5. Fitzroy River turtle and white-throated snapping turtle

Potential impacts on aquatic ecology have been addressed in the draft EIS (Volume 1 Chapter 7 Aquatic ecology). Management measures are addressed in the draft EIS EMP in Chapter 23 of Volume 1 and Chapter 13 of Volume 2. Submissions made on the draft EIS in this regard primarily relate to impacts on the Fitzroy River turtle and the recently listed white-throated snapping turtle as detailed in the following sections.

5.1 Environmental management

Submissions

This section provides information on the mitigation and management of impacts on the Fitzroy River turtle and the white-throated snapping turtle in response to submissions received from:

- CCC (029.27, 029.08)
- DEHP (028.16, 028.26, 028.27)
- DoE (021.18, 021.21, 021.22, 021.26)
- FBA (011.05, 011.08, 011.09, 011.10, 011.11, 011.13, 011.14, 011.15, 11.16, 011.28), 011.29.

Response

A review of the Nature Conservation (Wildlife) Regulation 2006 (NC Regulation) has been undertaken in response to the approved changes to the list of threatened species made by the Governor in Council on 27 August 2015. Flora and fauna species as assessed in the draft EIS remain valid.

It is noted that the white-throated snapping turtle (or southern snapping turtle) is listed as a threatened species (endangered) within the NC Regulation. Potential impacts, mitigation, management and offset measures in relation to the white-throated snapping turtle have been addressed in:

- The SMP for the Fitzroy River turtle and white-throated snapping turtle (Appendix E)
- The revised EMP (Section 12 and Appendix F)
- The revised offset proposal for the Fitzroy River turtle and white-throated snapping turtle (Appendix G)
- The revised Project commitments (Section 13 and Appendix D).

As at October 2014, the white-throated snapping turtle was listed as critically endangered under the EPBC Act. At the time of assessment and referral decision (EPBC 2009/56) being made (7 January 2010) the species was not listed as a threatened species. For this reason, under the EPBC Act further assessment as a MNES is not required.

5.2 Offsets

Submissions

This section provides revised information on proposed offsets for the Fitzroy River turtle and the white-throated snapping turtle in response to submissions received from:

- CCC (029.27)
- DEHP (028.17, 028.19, 028.22, 028.23)
- DoE (021.25, 021.26)
- FBA (011.05, 011.08, 011.10, 011.11, 011.13, 011.15, 011.28, 011.30).

Response

The offset proposals as presented in the draft EIS (Chapter 14 of Volume 2 and Chapter 22 of Volume 2) in relation to significant residual impacts on the Fitzroy River turtle have been consolidated and revised to include the white-throated snapping turtle and presented in Appendix G.

5.3 Turtle nesting habitat

Submissions

Weir operations are addressed in Section 7.2.2. Further to suggestions that the Project storages could be operated such that impacts on the nesting habitat of the Fitzroy River turtle and white-throated snapping turtle (upstream and downstream) could be mitigated and managed, clarifications are provided in the sections below. The following submissions are addressed in this section:

- DoE (021.20)
- DEHP (028.05)
- FBA (011.05, 011.08, 011.10, 011.12, 011.13, 011.16, 11.29).

Response

5.3.1 Approach and methodology

As described and discussed in the draft EIS (Volume 1, Chapter 7 Aquatic ecology), the storage of water within the raised Eden Bann Weir impoundment and the new Rookwood Weir impoundment has the potential to inundate turtle nesting habitat. The Fitzroy River turtle and the white-throated snapping turtle nesting seasons and nesting habitat requirements are summarised as follow:

- Fitzroy River turtle
  - The nesting period is from September to November with hatching occurring in summer
  - Nesting in the Fitzroy River is generally restricted to alluvial sand/loam banks. Banks with a relatively steep slope, low density of ground/understorey vegetation and partial shade cover appearing to be preferred

  - Nesting generally occurs approximately 5 m to 6 m from the water's edge (Limpus et al. 2007; Hamann et al. 2007; Limpus et al. 2011a).
- White-throated snapping turtle
  - The nesting period is from March to September with hatching occurring in early summer (December and January)
  - Nesting is primarily restricted to sand and loam alluvial deposits
  - Nesting generally occurs at the top of steep slopes in sand and soil substrates that are ~ 5 m from the water's edge and 3 m above water level. Nesting can, however, occur up to 60 m from the water edges and over 8 m above the water level (Limpus et al. 2007; Hamann et al. 2007; Limpus et al. 2011a).

It has been suggested by DEHP that the storages could be operated such that impacts on the turtle nesting habitat (that is water level relative to the nesting locations on the river bank) are mitigated and managed as is done for the Ben Anderson Barrage on the Burnett River. The Burnett Basin WRP contains rules about the nominal operating level of the Ben Anderson Barrage storage to be adopted during certain months of the year in order to minimise the risk of turtle nests becoming inundated during subsequent rises in the storage level.

The management of the Project storages, that is the ability (or not) to regulate storages levels and/or make releases relative to the nesting seasons and / or nesting habitat requirements is discussed further below.

In order to determine the feasibility of operating the Project storages (Eden Bann Weir and Rookwood Weir) by regulating storages levels and or releases relative to nesting periods and habitat (turtle nesting operation), the modelled daily water levels at the Rookwood Weir and the Eden Bann Weir were examined.

The modelled daily water level at each weir was determined utilising output data from the IQQM-Project for the simulation period (1900 through to 2007), measured as daily storage volume (ML). To convert the daily storage volume to the height of water at the weir (reduced level (RL) m AHD), GHD used the storage capacity data shown in SunWater drawing 222527, including the evaporation estimation in the IQQM-Project.

These water levels were then plotted during the months of the turtles nesting period. For the Fitzroy River turtle this was September through to November, and the white-throated snapping turtle, March through to September.

5.3.2 Turtle nesting upstream within storages

Storage levels for Eden Bann Weir during the Fitzroy River turtle and white-throated snapping turtle nesting periods are shown on Figure 5-1 and Figure 5-2, respectively.

Storage levels for Rookwood Weir during the Fitzroy River turtle and white-throated snapping turtle nesting periods are shown on Figure 5-3 and Figure 5-4, respectively.

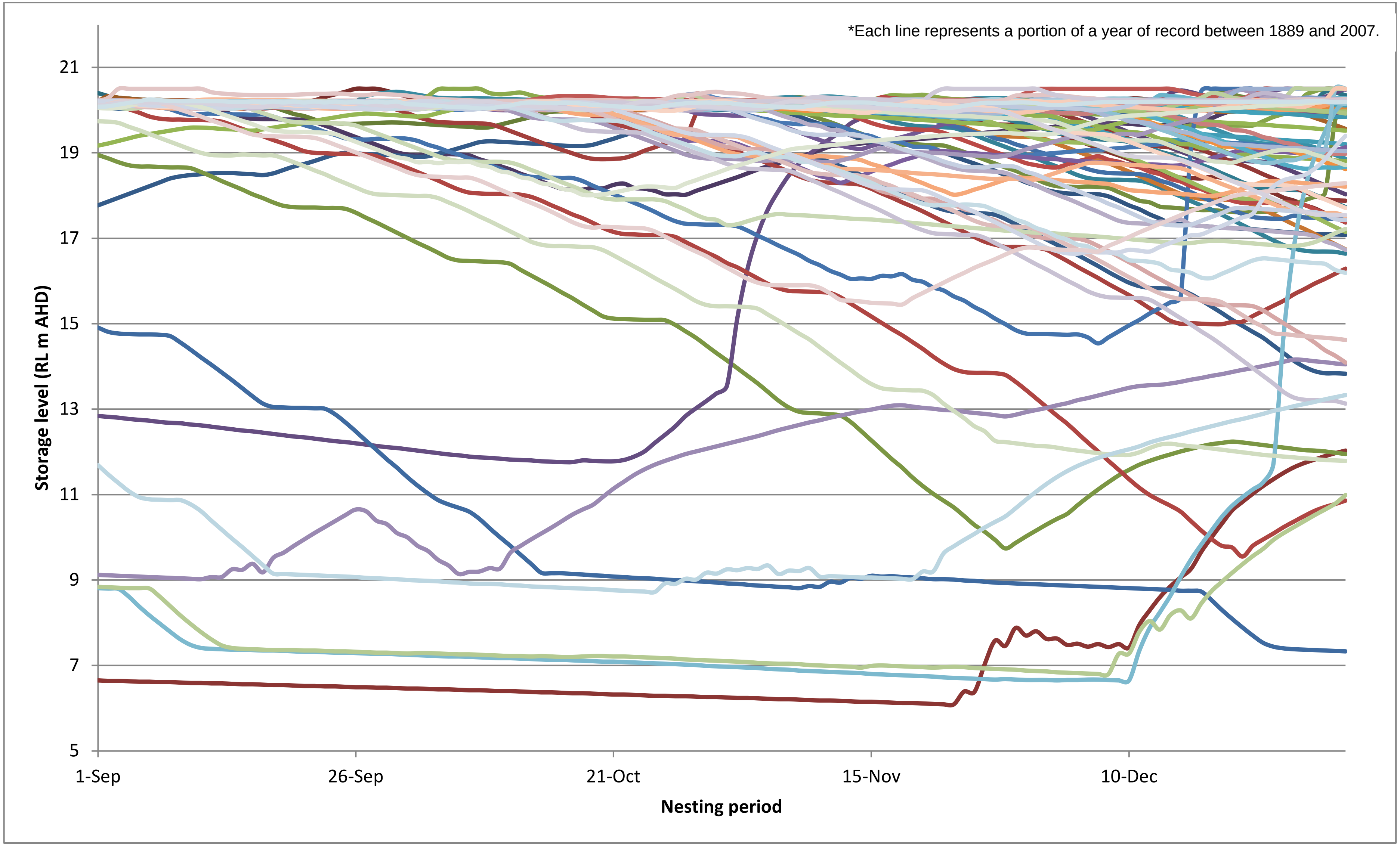


Figure 5-1 Eden Bann Weir Stage 3 storage levels during the Fitzroy River turtle nesting period

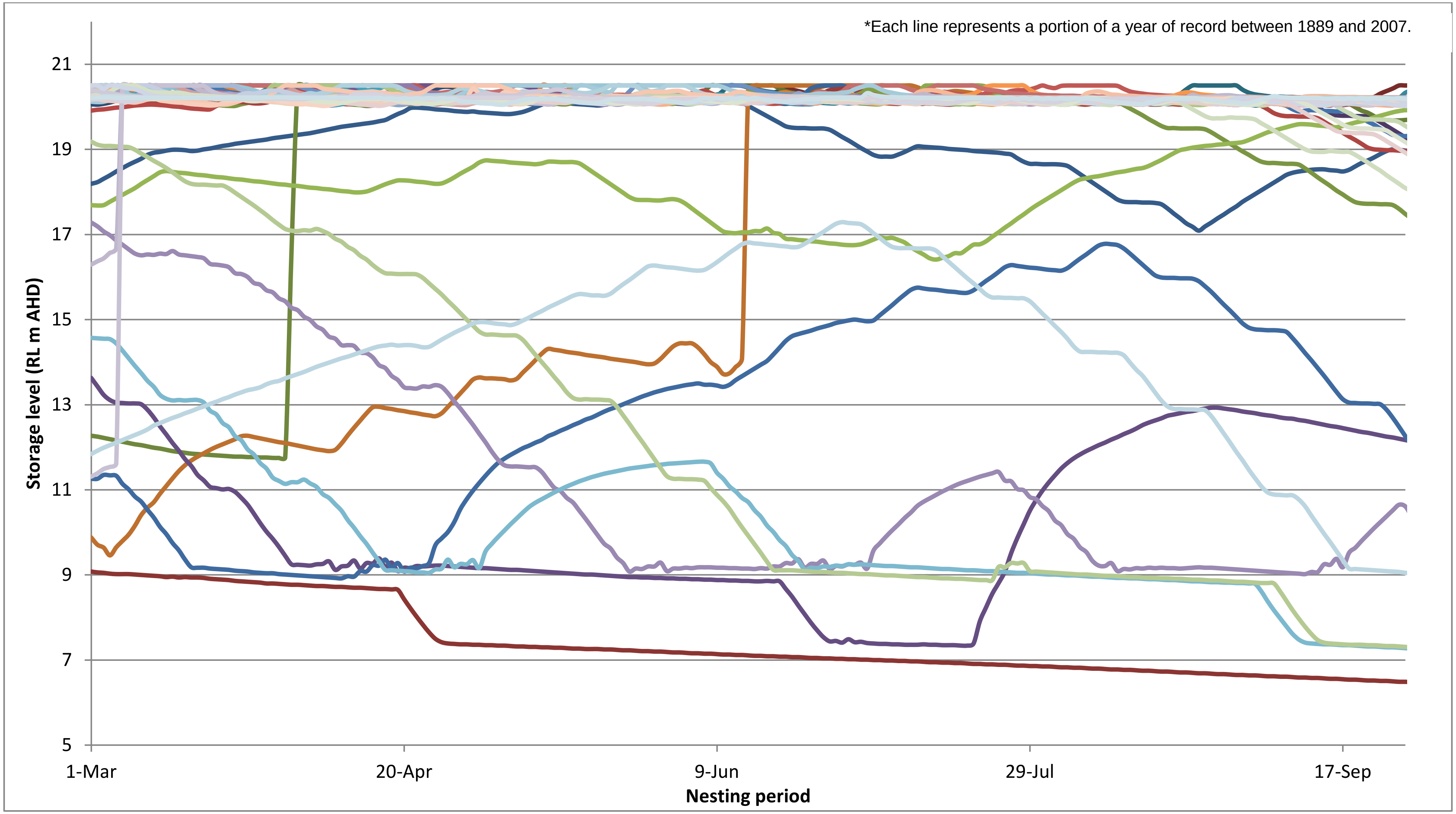


Figure 5-2 Eden Bann Weir Stage 3 storage levels during the white-throated snapping turtle nesting period

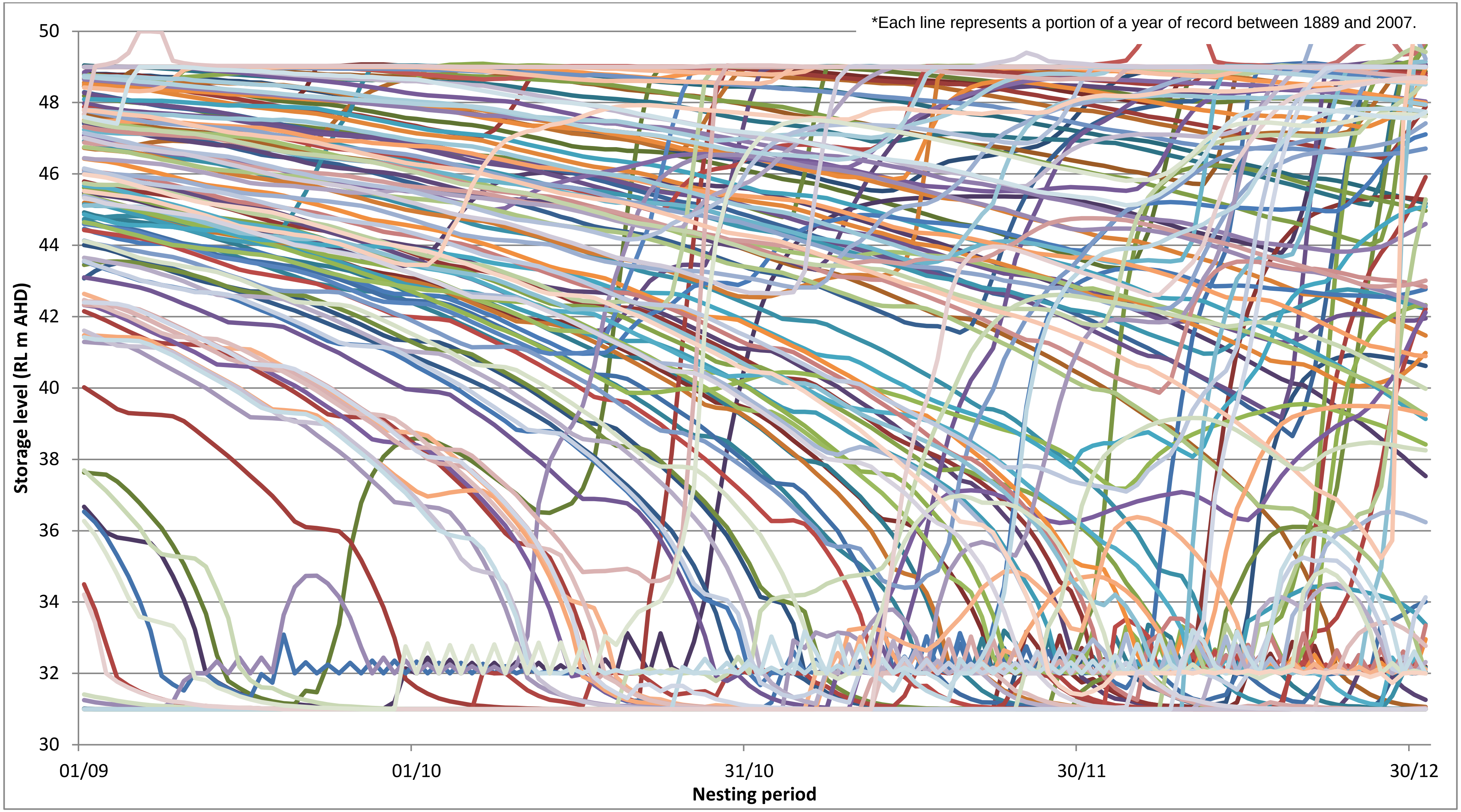


Figure 5-3 Rookwood Weir Stage 2 storage levels during the Fitzroy River turtle nesting period

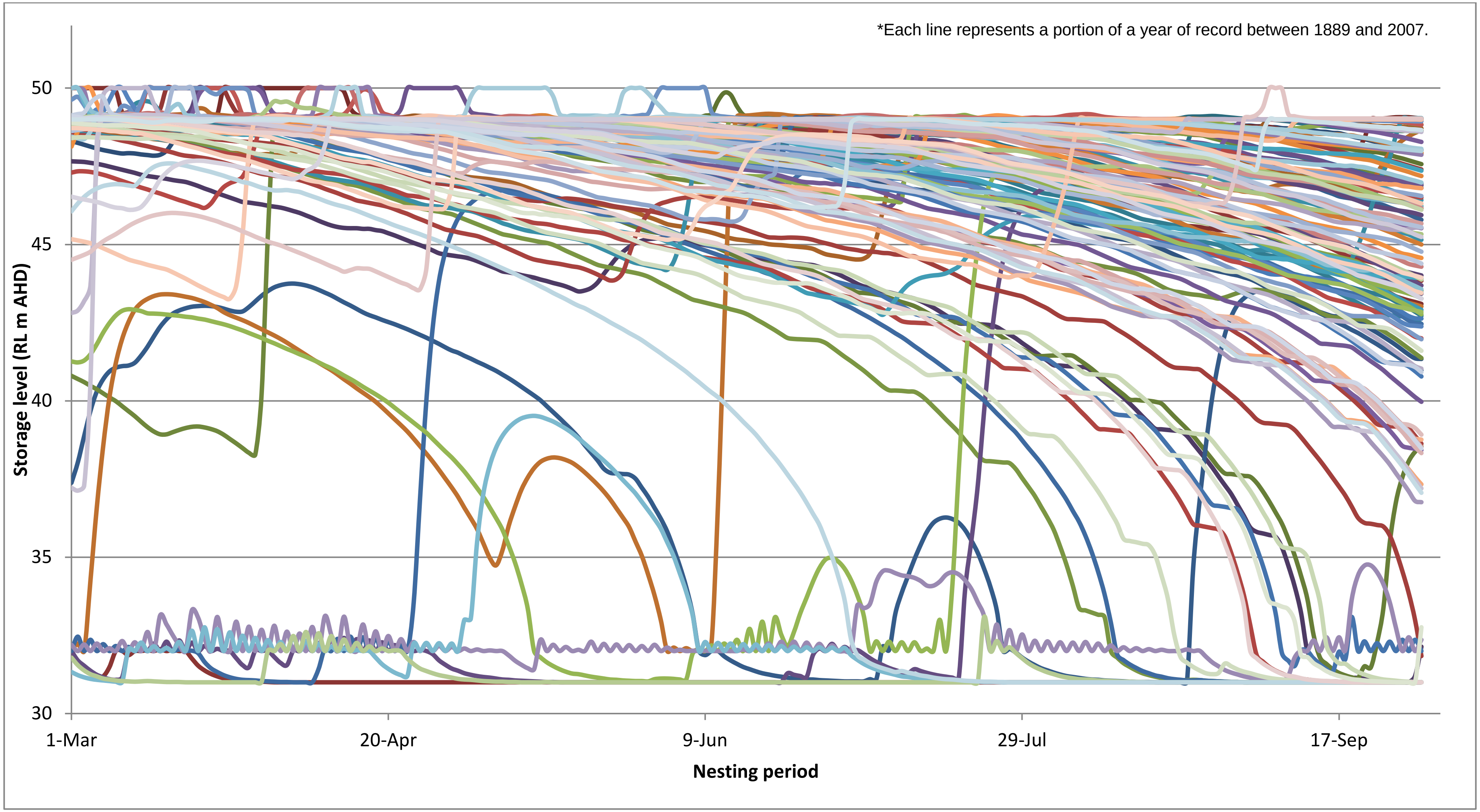


Figure 5-4 Rookwood Weir Stage 2 storage levels during the white-throated snapping turtle nesting period

Eden Bann Weir

At Eden Bann Weir, water levels vary from above FSL (20.2 m AHD) to empty. Upon examination of the data, the following is noted.

In relation to the Fitzroy River turtle:

- In keeping with the proposed operational regime, releases are made from Rookwood Weir to Eden Bann Weir to maintain FSL in order to pass water to the Fitzroy Barrage to maintain the Fitzroy Barrage at FSL (Section 7.2.2). This strategy reduces water evaporation and transportation losses and reduces pumping costs at the extraction points at the Fitzroy Barrage
- Water levels within the Eden Bann Weir storage are generally high (at or near to FSL) at the start of the turtle nesting season
- Figure 5-1 shows that there is generally a decreasing water level trend between the months of September to November as releases are made to satisfy demand and environmental flow requirements, and for the majority of the years modelled water levels remain between RL 17 m AHD and FSL (RL 20.2 m AHD)
- Water levels within the storage, while generally decreasing, start to rise again towards the end of the nesting season in response to spring and summer rainfall events in the catchment.

For the white-throated snapping turtle:

- As described for the Fitzroy River turtle above, releases are made from Rookwood Weir to Eden Bann Weir to maintain FSL in order to pass water to the Fitzroy Barrage to maintain the Fitzroy Barrage at FSL (Section 7.2.2) for the same reasons described above
- In years where water levels are below FSL at the start of the nesting period, there is considerable variability in storage levels which is consistent with the variability of climatic influences (flooding, early and late rainfall events etc.) experienced within the Fitzroy River system
- Generally, water levels remain at a constant level (approximately RL 20 m AHD) from March until the end of August. During this period, releases made to maintain the Fitzroy Barrage at FSL are facilitated from the Rookwood Weir
- Water levels begin to decline during September when Rookwood Weir is drawn down and releases are being made from Eden Bann Weir itself.

Under a full project development scenario (i.e. with all stages in place), inflows to Eden Bann Weir can potentially be managed to some degree through releases from Rookwood Weir (as is demonstrated to occur under the modelled operating scenarios) until such time as Rookwood Weir has been drawn down. It appears from the modelled storage levels that, in general terms FSL (or near to), is established ahead of the nesting seasons, however there remains no way of ‘topping up’ Eden Bann Weir should Rookwood Weir become empty.

Rookwood Weir

The water levels during the nesting periods generally fluctuate between FSL and empty.

Inflows to Rookwood Weir are governed by catchment climatic conditions. There are no storages upstream from which releases can be made ahead of the turtle nesting seasons to set the storage level at FSL. Similarly, there is no ability to capture flows associated with larger flood events to mitigate a rise in storage level.

In relation to the Fitzroy River turtle:

- Generally, water levels within the storage are high at the start of the nesting season and there is a decreasing water level trend between the months of September to November as releases are made to satisfy demand and environmental flow requirements
- From mid-November and throughout December, water level trends begin to rise with some fairly rapid increases present as uncontrolled inflows as a result of rainfall and runoff conditions consistent with the onset of the wet season are realised.

For the white-throated snapping turtle:

- Peak water levels occur throughout March and April as this is the start of the dry season and drawdown of the storage to satisfy demand (and environmental flow) releases would only have recently commenced
- Generally, decreasing water level trends are present from March through to September.

However, it is noted that at Rookwood Weir during both the Fitzroy River turtle and white-throated snapping turtle nesting seasons, spikes in water level occur throughout the simulation period due to uncontrolled river inflows, including inflows that result in the spilling of Rookwood Weir. These fluctuations have no apparent trend and occur irrespective of season.

5.3.3 Turtle nesting downstream of storages

At water levels above FSL, flow will occur through the spillway; either over the spillway ogee crest for Stage 1 at Rookwood Weir or Stage 2 at Eden Bann Weir, or by the lowering of spillway gates. These situations are referred to as a ‘spill event’. When this occurs, flows through the spillway are uncontrolled. This is separate to the controlled releases through the environmental and water supply outlets in accordance with the EFOs and WASOs (Section 7.2.2). Spill events may discharge well above 5,000 ML/day and raise water levels downstream of the weirs to levels above that which are set by controlled releases. Given that the weirs will fill and spill, it is considered that making releases ahead of the turtle nesting period in order to manage impacts on nesting habitat is not feasible as uncontrolled releases, or spill events, will potentially occur and result in stream water levels higher than during controlled releases. These spill events can occur at any time.

Despite the variable nature of the reservoirs, the outlets at both Eden Bann Weir and Rookwood Weir can be operated below FSL down to a minimum operating level (RL 7.25 m AHD and RL 31.0 m AHD, respectively) to facilitate:

- Base flows: up to 900 ML/day (EFOs and releases for the purpose of new water supply)
- Medium to high flows and first post winter flush flows up to 5, 000 ML/day.

During the nesting periods, controlled releases are generally made consistently to facilitate the base flows (up to 900 ML/day). However, there are some periods where inflows trigger the release rule for higher environmental releases.

The number of days during the two turtle species nesting where spill events occur was examined and is reported as a percentage of the number of days where a spill event occurs per annum. This situation occurs variably across the period of record as discussed below:

- At Eden Bann Weir during the Fitzroy River turtle nesting season, a number of years record no spill event, however in other years, up to 100 per cent of the days experience a spill event. Thirty years experienced a no spill event (Figure 5-5)
- At Eden Bann Weir during the white-throated snapping turtle nesting season, 93.4 per cent of years recorded a spill event, and from these years up to 100 per cent of the days during the nesting period were noted to experience a spill event. Only eight years experienced a no spill event (Figure 5-6)
- At Rookwood Weir during the Fitzroy River turtle nesting season, a number of years record no spill event, however for others up to 46.7 per cent of the days, would experience a spill event. Eighty years experienced no spill event (Figure 5-7)
- At Rookwood Weir during the white-throated snapping turtle nesting season, a number of years record no spill events, however for others up to 65.9 per cent of the days, would experience a spill event. Thirty-one years experienced no spill event (Figure 5-8).

5.3.4 Summary

At the proposed Rookwood Weir, there are no upstream storages from which to make regulated releases to maintain a nominated water level within the proposed impoundment. Similarly, while there is potential for the proposed Rookwood Weir to regulate flows to Eden Bann Weir to some degree, given the nature and operation of weir storages and reliance on natural inflows, this ability would be limited and are likely to be superseded by naturally occurring high river flows that overtop the spillway. As such, the Project cannot feasibly manage water levels to a nominated level in order to effectively avoid or minimise impacts on existing nesting habitat within the proposed impoundments.

This impact is considered to be unavoidable and offsets are proposed in relation to the Fitzroy River turtle and white-throated snapping turtle. It should be noted, however, that the proposed operational strategy of the whole system, will result in the water level at the Fitzroy Barrage being at, or near to, FSL for longer durations and for an increased number of days over the simulation period.

