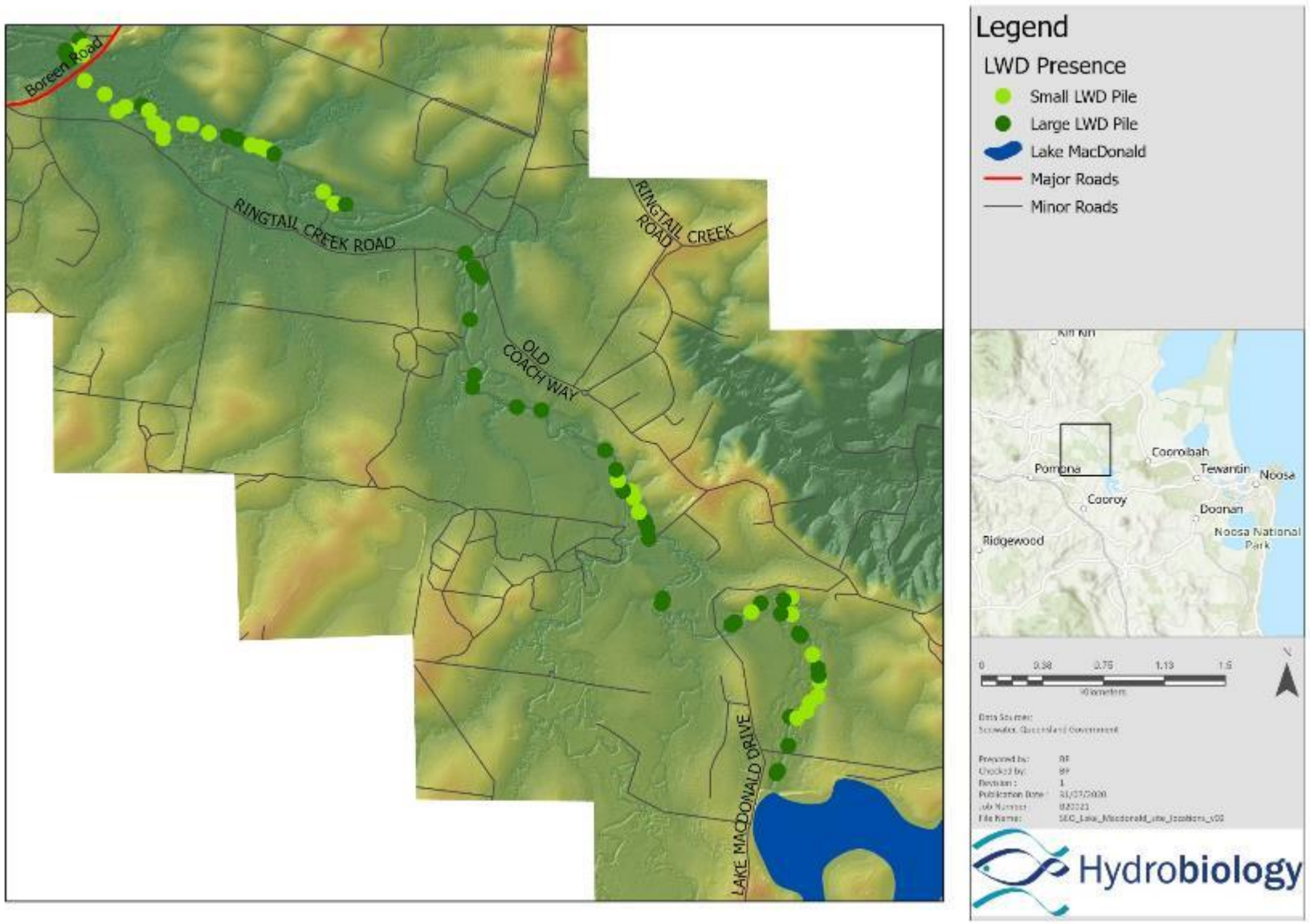

Figure 16-7: Distribution of LWD and large LWD clusters in the downstream study reach

Results – Aquatic Habitat Assessment

Downstream Study Reach

The habitat ratings for the listed species are shown in Figures G-5 to G-9 and a summary of key features is provided below:

- Mary River cod
  - The majority of upstream surveyed sites contained “excellent” potential habitat with further downstream sites on Six Mile Creek containing potentially “good” habitat. Sites closer to the dam are often characterised by complex microhabitat with a high incidence of LWD in channel and undercut banks at bends. The downstream sites have less LWD availability.
- Australian lungfish
  - Most sites contained “good” Australian lungfish habitat due to the presence of LWD and undercut banks. The presence of perennial still/ low flow waters also assured suitable habitat. The majority of “excellent” sites were located closer to the dam where the channels were wider, and pools were generally deeper. One of the main contributing factors to potential lack of habitat at sites further downstream was the depth of pools available, which may be a result of natural seasonal variations.
- Mary River and white-throated snapping turtles
  - Sites were largely characterised by “good” habitat in the upper 5 km and “poor” habitat further downstream. Although the LWD and undercut banks provided habitat throughout the downstream reach, submerged/emergent macrophytes were only at the more downstream sites, likely contributing to the absence of suitable habitat. Where there are adjacent urban areas downstream the incidence of predation is likely to reduce distribution.
- Giant Barred and Tusked Frogs
  - Habitat requirements for the giant barred frog and tusked frog were grouped together as they share similar criteria. The majority of sites surveyed contained either “excellent” or “good” potential habitat. Vegetation density, channel incision, leaf litter and ground cover were the parameters that dictated habitat scores for this species.
- Platypus
  - Most surveyed habitat along Six Mile Creek was classified as “excellent”. Water was generally clear at all sites, although there is potential for higher turbidity during flow events. Despite the presence of riparian clearing at some downstream locations, habitat remained ideal due to the substrate composition. The likely limiting factor to their presence would be periods of low/no rainfall.

