Rookwood Weir

Turtle Management and Conservation Outcomes Report - RWW-GHD-ENV-RP-0020

Sunwater

1 December 2023

→ **The Power of Commitment**

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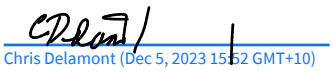
Abbreviations and acronyms

Abbreviation / acronym	Definition
AEIS	Addendum Environmental Impact Statement
AHD	Australian Height Datum
ALARP	As Low As Reasonably Practical
AMTD	Adopted Middle Thread Distribution
cm	Centimetre
CoG	Queensland Government's Coordinator General
CVC	Conventional Vibrated Concrete
DAWE	Department of Agriculture, Water and Environment
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DEE	Department of Environment and Energy
DEHP	Department of Environment and Heritage Protection
DES	Department of Environment and Science
DNRME	Department of Natural Resources, Mines and Energy
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999*
EIS	Environmental Impact Statement
ha	Hectare
kg	Kilogram
km	Kilometre
LFRIP	Lower Fitzroy River Infrastructure Project
m	Metre
mm	Millimetre
ML	Mega Litre
NC Act	*Nature Conservation Act 1992*
PIT	Passive Integrated Transponder
RL	Reduced Level
SM Plan	Species Management Plan
SMP	Species Management Program
WASC	Woorabinda Aboriginal Shire Council

Declaration of accuracy

In making this declaration, I am aware that section 491 of the *Environmental Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) makes it an offence in certain circumstances to knowingly provide false or misleading information or documents to specified persons who are known to be performing a duty or carrying out a function under the EPBC Act or the *Environment Protection and Biodiversity Conservation Regulations 2000* (Cth). The offence is punishable on conviction by imprisonment or a fine, or both. I am authorised to bind the approval holder to this declaration and that I have no knowledge of that authorisation being revoked at the time of making this declaration.

Signed:



Full name: Chirs Delamont

Organisation: Sunwater Limited

EPBC Referral Number: EPBC 2009/5173

Turtle Management and Conservation Summary Report (EPBC Offset Management Plan)

Date: 05/12/2023

Executive Summary

As a component of the Lower Fitzroy River Infrastructure Project (LFRIP), Rookwood Weir (the Project) will be constructed by Sunwater Limited (Sunwater) to satisfy short-to-medium-term water supply. The proposed Rookwood Weir is located at a 'greenfield' site at 265.3 km AMTD on the Fitzroy River, approximately 85 km south-west of Rockhampton.

The Fitzroy River turtle (*Rheodytes leukops*) and white-throated snapping turtle (*Elseya albagula*) are two freshwater turtle species known to occur within the footprint of the Project. The Fitzroy River turtle is listed as vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Queensland *Nature Conservation Act 1992* (NC Act). The white-throated snapping turtle is listed as critically endangered under the EPBC Act and the NC Act.

An Environmental Impact Statement (EIS; GHD 2015) including Addendum to the EIS (AEIS; GHD 2017) approval was approved by the Queensland Government's Coordinator General (CoG) in December 2016 (CoG, 2016) and the Federal Minister for Environment in February 2017 (EPBC 2009/5173), subject to conditions. These conditions required extensive avoidance and management of the two turtle species during Project design, construction and operations.

Unavoidable impacts to the Fitzroy River turtle and white-throated snapping turtle are expected to remain in relation to:

– Inundation of Fitzroy River turtle and white-throated snapping turtle nest sites within the impoundment area and downstream of the Weir
– Modifying 545.6[1] hectares (ha) turtle aquatic habitat.

These residual impacts are considered significant in accordance with the *Matters of National Environmental Significance - Significant impact guidelines 1.1* (DoE, 2013) and *Queensland Environmental Offsets Policy Significant Residual Impact Guideline* (State of Queensland, 2014).

The Rookwood Weir Offset Strategy Version 10 (Earthtrade 2022a) was approved by the Minister in November 2022. This strategy identified that to achieve the conservation outcome of a reduction in nest predation and increased recruitment of hatchlings into the population, a Fitzroy River Turtle and White-throated Snapping Turtle Nest Protection Management Plan will be implemented as a direct offset for residual impacts to nest inundation. The offset will be in accordance with Appendix G of the AEIS: Offset Proposal for the Fitzroy River Turtle and White-throated Snapping Turtle offset management plan and *Condition Appendix 2. Imposed conditions – Rookwood Weir, Schedule 1 White-throated snapping turtle Part C. Turtle nesting impacts, Condition 5 Nest protection programs*.

As per Condition 5 of the EPBC approval, offsets for impacts to turtle aquatic habitat will be delivered via a financial offset. In accordance with the Queensland environmental offsets policy's financial settlement calculator, the total cost to offset turtle aquatic habitat is $9,470,000. Delivery of this financial offset is proposed to occur through on-ground offsets and financial payment.

The purpose of this report is to demonstrate how the financial offset for turtle aquatic habitat has/will be delivered through on-ground conservation outcomes for the Fitzroy River turtle and white-throated snapping turtle. Justification is provided for how the conservation outcomes achieved for the Rookwood Weir Project benefit the species as a whole, directly offset residual impacts from the Project, and align with Commonwealth and State management strategies for species recovery. The key conservation and management actions presented in this report include:

– Preclearance surveys for turtle nesting habitat
– Design and implementation of a Turtle Movement Study
– Design and construction of turtle passage infrastructure and turtle protection design features
– Development and implementation of a Construction Species Management Plan (SMP) and Operations SMP

[1] Condition 4 states the LFRIP will modify 942 ha of aquatic habitat from Rookwood Weir Stage 2 and Eden Bann Stage 3. Rookwood Weir with a Weir crest height of RL 46.2 m AHD inundates 545.6 ha of aquatic habitat for the Fitzroy River turtle.

– Development and implementation of a Fitzroy River Turtle and White-throated Snapping Turtle Nest Protection Management Plan.
– Additional on-ground conservation actions including implementation of Turtle Habitat Enhancement Program: Feral Pest Animal Management Plan, and creation of a Turtle Conservation and Management GIS Data Platform.

The total cost of turtle management and conservation effort undertaken as part of the Rookwood Weir Project is estimated at approximately $20,500,000. This cost includes approximately $1,700,000 dedicated to implementation of Nest Protection Management Plans for the Fitzroy River turtle and white-throated snapping turtle over the life the Project to offset the inundation of turtle nests within the impoundment and downstream of Rookwood Weir.

The biggest threat to the survival of the Fitzroy River turtle and white-throated snapping turtle is the lack of recruitment into the population (Commonwealth of Australia, 2008; Limpus *et al*., 2011a). Predation of nests by feral animals, goannas and water rats, plus trampling of nests by cattle results in extremely poor survival of egg clutches (close to 100% of clutches predated each season) and current recruitment rates are not considered adequate to sustain populations within the catchment (Limpus *et al*., 2011a). The protection and management of nests as part of the Rookwood Weir Nest Protection Management Plans, will improve hatching success and thus birth rate, will target Project-specific impacts, as well as address the key processes currently threatening the survival of these species throughout the catchment. In accordance with EPBC Act Approval Condition 5, the Nest Protection Management Plan will be implemented until the conservation outcome is achieved. It is conservatively estimated that the time required for the proposed offset to achieve ecological benefits is five years (Appendix G of AEIS). A total of $1,700,000 will therefore be dedicated to achieving long-term protection and management of turtle nesting habitat and recruitment of hatchings into the population to support recovery of the species.

A total of $16,500,000 has/will be invested in on-ground turtle and turtle habitat protection, research and species management associated with pre-clearance surveys, a turtle movement study, turtle passage infrastructure and monitoring, and Species Management Programs. The management and conservation efforts have included $7,400,000 of commitments above those required by Project approval conditions. The additional conservation efforts will mitigate the impacts caused by the Rookwood Weir Project and will substantially contribute to the recovery of the Fitzroy River turtle and white-throated snapping turtle in the Fitzroy River catchment.

It is proposed that the $7,400,000 of on-ground conservation outcomes achieved by the Project above and beyond those required by approval conditions, contributes as partial payment of the $9,470,000 financial contribution required for turtle aquatic habitat. The remaining offset for aquatic habitat is proposed to be delivered through additional on-ground conservation actions for the two turtle species. Actions are expected to include implementation of the Turtle Habitat Enhancement Program: Feral Pest Animal Management Plan, creation of a Turtle Conservation and Management GIS Data Platform, and/or other conservation actions agreed with DCCEEW, up to an amount of $2,100,000. Sunwater will track the actual financial spend on the on-ground turtle conservation and management actions and report to DCCEEW annually to demonstrate delivery of the financial offset requirement.

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1. Introduction

1.1 Overview

Construction and operation of Rookwood Weir (the Project) will result in significant residual impacts to the threatened Fitzroy River turtle (*Rheodytes leukops*) and white-throated snapping turtle (*Elseya albagula*) in relation to inundation of nest sites and the modification of turtle aquatic habitat. As per approval conditions, offsets for impacts to turtle aquatic habitat is proposed to be achieved through the provision of a financial contribution calculated in accordance with the Queensland environmental offsets policy's financial settlement calculator. Approximately 546.5 ha of aquatic habitat occurs within the Rookwood Weir inundation area, with a total financial cost of $9,470,000.

Throughout the Project, Sunwater Limited (Sunwater) has implemented extensive turtle management and conservation actions that have achieved conservation outcomes for the species as a whole and directly offset residual impacts from the Project. The total cost of turtle management and conservation effort undertaken as part of the Rookwood Weir Project is estimated at approximately $20,500,000 (Table 1). This cost includes approximately $1,700,000 dedicated to implementation of Nest Protection Management Plans for the Fitzroy River turtle and white-throated snapping turtle to offset the inundation of turtle nests within the impoundment and downstream of Rookwood Weir. A total of $16,500,000 has/will be invested in on-ground turtle and turtle habitat protection, research and species management associated with pre-clearance surveys, a turtle movement study, turtle passage infrastructure and monitoring, and Species Management Programs (Table 1). It is estimated that the management and conservation efforts have included approximately $7,400,000 of commitments above those required by the Lower Fitzroy River Infrastructure Project (LFRIP) Environmental Impact Statement (EIS) and Addendum to the EIS (AEIS) approval conditions. The additional conservation efforts will mitigate the impacts caused by the Rookwood Weir Project and will substantially contribute to the recovery of the Fitzroy River turtle and white-throated snapping turtle. It is proposed that the $7,400,000 of on-ground conservation outcomes achieved by the Project above and beyond those required by approval conditions, contributes as partial payment of the $9,470,000 financial contribution required for turtle aquatic habitat. The remaining offset for aquatic habitat is proposed to be delivered through additional on-ground conservation actions for the two turtle species. Actions are expected to include implementation of the Turtle Habitat Enhancement Program: Feral Pest Animal Management Plan, creation of a Turtle Conservation and Management GIS Data Platform, and/or other conservation actions agreed with DCCEEW, up to an amount of $2,100,000 (Table 1).

Table 1 Summary of turtle offsets costs

Condition	Base cost estimate	Cost estimate with additional conservation effort	Financial offset contribution
Pre Clearance Surveys	$28,000	$510,000	$480,000
Turtle Movement Study	$740,000	$1,600,000	$860,000
Turtle Passage	$6,800,000	$12,600,000	$5,800,000
Species Management Program	$1,500,000	$1,800,000	$300,000
Sub-total (rounded)	**$9,100,000**	**$16,300,000**	**$7,400,000**
Nest Protection Management Plans	$1,700,000	$1,700,000	$0
Additional On-ground Conservation Actions			
- Turtle Habitat Enhancement Program: Expanded Feral Pest Animal Management Plan	$0	$2,000,000	$2,000,000
- Turtle Conservation and Management GIS Data Platform	$0	$100,000	$100,000
Sub-total (rounded)	**$1,700,000**	**$4,200,000**	**$2,100,000**
Total (rounded)	**$10,800,000**	**$20,500,000**	**$9,500,000**

1.2 Project description

The LFRIP includes construction and operational activities to establish a new weir at Rookwood on the Fitzroy River, Central Queensland. An EIS, including AEIS was approved by the Queensland Government's Coordinator General (CoG) in December 2016 (CoG 2016) and the Federal Minister for Environment in February 2017 (EPBC 2009/5173*)*, subject to conditions.

As a component of the LFRIP, Rookwood Weir (the Project) will be constructed by Sunwater Limited (Sunwater) to satisfy short-to-medium-term water supply. The proposed Rookwood Weir is located at a 'greenfield' site at 265.3 km AMTD on the Fitzroy River, approximately 85 km south-west of Rockhampton.

Rookwood Weir has a central concrete overflow with a smooth formed ogee spillway. The Weir has a deep smooth formed stilling basin that extends the full length of the spillway. The proposed Weir infrastructure will span 320 metres (m) across the river and have an approximate fixed crest of reduced level (RL) 46.2 m Australian Height Datum (AHD), storing approximately 86,000 megalitres (ML). The inundation area extends up to 323.3 km AMTD on the Mackenzie River and 10.3 km AMTD on the Dawson River.

A turtle passage facility in the form of a ramp and pool design is located on the right bank to facilitate upstream and downstream movement of turtles. A fishway complex, consisting of a low and high-level lock is provided for the provision of adequate fish passage.

The Project also includes:

– Replacing the low-level crossing at Riverslea with a new bridge and associated road approaches, upstream of the Weir
– Upgrading the existing low-level causeway at Hanrahan Crossing, downstream of the Weir
– Upgrading the existing low-level causeway at Foleyvale Crossing, upstream of the Weir; and
– Upgrading public roads (State and local) to facilitate construction traffic along Thirsty Creek Road (a local road) from the Capricorn Highway (including the intersection with the State-controlled Road) at Gogango.

1.3 Approval conditions

The Fitzroy River turtle and white-throated snapping turtle are two freshwater turtle species known to occur within the footprint of the Project. The Fitzroy River turtle is listed as vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Queensland *Nature Conservation Act 1992* (NC Act). The white-throated snapping turtle is listed as critically endangered under the EPBC Act and the NC Act.

An EIS (GHD, 2015), including an addendum (AEIS) (GHD, 2017) was approved by the Queensland Government's CoG in December 2016 (CoG, 2016) and the Federal Minister for Environment in February 2017 (EPBC 2009/5173), subject to conditions. At the time of the LFRIP EIS approval, the white-throated snapping turtle was not listed as a threatened species under the EPBC Act. As such, legislative requirements for this species have been specified by the CoG under the NC Act and Queensland *Planning Act 2016*, while requirements for Fitzroy River turtle have been conditioned by the Federal Minister for the Environment under the EPBC Act.

Project approval conditions of relevance to the Fitzroy River turtle and white-throated snapping turtle are provided in Section 3. In summary, the approval conditions required extensive avoidance and management of the two turtle species during Project design, construction and operations.

Unavoidable impacts to the Fitzroy River turtle and white-throated snapping turtle are expected to remain in relation to:

– Inundation of Fitzroy River turtle and white-throated snapping turtle nest sites within the impoundment area and downstream of the Weir
– Modifying 545.6[2] hectares (ha) turtle aquatic habitat.

These residual impacts are considered significant in accordance with the *Matters of National Environmental Significance - Significant impact guidelines 1.1* (DoE, 2013) and *Queensland Environmental Offsets Policy*

[2] Condition 4 states the LFRIP will modify 660 ha of aquatic habitat from Rookwood Weir Stage 2. Rookwood Weir with a Weir crest height of RL 46.2 m AHD inundates 545.6 ha of aquatic habitat for the Fitzroy River turtle.

Significant Residual Impact Guideline (State of Queensland 2014). Table 2 details the approval conditions requiring preparation of an offset strategy and offset management plan.

Table 2 Condition details for the Rookwood Weir offset strategy and offset management plan

<table>
<tr><th>Legislation</th><th>Condition</th><th>Conditions details</th></tr>
<tr><td rowspan="2">Minister for the Environment and Energy: EPBC 2009/5173
Variation dated 27/5/2020</td><td rowspan="2">Condition 4: Offset Strategy</td><td>a) The approval holder must submit for the Minister's written approval a separate Offset Strategy for each weir to be constructed or raised, which identifies the residual impacts arising from the respective weir on the following MNES:
i. Brigalow (Acacia harpophylla dominant and co-dominant) ecological community;
ii. Black Ironbox (Eucalyptus raveretiana);
iii. Red Goshawk (Erythrotriorchis radiates);
iv. Fitzroy River Turtle (Rheodytes leukops);
v. Great Barrier Reef World Heritage Area and National Heritage place.</td></tr>
<tr><td>b) The offset strategy for each weir must propose in general terms the offsets that the approval holder will provide for the residual impacts arising from the construction or raising of the relevant weir, as set out in Table 1, and how the approval holder intends to deliver the offset obligations.
Table 1
<table>
<tr><th>Impact</th><th colspan="2">Indicative Impact Area / Quantity</th></tr>
<tr><td></td><td>Rookwood Weir</td><td>Eden Bann Weir</td></tr>
<tr><td></td><td colspan="2">Listed threatened species and ecological communities</td></tr>
<tr><td>i. inundation of Fitzroy River turtle nest sites within the weir impoundment areas</td><td></td><td></td></tr>
<tr><td>ii. modifying aquatic habitat for the Fitzroy River turtle</td><td>660 ha</td><td>282 ha</td></tr>
<tr><td>iii. loss of red goshawk nesting habitat</td><td>588 ha</td><td>384 ha</td></tr>
<tr><td>iv. loss of the area of black iron box habitat</td><td colspan="2">Impact area to be determined by pre-clearance surveys required under condition 3</td></tr>
<tr><td>v. loss of the area of Brigalow (Acacia harpophylla dominant and co-dominant)</td><td colspan="2">Impact area to be determined by pre-clearance surveys required under condition 3</td></tr>
<tr><td>vi. any increase in nutrients, sediments, farm chemicals and/or other water quality parameters above baseline levels</td><td colspan="2">as determined by the approved Program at condition 1</td></tr>
<tr><td rowspan="2">vii. any increase in nitrogen due to decaying vegetation in the inundation area</td><td>At least 645 tonnes 1,2</td><td>At least 458 tonnes2</td></tr>
<tr><td colspan="2">unless the monitoring required at condition 1b) i. conclusively determines that the impact is less than predicted 1.</td></tr>
</table>
Notes: (1) The indicative areas/quantities will need to be determined based on the particular weir to (first) be constructed or raised. (2) Unless a different impact area is determined by the pre-clearance survey required under condition 3.
c) The offset strategy for each weir must include, but is not limited to:
i. offset outcomes to be achieved, for listed threatened species and ecological communities listed in Table 1;</td></tr>
</table>

Legislation	Condition	Conditions details
		ii. details of how offsets will be provided for modifying Fitzroy River Turtle aquatic habitat (Table 1, item ii.); iii. the timeline and legal mechanism/s for securing the offset area/s and offset outcomes; iv. information about how the offset area/s will provide connectivity with other relevant habitats and biodiversity corridors; v. details of how water quality offsets will be provided consistent with Table 1; vi. inputs and justification for inputs demonstrating that the offsets are likely to be in accordance with the EPBC Act Environmental Offsets Policy and relevant Reef 2050 Plan requirements, including the net benefit principle.
		d) The approval holder must not commence construction or raising of the relevant weir unless the offset strategy for that weir has been approved by the Minister in writing. The approved offset strategy relevant to each weir must be implemented.
Minister for the Environment and Energy: EPBC 2009/5173 Variation dated 27/5/2020	Condition 5: Offset Management Plan	a) The approval holder must submit for the Minister's written approval a separate offset management plan for each weir to be constructed or raised, addressing each offset requirement in condition 4 for any weir for which an offset strategy has been approved by the Minister.
		b) The offset management plan for each weir must be consistent with the approved offset strategy for the relevant weir.
		c) The Offset Management Plan/s must include, but not be limited to: i. the offset area/s to be secured for the listed threatened species and ecological communities listed in Table 1; ii. a description and map to clearly define the location and boundaries of the offset area/s, accompanied by the offset attributes; iii. information about how the offset area/s provide connectivity with other relevant habitats and biodiversity corridors; iv. a description of the management measures (including timing, frequency and duration) that will be implemented in each offset area; v details of how the management measures proposed are consistent with relevant approved conservation advice, recovery plans and threat abatement plans; vi. performance and completion criteria for implementing the offset management plan/s for evaluating its effectiveness, and criteria for triggering corrective action/s; vii. a program for monitoring and reporting on the effectiveness of the management measures, and progress against the performance and completion criteria; viii. a description of potential risks to the successful implementation of the offset/s, and contingency measures that can be implemented to mitigate against these risks; and ix. evidence that the offsets are in accordance with the EPBC Act Environmental Offsets Policy and relevant Reef 2050 Plan requirements including the net benefit principle.
		d) In respect of offsets for impacts to the Fitzroy River turtle (condition 4.b) i. [within Table 1]), the offset management plan for each weir must: i. be in accordance with Appendix G of the additional information to the EIS (AEIS) and the Addendum to the AEIS ii. ensure the effectiveness of the offset in achieving long-term protection and management of Fitzroy River Turtle nesting habitat until the outcomes of the offset management plan are achieved iii. specify the offset delivery mechanism. If the mechanism is through a financial settlement then the financial contribution must be calculated using the Financial Settlement Offset Calculator and offset payments in relation to each weir must be made in full within one year of the completion of each stage of construction or raising of that weir
		e) The approval holder must not begin inundation of the impoundment of a weir unless the Minister has approved in writing an offset management plan for the relevant weir for all offset requirements in the approved offset strategy for that weir. The approved offset management plan for each weir must be implemented.

Legislation	Condition	Conditions details
		f) For the offsets for modifying Fitzroy River turtle aquatic habitat (condition 4. b) ii. [within Table 1]), the approval holder may elect to provide a financial offset in a manner approved by the Minister, as calculated using the Financial Settlement Offset Calculator, or as otherwise agreed by the Minister.
** In accordance with the Rookwood Weir Offset Management Plan (Earthtrade 2022b), offset completion criteria will be obtained and maintained for the period of the EPBC Act approval (i.e. until August 2065).*		

The Rookwood Weir Offset Strategy Version 10 (Earthtrade, 2022a) was approved by the Minister in November 2022. This strategy identified that to achieve the conservation outcome of a reduction in nest predation and increased recruitment of hatchlings into the population, a Fitzroy River Turtle and White-throated Snapping Turtle Nest Protection Management Plan will be implemented as a direct offset for residual impacts to nest inundation. The offset will be in accordance with Appendix G of the AEIS: Offset Proposal for the Fitzroy River Turtle and White-throated Snapping Turtle offset management plan and *Condition Appendix 2. Imposed conditions – Rookwood Weir, Schedule 1 White-throated snapping turtle Part C. Turtle nesting impacts, Condition 5 Nest protection programs*.