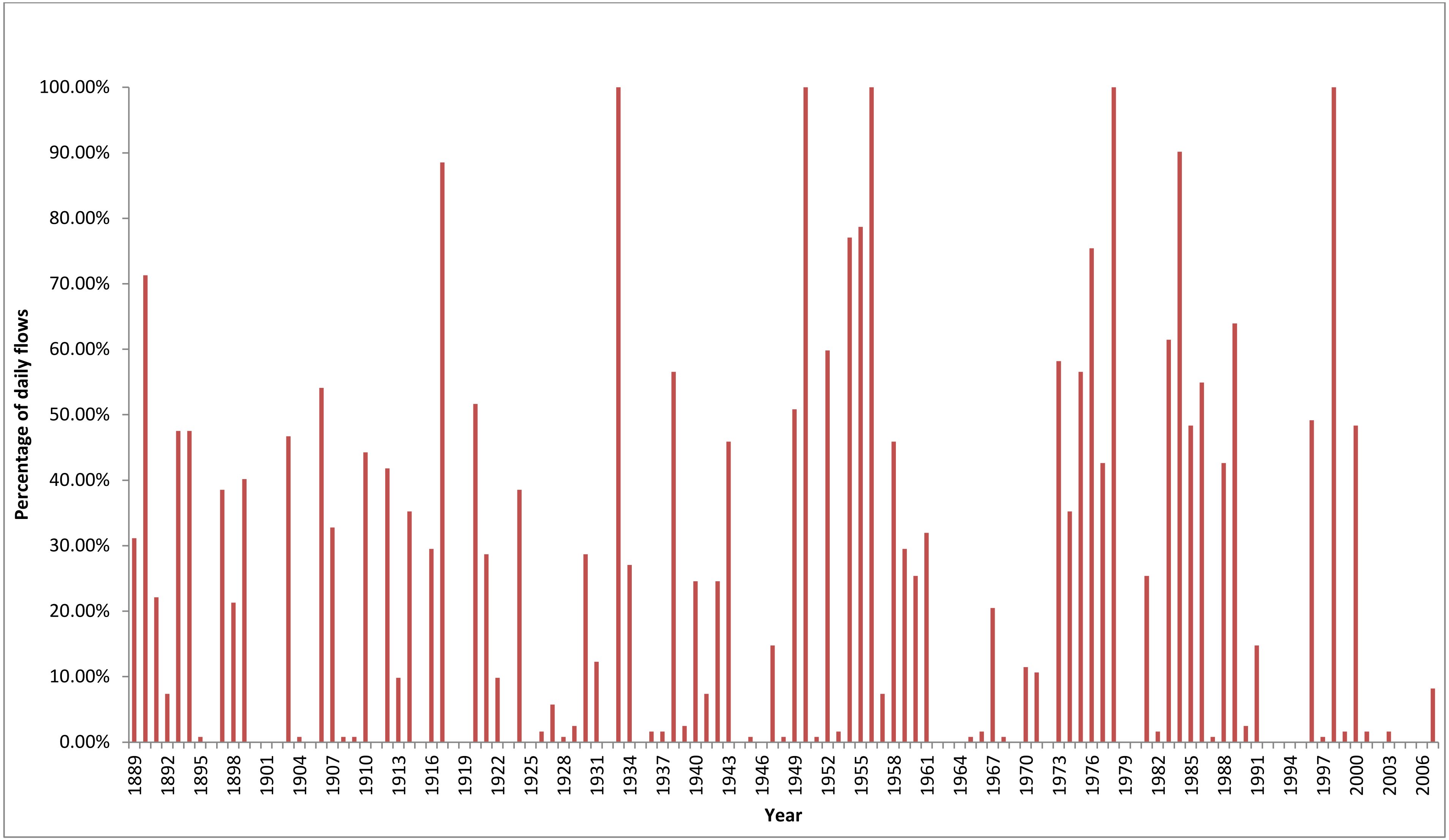


Figure 5-5 Percentage of daily flows over the Eden Bann Weir spillway during the Fitzroy River turtle nesting season

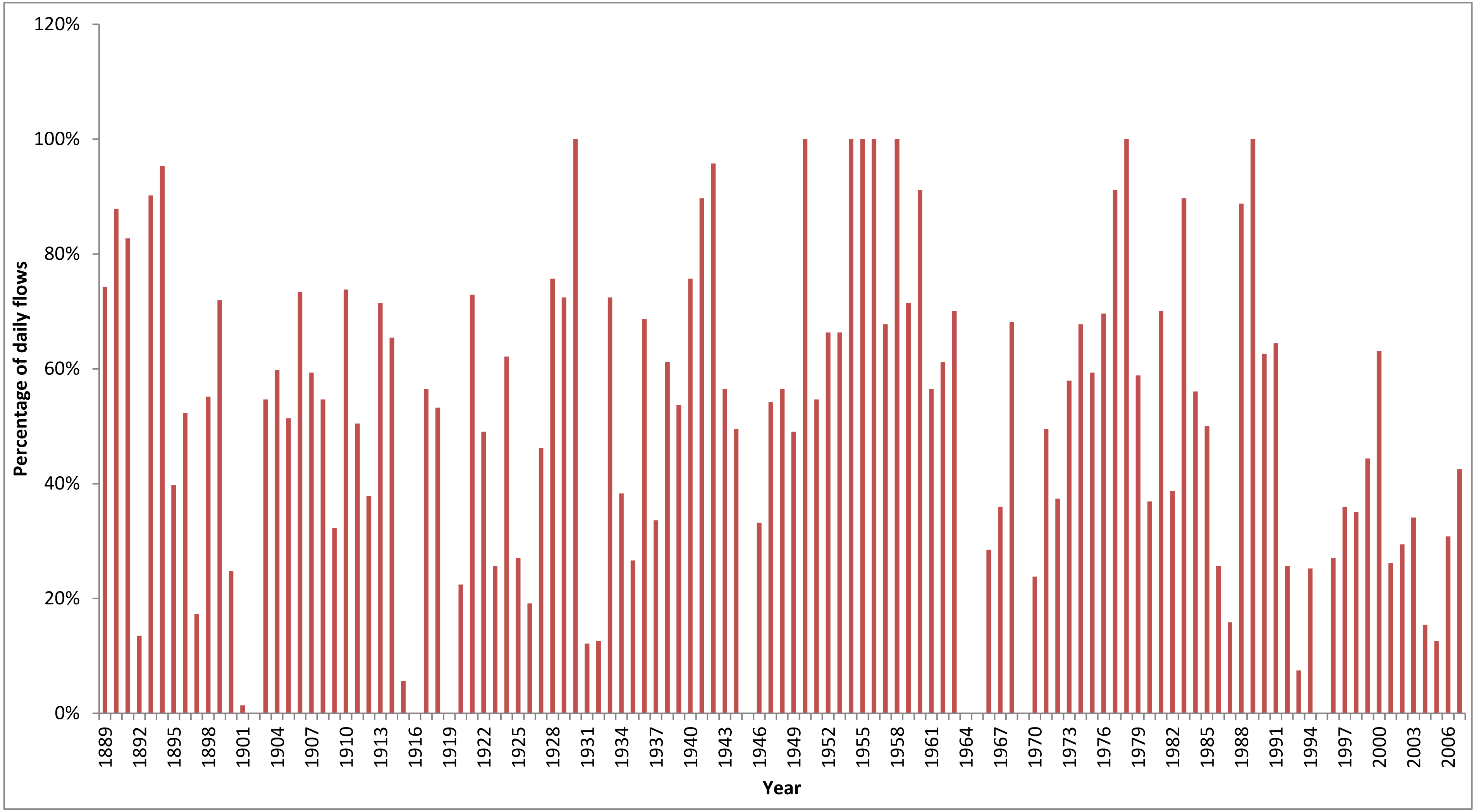


Figure 5-6 Percentage of daily flows over the Eden Bann Weir spillway during the white-throated snapping turtle nesting season

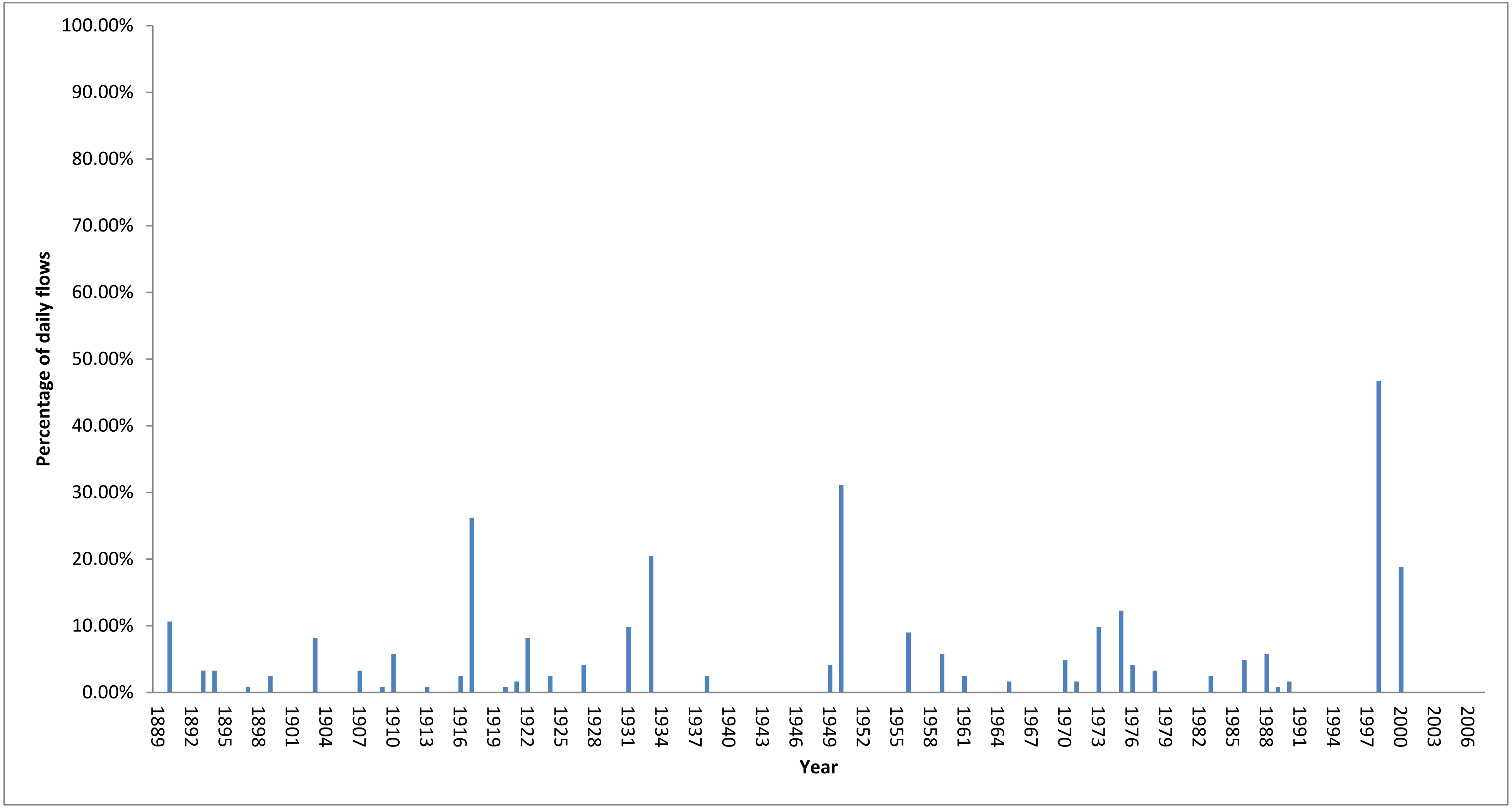


Figure 5-7 Percentage of daily flows over the Rookwood Weir spillway during the Fitzroy River turtle nesting season

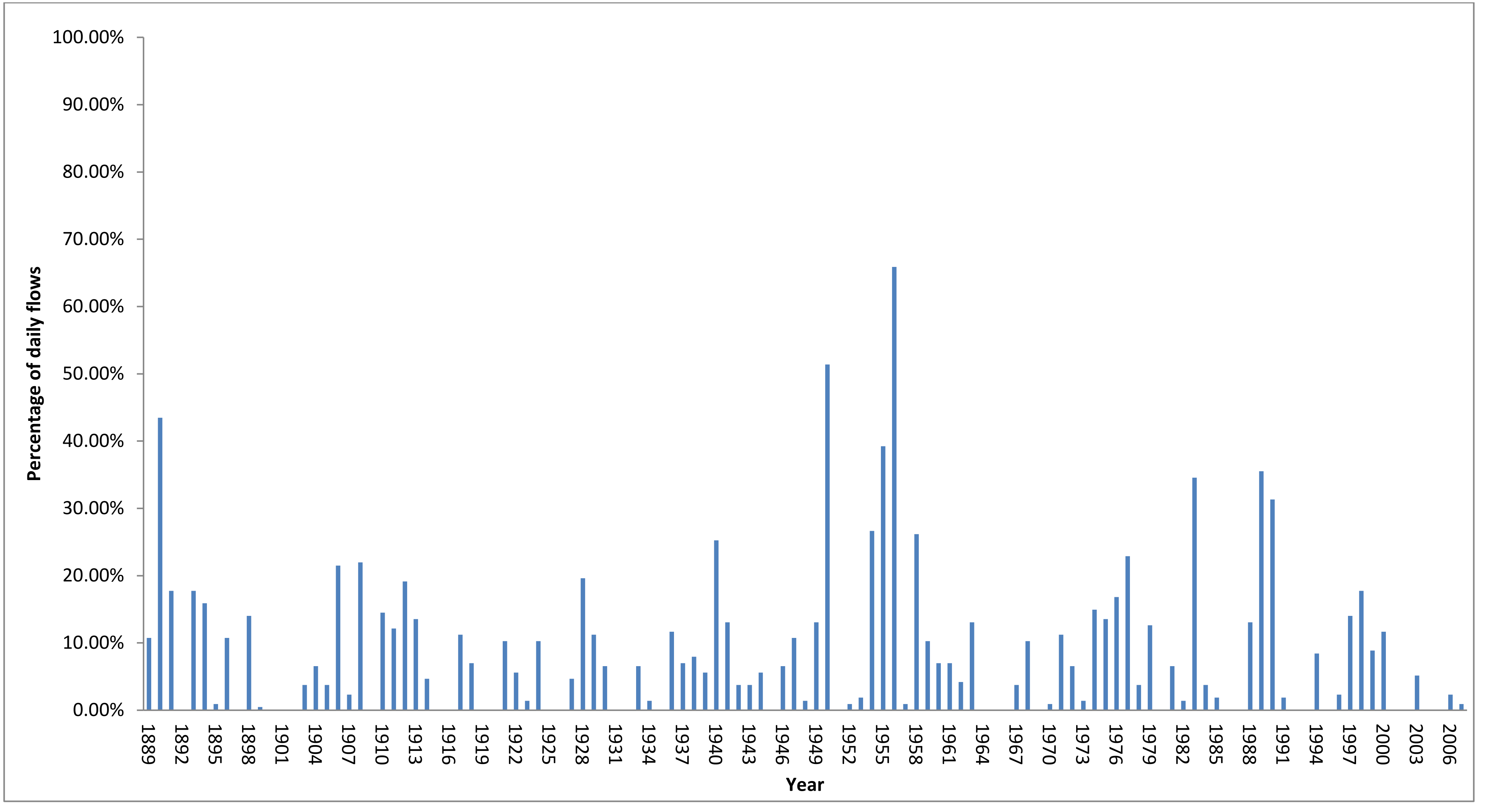


Figure 5-8 Percentage of daily flows over the Rookwood Weir spillway during the white-throated snapping turtle nesting season

6. Terrestrial fauna

Potential impacts on terrestrial fauna have been addressed in the draft EIS (Volume 1, Chapter 8 Terrestrial fauna). Management measures are addressed in the draft EIS EMP (Chapter 23 of Volume 1 and Chapter 13 of Volume 2). Submissions made on the draft EIS in this regard relate to the likelihood of occurrence and residual impacts on the red goshawk and powerful owl as detailed in the following sections.

6.1 Red goshawk

Submissions

DEHP and FBA submissions regarding the red goshawk (028.08, 028.09, 028.10 and 011.17, 011.27, respectively) relate to the adequacy of information used as the basis for the likelihood of occurrence assessment and subsequent requirements to provide offsets in regard to significant residual impacts.

Response

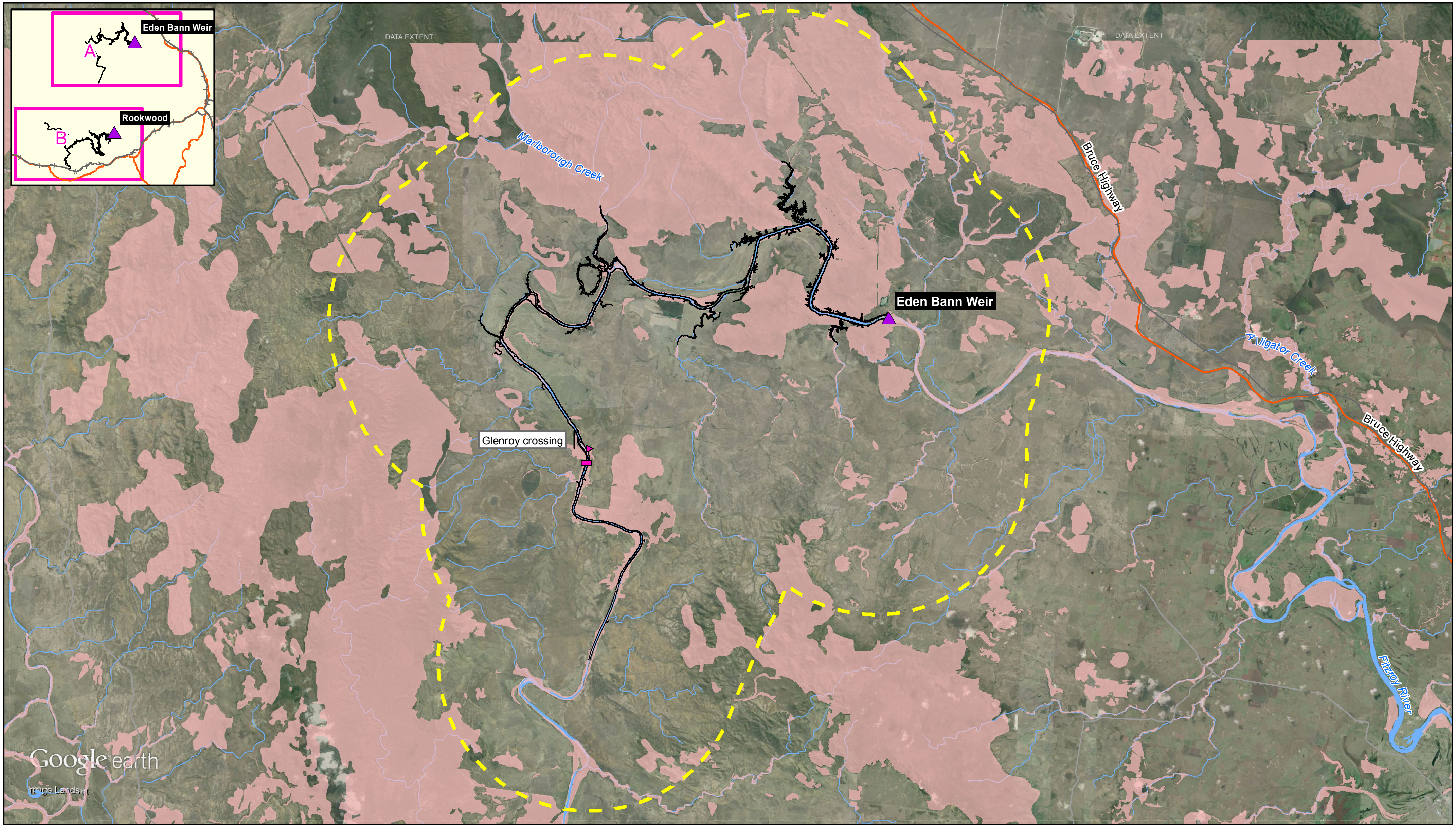
This section provides a revised likelihood of occurrence assessment for the species, an assessment against the Commonwealth Matters of National Environmental Significance Significant impact guidelines 1.1 and management options to minimise impact.

6.1.1 Habitat requirements

The red goshawk occupies a range of habitats in northern and eastern Australia including coastal and sub-coastal tall open forests and woodlands. The species has a large home range covering between 50 and 220 km^2. It prefers a mix of vegetation types with its habitat including tall open forest, woodland, lightly treed savannah and the edge of rainforest (Marchant and Higgins 1993).

6.1.2 Likelihood of occurrence

Given the red goshawk's large home range and the presence of suitable habitat within the Project footprint, it is considered to have the potential to occur. Although the species has not previously been recorded within the original 2 km search extents defined for the Project, a single record exist within 10 km from the Project area (Figure 6-1). Given the species large home range, it is likely that the species utilises habitats in proximity to the Project for foraging.



Paper Size A4

0 1 2 4 6 8

Kilometres

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

N

LEGEND

Weir Location	Highway	10km Buffer
River Crossing	Major Road	Red goshawk foraging habitat
Railway	Eden Bann Weir Impoundment (Stage 3)	Waterway

GHD

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Gladstone Area Water Board, SunWater
Lower Fitzroy River Infrastructure Project

Job Number | 41_29212
Revision | 1
Date | 04 Mar 2016

Eden Bann Weir - Potential red goshawk foraging habitat

Map A
Figure 6-1

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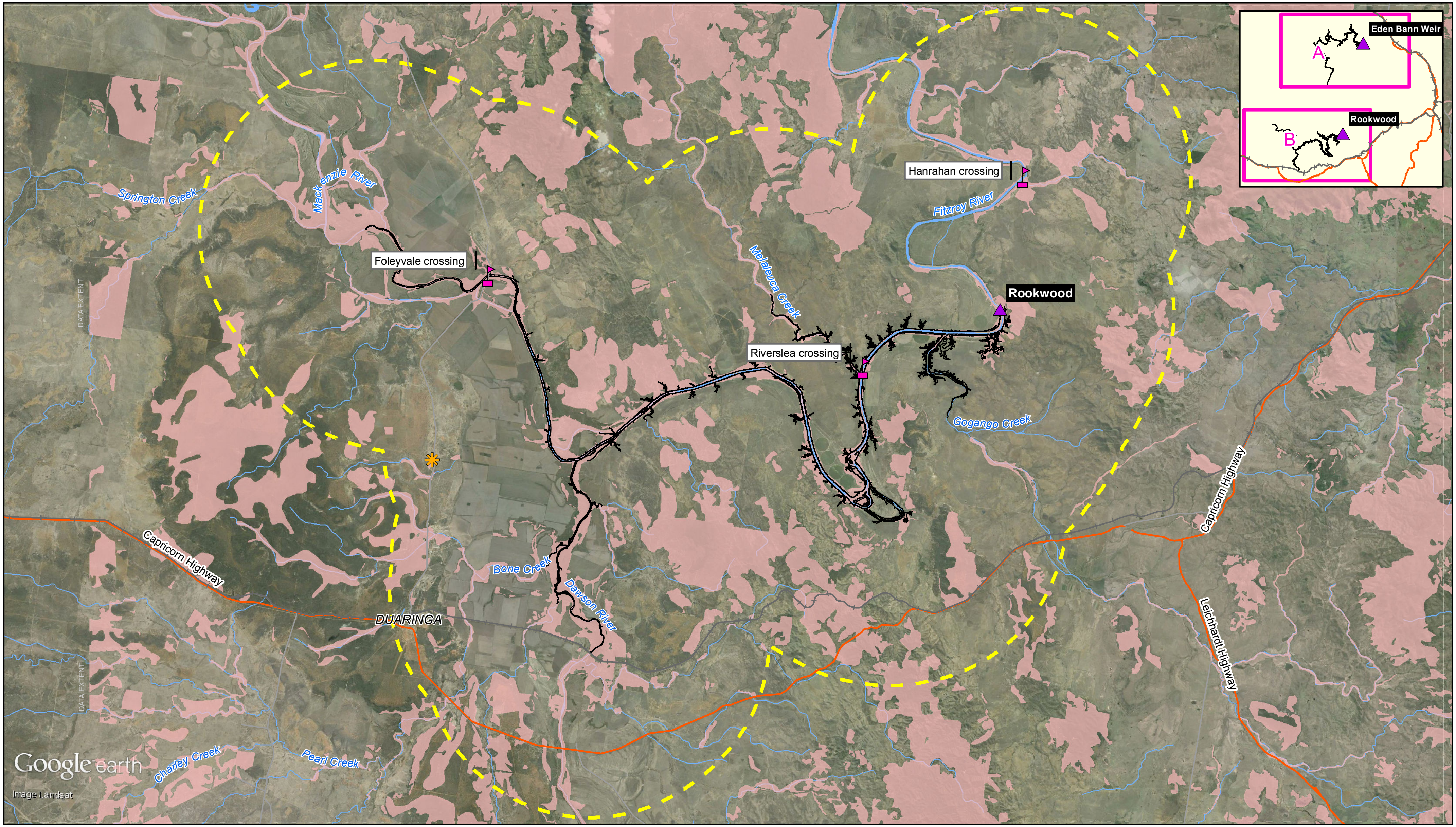
145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: GHD: Weir Location, River Crossing, 10km Buffer/2015, Potential Habitat/2015, Impoundment/2013; Google Earth Pro: Image extracted 14/12/2015. Created by: MS



Paper Size A4

0 1 2 4 6 8

Kilometres

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

N

LEGEND

- Weir Location
- River Crossing
- Red goshawk Wildlife Online record
- Railway
- Highway
- Major Road
- 10km Buffer
- Rookwood Weir Impoundment (Stage 2)
- Red goshawk foraging habitat
- Waterway

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Revision	1
Date	04 Mar 2016

Gladstone Area Water Board

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Rookwood Weir - Potential red goshawk foraging habitat

Map B
Figure 6-1

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145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: EHP: Red Goshawk Location/2016; GHD: Weir Location, River Crossing, 10km Buffer/2015, Potential Habitat/2015, Impoundment/2013; Google Earth Pro: Image date 12/09/2013. Created by: MS

Given the search intensity undertaken in surveys and the site fidelity shown by red goshawks to nesting territories, it is considered unlikely the species is nesting within the Project area for the following reasons:

- No red goshawk nests were observed during field surveys despite nest survey effort that is broadly consistent with the EPBC Act Survey Guidelines (80 hours of survey over ten days) being undertaken
- This species is iconic and nesting pairs draw the attention of amateur bird enthusiasts. Despite this, no historical records of the species are recorded for the Project footprint
- A record of detailed survey effort is provided in Table 6-1. Surveys were undertaken in accordance with the Commonwealth survey guidelines for the species with an effort of at least 196 person hours spent searching suitable habitat for nests, with teams undertaking searches on foot, from boats and from vehicles during wet and dry season surveys. No nests or individuals were observed
- The nest near Site 6 (referred to in DEHP's submission) was believed to have belonged to the white-bellied sea-eagle. This species was regularly observed in the vicinity of the nest in both the dry and wet season surveys. The nest structure is also more consistent with those constructed by the white-bellied sea-eagle, as it is a large structure built in the fork of a vertical trunk. Red goshawk nests are typically constructed on horizontal branches and tend to be relatively flat.

Table 6-1 Summary of red goshawk survey effort

Method	Location	Purpose	Estimated effort
On foot	All areas	As part of habitat assessments, targeted nest searches were undertaken at 17 fixed bird census sites (mapped on Figure 8-1 and 8-2 draft EIS, Volume 1, Chapter 8 Terrestrial Fauna).	28 hours (100 minutes per site x 17 sites)
Boat-based	Eden Bann Weir existing impoundment and upstream reach	Boat-based nest searches along the Fitzroy River between the existing weir and site 6 (Figure 8-1, draft EIS, Volume 1, Chapter 8 Terrestrial Fauna). This included all adjoining tributaries.	72 – 96 hours (12 days x 3 - 4 hours on river x 2 boats)
Canoe-based	Rookwood Weir Project area	Canoe-based surveys along the Fitzroy, Dawson and Mackenzie rivers.	24 hours (6 days x 4 hours on river x 1 canoe)
By vehicle	Rookwood Weir Project area	Opportunistic vehicle-based surveys were undertaken whilst driving between fixed terrestrial fauna sites. This included assessments of areas within the broader region, up to 1 km from the river.	72 hours (12 days x 3 teams x 2 hours)

6.1.3 Habitat assessment

Mapping of potential foraging and nesting habitat has been undertaken to quantify the magnitude of impact on the red goshawk resulting from the Project. Habitat has been identified and mapped to quantify the loss of potential foraging and nesting habitat for the red goshawk.

Criteria used to map habitat is detailed below:

- Foraging habitat for the red goshawk is shown in Figure 6-1. Foraging habitat includes all woodland, open woodland and vine thicket Regional Ecosystems (REs) within the Project area (REs 11.3.2, 11.3.3, 11.3.4, 11.3.6, 11.3.9, 11.3.11, 11.3.25, 11.3.26, 11.3.29, 11.3.30, 11.3.38, 11.4.1, 11.4.2, 11.4.8, 11.5.2, 11.5.3, 11.5.9, 11.7.1, 11.7.4, 11.8.1, 11.8.4, 11.9.1, 11.9.4, 11.9.9, 11.10.1, 11.11.1, 11.11.4, 11.11.5, 11.11.7, 11.11.9, 11.11.10, 11.11.15, 11.11.16, 11.11.18, 11.11.21, 11.12.1, 11.12.2, 11.12.4, 11.12.6). It excludes areas mapped as water (based on the watercourse cadastre)
- Potential nesting habitat for the red goshawk is shown in Figure 6-2 Nesting habitat overlaps with foraging habitat areas and includes all woodland REs with median vegetation taller than 22 m within 1 km of rivers (REs: 11.11.16, 11.3.25, 11.3.26, 11.3.38, 11.10.1, 11.3.4) (excluding areas mapped as water (based on the watercourse cadastre)). This is based on published information on the nesting requirements of the species: large trees, frequently the tallest and most massive in a tall stand, and nest trees are invariably within one km of permanent water (Aumann and Baker-Gabb 1991; Debus and Czechura 1988).

Loss of potential foraging habitat is estimated to be in the order of 1,243 ha:

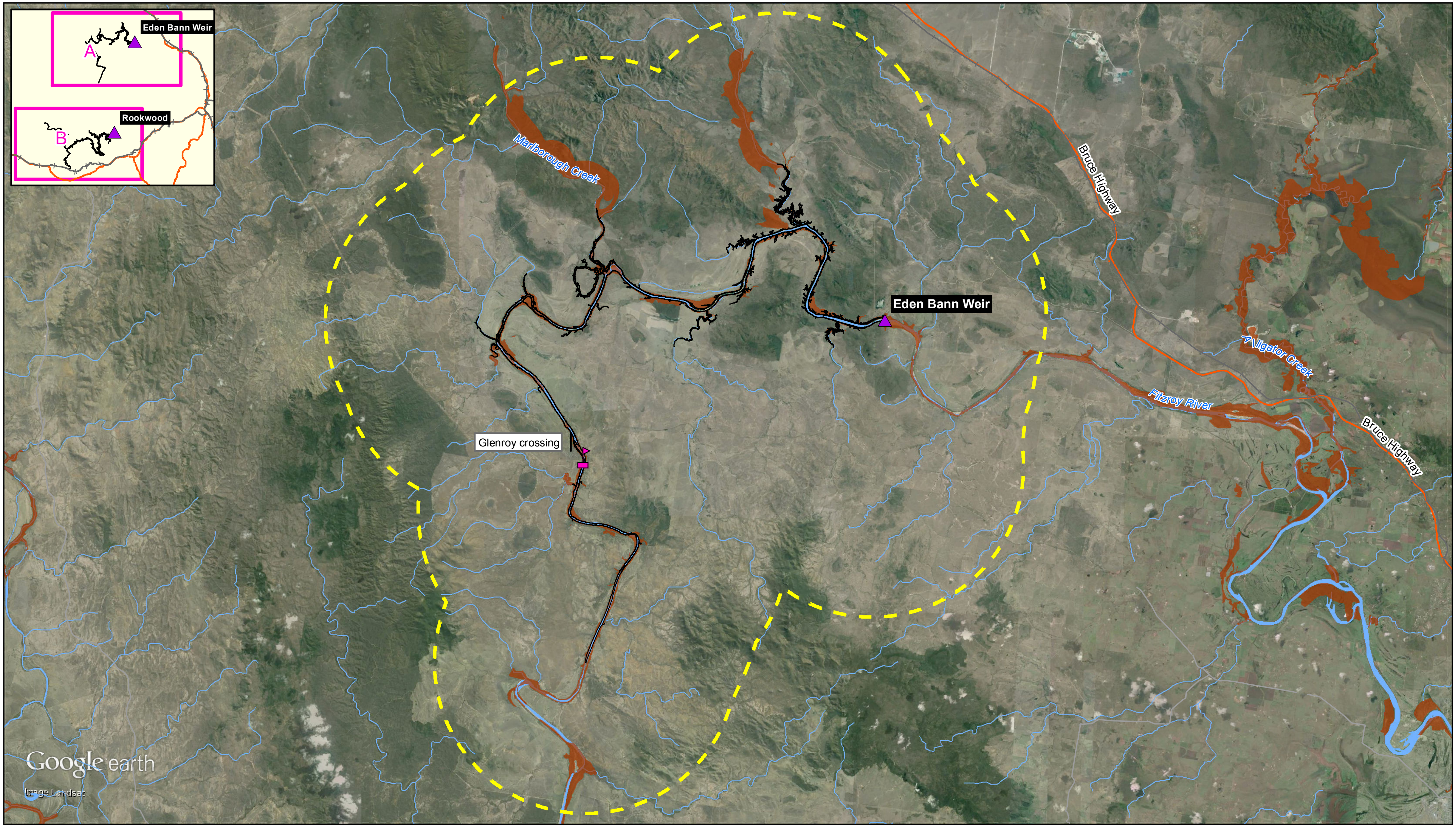
- Eden Bann Weir Stage 3 impoundment: 454 ha
- Rookwood Weir Stage 2 impoundment: 789 ha.

This represents 1.3 per cent of the potentially available foraging habitat available within a 10 km radius (90,440 ha).

Loss of potential nesting habitat is estimated to be 972 ha:

- Eden Bann Weir Stage 3 impoundment: 384 ha
- Rookwood Weir Stage 2 impoundment: 588 ha.

This represents 8.9 per cent of the potential nesting habitat available within a 10 km radius (10,870 ha).



Paper Size A4

0 1 2 4 6 8

Kilometres

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

N

LEGEND

- Weir Location
- River Crossing
- Railway
- Highway
- Major Road
- Waterway
- 10km Buffer
- Red goshawk nesting habitat
- Eden Bann Weir Impoundment (Stage 3)

GHD

Gladstone Area Water Board

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Lower Fitzroy River Infrastructure Project

Job Number	41_29212
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Date	04 Mar 2016

Eden Bann Weir - Potential red goshawk nesting habitat

Map A
Figure 6-2

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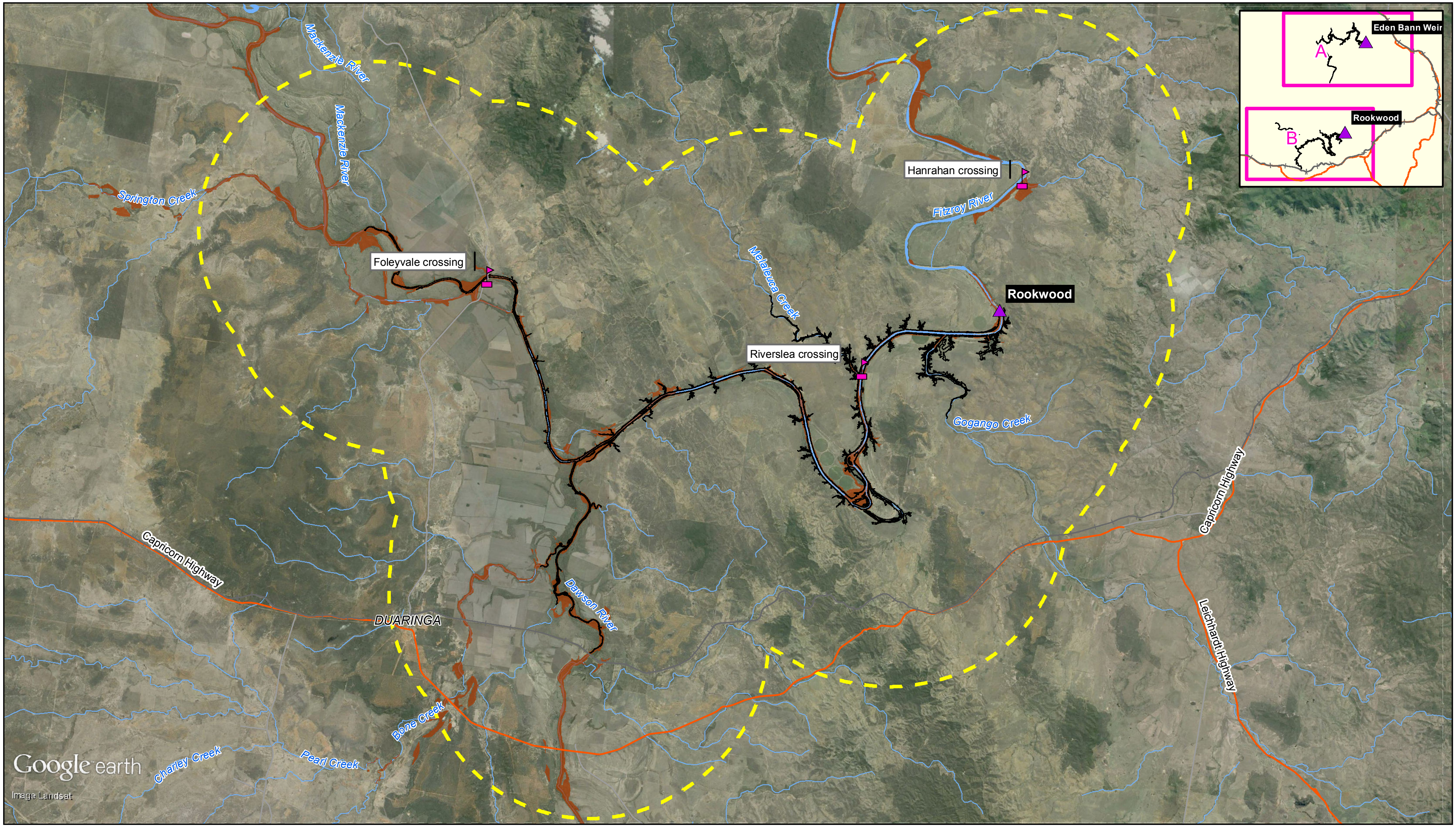
145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: GHD: Weir Location, River Crossing, 10km Buffer/2015, Potential Habitat/2015, Impoundment/2013; Google Earth Pro: Image extracted 14/12/2015. Created by: MS



Paper Size A4

0 1 2 4 6 8

Kilometres

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

N

LEGEND

- Weir Location
- River Crossing
- Railway
- Highway
- Major Road
- Waterway
- 10km Buffer
- Red goshawk nesting habitat
- Rookwood Weir Impoundment (Stage 2)

GHD

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Revision	1
Date	04 Mar 2016

Rookwood Weir - Potential red goshawk nesting habitat

Map B
Figure 6-2

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145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: GHD: Weir Location, River Crossing, 10km Buffer/2015, Potential Habitat/2015, Impoundment/2013; Google Earth Pro: Image date 12/09/2013. Created by: MS

6.1.4 Significance assessment

The red goshawk is listed as vulnerable under the EPBC Act and endangered under the *Nature Conservation Act 1992* (NC Act).