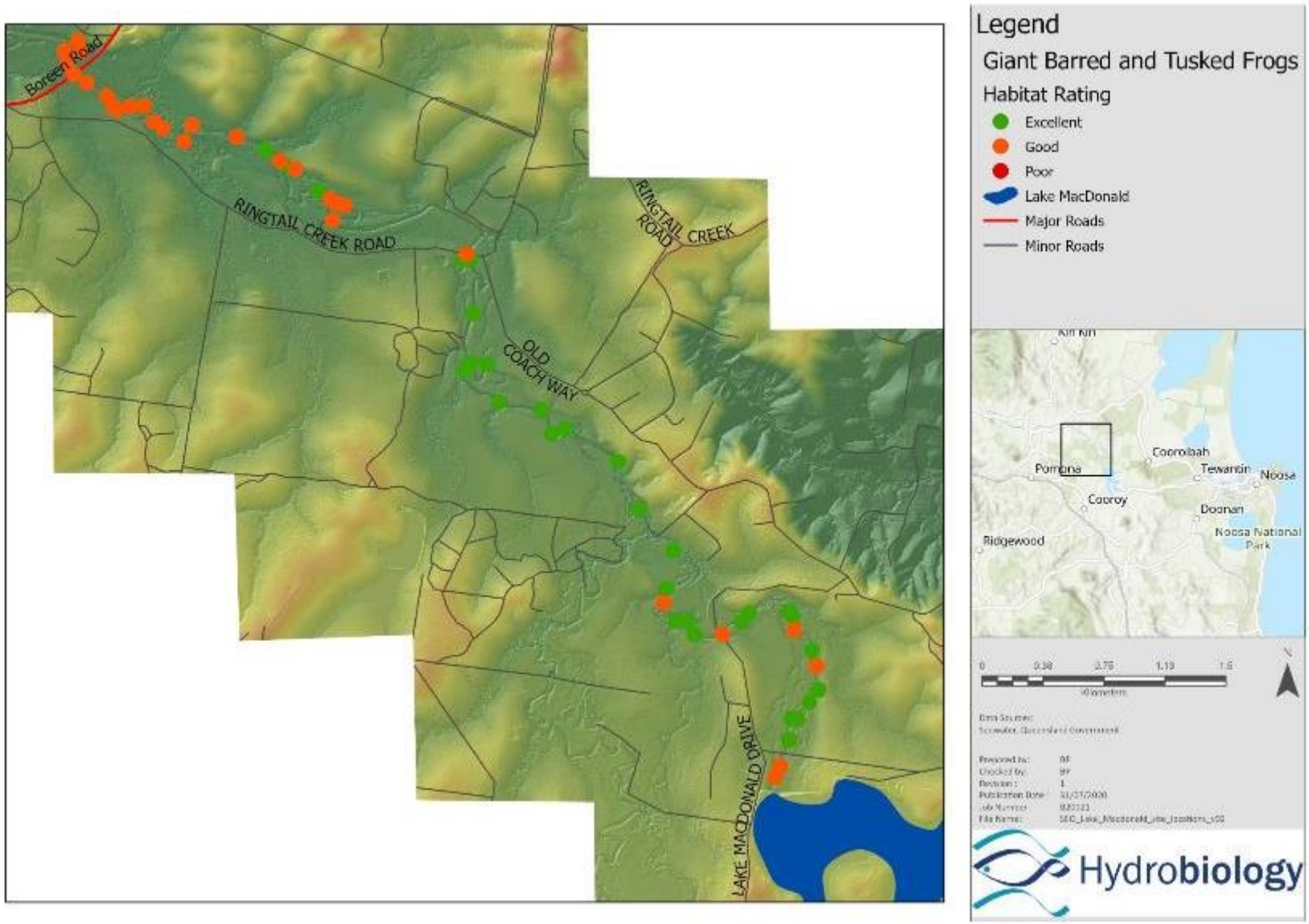

Figure 16-8: Habitat rating scores for giant barred and tusked frogs in the downstream study reach. Points indicate rating to the next downstream point.