As per Condition 5 of the EPBC approval, offsets for impacts to turtle aquatic habitat will be delivered via a financial offset. Like for like offsets for aquatic habitat are not practicable and cannot be achieved for this Project due to the nature of the habitat being offset. As such, offsets for impacts to turtle aquatic habitat is proposed to be achieved through the provision of a financial contribution calculated in accordance with the Queensland environmental offsets policy's financial settlement calculator.

Approximately 546.5 ha of aquatic habitat occurs within the Rookwood Weir inundation area. Table 3 provides the area of aquatic habitat impacted within each local government area, bioregion, and subregion, as required by the Queensland Government's financial offset calculator. In accordance with Appendix G of the AEIS: Offset Proposal for the Fitzroy River Turtle and White-throated Snapping Turtle offset management plan, the terrestrial calculator for the Fitzroy River turtle has been utilised to inform the financial contribution required for the impact area. The total financial cost to offset 545.6 ha of aquatic habitat is $9,470,000.

A summary of the reports and plans relating to the delivery of offsets for the Fitzroy River turtle and white-throated snapping turtle is provided in

Table 4.

Table 3 Aquatic habitat impact area and financial contribution

Local Government Area	Bioregion	Subregion	Area (ha)	Total cost
Central Highlands Regional Council	Brigalow Belt	Boomer Range	40.87	$750,000
		Isaac – Comet Downs	93.33	$1,700,000
Rockhampton Regional Council	Brigalow Belt	Boomer Range	133.33	$2,200,000
		Isaac – Comet Downs	72.78	$1,400,000
		Mount Morgan Ranges	196.14	$3,200,000
Wooranbinda Aboriginal Shire	Brigalow Belt	Isaac- Comet Downs	9.13	$220,000
TOTAL			545.6	$9,470,000

Table 4 Delivery documents relating to turtle offsets

Offset requirement	Delivery documents
Offset strategy	– The Rookwood Weir Offset Strategy Version 10 (RWW-SUN-NNV-SG-0003.I0.FI_v10)
Inundation of Fitzroy River turtle nest sites within the weir impoundment areas	– Fitzroy River Turtle Nest Protection Management Plan (RWW-GHD-ENV-PM-001) – White-throated Snapping Turtle Nest Protection Management Plan (RWW-GHD-ENV-PM-002)
Modifying aquatic habitat for the Fitzroy River turtle	– Turtle Management and Conservation Summary Report (RWW-GHD-ENV-RP-0020) • Turtle Habitat Enhancement Program: Expanded Feral Pest Animal Management Plan (RWP-ETR-ENV-MP-0001) • Turtle Infrastructure Design Process Report (RWW-GHD-ENV-RP-0018) • Construction Species Management Program (41-29978-02-AP-RPT-0008) • Operations Species Management Program (RWW-GHD-ENV-MP-003)

1.4 Purpose of this report

The purpose of this report is to demonstrate how the financial offset for turtle aquatic habitat has/will be delivered through on-ground conservation outcomes for the Fitzroy River turtle and white-throated snapping turtle. Justification is provided for how the conservation outcomes achieved for the Rookwood Weir Project benefit the species as a whole, directly offset residual impacts from the Project, and align with Commonwealth and State management strategies for species recovery (as outlined in Section 2). It is proposed that the conservation and management outcomes achieved by the Project contribute as partial payment of the financial contribution required for turtle aquatic habitat. In addition to the Fitzroy River Turtle and White-throated Snapping Turtle Nest Protection Management Plans (to offset inundation of turtle nests), additional on-ground conservation actions, in the form of Turtle Habitat Enhancement Program: Feral Pest Animal Management Plan, and creation of a Turtle Conservation and Management GIS Data Platform, will be delivered to achieve the remainder of the financial offset.

The key conservation and management actions presented in this report include:

– Preclearance surveys for turtle nesting habitat
– Design and implementation of a Turtle Movement Study
– Design and construction of turtle passage infrastructure and turtle protection design features
– Development and implementation of a Construction Species Management Plan (SMP) and Operations SMP
– Development and implementation of a Fitzroy River Turtle and White-throated Snapping Turtle Nest Protection Management Plan
– Additional on-ground conservation actions - Turtle Habitat Enhancement Program: Feral Pest Animal Management Plan, and creation of a Turtle Conservation and Management GIS Data Platform.

Each conservation and management action includes the following information:

– Conditions – details of the CoG and/or EPBC Act approval condition
– Description – description of the management and conservation actions conducted
– Condition compliance and conservation outcomes achieved – description of how the management and conservation effort has / will contribute to conservation outcomes and how the benefits achieved compares to that required by the approval conditions.

1.5 Scope and limitations

This report: has been prepared by GHD for Sunwater and may only be used and relied on by Sunwater for the purpose agreed between GHD and Sunwater as set out in Section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than Sunwater arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible. The services undertaken

by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Sunwater and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

GHD has prepared the preliminary cost estimates set out in Section 3 and summarised in Appendix A of this report ("Cost Estimate") using information reasonably available to the GHD employee(s) who prepared this report; and based on assumptions and judgments made by GHD.

The Cost Estimate has been prepared for the purpose of summarising turtle management and conservation effort undertaken for the Rookwood Weir Project and must not be used for any other purpose.

The Cost Estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the works/Project can or will be undertaken at a cost which is the same or less than the Cost Estimate.

Where estimates of potential costs are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. The user should therefore select appropriate confidence levels to suit their particular risk profile.

2. Commonwealth and State strategies for species recovery

Research and management actions necessary to stop the decline, and support the recovery, of the Fitzroy River turtle and white-throated snapping turtle in Australia have been identified by the Commonwealth and State Governments in the following documents:

– National Recovery Plan for white-throated snapping turtle (Commonwealth of Australia, 2020; hereafter referred to as Recovery Plan)
– Biology and Management Strategies for Freshwater Turtles in the Fitzroy Catchment, with particular emphasis on the *Rheodytes leukops* and *Elseya albagula* (Limpus *et al*., 2011a; hereafter referred to as Fitzroy Catchment Turtle Management Strategies).

There is currently no recovery plan for the Fitzroy River turtle, however the management actions described in Limpus *et al*. (2011a) indicate that the conservation efforts for white-throated snapping turtle as outlined in the Recovery Plan (Commonwealth of Australia, 2020), are also applicable to the Fitzroy River turtle. The Recovery Plan (Commonwealth of Australia, 2020) identifies the following criteria for success:

– Population structure has been regularly monitored throughout the species' distribution and shows an increasing shift towards a younger population distribution
– Hatching success in the wild population has substantially increased
– The number of juveniles recruiting into the population throughout the turtle's distribution has substantially increased
– Mortality rates of adults/subadults have decreased to a level comparable to natural mortality
– Appropriate measures have been put in place to manage key threats to the species
– Understanding of the biology and ecology of the species, including survivorship and habitat use, has increased.

The Recovery Plan (Commonwealth of Australia, 2020) also describes a range of strategies to ensure turtle populations are self-sustaining in all catchments they occur in and to maximise survival and reproductive success. Indicative costs for implementing priority 1 strategies over a five-year period are provided in Table 5.

Table 5 National Recovery Plan strategies (Commonwealth of Australia 2020)

Strategy	Indicative cost	Detail
1	**$1,600,000**	Strategy 1 aims to substantially improve the recruitment of hatchlings and juveniles in the population. The total indicative cost over five years for research actions in strategy 1 is $700,000 and includes monitoring trends in the population, developing effective predator control and identifying nesting sites in each catchment. The total indicative cost for on-ground management actions in strategy 1 is $900,000 and most of this cost includes protecting nests from predation, trampling and other disturbance in addition to implementing predator control.
2	**$2,100,000**	Strategy 2 is focussed on decreasing adult/subadult mortality and reducing barriers to movement along riverine habitats. The total indicative cost over five years for research and management actions in strategy 2 is $2,100,000 of which $1,800,000 is the indicative cost for designing and constructing new water infrastructure which allows the movement of turtles upstream and downstream with minimal injury and mortality.
3	**$400,000**	Strategy 3 is focussed on improving stream flow and habitat quality throughout the white-throated snapping turtle distribution. The only research action with an indicative cost is that which identifies habitat and movement patterns of the species ($200,000). On-ground actions for restoring and maintaining nesting banks over 200 km of river has an indicative cost of $200,000 over five years.
4	**-**	Strategy 4 is focussed on increasing public awareness and participation in conservation of the species and its habitat. No indicative costs are provided with potential implementation attributed to government departments, traditional land custodians and community groups. It is a completely on-ground action.

Strategy	Indicative cost	Detail
5	**$200,000**	Strategy 5 is focussed on improving the collation and availability of data to inform recovery actions for the species, namely by collating existing information on the species and by maintaining a register of research, monitoring, and management actions.

The Fitzroy Catchment Management Strategies identifies the following criteria for success:

1. Improved recruitment of hatchlings into the population
2. Maintenance of functional turtle nesting banks throughout the catchment
3. Maintenance of stream flow and high quality in-river habitat between impoundments
4. Maintenance of continuity of turtle populations throughout the catchment
5. Reduction in the incidence of death and physical injury of turtles at existing and future impoundment structures
6. Management of recreational fishing and boating activities in impoundments to be compatible with maintenance of sustainable turtle populations and reduce unnecessary injury to turtles
7. Improvement in water quality within the Lower Fitzroy catchment
8. Increase in the area of river and adjacent riverine habitat managed for conservation purposes
9. Increase in stake-holder participation in conservation and management processes
10. Monitoring the response of turtle populations in the Fitzroy Catchment to the management strategies and evaluate the effectiveness of these strategies.

3. Conservation and management actions and outcomes

This section outlines the conservation and management actions and outcomes achieved by Sunwater throughout the Project. Details are provided on the specific CoG and/or EPBC Act approval conditions relevant to each conservation/management action, the management and conservation actions conducted, how the management and conservation effort has / will contribute to conservation outcomes and how the benefits achieved compares to that required by the approval conditions.

The cost of each approval condition is informed by cost estimates within the Project detailed business case at the time of the EIS and/or actual cost estimates for standard requirements. The cost of actual conservation effort achieved for each condition is actual or expected costs incurred by the Project. A description of each estimated and/or actual cost is provided in Appendix A. All costs, including totals, have been rounded based on the confidence levels shown in Table 6. The total cost of annual actions has been calculated over 25 years based on the life of the EPBC Act approval to 2046 and include 10% increase for escalation every 5 years.

Table 6 Confidence level of costs (rounded to nearest)

Cost	Confidence level of cost (rounded to nearest)
Thousand	$100
Ten thousand	$1,000
Hundred thousand	$10,000
Million	$100,000

3.1 Pre-clearance surveys

3.1.1 Conditions

In accordance with EPBC Act Approval Condition 3, pre-clearance surveys for EPBC Act listed threatened species were required to be undertaken within the impact area prior to clearing/inundation of vegetation, as detailed in Table 7.

Table 7 Pre-clearance survey approval conditions

Legislation	Condition	Conditions details
Minister for the Environment and Energy: EPBC 2009/5173	Condition 3: Pre-clearance surveys for threatened species and ecological communities	a) Prior to clearing/inundation of vegetation for each weir that is to be constructed or raised, the approval holder must undertake a preclearance survey and prepare a pre-clearance survey report for the impact area of the relevant weir to identify the extent of EPBC Act listed threatened species and ecological communities.
		b) The pre-clearance survey for each weir must:
		(i) be undertaken in accordance with the Department's survey guidelines in effect at the time of the survey, or another survey methodology agreed by the Department prior to the survey being undertaken
		(ii) be undertaken by a suitably qualified person/s
		(iii) Revoked

Legislation	Condition	Conditions details
		(iv) Revoked
		(v) Revoked
		c) The pre-clearance survey report for each weir must:
		(i) Include details of survey methods utilised and the timing of the survey
		(ii) identify measures to minimise mortality of EPBC Act listed threatened species and impacts on listed threatened ecological communities
		(iii) identify measures to protect EPBC Act listed threatened species and ecological community habitat located adjacent to the cleared/inundated areas
		(iv) for any EPBC Act listed threatened species and ecological communities identified during the survey, provide to the Department precise data on the areas of habitat or ecological community directly and indirectly impacted by the action and a description of proposed management measures to be implemented.
		d) The approval holder must provide the pre-clearance survey report for each weir to be constructed or raised to the Department within 25 business days after the completion of the survey for the respective weir.

3.1.2 Description

As per Condition 3 of the EPBC approval, pre-clearance surveys were required in the impact area prior to clearing/inundation of vegetation. Pre-clearance surveys for turtle nesting activity have been undertaken within the following three areas:

– Rookwood Weir - encompassed a 33 km reach of the Fitzroy River ranging from The Pocket, approximately 16.5 km upstream of the proposed Rookwood Weir location, to Hanrahan's Crossing, approximately 16.5 km downstream.
– Foleyvale Crossing - extended from approximately 7 km upstream to 4 km downstream of Foleyvale Crossing. Foleyvale Crossing is located on the on the Mackenzie River immediately upstream of Rookwood Weir inundation area.
– Tartrus Weir - extended approximately 4 km downstream of Tartrus Weir. Tartrus Weir is located at 429.5 km AMTD on the Mackenzie River, approximately 107 km upstream of the Rookwood Weir inundation area.

In addition to these dedicated broad-scale pre-clearance surveys, targeted turtle nesting surveys have also been conducted at the specific locations of the permanent infrastructure including:

– Rookwood Weir
– Riverslea Crossing
– Foleyvale Crossing
– Hanrahan Crossing.

In each location, potential nesting locations with sand or loam banks were assessed for nesting suitability based on the following parameters:

– Bank height, length and width – Average bank slope: vertical (89 – 90°); steep (60 – 80°); moderate (30 – 60°); low (10 – 30°) and flat (< 10°)
– Average bank composition: percent of cobble/pebble; gravel; coarse sand; fine sand; and silt/clay – Ground cover: none (none); little (1 – 10 %); some (10 – 50 %); moderate (50 – 75 %) and extensive (> 75%)
– Riparian vegetation cover: none (none); little (1 – 10 %); some (10 – 50 %); moderate (50 – 75 %) and extensive (> 75%) – Cattle disturbance: heavy use; light use; tracks/use adjacent; no signs evident in immediate area
– Pig disturbance: heavy use; light use; tracks/use adjacent; no signs evident in immediate area
– Flow level: none (isolated pools); low (< watermark); moderate (= watermark); high (> watermark); flood – Habitats adjacent: deep pool (> 0.5 m); shallow pool (< 0.5 m); run; riffle.

Key features such as evidence of turtle nesting, extent of potential nesting area, extent of riparian vegetation, location of photos etc were also mapped.

Where nesting activity was detected, the following information was recorded:

– GPS location of nest
– Distance of nest from water (m) and height above the water's surface (m)
– Bank slope, ground cover and riparian vegetation cover as per ratings nesting bank characterisation ratings above
– Distance to first egg (m)
– Egg diameter (cm) and egg length (cm)
– Nest predation (yes/no)
– Number of predated eggs observed (if relevant).

In total, 16 targeted and broad-scale pre-clearance surveys for turtle nesting activity have occurred for the Project from 2017 – 2022 (Table 8).

Throughout the duration of the seasonal turtle nesting surveys, 46 sites have been regularly assessed for turtle habitat suitability, with 34 of these found to have confirmed evidence of turtle nesting. During pre-clearance surveys in 2021, 21 intact turtle nests (8.5 % of the 247 nests recorded in 2021) were identified within 24 hours of being laid and nest protection mesh was applied to protect the eggs from predation (Figure 1).

Figure 1 Photos of a turtle egg (left) and a nest site with protection mesh applied (right).

Table 8 Summary of survey effort and costs associated with pre-clearance surveys

Timing	Survey method	Survey location	Survey effort	Target species
2016 - 2017 (3 survey events)	Targeted nesting survey within construction footprints for geotechnical activities	– Rookwood – Riverslea – Foleyvale	7 days with 2 ecologists	Fitzroy River turtle (3x)
June 2019	Broad scale pre-clearance survey	– Upstream Rookwood Weir to The Pocket – Downstream Rookwood Weir to Hanrahan Crossing – Foleyvale Crossing	3 days with 2 ecologists	White-throated snapping turtle
September 2019	Broad scale pre-clearance survey	– Upstream Rookwood Weir to The Pocket – Downstream Rookwood Weir to Hanrahan Crossing – Foleyvale Crossing	3 days with 2 ecologists	Fitzroy River turtle
December 2019	Broad scale pre-clearance survey	– Upstream Rookwood Weir to The Pocket – Downstream Rookwood Weir to Hanrahan Crossing – Foleyvale Crossing	3 days with 2 ecologists	Fitzroy River turtle and white-throated snapping turtle hatching
June 2020	Broad scale pre-clearance survey	– Upstream Rookwood Weir to The Pocket – Downstream Rookwood Weir to Hanrahan Crossing – Foleyvale Crossing	3 days with 2 ecologists	White-throated snapping turtle
August 2020	Targeted nesting survey within construction footprint	Rookwood	2 days with 2 ecologists	Fitzroy River turtle and white-throated snapping turtle
September 2020	Targeted nesting survey within construction footprint	Rookwood	7 days with 1 ecologist	Fitzroy River turtle
October 2020	Broad scale pre-clearance survey	– Upstream Rookwood Weir to The Pocket – Downstream Rookwood Weir to Hanrahan Crossing – Foleyvale Crossing	3 days with 2 ecologists	Fitzroy River turtle
November 2020	Targeted nesting survey within construction footprint	Rookwood	2 days with 1 ecologist	Fitzroy River turtle
December 2020	Broad scale pre-clearance survey	– Upstream Rookwood Weir to The Pocket – Downstream Rookwood Weir to Hanrahan Crossing – Foleyvale Crossing – Tartrus Weir	5 days with 2 ecologists	Fitzroy River turtle and white-throated snapping turtle hatching

Timing	Survey method	Survey location	Survey effort	Target species
April 2021	Broad scale pre-clearance survey	– Upstream Rookwood Weir to The Pocket – Downstream Rookwood Weir to Hanrahan Crossing	2 days with 2 ecologists	White-throated snapping turtle
June 2021	Broad scale pre-clearance survey + targeted survey at Hanrahan Crossing	– Upstream Rookwood Weir to The Pocket – Downstream Rookwood Weir to Hanrahan Crossing – Tartrus Weir – Rookwood Weir upper Inundation area	7 days with 2 ecologists	White-throated snapping turtle
July 2021	Broad scale pre-clearance survey	– Upstream Rookwood Weir to The Pocket – Downstream Rookwood Weir to Hanrahan Crossing – Foleyvale Crossing – Tartrus Weir – Rookwood Weir upper Inundation area	7 days with 2 ecologists	White-throated snapping turtle
August 2021	Broad scale pre-clearance survey	– Upstream Rookwood Weir to The Pocket – Downstream Rookwood Weir to Hanrahan Crossing – Foleyvale Crossing – Tartrus Weir – Rookwood Weir upper Inundation area	8 days with 2 ecologists	Fitzroy River turtle
October 2021	Broad scale pre-clearance survey	– Upstream Rookwood Weir to The Pocket – Downstream Rookwood Weir to Hanrahan Crossing – Foleyvale Crossing – Tartrus Weir – Rookwood Weir upper Inundation area	7 days with 2 ecologists	Fitzroy River turtle
Total: 17 survey events	Six targeted nesting surveys 11 broad scale nesting surveys	Survey area extended from 18 km downstream of Rookwood Weir to 65 km upstream and 4 km downstream of Tartus Weir	129 days survey effort	– Twelve Fitzroy River turtle surveys – Eight white-throated snapping turtle surveys

3.1.3 Condition compliance and conservation outcome

Pre-clearance surveys are typically undertaken once within a direct impact area immediately prior to construction. The pre-clearance surveys undertaken for turtle nesting were conducted over 16 survey events spanning six years. The surveys were conducted over an extended area including within, upstream and downstream of Rookwood Weir and targeted both the Fitzroy River turtle and white-throated snapping turtle. These pre-clearance surveys have improved knowledge of nesting ecology in the two threatened species (e.g. timing of nesting, nesting habitat conditions), threatening processes and nesting success) and have identified important habitat and habitat

critical to the survival of these species. These conservation outcomes align with management Strategies 1 and 5 of the Recovery Plan (Commonwealth of Australia, 2020, refer to Section 2) and Success Criteria 1 and 10 of the Fitzroy Catchment Turtle Management Strategies (Limpus *et al*., 2011a; refer to Section 2). Entering year-six, the contribution of the pre-clearance surveys to knowledge on the species' is evidenced in the gathering, maintenance and reporting of population' data, mapping of important habitat areas and the identification of the extent and nature of threats to local nests and hatchlings. Table 9 compares the conservation effort and costs of the actual pre-clearance surveys implemented to those required by the approval conditions. In total, it is estimated that an additional $480,000 of pre-clearance surveys have been undertaken to achieve conservation outcomes. Refer to Appendix A for additional detail on cost estimates.

Table 9 ***Pre-clearance survey condition compliance and contribution to species conservation – approximate cost estimate and actual costs (grey)***

Condition	Base case cost estimate	Actual conservation effort	Actual cost
Pre-clearance survey for Fitzroy River turtle within impact area prior to clearing of vegetation/inundation	$28,000 (actual cost of one nesting survey event within inundation area)	16 x pre-clearance surveys for Fitzroy River turtle and white-throated snapping turtle within, upstream and downstream of the inundation area (actual cost)	
		2016 – 2017 (3 events)	$43,000
		June 2019	$28,000
		September 2019	$28,000
		December 2019	$28,000
		June 2020	$28,000
		August 2020	$20,000
		September 2020	$28,000
		October 2020	$28,000
		November	$13,000
		December 2020	$39,000
		April 2021	$25,000
		June 2021	$48,000
		July 2021	$48,000
		August 2021	$53,000
		October 2021	$48,000
Total (rounded)	**$28,000**		**$510,000**
Additional conservation effort (rounded)			**$480,000**

3.2 Turtle Movement Study

3.2.1 Conditions

In accordance with EPBC Act Approval Condition 7 and CoG Appendix 2, Schedule 1, Part B Condition 2, a Turtle Movement Study was required to be undertaken during the Project design phase to collect baseline data on turtle movement patterns and home range size. The turtle movement study was also required to inform the development of criteria for demonstrating successful movement of turtles around the weir. The approval conditions relating to the Turtle Movement Study are detailed in Table 10.