The Commonwealth Matters of National Environmental Significance Significant impact guidelines 1.1 has been adopted for the assessment of the significance of residual impacts on red goshawk as presented in Table 6-2.

The assessment has been undertaken considering the likelihood of occurrence assessment and potential impact areas as presented in sections above.

Table 6-2 Significant residual impact assessment for red goshawk

Significance criterion	Assessment
An action is likely to have a significant residual impact on habitat for an animal that is vulnerable wildlife if the action will:	
Lead to a long term decrease in the size of a local population	The Project is not expected to result in a decrease in the size of the local red goshawk population. Given that no individuals or nests were observed in field survey effort that was consistent with Commonwealth survey guidelines for the species (196 person search hours from surveys undertaken on foot, from boats and vehicles) suggests the Project is unlikely to impact on actual nesting habitat. The loss of potential habitat is considered moderate. Potential red goshawk nesting habitat has been mapped for the area, based on published information on nesting habitat requirements (that is, tall eucalypt forest within 1 km of rivers as detailed in Aumann and Baker-Gabb 1991; Debus and Czechura 1988). The Project will result in a loss of 972 ha of potential nesting habitat, which represents 8.9 per cent of the total area of potential nesting habitat within a 10 km radius. The Project will result in the loss of 1,243 ha of potential foraging habitat, representing 1.3 per cent of the available foraging habitat within a 10 km radius. Given the low density at which red goshawks occur (estimated at one breeding pair per 10 - 20 km of riverine habitat (Czechura 2001), the lack of impact on actual nesting habitat and the relative abundance of potential nesting habitat and foraging habitat that will remain available within their home range, the species is unlikely to experience a significant increase in competition for resources as a result of the Project.
Reduce the area of occupancy of an important population	The red goshawk has a large home range that exceeds the size of the Project area. Large areas of potentially suitable red goshawk habitat will persist within the local area and surrounding landscape. Possible impacts are expected to be experienced at a more localised scale that will not disrupt movement of individuals between habitat remnants or across the area more broadly. As such, there will be no change in the extent of occurrence of the species as a result of the Project.

Significance criterion	Assessment
Fragment an existing important population into two or more populations	The red goshawks' large home range and capacity for foraging within ecotones suggests the species is to some extent tolerant of fragmentation. The species has been observed persisting within fragmented habitats at least during non-breeding periods (Hughes and Hughes 1988). While nesting habitat may be more sensitive to fragmentation effects, the scale of habitat fragmentation anticipated to result from the Project is small in comparison with the home range of the species. As a result, the localised nature of habitat fragmentation would likely be of insufficient magnitude to fragment the population into isolated populations. As a result, the Project is not likely to fragment an existing population into two or more populations.
Adversely affect habitat critical to the survival of a species	The absence of records and nests from the Project footprint (despite intensive search effort) and the presence of a single red goshawk record 10 km from the confluence of the Dawson and Mackenzie rivers (outside the Project footprint) suggests the species is likely to be nesting near that location. Given the species fidelity to nesting territories, impact on critical nesting habitat resulting from the Project is therefore likely to be negligible. Impacts likely to result from the project are therefore limited to a loss of foraging habitat and a reduction in the area of potential nesting habitat, available to individuals that may need to establish new breeding territories in the future. The inundation of vegetation represents a loss of 8.9 per cent of potential nesting habitat and 1.3 per cent of foraging habitat available within a 10 km radius. In the context of the surrounding landscape, the scale of habitat loss is of insufficient magnitude to adversely affect habitat critical to the survival of the species. While it may reduce the capacity for the species to establish new breeding territories and increase its local density of occurrence, the proportional loss of habitat would be insufficient to threaten the species persistence in the region.
Disrupt the breeding cycle of an important population	Due to the low density at which red goshawks occur, any breeding pairs are considered part of an important population. However, since no individuals or nests were identified in field surveys (using survey methods and effort consistent with Commonwealth survey guidelines), and given the species typically uses the same nesting territories year after year, the species is considered unlikely to nest within the Project footprint. While the Project will result in a localised loss of potential nesting, it is unlikely to disrupt the breeding cycle of existing individuals.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Loss or modification of habitat resulting from the Project is unlikely to be of sufficient magnitude to cause a decline in the species. The Project will result in the loss of 972 ha of potential nesting habitat and 1,243 ha of potential foraging habitat. This represents 8.9 per cent of potential nesting habitat and 1.3 per cent of potential foraging habitat present within a 10 km radius. Individuals do occur within the region, and sufficient nesting and foraging habitat is likely to persist.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	Invasive species are not listed among the key threats to the red goshawk. The Project is also unlikely to result in significant increases in invasive species. As such, the Project will have negligible impact on the red goshawk through any potential or conceivable increase in the density of invasive species.

Significance criterion	Assessment
Introduce disease that may cause the species to decline	Recognised threats to red goshawk do not include diseases. It is however not expected that the Project would result in the introduction of disease.
Interfere substantially with the recovery of the species	Given the relative abundance of suitable habitat remaining within the region, and the lack of impact on current nesting habitat, the Project is not expected to interfere with the recovery of the species.

It is not considered that the Project is likely to have a significant impact on the red goshawk and offsets are not proposed.

6.2 Powerful owl

6.2.1 Overview

Submissions

DEHP and FBA submissions regarding the powerful owl (028.15 and 011.17, 011.27, respectively) relates to the impact significance assessment undertaken in the draft EIS. DEHP requests the extent of residual impact on foraging, roosting and nesting habitat of the powerful owl be estimated and mapped and that a revised significant impact assessment is undertaken.

Response

This section provides habitat mapping for the powerful owl and a revised significant impact assessment against the Queensland Government Significant Residual Impact Guideline (DSDIP 2014).

6.2.2 Habitat requirements

The powerful owl is known to occur in a range of habitats boasting large trees including mountain forests and woodlands, coastal forests, woodlands, pine plantations and urban areas. The preferred habitat of the powerful owl includes forests and woodlands with a high abundance of large trees. Mating pairs occupy a large home range (Higgins 1999).

Riparian nesting habitats of the powerful owl are typically located in larger intact remnants of forest associated with small streams and minor drainage lines (DEC 2006). The species typically does not occur within fragmented forest remnants <200 ha (Kavanagh and Stanton 2002). Within the Project area, riparian habitats along the main river channels are generally small and fragmented and therefore do not represent nesting habitat. Areas of more protected dense woodland associated with smaller side tributaries and gullies, particularly those in rocky foothills and headwaters are considered to represent nesting habitat within the region.

A further literature review has been undertaken to define powerful owl habitat requirements as summarised in Table 6-3.

Table 6-3 Powerful owl habitat requirements summary

Description	Source
Habitat for this species is widespread, with the species occurring in coastal habitats from 0 to 1500 m above sea level between Eungella in Queensland to Victoria.	Higgins, 1999
Currently, the majority of potential habitat for this species is restricted to conservation reserves and state forests, although the powerful owl also occurs within large areas of forest on other public lands and on private land, including suburban bushland.	DEC NSW 2006
The powerful owl inhabits a range of habitat types including wet sclerophyll forest, dry sclerophyll forest and woodland, inland riverine woodland and rainforest gullies within sclerophyll forest	Higgins, 1999
The species nests in large hollows (1 m wide and 2 m deep) usually in mature living eucalypts in unlogged, unburnt gullies and lower slopes immediately adjacent to streams or minor drainage lines, surrounded by canopy trees and sub-canopy or understorey trees or tall shrubs.	Higgins, 1999
The species typically roosts in dense groves of mid-storey vegetation within closed forest, including rainforest, wet sclerophyll forest, mangrove forest, melaleuca, acacias and casuarina in sheltered gullies typically on wide creek flats and at the heads of minor drainage lines, but also adjacent to cliff faces and below dry waterfalls.	Higgins, 1999
The species relies on the presence of mature, hollow-bearing trees for nesting sites and also to provide den sites for the hollow-dwelling arboreal mammals which form the bulk of its prey. Given the reliance on hollow-bearing trees, the species favours mature mid-to-late succession, mixed age or multi-aged forest greater than 60 years old. Nests are typically found in trees greater than 150 years of age and prey items utilise hollows in trees greater than 120 years of age.	Davey, 1993; Milledge et al., 1991; Higgins, 1999
Despite the species reliance on old growth forest, it does appear to be tolerant of some levels of selective logging, with owls persisting in areas that have been exposed to light, moderate and heavy logging. Nesting appears to be restricted to unlogged areas.	Kavanagh and Peake 1993; Kavanagh et al. 1993; Kavanagh and Bamkin 1995; Kavanagh 1997
Optimal habitat includes a tall shrub layer and abundant hollows supporting high densities of arboreal marsupials.	DEC NSW 2006
The powerful owl is generally thought to require large intact forest remnants, >200 ha and avoids small patches and strips of vegetation. For this reason, the species has been inferred to be adversely affected by habitat fragmentation. While the species has been found in small forest remnants, these are typically used for foraging only and are located within 1 km of a more extensive remnant of intact forest.	Kavanagh and Stanton, 2002
The species has demonstrated considerable resilience to low-level habitat disturbance through its continuing and successful occupancy of bushland among the outer suburbs of major Australian cities.	Pavey et al., 1994; Pavey, 1995; Kavanagh, 1997; Webster et al, 1999

Description	Source
Historically, powerful owls have been considered dependent on old growth forests and of being susceptible to habitat modification and human induced disturbance (Fleay 1968). They have been thought to require large home ranges (about 1,000 ha per pair) and need habitat with nest hollows for their own breeding and that of their arboreal marsupial prey (Schodde and Mason 1980). However, habitat and dietary studies on the powerful owl have found that it is more numerous, flexible and tolerant of low level disturbance with a wider habitat, altitudinal and dietary tolerance than formerly believed (Debus and Chafer 1994).	Cooke and Wallis, 2004
Powerful owls are known to disperse up to 18 km including across sparsely wooded areas (Higgins 1999; Isaac et al 2008) so population fragmentation is unlikely.	NSW Scientific Committee 2008

6.2.3 Likelihood of occurrence

Although not detected during the wet and dry season surveys in the Project footprint areas, this species has previously been recorded within the study area as reported in BAAM 2008 based on Wildlife Online search results and shown in Figure 6-3 for the proposed Rookwood Weir Project area. No records exist within the vicinity of the Eden Bann Weir Project area. Previously recorded sightings were within and on the fringe of cleared grazing areas in proximity to the Fitzroy River but outside of the Project inundation area. In accordance with the methodology defined for determination of species likelihood of occurrence, the draft EIS concluded that the powerful owl has a high likelihood of occurrence within the vicinity of the Project areas. It considered that the powerful owl has a large home range and the Project footprint may be visited by birds that occur within the wider study area.

6.2.4 Habitat assessment

Mapping of potential foraging and nesting habitat has been undertaken to quantify the magnitude of impact on the powerful owl resulting from the Project. Habitat has been identified and mapped to quantify the loss of potential foraging and nesting habitat for the powerful owl. To assess the significance of impact, the area of habitat lost was compared with that occurring within a 10 km radius which is roughly equivalent to the home range of the species.

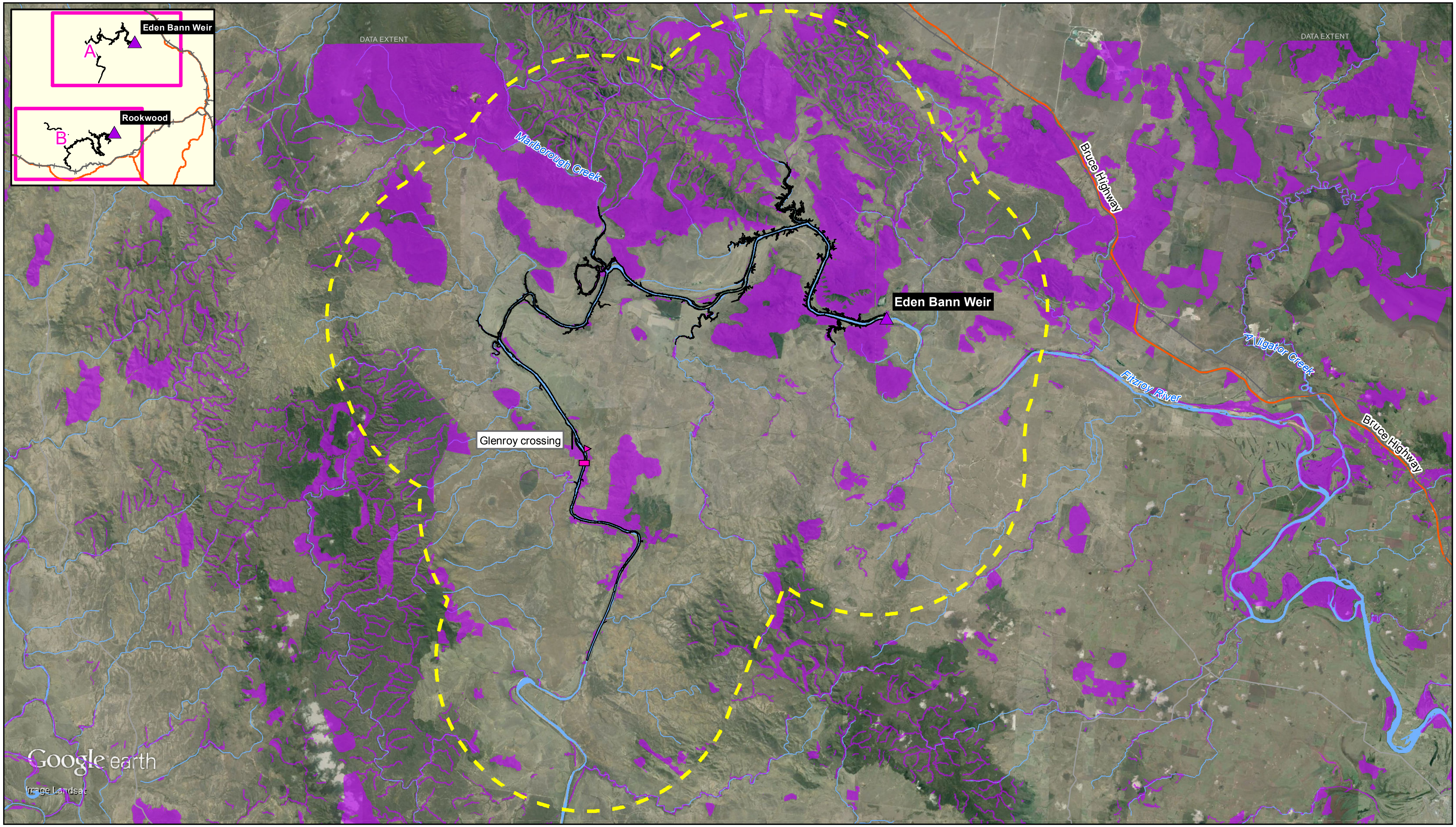
Potential foraging habitat for the powerful owl is shown in Figure 6-3. Criteria used to define powerful owl foraging habitat is as follows:

- All woodland, open woodland and vine thicket REs within the Project area (REs 11.3.2, 11.3.3, 11.3.4, 11.3.6, 11.3.9, 11.3.25, 11.3.26, 11.3.29, 11.3.30, 11.3.38, 11.4.2, 11.4.8, 11.5.2, 11.5.3, 11.5.9, 11.7.1, 11.7.4, 11.8.1, 11.8.4, 11.9.1, 11.9.9, 11.10.1, 11.11.1, 11.11.4, 11.11.7, 11.11.9, 11.11.10, 11.11.15, 11.11.16, 11.12.1, 11.12.2, 11.12.6)
- Areas mapped as watercourse (based on the watercourse cadastre) are excluded.

Loss of potential powerful owl foraging habitat is estimated to be 500 ha:

- Eden Bann Weir Stage 3 impoundment: 182 ha
- Rookwood Weir Stage 2 impoundment: 318 ha.

This represents one per cent of the potentially available foraging habitat available within a 10 km radius (52,349 ha).



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Kilometres

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

N

LEGEND

Weir Location	Highway
River Crossing	Major Road
Railway	Eden Bann Weir Impoundment (Stage 3)
10km Buffer	Powerful owl foraging habitat
Waterway	

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Revision | 1
Date | 04 Mar 2016

Eden Bann Weir - Potential powerful owl foraging habitat

Map A
Figure 6-3

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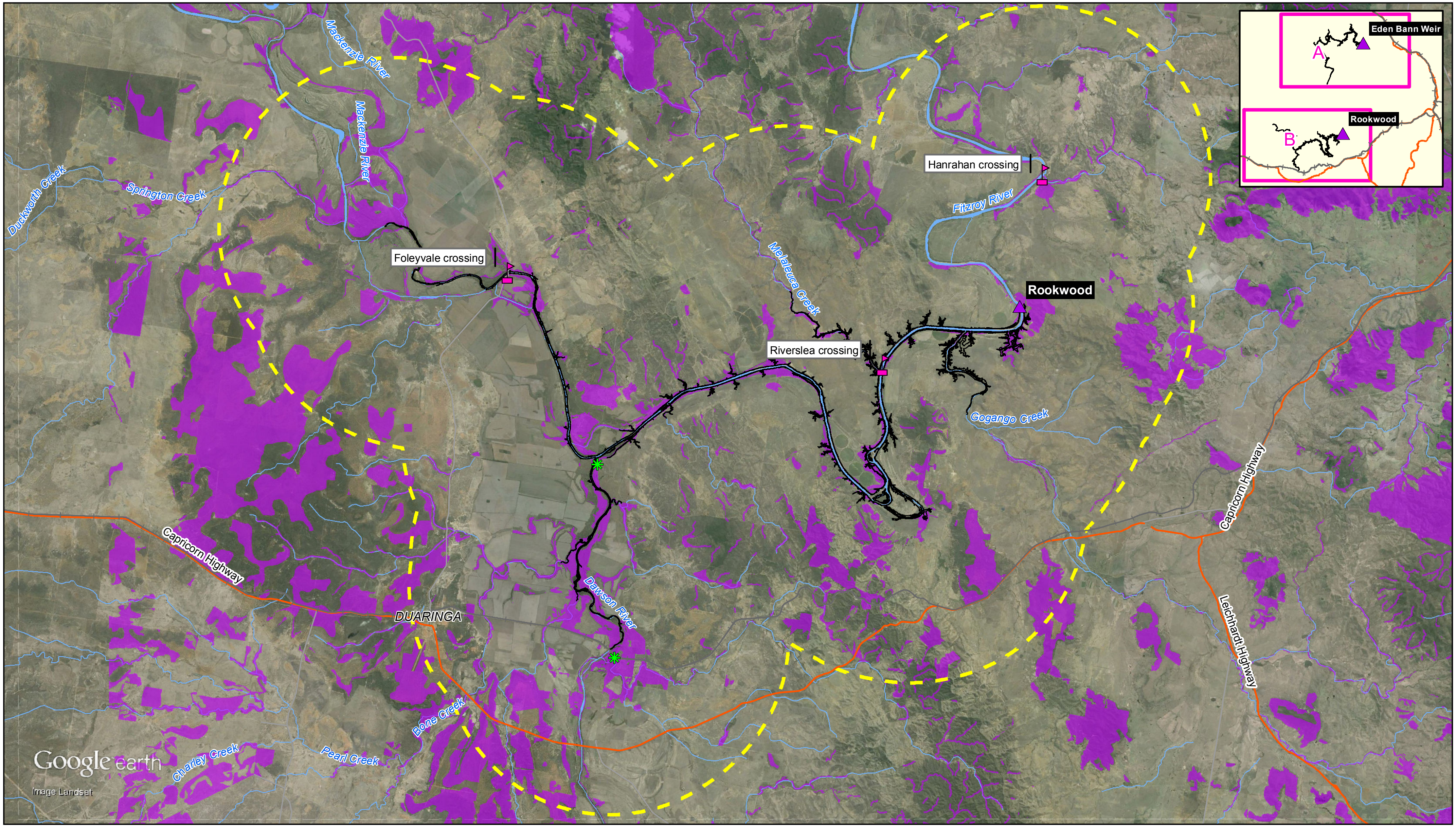
145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: WildNet: Powerful Owl/2009; GHD: Weir Location, River Crossing, 10km Buffer/2015, Potential Habitat/2015, Impoundment/2013; Google Earth Pro: Image extracted 14/12/2015. Created by: MS



Paper Size A4

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Kilometres

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

N

LEGEND

- Powerful owl Wildlife Online record
- Weir Location
- River Crossing
- Railway
- Highway
- Major Road
- 10km Buffer
- Rookwood Weir Impoundment (Stage 2)
- Powerful owl foraging habitat
- Waterway

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Rookwood Weir - Potential powerful owl foraging habitat

Map B
Figure 6-3

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145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: WildNet: Powerful Owl/2009; GHD: Weir Location, River Crossing, 10km Buffer/2015, Potential Habitat/2015, Impoundment/2013; Google Earth Pro: Image date 12/09/2013. Created by: MS

Potential nesting habitat for the powerful owl is shown in Figure 6-4. Nesting habitat overlaps with foraging habitat and criteria used to define powerful owl nesting habitat is as follows:

- All woodland, open woodland and vine thicket REs (as described above) within 50 m of all mapped first to eighth order streams. Powerful owl nests are typically located within close proximity to minor tributaries (Higgins 1999)
- Areas mapped as watercourse (based on the watercourse cadastre) are excluded.

Loss of potential powerful owl nesting habitat is estimated to be 275 ha:

- Eden Bann Weir Stage 3 impoundment: 137 ha
- Rookwood Weir Stage 2 impoundment: 139 ha.

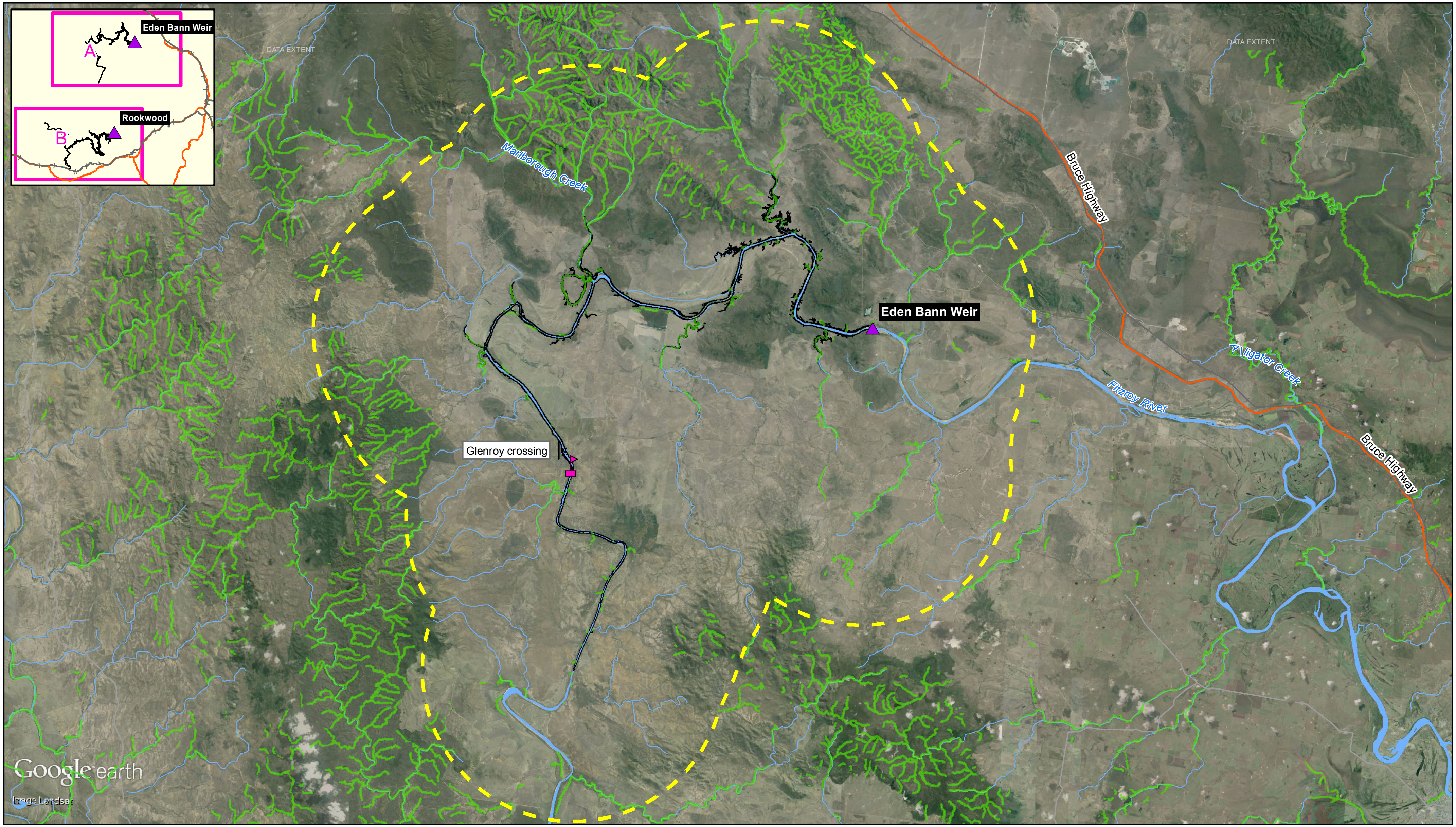
This represents 3.1 per cent of the potential nesting habitat available within a 10 km radius (9,016 ha).

6.2.1 Significance assessment

The powerful owl is listed as vulnerable under the NC Act. The Queensland Government Significant Residual Impact Guideline (DSDIP 2014) was adopted in the draft EIS for the assessment of the significance of residual impacts on the powerful owl. The Queensland Government Significant Residual Impact Guideline (DSDIP 2014) is consistent with the current (December 2014) Queensland Environmental Offsets Policy, Significant Residual Impact Guideline (December 2014) for an activity prescribed in the EO Regulation that requires an approval in relation to a MSES under the NC Act (amongst others).

The assessment has been reviewed with consideration of the literature review and habitat assessment as presented above and is presented in Table 6-4.

It is not considered that the Project is likely to have a significant impact on the powerful owl and offsets are not proposed.



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Kilometres

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

N

LEGEND

- Weir Location
- River Crossing
- Railway
- Highway
- Major Road
- Eden Bann Weir Impoundment (Stage 3)
- 10km Buffer
- Powerful owl nesting habitat
- Waterway

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Eden Bann Weir - Potential powerful owl nesting habitat

Map A
Figure 6-4

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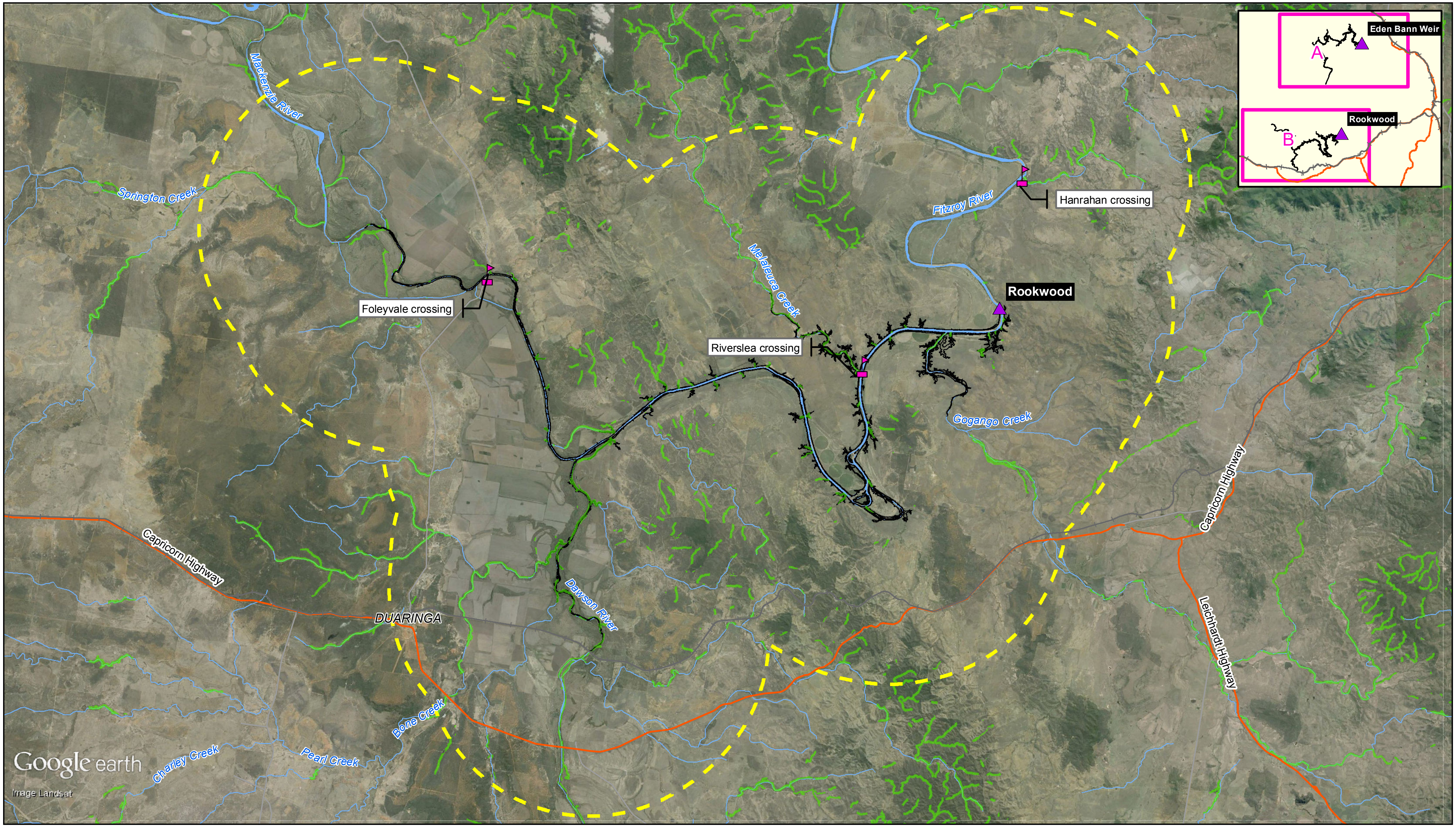
145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: GHD: Weir Location, River Crossing, 10km Buffer/2015, Potential Habitat/2015, Impoundment/2013; Google Earth Pro: Image extracted 14/12/2015. Created by: MS



Paper Size A4

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Kilometres

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

N

LEGEND

- Weir Location
- River Crossing
- Railway
- Highway
- Major Road
- Rookwood Weir Impoundment (Stage 2)
- 10km Buffer
- Powerful owl nesting habitat
- Waterway

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Revision 1
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Rookwood Weir - Potential powerful owl nesting habitat

Map B
Figure 6-4

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145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: GHD: Weir Location, River Crossing, 10km Buffer/2015, Potential Habitat/2015, Impoundment/2013; Google Earth Pro: Image date 12/09/2013. Created by: MS

Table 6-4 Significant residual impact assessment for the powerful owl

Significance criterion	Assessment
An action is likely to have a significant residual impact on habitat for an animal that is endangered or vulnerable wildlife if the action will:	
Lead to a long term decrease in the size of a local population	The Project is not expected to result in a decrease in the size of the local powerful owl population. Powerful owls are not expected to experience a significant reduction in foraging and breeding success due to any increase in competition for resources. The Project is estimated to result in localised loss of 275 ha of potential nesting habitat. This represents 3.1 per cent of the potential nesting habitat available within a 10 km radius. Loss of potential powerful owl foraging habitat is estimated to be 500 ha. This represents one per cent of the potentially available foraging habitat available within a 10 km radius. Given the low density at which powerful owls typically occur, the availability of potential nesting habitat and the relative abundance of potential nesting habitat and foraging habitat that will remain available within their home range, competition for nesting habitat and foraging resources is expected to be low. The species is unlikely to experience a significant increase in competition for resources as a result of the Project.
Reduce the extent of occurrence of the species	Large areas of suitable powerful owl habitat will persist within the local area. The Project is estimated to result in localised loss of 275 ha of potential nesting habitat. This represents 3.1 per cent of the potential nesting habitat available within a 10 km radius. Loss of potential powerful owl foraging habitat is estimated to be 500 ha. This represents one per cent of the potentially available foraging habitat available within a 10 km radius. The project will not disrupt connectivity to the extent that movement between remnant patches will be inhibited. As such, there will be no change in the extent of occurrence of the species.