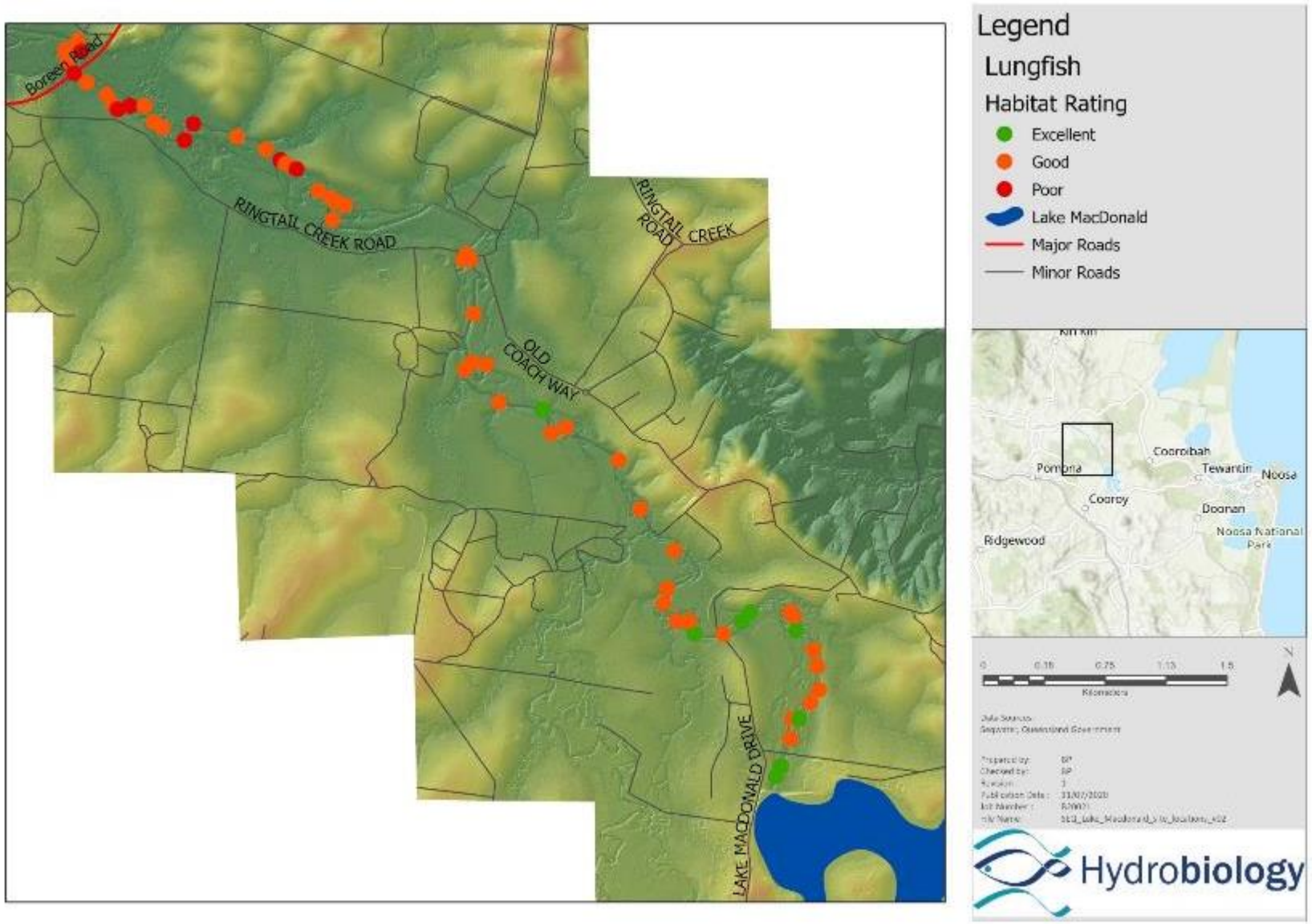

Figure 16-9: Habitat rating scores for the lungfish in the downstream study reach. Points indicate rating to the next downstream point.