Table 10 Turtle Movement Study approval conditions

Legislation	Condition	Conditions details
Minister for the Environment and Energy: EPBC 2009/5173	Condition 7: Turtle passage infrastructure	b) Before finalising the design of turtle passage infrastructure for each weir (condition 7), the approval holder must undertake a turtle movement study for the relevant weir (Study), in accordance with the AEIS and Addendum to the AEIS, to collect baseline data for relevant sections of the Fitzroy River.
		c) The Study for each weir must:
		i. be prepared and undertaken by a suitably qualified person in accordance with a methodology determined in consultation with DES
		ii. collect data on seasonal movement patterns and home ranges of the Fitzroy River turtle. The study must include wet and dry season movements, breeding periods and nesting distribution; and
		iii. inform the development of criteria for demonstrating successful movement of Fitzroy River turtles around the relevant weir (success criteria).
LFRIP CoG Evaluation Report on the EIS December 2016	Appendix 2. Imposed conditions – Rookwood Weir. Schedule 1: White-throated snapping turtle. Part B. Condition 2. Turtle Movement Study	(a) Prior to finalisation of the design for the turtle passage infrastructure, undertake a Turtle Movement Study to collect baseline data for sections of the Fitzroy River, at locations approved by DEHP (DES).
		(b) The Turtle Movement Study must:
		i. collect data on seasonal movement patterns and home ranges of the white-throated snapping turtle. The study should include wet and dry season movements, breeding periods and nesting distribution
		ii. be prepared and undertaken by a suitably qualified person in accordance with a methodology agreed in writing by DEHP (now DES)
		iii. inform the development of the criteria for monitoring the success of turtle movement around the weir (the turtle movement success criteria) based on the data collected during the Turtle Movement Study.
		(c) The methodology for the study must be submitted DEHP (DES) for approval, 90 days prior to commencing the Turtle Movement Study, or as otherwise agreed with DEHP (DES).
		(d) The turtle movement success criteria must be approved by DEHP (DES), in writing, prior to the construction of turtle passage infrastructure at the weir site.

3.2.2 Description

The design of the Turtle Movement Study was developed in consultation with Dr Col Limpus, Chief Scientist Threatened Species Unit, DES (formally, Department of Environment and Heritage Protection (DEHP)). This consultation involved face to face meetings, expert advice and review of the draft Turtle Movement Study design report. Formal approval of the Turtle Movement Study design was granted in writing by the A/Program Coordinator (Wildlife Assessments) on 21 April 2017.

The purpose of the Turtle Movement Study was to improve baseline knowledge on the movement of the Fitzroy River turtle and white-throated snapping turtle and inform design and operational requirements of Rookwood Weir. Specifically, the aims of the Turtle Movement Study were to:

– Aim 1 - Improve current knowledge of Fitzroy River turtle and white-throated snapping turtle movement patterns, home range and seasonal variations through monitoring and tracking
– Aim 2 - Inform the requirements of turtle passage at Project locations, as applicable and through adaptive management
– Aim 3 - Inform the development of quantifiable performance criteria to measure the effectiveness of turtle passage once operational.

The specific objectives selected to improve current knowledge of Fitzroy River turtle and white-throated snapping turtle movement patterns, home range and seasonal variations through monitoring and tracking, included:

– Determining the home range size of adult male and female turtles
– Determining habitat use and movement behaviour of adult male and female turtles within their home range
– Determining seasonal variations in home range size, habitat use and movement behaviours of adult male and female turtles during dry (April - September) and wet seasons (October - March)
– Identifying movement behaviour of breeding males and nesting females (including timing of movement, distance travelled, direction of movement, location of breeding/nesting)
– Investigating flow-initiated movement behaviour (i.e. flooding conditions) of adult male and female turtles
– Investigating the environmental and/or ecological triggers for movement of adult male and female turtles
– Determining the home range size, habitat use and movement behaviour of hatchling and juvenile turtles
– Determining seasonal variations in home range size, habitat use and movement behaviours of hatchling and juvenile turtles during dry (April – September) and wet seasons (October - March)
– Determining the dispersal behaviour of hatchling and juvenile turtles
– Investigating the environmental and/or ecological triggers for movement of hatchling and juvenile turtles.

The Turtle Movement Study was initially planned to be undertaken over 18 months during the Project design phase prior to commencement of construction, as per the Turtle Movement Study Design Report (GHD, 2017), approved by DES. The Turtle Movement Study was extended to collect baseline data on turtle movement behaviour for four years prior to construction and three years during construction (total seven years implementation to date (2017 – 2023)). The Turtle Movement Study is the largest freshwater turtle tracking study of its kind in Australia and Internationally. To date, the Turtle Movement Study has captured a total of 89 Fitzroy River turtles and 107 white-throated snapping turtles.

Turtle capture surveys were conducted over multiple seasons (wet and dry), years and survey conditions. The specific locations of the turtle capture surveys within the survey area were selected based on the diversity and location of habitat types (i.e. pools, riffles, runs, creeks, floodplains, potential nesting banks), turtle population size/capture success and access. Fitzroy River turtles and white-throated snapping turtles captured during the field survey events were measured and tagged in accordance with standard DES procedures. Mark-recapture identification tags included passive integrated transponder (PIT) tags and monel foot tags. Turtles were also carapace notched. These mark-recapture measures allowed for the identification of individuals to facilitate the long-term monitoring of the turtle population throughout the catchment over the life of the Project.

Turtles captured during the Turtle Movement Study were also tagged with acoustic transmitters (V13 Vemco Amirix Systems Ltd, NS, Canada) (Figure 2). The original Turtle Movement Study survey area encompassed 23 underwater receivers/hydrophones (VR2-W Vemco Amirix Systems Ltd, NS, Canada hydrophones (acoustic recording stations) within a 33 km reach of the Fitzroy River ranging from The Pocket, approximately 17 km upstream of the proposed Rookwood Weir location, to approximately 1.9 km downstream of Hanrahan Crossing, for a total of approximately 18 km downstream of Rookwood Weir (Figure 3). An additional five hydrophones have been added to the survey area over time to improve survey coverage and capture finer-scale movement behaviours of the two species. The purpose of the receivers was to continuously detect and log the acoustic pulses from the acoustic transmitters attached to the turtles.

The use of GPS satellite tags (SPLASH10-BF-351) was also trialled during the Turtle Movement Study to assess suitability for freshwater turtle species and their effectiveness to record turtle movement within the river channel, creeks, floodplain and over land (Figure 4). Mark-recapture, acoustic and satellite data was analysed to inform home range and dispersal, season movement behaviours and breeding and nesting migrations.

Between 22 April 2017 and 22 January 2022, 11,180,043 detections were obtained on acoustic receivers from turtles tagged with acoustic transmitters. Two adult female white-throated snapping turtles were also tracked by GPS satellite telemetry for 510 and 586 days.

The results of the Turtle Movement Study are available within the Rookwood Weir Turtle Movement Study Annual Technical Reports (GHD, 2020, 2021 and 2022).

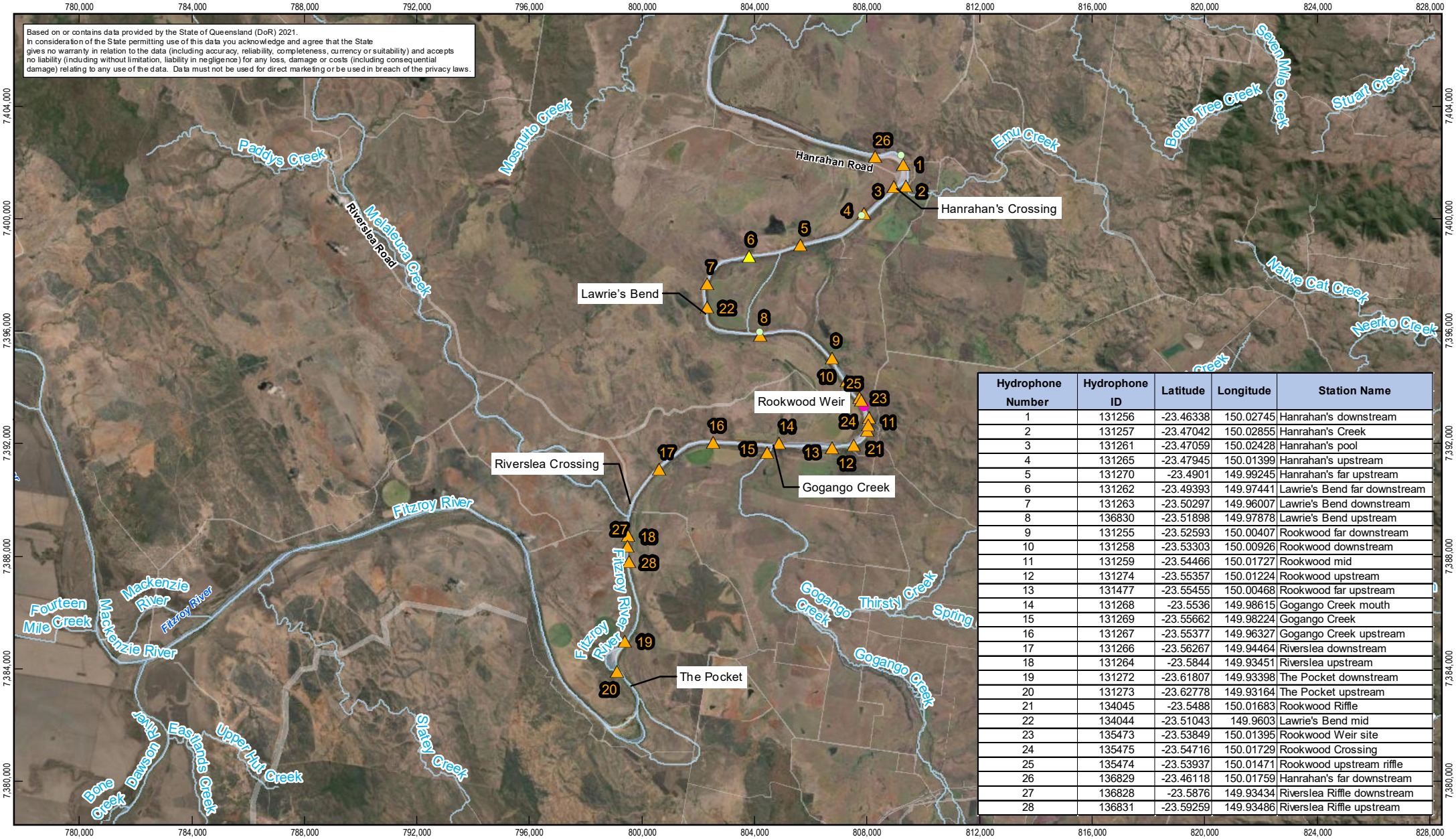
These results contribute significantly to achieving the objectives identified in the Recovery Plan (Commonwealth of Australia, 2020) and Fitzroy Catchment Turtle Management Strategies (Limpus *et al*., 2011a), by improving

knowledge on the movement ecology and biology of the two turtle species. The baseline knowledge of turtle movement behaviour that has been developed through implementation of the Turtle Movement Study, has directly informed the design criteria for the turtle passage infrastructure and development of quantifiable success criteria at Rookwood Weir. Through this process, the Turtle Movement Study has facilitated the development of an ecologically sustainable design for safe upstream and downstream movement of turtles at Rookwood Weir. The provision of safe turtle passage directly aligns with Strategy 2 of the Recovery Plan (Commonwealth of Australia, 2020) and success criteria of the Fitzroy Catchment Turtle Management Strategies (Limpus *et al*., 2011a). Specifically, the Success Criteria against which monitoring results will be assessed are:

1. 75% of white-throated snapping turtle and Fitzroy River turtles that attempt to use the turtle passage each year for upstream passage will do so successfully
2. Turtle monitoring downstream of the weir demonstrates no turtle injury/mortality during downstream turtle passage over the spillway, as evidence by impact damage to turtles
3. The turtle passage remains operational (attraction flow is provided and passage unobstructed) continuously when the storage is above 8000 ML up to a 1 in 5-year spilling event
4. The turtle passage operates for one week after each four weeks of non-operation when the storage is below 8000 ML
5. 75% of adult white-throated snapping turtle and Fitzroy River turtle recorded within 50 m of the turtle ramp and fishway entrances within a 12-month period, are attracted to and can successfully locate the turtle passage entrance (as defined as entering the funnel shaped ramp)
6. 75% of adult white-throated snapping turtle and Fitzroy River turtle that attempt to use the ramp within a 12-month period can successfully ascend the ramp and pool arrangement to reach the abutment throughfare
7. 75% of adult white-throated snapping turtle and Fitzroy River turtle that attempt to use the ramp within a 12-month period can successfully move through the abutment throughfare
8. 75% of adult white-throated snapping turtle and Fitzroy River turtle that attempt to use the ramp can successfully descend the turtle ramp from the abutment throughfare into the impoundment to complete passage past the weir
9. Turtle monitoring demonstrates no predation of turtles from within the turtle passage infrastructure
10. Turtle monitoring demonstrates no turtle injury and/or mortality from within the turtle passage as a result of falls
11. The ratio of adult male and female white-throated snapping turtle and Fitzroy River turtle successfully moving upstream through the turtle ramp within a 12-month period is equivalent to pre-development ratios of turtles moving outside their home range
12. Seasonal variation in use of the turtle ramp by adult male and female white-throated snapping turtle and Fitzroy River turtle is equivalent to pre-development seasonal trends over a 12-month period
13. Measurement of the turtle ramp attraction flow during inspections and turtle capture monitoring events indicates that the depth of water flow on the upstream ramp remains suitable for turtles to climb as per annual depth criteria
14. Over a 12-month period, habitat conditions within the resting pools remain suitable for adult white-throated snapping turtle and Fitzroy River turtle as evidenced by achievement of suitable pool depth criteria, compliance with water quality objectives and long-term availability of shelters
15. Annual monitoring downstream of the weir trash screens and inlets indicates no entrapment or drowning of white-throated snapping turtle or Fitzroy River turtle
16. Monitoring of the fishway over a 12-month period indicates no injury/mortality of white-throated snapping turtle or Fitzroy River turtle within the fishway complex
17. At least 20 adult Fitzroy River turtle and white-throated snapping turtle recorded attempting to use the turtle passage within a 12-month period.

In accordance with approval conditions, these success criteria were developed in consultation with Dr Col Limpus (DES) and have been approved by DES and DCCEEW (the Minister for Environment).

Figure 2 *Fitzroy River turtle (top) and white-throated snapping turtle (bottom) with acoustic tags attached to carapace*



Hydrophone Number	Hydrophone ID	Latitude	Longitude	Station Name
1	131256	-23.46338	150.02745	Hanrahan's downstream
2	131257	-23.47042	150.02855	Hanrahan's Creek
3	131261	-23.47059	150.02428	Hanrahan's pool
4	131265	-23.47945	150.01399	Hanrahan's upstream
5	131270	-23.4901	149.99245	Hanrahan's far upstream
6	131262	-23.49393	149.97441	Lawrie's Bend far downstream
7	131263	-23.50297	149.96007	Lawrie's Bend downstream
8	136830	-23.51898	149.97878	Lawrie's Bend upstream
9	131255	-23.52593	150.00407	Rookwood far downstream
10	131258	-23.53303	150.00926	Rookwood downstream
11	131259	-23.54466	150.01727	Rookwood mid
12	131274	-23.55357	150.01224	Rookwood upstream
13	131477	-23.55455	150.00468	Rookwood far upstream
14	131268	-23.5536	149.98615	Gogango Creek mouth
15	131269	-23.55662	149.98224	Gogango Creek
16	131267	-23.55377	149.96327	Gogango Creek upstream
17	131266	-23.56267	149.94464	Riverslea downstream
18	131264	-23.5844	149.93451	Riverslea upstream
19	131272	-23.61807	149.93398	The Pocket downstream
20	131273	-23.62778	149.93164	The Pocket upstream
21	134045	-23.5488	150.01683	Rookwood Riffle
22	134044	-23.51043	149.9603	Lawrie's Bend mid
23	135473	-23.53849	150.01395	Rookwood Weir site
24	135475	-23.54716	150.01729	Rookwood Crossing
25	135474	-23.53937	150.01471	Rookwood upstream riffle
26	136829	-23.46118	150.01759	Hanrahan's far downstream
27	136828	-23.5876	149.93434	Riverslea Riffle downstream
28	136831	-23.59259	149.93486	Riverslea Riffle upstream

1:180,000 (at A4)
0 2,000 4,000
Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Hydrophone locations
- Old Hydrophone Location
- Hydrophone temporarily removed
- Weir Loation
- Watercourse
- Road Reserve
- Watercourse Reserve

GHD

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Sunwater
Rookwood Weir Project

Job Number 41-29978
Revision 5
Date 17 May 2021

Acoustic receiver/ hydrophone locations

Figure 3

\ghdnet\ghd\AU\Brisbane\Projects\41\29978\GIS\Maps\MXD\41-29978_105_Turtle_HydrophoneLocations_Rev5.mxd

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Imagery Souce: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community Data Source: GHD: Hydrophone Locations (2021), Hydrophone Locations (2018); DoR: Reserve, Road (2016), Watercourse (2014); Created by: AJ

Figure 4 ***Attachment of SPLASH10 GPS satellite tag and Vemco V13tp acoustic transmitter on an adult female white-throated snapping turtle***

3.2.3 Condition compliance and conservation outcome

To date, Sunwater has invested approximately $1.6 million on tracking the movement behaviour of turtles. The Turtle Movement Study is the largest freshwater turtle tracking project both Nationally and Internationally. The results of the study have not only improved the knowledge of movement behaviour for Fitzroy River turtle and white-throated snapping turtle, but also contributed to broader knowledge on freshwater turtle ecology. The Turtle Movement Study has identified timing of Fitzroy River turtle and white-throated snapping turtle movement, variation in home range and distance travelled, sex-related differences in space use, age-related differences in space use, depth preference, temperature variability, nesting success and distribution and identified important habitat areas.

Prior to the implementation of the Turtle Movement Study, knowledge of movement behaviour in the Fitzroy River turtle and white-throated snapping turtle was extremely limited. Movement behaviour of the Fitzroy River turtle was based on two small radio-tracking studies by Tucker *et al*. 2001 and Gordos *et al*. 2003. These studies tagged 10 and 30 turtles and monitored their movement over 0.5-12 months and four one-month periods, respectively. Similarly, knowledge of movement behaviour of the white-throated snapping turtle was based on radio tracking studies by Hamman *et al*. 2007 and more recently, a small acoustic tracking projects by Micheli-Campbell *et al.* 2017. The acoustic tracking project on the white-throated snapping turtle involved tagging of five female white-throated snapping turtles and monitoring of movement behaviour over a distance of 5.5 kms within the Mary River over 12 months.

The Turtle Movement Study was required by approval conditions to be conducted for 18 months during the Project design phase. However, the study was extended to collect baseline data over a four-year period and construction phase data over an additional three- year period (seven years total). During the baseline design phase, it was expected, as per the Turtle Movement Study Design Report approved by DES, that 20 adult males and 20 adult females of each turtle species (Fitzroy River turtle and white-throated snapping turtle) would be tagged with acoustic tags. The number of turtles tagged during the four-year baseline design phase (2017-2020) was also expanded to the following totals for each species:

– 28 adult male Fitzroy River turtles
– 26 adult female Fitzroy River turtles
– Four juvenile Fitzroy River turtles
– 29 adult male white-throated snapping turtles
– 24 adult female white-throated snapping turtles
– Four juvenile white-throated snapping turtles.

Additional turtle tagged with acoustic tags and tracked during the three-year construction phase included:

– 12 adult female Fitzroy River turtles
– Four juvenile Fitzroy River turtles
– 12 adult male white-throated snapping turtles
– Six adult female white-throated snapping turtles.

In the Turtle Movement Study Design Report approved by DES, 20 hydrophones were initially proposed (GHD, 2017). Eight additional hydrophones were installed throughout the study area to improve survey coverage and collected data on finer scale movement behaviour of the two turtle species. Two satellite tags were also trailed during the study and data collected for up to 586 days.

The duration of the study, the survey area over which turtle movement behaviour has been recorded and number of acoustic tags deployed on two turtle species has made the Rookwood Weir Turtle Movement Study the largest freshwater turtle tracking project ever conducted both within Australia and Internationally. The conservation outcome of improved knowledge of species ecology and behaviour align with management Strategies 2, 3 and 5 of the Recovery Plan (Commonwealth of Australia, 2020 refer to Section 2) and Success Criteria 4 of the Fitzroy Catchment Turtle Management Strategies (Limpus *et al*., 2011a, refer to Section 2). Table 11 below compares the conservation effort and costs of the actual Turtle Movement Study implemented to that required by the approval conditions. In total, it is estimated that an additional $860,000 of conservation effort has been undertaken to achieve conservation outcomes. Refer to Appendix A for additional detail on cost estimates.