Significance criterion	Assessment
Fragment an existing population	The Project is not expected to result in the fragmentation of the local powerful owl population. The species is generally not susceptible to population fragmentation, given its large home range and capacity to disperse over relatively cleared landscapes (NSW Scientific Committee 2008). Habitat losses projected for the Project represent only 3.1 per cent of nesting habitat available within a 10 km radius. As such, these represent a relatively localised impact within the context of the species' home range. Given the species' large home range and capacity to disperse over relatively open landscapes, the localised losses of habitat associated with the Project are unlikely to fragment the local powerful owl population. This is supported by: • Barrett et al. 2007 have shown the powerful owl has displayed little evidence of population fragmentation as a result of habitat clearing, with populations persisting in areas that have been cleared by 16-39 per cent in coastal bioregions, 53-58 per cent for tableland bioregions and 60-84 per cent for bioregions on slopes. • Cooke and Wallis (2004): Historically, powerful owls have been considered dependent on old growth forests and of being susceptible to habitat modification and human induced disturbance (Fleay 1968). They have been thought to require large home ranges (about 1,000 ha per pair), and need habitat with nest hollows for their own breeding and that of their arboreal marsupial prey (Schodde and Mason 1980). However, habitat and dietary studies on the powerful owl have found that it is more numerous, flexible and tolerant of low level disturbance with a wider habitat, altitudinal and dietary tolerance than formerly believed (Debus and Chafer 1994). • Cooke and Wallis (2002): The powerful owl was once considered to be a specialist in ecological terms because of its apparent restricted habitat and dietary requirements (Fleay 1968; Seebeck 1976), indicating that it is vulnerable to habitat modification and that it has specific conservation needs. However, later studies have contested those earlier findings and have questioned the degree to which the powerful owl is vulnerable to habitat modification and disturbance (Debus and Chafer 1994; Kavanagh and Bamkin 1995; Pavey et al. 1994; Cooke et al. 1997; Cooke et al. 2002). • Higgins (1999): The species may require large tracts of forest (Loyn 1985, Kavanagh 1997) but sometimes occur in fragmented landscapes, for example open areas adjoining forest, such as farmland, parkland, or suburban development; remnant patches of forest or woodland surrounded by open habitat; and mosaics of logged and unlogged forest (Hughes and Hughes 1984; Evans 1986; Chafer 1992; Pavey 1994; 1995; Kavanagh and Bamkin, 1995).
Result in genetically distinct populations forming as a result of habitat isolation	Given the species capacity to fly over cleared areas, the Project is unlikely to disrupt movement of powerful owls such that it would result in the formation of genetically distinct populations.

Significance criterion	Assessment
Result in invasive species that are harmful to an endangered or vulnerable species becoming established in the endangered or vulnerable species habitat	Invasive pest species such as foxes, cats and dogs represent a potential threat to powerful owl fledglings (McNabb 1987; Gibbons 1989). The Project area already supports foxes, cats and dogs. The implementation of the Weed and Pest Management Plan will help in limiting the impact that these species have on the local powerful owl population.
Introduce disease that may cause the population to decline	Recognised threats to powerful owl do not include diseases. It is however not expected that the Project would result in the introduction of disease.
Interfere with the recovery of the species	Given the relative abundance of suitable habitat remaining within the region, the Project is not expected to interfere with the recovery of the species.
Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species	Habitats within the Project footprint will be important for foraging and breeding, however, they are part of a broader area of habitat within the floodplain that will be utilised by the species.

6.3 Yellow chat (Dawson)[2]

Submissions

DoE submissions (021.16, 021.17) relate to impacts on the yellow chat (Dawson) habitat downstream of the Project noting that an additional site identified by Houston et al. (2009) was not previously considered in the draft EIS.

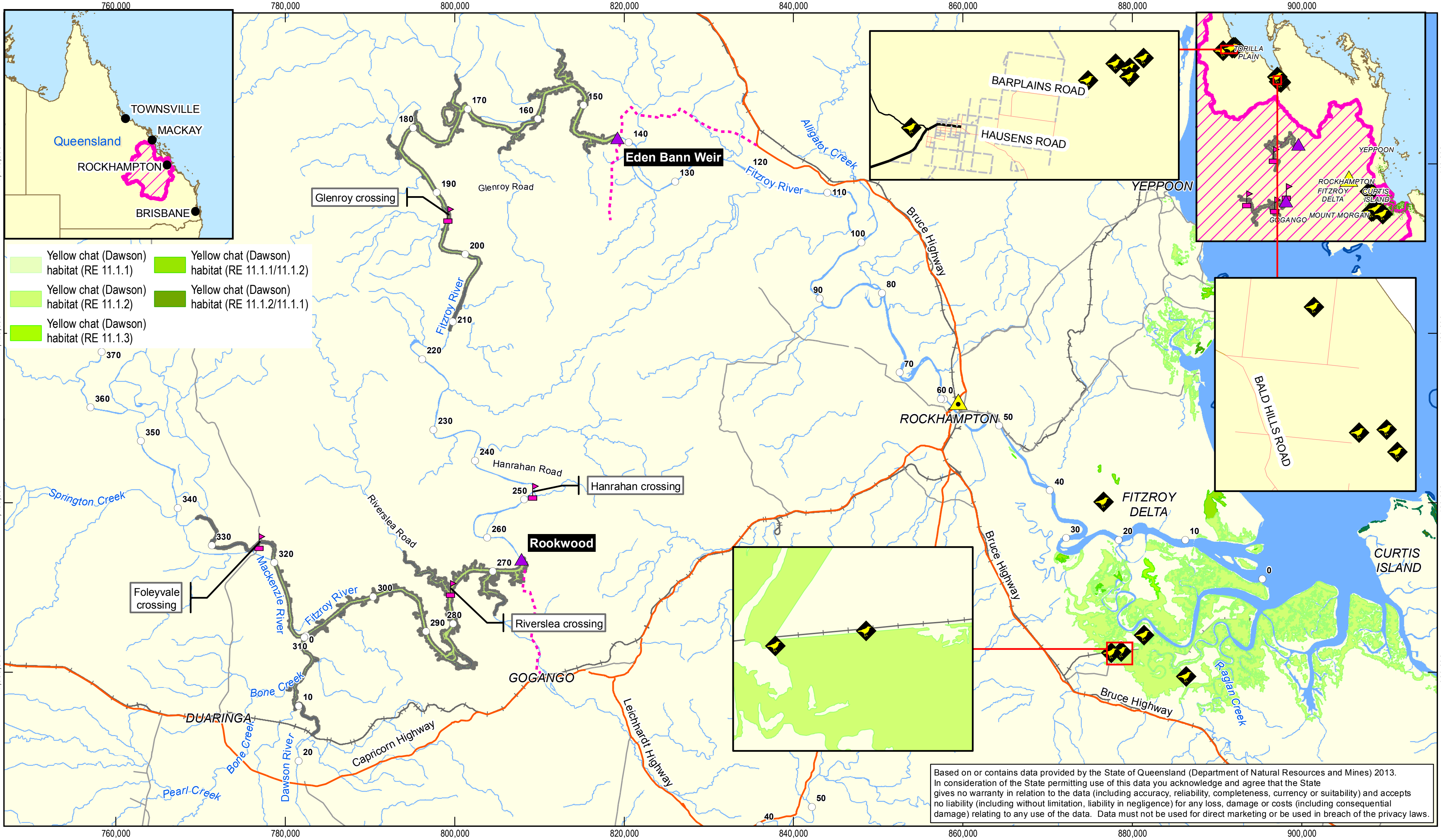
Response

Figure 6-5 shows the distribution and habitat for the yellow chat (Dawson) in relation to the Project areas, including Houston et al's (2009) resighting of a historical record.

Flows downstream of the Fitzroy Barrage are regulated in accordance with the Fitzroy WRP and under rules as defined in the Fitzroy ROP. As described in Section 7.4, flows downstream of the Fitzroy Barrage will not be reduced as a result of the Project. In fact some additional releases are predicted to be made from the Fitzroy Barrage under the operating rules as a result of the Project. These releases are in the order of 18 ML/day and are associated with very small releases made to operate the fishway.

Yellow chat (Dawson) habitat is dependent on freshwater flows which will not be reduced as a result of the Project. It is not expected that the additional small (18 ML/day) fishway flows would influence flows downstream in the estuary such that wetland habitat utilised by the yellow chat (Dawson) is impacted.

[2] 021.16, 021.17



1:600,000 (at A4)

0 5 10 15 20

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA94)
Grid: Map Grid of Australia 1994, Zone 55

LEGEND

- AMTD (km)
- Weir Location
- Fitzroy Barrage
- River Crossing
- Highway
- Major Road
- Streets (Local)
- Fitzroy Basin
- Rookwood Weir Stage 1 impoundment
- Rookwood Weir Stage 2 impoundment
- Eden Bann Weir Stage 2 impoundment
- Eden Bann Weir Stage 3 impoundment
- Access Road
- Yellow chat

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Job Number	41-29212
Revision	D
Date	04 Mar 2016

Yellow chat (Dawson) distribution and habitat

Figure 6-5

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Data Source: © Copyright Commonwealth of Australia (Geoscience Australia): Places, Waterways (2007); Sunwater: Waterways, Weir Locations /2008; DNRM: Habitat- RE v6.1/Nangura/2011/2007, Railways, Roads/2010; Wildnet: Wildlife online/2009; Houston/McDougall et al/DOE: Yellow chat (Discovered 2005-2008) /2015; Created by: MS
*See Appendix for disclaimers and copyrights.

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7. Surface water resources

Impacts, mitigation and management in relation to surface water resources are addressed in the draft EIS (Volume 1, Chapter 9 Surface water resources). Submissions made on the draft EIS in this regard primarily relate to water allocations and entitlements, modelling methodology, changes to flow and the operational strategy of the weirs as detailed in the following sections.

7.1 Water allocation security objectives

Submissions

Submissions were received relating to the Fitzroy WRP and Fitzroy ROP, water allocations and entitlements as follows:

- DNRM (032.07, 032.08, 032.11)
- Private submitter 6 (016.08)
- Private submitter 14 (036.01).

Response

The Fitzroy ROP specifically deals with the management arrangements for supplemented water supply schemes and associated infrastructure, and those for unsupplemented water in water management areas.

Supplemented water is managed through water supply schemes. The Lower Fitzroy Water Supply Scheme includes the existing Eden Bann Weir Stage 1 storage. It is expected that the raised Eden Bann Weir storage and the proposed Rookwood Weir storage will be included in the Lower Fitzroy Water Supply Scheme.

Unsupplemented water is managed by the State in water management areas. The Fitzroy Water Management Area overlaps the existing Eden Bann Weir Stage 1 storage and will overlap the raised Eden Bann Weir storage and most of the proposed Rookwood Weir storage.

Small areas of the Dawson Valley Water Management area and the Nogoa Mackenzie Water Management Area overlap with the upper most extents of the proposed Rookwood Weir storage in the Dawson River and Mackenzie River, respectively.

Supplemented water from the Project will be supplied under commercially negotiated terms. Water entitlements for unsupplemented water cannot be sought through the Project and will remain under management of the State.

For supplemented water supply, performance indicators for WASOs are defined by water allocation priority groups, namely a high priority group or a medium priority group. For unsupplemented water, performance indicators for WASOs are defined for water allocation groups. Unsupplemented water allocation groups in the Fitzroy Water Management Area relative to the Project include Class 5A, Class 5B, Class 6C and Class 7D.

Low flow or no flow (waterholes) entitlements have the potential to be impacted as a result of the project, both upstream and downstream of the weirs. It is likely that changes to stream flow regimes will alter the ability of the existing users to extract water under the existing water sharing rules as identified in the Fitzroy ROP. It is envisaged that individual negotiations will be undertaken between the proponents and entitlement holder once the Project receives a trigger and a development scenario is determined. The negotiations will be based on the voluntary purchase/sale of entitlements and will consider the inclusion of options for the provision of an alternative water supply. Proposed arrangements will be submitted to the State for review and approval prior to negotiations commencing to ensure that any arrangements are within the current regulatory framework.

7.2 Environmental flow objectives

7.2.1 Corrections

Submissions

A submission from DNRM (032.09) required the amendment of text to include reference to Node 0 in defining EFOs.

Response

EFOs are specified at nodes within the Fitzroy WRP plan area. EFOs relevant to the Project are reported only at Node 0 and include:

- For assessing periods of low flow (the seasonal base flow). It is important to note that the Fitzroy WRP states that these values 'should be' met indicating aspirational targets, rather than mandated minimum requirements
- For assessing periods of medium to high flow. EFOs listed are mandatory requirements as indicated by the statement in the Fitzroy WRP of 'is to be at least' or 'is to be not more than'
- For assessing the first post-winter flow event. EFOs listed are mandatory requirements under the Fitzroy WRP.

7.2.2 Weir operating strategy

Submissions

Submissions were received relating to the operational strategy of the weirs and compliance with EFOs. The following submissions are addressed in this section:

- DEHP (028.05)
- DoE (021.05, 021.09, 021.20)
- Private submitter 1 (006.01).

Response

At present, the operational regime within the Lower Fitzroy Water Supply Scheme and Fitzroy Barrage Water Supply Scheme operates to maintain the Fitzroy Barrage at its FSL. Releases are made from the existing Eden Bann Weir Stage 1. This same philosophy is intended to apply to the Project. That is both, the proposed Rookwood Weir and raised Eden Bann Weir (either separately or together) will operate to maintain the Fitzroy Barrage at FSL.

Of relevance to the Project, performance criteria for EFOs are defined in the Fitzroy WRP at Node 0 (located at the end of system at the Fitzroy Barrage). The Fitzroy ROP presently dictates operating and environmental management rules in relation to seasonal base flow only. This is because currently the Eden Bann Weir Stage 1 passes high flows over the spillway within the required timeframe as opposed to be needing to be met through releases from large environmental outlets.

Further performance indicators and operational rules are not defined for Node 1. Node 1 is located immediately downstream of the existing Eden Bann Weir Stage 1 at Wattlebank (adopted middle thread distance (AMTD) 141.2 km). Wattlebank serves only as a gauging station to record outflows from Eden Bann Weir Stage 1.

Weir design for the Project (raising Eden Bann Weir and construction of Rookwood Weir) has considered the need to make releases that satisfy all EFOs and can make releases across the flow range from a base flow of 260 ML/day up to a first post-winter flow of 5,000 ML/day. This has necessitated the inclusion of outlets.

For low and normal flow releases, five times the base flow (between 260 ML/day and 1,300 ML/day) can be released. Outlets will be capable of opening and closing regularly and operate over a range of flows. The fishway may assist in achieving the required release and the outlets will be located adjacent to the fishway to provide fish attraction flows downstream of the weir.

For high flow releases, up to 5,000 ML/day can be released.

The IQQM-Project includes rating curves for the necessary outlets with a maximum 1,300 ML/day flow consistent with the base flow requirements and 5,000 ML/day consistent with high flow requirements.

DNRM advised that, within the IQQM the daily high priority demand modelled was 420 ML/day to accommodate the existing RRC (50,000 ML/a) and SunWater (25,000 ML/a) allocations as well as the anticipated allocation to the Project (76,000 ML/a). This was adopted in the IQQM-Project. The Project demand within the IQQM-Project is included as an extraction point from a new node, Node 448.

7.3 Integrated quantity and quality model

Submission

This section addresses submissions relating to the IQQM methodology and model parameters as relevant to the operational regime of the Fitzroy Barrage fishway and the long term impacts of changing climatic conditions. The following submissions are addressed in this section:

- CCC (029.05)
- DEHP (028.06)
- DoE (021.04)
- RRC (008.04).

Response

Draft EIS Volume 3, Appendix P provides detailed information regarding the IQQM used for the assessment of flow regimes.

The IQQM is a water balance model. Each node represents water input or output to the system:

- Inflows to the Fitzroy system

- Licence holders (and the rules associated with those licences about the quantity of water licenced and rules regarding the timing of the water take)
- Losses (such as river seepage loss or evaporation)
- Infrastructure (such as the physical infrastructure of a weir or dam and the associated outlets and spillway configuration).

IQQM (CAS2134) is the IQQM as supplied by the former DSITIA. IQQM-Project comprises the IQQM (CAS2134) as augmented in agreement with the Queensland Government for the Project.

With regard to the Fitzroy Barrage, the following parameters applied within the IQQM-Project:

- The Fitzroy Barrage storage curve
  - The storage curve in the IQQM (CAS2134) was based on SunWater drawing No. A3-209321 (March 1998); used for Node 274; with a full supply volume of 81,290 ML
  - No update was required for IQQM-Project.
- Fitzroy Barrage outlet curve
  - The adopted outlet curve for the IQQM (CAS2134) was taken from the Fitzroy WRP
  - DSITIA advised that the outlet curve at the Fitzroy Barrage has been adjusted artificially to correct errors encountered in previous versions of the IQQM with respect to water harvesters. The adjustment in the outlet curve is required to avoid choke for on-pond demand nodes located downstream in the model.
  - IQQM-Project adopted the DSITIA adjusted curve in the Project model.
- Fitzroy Barrage spillway curve
  - The adopted spillway curve for the IQQM (CAS2134) was taken from the Fitzroy WRP
  - No update was required for IQQM-Project.
- Fitzroy Barrage dead storage
  - Dead storage volumes were estimated by the former Department of Environment and Resource Management at 57,219 ML; by SunWater at 27,240 ML; and GHD at 27,984 ML
  - IQQM-Project adopted SunWater's dead storage volume of 27,240 ML as suggested by DSITIA.

For the purposes of the draft EIS, operational regimes of existing infrastructure within the Lower Fitzroy Water Supply Scheme and the Fitzroy Barrage Water Supply Scheme (that is existing Eden Bann Weir Stage 1 and the Fitzroy Barrage, respectively) were modelled as per the IQQM-Project in accordance with the Fitzroy ROP.

Due to the operational regime of the proposed Project, the Fitzroy Barrage will be maintained at FSL for as long as releases from the Project storages persist. Consequently, the existing fishway is able to operate for an increased number of days over the period of record (Section 7.4.2). It is expected that the same would apply to the proposed new small-fish fishway. Base flows can occur without the fishway operating (via outlets). Modelling to be undertaken for augmentation of the Fitzroy ROP will further validate this.

IQQM-Project parameters and results have been developed and agreed with representatives from DNRM and (former) DSITIA as discussed and clarified with DEHP at a meeting held 22 October 2015.

Climate change sensitivities have not been included within yield modelling (IQQM-Project) undertaken to date. The technical ecological assessments undertaken as part of the Fitzroy Basin Draft Water Resource Environmental Assessment – Stage 2 Assessment Report (DERM 2010) did however include climate change analysis. The Stage 2 Assessment Report was utilised for the development of performance indicators for EFOs within the Fitzroy Basin.

Predicted increased temperatures, increased evaporation and reduced rainfall as a result of climate change may impact catchment yields. Staging the development will allow the Project to respond to actual demand over time taking into account climate variation, economic considerations and Government policy, planning instruments and guidelines based on circumstances at the time. Water storages are likely to become more important for the purpose of water supply, mitigating drought and for maintaining environment flows as climate change impacts are realised.

It is proposed that once a Project trigger is realised, further yield modelling will be undertaken to develop a robust business case and inform augmentation of the Fitzroy ROP. Climate change scenarios will be included at this time.

7.4 Flow regime and analysis

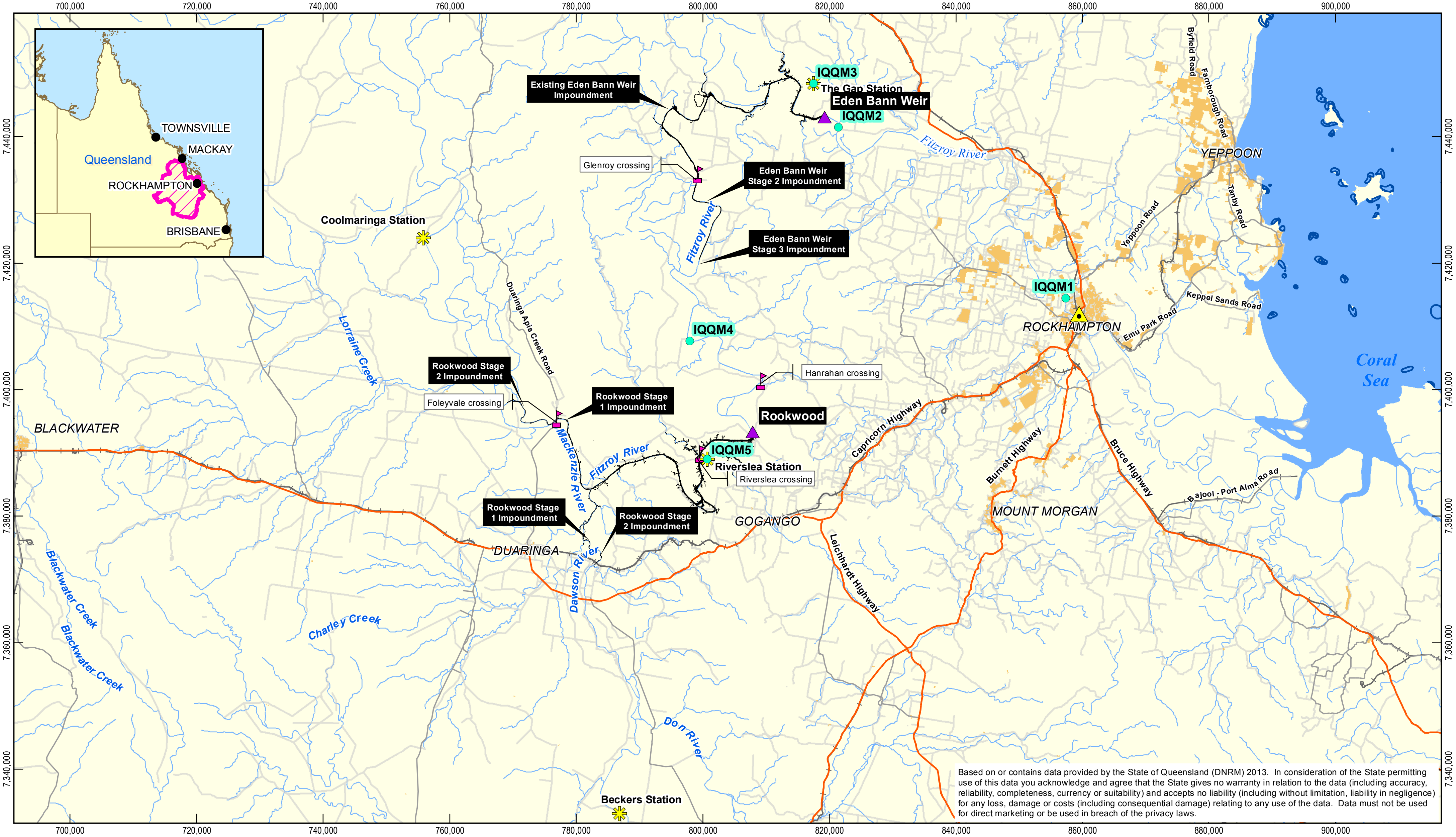
7.4.1 Modelled flow statistics

Submission

This section provides information on the modelling undertaken to assess changes to flow as a result of the Project in response to submissions received from DoE (021.02, 021.04, 021.07, 021.08) and Private submitter 1 (006.01, 006.02).

Response

Analysis of flows for a range of Project development scenarios at representative locations within the system were presented in the draft EIS (Volume 3, Appendix P) as shown in Figure 7-1 and described in Table 7-1.



1:800,000 (at A4)

0 5 10 15 20

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA94)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Weir Location
- River Crossing
- Fitzroy Barrage
- Highway
- Major Road
- Streets (Local)
- Railway
- Waterway
- Fitzroy Basin
- Urbanised Area
- Impoundment Area
- Flow assessment locations
- Stream Gauges

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Gladstone Area Water Board

SunWater MAKING WATER WORK

Gladstone Area Water Board, SunWater
Lower Fitzroy River Infrastructure Project

Job Number	41-20736
Revision	A
Date	04 Mar 2016

Gauging stations and flow assessment locations within and near to Project areas

Figure 7-1

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Level 9, 145 Ann Street Brisbane QLD 4000 Australia T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: © Copyright Commonwealth of Australia (Geoscience Australia): Places, Waterways (2007); Sunwater: Waterways, Weir Locations - 2008; DNRM: Railways, Roads, Fitzroy River Delta, Stream Gauges - 2010;
GHD: Impoundment Area, Crossings (2012), Flow assessment locations - 2014. Created by: MS *See Appendix for disclaimers and copyrights.

Table 7-1 Flow analysis locations

Reference	Assessment location	Description
IQQM1	End of system	Located downstream of the Fitzroy Barrage and representative of the marine/estuarine environment. Approximately concurrent with Node 0.
IQQM2	Wattlebank	Downstream of the existing Eden Bann Weir.
IQQM3	The Gap	Located at the gauging station on the Fitzroy River (142.1 km AMTD), approximately 1 km upstream of the existing Eden Bann Weir; within the current impoundment.
IQQM4	-	An area downstream of the proposed Rookwood Weir but upstream of the existing Eden Bann Weir impoundment.
IQQM5	Riverslea	At the Riverslea gauging station located on the Fitzroy River at 276 km AMTD within an unregulated stretch of the river approximately 11 km upstream of the proposed Rookwood Weir.

Mean and median annual flows have been modelled using the IQQM-Project (Section 7.2.2) for the following scenarios at two locations within the Fitzroy sub-catchment:

- Scenarios:
  - **Pre-development**, whereby all existing and proposed storages, water infrastructure and allocations or extractions have been excluded from the IQQM. The pre-development scenario is taken to represent the natural condition of the catchment
  - **Base case** (Eden Bann Weir base case (EB1)) comprises the 'existing case'. The base case was simulated to include all existing water storage infrastructure within the Nogoa/Fitzroy system. Specifically with relevance to the Project, this included the Fitzroy Barrage and Eden Bann Weir (Stage 1). In-flow data from the Mackenzie and Dawson rivers also accounted for the presence of proposed water storage infrastructure, namely Connors River Dam and Nathan Dam, respectively. These storages are included so as to conservatively represent the potential yield for the Project as dictated by the IQQM (CAS2134) and adopted for the IQQM-Project in agreement with the State
  - **Developed case** or with Project case comprising full development of EB3 and RW2 (EB3+RW2).
- Locations:
  - Wattlebank (IQQM node 002): immediately downstream of the existing Eden Bann Weir and downstream of the Project on the Fitzroy River
  - End of system (IQQM node 249): representative of flows from the Fitzroy Barrage to the estuary and the GBR.

As presented in Table 7-2, under the base case scenario, mean annual flow within the Fitzroy River and at the end of the system has reduced by between 16 per cent and 18 per cent from pre-development levels, respectively, as development has occurred and the system has become more regulated. It is predicted that, with the developed case in place, a further reduction in mean annual flow of less than 0.5 percent would be experienced within the Fitzroy River and a reduction in mean annual flow of approximately 2.5 per cent at the end of the system as a result.

Similarly, median annual flows as presented in Table 7-3 within the Fitzroy River and at the end of the system have reduced by approximately 27 per cent and 31 per cent, respectively from pre-development levels to the base case situation. A further reduction of approximately 4 per cent and 8 per cent will be experienced as a result of the developed case on the Fitzroy River and at the end of the system, respectively.

Daily flow duration curves for the pre-development, base case and developed case scenarios are presented in Figure 7-2 and Figure 7-3 for Wattlebank and at the end of the system, respectively.