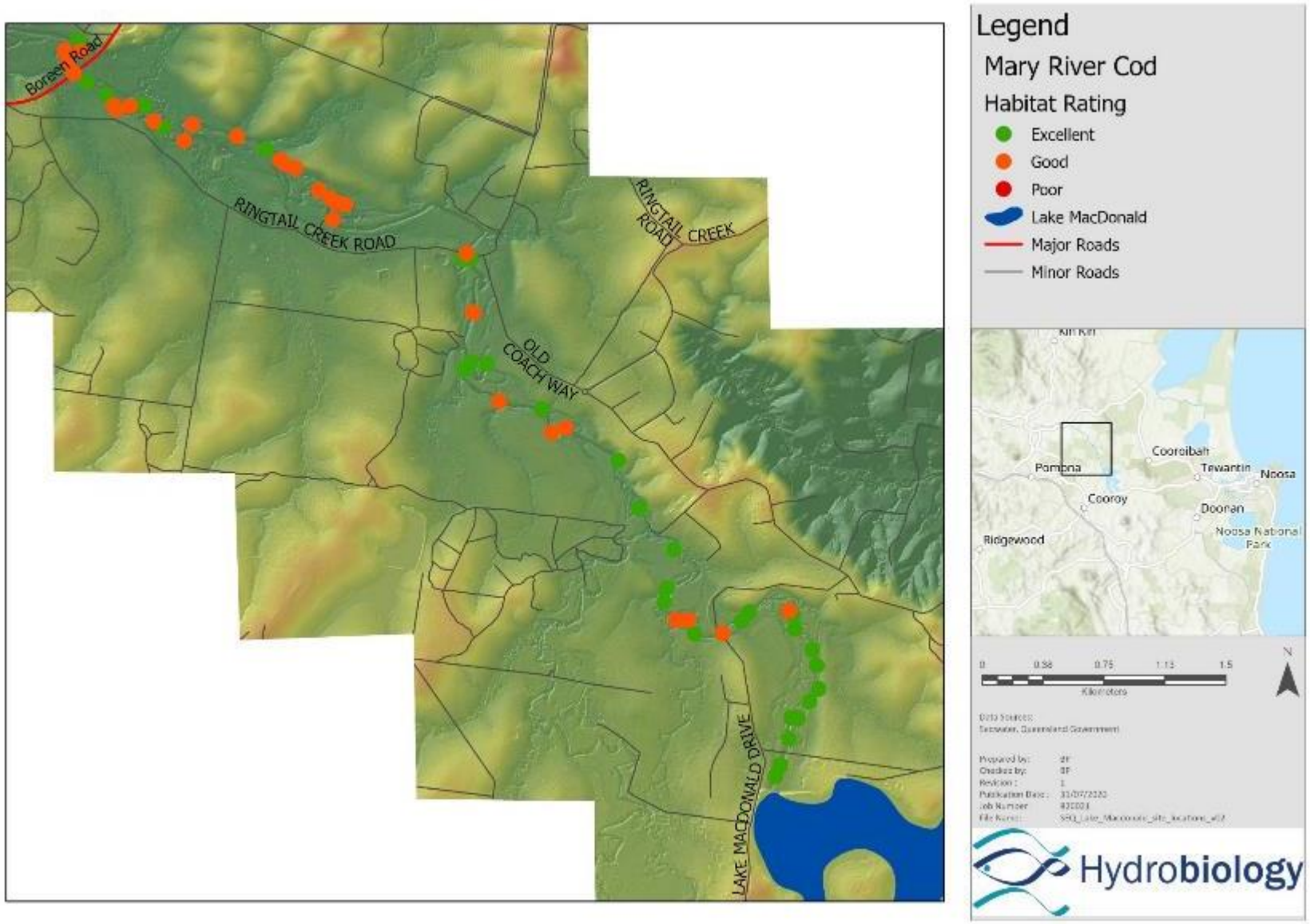

Figure 16-10: Habitat rating scores for Mary River cod in the downstream study reach. Points indicate rating to the next downstream point.

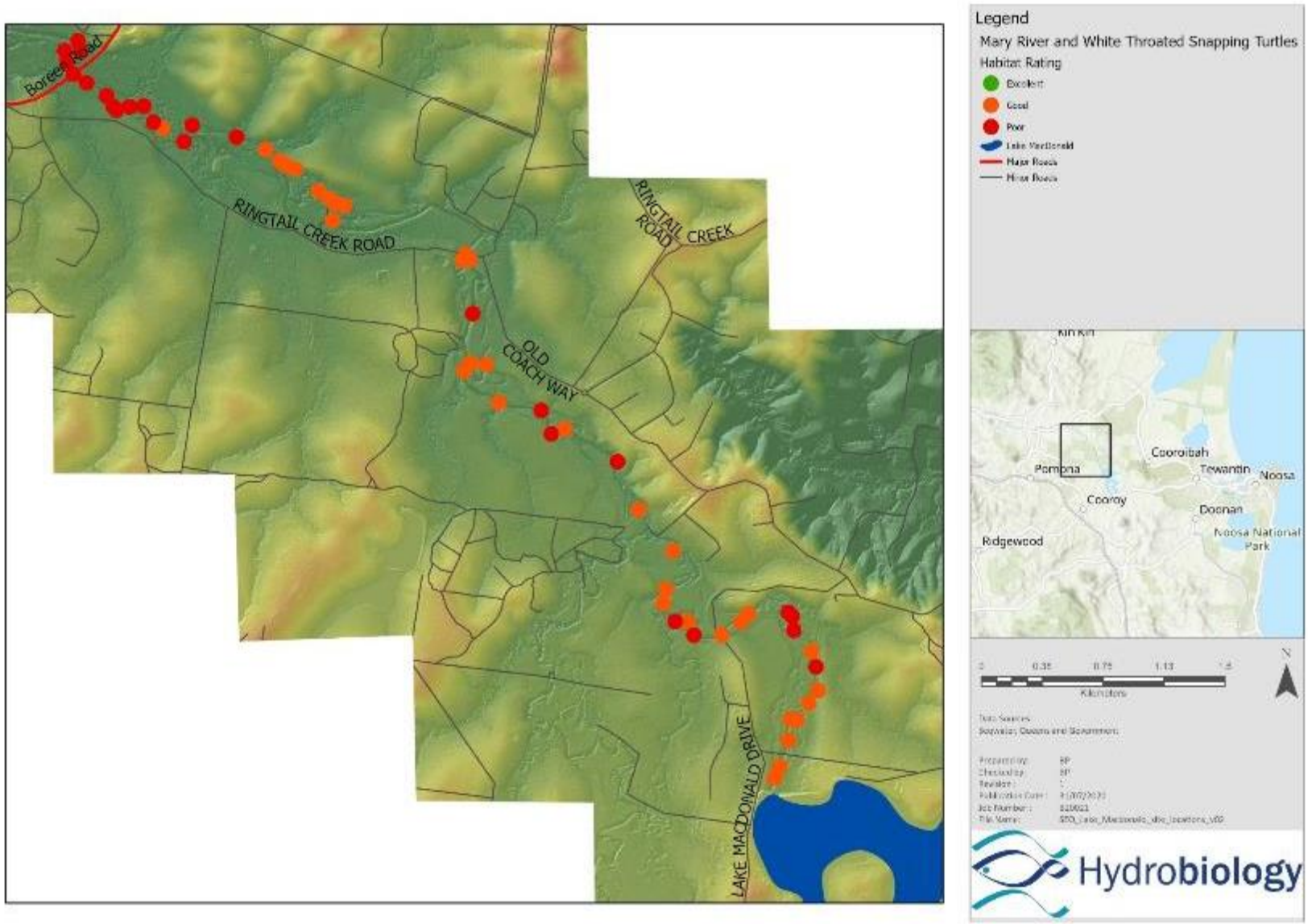

Figure 16-11: Habitat rating scores for both turtle species assessed in the downstream study reach. Points indicate rating to the next downstream point.