Table 11 *Turtle Movement Study condition compliance and contribution to species conservation – approximate cost estimate and actual costs (grey)*

Conditions	Base case cost estimate	Actual conservation effort	Actual cost
Design of turtle movement study in consultation with DES	$33,000 (business case estimate)	Design of turtle movement study in consultation with DES	$28,000 (actual cost)
Turtle movement study conducted for 18 months during the Project design phase	$560,000 (business case estimate)	Turtle movement study conducted for four years during the Project design phase and three years during Project construction	$1,400,000 (actual cost design phase, cost estimate construction phase)
80 acoustic tags to be deployed during the Project design phase (20 each per male and female of each species)	$88,000 (actual cost)	A total of 115 acoustic tags deployed over the Project design phase	$130,000 (actual cost)
		Trial of two satellite tags over 586 days	$11,000 (actual cost)
20 acoustic hydrophone receivers (with attachment cable) to be deployed during the Project planning and design phase	$60,000 (actual cost)	A total of 28 acoustic hydrophone receivers deployed during the Project planning and design phase	$84,000 (actual cost)
Consultation with DES on design and development of success criteria	Refer to Table 15	Extensive consultation with DES over four years and preparation of Turtle Infrastructure Design Process Report	Refer to Table 15
Total (rounded)	**$740,000**		**$1,600,000**
Additional conservation effort (rounded)			**$860,000**

3.3 Turtle Passage

3.3.1 Conditions

In accordance with EPBC Act Approval Condition 7 and CoG Appendix 2, Schedule 1, Part B Condition 3, turtle passage infrastructure was required to be designed, constructed, and monitored to provide safe upstream and downstream movement of turtles past Rookwood Weir. The approval conditions relating to turtle passage infrastructure are detailed in Table 12.

Table 12 *Turtle passage infrastructure approval conditions*

Legislation	Condition	Conditions details
Minister for the Environment and Energy: EPBC 2009/5173	Condition 7: Turtle passage infrastructure	a) At each weir to be constructed or raised, the approval holder must:
		i. construct turtle passage infrastructure (suitable for the Fitzroy River turtle) before the commencement of operation of the relevant weir
		ii. construct turtle passage infrastructure at the relevant weir site in accordance with a design informed by the turtle movement study (at conditions 7b) and 7c));
		iii. ensure turtle passage infrastructure and weir design and operation minimise the incidence of turtle injury.
		iv. monitor the effectiveness of the turtle passage infrastructure against the success criteria approved by the Minister (at conditions 7c) iii. and 7d)) twelve months after the construction of the relevant weir; and
		d) The approval holder must not commence the construction of turtle passage infrastructure at the Eden Bann or Rookwood Weir sites unless the success criteria for the relevant weir have been approved by the

Legislation	Condition	Conditions details
		Minister. The approval holder must provide written advice to the Minister on how DES's advice has been addressed for each weir prior to submitting the success criteria for approval.
		e) The turtle passage infrastructure design and success criteria approved under condition 7d) must be applied to the Eden Bann Weir or Rookwood Weir, as relevant.
		f) The monitoring and reporting of the effectiveness of the turtle passage infrastructure (condition 7a) iv.) must be undertaken by a suitably qualified person and externally peer reviewed.
		g) If the monitoring specified by conditions 7a) iv. and 7a) v. fails to demonstrate that the success criteria are being met, the turtle passage infrastructure must be modified in accordance with advice provided by DES with the aim of achieving the success criteria.
		h) The approval holder must maintain the operation of the turtle passage infrastructure while the relevant weir remains in operation and provide for the safe access by officers of DES and the Department to the weir infrastructure (including the turtle passage) for monitoring and compliance purposes.
		i) If the monitoring specified by condition 7a) iv. demonstrates that the success criteria are not being met, the approval holder must implement an ongoing catch and release program for the Fitzroy River turtle until the criteria are met.
		j) The catch and release program must ensure complete, safe turtle passage upstream and downstream of the relevant weir site.
		k) The catch and release program must be prepared and implemented by a suitably qualified person in accordance with a methodology determined in consultation with DES.
LFRIP CoG Evaluation Report on the EIS December 2016	Appendix 2. Imposed conditions – Rookwood Weir. Schedule 1: White-throated snapping turtle. Part B Condition 3. Turtle passage infrastructure	a) Turtle passage infrastructure must be built prior to the commencement of operation of each stage of the weir.
		b) Construct turtle passage infrastructure at the weir site in accordance with a design informed by the Turtle Movement Study and approved by DEHP (DES)
		c) Ensure turtle passage infrastructure and weir design and operation minimises the incidence of turtle injury or mortality.
		d) Monitor the effectiveness of the turtle passage infrastructure against the success criteria approved in accordance with Condition 2(d) (which states the turtle movement success criteria must be approved by DEHP (DES), in writing, prior to the construction of turtle passage infrastructure at the weir site.)
		e) Report to DEHP (DES) on the effectiveness of the turtle passage infrastructure in relation to the turtle movement success criteria twelve months after the construction of the relevant stage of the weir and annually thereafter.
		(f) The monitoring methodology and reporting of the effectiveness of the turtle passage infrastructure must be externally peer reviewed and undertaken by a suitably qualified person.
		g) If monitoring evidence indicates that the turtle movement success criteria are not being met, the turtle passage infrastructure is to be modified to achieve the success criteria.
		h) Maintain the operation of the turtle passage infrastructure while the weir remains in operation and provide for safe access to the weir infrastructure (including the turtle passage) for monitoring and compliance purposes.
LFRIP CoG Evaluation Report on the	Appendix 2. Imposed conditions – Rookwood Weir.	a) Should the monitoring specified by Condition 3(d) and Condition 3(g) provide evidence that turtle movement success criteria are not being met, implement an ongoing catch and release program until the criteria are met.

Legislation	Condition	Conditions details
EIS December 2016	Schedule 1: White-throated snapping turtle. Part B Condition 4. Turtle movement contingency program	b) The catch and release program must ensure turtle passage upstream and downstream of the weir site.
		c) The catch and release program must be prepared and implemented by a suitably qualified person in accordance with a methodology agreed by DEHP (DES).

3.3.2 Description

The Rookwood Weir provides for movement of turtles upstream and downstream of the Weir through the construction and operation of turtle passage infrastructure in the form of a ramp (Figure 5).

The turtle passage infrastructure at Rookwood Weir consists of a 172 m long by 2 m wide sloped turtle ramp with resting pools every 15 m. The entry and exit points of the turtle passage are located at the river margins where turtles can access them during low velocity conditions. A widened (6 m) funnel entrance/exit is provided both upstream and downstream to increase the area over which turtles can access the turtle passage at minimum headwater and tailwater conditions. The downstream entrance is immediately adjacent to the low flow outlet and fishway.

The ramp varies in slope up to a maximum of 45 degrees and is textured with exposed aggregate (5 mm greencut) to create a roughened surface for the turtles to grip. The entry and exits into each resting pool are sloped for easy turtle access. Resting pool shelters provide shade and protection within each resting pool.

The sides of the ramp and pools are at least 0.5 m above water level and angled inward to prevent turtles falling over the edges. A smooth finish (anti-graffiti paint) is also provided on the top of the ramp sides to prevent turtles climbing onto unsafe locations.

The turtle passage is required to pass through the right abutment to minimise the length of the ramp and comply with dam safety requirements. The abutment throughfare has been positioned as close to the surface as possible and a mesh grid roof provided to maximise natural light and provide an open view to the sky.

A small attraction flow will be provided down the ramp and permanent water contained within the resting pools. The turtle passage will be constructed from reinforced concrete to increase durability and minimise ongoing repair/maintenance. Stairs, handrails and trap attachment points are provided to facilitate access and turtle monitoring. Passive Integrated Transponder (PIT) tag readers are included at the entrance, middle and exit of the turtle passage to facilitate turtle monitoring.

The turtle passage has been designed to allow for future adjustments in operation or design if required. The turtle passage infrastructure will be operated and maintained for the life of the Project.

The structural components of Rookwood Weir and the turtle passage infrastructure have also been designed to avoid/minimise risk of turtle injury and mortality, thereby restoring safe turtle passage. The turtle protection design features that have been incorporated into the Rookwood Weir and turtle passage infrastructure are detailed in Table 13. A risk assessment was undertaken to identify potential risks of turtle injury and mortality with avoidance and mitigation measures developed in accordance with As Low As Reasonably Practical (ALARP) risk management framework. With the implementation of turtle protection design features into the Weir and turtle passage design, the likelihood of risks occurring have all been reduced to unlikely or rare (GHD, 2021a).

Table 13 Turtle protection design features

Design components
A fixed crest Conventional Vibrated Concrete (CVC) ogee spillway to provide a smooth formed surface finish at the crest of the weir in the spillway section
Stilling basin that extends across the full length of the spillway to prevent turtles being projected against hard concrete during spilling events
Type 1 stilling basin without baffles or dissipator teeth to avoid turtles contacting hard structures
A smooth stilling basin floor with a 45-degree sloped end sill below lowest tailwater to allow turtles to move freely between the stilling basin and downstream approach channel
Computational fluid dynamics modelling of turbulence conditions in the stilling basin has been undertaken to provide hydraulic flow paths that allow turtles to escape extreme turbulence locations
A minimum tailwater depth of 2 m is provided during non-spilling conditions to provide sufficient water depth for downstream turtle passage at commence of spilling and during non-spilling conditions
Trash and inlet screens are provided to prevent turtles entering the outlet works from the impoundment
The inlet screens for the outlets are designed to prevent turtles being trapped by high water pressures on the upstream side of the outlet works. The outlet screens are inclined at 45 degrees to the flow channel. Screen openings are 20 mm with a maximum water velocity through the screen of approximately 0.3 m/s. The 0.3 m/s velocity occurs at a maximum discharge of 15 m^3/s through the outlet, which will occur infrequently. There is no discharge / flow through the outlet screens during spilling conditions.
500 mm wide fishway attraction slots are designed to allow turtle access to the fishway lock chambers and prevent turtles getting stuck in the slots
Lock chambers are designed to minimise turbulence conditions within the chambers and avoid injury of turtles
Diffusers are included within the lock chambers to present turtle access to outlets and provide safe hydraulic conditions during attraction flow release
Height of low flow outlet weir (>6 m) is designed to prevent turtle access during non-spilling conditions
Side-winder gate included in low flow outlet to allow turtles to exit the area following elevated tailwater
Selector bulks used to select the draw off level for water quality control in discharges
Actuators exposed to the environment feature leakage chambers attached to a leakage drain line for collection to prevent contamination of oil to the waterway in the event of actuator leak
Shelters are positioned within all resting pools to provide protection to turtles along the turtle passage
Turtle passage ramp and pools contain 0.5 m high inward sloping walls and smooth surfaces (anti-graffiti paint) to prevent turtles falling or climbing unsafe locations
Turtle passage infrastructure is textured with exposed aggregate (5 mm) to create a roughened surface for the turtles to grip and minimise risk of falls
Constant water supply provided within the turtle passage infrastructure to maintain water quality conditions within resting pools
Access to weir infrastructure for monitoring of turtle populations is facilitated

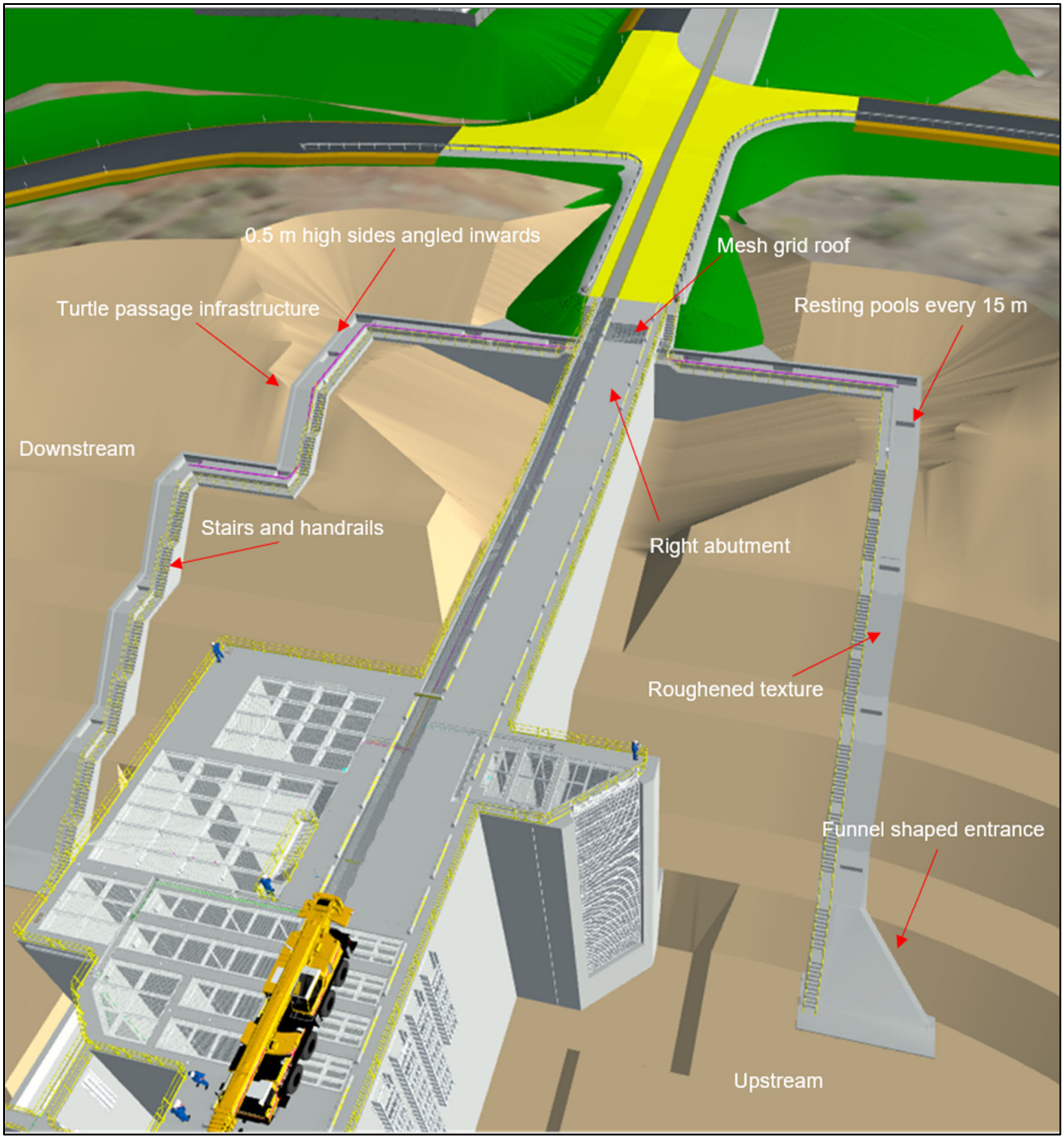

Figure 5 *Turtle infrastructure design (3D model)*

The Rookwood Weir turtle passage infrastructure will facilitate safe upstream and downstream movement of turtles past the Weir. The turtle ramp is the very first specifically designed passage infrastructure for turtles in Australia and Internationally, and the turtle protection design features of the weir vastly decrease risks of turtle injury or morality in comparison to historical designs.

The connectivity of the Fitzroy River turtle and white-throated snapping turtle populations within the Fitzroy River catchment is currently restricted as a result of existing in-stream infrastructure. The Project will create an additional physical barrier (Rookwood Weir) that may further restrict turtle movement and increase population fragmentation. Unmitigated, raising of waterway barriers such as weirs and dams are known to inhibit turtle movement. Long term decrease in turtle movement may result in reduction in gene flow, resulting in the formation of genetically isolated populations and localised extinctions (Tucker *et al*., 2000; Hamann *et al*., 2007). Restriction of movement may result in disruption of breeding cycles and may inhibit nesting in traditional areas (Lumpus *et al*., 2017a).

Freshwater turtles are not known to effectively utilise fishways, which are designed to facilitate upstream and downstream movement of fish, and as a result, large numbers of turtles are regularly observed accumulating downstream of existing dams and weirs (Clark *et al*., 2018; Limpus *et al*., 2011a; Limpus *et al*., 2011b).

Monitoring studies have also found that higher incidences of turtle injury and mortality occur in areas near dams and weirs than for turtles residing in areas away from water infrastructure (Hamman *et al*., 2007). Hamman *et al*. (2007) speculates that many of the incidents may occur as a result of turtles washing over weir walls during spilling events, resulting in damage as they come into contact with walls or weir footings, coming into contact with turbulent water in the pools immediately downstream of the weir walls, and attempts to climb upstream past water infrastructure. Non-fatal injuries to freshwater turtles may result in increased likelihood of infection, disabilities, reduced growth rates and/or fecundity (Hamman *et al*., 2007).

For the first time in Australia, infrastructure to support safe upstream and downstream movement of turtles has been developed at Rookwood Weir. The turtle ramp and turtle protection design features at Rookwood Weir will maintain safe turtle movement across a length of 369.58 km of the Fitzroy, Mackenzie and Dawson Rivers, comprised of:

– Downstream to Eden Bann Weir at 141.2 km AMTD on the Fitzroy River
– Upstream to Tartrus Weir at 429.5 km AMTD on the Mackenzie River
– Upstream to Neville Hewitt Weir at 83 km AMTD on the Dawson River.

Without the Rookwood Weir turtle passage infrastructure, movement within the Fitzroy, Mackenzie and Dawson Rivers would be limited to 125.54 km from Eden Bann Weir to Rookwood Weir and 244.04 km from Rookwood Weir to Tartrus and Neville Hewitt Weirs.

Rookwood Weir restores turtle movement through the provision of safe upstream and downstream turtle passage achieving ecological sustainability of the turtle population.

The Rookwood Weir turtle ramp is the very first specifically designed turtle passage infrastructure in Australia and Internationally. This innovated design was developed through an extensive design process involving collection of baseline data on turtle movement behaviour, extensive consultation with Dr Col Limpus (DES) over a four year period, and observations of turtle behaviour at existing structures (GHD, 2021b). The design specifically targets the movement behaviour of turtles and creates conditions suitable for upstream and downstream turtle movement. In addition, all aspects of Rookwood Weir including the spillway, stilling basin, outlet works, intake screen, fishway and turtle ramp have been innovatively designed for turtle protection. High levels of turtle injury and mortality are recorded at existing water infrastructure and for the first time in Australia, all potential risks of turtle injury and morality have been considered and minimised for achievement of sustainable weir design.

In accordance with Project approval conditions, the turtle passage infrastructure and turtle protection design features will be monitored to assess their effectiveness against the approved success criteria. This monitoring will be a continuation of the Turtle Movement Study. The deployment of identification and acoustics tags on Fitzroy River turtles and white-throated snapping turtles, completed as part of the baseline and construction phase Turtle Movement Study, will facilitate ongoing monitoring of the turtle passage infrastructure and turtle protection design features into Project operation.

The operations phase Turtle Movement Study will include a range of monitoring techniques to assess compliance with the approved success criteria. The Rookwood Weir, including fishway and turtle passage infrastructures, have been designed to facilitate safe access of personnel for monitoring and compliance purposes. The operation phase Turtle Movement Study will commence at the completion of weir construction and will continue annually for the first five years of Project operation. The monitoring plan will include the following survey techniques:

– **Remote telemetry** - PIT tag readers will be positioned along the turtle passage at the entrance, middle and exit for purposes of detecting tagged Fitzroy River turtles and white-throated snapping turtle movement along the turtle passage. Acoustic hydrophones will also monitor the fine-scale movement and behaviour of turtles with the turtle passage infrastructure and upstream and downstream of the weir. Hydrophones will be positioned around the entrance (upstream and downstream sides), on the turtle passage and within the impoundment. There is potential to position some hydrophones within resting pools on the turtle passage.
– **Cameras** - In order to visually monitor turtle movement and interaction with the turtle passage, installation of remote cameras will be used to view the entrance, middle and exit of the turtle passage. The cameras will

assist in visually observing turtle movement and behaviour within the turtle passage infrastructure and will monitoring for signs of predation and/or turtle aggression.

- **Turtle capture** - Two trapping surveys will be completed within an annual river cycle to monitor the effectiveness of the turtle passage infrastructure against the success criteria and levels of turtle injury/mortality. Traps will be placed in the first downstream pool, upper downstream pool, downstream side of the throughfare, upstream side of the throughfare, upstream pool above storage level (expected one site per 24 hours). Turtle capture surveys will also be undertaken within the stilling basin and approach channel downstream of Rookwood Weir and within the impoundment. Fitzroy River turtles and white-throated snapping turtles captured will be measured, tagged and assessed for health/injury and if gravid (with eggs). During these surveys, water quality and habitat suitability conditions will also be monitored.
- **Observation** - A turtle observation form will be developed to record incidental observations of turtle behaviour at Rookwood Weir and use of the turtle passage. Observations will be recorded during operator site visits, maintenance, and inspections. The form will capture operating conditions, location and behaviour of turtles, species, and age class (where possible).
- **Inspection** – An inspection form will be developed to document the operating conditions of the turtle passage (for example, water quality, build-up of algae, water levels and flow, presence of fish, presence of predatory birds, presence of sediment and debris) during various river cycle conditions (including low headwater and tailwater conditions, during and following flooding events). The form will also document whether any repair or maintenance is required and/or completed.

How each success criteria will be monitored and assessed by these survey methodologies and techniques is summarised in Table 14, along with frequency of monitoring and potential corrective actions.

Approval conditions require the effectiveness of the turtle passage infrastructure in relation to the turtle movement success criteria to be reported to DES twelve months after the construction of the weir and annually thereafter for the duration of the operation phase Turtle Movement Study. The monitoring methodology and reporting of the effectiveness of the turtle passage infrastructure will be externally peer reviewed and undertaken by a suitably qualified person. After five years of monitoring, Sunwater will prepare a report detailing the results of the operation phase Turtle Movement Study and compliance of the turtle passage and turtle protection design features with the success criteria, as well as recommendations for ongoing monitoring to enable reporting against the success criteria. This report will be submitted to DCCEEW and DES.

If monitoring evidence indicates that the turtle movement success criteria are not being met, the turtle passage infrastructure and/or turtle protection design features will be modified to achieve the success criteria and a catch and release program implemented until criteria are met. The process that will implemented in the event that monitoring indicates that the success criteria are not being met is outlined in Figure 6.

The turtle passage infrastructure has been designed to allow for adaptive management if required. Potential contingency actions for modification of the turtle passage infrastructure and/or turtle protection design features are identified against each success criteria in Table 14. A corrective action plan will be developed to identify the specific design and/or operational modifications required, including expected timeframes for implementation. This corrective action plan will be developed in consultation with DES. In accordance with Project approval conditions, an ongoing turtle catch and release program will be implemented until criteria are met. The methodology for the catch and release program required to achieve complete, safe turtle passage upstream and downstream of the weir will be determined in consultation with DES based on results of the operations phase Turtle Movement Study and cause of the non-compliance with success criteria. The catch and release program will be implemented by suitably qualified personnel and results reported in the annual operations phase Turtle Movement Study report.