Table 7-2 Modelled mean annual flow

Location	AMTD (km)	Mean annual flow (ML/a)		% change from pre-development	Mean annual flow (ML/a)	% change from base case (EB1)
		Pre-development	Base case		Developed case	
Wattlebank (IQQM2; Node 002)	141.2	6,014,357	5,051,787	-16.00	5,027,908	-0.47
End of system (IQQM1; Node 249)	59.6	6,271,340	5,165,951	-17.63	5,035,439	-2.53

Table 7-3 Modelled median annual flow

Location	AMTD (km)	Median annual flow (ML/a)		% change from pre-development	Median annual flow (ML/a)	% change from base case (EB1)
		Pre-development	Base case		Developed case	
Wattlebank (IQQM2; Node 002)	141.2	3,201,440	2,345,249	-26.67	2,241,905	-4.41
End of system (IQQM1; Node 249)	59.6	3,347,066	2,297,885	-31.35	2,119,858	-7.75

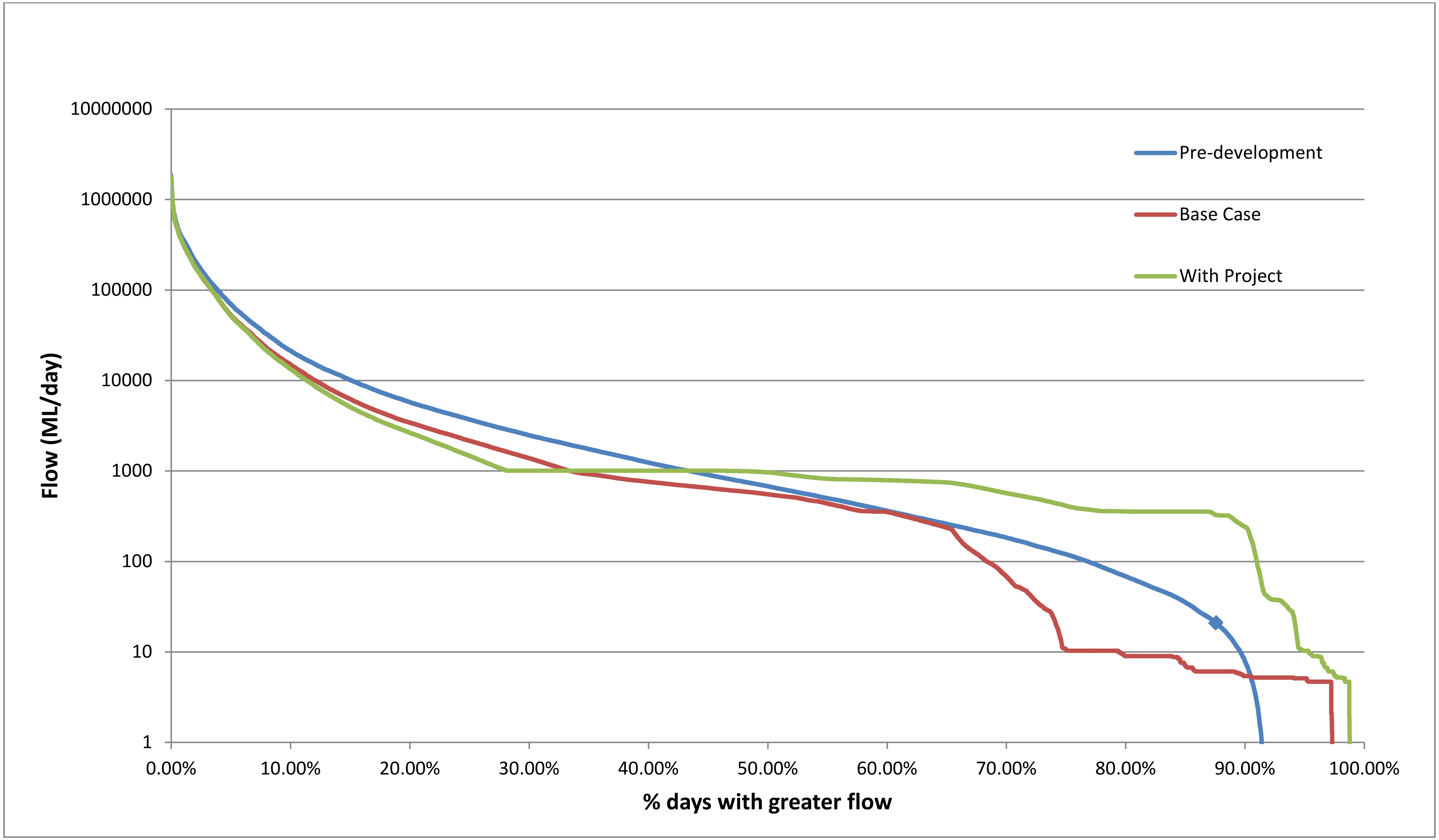

Figure 7-2 Daily flow duration curve – Wattlebank (IQQM Node 002)

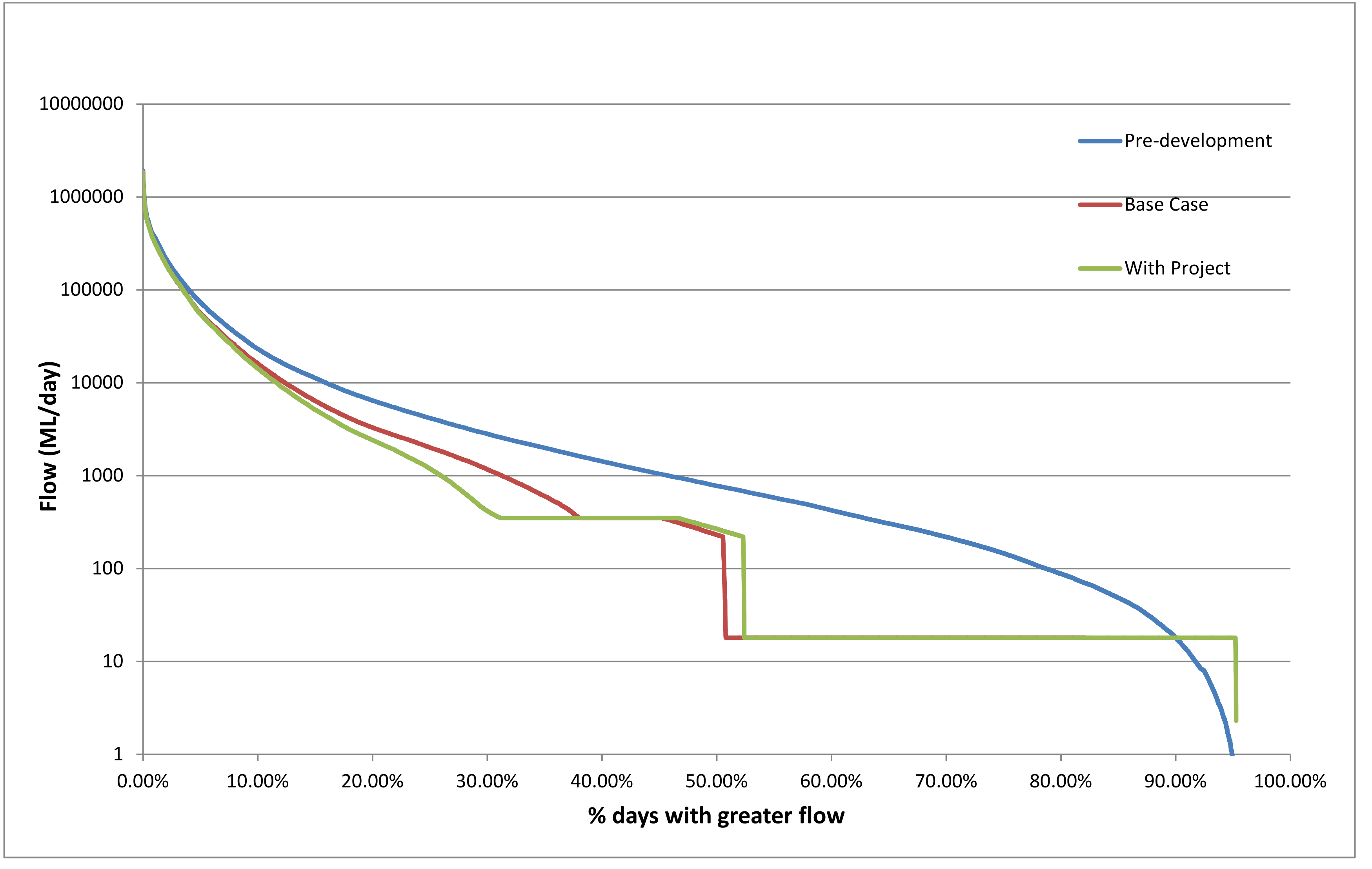

Figure 7-3 Daily flow duration curve – end of system (IQQM Node 249)

The pre-development and base case modelled flow duration curves show the impact of base case storages on the flows within the Fitzroy River.

At Wattlebank, located downstream of Eden Bann Weir (Figure 7-2), for flows above 1,000 ML/day, the developed case flows align relatively closely with the base case flows. However, in accordance with the operational philosophy, more consistent base flows will maintain the Fitzroy Barrage at its FSL. Flows between approximately 300 ML/day and 1,000 ML/day will be made for a longer period under the developed case scenario compared to the base case. This correlates to the releases required to satisfy the predicted demand and environmental base flows.

At the end of the system (Figure 7-3), high flows (above 10,000 ML/day) are not significantly impacted by the developed case. Low flow (10th percentile) (Section 7.4.2) is zero flow and it is evident that with the developed case, the percentage of time that flow will be facilitated is improved and trending towards the pre-development scenario.

Flow duration curves for a range of developed case scenarios at representative locations within the system were presented in the draft EIS (Volume 3, Appendix P) as shown in Figure 7-1 and described in Table 7-1.

For clarification, the developed case scenarios for which flow duration curves are presented and compared to the base case are presented below. These are based on consideration of assessment of the maximum development opportunity (EB3+RW2) and likely staging options in response to emerging demand and associated yield i.e.:

- EB2 at IQQM1, IQQM2 and IQQM3. Eden Bann Weir development does not impact on the system upstream of its inundation area and flows are not reported at IQQM4 or IQQM5
- RW1 and the existing EB1 at IQQM1, IQQM2, IQQM3, IQQM4 and IQQM5
- RW2 and EB3 (upper limit of infrastructure development) IQQM1, IQQM2, IQQM3, IQQM4 and IQQM5.

Daily flow duration curves are reproduced in Appendix H.

Modelled flow has been undertaken using a recognised and accepted methodology developed in consultation with DNRM, DEWS and DSITI (Section 7.3). The IQQM (CAS2134) (as provided by the State Government) and the adopted IQQM-Project reflects a data period (the simulation period) of more than 100 years from 1 January 1900 to 31 December 2007 as per the Fitzroy WRP. This period includes the extended dry period/drought conditions experienced between 2000 and 2007 and is considered representative of the range of climatic conditions and associated flow regimes that may occur. Demand assumptions and operational regimes are assumed at upper limits and are in keeping with the current operational philosophy that maintains the Fitzroy Barrage at its FSL. Following detailed design, the Fitzroy ROP will be updated. Further modelling will be undertaken to refine the operating regime, but will retain compliance with EFOs in accordance with the Fitzroy WRP.

7.4.2 Analysis for periods of low flow and antecedent conditions

Submissions

A number of submissions were received from DoE (021.03, 021.13, 021.14) in relation to assessment of impacts during low flow years and antecedent conditions. The Office of Water Science within DoE considers that there may be a significant percentage reduction in total and monthly flow in low flow years and drought periods without major flow events, due to capture of low to medium flows in dry years.

Response

Methodology

The impact assessment of low river flows was undertaken using data previously extracted from the IQQM-Project (Section 7.2.2 and as detailed in the draft EIS Volume 3, Appendix P).

Two scenarios were analysed.

- Scenario 1: **Base case** (EB1) (Section 7.4.1)
- Scenario 2: **Developed case**, i.e. with Project at full development infrastructure (EB3+RW2).

The flow data extracted from the IQQM-Project covers the years 1900 to 2007 inclusive and comprises daily modelled data.

Three locations within the system (correlating to areas as shown on Figure 7-1 and nodes as described in Table 7-1) were selected for assessment:

- IQQM4 (Node 443): located downstream of the proposed Rookwood Weir site and upstream of the Eden Bann Weir (existing and proposed Stages 2 and 3) pool
- IQQM2 (Node 002): located at Wattlebank gauging site downstream of Eden Bann Weir (existing and proposed Stages 2 and 3) and upstream of the existing Fitzroy Barrage pool
- IQQM1 (Node 249): located downstream of the existing Fitzroy Barrage and noted in the IQQM as representative of the ‘end of system’.

The low flow threshold for Scenario 1 was assessed for the base case using the 10th percentile for all daily data. That is, of the daily flows over the 110 years (43,435 days) of record, the river will have minimal or no flow for 10 percent of those days at the flows listed below:

- IQQM4 (Node 443): zero flow
- IQQM2 (Node 002): 5.4 ML/day
- IQQM1 (Node 249): zero flow.

The developed case was then assessed by comparing the daily flow where values equal to or less than the defined low flow values listed above, occurred.

IQQM4 (Node 443) downstream of the proposed Rookwood Weir site

At IQQM4 location (Node 443) the low flow is defined as ‘zero’ flow. That is for 10 per cent of all recorded daily flows there is no flow in this reach of the river under the base case (EB1).

With the developed case, depending on the level of water in storage at Rookwood Weir (as Stage 2), water demand releases and/or environmental flow releases are made (Table 7-4).

The following is noted for low flows under the developed case:

- No release is made below dead storage (that is, weir empty), which accounts for up to 25 per cent of daily low flow data post development.
- As per the IQQM (CAS2134) and adopted for the IQQM-Project (Section 7.3), 900 ML/day releases account for new water demand for the Project and base flow environmental releases, however, this release is not achieved if there is insufficient storage in the weir.

As shown in Table 7-4, the median flow under the base case scenario is zero and under the developed case it is 436 ML/day as a result of flows being able to be made from the proposed Rookwood Weir.

IQQM2 (Node 002) Wattlebank

At IQQM2 location (Node 002) (representing releases made from Eden Bann Weir to the Fitzroy Barrage), low flow is defined as 5.4 ML /day. This comprises the base case with releases made from the existing Eden Bann Weir as per the Fitzroy ROP to satisfy existing water user demands, environmental flows and fishway operation.

Under the developed case, water demand releases and/or environmental flow releases are made as shown in Table 7-5.

From Table 7-5 it is evident that:

- No releases are made below dead storage, which accounts for up to 20% of the daily low flow data post development
- Releases between zero up to 269.20 ML/day are under the developed case compared to zero release under the base case for up to 35 per cent of daily low flow data
- Where low flow releases are made under the base case scenario (4.70 to 5.40 ML/day), the developed case will increase flows significantly (354.70 to 1010.30 ML/day) to meet existing and project demands, environmental flows and fishway releases.

Base case median flows are 5.1 ML/day compared to median with developed case flows of 355.2 ML/day. Average flows also increase significantly from the base case to the developed case (3.89 to 500.91 ML/day).

IQQM1 (Node 249) end of system

At IQQM1 location (Node 249) (representing flows at the end of the system downstream to the GBR), low flow is defined as zero (10^{th} percentile).

As shown in Table 7-6 for the developed case, up to 95 per cent of the low flows are now 18 ML/day, noting that some days still contain no flow. Median base case flows are zero, while median developed case flows are 18 ML/day. 18 ML/day equates to a flow rate of 0.2 m^3/s and is considered representative of flows operating the fishway at the Fitzroy Barrage.

For all low/zero flow conditions, developed case flows are not lower than base case flows.

Table 7-4 Percentage of time of low (zero) flows – base case and developed case at IQQM4

Analysis location: IQQM4 (Node 443)		
Percentage of daily flows	Releases made during corresponding time of zero flow	
	Base case (ML/d)	Developed case (ML/d)
5.00	-	-
10.00	-	-
15.00	-	-
20.00	-	-
25.00	-	-
30.00	-	81.44
35.00	-	370.58
40.00	-	407.10
45.00	-	418.10
50.00	-	436.00
55.00	-	554.36
60.00	-	799.48
65.00	-	900.00
70.00	-	900.00
75.00	-	900.00
80.00	-	900.00
85.00	-	900.00
90.00	-	900.00
95.00	-	900.00
100.00	-	900.00
Median	-	436.00
Average	-	489.11

Table 7-5 Percentage of time of low (zero) flows – base case and developed case at IQQM2

Analysis location: IQQM 2 (Node 002)		
Percentage of daily flows	Releases made during corresponding time of up to 5.4 ML/day flow	
	Base case (ML/d)	Developed case (ML/d)
5.00	-	-
10.00	-	-
15.00	-	-
20.00	-	-
25.00	-	5.60
30.00	-	37.30
35.00	-	269.20
40.00	4.70	354.70
45.00	4.70	355.10
50.00	4.70	355.20
55.00	4.70	377.80
60.00	5.10	560.60
65.00	5.10	797.00
70.00	5.20	973.40
75.00	5.20	1,004.70
80.00	5.20	1,005.00
85.00	5.20	1,005.20
90.00	5.20	1,005.20
95.00	5.20	1,008.80
100.00	5.40	1,010.30
Median	5.10	355.20
Average	3.89	500.91

Table 7-6 Percentage of time of low (zero) flows – base case and developed case at IQQM1

Analysis location: IQQM 1 (Node 249)		
Percentage of daily flows	Releases made during corresponding time of zero flow	
	Base case (ML/d)	Developed case (ML/d)
5.00	-	-
10.00	-	-
15.00	-	-
20.00	-	-
25.00	-	18.00
30.00	-	18.00
35.00	-	18.00
40.00	-	18.00
45.00	-	18.00
50.00	-	18.00
55.00	-	18.00
60.00	-	18.00
65.00	-	18.00
70.00	-	18.00
75.00	-	18.00
80.00	-	18.00
85.00	-	18.00
90.00	-	350.00
95.00	-	350.00
100.00	-	14,347.10
Median	-	18.00
Mean	-	63.55

Analysis of flow under antecedent conditions

In considering antecedent conditions the modelled flow (ML/day) output data from the IQQM (at IQQM1 that is the end of the system) were analysed for aggregated monthly and annual low flows.

Again low flows were identified as the 10th percentile flow for the base case (EB1), calculated as 192,118 ML/a and 0 ML/mth.

Where these values or less occurred in the dataset, the year and month was identified and the flow data either side of these occurrences was assessed with respect to the length of time that these flows persist.

Years with annual flow of less than 192,118 ML/a are identified in 1892, 1901/1902, 1915, 1919, 1935, 1945, 1964/1965, 1969, 1987, 1992/1993, 1995 and 2002.

The Fitzroy River is a dynamic system located at the end of a large catchment. From the annual flow hydrograph presented in Figure 7-4 and hydrographs in Figure 7-5 through Figure 7-12 showing flows preceding and following each of the low flow periods it is evident that annual flows vary considerably year to year. Periods of no or low flow (10th percentile) are limited and do not extend for more than two years with significantly larger flows preceding and following each no or low flow period.

Consistent with data presented in the draft EIS the data presented above indicates a negligible impact associated with flows under the developed case scenario under antecedent conditions. Statistical analysis presented in the draft EIS (Volume 2, Chapter 8 General impacts, Section 8.2.2) has shown that with the Fitzroy ROP in place, there are no significant differences between base case flow regimes and the flow regimes projected with the developed case in place.

Summary

Water flows downstream of the weirs are predicted to increase during the dry season and the frequency and duration of no flow periods will decrease under the developed case compared to the base case. The increase in flows during the dry season has the potential to improve the quality of Fitzroy River turtle and white-throated snapping turtle habitat by reducing the duration and severity of pool isolation downstream of the weirs and prolong the presence of flowing riffles zones and runs. The increase in habitat availability during the dry season will provide additional resources for the turtle during times when conditions are limiting.