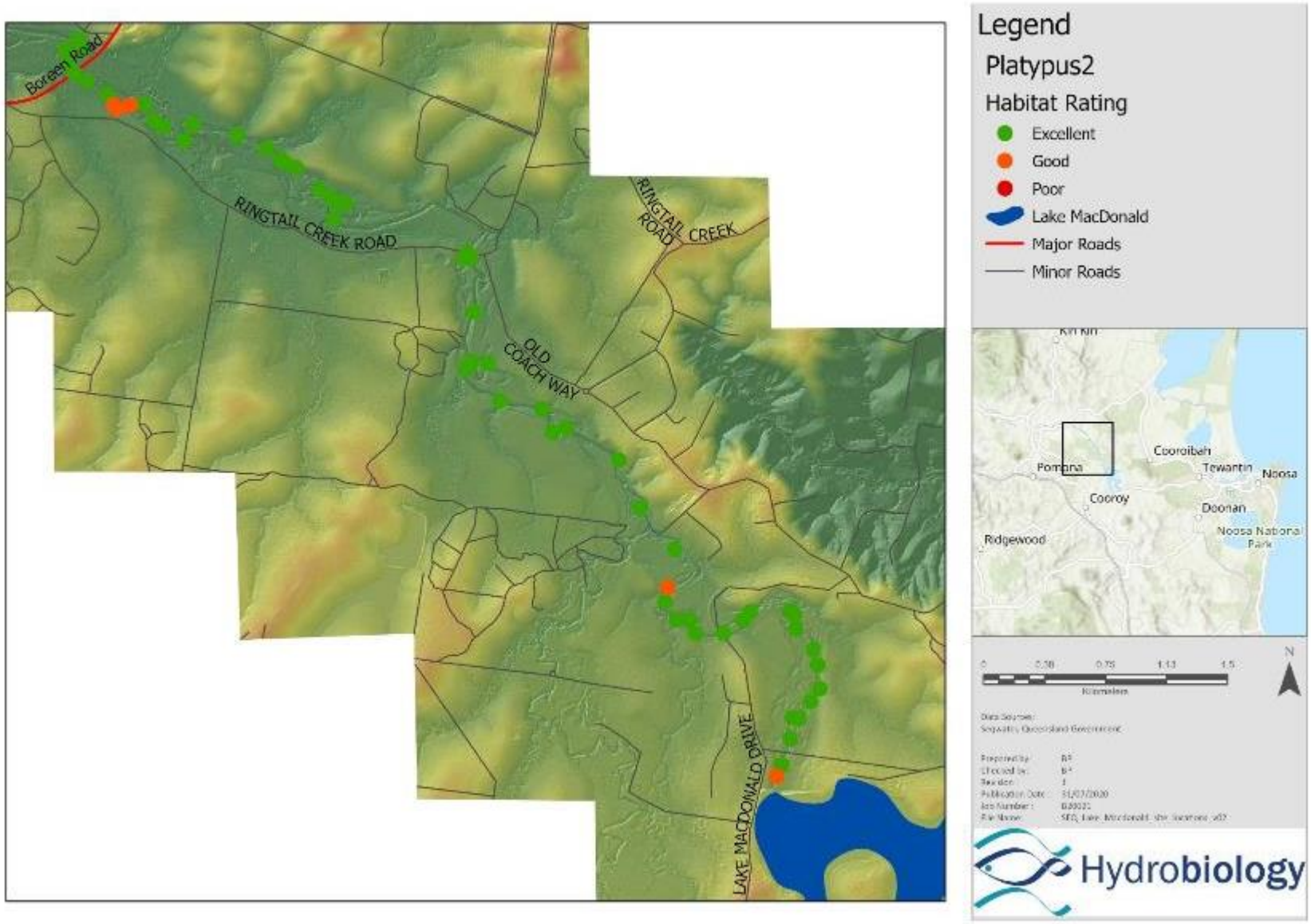

Figure 16-12: Habitat rating scores for the platypus in the downstream study reach. Points indicate rating to the next downstream point.

Lake Macdonald

Habitat rating assessment results for relevant species are shown in Figures G-10 to G-13. Key results were:

- Much of the lake provides excellent subsistence habitat for Mary River cod and lungfish, but is unlikely to provide habitat for their entire lifecycles.
- There are small areas of excellent habitat and large areas of good habitat for turtles.
- The majority of the lake margins provide poor habitat for the frog species.
- The majority of the lake consists of poor habitat for platypus, although some of the upper reaches are rated as excellent.