Table 14 Turtle passage monitoring and corrective actions for success criteria

Success criteria	Type of monitoring	Frequency	Monitoring methodology and timing	Contingency program
1. 75% of white-throated snapping turtle and Fitzroy River turtles that attempt to use the turtle passage each year for upstream passage will do so successfully	Remote telemetry (acoustic and PIT)	Continuous monitoring Data downloaded quarterly	Acoustic hydrophones located upstream, downstream, within the turtle passage and in the impoundment area will detect and record successful movement of tagged turtles past Rookwood Weir and use of the turtle passage. PIT tag readers located upstream and downstream entrances and within the turtle passage and fishway will record movement of tagged turtles	If less than 50% of adult turtles that attempt to use the turtle passage in a 12-month period fails to successfully use the ramp, a catch and release program will be implemented as required until the criteria are met
	Cameras	Continuous monitoring Data downloaded at least monthly for the first three years	Time-stamped motion-triggered cameras will be positioned to view the entrance, middle and exit of the turtle passage to photograph and record turtle movement	
	Turtle capture surveys	Two survey events per year targeting optimal turtle capture conditions (e.g., pre- and post-wet)	Two trapping surveys will be completed over an annual river cycle to capture turtles from within resting pools and monitor use of turtle passage by the turtle population. Traps will be placed in the first downstream pool, upper downstream pool, downstream side of the throughfare, upstream side of the throughfare, upstream pool above storage level.	
	Observations	Ad hoc	A turtle observation form will be completed to record incidental observation of turtle use within the turtle passage during operator site visits	
2. Turtle monitoring downstream of the weir demonstrates no turtle injury/mortality during downstream turtle passage over the spillway, as evidence by impact damage to turtles	Remote telemetry (acoustic and PIT)	Continuous monitoring Data downloaded quarterly	Acoustic hydrophones located upstream, downstream, within the turtle passage and in the impoundment area will detect and record successful movement of tagged turtles past Rookwood Weir. PIT tag readers located upstream and downstream entrances and within the turtle passage and fishway will record movement of tagged turtles. Turtles not detected within turtle passage are likely to have	If greater than 5% of turtles recorded within 500 m downstream of the weir within a 12-month period show evidence of impact damage (i.e., serious shell fractures), corrective actions will be developed based on identified cause of injury/mortality. Design options may include: Install barrier arm/boom in front of trash/intake screens as adaptive management if monitoring indicates velocities cause risk of turtle injury/mortality

Success criteria	Type of monitoring	Frequency	Monitoring methodology and timing	Contingency program
			moved downstream over the spillway.	Add smooth surface finish (anti-graffiti paint) to prevent turtles climbing unsafe locations Increase frequency of inspections and maintenance to clear debris Adjust fishway operating strategy (where possible in compliance with fishway requirements) to improve water release and/or gate operating procedures for turtle protection Adjust weir operating strategy (where possible in compliance with Fitzroy Basin Water Plan and demand requirements) to improve downstream releases and water levels for turtle protection
	Turtle capture surveys	Two survey events per year targeting optimal turtle capture conditions (e.g., pre- and post-wet)	Turtle capture surveys will be undertaken within the stilling basin and downstream of Rookwood Weir. Turtles captured will be monitored for signs of injury/mortality.	
	Observations	Over course of a river cycle and ad hoc	A turtle observation form will be completed to record incidental observation of turtle behaviour at Rookwood Weir during turtle capture surveys and during operator site visits.	
	Inspections	During regular maintenance and periods of low storage levels	A turtle injury/mortality form will be completed during inspections of trash screens and inlets to record evidence of impacts to turtles. Forms will be completed during regular maintenance activities and when storage levels are at dead storage.	
3. The turtle passage remains operational (attraction flow is provided and passage unobstructed) continuously when the storage is above 8000 ML up to a 1 in 5-year spilling event	Operational inspections when weir storage is above 8000 ML up to a 1 in 5-year spilling event	During regular maintenance and operational inspections	Operational and maintenance inspections of the turtle passage will be undertaken in accordance with the Rookwood Weir operating strategy to document operation of the turtle passage during various river cycle conditions including low headwater and tailwater conditions, during and following flooding events, where safe to do so. Operating conditions of the turtle passage will be documented included any repair and maintenance required and/or completed	If greater than four weeks of continuous non-operation within a 12-month period when storage is above 8000 ML and below a 1 in 5-year spilling event, the following corrective actions will be initiated: Notification to DES and DCCEEW with details of corrective actions and timeframes for implementation Non-operation to trigger inspection and identification of maintenance/repair. Completion of maintenance/repair actions to restore operation as soon as possible. Increase frequency of inspections and maintenance
4. The turtle passage operates for one week after each four weeks of non-operation when the storage is below 8000 ML	Operational inspections when weir storage is below 8000 ML	During targeted maintenance and operational inspections	Operational and maintenance inspections of the turtle passage will be undertaken in accordance with the Rookwood Weir operating strategy to document operation of the turtle passage when the storage is below 8000 ML. Operating conditions of the turtle passage will be	If greater than eight continuous weeks of non-operation within a 12-month period when storage is below 8000 ML, the following corrective actions will be initiated: Notification to DES and DCCEEW with details of corrective actions and timeframes for implementation

Success criteria	Type of monitoring	Frequency	Monitoring methodology and timing	Contingency program
			documented including any repair and maintenance required and/or completed	Repair any damage to the turtle passage infrastructure Increase frequency of inspections and maintenance
5. 75% of adult white-throated snapping turtle and Fitzroy River turtle recorded within 50 m of the turtle ramp and fishway entrances within a 12-month period, are attracted to and can successfully locate the turtle passage entrance (as defined as entering the funnel shaped ramp)	Remote telemetry (acoustic)	Continuous monitoring Data downloaded quarterly	Acoustic hydrophones located downstream of the weir, in the approach channel at the turtle passage entrance and within the turtle passage will record turtle attraction to, and success in locating the turtle passage entrance.	If less than 50% adult white-throated snapping turtle and Fitzroy River turtle recorded within 50 m of the turtle ramp and fishway entrances within a 12-month period, are attracted to and can successfully locate the turtle passage entrance (as defined as entering the funnel shaped ramp), corrective actions will be developed and implemented. Options may include: Add additional attraction in the form of a solar power water sprinkler (to provide auditory cue) and/or increase water volume/velocity attraction flow Modify attraction channel (where possible in compliance with fishway requirements) to improve pathway/ connectivity between downstream river channel and turtle passage infrastructure Modify entrance ramp substrate to improve grip
	Cameras	Continuous monitoring Data downloaded at least monthly for the first three years	Time-stamped motion-triggered cameras will be positioned at the passage entrance to photograph and record turtle behaviour.	
	Turtle capture surveys	Two survey events per year targeting optimal turtle capture conditions (e.g., pre- and post-wet)	Two trapping surveys will be completed over an annual river cycle to capture turtles from downstream of the weir, within the approach channel at the entrance of the turtle passage and within the first resting pool above the passage entrance.	
	Observations	Ad hoc	A turtle observation form will be completed during operator site visits to record incidental observation of turtle presence/aggregation at the turtle passage entrance or use of the turtle passage.	
6. 75% of adult white-throated snapping turtle and Fitzroy River turtle that attempt to use the ramp within a 12-month period can successfully ascend the ramp and pool arrangement to reach the abutment throughfare	Remote telemetry (acoustic and PIT)	Continuous monitoring Data downloaded quarterly	Acoustic hydrophones and PIT tag readers located within the turtle passage will record turtle movement from the passage entrance to the abutment throughfare.	If less than 50% of adult turtles that attempt to use the turtle passage in a 12-month period fails to successfully ascend the ramp and pool arrangement to reach the abutment throughfare, corrective actions will be developed and implemented. Options may include: Provide additional roughness to the turtle ramp to increase grip Adjust volume/velocity of attraction flow and/or water depth/quality within resting pools Add additional attraction in the form of a solar power water sprinkler to provide auditory cue Provide additional shelters and/or other habitat features
	Cameras	Continuous monitoring Data downloaded at least monthly for the first three years	Time-stamped motion-triggered cameras will be positioned to view the entrance, middle and exit of the turtle passage to photograph and record turtle behaviour.	
	Turtle capture surveys	Two survey events per year targeting optimal turtle capture	Two trapping surveys will be completed over an annual river cycle to capture turtles from within turtle passage between	

Success criteria	Type of monitoring	Frequency	Monitoring methodology and timing	Contingency program
		conditions (e.g., pre- and post-wet)	the ramp entrance and abutment throughfare.	Alternative solutions, such as the addition of intermittent resting pools and/or alteration of the concrete surface will be developed and implemented as required
	Observations	Ad hoc	A turtle observation form will be completed during operator site visits to record incidental observation of turtle use of the turtle passage.	
7. 75% of adult white-throated snapping turtle and Fitzroy River turtle that attempt to use the ramp within a 12-month period can successfully move through the abutment throughfare	Remote telemetry (acoustic and PIT)	Continuous monitoring Data downloaded quarterly	Acoustic hydrophones and PIT tag readers located on the upstream, downstream and abutment throughfare of the turtle passage will record turtle movement through the abutment throughfare.	If less than 50% of adult turtles that attempt to use the turtle passage in a 12-month period fails to successfully move through the abutment throughfare, corrective actions will be developed and implemented. Options may include: Modify design of mesh grid to increase natural light Adjust volume/velocity of attraction flow and/or water depth/quality within resting pools Add additional attraction in the form of a solar power water sprinkler to provide auditory cue Provide additional shelters and/or other habitat features within abutment throughfare Alternative solutions, such as the addition of intermittent resting pools and/or alteration of the concrete surface will be developed and implemented as required
	Cameras	Continuous monitoring Data downloaded at least monthly for the first three years	Time-stamped motion-triggered cameras will be positioned to view to middle/abutment throughfare of the turtle passage to photograph and record turtle behaviour and movement at/through the abutment throughfare	
	Turtle capture surveys	Two survey events per year targeting optimal turtle capture conditions (e.g., pre- and post-wet)	Two trapping surveys will be completed over an annual river cycle to capture turtles from upstream and downstream of the abutment throughfare. Traps will be placed in the first downstream pool, upper downstream pool, downstream side of the throughfare, upstream side of the throughfare, upstream pool above storage level.	
	Observations	Ad hoc	A turtle observation form will be completed during operator site visits to record incidental observation of turtle movement and behaviour at the abutment throughfare.	
8. 75% of adult white-throated snapping turtle and Fitzroy River turtle that attempt to use the ramp can successfully descend the turtle ramp from the abutment throughfare into the impoundment to	Remote telemetry (acoustic and PIT)	Continuous monitoring Data downloaded quarterly	Acoustic hydrophones and PIT tag readers located on the downstream side of the abutment throughfare and within the impoundment will record turtle movement from the abutment throughfare and into the impoundment.	If less than 50% of adult turtles that attempt to use the turtle passage in a 12-month period fails to successfully descend the turtle ramp from the abutment throughfare into the impoundment to complete passage past the weir, corrective actions will be developed and implemented. Options may include:
	Cameras	Continuous monitoring	Time-stamped motion-triggered cameras will be	

Success criteria	Type of monitoring	Frequency	Monitoring methodology and timing	Contingency program
complete passage past the weir		Data downloaded at least monthly for the first three years	positioned to view middle/abutment throughfare and upstream entrance of the turtle passage into the impoundment photograph and record turtle behaviour and movement from the abutment throughfare and into the impoundment.	Adjust volume/velocity of attraction flow and/or water depth/quality within resting pools Add additional attraction in the form of a solar power water sprinkler to provide auditory cue Modify ramp substrate to improve grip Alternative solutions, such as the addition of intermittent resting pools and/or alteration of the concrete surface will be developed and implemented as required Provide additional shelters and/or other habitat features
	Turtle capture surveys	Two survey events per year targeting optimal turtle capture conditions (e.g., pre- and post-wet)	Two trapping surveys will be completed over an annual river cycle to capture turtles that have exited the abutment throughfare and are moving into the impoundment. Traps will be placed in the upstream side of the throughfare, upstream pool above storage level.	
	Observations	Ad hoc	A turtle observation form will be completed during operator site visits to record incidental observation of turtle movement from the abutment throughfare and into the impoundment.	
9. Turtle monitoring demonstrates no predation of turtles from within the turtle passage infrastructure	Remote telemetry (acoustic)	Continuous monitoring Data downloaded quarterly	Acoustic hydrophones located upstream, downstream and within the turtle passage will record turtles that enter the turtle passage but do not exit and are no longer detected.	If greater than 5% of turtle recorded within the turtle ramp within a 12-month period are subject to predation or attempted predation, corrective actions will be developed and implemented. Options may include: Provide additional protection and shelter from predatory birds. Options may include the installation of open wire mesh screen along the ramp or additional shelter positioned longitudinally along the sides of the ramp Provide additional shelters and/or other habitat features within resting pools Modify the design of the shelters to increase protection
	Cameras	Continuous monitoring Data downloaded at least monthly for the first three years	Time-stamped motion-triggered cameras will be positioned to view the along the upstream and downstream entrances and middle/abutment throughfare area of the turtle passage to photograph and record turtle predation.	
	Observations	Ad hoc	A turtle observation form will be completed during operator site visits to record incidental observation of turtle predation from within the turtle passage.	
10. Turtle monitoring demonstrates no turtle injury and/or mortality	Turtle capture surveys	Two survey events per year targeting optimal turtle capture	Two capture surveys will be undertaken within the stilling basin and downstream of Rookwood Weir. Turtles captured will	If greater than 5% of turtles recorded within the turtle ramp within a 12-month period are observed falling within or from the turtle ramp resulting in

Success criteria	Type of monitoring	Frequency	Monitoring methodology and timing	Contingency program
from within the turtle passage as a result of falls		conditions (e.g., pre- and post-wet)	be monitored for signs of injury.	serious turtle injury/mortality, corrective actions will be developed and implemented. Options may include: Add smooth surface finish (anti-graffiti paint) to prevent turtles climbing unsafe locations Install mesh cover/screens along turtle passage to prevent turtles from climbing over side walls Add stainless plates or similar to increase height of walls
	Cameras	Continuous monitoring Data downloaded at least monthly for the first three years	Time-stamped motion-triggered cameras will be positioned to view the upstream and downstream entrances and along the turtle passage including the middle/abutment area to photograph and record fall incidents.	
	Observations	Ad hoc	A turtle observation form will be completed to record incidental observation of turtle behaviour at the weir during turtle capture surveys and during operator site visits.	
11. The ratio of adult male and female white-throated snapping turtle and Fitzroy River turtle successfully moving upstream through the turtle ramp within a 12-month period is equivalent to pre-development ratios of turtles moving outside their home range	Remote telemetry (acoustic and PIT)	Continuous monitoring Data downloaded quarterly	Acoustic hydrophones located upstream, downstream, within the turtle passage and in the impoundment area will detect and record successful movement of tagged adult and male turtles past Rookwood Weir and use of the turtle passage. PIT tag readers located upstream and downstream entrances and within the turtle passage and fishway will record movement of tagged adult and male turtles.	If the ratio of adult male to female turtles successfully utilising the turtle ramp from the entrance channel to the impoundment within a 12-month period is statistically significantly different to pre-development ratios of turtles moving outside their home range within a 12-month period, corrective actions will be developed and implemented. Options will be based on the potential cause of non-compliance for each species (e.g., attraction to ramp, ascend ramp pool sequences, abutment throughfare, descend into impoundment)
	Cameras	Continuous monitoring Data downloaded at least monthly for the first three years	Time-stamped motion-triggered cameras will be positioned along the passage to photograph and record turtle movement	
	Turtle capture surveys	Two survey events per year targeting optimal turtle capture conditions (e.g., pre- and post-wet)	Two trapping surveys will be completed over an annual river cycle to capture turtles from within resting pools and monitor use of turtle passage by the turtle population	
12. Seasonal variation in use of the turtle ramp by adult male and female white-throated snapping turtle and Fitzroy River turtle is	Remote telemetry (acoustic and PIT)	Continuous monitoring Data downloaded quarterly	Acoustic hydrophones located upstream, downstream, within the abutment and in the impoundment area will continuously detect and record successful movement of tagged	If seasonal use of the turtle ramp (measured by attempted use and successfully passage per month) by adult white-throated snapping turtle and Fitzroy River turtle is statistically different to pre-development seasonal trends in movement behaviour over a 12-

Success criteria	Type of monitoring	Frequency	Monitoring methodology and timing	Contingency program
equivalent to pre-development seasonal trends over a 12-month period			turtles past Rookwood Weir and use of the turtle passage. PIT tag readers located upstream and downstream entrances and within the turtle passage and fishway will also continuously record movement of tagged turtles. Movement data will be analysed for seasonal trends and influence of environmental conditions and/or weir operation.	month period, corrective actions will be developed and implemented. Options may include: Adjust volume/velocity of attraction flow during varying headwater and tailwater conditions Add additional attraction in the form of a solar power water sprinkler to provide auditory cue for ramp entrance at varying headwater and tailwater levels Adjust water supply and modify shelters and/or other habitat features to control environmental conditions within turtle passage infrastructure
	Cameras	Continuous monitoring Data downloaded at least monthly for the first three years	Time-stamped motion-triggered cameras will be positioned to view the along the upstream and downstream entrances and middle/abutment throughfare area of the turtle passage to photograph and record turtle movement and provide evidence of on-site environmental conditions such as rain	
	Turtle capture surveys	Two survey events per year targeting optimal turtle capture conditions (e.g., pre- and post-wet)	Two trapping surveys will be completed over an annual river cycle to capture turtles from within resting pools and monitor use of turtle passage by the turtle population. Traps will be placed in the first downstream pool, upper downstream pool, downstream side of the throughfare, upstream side of the throughfare, upstream pool above storage level.	
	Observations	Ad hoc	A turtle observation form will be completed to record incidental observation of turtle use within the turtle passage during operator site visits. Data will be captured on river and weir operating conditions	
13. Measurement of the turtle ramp attraction flow during inspections and turtle capture monitoring events indicates that the depth of water flow on the upstream ramp remains suitable for	Cameras	Continuous monitoring Data downloaded at least monthly for the first three years	Time-stamped motion-triggered cameras will be positioned to view the along the upstream and downstream entrances and middle/abutment throughfare area of the turtle passage to photograph and record turtle climbing ability. Data will be collected on flow conditions at various	If average water flow on the upstream ramp (as measured at three locations) is greater than 25% different to the annual depth criteria (initially defined as 5 cm of flow) to be refined and set after each 12 months of monitoring), corrective actions will be developed and implemented. Options may include:

Success criteria	Type of monitoring	Frequency	Monitoring methodology and timing	Contingency program
turtles to climb as per annual depth criteria			points along the ramp during turtle capture surveys.	Adjust volume/velocity of attraction flow: Globe values and SCADA to be adjusted as per Rookwood Weir Operation and Maintenance Plan, to maintain required discharge and height of flow over the ramps and pools. Discharge to be initially set to achieve 5-15 mm of flow over the ramps and pools. Target discharge and height to be informed by results of the turtle passage infrastructure monitoring. Modify ramp substrate to improve grip Completion of maintenance/repair actions to restore operation as soon as possible
	Observations	Ad hoc	A turtle observation form will be completed to record incidental observation of turtles within the turtle passage during operator site visits.	
14. Over a 12-month period, habitat conditions within the resting pools remain suitable for adult white-throated snapping turtle and Fitzroy River turtle as evidenced by achievement of suitable pool depth criteria, compliance with water quality objectives and long-term availability of shelters	Turtle capture surveys	Two survey events per year targeting optimal turtle capture conditions (e.g., pre- and post-wet)	Two trapping surveys will be completed over an annual river cycle to capture turtles from within resting pools and monitor use of turtle passage by the turtle population. During these surveys, water quality and habitat suitability conditions within resting pools will be monitored. Traps will be placed in the first downstream pool, upper downstream pool, downstream side of the throughfare, upstream side of the throughfare, upstream pool above storage level.	If average habitat conditions within resting pools (as measured at three locations) is greater than 25% different to annual pool suitability criteria (initially defined as 0.50 m water depth, water quality equivalent to background levels (temperature, pH, dissolved oxygen, conductivity and turbidity compliant (±25%) with conditions within similar depth habitat upstream and/or downstream), and shelter is available/functioning), to be refined and set after each 12 months of monitoring), corrective actions will be developed and implemented. Options may include: Adjust volume/velocity of attraction flow and/or water depth/quality within resting pools Provide additional shelters and/or other habitat features within resting pools to control environmental conditions, provide protection and increase habitat value (foraging resources) Pipework outlets for washdown lines allow for connection of temporary water pump to maintain flow during maintenance/repair of submersible pump Completion of maintenance/repair actions to restore operation as soon as possible.
	Cameras	Continuous monitoring Data downloaded at least monthly for the first three years	Time-stamped motion-triggered cameras will be positioned to view the along the upstream and downstream entrances and middle/abutment throughfare area of the turtle passage to photograph and record environmental conditions within resting pools and turtle behaviour including aggression between turtles and use of shelters.	
	Observations	Ad hoc	A turtle observation form will be completed to record incidental observation of turtles within the turtle passage during operator site visits.	
	Operational inspections	During regular maintenance	An inspection form will be completed during all	

Success criteria	Type of monitoring	Frequency	Monitoring methodology and timing	Contingency program
		and operational inspections	inspections of the turtle passage infrastructure to document the operating conditions (for example, water quality, build-up of algae, water levels and flow, presence of fish, presence of predatory birds, presence of sediment and debris) during various river cycle conditions (including low headwater and tailwater conditions, during and following flooding events). The form will also document whether any repair or maintenance is required and/or completed.	
15. Annual monitoring downstream of the weir trash screens and inlets indicates no entrapment or drowning of white-throated snapping turtle or Fitzroy River turtle	Operational inspections	During regular inspections and when the impoundment is at dead storage	A turtle injury/mortality form will be completed during inspections of trash screens and inlets to record evidence of impacts to turtles	If greater than 5% of turtles recorded within 500 m upstream and downstream of the weir within a 12-month period show evidence of entrapment/drowning on the weir trash screens or inlets, corrective actions will be developed and implemented. Options may include: Install barrier arm/boom in front of trash/intake screens as adaptive management if monitoring indicates velocities cause risk of turtle injury/mortality
16. Monitoring of the fishway over a 12-month period indicates no injury/mortality of white-throated snapping turtle or Fitzroy River turtle within the fishway complex	Fishway monitoring	During fishway monitoring events	Fisheries monitoring program to record turtles during monitoring of the fishway and broad scale fish community monitoring.	If the number of turtles with evidence of injury/mortality within the fishway or from fishway operation (as evidenced by entrapment/drowning within fishway and/or crushing injuries from gates) is n greater than 5% of the total number of turtles recorded within 500 m downstream of the fishway within a 12-month period, corrective actions will be developed and implemented. Options would be developed in calculation with suitability qualified fishway professional and the Department of Agriculture and Fisheries.
17. At least 20 adult Fitzroy River turtle and white-throated snapping turtle recorded attempting to use the turtle passage within a 12-month period	All monitoring techniques combined	As per each monitoring technique	Analysis of attempted use of the turtle passage by adult turtles from combined monitoring methods over a 12-month period	If sampling sizes for the Fitzroy River turtle and white-throated snapping turtle are too low to allow the success criteria to be assessed (less than 20 turtles recorded using the turtle ramp within a 12-month period), corrective actions will be implemented and may include:

Success criteria	Type of monitoring	Frequency	Monitoring methodology and timing	Contingency program
				Expansion of the Turtle Movement Study to include monitoring of the common Krefft's River turtle (*Emydura macquarii krefftii*). Data from the Krefft's River turtle would then be used to infer suitability of ramp for the threatened species. Initially, monitoring via PIT tags readers, cameras, turtle capture surveys, observations and inspections to occur following the first year of non-compliance. Inclusion of acoustic tags to be considered following the second consecutive year of non-compliance. Artificial experimentation involving the relocation of tagged turtles from upstream of the Weir to the downstream entrance of the turtle passage and/or to within the turtle passage to obtain results on the physical suitability of the turtle passage for the Fitzroy River turtle and white-throated snapping turtle.