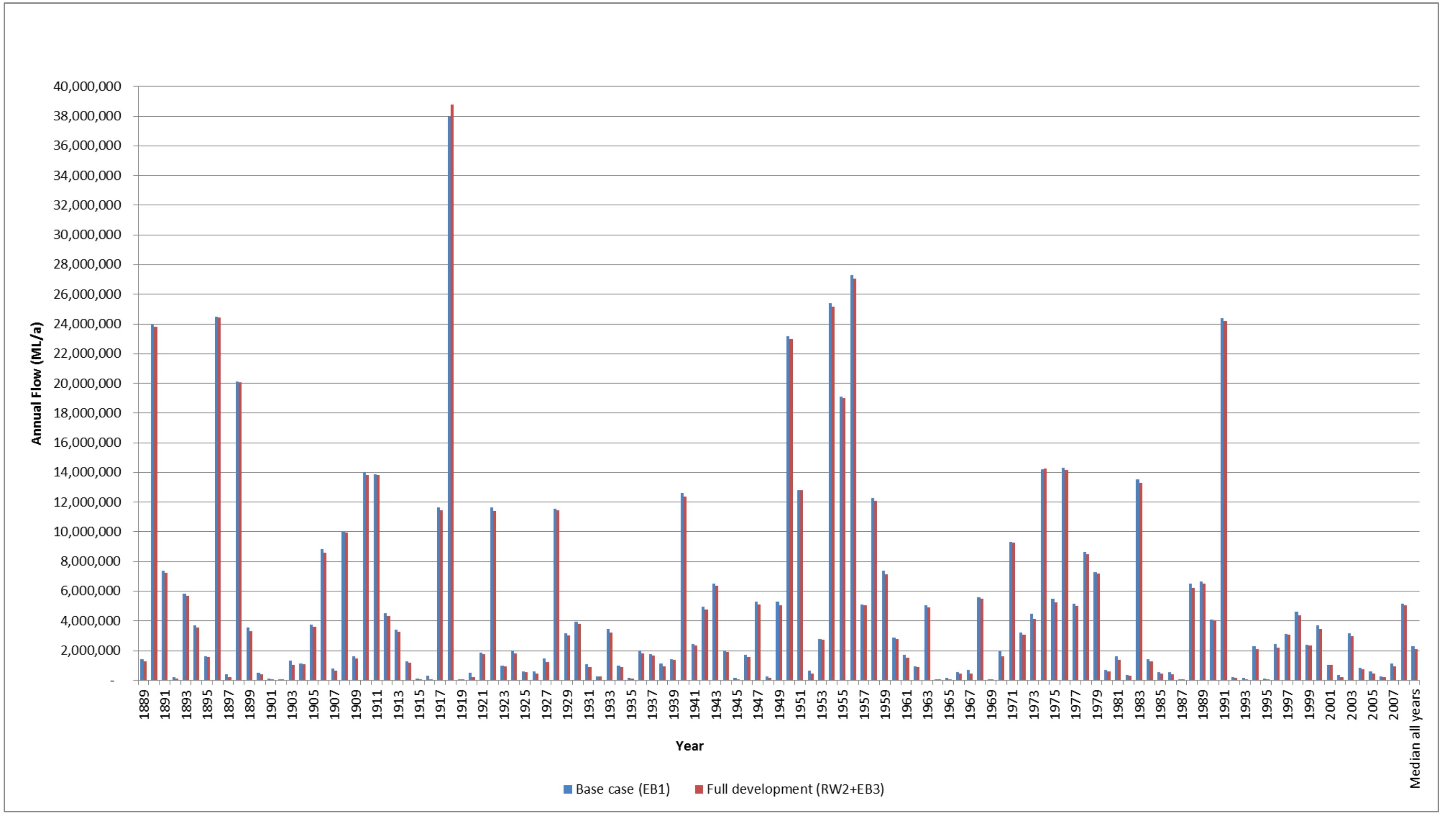

Figure 7-4 Annual flow hydrograph at IQQM1

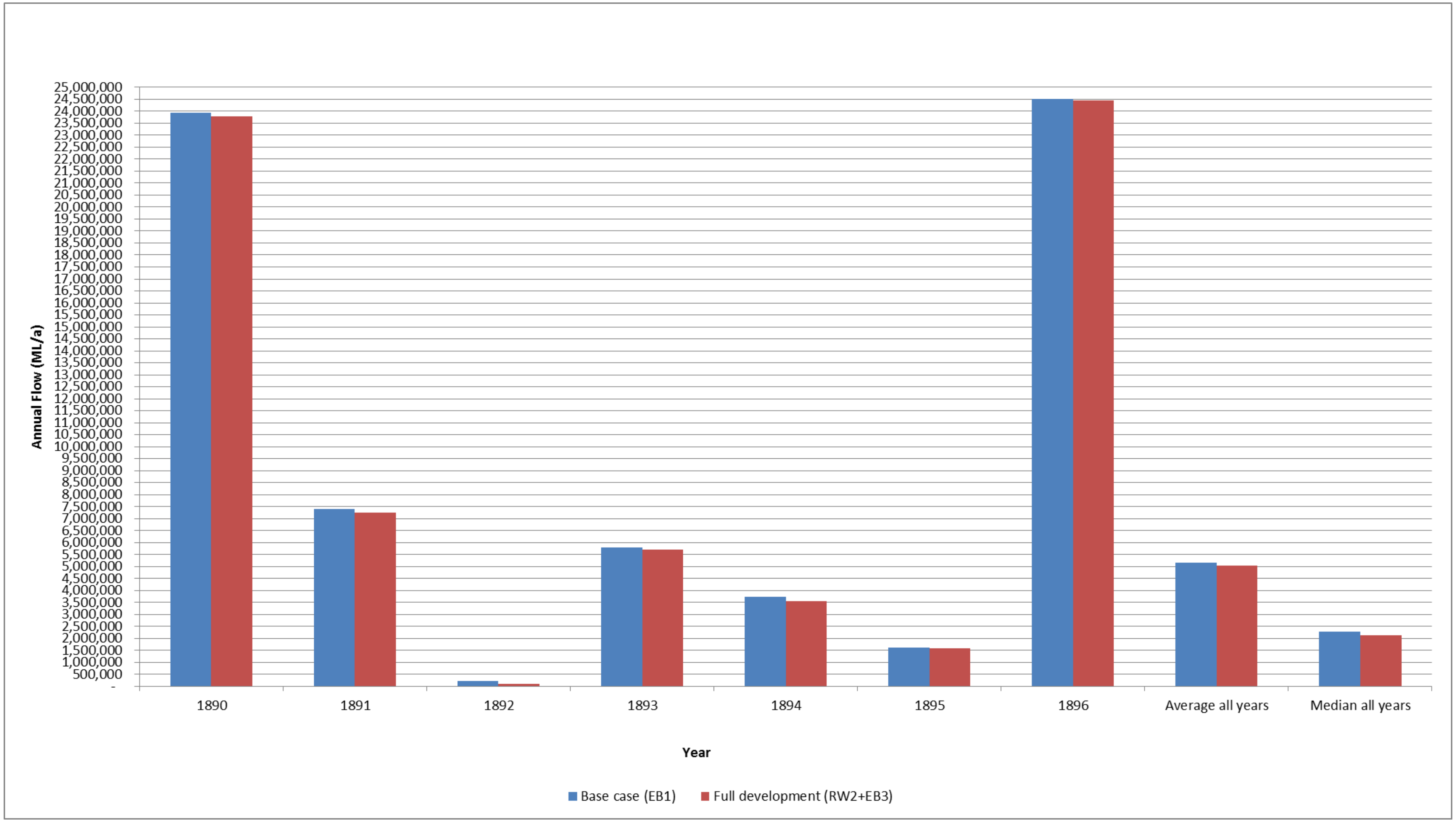

Figure 7-5 Annual flow preceding and post low flow year 1892

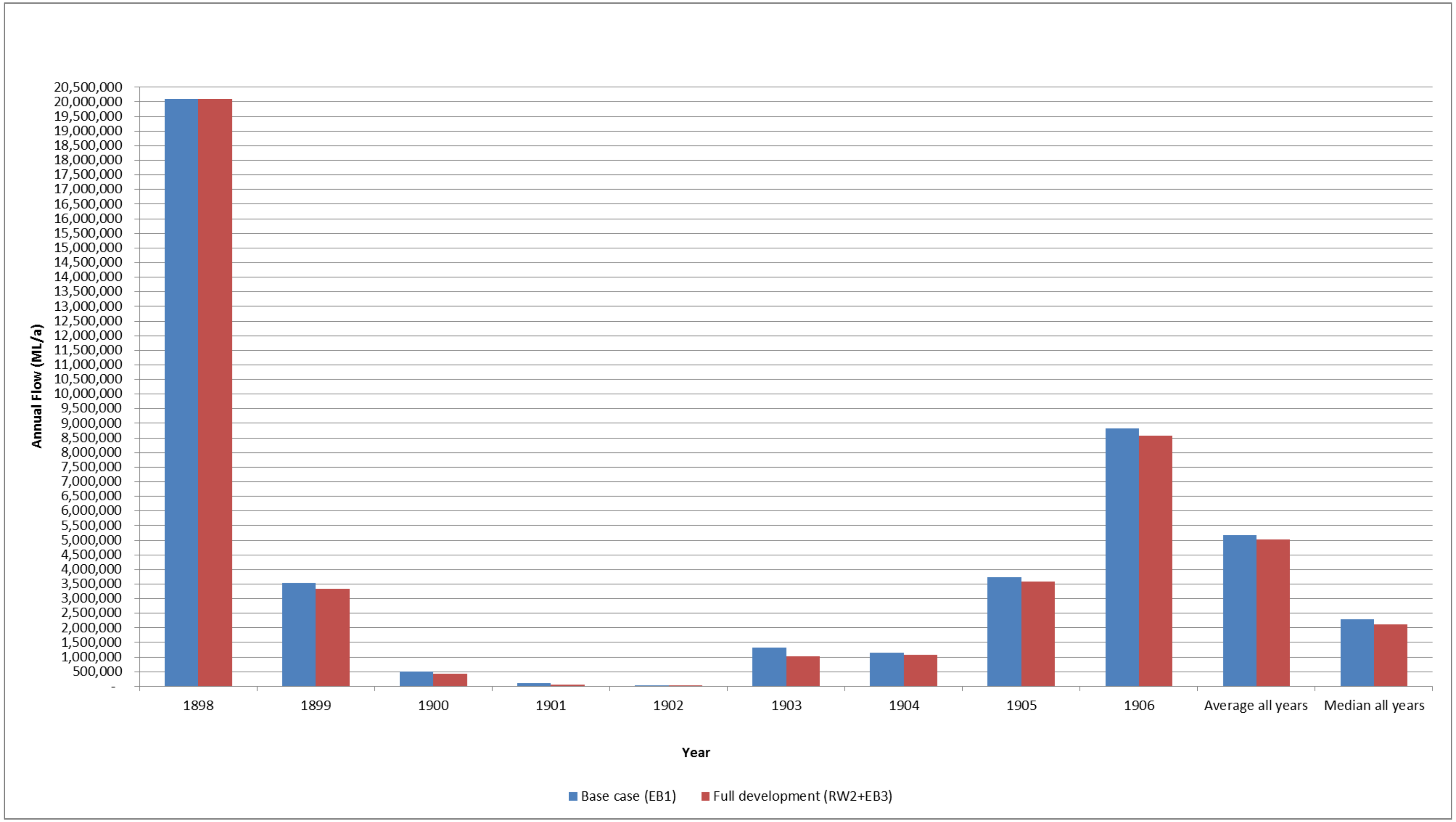

Figure 7-6 Annual flow preceding and post low flow years 1901/1902

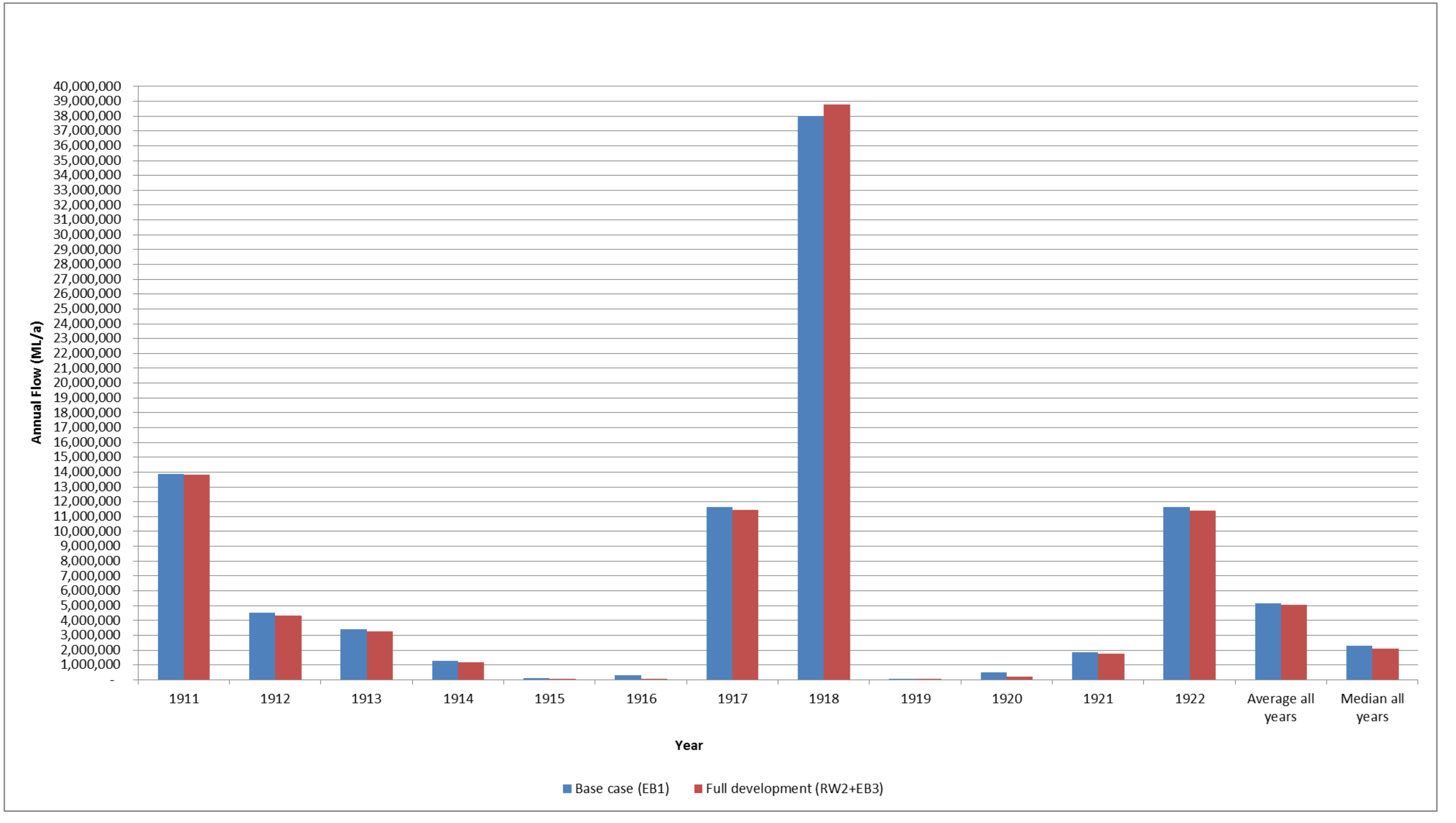

Figure 7-7 Annual flow preceding and post low flow years 1915/1916 and 1919

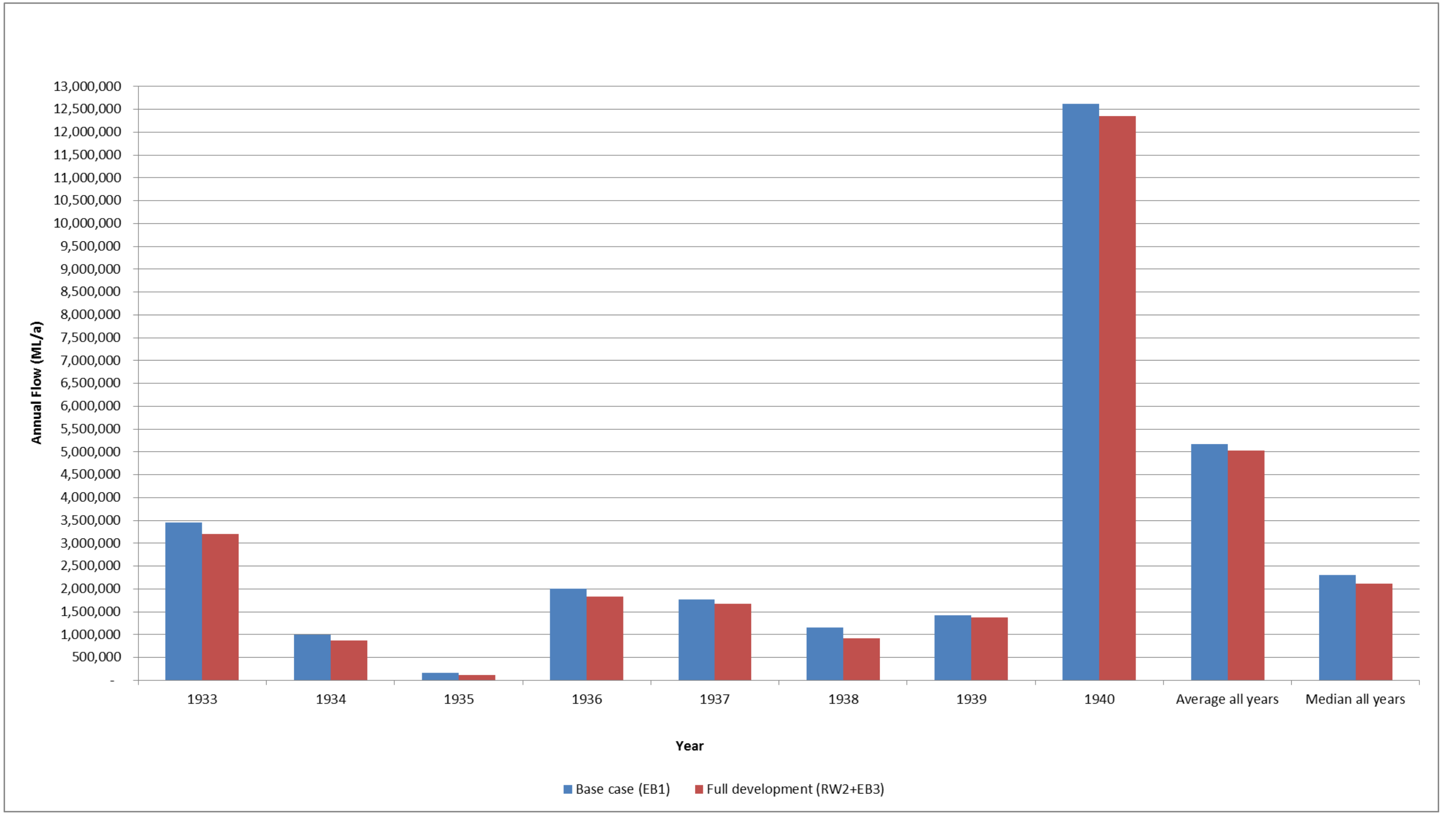

Figure 7-8 Annual flow preceding and post low flow year 1935

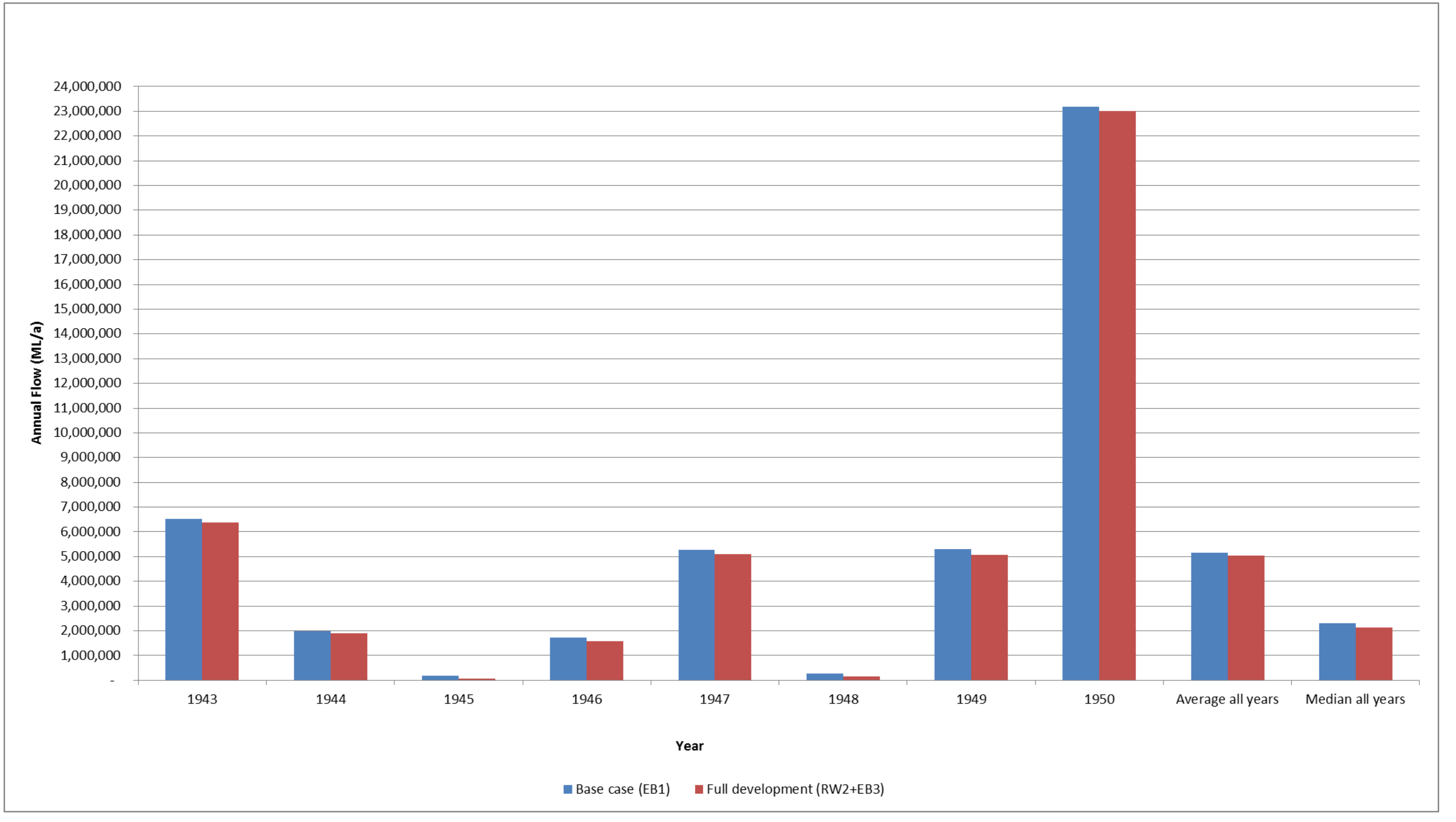

Figure 7-9 Annual flow preceding and post low flow year 1945

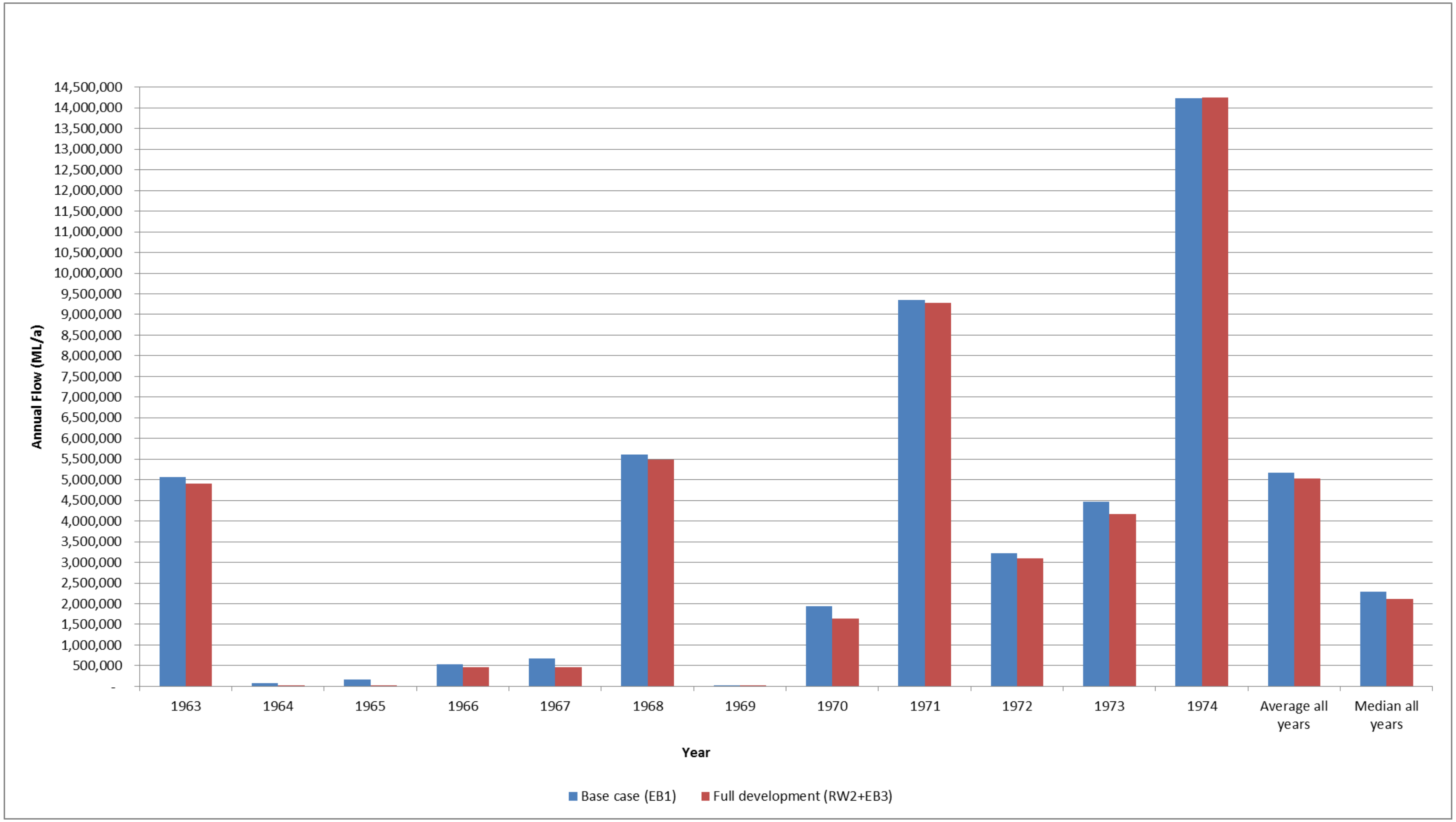

Figure 7-10 Annual flow preceding and post low flow years 1964/1965 and 1969

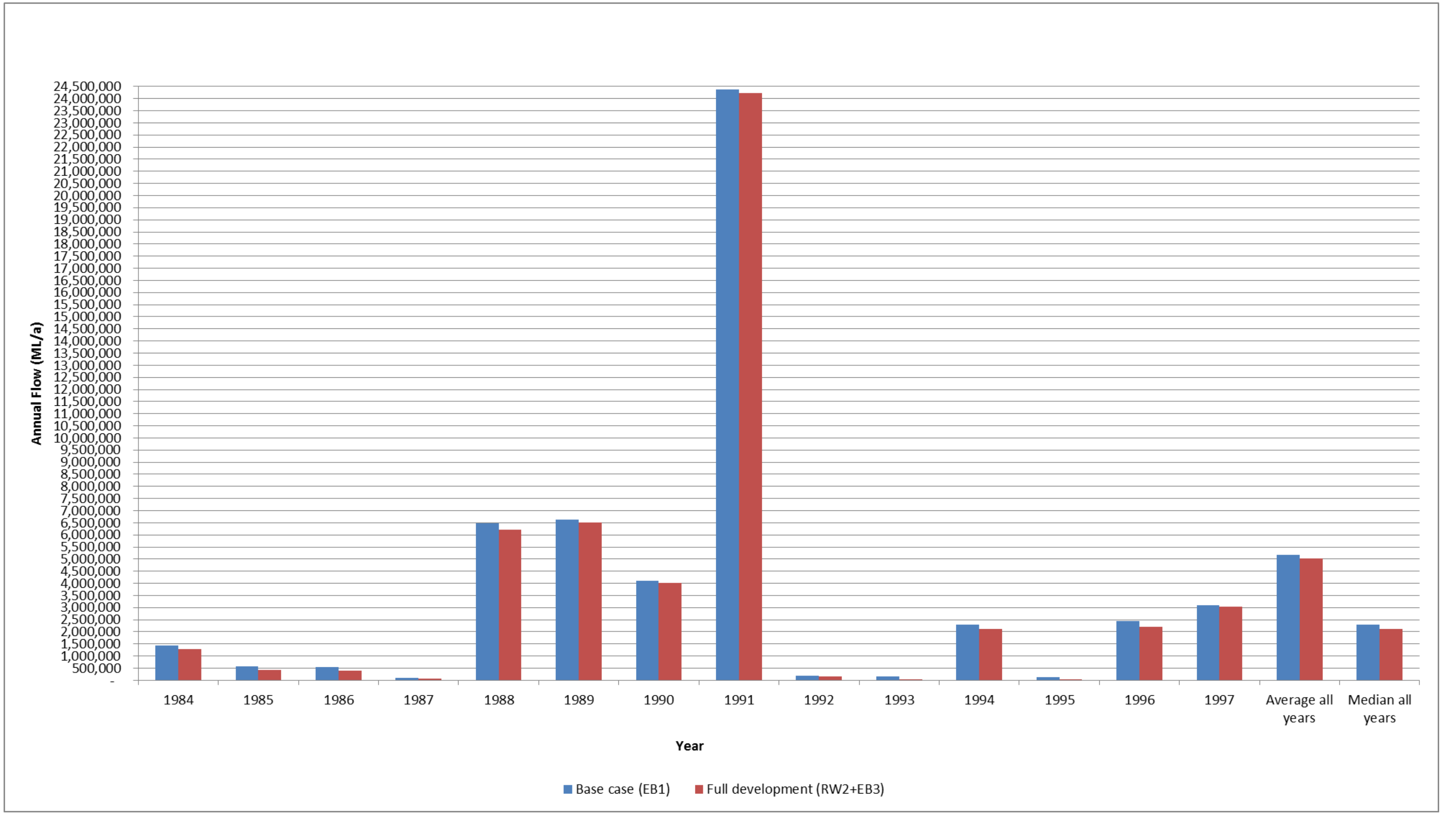

Figure 7-11 Annual flow preceding and post low flow years 1987 and 1993

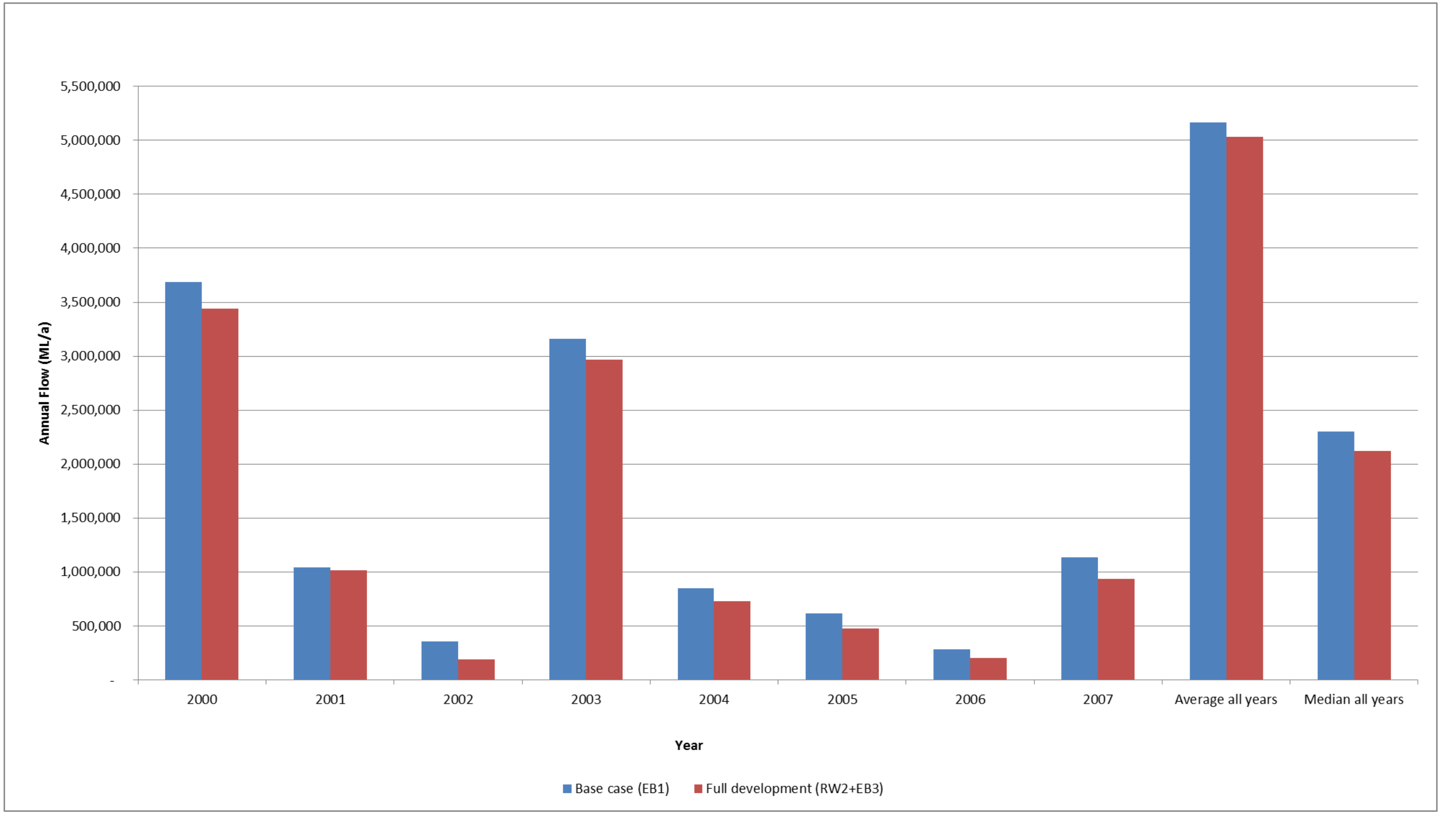

Figure 7-12 Annual flow preceding and post low flow year 2002

7.4.3 Analysis for seasonal daily impact

Submissions

This section provides information on the modelling undertaken to assess the seasonal impact on flows as a result of the Project in response to submissions received from DoE (021.19, 021.20, 021.21, 021.23).

Response

Methodology

The seasonal impact on flows was assessed by utilising the same IQQM-Project data as described above (7.4.2).

All daily data on record (over 43,000 days) was divided into seasons in alignment with the Fitzroy WRP seasonal EFOs, that is:

- January to April inclusive
- May to August inclusive
- September to December inclusive

An assessment of base case and developed case daily flows was then undertaken at the following locations (Figure 7-1):

- IQQM4 (Node 443): located downstream of the proposed Rookwood Weir site and upstream of the Eden Bann Weir (existing and proposed Stages 2 and 3) pool
- IQQM2 (Node 002): located at Wattlebank gauging site downstream of Eden Bann Weir (existing and proposed Stages 2 and 3) and upstream of the existing Fitzroy Barrage pool
- IQQM1 (Node 249): located downstream of the existing Fitzroy Barrage and noted in the IQQM as representative of the ‘end of system’.

Results

IQQM4 (Node 443) downstream of Rookwood Weir

Median and mean seasonal flows under the base case and developed case are presented in Table 7-7.

Table 7-8 presents a comparison of seasonal flows pre- and post-project development at IQQM4.

Table 7-7 Median and average seasonal base case and developed case flows at IQQM4

	Seasonal flows (ML/d)								
	January - April			May - August			September - December		
	Base case	Developed case	Variation	Base case	Developed case	Variation	Base case	Developed case	Variation
Median	2,266.25	1,625.90	-640.35	168.70	858.60	689.90	86.25	900.00	813.75
Mean	34,893.03	34,568.39	-324.64	4,223.64	4,448.32	224.68	2,867.86	2,823.92	-43.93

Table 7-8 Comparison of base case and developed case flows per season at IQQM4

Percentage of daily flows	Seasonal flows (ML/d)								
	January - April			May - August			September - December		
	Base case	Developed case	Variation	Base case	Developed case	Variation	Base case	Developed case	Variation
100.00	-	-	-	-	-	-	-	-	-
95.00	-	29.30	29.30	-	44.64	44.64	-	-	-
90.00	71.77	811.50	739.73	-	72.26	72.26	-	-	-
85.00	166.91	811.50	644.59	-	357.98	357.98	-	3.70	3.70
80.00	269.60	859.94	563.34	-	405.20	405.20	-	138.92	138.92
75.00	487.90	862.90	375.00	-	412.60	412.60	-	426.33	426.33
70.00	711.39	900.00	188.61	14.90	425.00	410.10	-	454.30	454.30
65.00	977.84	900.00	-77.83	47.10	566.56	519.46	-	610.80	610.80
60.00	1,306.62	1,051.84	-254.78	85.94	707.92	621.98	20.20	830.86	810.66
55.00	1,737.12	1,340.00	-397.12	124.20	840.74	716.54	46.07	860.90	814.84
50.00	2,266.25	1,625.90	-640.35	168.70	858.60	689.90	86.25	900.00	813.75
45.00	2,948.09	2,313.66	-634.44	238.50	859.10	620.60	134.74	900.00	765.27
40.00	3,829.62	3,157.92	-671.70	333.78	900.00	566.22	192.62	900.00	707.38

Percentage of daily flows	Seasonal flows (ML/d)								
	January - April			May - August			September - December		
	Base case	Developed case	Variation	Base case	Developed case	Variation	Base case	Developed case	Variation
35.00	5,198.73	4,409.42	-789.31	449.20	900.00	450.80	302.41	900.00	597.59
30.00	7,583.45	6,629.67	-953.78	594.52	900.00	305.48	468.09	900.00	431.91
25.00	12,149.60	10.922.63	-1,226.98	797.30	900.00	102.70	769.80	900.00	130.20
20.00	20,606.32	19,281.20	-1,325.12	1,165.88	1,043.64	-122.24	1,250.26	900.00	-350.26
15.00	38,482.29	37,274.72	-1,207.57	1,934.14	1,580.70	-353.44	1,995.82	1,120.00	-875.81
10.00	81,158.72	80,639.34	-519.38	3,821.88	3,319.64	-502.24	3,543.56	1,503.59	-2,039.91
5.00	194,550.10	195,703.16	1,153.06	13,749.00	13,090.32	-658.68	7,811.62	4,827.60	-2,984.02
0.00	1,809,233.10	1,750,124.60	-59,108.50	586,314.50	585,314.50	-521.70	531,906.40	530,501.90	-1,404.50

The results as presented in Table 7-7 and Table 7-8 can be summarised as follows:

- January to April
  - The reduction in flows under the developed case is most obvious in the wet season
  - The developed case impacts primarily on medium to high flows i.e. most of the water take is associated with these flows
  - There is an increase in low flows under the developed case due to demand releases and environmental releases being made.
- May to August
  - Under the developed case there is an overall increase in the flows between the Rookwood Weir and Eden Bann Weir as shown in the comparison of median and mean flows. This is expected during the drier period as releases are made for the developed case to satisfy project demand releases and to maintain environmental flows
  - The developed case flows are in the order of 900 ML/day (approximately $10m^3/s$), which is considered sufficient to maintain riffle/run/pool sequences downstream during this typically drier period
  - The developed case affects medium to high volume flows but does so marginally with reductions in the order of 100 ML/day to 700 ML/day)
- September to December
  - Overall, there is an increase in the flows between the Rookwood Weir and Eden Bann Weir as shown in the comparison of median and mean flows
  - The developed case affects medium to high volume flows for up to 15 per cent of daily flows with reductions of between 1,500 ML/day and 3,000 ML/day. This aspect could be further controlled using operating rules in order to make EFO releases during periods of extended dry periods assuming inflows to Rookwood Weir occur
  - The developed case flows are in the order of 500 ML/day to 1,000 ML/day (approximately 5.7 m^3/s to 11.6 m^3/s), which is sufficient to maintain riffle/run/pool sequences.

IQQM2 (Node 002) Wattlebank

Median and mean seasonal flows under base case and developed case are presented in Table 7-9. A comparison of seasonal flows under base case and developed case is presented in Table 7-10 for IQQM2.

Table 7-9 Median and mean seasonal base case and developed case flows at IQQM2

	Seasonal flows (ML/d)								
	January - April			May - August			September - December		
	Base case	Developed case	Variation	Base case	Developed case	Variation	Base case	Developed case	Variation
Median	2,133.45	1,522.40	-611.05	357.10	794.60	437.50	199.25	887.20	687.95
Mean	34,814.65	34,466.56	-348.08	4,262.98	4,404.24	141.26	2,799.11	2,804.01	4.91

Table 7-10 Comparison of base case and developed case flows per season at IQQM2

Percentage of daily flows	Seasonal flows (ML/d)								
	January - April			May - August			September - December		
	Base case	Developed case	Variation	Base case	Developed case	Variation	Base case	Developed case	Variation
100.00	-	-	-	-	-	-	-	-	-
95.00	6.70	147.02	140.32	4.70	5.90	1.20	5.90	9.00	3.10
90.00	34.50	617.56	583.06	5.10	163.18	158.08	6.10	36.00	29.90
85.00	286.04	617.56	331.52	5.20	350.84	345.64	6.60	269.92	290.32
80.00	414.88	767.94	353.06	5.20	355.10	349.90	9.00	356.10	347.10
75.00	575.88	793.40	217.53	20.00	355.20	335.20	9.00	360.30	351.30
70.00	722.55	948.29	225.74	57.88	361.38	303.50	10.30	426.91	416.61
65.00	903.45	1,006.70	103.26	108.96	434.12	325.16	10.30	568.98	558.68
60.00	1,161.82	1,008.80	-153.02	307.54	556.44	248.90	38.47	744.20	705.74
55.00	1,584.72	1,024.58	-560.15	307.54	687.98	380.44	38.47	782.77	744.30
50.00	2,133.45	1,522.40	-611.05	357.10	794.60	437.50	199.25	887.20	687.95
45.00	2,768.80	2,204.54	-564.26	440.68	805.50	364.82	352.80	992.84	640.04
40.00	3,662.64	2,992.52	-630.12	544.22	817.16	272.94	463.62	1,006.10	542.48

Percentage of daily flows	Seasonal flows (ML/d)								
	January - April			May - August			September - December		
	Base case	Developed case	Variation	Base case	Developed case	Variation	Base case	Developed case	Variation
35.00	4,965.29	4,232.42	-732.86	636.66	918.44	281.78	552.62	1,009.00	456.39
30.00	7,409.66	6,405.10	-1,004.56	721.96	1,003.60	281.64	627.58	1,009.00	381.42
25.00	11,949.18	10,658.93	-1,290.25	830.80	1,005.10	174.30	725.23	1,010.30	285.08
20.00	20,445.46	18,658.93	-1,532.24	1,057.40	1,005.20	-52.20	878.20	1,010.30	132.10
15.00	38,208.48	37,045.44	-1,163.04	1,788.20	1,531.06	-257.14	1,535.17	1,010.30	-524.87
10.00	81,321.92	80,232.64	-1,089.28	3,621.58	3,245.48	-376.10	3,002.26	1,346.29	-1,655.97
5.00	194,457.00	192,059.54	-2,397.47	13,651.92	13,104.16	-547.76	7,154.63	4,541.81	-2,612.83
0.00	1,809,178.30	1,814,406.30	5,228.00	586,155.20	582,442.50	-3,712.70	531,608.10	525,608.10	-6,095.10

Results as presented in Table 7-9 and Table 7-10 can be summarised as follows with the developed case:

- January to April
  - The reduction in flows as a result of the Project is most obvious in the wet season
  - The Project affects medium to high flows
  - There is an increase in the flows defined as low flows due to demand releases and environmental releases being made from Eden Bann Weir.
- May to August
  - Overall, there is an increase in the flows between Eden Bann Weir and the Fitzroy Barrage pool
  - The flows are in the order of 500 ML/day (approximately 6 m^3/s), which is enough to maintain riffle/run/pool sequences
  - Water extraction marginally affects medium to high volume flows
- September to December
  - Overall, there is an increase in flows between Eden Bann Weir and the Fitzroy Barrage pool
  - The Project reduces medium to high volume flows for up to 10 per cent of daily flows. This aspect could be controlled with operating rules to make EFO releases during periods of extended dry
  - The flows are in the order of 500 ML/d -1,000 ML/day which is approximately 5.7 m^3/s - 11.6 m^3/s, which is sufficient to maintain riffle/run/pool sequences.

IQQM1 (Node 249) end of system

Median and average seasonal flows under the base case and developed case are presented in Table 7-11. A comparison of seasonal flows under the base case and developed case is presented in Table 7-12 for IQQM1.

Table 7-11 Median and average seasonal base case and developed case flows at IQQM1

	Seasonal flows (ML/d)								
	January - April			May - August			September - December		
	Base case	Developed case	Variation	Base case	Developed case	Variation	Base case	Developed case	Variation
Median	2,004.35	1,196.40	-807.95	18.00	18.00	0.00	18.00	18.00	0.00
Mean	36,016.00	35,374.45	-641.56	4,431.04	4,280.04	-151.00	2,381.46	2,096.20	285.25

Table 7-12 Comparison of base case and developed case at IQQM1

Percentage of daily flows	Seasonal flows (ML/d)								
	January - April			May - August			September - December		
	Base case	Developed case	Variation	Base case	Developed case	Variation	Base case	Developed case	Variation
100.00	-	-	-	-	-	-	-	-	-
95.00	-	18.00	18.00	-	18.00	18.00	-	-	-
90.00	18.00	18.00	-	18.00	18.00	-	-	18.00	18.00
85.00	18.00	18.00	-	18.00	18.00	-	-	18.00	18.00
80.00	18.00	220.34	202.34	18.00	18.00	-	-	18.00	18.00
75.00	310.38	350.00	39.63	18.00	18.00	-	-	18.00	18.00
70.00	350.00	350.00	-	18.00	18.00	-	-	18.00	18.00
65.00	510.27	350.00	-160.27	18.00	18.00	-	-	18.00	18.00
60.00	931.18	350.00	-581.18	18.00	18.00	-	18.00	18.00	-
55.00	1,427.26	614.64	-812.63	18.00	18.00	-	18.00	18.00	-
50.00	2,004.35	1,196.40	-807.95	18.00	18.00	-	18.00	18.00	-
45.00	2,700.23	1,938.69	-761.54	18.00	18.00	-	18.00	18.00	-
40.00	3,611.94	2,753.12	-858.82	270.20	267.50	-2.70	18.00	18.00	-

Percentage of daily flows	Seasonal flows (ML/d)								
	January - April			May - August			September - December		
	Base case	Developed case	Variation	Base case	Developed case	Variation	Base case	Developed case	Variation
35.00	5,085.81	4,124.90	-960.91	350.00	350.00	-	18.00	18.00	-
30.00	7,850.60	6,607.01	-1,243.59	350.00	350.00	-	245.68	330.48	84.80
25.00	12,889.43	11,360.90	-1,528.53	572.30	350.00	-222.30	350.00	350.00	-
20.00	22,816.34	20,910.48	-1,905.86	978.98	527.06	-451.92	350.00	350.00	-
15.00	41,877.39	40,531.30	-1,346.09	1,835.38	1,363.38	-472.00	1,063.48	350.00	-713.48
10.00	86,071.19	85,277.99	-793.20	3,812.44	3,174.58	-637.86	2,503.06	999.82	-1,503.24
5.00	205,279.38	203,949.39	-1,329.99	15,202.90	14,369.94	-832.96	6,287.60	4,376.50	-1,911.10
0.00	1,850,772.60	1,839,450.10	-11,322.50	672.095.90	664,639.50	-7,456.40	560,113.10	550,616.40	-9,496.70

The results as presented in Table 7-11 and Table 7-12 can be summarised as follows with the developed case:

- January to April
  - The extraction of water from the system is most obvious in the wet season (January to April) and affects medium to high flows
  - There is an increase in low flows entering the GBR when the operating strategy of keeping the Fitzroy Barrage at FSL (or near to), results in outflows via the fishway or EFO releases.
- May to August
  - Overall, there is minimal change to the flows
  - Some periods of no flow under the base case result in small flows under the developed case that result in the fishway operating for longer. This is due to the operating rule that requires the Fitzroy Barrage to be maintained at (or near to) FSL
  - Water extraction as a result of the Project affects medium to high flows.
- September to December
  - The extended periods of zero flows in the river below the Fitzroy Barrage in the base case will be reduced with the developed case
  - The period of operation of the fishway will be extended. Flows out of the Barrage in this regard are relatively low (in the order of 18 ML/day)
  - The Project affects medium to high flows during this period.

7.4.4 Sensitivity analysis

Submissions

This section presents the flow duration curves omitted from the draft EIS (Volume 3, Appendix P) in response to DoE’s submission (021.06). DoE also requested analysis and flow duration curves for a very dry scenario.

Response

Flow duration curves were generated for representative locations within the Project area as shown in Figure 7-1 and described in Table 7-1. At each location, the developed case (EB3 and RW2) was compared to the base case (EB1) over the period of record as presented in the draft EIS (Volume 3, Appendix P2).