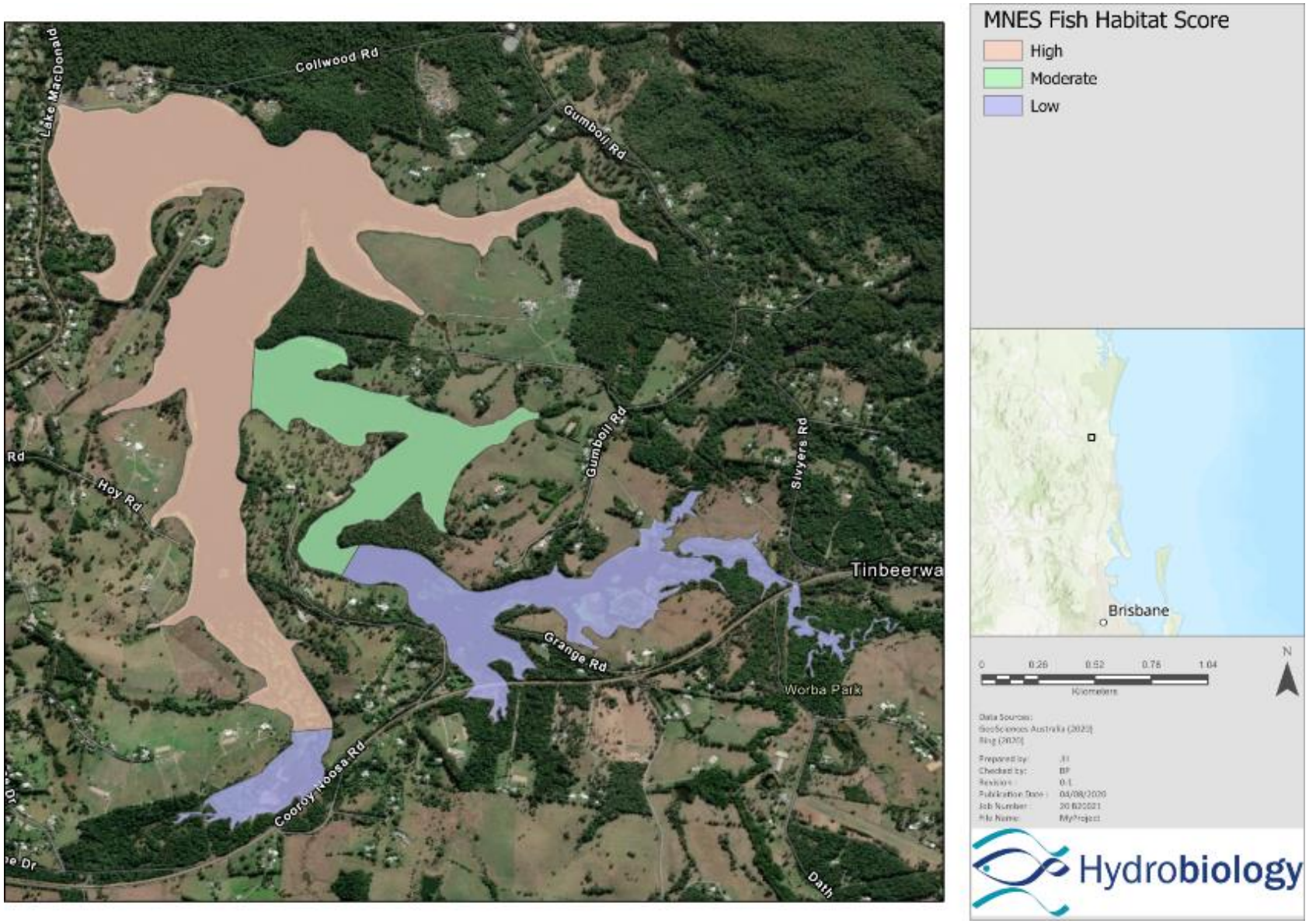

Figure 16-13: Habitat rating scores for Mary River cod and lungfish in the impoundment study area.