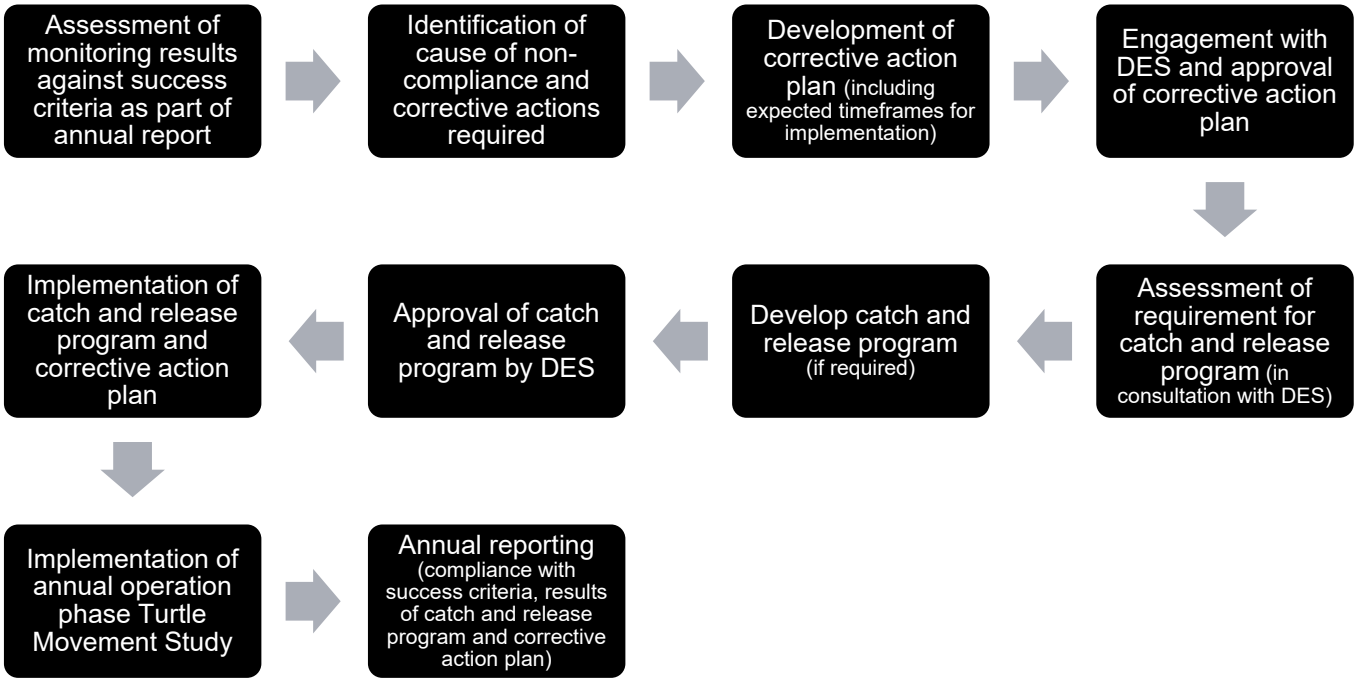

Figure 6 ***Progress for corrective actions and turtle catch and release program in the event of non-compliance with success criteria***

3.3.3 Condition compliance and conservation outcome

The provision of safe turtle passage at water infrastructure locations is a key conservation outcome of the Recovery Plan (Strategy 2; Commonwealth of Australia, 2020), and the Fitzroy Catchment Turtle Management Strategies (Success Criteria 4 and 5; Limpus *et al*., 2011a). The total cost of providing turtle passage at water infrastructure locations through the distribution of the white-throated snapping turtle is estimated at $1,600,000 within the Recovery Plan (Commonwealth of Australia, 2020). The expected cost of turtle passage infrastructure at Rookwood Weir based on the EIS concept design was $600,000. The EIS design included a shotcrete lined channel located on the right bank. Design features approved included:

– Provides for both upstream and downstream passage
– Provides passage in all headwater/tailwater conditions from dead storage up to drown out of the weirs.
– Provides passage on the bank adjacent to the main river channel
– Entry and exit points sloped and located at the river margins where turtles can assess them at low velocity conditions
– Slope suitable for turtle climbing, not more than 45° at any point
– Width of 2 m
– A shotcrete or roughened concrete lined channel to provide a roughened surface for climbing
– Small attraction flow maintained by a pump
– Mesh grid cover to provide natural light where the ramp passes through the abutment of the weir.

The detailed design process for the turtle passage infrastructure was undertaken over four years and involved extensive consultation between Sunwater, turtle specialists, DES, and the design engineers. The design was developed is the first of its kind in Australia and Internationally and includes many design features that were not originally proposed during the EIS or Business Case phases of the Project. These features include:

– Pools, (2 m length x 2 m width x 0.5 m depth), are provided along the length of the turtle passage every 15 m to provide resting habitat (15 resting pools in total)
– Resting pool shelters (1 m length x 0.5 m width x 0.3 m height), to provide shade and protection within each resting pool
– Widened funnel entrance/exit to increase the area over which turtles can access the passage
– Exposed aggregate surface to provide additional grip
– Sloped sides of ramp 0.5 m above water level and angled inward to prevent turtles falling over the edges
– A smooth finish (anti-graffiti paint) is also provided on the top of the ramp sides to prevent turtles climbing onto unsafe locations
– Attraction flow and water for resting pools distributed through pipework and hand valves used to evenly distribute the discharge through each resting pool
– Spare pump stored on site for redundancy to maintain constant turtle passage operation
– Turtle passage constructed from reinforced concrete to increase durability and minimise ongoing repair/maintenance
– PIT tag readers are included at the entrance, middle and exit of the turtle passage for turtle monitoring
– Flexibility incorporated into design to allow for adaptive management.

In total, the actual cost of constructing the turtle passage infrastructure at Rookwood Weir was approximately $2,400,000. Operating the turtle ramp is expected to require 2.2 ML of water per day and $220,000 in annual operation and maintenance costs, totally $7,400,000 over 25 years.

The Turtle Movement Study implemented during the Project design phase informed developed of the success criteria for the turtle passage infrastructure. These criteria, and the associated monitoring program, were developed in consultation with DES and the success criteria approved by DES and the Federal Minister for the Environment. The operations phase Turtle Movement Study includes a range of survey techniques to not only assess compliance with the success criteria but to also broadly monitor turtle behaviour and physical interaction with the turtle passage infrastructure. This information will improve knowledge of turtle movement behaviour and inform refinements of future passage designs. The monitoring program that has been developed based on the

success criteria defined during the detailed design process, is substantially more detailed that the monitoring program proposed during the EIS and costed in the Project Business Case. The monitoring program also includes a commitment of adaptive management in the event that the success criteria are not achieved. This adaptive management includes a contingency program to maintain turtle movement, as well as potential adaptations to the design and operation of the turtle passage infrastructure and turtle protection design features.

Table 15 below compares the conservation effort and costs of the design and construction of the turtle passage infrastructure to those required by the approval conditions. In total, actual costs totalled $12,600,00 and of this, it is estimated that an additional $5,800,000 of conservation effort has been undertaken to achieve conservation outcomes. Refer to Appendix A for additional detail on cost estimates.

Table 15 ***Turtle passage condition compliance and contribution of species conservation – approximate cost estimate and actual costs (grey)***

Condition	Base case cost estimate	Actual conservation effort	Actual cost
Detail design including consultation with DES and development of success criteria	$57,000 (business case estimate)	Extensive consultation with DES over four years and preparation of Turtle Infrastructure Design Process Report. Extensive structural and mechanical detailed design	$85,000 (actual cost)
Construction	$600,000 (business case estimate)	Construction	$2,400,000 (actual cost estimate)
Operations and maintenance	Annual - $120,000 Total (25 years) - $4,000,000 (cost estimate based on 60% percent of actual expected cost. 60% based on difference in EIS and actual construction cost)	Operations, maintenance and flood repair	Annual - $220,000 Total (25 years)- $7,400,000 (actual cost estimate)
Turtle passage infrastructure monitoring program	$2,000,000 (business case estimate)	Extensive monitoring program based on success criteria developed during detailed design phase and in consultation with DES	$2,500,000 (actual cost estimate)
Adaptive management of design	$60,000 (cost estimate based on 20% of EIS design construction cost)	Adaptive management of design	$200,000 (cost estimate based on 20% of actual design construction cost)
Catch and release program	$33,000 (as per actual cost estimate)	Catch and release program	$33,000 (actual cost estimate)
Total (rounded)	**$6,800,000**		**$12,600,000**
Additional conservation effort (rounded)			**$5,800,000**

3.4 Species Management Programs

3.4.1 Conditions

In accordance with EPBC Act Approval Condition 6 and CoG Appendix 2, Schedule 1 Part A Condition 1, a Species Management Plan (SM Plan) must be prepared for the Fitzroy River turtle and Species Management Program (SMP) prepared for the white-throated snapping turtle, to detail how the population and habitat for the two species will be protected during construction and operation. The approval conditions relating to the species management programs are detailed in Table 16.

Table 16 Species management program approval conditions

Legislation	Condition	Conditions details
Minister for the Environment and Energy: EPBC 2009/5173	Condition 6: Fitzroy River Turtle	a) The approval holder must submit for the Minister's written approval, a separate species management plan to minimise impacts on the Fitzroy River turtle (*Rheodytes leukops*) for each weir to be constructed or raised.
		b) The species management plan for each weir must:
		i. be developed in consultation with DES and be in accordance with Appendix E of the AEIS
		ii. detail how the population and habitat for the Fitzroy River turtle will be protected during construction and operation of the action
		iii. detail how, subject to compliance with the Queensland Fitzroy Basin Water Plan and the weir operating plan, the approval holder will manage weir storage levels within the impoundment of the relevant weir to minimise the inundation of Fitzroy River turtle nests; and
		iv. detail how the approval holder will manage the impoundment water levels of the relevant weir during the period from May to January to encourage high nesting positions and reduce the risk of nest inundation.
		c) The species management plan may include sub-plans relative to each development stage (if relevant).
		d) The approval holder must not commence construction or raising of a weir unless the species management plan for the relevant weir has been approved by the Minister in writing. The approved species management plan for each weir must be implemented.
LFRIP CoG Evaluation Report on the EIS December 2016	Appendix 2. Imposed conditions – Rookwood Weir. Schedule 1: White-throated snapping turtle. Part A. Condition 1. Species Management Program	(a) Prior to commencement of construction, submit to DEHP (DES) for approval, a species management program (SMP) for the white-throated snapping turtle.
		(b) The SMP must detail how the population and habitat for the white-throated snapping turtle would be managed during construction and operation of the Project.
		(c) The SMP must be prepared generally in accordance with Appendix E of the additional information to the draft environmental impact statement (AEIS), and must be consistent with the conditions in this Coordinator-General's report.
		(d) Implement the approved SMP in the construction and operation phases of the Project.

3.4.2 Description

In accordance with the approval conditions detailed in Table 16, an SM Plan and SMP were required to detail how the population and habitat for the Fitzroy River turtle and white-throated snapping turtle would be managed throughout the construction and operation of the Project. The SMP and SM plan were developed in a staged approach, with separate sub-plans for construction (Stage 1) and operation (Stage 2). The construction SM Plan and SMP were combined into a single consolidated Construction SMP, which provided a framework for the management of the two turtle species during construction. The Construction SMP was developed in October 2020,

accordance with Appendix E of the AEIS and was approved by DES and the Federal Minster for the Environment. They key protection and management strategies in the Construction SMP include:

– Pre-clearance surveys undertaken to assess nesting habitat suitability and to identify and relocate turtle nest
– Pre-clearance surveys undertaken to inspect aquatic habitat for the presence of the Fitzroy River turtle and white-throated snapping turtle
– All turtles captured during pre-clearance surveys tagged with identification and acoustics tags, and biological parameters recorded:
    - Aquatic habitat disturbed to initiate an evasive startled movement of turtles away from the area
    - Exclusion fencing erected along the water's edge of nesting bank/s supporting confirmed breeding places to prevent further nesting to prevent turtle nesting within construction footprints during the construction period
    - Location of access tracks optimised to avoid causing direct impact to turtle breeding places
    - Suitable breeding habitat adjacent to and/or in the vicinity of the construction footprints protected and maintained where possible to provide alternative suitable breeding habitat throughout construction
    - Breeding places within 'no access habitat protection areas' and within/adjacent to construction footprints identified and protected
    - Relocated turtle nests monitoring throughout the nesting season and success recorded following hatching
    - Additional works areas or sites, such as machinery/equipment storage and site offices located within existing cleared terrestrial areas and not within confirmed or potentially suitable turtle breeding places
    - A construction environmental management plan prepared and implemented to detail specific environmental risk minimisation measures throughout the course of the proposed works
    - Aquatic habitat adjacent to and within construction footprint monitored daily
    - Site supervisor/s (or suitably qualified delegate) trained on the identification and detection of turtle nesting activity and the procedures for examining disturbance footprints for turtle nests
    - All site personnel informed on the potential impacts of the works on the Fitzroy River turtle and white-throated snapping turtle, requirements to manage risks to these species and location of 'no access habitat protection areas'
    - Breeding register maintained to document interactions with breeding places
    - Flow diversion strategy developed to limit river diversion and maintain river flow and turtle movement within its natural course for as long as possible
    - Temporary river crossings/working platforms designed and constructed to maintain flow and turtle movement
    - Habitat restored to pre-disturbance conditions.

Sunwater is currently in the process of developing a separate operations SMP and SM Plan combined into a single consolidated Operations SMP, to detail how the population and habitat for the Fitzroy River turtle and white-throated snapping turtle will be managed during the Operations phase of the Project. Specifically, the Operations SMP will include details of how weir storage levels will be managed to minimise the inundation of turtle nests (EPBC Condition 6(b) (*iii*)), and how impoundment water levels (EPBC Condition 6(b) *(iv*)) will be managed to encourage high nesting positions and reduce the risk of nest inundation. To facilitate the design of these management strategies, Sunwater have undertaken consultation with the Queensland Department of Natural Resources, Mines and Energy (now Department of Resources) to include Rookwood Weir into the region's water planning process. In general, risks to turtle nesting will be minimised through the control of weir storage levels and water releases to minimise increases in water levels during the nest incubation period and thereby minimise risks of nest inundation. The key protection and management strategies expected to be included in the Operations SMP include:

– Weir operating strategy implemented to avoid/minimise risk of turtle injury and mortality

- Weir storage levels and water releases managed to encourage high nesting positions and minimise the inundation of nests
- Turtle passage infrastructure operated and maintained to facilitate upstream and downstream turtle movement
- Turtle passage infrastructure monitored against success criteria to determine success and allow for adaptive management if required
- Evidence of turtle injury and/or mortality monitored against success criteria to allow for adaptive management if required
- Fishway design monitored for use by turtles
- Fitzroy River turtle nest protection management plan implemented, as per Rookwood Weir Offset Management Plan, to improve turtle nesting habitat suitability and recruitment of hatchlings into the population. Key actions to be implemented include:
    - Priority Nest Protection Areas protected and enhanced through removal and control of terrestrial and aquatic weeds and installation of electric fencing of the bank to provide protection from predators and prevent disturbance by cattle and/or vehicles
    - Broad-scale predator control conducted at Priority Nest Protection Areas
    - Priority Nest Protection Areas monitored regularly and turtle nests protected from predation
    - Hatching success monitored and reported.
- White-throated snapping turtle nest protection management plan implemented, as per Rookwood Weir Offset Management Plan, to improve turtle nesting habitat suitability and recruitment of hatchlings into the population. Key actions to be implemented include:
    - Priority Nest Protection Areas protected and enhanced through removal and control of terrestrial and aquatic weeds and installation of electric fencing of the bank to provide protection from predators and prevent disturbance by cattle and/or vehicles
    - Broad-scale predator control conducted at Priority Nest Protection Areas
    - Priority Nest Protection Areas monitored regularly and turtle nests protected from predation
    - Hatching success monitored and reported.
- Recreational activities within the impoundment will not be encouraged or facilitated
- An Operational Environmental Management Plan will be developed and implemented for the protection of turtles and turtle habitat.
- A Broad-Scale Turtle Population Monitoring Program will be developed and implemented to monitor the turtle population within, upstream and downstream of the weir. Key actions to be implemented include:
    - Turtle capture – trapping of turtles from within, upstream and downstream of Rookwood Weir
    - Remote telemetry – remote monitoring of turtle movement via acoustic telemetry
    - Measuring and tagging of captured turtles
    - Assessment of relative abundance, population dynamics, health, and movement behaviour.

An Operations SMP compliance report will be completed annually for a total period of five years from construction completion. The compliance report will be prepared by an independent and appropriately qualified person and will be submitted to DES.

3.4.3 Condition compliance and conservation outcome

The Project approval conditions (refer to Section 3.4.1) require implementation of a SMP and SM Plan in accordance with Appendix E of the AEIS. Rather than simply adopting the SMP from the EIS, the objectives, performance criteria and management strategies of the AEIS SMP were further developed to achieve avoidance and mitigation of impacts during Project Construction and Operations. This process required additional engagement with DES, collaboration between design, construction and operations teams, and further development of management strategies into the updated Construction SMP and Operations SMP. The Construction SMP and Operation SMP achieve a range of avoidance, mitigation, and monitoring actions for the protection of the Fitzroy River turtle, white-throated snapping turtle and their habitats. In addition to standard requirements, the

Construction SMP included an additional commitment to deploy identification and acoustic tags on all threatened turtles captured during pre-clearance surveys. This commitment increased the number of turtles monitored throughout the construction phase and into operations thereby contributing to increased knowledge of the species' movement behaviour, response to construction disturbance and potential impacts from inundation of habitat during the initial phases of Project operations. As of March 2022, three separate turtle tagging surveys have been conducted in response to turtle salvage activities within the construction footprint with an additional two surveys expected to occur over the remaining period of construction.

The Operations SMP includes extensive commitments to monitoring the success of the design features at protecting turtles from injury/morality and maintaining turtle movement. The results of this monitoring will directly achieve key conservation outcomes relating to turtle protection within the Recovery Plan (Strategy 2; Commonwealth of Australia, 2020) and Fitzroy Catchment Turtle Management Strategies (Success Criteria 4 and 5; Limpus *et al*., 2011a). As required by Project approval conditions, the Operations SMP includes commitments to adaptive management of turtle passage infrastructure and turtle protection design features if success criteria are not achieved (refer to Section 3.3). Protection of turtle nests and increased recruitment of hatchlings into the population through implementation of targeted Nest Protection Management Plans is also a key component of the Operations SMP (refer to Section 3.6). In addition to these approval condition requirements, the Operations SMP includes a Broad-Scale Turtle Population Monitoring Program. This monitoring program will provide a holistic overview of the turtle population within, upstream and downstream of the Weir. Results of the monitoring will support the finding of the Turtle Movement Study and Nest Protection Management Plans to greatly improve knowledge of the two threatened turtles and long-term effects of water infrastructure on turtle populations. An additional $280,000 will be dedicated to the Broad-Scale Turtle Population Monitoring Program for the first five years of Project operation.

Table 17 below compares the conservation effort and costs of the Construction SMP and Operation SMP to those required by the approval conditions. In total, it is estimated that an additional $300,000 of conservation effort has/will be undertaken to achieve conservation outcomes. Refer to Appendix A for additional detail on cost estimates.

Table 17 ***Species Management Program condition compliance and contribution of species conservation – approximate cost estimate and actual costs (grey)***

Condition	Base case cost estimate	Actual conservation effort	Actual cost
Design of standard Construction SMP (as per Appendix E of the AEIS)	$0 (SMP prepared as part of EIS)	Design of revised Construction SMP (additional engagement, collaboration across design, construction and operations teams and further development of management strategies into updated Construction SMP)	$25,000 (actual cost)
Implementation of standard Construction SMP	$300,000 (as per actual cost)	Implementation of revised Construction SMP	$300,000 (actual cost)
		Additional tagging of Fitzroy River turtles and white-throated snapping turtles with acoustic and identification tags	$10,000 (actual cost)
Design of standard Operations SMP (as per Appendix E of the AEIS)	$0 (SMP prepared as part of EIS)	Design of revised Operations SMP	$15,000 (actual cost)
Implementation of standard Operations SMP	Annual - $15,000 Total (25 years) - $1,200,000 (as per actual cost estimate)	Implementation of revised Operations SMP	Annual - $15,000 Total (25 years) - $1,200,000 (cost estimate for actual revised SMP)

Condition	Base case cost estimate	Actual conservation effort	Actual cost
		Key Operations SMP actions: - Turtle Movement Study	Refer to Section 3.2
		- Fitzroy River turtle Nest Protection Management Plan	Refer to Section 3.5
		- White-throated snapping turtle Nest Protection Management Plan	Refer to Section 3.5
		- Turtle Monitoring Program	$280,000 (cost estimate for actual monitoring program)
Total (rounded)	**$1,500,000**		**$1,800,000**
Additional conservation effort (rounded)			**$300,000**

3.5 Nest Protection Management Plan

3.5.1 Conditions

In accordance with EPBC Act Approval Condition 4, Condition 5 and CoG Appendix 2, Schedule 1 Part C Condition 5, a Nest Protection Management Plan required to be designed and implemented to protect turtle nests and increase recruitment of hatchlings into the population. The approval conditions relating to the Nest Protection Management Plans are detailed in Table 18.