To further differentiate what is occurring at each location for the scenario, a sensitivity check was undertaken by developing daily flow duration curves for a dry (10th percentile) year and a wet (90th percentile) year.

Daily flow data (ML/day) was extracted from the IQQM-Project for the period of record at data location IQQM5 (Riverslea Node 003). Riverslea is upstream of the Project nodes and represents inflows to the Project area Rookwood Weir impoundment. The daily data was converted to total annual flow and an analysis done to identify the 90th percentile annual flow total, which is taken to represent a wet year and the 10th percentile annual flow total to represent a dry year for the base case. The 90th percentile flow was 313,489,785 ML/annum and the 10th percentile flow was 343,701 ML/annum. 1993 and 1974 were selected as the years that were considered representative of the total annual flows for dry and wet years, respectively.

These two years were then analysed for the base case and developed case with respect to representative areas within the system as follows (and shown on Figure 7-1 and described in Table 7-1):

- IQQM5 (Riverslea; Node 003)
- IQQM4 (downstream of the proposed Rookwood Weir; Node 443)
- IQQM3 (The Gap; Node 005)
- IQQM2 (Wattlebank; Node 002)
- IQQM1 (End of system; Node 249)

Daily flow duration curves for a dry year and a wet year at representative locations in the system (Figure 7-1 and Table 7-1)) are presented in Appendix I.

It is evident from the plots that for wet years the impacts on flow by the developed case are negligible and in fact small flows (below 1,000 ML/day) are maintained for longer periods compared to the base case. In a dry year flows are maintained for a significantly longer period and at a higher flow than for the base case. This is consistent with the releases made to satisfy demand and environmental flow requirements.

At data location IQQM5 (Riverslea; Node 003) flow data represents inflows to the system. As Rookwood Weir does not impact on inflows it is expected that base case and developed case flows are the same as is reflected on the flow duration curves above.

7.5 Stream gauges

Submissions

Submissions from DNRM (032.03, 032.04) request clarification in relation to the impact on and operation of DNRM operated stream gauge stations at The Gap and Riverslea.

Response

The draft EIS (Volume 1, Chapter 2 Project description, Section 2.3.3.3 and Chapter 9 Surface water resources, Section 9.3.2.2) reports that stream gauge stations at The Gap (GS130005A) and Riverslea (GS130003A) are expected to be impacted as a result of inundation associated with the Project. It is confirmed that the stream gauge stations are owned by DNRM. It is proposed that new stream gauges be established as necessary, or existing stream gauges be reinstalled and re-calibrated post-inundation as negotiated with DNRM.

DNRM has indicated that the stream gauge stations would require reinstatement and recalibration. It should be noted that The Gap station and Riverslea station could remain operational until EB2 and the proposed RW1, respectively, are developed.

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8. Water quality

Water quality was addressed in the draft EIS (Volume 1, Chapter 11 Water quality). Submissions made on the draft EIS in this regard primarily relate to baseline water quality data and water quality impacts on the GBR as detailed in the following sections.

8.1 Water quality data and parameters

Submissions

Submissions were received from DEHP (028.02, 028.03, 028.04) relating to water quality objectives and data presented for baseline metal concentrations in the draft EIS.

DNRM further highlighted risks associated with potential increases in blue green algal blooms.

Response

The draft EIS presents baseline water quality parameters and water quality objectives (Volume 1, Chapter 11 Water quality, Section 11.2). Clarifications with regard to datasets are provided in this section.

Based on the Australian Water Quality Guidelines the water quality objective for iron (Fe) (as Fe soluble) is reported as 300 µg/L. The Australian Water Quality Guidelines have based this objective on a Canadian guideline level as an interim indicative working level in the absence of sufficient data to establish a reliable trigger value. DEHP has advised that the Fe water quality objective has been updated to 350 µg/L.

Fe soluble levels within the Project area (as measured at DNRM gauging stations) are below guideline levels, for example:

- Fitzroy River (GS130005A): median values range between 60 µg/L (short-term) and 30 µg/L (long-term)
- Lower Dawson River (GS130322A): median values range between 200 µg/L (short-term) and 70 µg/L (long-term)
- Lower Mackenzie River (GS130105A): median values range between 60 µg/L (short-term) and 50 µg/L (long-term).

Water quality data presented in the draft EIS Volume 1, Chapter 11 Water quality, specifically tables 11-6, 11-8 and 11-10, in relation to copper (Cu) is for Cu soluble (µg/L) as per data obtained from DNRM stream gauging stations.

Water quality characteristics assessed in the draft EIS (Volume 1, Chapter 11 Water quality) included summary statistics for the following water quality parameters (as available and relevant to the Project) as sourced from DNRM stream gauging stations (throughout the Project area) and SunWater (for Eden Bann Weir Stage 1):

- pH
- Electrical conductivity
- Water temperature
- Dissolved oxygen

- Turbidity
- Total Suspended Solids (TSS)
- Total Nitrogen (TN)
- Total Phosphorus (TP)
- Chlorophyll a.

Metals concentration data was sourced from existing monitoring programs and was limited for the Project area at the time of reporting. Available parameters were limited to:

- Aluminium (Al)
- Cu
- Iron (Fe)
- Magnesium
- Manganese (Mn)
- Zinc (Zn).

These parameters represent the baseline monitoring programs conducted by DNRM and as such are considered to represent the relevant primary ecosystem toxicants of the Fitzroy system. Whilst this limited data set has been analysed, it is not considered necessary to assess a broad suite of potential metals and metalloids as the Project is considered unlikely to contribute to input of toxicants into the water system.

It is noted that in 2012, in response to coal mine water management within the Fitzroy Basin, the Queensland Government commenced implementing an enhanced environmental monitoring program in relation to the Fitzroy River inclusive of monitoring for a wider suite of metals to include total and dissolved metals (Al, Sb, As, B, Ba, Be, Cd, Cr, Cu, Co, Fe, Pb, Mn, Mo, Ni, Se, Ag, U, V, and Zn).

Blue green algae and the potential for algal blooms to occur in relation to the Project are described in the draft EIS (Volume 1, Chapter 11 Water quality, Section 11.3.2.2). It is noted that the presence of nutrients such as nitrogen and phosphorous under the correct climatic conditions can result in such blooms.

In addition it is noted that blue green algae blooms are known to, or expected to occur in impoundments and river systems across Queensland. The Fitzroy River can also be expected to experience blooms periodically.

Methods for the treatment of drinking water are widely known, applied and well managed by water authorities, including for blue green algal blooms. FRW monitors the Fitzroy River and the Fitzroy Barrage impoundment in particular, for many parameters in relation to water quality. FRW implements the fundamental treatment methods for the management of blue green algae in order to meet the Australian Drinking Water Guidelines with respect to taste, odour and toxins, for example at its Glenmore Water Treatment Plant. It is considered that the applied methods have been well researched and applied in practice over the last twenty years across Queensland and throughout Australia.

Water service providers, such as GAWB and SunWater, operate under water quality management systems and plans. GAWB and SunWater currently monitor blue green algae levels associated with their water storage infrastructure. In response to alerts (where blue green algae hazard levels are recorded) management measures and/or treatment methods are implemented under established systems and plans. This may include alerts to the public, land users and water users and/or for operational actions required to maintain water quality.

The revised EMP presented in Appendix F commits to a water management programme for the construction (Section 4.4) and operations (Section 5.2) phases. The water management programmes include the requirement to develop and maintain a water quality monitoring programme and make specific reference to the need for the management of blue green algae.

8.2 Reef 2050 assessment

8.2.1 Overview

Submissions

A number of submissions were received regarding potential water quality impacts to the GBR as a result of the Project. The section provides an assessment against Reef 2050 Plan in response to the following submissions:

- Australian Heritage Council (024.01)
- CCC (029.07, 029.12)
- DEHP (028.20, 028.21)
- DoE (021.10, 021.11, 021.12, 021.15)
- FBA (011.23, 011.31)
- WWF-Australia (031.02).

In addition, DNRM has sought further information with regard to the potential impacts on water quality associated with agricultural development potentially facilitated by the Project as is discussed in Section 11.

Response

The Reef 2050 Plan is the overarching framework for protecting and managing the GBR from 2015 to 2050 (DoE 2015a). The plan is a key component of the Australian Government's response to the recommendations of the UNESCO World Heritage Committee (DoE 2015a). It includes a description of existing management arrangements, future steps for the protection and adaptive management of the reef, an implementation plan and an outline of the integrated monitoring and reporting program.

Central to the plan are seven overarching themes with associated actions, targets, objectives and outcomes. The seven themes are ecosystem health, biodiversity, water quality, community benefits, economic benefits and governance. Each theme and their associated actions have been reviewed for relevance to the Project. By meeting the Reef 2050 WQTs, the Project would contribute to improving ecosystem health.

Section 11 specifically describes and quantifies the impacts associated with agricultural develop potentially facilitated by the Project through the provision of a high reliability water supply (42,000 ML/a). This includes:

- The types of agricultural development that could be facilitated by the uptake of the 42,000 ML (Sections 11.3.1 and 11.3.2)
- An appropriate agricultural development scenario potentially facilitated by 42,000 ML (Section 11.3.3)
- The pollutant loads potentially generated from the potentially facilitated agricultural development (Section 11.4.2)
- The change in pollutant loads as a result of the potentially facilitated agricultural development scenario (Section 11.5.1)

The outcomes of the assessment were used to inform the Project's potential impacts on Reef 2050 Plan WQTs as presented in Section 8.2.2 and Section 8.2.1.

The revised EMP presented in Appendix F commits to a water management programme for the construction (Section 4.4) and operations (Section 5.2) phases of the Project. The water management programmes include the requirement to develop and maintain a water quality monitoring programme. Implementation of the EMP is a Project commitment (Appendix D, Table D-6).

The management of water quality within the Fitzroy River and development of water management and monitoring programmes in relation to the Project will require liaison between the proponents and regulatory authorities, including local governments with responsibilities for providing drinking water to towns and communities.

GAWB already participates and contributes to monitoring programs through the Fitzroy River Partnership for River Health, that promote and facilitate river stewardship actions, including waterway monitoring to actively improve the health of the Fitzroy River, in the context of sediment and nutrient runoff to the Fitzroy River and potentially to the inshore GBR lagoon. SunWater undertake water quality monitoring in accordance with the Fitzroy ROP. The water quality data is provided to DNRM on a regular basis. Other organisations can obtain this data directly from DNRM.

8.2.2 Assessment of Project against water quality targets

An assessment of potential Project impacts against the Reef 2050 WQTs is provided in Table 8-1.

8.2.3 Assessment of facilitated development against water quality targets

An assessment of potential impacts from development consequential to, or potentially facilitated by, the Project, against the Reef 2050 WQTs is provided in Table 8-2.

Consequential or facilitated development is discussed in more detail in Section 11.

Table 8-1 Assessment of Project impacts against the Reef 2050 water quality targets

WQTs	Project assessment
WQT1	
At least a 50 per cent reduction in anthropogenic end-of-catchment dissolved inorganic nitrogen loads in priority areas, on the way to achieving up to an 80 per cent reduction in nitrogen by 2025.	The Fitzroy Basin catchment is not a priority area for nitrogen management as defined in the Reef Water Quality Protection Plan 2013 (State of Queensland 2013) (RWQPP). No further assessment against this WQT is required. Nevertheless, dissolved inorganic nitrogen loads are primarily associated with runoff from fertilised agricultural areas.
At least a 20 per cent reduction in anthropogenic end-of-catchment loads of sediment in priority areas, on the way to achieving up to a 50 per cent reduction by 2025.	The Fitzroy Basin is a priority area for suspended sediment management as defined in the RWQPP. Sediments delivered to the Fitzroy River estuary are derived almost exclusively from erosion in the upper Fitzroy Basin (Douglas et al. 2005). Episodic, generally short-lived flow/flood events during the summer months carry the majority of the suspended sediment from the Fitzroy River to the Fitzroy estuary (Webster et al. 2006). The operation of the Project alone is not expected to alter the sediment load within the system. There is the potential for the weirs to hold back sediment in the short-term. However, sediment within the system would be transported over the weirs during large flows in (excess of 5 m/s) and floods. While it is possible that some localised erosion may occur immediately downstream of the weir sites it is considered that the potential contribution to current sediment load would be negligible. Further, erosion protection works downstream of the weirs would reduce the potential for scour and erosion thereby minimising the potential to increase sediment loads.
At least a 20 per cent reduction in anthropogenic end-of-catchment loads of particulate nutrients in priority areas.	The Fitzroy Basin is a priority area for suspended sediment management and the sediment target has been refined to include particulate nutrients (particulate nitrogen and particulate phosphorous) in priority areas (Queensland Government 2015). Prior to the first fill, it is not intended to clear vegetation from within the watercourse. Consequently that vegetation would decay (over time) releasing nutrients which would then be conveyed downstream and output to the Fitzroy estuary, particularly during flood events. Calculations presented in the draft EIS indicated that more than half the available TN and TP associated with this decay is liberated in the first year of impoundment and will reduce significantly in each subsequent year for a period of approximately six years. The overall contribution of nutrients to the system is predicted to be low in the context of the overall quantities that are transported annually from the Fitzroy Basin to the GBR (as described by Johnston et al. 2008). Moreover, the percentage contribution declines markedly after the first year to negligible proportions after several years. During detailed design, operational strategies (including initial operation) will be developed including water quality monitoring programs covering upstream, impoundment and downstream environments.
At least a 60 per cent reduction in end-of-catchment pesticide loads in priority areas.	The Fitzroy Basin is a priority area for pesticide management as defined in the RWQPP. The Project alone would not change land use practices or anthropogenic inputs of fertilisers, pesticides and herbicides from catchment sources.
WQT2	

WQTs	Project assessment
Ninety per cent of sugarcane, horticulture, cropping and grazing lands are managed using best management practice systems (soil, nutrient and pesticides) in priority areas.	The Project alone would not influence land management practice systems in the Fitzroy Basin.
Minimum 70 per cent late dry season groundcover on grazing lands.	The Project alone would not influence land management practice systems in the Fitzroy Basin.
The extent of riparian vegetation is increased.	Inundation of riparian vegetation is an unavoidable consequence of the Project. Vegetation is expected to re-establish on riverbanks at the new impoundment level as is evident from the existing Eden Bann Weir impoundment. The proponents contribute to monitoring programs that promote and facilitate river stewardship actions including waterway monitoring and restoration of riparian zones.
There is no net loss of the extent, and an improvement in the ecological processes and environmental values, of natural wetlands.	A GBR wetland protection area and wetland of high ecological significance is mapped within 350 m of the upper most extent of the Rookwood Weir (Stage 2 only) impoundment on the Mackenzie River (at 334 km AMTD). The Stage 2 Rookwood Weir impoundment is not expected to inundate these wetland areas and will not directly impact the functioning of the wetland ecosystem at this location. No lacustrine wetland areas will be directly impacted by the Project. Two small off-stream water bodies (palustrine wetlands) located at approximately 270 km AMTD and 284 km AMTD associated with the Rookwood Weir impoundment will be inundated. Given the nature of water storage within the main river channel bed and banks, it is not expected that the Project will adversely impact off-stream wetland connectivity with the river, or adversely alter the seasonality, duration, frequency and volume of water entering and leaving the off-stream water bodies.
WQT3	
By 2020, Reef-wide and locally relevant WQTs are in place for urban, industrial, aquaculture and port activities and monitoring shows a stable or improving trend.	The Project will not inhibit the development of reef-wide and locally relevant WQTs for urban, industrial, aquaculture and port activities. The Project alone will not contribute significantly to long-term trends in water quality.
WQT4	

WQTs	Project assessment
Water quality in the GBR has a stable or positive trend.	With mitigation and management measures in place, no significant impacts to the water quality of the GBR are expected as a result of the Project. While it is possible that some localised erosion may occur immediately downstream of the weir sites during operation, it is considered that the potential additional contribution to the current sediment load entering the GBR will be negligible. Other than from decaying vegetation, the Project will not directly contribute nutrients downstream of the Fitzroy River and subsequently the GBR. Water quality impacts as a result of decaying vegetation will be short term during the initial years of operation and will not persist into long-term operations. Weir design and operations will seek to reduce the potential for the release of poor quality water, through measures such as multi-level off takes. Consequently discharges of poorly oxygenated water to the GBR are not expected. Aside from local areas of lower velocity around weir structures such as towers and intakes, the weirs are expected to provide unimpeded transfer of sediment (from land-based activities) down the river.
WQT5	
Traditional Owners, industry and community are engaged in on-ground water quality improvement and monitoring	The Project will not inhibit the engagement of Traditional Owners, industry and community in on-ground water quality improvement and monitoring and there are opportunities for contribution by these parties to the implementation of proposed Project management and offsets. Traditional owners have been engaged with the Project through the development of Cultural Heritage Management Plans.

Table 8-2 Assessment of potential facilitated development against water quality targets

WQTs	Facilitated development
WQT1	
At least a 50 per cent reduction in anthropogenic end-of-catchment dissolved inorganic nitrogen loads in priority areas, on the way to achieving up to an 80 per cent reduction in nitrogen by 2025.	The Fitzroy Basin catchment is not a priority area for nitrogen management as defined in the RWQPP. An assessment has been undertaken in relation to consequential impacts arising from agricultural development potentially facilitated by the Project. Section 11 indicates that a negligible contribution (0.05 – 1.70 per cent increase) to end of system nitrogen loads may result from facilitated agricultural development.
At least a 20 per cent reduction in anthropogenic end-of-catchment loads of sediment in priority areas, on the way to achieving up to a 50 per cent reduction by 2025.	The Fitzroy Basin is a priority area for suspended sediment management as defined in the RWQPP. A number of activities that may be facilitated by the Project have the potential to contribute to sediment levels as follows: • Industrial and residential developments have the potential to increase sedimentation during construction due to erosion associated with land clearing. However, construction activities will be regulated and managed through existing environmental permitting requirements. Similarly the overall land area of potential development represents a proportionately negligible increase in the coastal urban footprint. • Intensive animal husbandry has the potential to increase sedimentation during construction and operation, however these activities are highly regulated and are required to implement effective management practices to limit off-site impacts. • Broad-acre cropping may reduce groundcover and expose soils during times of harvest and before the next crop has established. However, it will also promote groundcover during the growing season. Areas of remnant vegetation were included as a high level constraint when defining the potential agricultural development areas and were excluded as suitable sites within potential agricultural zones. It is expected that clearing impacts are likely to be on areas that are currently sparsely vegetated, already cleared and degraded for other purposes (likely grazing). The potential development areas (PDAs) of irrigated broad-acre cropping and horticulture attributable to the Project represents a three per cent increase in this land use for the region. Furthermore, it is evident from the extensive monitoring being undertaken within GBR catchments that improved land management practices are being implemented by landholders. This is expected to demonstrate a long term reduction in overall impact to inshore areas associated with sedimentation. Having regard to the scale of potential agricultural development, the environmental permitting requirements for intensive agricultural activities, the land management practices being adopted throughout the region and collaboration between stakeholders with regard to data sharing and reporting it is considered that facilitated development is unlikely to contribute to an increase to end-of-catchment sediment loads.

WQTs	Facilitated development
At least a 20 per cent reduction in anthropogenic end-of-catchment loads of particulate nutrients in priority areas	The Fitzroy Basin is a priority area for suspended sediment management and the sediment target has been refined to include particulate nutrients (particulate nitrogen and particulate phosphorous) in priority areas (Queensland Government 2015). A number of activities that may be facilitated by the Project have the potential to contribute to particulate nutrient levels as follows: • Industrial development has the potential to contribute to the nutrient levels within terrestrial run-off. However, these activities are heavily regulated and are managed through environmental permitting requirements, significantly reducing the potential for off-site impact to water quality. Similarly the overall land area of potential development represents a proportionately negligible increase in the coastal urban footprint. • New residential developments may contribute to nutrient runoff primarily through sewage discharge however new developments will be required to treat sewage to a tertiary standard where very limited nutrients will remain following treatment. • Intensive animal husbandry has the potential to contribute to nutrient loads within surface run-off. However, these activities are highly regulated and are required to implement effective management practices to limit off-site impacts and achieve environmental conditions. Widely adopted practice management measures are demonstrated to be effective in limiting off-site impacts. • Irrigated broad-acre cropping and intensive horticulture activities have the potential to contribute to the nutrient and pesticide load entering the Great Barrier Reef World Heritage Area (GBRWHA). Farming practices within the GBRWHA catchment are becoming more regulated and the Queensland Government is working with the industry to support the development of best management practice programmes. The Reef 2050 Plan together with the RWQPP is focused on halting and reversing the decline in water quality entering the reef from broad scale land use and seeks to move land management to best practice in as wide an area as possible. It is expected that the Water Quality Improvement Plan (WQIP) for the Fitzroy/Capricorn Coast region (under development) will also contribute to the implementation of best practice management strategies and contribute to the improvement of water quality within the Project area. Having regard to the scale of agricultural development potentially facilitated by the Project, the environmental permitting requirements for intensive activities and the land management practices being adopted throughout the region, it is considered that the Project is unlikely to contribute to an increase in anthropogenic end-of-catchment loads of particulate nutrients.
At least a 60 per cent reduction in end-of-catchment pesticide loads in priority areas.	The Fitzroy Basin is a priority area for pesticide management as defined in the RWQPP. Irrigated broad-acre cropping and intensive horticulture activities have the potential to contribute to the pesticide load entering the GBR. Land management practices within the region, whilst not specifically regulated through permitting, are increasingly being regulated and managed through the adoption of best management practices. The GBR Outlook Report 2014 (GBRMPA 2014) results indicate an overall trend of an increasing number of farms adopting improved land management practices with a resultant improvement in water quality of the GBR. Modelled annual average pesticide load reduction across the GBR from 2009 to 2014 was 30.5 per cent.

WQTs	Facilitated development
WQT2	
90 per cent of sugarcane, horticulture, cropping and grazing lands are managed using best management practice systems (soil, nutrient and pesticides) in priority areas	Irrigated agriculture and intensive horticulture that may be facilitated by the Project will be subject to the expected increased pressure for adoption of management practices under the actions of the Reef 2050 Plan.
Minimum 70 per cent late dry season groundcover on grazing lands	The Project would not facilitate changes to late dry season ground cover on grazing lands.
The extent of riparian vegetation is increased	It is unlikely that facilitated development would impact riparian vegetation. Agricultural development that may be facilitated by the Project will be subject to the expected increased pressure for adoption of management practices under the actions of the Reef 2050 Plan including riparian management practices.
There is no net loss of the extent, and an improvement in the ecological processes and environmental values, of natural wetlands.	It is unlikely that facilitated development would impact natural wetlands. Agricultural development that may be facilitated by the Project will be subject to the expected increased pressure for adoption of management practices under the actions of the Reef 2050 Plan including protection of natural wetlands.
WQT3	
By 2020, Reef-wide and locally relevant WQTs are in place for urban, industrial, aquaculture and port activities and monitoring shows a stable or improving trend.	Facilitated development would not inhibit the development of reef-wide and locally relevant WQTs for urban, industrial, aquaculture and port activities. Irrigated agriculture and intensive horticulture will also be subject to the expected increased pressure for adoption of management practices under the actions of the RWQPP.
WQT4	
Water quality in the GBR has a stable or positive trend.	Having regard to the scale of potential agricultural development, the environmental permitting requirements for intensive agricultural activities, the land management practices being adopted throughout the region and collaboration between stakeholders with regard to data sharing and reporting it is considered that facilitated development is unlikely to contribute to an increase in water quality impacts on the GBR.
WQT5	
Traditional Owners, industry and community are engaged in on-ground water quality improvement and monitoring.	Facilitated development would not inhibit the engagement of Traditional Owners, industry and community in on-ground water quality improvement and monitoring. Facilitated development would result in new opportunities engaging Traditional Owners, industry and community in the development of new practices and methods for water quality improvement and monitoring.

8.2.4 Riparian vegetation and ecosystem health targets

Action EHA10 (2015-2020) is to ‘improve connectivity and resilience through protection, restoration and management of Reef priority coastal ecosystems including islands through innovative and cost-effective measures’.

Inundation of riparian vegetation is an unavoidable consequence of the Project. Vegetation is expected to re-establish on riverbanks at the new impoundment level as is evident from the existing Eden Bann Weir impoundment.

The proponents contribute to and undertake water quality monitoring that promotes and facilitates river stewardship actions and programs including waterway monitoring and restoration of riparian zones.

It is unlikely that facilitated development would impact riparian vegetation. Agricultural development that may be facilitated by the Project will be subject to the expected increased pressure for adoption of management practices under the actions of the Reef 2050 Plan including riparian management practices.

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9. Noise and vibration

Submissions

Impacts associated with noise and vibration in relation to the Project are addressed in the draft EIS (Volume 1, Chapter 14 Noise and vibration). Submissions from DEHP (028.11, 028.12, 028.13, 028.14) on the noise assessment relate to background noise levels with reference to the Environmental Protection Policy (Noise) Policy 2008 (EPP Noise).

Response

Background creep requirements of the EPP Noise relate to when noise levels creep higher over time with the establishment of new development. Construction is only temporary in nature and wouldn't be included in long term background creep noise assessments. The rural nature of the site means that it is highly unlikely other noise sources will be required to be assessed with regards to background noise creep.

Background noise measurements will be taken once the Project is triggered at the Eden Bann Weir site, the proposed Rookwood Weir site and at Gogango. Given the remote and rural nature of the Project areas, it is considered that the background noise estimates in the draft EIS (Volume 1, Chapter 14 Noise and vibration, Section 14.2.2) are conservative estimates. Noise predictions are compared with the EPP (Noise) noise requirements and mitigation measures provided.

The EIS also provides acoustic quality objectives from the EPP (Noise). The relevant daytime noise objective is an LAeq of 50 dB(A) when measured over a 1 hour period. Based on assumptions in the assessment, noise levels at receptor 1, 2 and 3 (Volume 1, Chapter 14 Noise and vibration, Section 14.2.1) are predicted to be 59 dB(A) under worst case conditions. Additional suitable noise management that would reduce predicted noise levels to 50 dB(A) includes:

- Use shielding or portable noise barriers around jackhammers and rock breakers (if required to be used) as far as is practical and appropriate
- Situate the concrete batching plant at the furthest distance possible from the receptors. Use of screening or barriers may be used to reduce noise levels
- A noise management plan will include specific actions for piling including respite periods (Section 12).

The predicted construction noise levels (draft EIS Volume 1, Chapter 14 Nosie and vibration, Table 14-7) are highly conservative. They assume that all equipment is operating concurrently, there is no shielding or ground attenuation and assume the equipment is operating in the worst case position at the site. The sound power level used (124 dBA) assumed that a jackhammer and a breaker are operating together along with everything else which will not likely to occur on this project during construction. Tonality is not expected and impulsive noise may be intermittently present from some activities.

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10. Transport

Transport related Project impacts, mitigation and management measures are addressed in the draft EIS (Volume 1, Chapter 16 Transport). Submissions made on the draft EIS regarding transport aspects of the Project relate to intersection upgrades and Foleyvale Crossing bridge design and flood immunity as detailed in the following sections.

10.1 Bruce Highway/Atkinson Road and Capricorn Highway/Third Street intersections upgrades

10.1.1 Traffic impact assessments

Submission

A submission from DTMR (019.02) suggests further consideration of Gogango Creek Bridge in the configuration of the Capricorn Highway/Third Street intersection upgrade due to the proximity of the bridge to the upgrade location.

Response

Road and traffic impacts were assessed for the construction phase of the Project. A traffic impact assessment was undertaken for the relating to access for construction of Eden Bann Weir and Rookwood Weir, respectively.

DTMR has sought clarification regarding the Capricorn Highway intersection at Gogango. The intersection analysis shows that Capricorn Highway approach from the east will require a channelized right turn treatment with a short turn slot treatment to cater for the movement of construction traffic scenarios predicted in 2015, 2020 and 2025. Operational traffic is negligible.

It is noted that further consideration of the location of the proposed intersection is required. It is considered feasible that the intersection could be relocated further west. It is not proposed that the Gogango Creek Bridge be widened as part of the Project. Further assessment during preliminary works and detailed design will consider intersection form given the proximity of Young Street and Gogango Creek Bridge to the Capricorn Highway / Third Street intersection. This will include reducing speeds and increased signage, the deployment of active/manned traffic control at key times during construction (for example mobilisation) and consideration being given to staged mobilisation and demobilisation to reduce the traffic generated at any one time.

The final location and design of the intersection upgrade will be undertaken in consultation with DTMR and RRC.

10.1.2 Construction schedule

Submission

This section provides additional information regarding the timing of upgrades to intersections and bridges in response to a submission from DTMR (019.03).

Response

Intersection upgrades will be undertaken relative to the Project development triggered:

- Eden Bann Weir raising - Bruce Highway/Atkinson Road intersection
- Rookwood Weir – Capricorn Highway intersection at Gogango.

The milestones and timeframes for the Project are as follows, noting that an actual start date will be determined by a demand trigger coinciding with seasonal factors:

- Preparatory and early works (15 to 18 months prior to Q1 Year 1)
- Contract award (Q1 Year 1)
- Commencement of construction (start-Q1 Year 1)
- Spillway concrete complete (start-Q4 Year 2)
- Commencement of impounding (mid-Q4 Year 2)
- Weir construction practically complete (end-Q4 Year 2)
- Impoundment and commissioning (Q5).

Intersection upgrades necessary to facilitate construction traffic will be undertaken during the latter period of the preparatory and early works phase and prior to the start of significant Project construction activities scheduled for late in Q1 (and commencement of Q2) Year 1.

10.2 Road and river crossings

10.2.1 Foleyvale Crossing

Submission

This section provides additional information regarding the deck level and flood immunity of Foleyvale Crossing in response to submissions from DTMR (019.04) and Private submitter 13 (035.01). Consultation undertaken with regard to the Project, including briefings and meetings with DTMR, Councils and stakeholders (Duaringa Road Users Group) are detailed in Section 2.

Response

The existing Foleyvale Crossing has a deck level at RL 49.1 m AHD. The current flood immunity for the Foleyvale Crossing is poor. Table 10-1 summarises the average annual time of closure (AATOC) and time of closure (TOC) pre- and post-development (Rookwood Weir Stage 1) under a 2 year average recurrence interval (ARI) event at the crossing.

Table 10-1 Impacts on Foleyvale Crossing (2 year ARI event)

Foleyvale deck level (RL m AHD)	Weir option	Foleyvale peak water level (m AHD)	Riverslea peak water level (m AHD)	Riverslea peak water level (gauge m*)	AATOC (days)	TOC (days)
49.10	None	56.97	45.90	12.4 (45.9-33.5)	16.04	26
49.10	Rookwood Stage 1	+0.22	49.67	16.17 (49.67-33.5)	nd	27

* That is the reading on the Riverslea gauge, gauge zero is at 33.5 m AHD.

Currently during a 2 year ARI event, Foleyvale Crossing is inundated (peak water level) to 8 m above the existing deck level of the crossing and the TOC is estimated at 26 days. With Rookwood Weir Stage 1 in place, the peak water level at Foleyvale Crossing is raised by 0.22 m to 8.22 m above deck level for a 2 year ARI event. The TOC associated with Rookwood Weir Stage 1 in place is estimated to increase by one day to 27 days.

The only event modelled for the proposed Rookwood Weir Stage 1 scenario is the 2 year ARI event. This methodology was adopted as the 1D model (of the Fitzroy River) showed an increase of less than 0.2 m at the upstream end of that model for the 5 year ARI event and less for smaller probability events. The upstream end of the 1D model is the downstream boundary condition of the 2D model that covers the Dawson and Mackenzie Rivers, located approximately 20 km downstream of the Foleyvale Crossing (draft EIS Volume 1, Chapter 9 Surface water resources, Section 9.3.2.6).

The 2 year ARI event produces the highest afflux compared to smaller probability events, that is 5 year ARI event and greater. The influence of Rookwood Weir Stage 1 is considered greatest during the 2 year ARI event. Events larger in flood magnitude than the 2 year ARI event will have even less of an impact, if any, on water levels at the Foleyvale Crossing. This is supported by 2 year ARI event modelled outputs showing that the afflux at the Foleyvale Crossing post-development is estimated at 0.22 m for the 2 year ARI event. The predicted afflux for a 2 year ARI event under the Rookwood Weir Stage 1 scenario of 0.22 m is considered very low in modelling terms and represents the acceptable accuracy of the model where afflux is taken to be ± 0.3 m.

Associated with Rookwood Stage 2, Foleyvale Crossing would be upgraded to a deck level of RL 61.5 m AHD. The AATOC is estimated at 2.5 days and TOC is zero during in a 2 year ARI event.

As is reported in the draft EIS (Volume 3, Appendix Q, Section 1.2.3 and Appendix B), DTMR investigated upgrade proposals for the Foleyvale Crossing in 1989 (KBR 2007). DTMR identified a significant debris problem on the existing structure. It also identified that the current crossing is often submerged, for example the crossing was untrafficable for 72 days in 1983 and for 160 days in 1988-1989. DTMR examined options to build up the existing causeway but ruled these out due to debris issues. The recommended option was to build a new bridge at RL 55.6 m at a cost of $1.65 million, plus an optional $0.65 million for straightening the approach alignment (KBR 2007).