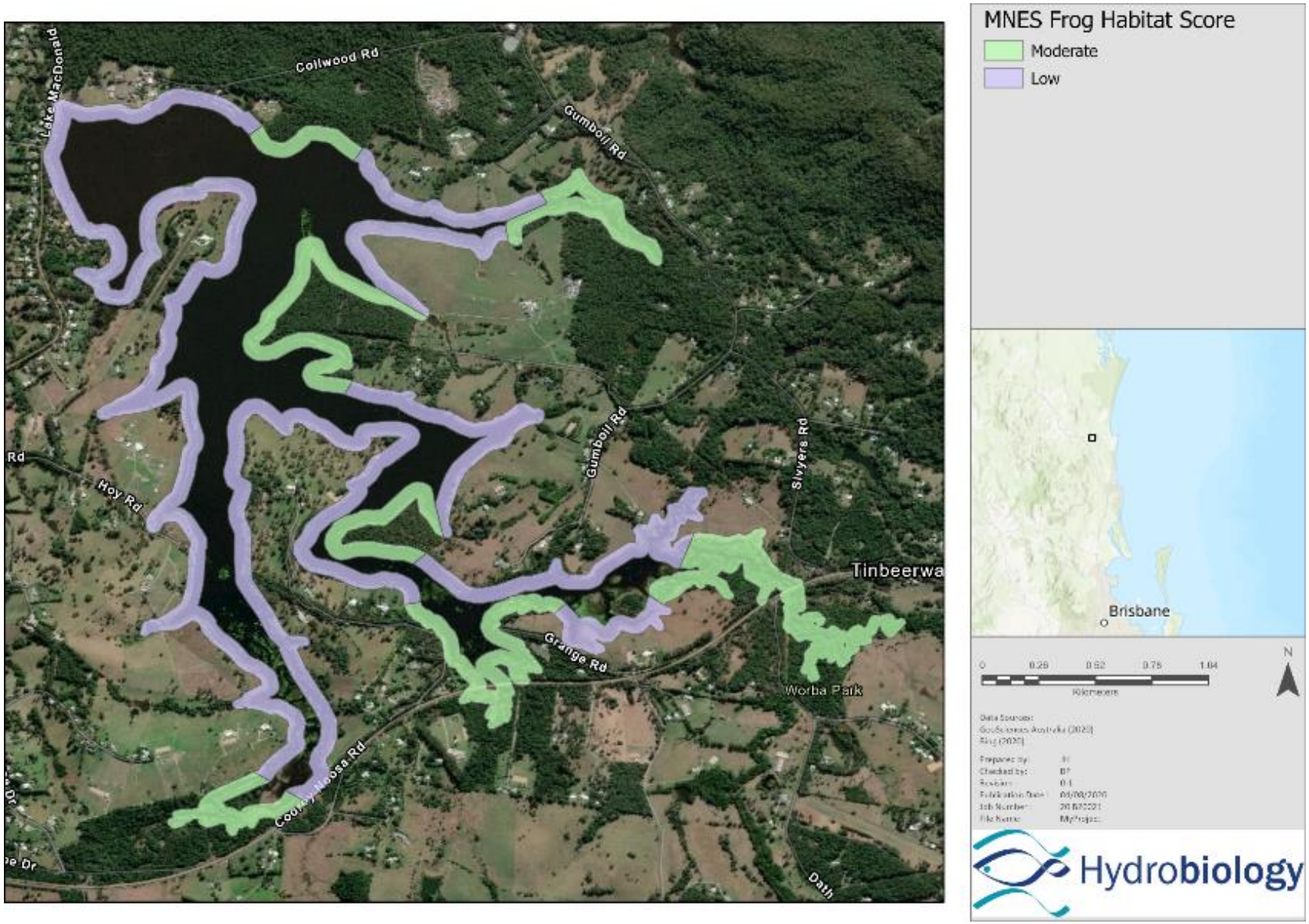

Figure 16-14: Habitat rating scores for the Giant barred frog and tusked frog in the impoundment study area