Table 18 Nest Protection Management Plan condition compliance and contribution to species conservation

Legislation	Condition	Conditions details
Minister for the Environment and Energy: EPBC 2009/5173	Condition 4: Offset Strategy	a) The approval holder must submit for the Minister's written approval, a separate Offset Strategy for each weir to be constructed or raised, which identifies the residual impacts arising from the respective weir on the following MNES:
		i. Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community
		ii. Black ironbox (*Eucalyptus raveretiana*)
		iii. Red goshawk (*Erythrotriorchis radiates*)
		iv. Fitzroy River Turtle (*Rheodytes leukops*)
		v. Great Barrier Reef World Heritage Area and National Heritage place.
		b) The offset strategy for each weir must propose in general terms the offsets that the approval holder will provide for the residual impacts arising from the construction or raising of the relevant weir, as set out in Table 1, and how the approval holder intends to deliver the offset obligations: **Table 1** **Impact** — **Indicative impact area/Quantity**: Rookwood Weir; Eden Dam Weir **Listed threatened species and ecological communities** (i) inundation of Fitzroy River turtle nest sites within the weir impoundment areas

Legislation	Condition	Conditions details		
		(ii) modifying aquatic habitat for the Fitzroy River Turtle	660 ha	282 ha
		(iii) loss of Red Goshawk nesting habitat	588 ha	384 ha
		(iv) loss of the area of Black Ironbox habitat	Impact area to be determined by pre-clearance surveys required under condition 3	
		(v) loss of the area of Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community	Impact area to be determined by pre-clearance surveys required under condition 3	
		(vii) any increase in nitrogen due to decaying vegetation in the inundation area	at least 645 tonnes[1,2] unless the monitoring required at condition 1b) i. conclusively determines that the impact is less than predicted[1]	at least 458 tonnes[1,2]
		Notes: (1) The indicative areas/quantities will need to be determined based on the particular weir to (first) be constructed or raised. (2) Unless a different impact area is determined by the pre-clearance survey required under condition 3.		
		c) The Offset Strategy must include, but is not limited to:		
		(i) offset outcomes to be achieved, for listed threatened species and ecological communities listed in Table 1		
		(ii) details of how offsets will be provided for modifying Fitzroy River Turtle aquatic habitat (Table 1, item ii.)		
		(iii) the timeline and legal mechanism/s for securing the offset area/s and offset outcomes		
		(iv) information about how the offset area/s will provide connectivity with other relevant habitats and biodiversity corridors		
		(v) details of how water quality offsets will be provided consistent with Table 1		
		(vi) inputs and justification for inputs demonstrating that the offsets are likely to be in accordance with the EPBC Act Environmental Offsets Policy and relevant Reef 2050 Plan requirements, including the net benefit principle.		
		d) The approval holder must not commence construction or raising of the relevant weir unless the offset strategy for that weir has been approved by the Minister in writing. The approved offset strategy relevant to each weir must be implemented.		
Minister for the Environment and Energy: EPBC 2009/5173	Condition 5: Offset Management Plan	a) The approval holder must submit for the Minister's written approval a separate offset management plan for each weir to be constructed or raised, addressing each offset requirement in condition 4 for any weir for which an offset strategy has been approved by the Minister.		
		b) The offset management plan for each weir must be consistent with the approved offset strategy for the relevant weir.		
		c) The offset management plan for each weir must include, but not be limited to:		
		i. the offset area/s to be secured for the listed threatened species and ecological communities listed in Table 1		

Legislation	Condition	Conditions details
		ii. a description and map to clearly define the location and boundaries of the offset area/s, accompanied by the offset attributes
		iii. information about how the offset area/s provide connectivity with other relevant habitats and biodiversity corridors
		iv. a description of the management measures (including timing, frequency and duration) that will be implemented in each offset area
		v. details of how the management measures proposed are consistent with relevant approved conservation advice, recovery plans and threat abatement plans
		vi. performance and completion criteria for implementing the offset management plan/s for evaluating its effectiveness, and criteria for triggering corrective action/s
		vii. a program for monitoring and reporting on the effectiveness of the management measures, and progress against the performance and completion criteria
		viii. a description of potential risks to the successful implementation of the offset/s, and contingency measures that can be implemented to mitigate against these risks; and
		ix. evidence that the offsets are in accordance with the EPBC Act Environmental Offsets Policy and relevant Reef 2050 Plan requirements including the net benefit principle.
		d) In respect of offsets for impacts to the Fitzroy River turtle (condition 4.b) i. [within Table 1]), the offset management plan for each weir must:
		i. be in accordance with Appendix G of the additional information to the EIS (AEIS) and the Addendum to the AEIS
		ii. ensure the effectiveness of the offset in achieving long-term protection and management of Fitzroy River Turtle nesting habitat until the outcomes of the offset management plan are achieved
		iii. specify the offset delivery mechanism. If the mechanism is through a financial settlement then the financial contribution must be calculated using the Financial Settlement Offset Calculator and offset payments in relation to each weir must be made in full within one year of the completion of each stage of construction or raising of that weir.
		e) The approval holder must not begin inundation of the impoundment of a weir unless the Minister has approved in writing an offset management plan for the relevant weir for all offset requirements in the approved offset strategy for that weir. The approved offset management plan for each weir must be implemented.
		f) For the offsets for modifying Fitzroy River turtle aquatic habitat (condition 4. b) ii. [within Table 1]), the approval holder may elect to provide a financial offset in a manner approved by the Minister, as calculated using the Financial Settlement Offset Calculator, or as otherwise agreed by the Minister.
		(a) Prior to construction submit to EHP, for approval, a nest protection management plan for the white-throated snapping-turtle.

Legislation	Condition	Conditions details
LFRIP CoG Evaluation Report on the EIS December 2016	Appendix 2. Imposed conditions – Rookwood Weir. Schedule 1: White-throated snapping turtle. Part C Condition 5. Nest protection programs	(b) Implement nest protection measures for the white-throated snapping-turtle generally in accordance with Appendix G of the AEIS (Offset Proposal for the Fitzroy River Turtle and White-throated Snapping Turtle).

3.5.2 Description

Unavoidable impacts to the Fitzroy River turtle and white-throated snapping turtle are expected to remain in relation to inundation of turtle nest sites within the weir impoundment area and downstream of the Weir. The Rookwood Weir Offset Strategy Version 3 (Earthtrade, 2022a) identified that to achieve the conservation outcome of a reduction in nest predation and increased recruitment of hatchlings into the population, a Fitzroy River Turtle and White-throated Snapping Turtle Nest Protection Management Plan will be implemented as a direct offset for residual impacts to nest inundation. The offset will be in accordance with Appendix G of the AEIS: Offset Proposal for the Fitzroy River Turtle and White-throated Snapping Turtle Offset Management Plan.

The Fitzroy River and White-throated Snapping Turtle Nest Protection Management Plans have been prepared as an attachment to the Rookwood Weir Offset Management Plan (Earthtrade, 2022b) and Operations SMP, to provide a framework for the implementation of turtle nest protection actions required to achieve the required conservation outcomes. They key objectives of the Nest Protection Management Plans are to:

– Maintain function turtle nesting habitat within, upstream and/or downstream of Rookwood Weir
– Reduce nest predation
– Increase recruitment of hatchlings into the population.

Each nesting season, Priority Nest Protection Area/s will be identified based on previously confirmed turtle nesting sites, nesting habitat suitability, access requirements, landholder agreements and suitability/condition of the site for nesting. The Priority Nest Protection Area/s will be located within one or more of the following regions: Inundation area; upstream of the inundation area to the terrestrial offset area at Foleyvale Crossing, and/or downstream of the weir to Hanrahan Crossing.

The specific location/s of the Priority Nest Protection Area/s within these regions are expected to change throughout the life of the Project. Initial Priority Nest Protection Area/s will be established following first filling of the impoundment, as well as any flooding events that occur. These initial areas are expected to align with confirmed aggregated nesting areas identified during pre-clearance survey. Throughout Project operation, the condition, suitability and use of these areas by turtles for nesting will be monitored and alternative Priority Nest Protection Area/s identified and established based on natural and/or Project-related fluctuations in habitat suitability and actual use by turtles for nesting. These factors will also influence the number and size of Priority Nest Protection Area/s established annually. A description of the Priority Nest Protection Area/s will be recorded at the start of the nesting season. The following parameters will be recorded:

– Location
– Photographs of area (north, south, east and west at 50 m internals along bank).
– Bank height, length and width.
– Average bank slope: vertical (89–90°); steep (60–80°); moderate (30-60°); low (10–30°) and; flat (<10°).
– Average bank composition: percent of cobble/pebble; gravel; coarse sand; fine sand; and silt/clay.
– Riparian canopy vegetation cover including ground cover, scrub, canopy cover: none (none); little (1–10%); some (10–50%); moderate (50–75%) and extensive (>75%).
– Weed density overall; little (1–10%); some (10–50%); moderate (50–75%) and extensive (>75%).
– Weed density per species; little (1–10%); some (10–50%); moderate (50–75%) and extensive (>75%).
– Evidence of predator activity: little (1–10%); some (10–25%); moderate (25–50%) and extensive (>50%).
– Cattle disturbance: little (1–10%); some (10–25%); moderate (25–50%) and extensive (>50%).
– Pig disturbance: little (1–10%); some (10–25%); moderate (25–50%) and extensive (>50%).
– Flow level: none (isolated pools); low (<watermark); moderate (=watermark); high (>watermark); flood.
– Habitats adjacent: deep pool (>0.5 m); shallow pool (<0.5 m); run; riffle.

The condition and nesting habitat suitability of the Priority Nest Protection Area/s will be restored annually through the actions detailed below, prior to the nesting seasons of the Fitzroy River turtle and white-throated snapping turtle. Specific management actions will include:

– Installing electric fence (e.g. 150 m perimeter fence) around the Priority Nesting Protection Area/s to protect against predators and exclude other forms of potential nest disturbance such as cattle and/or vehicles.

– Removing/controlling terrestrial and aquatic weeds, where required, from within the Priority Nesting Protection Area/s to facilitate turtle access to the area for nesting.

Predator control will be undertaken for predators that occur at Priority Nest Protection Area/s in accordance with the Turtle Habitat Enhancement Program: Feral Pest Animal Management Plan (Section 3.6). Activities will be identified annually based on levels of activity and type of predators recorded during the pre-nesting season. Activities may include culling, baiting, trapping of pigs, foxes, wild dogs, feral cats.

Priority Nest Protection Area/s will be monitored regularly (indicative frequency of three times per week) during the peak nesting seasons of the Fitzroy River turtle and white-throated snapping turtle for the purposes of identifying and protecting individual nests. Nesting is triggered by rainfall and monitoring will occur during and/or immediately following events.

Priority Nest Protection Area/s will be examined for signs of nesting (which included the presence of turtle tracks, diggings, nests and predated eggshells) using a single strip transect parallel to the water's edge, as per the standard methodology of Limpus *et al*., 2011a. Transects will vary in length and width according to bank morphology and will cover all potentially suitably nesting habitat within the Priority Nest Protection Area/s. Any evidence of turtle nesting will be photographed, and the GPS location recorded. If nests are detected, the following information will be recoded:

– GPS location of nest
– Photographs of nesting bank, nest and eggs or predated eggshell
– Distance of nest from water (m) and height above the water's surface (m)
– Bank slope, ground cover and riparian vegetation cover as per ratings nesting bank characterisation ratings above
– Distance to first egg (m)
– Egg diameter (cm) and egg length (cm)
– Number of eggs within nest
– Species of nest
– Nest predation (yes/no)
– Number of predated eggs observed (if relevant).

Nest protection cages will be installed, where possible and safe to do so, within 24 hours of nests being laid to minimise predation. Cages will be installed over nests *in-situ* or individual nests relocated to a communal protection cage/s located within the Priority Nest Protection Area/s, as per DES methodology. Handling and relocation of eggs will occur in accordance with animal ethics permit approvals to minimise risk of embryo dislocation and other risks to egg viability.

The hatching success of individual nests protected will be recorded throughout the hatching season. Monitoring may include the use of remote cameras to record emergence of hatchlings and/or the physical excavation of the nests to the top of the first egg to check for evidence of hatching. Physical excavation of hatched nests will be conducted by a field team member based on the timing and abundance of nests laid during the nesting season with hatching success monitoring conducted within two weeks of the expected date of hatching of each nest.

For those nests that have hatched, the number of eggs from which the hatchlings have successfully emerged will be recorded and compared to the total number of eggs laid. Predated eggshell and evidence of predators (e.g. tracks and scats) will also be recorded and photographed. Nests that have not hatched at the time of survey will be covered over and reassessed during subsequent monitoring.

At the end of the hatching success monitoring, predator protection cages and electric fencing will be removed prior to wet season flow events.

The success of the Nest Protection Management Plan will be evaluated annually against the performance criteria for each conservation outcome. The suitability of the management actions will be assessed and the requirement for adaptive management identified in light of new information and developments in technology. Data collected throughout the pre-nesting, nesting, and hatching seasons will be analysed in accordance with performance criteria to provide an assessment of compliance with conservation outcomes. An annual Nest Protection

Management Plan Report will be prepared to document the management actions implemented each year and the assess the success of actions against the performance objectives for each conservation outcome.

3.5.3 Condition compliance and conservation outcome

The biggest threat to the survival of the Fitzroy River turtle and white-throated snapping turtle is the lack of recruitment into the population (Commonwealth of Australia, 2008; Limpus *et al*., 2011a). Predation of nests by feral animals, goannas and water rats, plus trampling of nests by cattle results in extremely poor survival of egg clutches (close to 100% of clutches predated each season). The bias in favour of adult turtles within the Fitzroy River catchment indicates that low recruitment of hatchlings has been occurring over many decades (Commonwealth of Australia, 2008; Limpus *et al*., 2011a). Current recruitment rates are not considered adequate to sustain populations within the catchment (Limpus *et al.,* 2011a).

The protection and management of nests will improve hatching success and thus birth rate, will target Project-specific impacts, as well as address the key processes currently threatening the survival of these species throughout the catchment. These actions will reduce nest predation, increase population recruitment and promote the recovery of the species. Nest protection programs implemented in the Fitzroy River catchment under guidance from the DES and in other river systems throughout Australia (Connell and Wedlock, 2006; Connell, 2011; Connell, 2012; Stockfeld and Kleinert, 2013), are shown to immediately improve turtle nesting success and recruitment of hatchlings within a single breeding season. For example, in 2007 the Greening Australia team protected over 110 nests with an average of 15 eggs per nest. The sites were searched every morning at dawn for evidence of new nests between mid-September and the end of November. A protective mesh was placed over nests found to keep predators from gaining access but still allowing the turtles to hatch and make their way to the water. It is estimated that over 1,700 hatchlings reached the Fitzroy River (Hale, 2009). This success was repeated in 2008 (Hale, 2009). Similar levels of success have been recorded in the Burnett and Mary River catchment with nest protection programs for other species (B. Crosbie pers. comm.).

In accordance with EPBC Act Approval Condition 5, the Nest Protection Management Plan will be implemented until the conservation outcome is achieved. Due to the existing extremely high predation rates (close to 100 per cent), it is considered that the future value of the birth rate without secure and consistent management from the proposed offset will be at a low level (rated as 5 out of 100). With protection and the implementation of management measures proposed, the future value of the Fitzroy River turtle birth rate is predicted to improve (rating of 95 out of 100). Based on proven results, the confidence in the proposed change in nesting success and improved recruitment of hatchlings is 90 per cent. It is therefore conservatively estimated that the time required for the proposed offset to achieve ecological benefits is five years.

Table 19 details how the conservation effort and costs of the Fitzroy River Turtle Nest Protection Management Plan and White-throated Snapping Turtle Nest Protection Management Plan are aligned to those required by the approval conditions. Refer to Appendix A for additional detail on cost estimates.

Table 19 ***Nest Protection Management Plan condition compliance and contribution of species conservation – approximate cost estimate and actual costs (grey)***

Condition	Base case cost estimate	Actual conservation effort	Actual cost
Design of nest protection program as per Appendix G of the AEIS	$0 (prepared as part of EIS)	Design of revised nest protection program	$17,000 (actual cost)
Five years of implementation	Annual - $300,000 Total ($1,700,000 (cost estimate for 5 years)	Fitzroy River Turtle Nest Protection Management Plan and White-throated Snapping Turtle Nest Protection Management Plan implemented for life of the Project (5 years)	Annual - $300,000 Total ($1,700,000 (cost estimate for 5 years)
Total (rounded)	**$1,700,000**		**$1,700,000**
Additional conservation effort (rounded)			**$0**

3.6 Additional on-ground conservation actions

3.6.1 Conditions

In accordance with EPBC Act Approval Condition 5, offsets for modifying turtle aquatic habitat (Condition 4. b), can be provided through a financial offset (refer to Table 18).

3.6.2 Description

As discussed in Section 1.3, the total cost to offset 545.6 ha of aquatic habitat is $9,470,000, and this financial offset is proposed to be delivered through on-ground conservation actions. Additional on-ground conservation actions that will be implemented as part of this offset delivery include implementation of the Turtle Habitat Enhancement Program: Feral Pest Animal Management Plan, creation of a Turtle Conservation and Management GIS Data Platform, and/or other conservation actions agreed with DCCEEW.

Turtle Habitat Enhancement Program: Feral Pest Animal Management Plan

The Turtle Habitat Enhancement Program: Feral Pest Animal Management Plan, supplements both the Fitzroy River Turtle and White-throated Snapping Turtle Nest Protection Management Plans (Section 3.5). The Turtle Habitat Enhancement Program: Feral Pest Animal Management Plan details the implementation, management and monitoring of an expanded pest feral animal control program that will specifically target the priority nest protection areas and extending inland for up to 1 km.

The management actions detailed within the Turtle Habitat Enhancement Program: Feral Pest Animal Management Plan have been developed to meet the feral predator control outcomes as described in each of the Nest Protection Management Plans as follows:

– Measure of success: successful implementation (>95%) of planned predator control measures implemented annually.
– Evaluation methodology: feral predator control measures will be planned and implemented according to industry best practice and measured against planned activities. Feral pest populations will be monitored utilising camera trap arrays on priority control areas (PCAs).

Achievement of the predator control measures are critical to achievement of the overall success measures of each of the Nest Protection Management Plans, namely:

– Reduction of 80% in feral predator activity on PCAs
– Reduction of 90% in the nest predation rate
– Increase of 90% in the hatchling success rate.

The expanded feral pest animal management area has been determined as being within a 1 km buffer either side of the centreline of the Fitzroy, Mackenzie and Dawson Rivers between Hanrahan's Crossing and the northern boundary of Foleyvale. Priority Control Areas (PCAs) for feral pest animal control will be determined yearly based on the pre-nesting surveys to be undertaken as part of the Nest Protection Management Plans. The PCA areas include the high and medium priority nesting sites and the adjoining areas containing lacustrine, palustrine and/or riverine wetland areas up to 1km either side of the high bank of the river, where access is permitted.

The feral pest animal management measures have been developed in consultation with industry experts who provided advice relating to pest control strategies and principles, control effort and timing, and monitoring and evaluation techniques. Primary control methods will form the basis of this pest control program and will include:

– 1080 ground baiting of wild dogs and foxes in priority pest control areas
– Aerial shooting of feral pigs (and incidental shooting wild dogs and foxes).

Secondary control methods are sub-optimal techniques (in functional response) and tools that may be used where primary control methods are not suitable or are essential in gaining access permission from landholders. Secondary control methods may also be employed where pest predators are avoiding conventional control techniques. Secondary control methods utilised will be:

– Feral pig trapping

– Feral pig 1080 meat baiting (also sodium nitrate baiting)
– Wild dog and fox foothold trapping.

The timing of the management measures over the course of each year has been designed around the nesting and hatching seasons of the two turtle species. Monitoring of pest animal activity pre- and post-control operations will be undertaken using camera traps placed at 500 m intervals across the PCAs. Pest animal activity will be recorded and reported in annual reports and will be used to inform management decisions and to adapt and improve management actions.

Turtle Conservation and Management GIS Data Platform

A Turtle Conservation and Management GIS Data Platform will be created and managed throughout the operation of Rookwood Weir to collate and record turtle research, management and monitoring data. The platform will include:

– Data from previous studies, e.g. EIS.
– Existing turtle monitoring and nesting sites data from the design and construction phase of the project
– Annual monitoring data
– Annual nest protection areas and feral pest management locations
– Other environmental information.

The GIS platform will provide a centralised databased of turtle conservation and management activities and results, making information available inform recovery actions for the species.

3.6.3 Condition compliance and conservation outcome

As discussed in Section 3.5.3, the biggest threat to the survival of the Fitzroy River turtle and white-throated snapping turtle is the lack of recruitment into the population with predation of nests by feral animals contributing to extremely poor survival of egg clutches (Commonwealth of Australia, 2008; Limpus *et al*., 2011a). The Turtle Habitat Enhancement Program: Expanded Feral Pest Animal Management Plan will supplement both the Fitzroy River Turtle and White-throated Snapping Turtle Nest Protection Management Plans (Section 3.5) to address the key processes currently threatening the survival of these species throughout the catchment. The conservation outcome of predator control aligns with Management Strategy 1 of the Recovery Plan (Commonwealth of Australia, 2020 refer to Section 2) and Success Criteria 1, 2 and 8 of the Fitzroy Catchment Turtle Management Strategies (Limpus *et al*., 2011a, refer to Section 2).