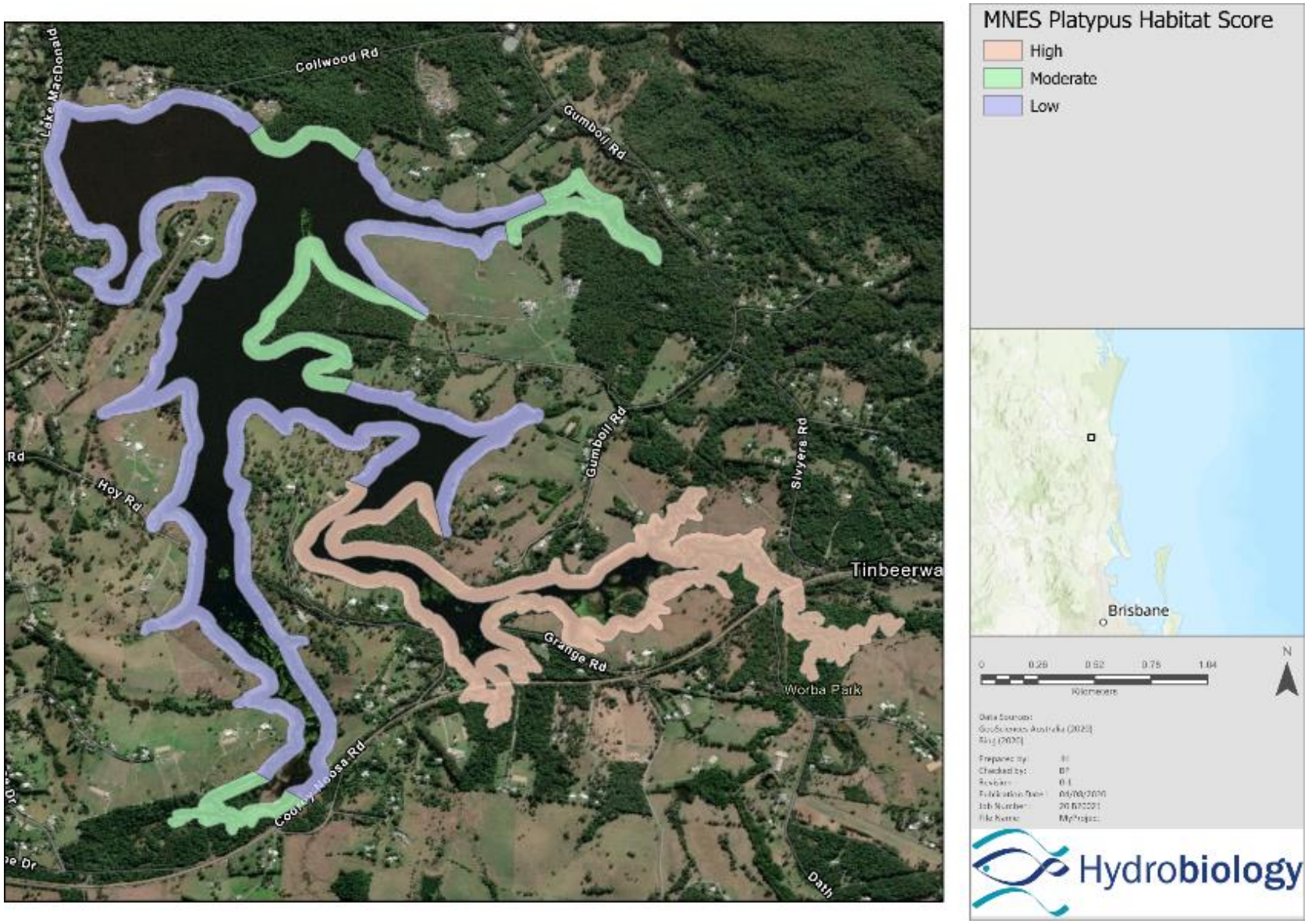

Figure 16-15: Habitat rating scores for the platypus in the impoundment study area

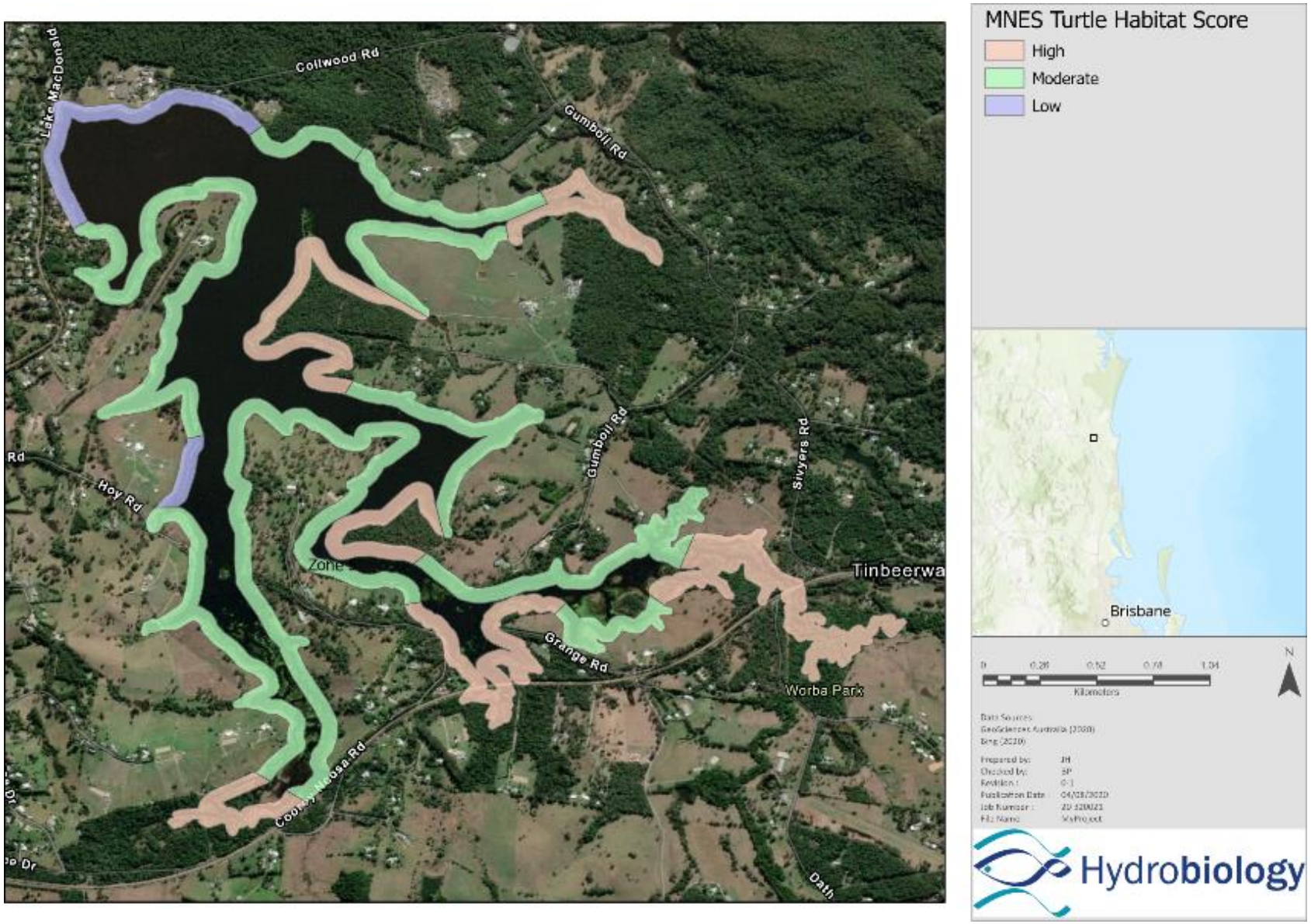

Figure 16-16: Habitat rating scores for the Mary River and white-throated snapping turtles in the impoundment study area.

Appendix H

Relocation Site Assessment Report

Appendix I

Lake Macdonald (Six Mile Creek) Dam Improvement Project – Biomass Survey

Member of the Surbana Jurong Group

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Through our specialist expertise, we're challenging boundaries to deliver advanced infrastructure solutions.

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