In addition, the Turtle Conservation and Management GIS Data Platform aims to improve the collation and availability of data to inform recovery actions for the species, namely by collating existing information on the species and by maintaining a register of research, monitoring, and management actions. The platform aligns with Management Strategy 5 of the Recovery Plan (Commonwealth of Australia, 2020 refer to Section 2).

These additional on-ground conservation actions are not specified approval conditions and therefore not included in base case cost estimate. In total, the additional on-ground conservation actions will include $2,100,000 in conservation effort to achieve conservation outcomes (Table 20). Refer to Appendix A for additional detail on cost estimates.

Table 20 ***Additional on-ground conservation actions contribution of species conservation – approximate cost estimate and actual costs (grey)***

Condition	Base case cost estimate	Actual conservation effort	Actual cost
Turtle Habitat Enhancement Program: Expanded Feral Pest Animal Management Plan	$0	Turtle Habitat Enhancement Program: Expanded Feral Pest Animal Management Plan Implementation, management and monitoring of a expanded pest feral animal control program that will specifically target the priority nest protection areas to contribute to the overall success of the Nest Protection Management Programs	$2,000,000
Turtle Conservation and Management GIS Data Platform	$0	Turtle Conservation and Management GIS Data Platform Creation and management of GIS data platform to collate and record turtle research, management and monitoring data.	$100,000
Total (rounded)	**$0**		**$2,100,000**
Additional conservation effort (rounded)			**$2,100,000**

4. Summary

As per Condition 4 and 5 of the EPBC approval, offsets are required for modifying 545.6[3] hectares (ha) of aquatic habitat. In accordance with the Queensland environmental offsets policy's financial settlement calculator, the total cost to offset turtle aquatic habitat is $9,470,000. Delivery of this financial offset is proposed to occur through delivery of on-ground conservation actions. The total cost of turtle management and conservation effort undertaken as part of the Rookwood Weir Project is $20,500,000 (Table 21). This cost includes $1,700,000 dedicated to implementation of Nest Protection Management Plans for the Fitzroy River turtle and white-throated snapping turtle to offset the inundation of turtle nests within the impoundment and downstream of Rookwood Weir.

The biggest threat to the survival of the Fitzroy River turtle and white-throated snapping turtle is the lack of recruitment into the population (Commonwealth of Australia, 2008; Limpus *et al*., 2011a). Predation of nests by feral animals, goannas and water rats, plus trampling of nests by cattle results in extremely poor survival of egg clutches (close to 100% of clutches predated each season) and current recruitment rates are not considered adequate to sustain populations within the catchment (Limpus *et al*., 2011a). The protection and management of nests as part of the Rookwood Weir Nest Protection Management Plans, will improve hatching success and thus birth rate, will target Project-specific impacts, as well as address the key processes currently threatening the survival of these species throughout the catchment. In accordance with EPBC Act Approval Condition 5, the Nest Protection Management Plan will be implemented until the conservation outcome is achieved. It is conservatively estimated that the time required for the proposed offset to achieve ecological benefits is five years (Appendix G of AEIS). A total of $1,700,000 (Table 21) will therefore be dedicated to achieving long-term protection and management of turtle nesting habitat and recruitment of hatchings into the population to support recovery of the species.

A total of $16,500,000 has/will be invested in on-ground turtle and turtle habitat protection, research and species management associated with pre-clearance surveys, a turtle movement study, turtle passage infrastructure and monitoring, and Species Management Programs (Table 21). The management and conservation efforts have included $7,400,000 of commitments above those required by Project approval conditions. The additional conservation efforts will mitigate the impacts caused by the Rookwood Weir Project and will substantially contribute to the recovery of the Fitzroy River turtle and white-throated snapping turtle in the Fitzroy River catchment. Specifically, these targeted management and conservation efforts will achieve the following conservation outcomes the Recovery Plan (Commonwealth of Australia, 2020), and the Fitzroy Catchment Turtle Management Strategies:

– Recovery plan:
  - Strategy 1 - Improve the recruitment of hatchlings and juveniles in the population.
  - Strategy 2 -Decrease adult/subadult mortality and reducing barriers to movement along waterways.
  - Strategy 3 - Improve stream flow, habitat quality and identify habitat and movement patterns of the species
  - Strategy 5 - Improve the collation and availability of data to inform recovery actions for the species.
– Fitzroy Catchment Turtle Management Strategies
  - Success criteria 1 - Improved recruitment of hatchlings into the population
  - Success criteria 2 - Maintenance of functional turtle nesting banks throughout the catchment
  - Success criteria 3 - Maintenance of stream flow and high quality in-river habitat between impoundments
  - Success criteria 4 - Maintenance of continuity of turtle populations throughout the catchment
  - Success criteria 5 - Reduction in the incidence of death and physical injury of turtles at existing and future impoundment structures
  - Success criteria 8 - Increase in the area of river and adjacent riverine habitat managed for conservation purposes

[3] Condition 4 states the LFRIP will modify 942 ha of aquatic habitat from Rookwood Weir Stage 2 and Eden Bann Stage 3. Rookwood Weir with a weir crest height of RL 46.2 m AHD inundates 545.6 ha of aquatic habitat for the Fitzroy River turtle.

- Success criteria 10 - Monitoring the response of turtle populations in the Fitzroy Catchment to the management strategies and evaluate the effectiveness of these strategies.

It is proposed that the $7,400,000 of on-ground conservation outcomes achieved by the Project above and beyond those required by approval conditions, contributes as partial payment of the $9,470,000 financial contribution required for turtle aquatic habitat. The remaining offset for aquatic habitat is proposed to be delivered through additional on-ground conservation actions for the two turtle species. Actions are expected to include implementation of the Turtle Habitat Enhancement Program: Feral Pest Animal Management Plan, creation of a Turtle Conservation and Management GIS Data Platform, and/or other conservation actions agreed with DCCEEW, up to an amount of $2,100,000 (Table 21).

Table 21 provides a summary of all required approval conditions and associated costs compared to actual conservation effort undertaken for the Fitzroy River turtle and white-throated snapping turtle. Sunwater will track the actual financial spend on the on-ground turtle conservation and management actions and report to DCCEEW annually to demonstrate delivery of the financial offset requirement.

Table 21 Summary of condition compliance and contribution to species conservation

Condition	Base cost estimate	Actual conservation effort	Actual cost with additional conservation effort	Financial offset contribution
Pre-clearance surveys – 1 survey event	$28,000	**Pre-clearance surveys** – 16 survey events	$510,000	$482,000
Turtle movement study – 18-month duration – 80 acoustic tags – 20 hydrophones	$740,000	**Turtle movement study** – Six years duration – 115 acoustic tags – 28 hydrophones – Two satellite tags	$1,600,000	$860,000
Turtle passage – Standard consultation and detailed design – Construction of basic concept design – Operation and maintenance of basic concept design – Turtle passage infrastructure monitoring program – Adaptive management of basic concept design – Catch and release program	$6,800,000	**Turtle passage** – Extensive consultation and detailed design over four years – Construction of world first state of the art design – Operation and maintenance of world first state of the art design – Extensive turtle passage infrastructure monitoring program based on success criteria – Adaptive management of world first state of the art design – Catch and release program	$12,600,000	$5,800,000
Species Management Programs – Design of standard Construction SMP per Appendix E of the AEIS	$1,500,000	**Species Management Programs** – Design of revised Construction SMP – Implementation of revised Construction	$1,800,000	$300,000

Condition		Base cost estimate	Actual conservation effort	Actual cost with additional conservation effort	Financial offset contribution
– Implementation of standard Construction SMP – Design of standard Operations SMP per Appendix E of the AEIS – Implementation of standard Operations SMP			SMP including turtle tagging – Design of revised Operations SMP – Implementation of standard Operations SMP – Broad-scale turtle monitoring program		
Sub-total (rounded)		**$9,100,000**		**$16,500,000**	**$7,400,000**
Nest Protection Management Programs – Design as per Appendix G of the AEIS – Five years of implementation		$1,700,000	**Nest Protection Management Programs** – Revised design of Fitzroy River Turtle and White-throated Snapping Turtle Nest Protection Management Programs – Five years of implementation	$1,700,000	$0
Additional On-ground Conservation Actions	Turtle Habitat Enhancement Program: Expanded Feral Pest Animal Management Plan	$0	**Turtle Habitat Enhancement Program: Expanded Feral Pest Animal Management Plan** – Implementation, management and monitoring of a expanded pest feral animal control program that will specifically target the priority nest protection areas to contribute to the overall success of the Nest Protection Management Programs	$2,000,000	$2,000,000
	Turtle Conservation and Management GIS Data Platform	$0	**Turtle Conservation and Management GIS Data Platform** – Creation and management of GIS data platform to collate and record turtle research, management and monitoring data.	$100,000	$100,000
Sub-total (rounded)		**$1,700,000**		**$4,000,000**	**$2,100,000**
Total (rounded)		**$10,800,000**		**$20,500,000**	**$9,500,000**
Note: All values and totals have been rounded - refer to Table 6					

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Appendices

Appendix A

Cost estimate

Condition	Cost estimate	Details of estimates	Actual conservation effort	Actual cost	Details of costings
Pre-clearance surveys					
Pre-clearance survey for Fitzroy River turtle within impact area prior to clearing of vegetation/inundation	$28,000	Actual GHD costs based on one nesting survey event within the inundation area Cost includes time for field preparation, travel, three-day field survey for two-staff, reporting, project management and disbursements including flights, vessel, accommodation, field equipment	16 x pre-clearance surveys for Fitzroy River turtle and white-throated snapping turtle within, upstream and downstream of the inundation area.		Actual GHD costs based on field preparation, travel, field survey, reporting, project management and disbursements including flights, vessel, accommodation and field equipment Survey type, duration of field survey and number of ecologists are summarised below with further details provided in Section 3.1.2: Table 8
			2016 – 2017 (3 events)	$44,000	Targeted nesting survey within construction footprints. Three separate surveys conducted over for 7 days with 2 ecologists
			June 2019	$28,000	Broad scale pre-clearance survey for 3 days with 2 ecologists
			September 2019	$28,000	Broad scale pre-clearance survey for 3 days with 2 ecologists
			December 2019	$28,000	Broad scale pre-clearance survey for 3 days with 2 ecologists
			June 2020	$28,000	Broad scale pre-clearance survey for 3 days with 2 ecologists
			August 2020	$20,000	Targeted nesting survey within construction footprint for 2 days with 2 ecologists
			September 2020	$28,000	Targeted nesting survey within construction footprint for 7 days with 1 ecologist

Condition	Cost estimate	Details of estimates	Actual conservation effort	Actual cost	Details of costings
			October 2020	$28,000	Broad scale pre-clearance survey for 3 days with 2 ecologists
			November 2020	$13,000	Targeted nesting survey within construction footprint for 2 days with 1 ecologist
			December 2020	$39,000	Broad scale pre-clearance survey for 5 days with 2 ecologists
			April 2021	$25,000	Broad scale pre-clearance survey for 2 days with 2 ecologists
			June 2021	$48,000	Broad scale pre-clearance survey + targeted survey at Hanrahan Crossing for 7 days with 2 ecologists
			July 2021	$48,000	Broad scale pre-clearance survey for 7 days with 2 ecologists
			August 2021	$53,000	Broad scale pre-clearance survey for 8 days with 2 ecologists
			October 2021	$48,000	Broad scale pre-clearance survey for 7 days with 2 ecologists
Turtle Movement Study					
Design of turtle movement study in consultation with DES	$33,000	Business case cost estimate for preparation of turtle movement study design report	Design of turtle movement study in consultation with DES	$28,000	Actual GHD costs for preparation of turtle movement study design report
Turtle movement study conducted for 18 months during the Project design phase	$560,000	Business case cost estimate for implementation of turtle movement study for 18 months during the Project design phase	Turtle movement study conducted for four years during the Project design phase and three years during Project construction	$1,400,000	Actual GHD costs from Years 1-7 (Project design phase and construction phase) Total cost excludes any costs associated with broad-scale nesting (as

Condition	Cost estimate	Details of estimates	Actual conservation effort	Actual cost	Details of costings
					costed above) and equipment costs detailed below for acoustic tags, satellite tags and hydrophones
Tagging - 80 acoustic tags to be deployed during the Project design phase (20 each per male and female of each species)	$88,000	Actual GHD costs for 80 tags at $1,100 per acoustic tag including cost of supply and attachment disbursements	A total of 115 acoustic tags deployed over the Project design phase	$130,000	Actual GHD costs for 115 tags at $1,100 per acoustic tag including cost of supply and attachment disbursements
			Trial of two satellite tags over 586 days	$11,000	Actual GHD costs for 2 tags at $7,090 per satellite tag including cost of supply and attachment disbursements, + $150 per month satellite time for 20 months
20 acoustic hydrophone receivers (with attachment cable) to be deployed during the Project planning and design phase	$60,000	Actual GHD costs for 20 hydrophone receivers at $3,000 per hydrophone receivers including cost of supply and installation disbursements	A total of 28 acoustic hydrophone receivers deployed during the Project planning and design phase	$84,000	Actual GHD costs for 28 hydrophone receivers at $3,000 per hydrophone receivers including cost of supply and installation disbursements
Consultation with DES on design and development of success criteria	Refer to Table 15		Extensive consultation with DES over four years and preparation of Turtle Infrastructure Design Process Report	Refer to Table 15	
Turtle passage					
Detail design including consultation with DES and development of success criteria	$57,000	Business case estimate for DES engagement ($22,000) and detailed design ($35,000)	Extensive consultation with DES over four years and preparation of Turtle Infrastructure Design Process Report Extensive structural and mechanical detailed design	$85,000	Actual GHD cost for DES engagement and preparation of report ($20,000) and structural and mechanical design ($65,000)

<table>
<tr><th>Condition</th><th>Cost estimate</th><th>Details of estimates</th><th>Actual conservation effort</th><th>Actual cost</th><th>Details of costings</th></tr>
<tr><td>Construction</td><td>$600,000</td><td>Sunwater business case estimate for EIS design</td><td>Construction</td><td>$2,400,000</td><td>Actual construction cost estimate from Rookwood Alliance
Total cost based on actual design developed in association with DES</td></tr>
<tr><td>Operations and maintenance</td><td>Annual - $120,000
Total (25 years) - $4,000,000
<table><tr><th>Years</th><th>Annual (plus 10% inflation)</th><th>5 year total</th></tr><tr><td>1-5</td><td>132,000</td><td>660,000</td></tr><tr><td>5-10</td><td>145,200</td><td>726,000</td></tr><tr><td>10-15</td><td>159,720</td><td>798,600</td></tr><tr><td>15-20</td><td>175,692</td><td>878,460</td></tr><tr><td>20-25</td><td>193,261</td><td>966,306</td></tr><tr><td colspan="2">Total ($ rounded))</td><td>4,000,000</td></tr></table></td><td>Cost estimate based on EIS design, calculated as 60% of actual operation and maintenance costs
Percentage used (60%) based on difference in construction costs of EIS design and actual design
Total includes 10% inflation every 5 years</td><td>Operations, maintenance and flood repair</td><td>Annual - $220,000
Total (25 years)- $7,400,000
<table><tr><th>Years</th><th>Annual (plus 10% inflation)</th><th>5 year total</th></tr><tr><td>1-5</td><td>242,000</td><td>1,210,000</td></tr><tr><td>6-10</td><td>266,200</td><td>1,331,000</td></tr><tr><td>11-15</td><td>292,820</td><td>1,464,100</td></tr><tr><td>16-20</td><td>322,102</td><td>1,610,510</td></tr><tr><td>21-25</td><td>354,312</td><td>1,771,560</td></tr><tr><td colspan="2">Total ($ rounded))</td><td>7,400,000</td></tr></table></td><td>Actual operation and maintenance cost estimate from Sunwater based on actual design
Total includes 10% inflation every 5 years</td></tr>
<tr><td>Turtle passage infrastructure monitoring program</td><td>$2,000,000</td><td>Business case estimate based on EIS monitoring program design</td><td>Extensive monitoring program based on success criteria developed during detailed design phase and in consultation with DES</td><td>$2,500,000</td><td>Actual cost estimate based on monitoring program developed for agreed success criteria as detailed in Turtle Infrastructure Design Process Report</td></tr>
<tr><td>Adaptive management of design</td><td>$60,000</td><td>Cost estimate based on 20% of estimated construction cost for EIS design</td><td>Adaptive management of design</td><td>$200,000</td><td>Cost estimate based on 20% of actual construction cost</td></tr>
<tr><td>Catch and release program</td><td>$33,000</td><td>As per actual cost</td><td>Catch and release program</td><td>$33,000</td><td>Cost estimate based on actual catch and release program detailed in Turtle Infrastructure Design Process Report</td></tr>
</table>

Condition	Cost estimate	Details of estimates	Actual conservation effort	Actual cost	Details of costings
Species Management Program					
Design of standard Construction SMP (as per Appendix E of the AEIS)	$0	No cost – SMP prepared as part of EIS	Design of revised Construction SMP (Additional engagement, collaboration across design, construction and operations teams and further development of management strategies into updated Construction SMP)	$25,000	Actual GHD cost for design of revised SMP
Implementation of standard Construction SMP	$300,000	As per actual cost from Rookwood Alliance	Implementation of revised Construction SMP	$300,000	Actual cost from Rookwood Alliance
	$0	Not included in EIS	Additional tagging of Fitzroy River turtles and white-throated snapping turtles with acoustic and identification tags	$10,000	Actual GHD cost for 5 x 1 day field surveys for 1 ecologist including travel disbursements Total does not include equipment costs which are included in Turtle Movement Study costs
Design of standard Operations SMP (as per Appendix E of the AEIS)	$0	No cost – SMP prepared as part of EIS	Design of revised Operations SMP	$15,000	Actual GHD cost for design of revised SMP
Implementation of standard Operations SMP	Annual - $15,000 Total (25 years) - $500,000	As per actual cost estimate Annual costs associated with inspections annual compliance reporting and incident reporting Total includes 10% escalation every 5 years	Implementation of revised Operations SMP	Annual - $15,000 Total (25 years) - $500,000	Cost estimate for revised SMP Annual costs associated with inspections annual compliance reporting and incident reporting Total includes 10% escalation every 5 years

Condition	Cost estimate	Details of estimates	Actual conservation effort	Actual cost	Details of costings
	Years / Annual (plus 10% inflation) / 5 year total 1-5: 16,500 / 82,500 5-10: 18,150 / 90,750 10-15: 19,965 / 99,825 15-20: 21,962 / 109,808 20-25: 24,158 / 120,788 Total ($ rounded)): 500,000			Years / Annual (plus 10% inflation) / 5 year total 1-5: 16,500 / 82,500 5-10: 18,150 / 90,750 10-15: 19,965 / 99,825 15-20: 21,962 / 109,808 20-25: 24,158 / 120,788 Total ($ rounded): 500,000	
	$0	Not included in EIS	Key Operations actions: Turtle Movement Study	Refer to Section 3.2	
	$0	Not included in EIS	Fitzroy River turtle Nest Protection Management Plan	Refer to Section 3.5	
	$0	Not included in EIS	White-throated snapping turtle Nest Protection Management Plan	Refer to Section 3.5	
	$0	Not included in EIS	Turtle Monitoring Program	$280,000	Cost estimate based on actual Operational Phase Monitoring Program as detailed in Operations SMP 5 years of broad-scale monitoring (2 survey events per year) and reporting
Nest Protection Management Plans					
Design of nest protection program as per Appendix G of the AEIS	$0	Prepared as part of EIS	Design of revised nest protection program	$17,000	Actual cost from GHD

<table>
<tr><th>Condition</th><th>Cost estimate</th><th>Details of estimates</th><th>Actual conservation effort</th><th>Actual cost</th><th>Details of costings</th></tr>
<tr><td>Five years of implementation</td><td>Annual - $300,000
Total (5 years)
Total ($1,700,000)<table><tr><th>Years</th><th>Annual (plus 10% inflation)</th></tr><tr><td>1</td><td>300,000</td></tr><tr><td>2</td><td>330,000</td></tr><tr><td>3</td><td>363,000</td></tr><tr><td>4</td><td>399,300</td></tr><tr><td>5</td><td>439,230</td></tr><tr><td>Total ($ rounded)</td><td>1,700,000</td></tr></table></td><td>Cost estimate for 5 years implementation
Total cost includes nest protection, weed and pest management activities as per Nest Protection Management Plans
Total includes 10% escalation over 5 years</td><td>Fitzroy River Turtle Nest Protection Management Plan and White-throated Snapping Turtle Nest Protection Management Plan implemented for 5 years</td><td>Annual - $300,000 per year for 5 years
Total (5 years) - $1,700,000<table><tr><th>Years</th><th>Annual (plus 10% inflation)</th></tr><tr><td>1</td><td>300,000</td></tr><tr><td>2</td><td>330,000</td></tr><tr><td>3</td><td>363,000</td></tr><tr><td>4</td><td>399,300</td></tr><tr><td>5</td><td>439,230</td></tr><tr><td>Total ($ rounded)</td><td>1,700,000</td></tr></table></td><td>Cost estimate for 5 years implementation
Total cost includes nest protection, weed and pest management activities as per Nest Protection Management Plans
Total includes 10% escalation over 5 years</td></tr>
<tr><td colspan="6">Turtle Habitat Enhancement Program: Expanded Feral Pest Animal Management Plan</td></tr>
<tr><td>Implementation of Turtle Habitat Enhancement Program: Expanded Feral Pest Animal Management Plan</td><td>$0</td><td>Not included in EIS</td><td>Implementation, management and monitoring of a expanded pest feral animal control program that will specifically target the priority nest protection areas to contribute to the overall success of the Nest Protection Management Programs</td><td>$2,200,000</td><td>Cost estimate for x years implementation Total cost includes xxx</td></tr>
<tr><td colspan="6">Turtle Conservation and Management GIS Data Platform</td></tr>
<tr><td></td><td>$0</td><td>Not included in EIS</td><td>Creation and management of GIS data platform to collate and record turtle research, management and monitoring data.</td><td>$100,000</td><td>Cost estimate includes creation of GIS data platform, incorporation of existing environmental and turtle data, ongoing collation of annual turtle research, management and monitoring data.</td></tr>
</table>

Note: All values and totals have been rounded - refer to Table 6

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