The proposed upgrade (deck level RL 61.5 m AHD) provides for a flood immunity of approximately a 1 in 5 year AEP event. Higher immunity was examined but was found to be unviable due to the need for long approaches which would inhibit the floodplain and the ability to keep the existing crossing operational while the new bridge is being built.

Consultation with regard to the Project and a proposed upgrade to Foleyvale Crossing is considered to have been extensive as is documented in the draft EIS (Volume 3, Appendix F and Appendix Q) and has included meetings with DTMR and the Duaringa Road Users Group. The proposed deck level of the upgrade is significantly higher than DTMR's previous proposal and provides significantly improved hydraulic immunity and network trafficability. Subject to consultation with DTMR and Councils regarding technical design and management it is not considered that future consultation on additional design matters is required with the community.

Bridge design has been and will be undertaken in accordance with DTMR's Road Planning and Design Manual.

While Foleyvale Bridge is a State-controlled crossing, it is not carrying a National Highway. Therefore, Table 7.18 of the Road Planning and Design Manual (Department of Main Roads 2004) was considered applicable with regard to setting bridge carriageway widths. Following confirmation from DTMR (11 March 2010), specific considerations for the Foleyvale Crossing on the Duaringa-Apis Creek Road included a kerb to kerb width of 8.6 m providing two 3.5 m wide traffic lanes and 0.8 m shoulders each side, based on the following parameters:

- Two-way traffic flow
- A double lane
- Average annual daily traffic values of less than 100 vehicles/day
- A bridge of any length.

The proposed new bridge will be designed for a SM1600 loading in accordance with AS5100. This provides for Type 1 road trains.

Construction of Foleyvale Bridge is proposed to be triggered on commencement of construction of Rookwood Weir Stage 2. Given that the bridge has an estimated 12 month construction period and the weir a 24 month construction period, and that the bridge location is at the uppermost point of the impoundment, the risk of the bridge not being fully operational by the time Rookwood Weir Stage 2 is commissioned is considered to be extremely low.

11. Consequential impacts

Submissions

Consequential (or facilitated) development in relation to the Project was addressed in the draft EIS (Volume 2, Chapter 12 Cumulative and consequential, Section 12.4). Submissions made on the draft EIS in this regard relate to water quality impacts as a result of facilitated development, particularly agricultural use of the additional water made available through the Project.

This section provides further information regarding potential consequential impacts resulting from use of water from the Project in response to submissions from CCC (029.01, 029.02, 029.07, 029.12, 029.17), FBA (011.23 and 011.31), DEHP (028.21) and DoE (021.11, 021.24).

DNRM further submits that agricultural development potentially facilitated by the Project has the potential to impact downstream drinking water quality through the improper management and failure of feedlot effluent ponds, groundwater leaching and surface runoff.

Response

11.1 Background

The Water Resource (Fitzroy Basin) Plan 2011 (Fitzroy WRP) identifies unallocated water held as strategic water infrastructure reserve; a nominal volume of 76,000 ML (for supplemented water allocations) reserved for water infrastructure on the Fitzroy River, within which the Lower Fitzroy River Infrastructure Project (Project) is included. The Project's objective is to provide water storage infrastructure on the Fitzroy River with the primary aim of securing the strategic water infrastructure reserve.

The Fitzroy ROP specifies that the chief executive may accept submissions for making unallocated water available from the strategic infrastructure reserve on the Fitzroy River as follows:

- GAWB: up to 30,000 ML of the reserve for urban and industrial water supplies
- Local government authority: up to 4,000 ML of the reserve for urban water supplies for the Capricorn Coast
- Person or entity: up to the remaining 42,000 ML of the reserve.

A water supply use for the remaining 42,000 ML of the strategic water infrastructure reserve is not specified. Based on development demand within the region it is reasonable to expect that this water could be utilised for a mix of industrial, urban and agricultural uses. Regional planning documents and policy indicate a focus on industrial development within the Gracemere-Stanwell Industrial Corridor (Fitzroy Planning Scheme 2005), urban residential development within the designated priority living areas of the regional plan (DSDIP, 2013) and potential agricultural development within the Fitzroy Agricultural Corridor (RDA 2014).

Agricultural development has been identified as a priority for the Fitzroy region (RDA, 2014). Previous studies, including the FIIS (GHD 2006) and Queensland Agricultural Land Audit (DAFF 2013), have identified areas of suitable land for irrigated agricultural development which could be facilitated through the provision of water supply. The studies showed that the Lower Fitzroy

Region is suitable for intensive livestock production and some horticultural activities (Department of Infrastructure, 2007).

Subsequently agricultural development opportunities within the region are focusing on the development of intensive animal husbandry, intensive agricultural/horticulture and broad acre cropping. The extent of future agricultural development will be dependent on a range of matters from availability of water and suitability of land, to the provision of supporting infrastructure and market demands for product, among others. DAF has identified a potential long term scenario for development of agricultural activities which could be achieved through provision of water from a number of sources of which the Project represents one contributing source.

Consequential or facilitated industrial, urban and agricultural development and the potential resulting impacts on MNES were discussed in Volume 3, Chapter 12 Cumulative and consequential, Section 12.4 of the draft EIS.

Potential impacts to MNES associated with agricultural development may include:

- Water quality degradation (nutrients, pesticides and sediments)
- Vegetation impacts (clearing).

Submissions made on the draft EIS have sought further information in regard to the potential agricultural development that may be facilitated by the Lower Fitzroy River Infrastructure Project (Project), in particular the potential to have a negative effect upon MNES (including the GBRWHA).

Potential impacts on water quality are addressed separately in Section 8.

11.2 Approach

The draft EIS (Volume 2, Chapter 12 Cumulative and consequential, Section 12.4.2.3) anticipated that 20,000 ML of the 42,000 ML reserve could be utilised to provide water supply to agricultural development. The Project is intended to provide supplemented high priority water. This classification would affect the economic viability of low value agricultural activities such as broad acre cropping and limit the potential for its utilisation for irrigation in this regard. It is considered substantially more likely that intensive agricultural land uses such as cattle feedlots, and intensive horticulture would be sufficiently economically viable to justify the allocation and use of high priority water.

Based on the availability of 20,000 ML of high priority water, the economic value of development and projected growth the facilitated development scenario considered in the draft EIS comprised:

- 735 ha of irrigated broadacre crops (a mix a cereals, legumes and other crops**)** as commonly grown in Central Queensland
- 315 ha of irrigated horticultural crops (vegetable crops, tree crops such as citrus, lychee and mango)
- Two 10,000 standard cattle unit feedlots and 2,000 ha for irrigated green fodder/silage crops for use by the feedlots.

The FIIS identified nine areas of potential agricultural development, totalling approximately 31,000 ha of unconstrained land in the vicinity of the Project (Section 11.4.1). Utilising 20,000

ML, of the available 42,000 ML, from the Project was determined to have the potential to facilitate development of approximately 3,050 ha of this land.

It is noted that the available 42,000 ML of high priority supplemented water has an unspecified use and could facilitate agricultural development. As such this additional information report considers:

- The types of agricultural development that could be facilitated by the uptake of the 42,000 ML (Sections 11.3.1 and 11.3.2)
- An appropriate agricultural development scenario potentially facilitated by 42,000 ML (Section 11.3.3)
- The pollutant loads potentially generated from the potentially facilitated agricultural development (Section 11.4.2)
- The change in pollutant loads as a result of the potentially facilitated agricultural development scenario (Section 11.5.1)
- The potential impacts on MNES arising from the potentially facilitated agricultural development (Sections 11.5.2 and 11.5.3).

An assessment of the impacts arising from potentially facilitated agricultural development against the Reef 2050 targets is included at Section 8.2.1.

11.3 Agricultural development options

11.3.1 Irrigated cropping potential

Currently, the key horticultural areas in the Central Queensland region are along the coastal areas and around Emerald (DAF 2015a). Significant areas of Central Queensland have potential to grow annual and perennial crops depending on the availability of labour, water and access to markets.

Based on the Fitzroy Agricultural Development Area Land Suitability Study (GHD 2006), there is potentially 25,000 ha of black soils available and suitable for broad scale cropping; and 5,000 ha of lighter soils available and suitable for horticulture.

Depending upon the crop being grown, the type of soil and climatic conditions, the volume of water required for irrigation varies from 4 ML/ha for sorghum (DAF 2015b) to 7 ML/ha for cotton (DAF 2015c).

Irrigated horticulture is estimated to use in the order of 8 ML/ha.

Existing irrigated cropping within the Fitzroy WRP area is estimated to be approximately 66,000 ha (DERM 2009).

11.3.2 Intensive livestock production potential

Grazing, predominately cattle, is the dominant agricultural land use in Central Queensland.

Beef feedlots are of significant economic importance in the Central Queensland region and are complementary to other existing significant agricultural activities. There are opportunities to expand intensive industries within Central Queensland (DAF 2015a).

The operation of cattle feedlots requires high-priority water for cattle consumption, preparation of feed, cattle washing, administration and sundry uses. Stock water consumption is the most significant use with an average of approximately 50-60 litres of water used per head of cattle per day. The total average annual high security water requirement for cattle feedlots in Queensland is approximately 24 ML per 1,000 head of cattle and includes water for stock, dust suppression, feed processing, cattle wash down, general cleaning and staff and office amenities (DAF 2015d; Meat & Livestock Australia 2012).

Separately, water supply is required for irrigation of fodder crops for feed development. It is estimated that 5 ML/ha is required to be applied annually as irrigation for fodder crops (DAF 2015e). An allowance of 1,000 ha of irrigated green fodder/silage crops per 10,000 standard cattle unit feedlot has been made.

Total annual water consumption per 10,000 standard cattle unit feedlot is therefore in the order of 5,240 ML.

The Nutrient Export Risk from Hypothetical Feedlots report (GHD 2007) developed as part of the investigations into the development of the Fitzroy Agricultural Corridor concluded that it is possible to construct feedlots in the area where nutrient export concentrations are not expected to exceed the Queensland Water Quality Guidelines 2006 values from either overtopping of the effluent storage pond or from irrigation of effluent over the irrigation area. This is based on the feedlots being appropriately designed and managed, noting that some areas and soil types would be constrained for such use and should not be utilised for effluent irrigation.

In the modelled scenario presented in the Nutrient Export Risk from Hypothetical Feedlots report (GHD 2007), three feedlot sites were evaluated (allowing identification of both low and high export risk sites), each with a 15,000 head capacity. The investigation predicted concentrations of nutrients which could be exported from a feedlot through:

- Overtopping of the effluent collection pond and overland flow to the Fitzroy River
- Leaching over the effluent irrigation area.

Approximately 140 grazing properties and feedlots with a capacity of 135,000 animals are currently located within the Fitzroy WRP area, the majority of which are small farms, each with less than 500 animals (DERM 2009).

11.3.3 Development scenario

It is considered most likely that the uptake of unallocated water resources (42,000 ML) would facilitate a mix of agricultural uses being developed as opposed to a single development type. The likely mix would be a combination of feedlots and irrigated cropping. This aligns with current agricultural development initiatives being advocated by the Growing Central Queensland Initiative and RRC.

As such, the following agricultural development scenario is proposed for the purposes of assessment:

- In the order of 1,600 ha of irrigated broadacre crops (a mix a cereals and legumes)
- 700 ha of irrigated horticultural crops (vegetable crops, tree crops such as citrus, lychee and mango)

- Four 10,000 standard cattle unit feedlots and 4,000 ha for irrigated green fodder/silage crops for use in the feedlots.

Based on this scenario, agricultural development potentially facilitated within the Fitzroy WRP plan area through the provision of 42,000 ML/a of high-security water would contribute:

- Three per cent to the current level of irrigated cropping
- Thirty per cent to the total number of animals produced by feedlots.

11.4 Land use and generated pollutant runoff

11.4.1 Land use

Existing land use within the Project area based on the Queensland Land Use Mapping Program (QLUMP[3]) is shown on Figure 11-1 and Figure 11-2 for Eden Bann Weir and Rookwood Weir, respectively. The predominant existing land use is grazing native vegetation (Australian Land Use Management (ALUM) Class 2 Production from relatively natural environments).

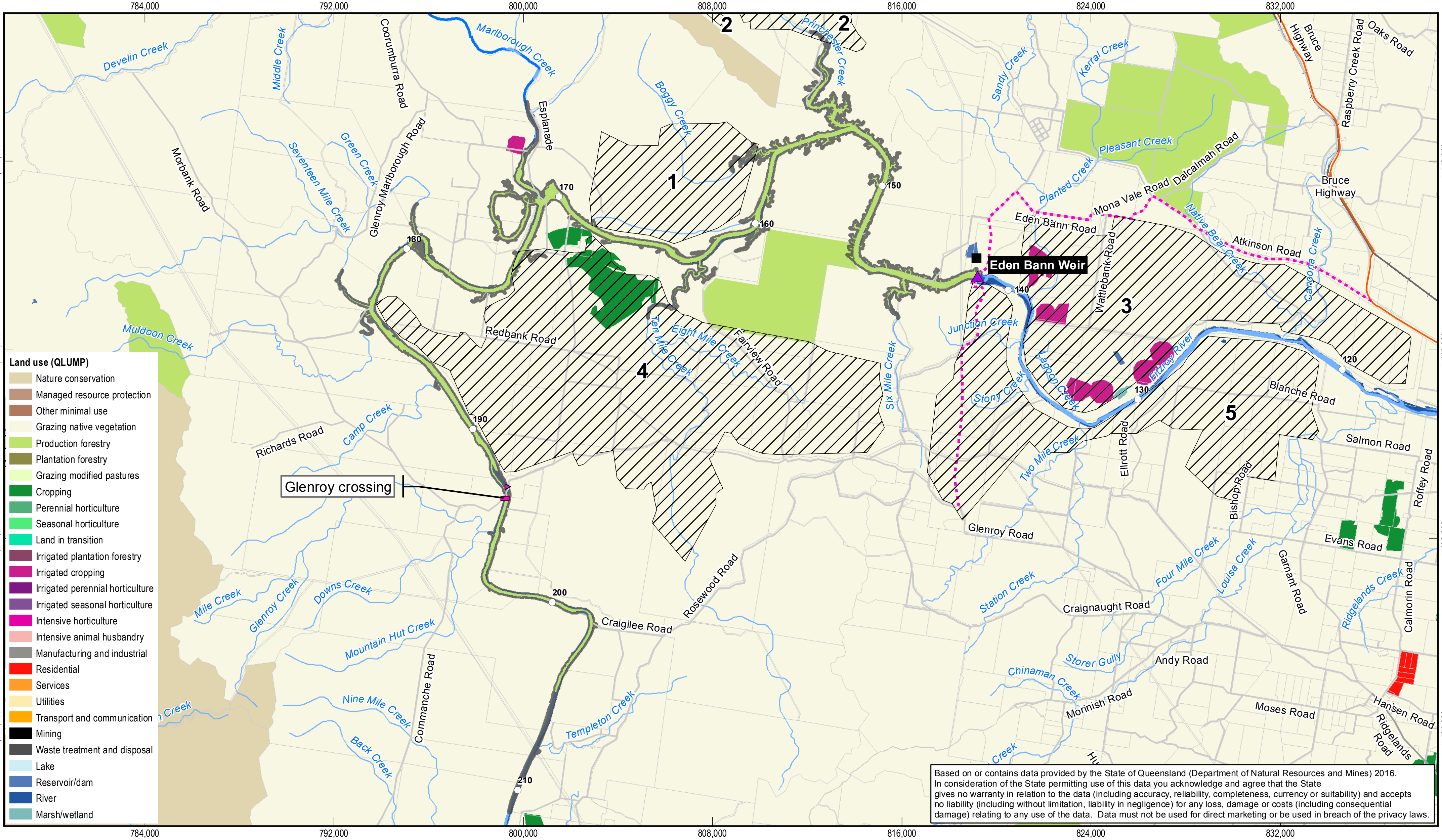
The Land Suitability Study (GHD 2006) prepared in relation to the Fitzroy Agricultural Development Area identified nine PDAs suitable for cattle feedlots, piggeries, silage production and horticulture (mixed crops) in the vicinity of the Project areas. PDAs are included on Figure 11-1 and Figure 11-2.

The agricultural development scenario (Section 11.3.3) potentially facilitated by the Project is considered to comprise ALUM land use classes as described in Table 11-1.

Agricultural development potentially facilitated by the Project may result in an area of 6,300 ha (Section 11.3.3) currently under grazing native vegetation land use being converted to an alternate land use as follows:

- 25 per cent irrigated cropping (1,600 ha)
- 11 per cent irrigated horticulture (700 ha)
- 63 per cent cattle feedlots and irrigated green fodder/silage production (4,000 ha).

[3] QLUMP maps and assesses land use patterns and changes according to the Australian Land Use and Management Classification System (Version 7 (May 2010)).



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA94)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Homestead
- River Crossing
- Access Road
- AMTD (km)
- Weir Location
- Highway
- Major Road
- Streets (Local)
- Waterway
- Property Boundary
- Eden Bann Weir Stage 2 impoundment
- Eden Bann Weir Stage 3 impoundment
- Potential Development Area

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Lower Fitzroy River Infrastructure Project

Job Number	41-29212
Revision	A
Date	07 Mar 2016

Eden Bann Weir existing landuse and PDAs

Figure 11-1

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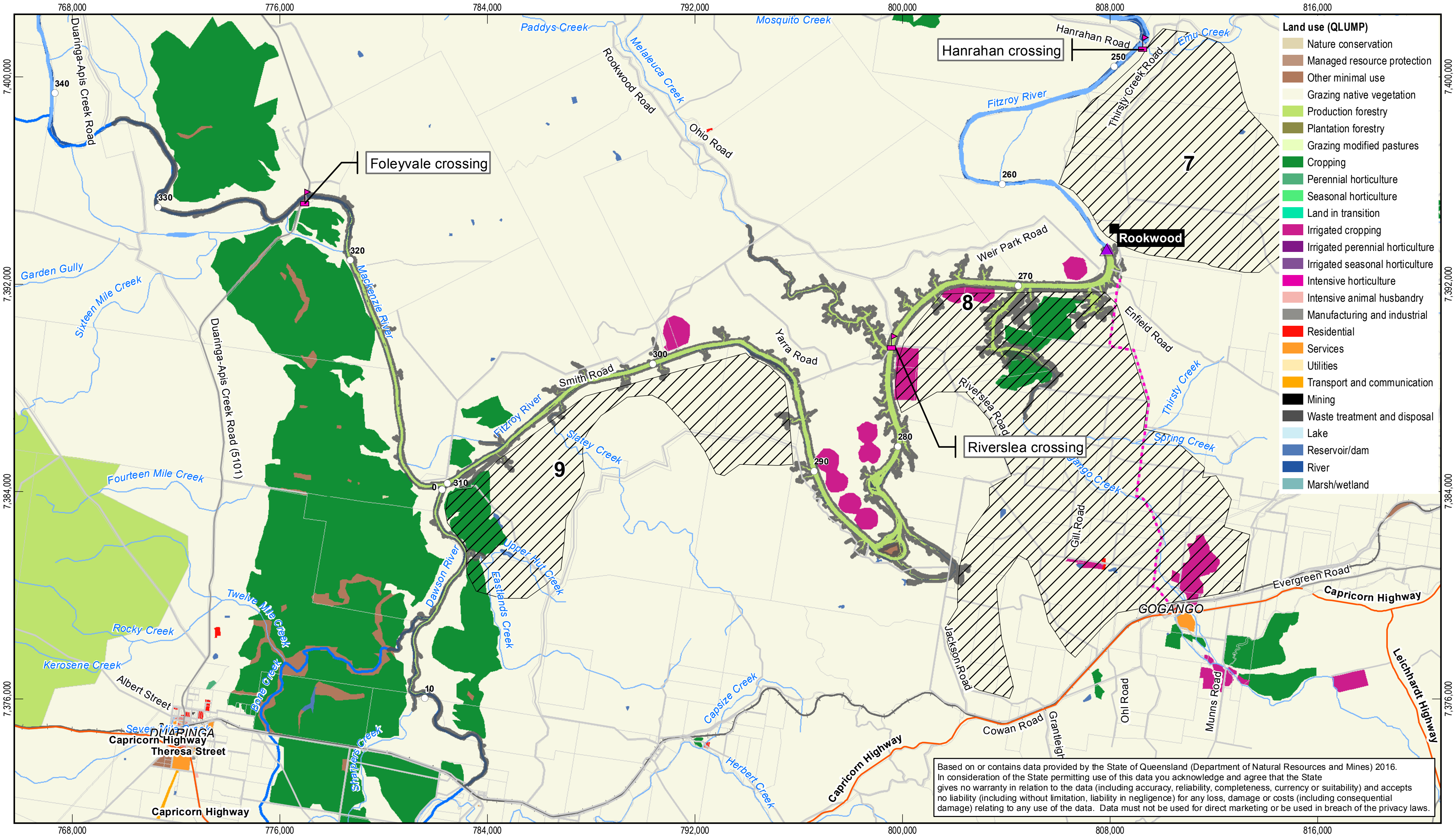
Data Source: © Copyright Commonwealth of Australia (Geoscience Australia): Places, Waterways (2007); Sunwater: Waterways, Weir Locations - 2008; DNRM: QLUMP(2009), Railways, Roads (2011), DCDB (2014); © Copyright Commonwealth of Australia; GHD: Proposed Development Area (2016) Impoundment Area (2013)*See Appendix for disclaimers and copyrights.



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0 2 4 6 8

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA94)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Homestead
- River Crossing
- Access Road
- AMTD (km)
- Weir Location
- Highway
- Major Road
- Streets (Local)
- Railway
- Waterway
- Property Boundary
- Rookwood Weir Stage 1 impoundment
- Rookwood Weir Stage 2 impoundment
- Potential Development Area

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Job Number 41-29212
Revision A
Date 07 Mar 2016

Proposed Rookwood Weir existing landuse and PDAs

Figure 11-2

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Table 11-1 ALUM land use classes for potential facilitated agricultural development scenario

Facilitated development scenario components	ALUM class	ALUM secondary/tertiary class	Bartley and Speirs (2010) landuse classification
Irrigated broadacre crops (1,600 ha)	Class 4 Production from irrigated agriculture and plantations	4.3 Irrigated cropping	Cotton*
Irrigated horticultural crops (700 ha)	Class 4 Production from irrigated agriculture and plantations	4.4 Irrigated perennial horticulture 4.5 Irrigated seasonal horticulture	Horticulture
Feedlots and irrigated green fodder/silage crops (4,000 ha)	Class 3 Production from dryland agriculture and plantations Class 4 Production from irrigated agriculture and plantations Class 5 Intensive uses	3.2 Grazing modified pastures 4.2 Grazing irrigated modified pastures 4.3 Irrigated cropping 4.3.3 Irrigated hay and silage 5.2 Intensive animal husbandry 5.2.2 Cattle feedlots	Grazing modified pastures

* Please note that cotton is not proposed as an alternate agricultural development scenario however land use for cotton is the closest comparative land use for irrigated broadacre cropping (a mix a cereals, legumes and other crops as commonly grown in Central Queensland) and is therefore used for the purposes of assessment.

11.4.2 Pollutant loads associated with differing land uses

Generated runoff

Runoff generated from different land use types has been considered with regard to:

- Sediment, as TSS
- Nutrients, as TN and TP.

Mean event generated runoff factors for TSS, TN and TP for existing land use types of relevance to the Project area and the facilitated development scenario have been adopted from Bartley and Speirs[4] (2010) and are presented in Table 11-2. Land use classifications in Bartley and Speirs (2010) are based on ALUM classifications and correspond to the potential facilitated development scenario land use types as presented in Table 11-1.

[4] Bartley and Speirs (2010) undertook a study to collate runoff, concentration and constituent load data for Australian catchments, inclusive of water quality data for use in catchment water quality models. The study included in the order of 750 entries from 514 geographical sites (noting a heavy bias towards data from Queensland) covering 13 different land uses. Published as Bartley et al (2012).

Table 11-2Generated runoff factors for TSS, TN and TP (adapted from Bartley and Speirs 2010)

Land use		Generated runoff factors (mean)		
Bartley and Speirs	**Facilitated development scenario**	**TSS (mg/L)**	**TN (µg/L)**	**TP (µg/L)**
Grazing native pastures	n/a – existing land use	837	1,593	482
Cotton	Irrigated broadacre crops	732	6,436	239
Horticulture	Irrigated horticultural crops	5,945	31,539	3,233
Grazing modified pastures	Feedlots and irrigated green fodder/silage crops	256	6,763	563

Generated runoff factors (Table 11-2) for TSS, TN and TP have been used to estimate pollutant loads and the change in contribution to TSS, TN and TP GBR catchment loads (Section 11.5.1). Existing GBR catchment loads are discussed below.

Catchment loads

Under the RWQPP, pollutant loads are assessed through the Paddock to Reef Integrated Monitoring, Modelling and Reporting Program, using a combination of monitoring and modelling data.

Great Barrier Reef Catchment Loads Monitoring Program

Pollutant loads are calculated annually by the Great Barrier Reef Catchment Loads Monitoring Program in six natural resource management (NRM) regions and priority catchments as shown on Figure 11-3 and listed below:

- Cape York region – Normanby catchment
- Wet Tropics region – Barron, Mulgrave-Russell, Johnstone, Tully and Herbert catchments
- Burdekin region – Burdekin and Haughton catchments
- Mackay Whitsunday region – O'Connell, Pioneer and Plane catchments
- Fitzroy region – Fitzroy catchment
- Burnett Mary region – Burnett and Mary catchments.

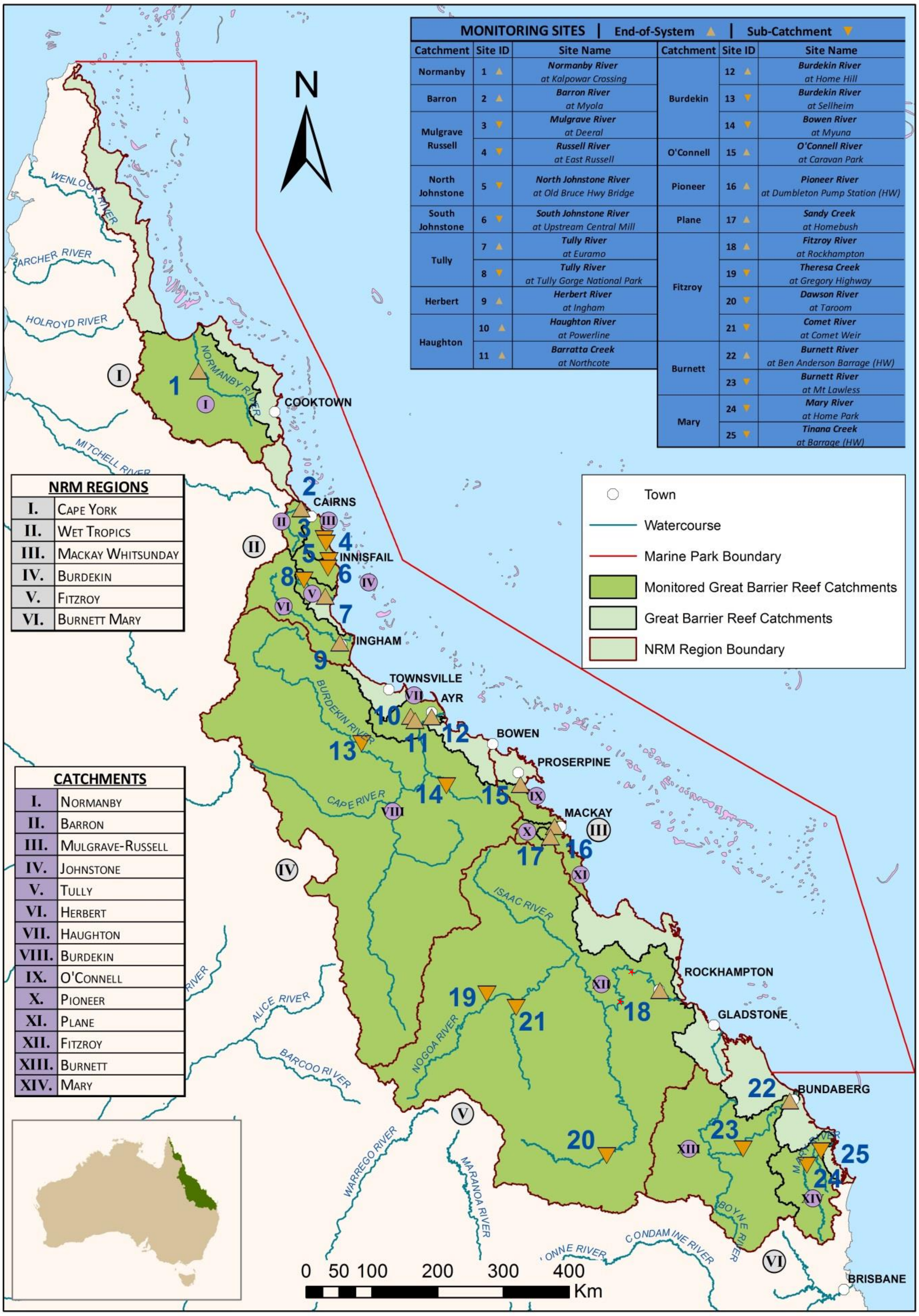

Figure 11-3 Great Barrier Reef Catchments Loads Monitoring Program areas

*** Location of the exisitng Eden Bann Weir and the proposed Rookwood Weir**

Source: Garzon-Garcia et al (2015) Figure 2.1 Map indicating the natural resource management regions, catchments and sites where the Great Barrier Reef Catchment Loads Monitoring Program monitoired during the 2013-2014 monitoring year.

Catchment loads have been monitored annually since 2009 and are variable between catchments and years depending on the variability in discharge together with land use and vegetation cover. Loads are calculated for the monitored area of each catchment and as such do not represent the total load discharged to the GBR lagoon.

The total annual monitored loads for all NRM regions and catchments (covering a monitored surface area of 366,779 km^2) are presented in Table 11-3. The relatively small load reported for the 2013-2014 period is attributed to very low end-of-system discharges, the lowest recorded between the 2006–2014 monitoring years (Garzon-Garcia et al 2015). The annual monitored loads for the Fitzroy NRM area (Fitzroy catchment) (with a monitored surface area of 139,159 km^2) are presented in Table 11-4.

Table 11-3 Total monitored loads – NRM regions and catchments

Period	Water quality parameter constituent loads			Source
	TSS (t)	TN (t)	TP (t)	
2013-2014	1,400,000	12,000	1,800	Garzon-Garcia et al 2015
2012-2013	9,600,000	34,000	9,400	Wallace et al 2015
2011-2012	5,600,000	28,000	7,800	Wallace et al 2014
2010-2011	20,000,000	100,000	32,000	Turner et al 2013
2009-2010	6,950,000	30,000	9,300	Turner et al 2012
Average load	**8,710,000**	**40,800**	**12,060**	

Table 11-4 Monitored load – Fitzroy NRM area (Fitzroy Catchment)

Period	Water quality parameter constituent loads			Source
	TSS (t)	TN (t)	TP (t)	
2013-2014	52,000	1,000	160	Garzon-Garcia et al 2015
2012-2013	2,500,000	9,300	3,700	Wallace et al 2015
2011-2012	1,300,000	6,400	2,700	Wallace et al 2014
2010-2011	7,000,000	36,000	15,000	Turner et al 2013
2009-2010	3,563,583	12,898	5,321	Turner et al 2012
Average load	**2,883,117**	**13,120**	**5,376**	

Great Barrier Reef catchment load modelling

Dougall et al (2014) reports on catchment modelling for the Fitzroy NRM region area using an eWater Ltd Source Catchments modelling framework. The region is comprised of six drainage basins: Styx, Shoalwater, Water Park Creek, Fitzroy, Calliope and Boyne as shown on Figure 11-4. The Fitzroy Basin comprises 93 per cent of the NRM area (142,552 km^2). The Fitzroy NRM region is approximately 37 per cent of the total GBR catchment area (423,122 km^2) (Dougall et al 2014).

Modelled outputs estimate the loads generated from the Fitzroy NRM region and exported to the GBR as presented in Table 11-5.

Table 11-5 Modelled pollutant loads

Methodology and catchment area	Period	Relevant area	Water quality parameter constituent loads		
			TSS (t)	TN (t)	TP (t)
GBR total modelled load	Per annum	GBR NRM regions 423,134 km2	8,545,000	36,699	6,294
Modelled loads – Fitzroy NRM area	Per annum	Fitzroy NRM area 155,740 km2	1,948,000	4,244	1,093
Modelled loads – Fitzroy Basin	Per annum	Fitzroy Basin 142,552 km2	1,740,000	3,688	983

11.5 Potential impacts

11.5.1 Generated runoff

Approach and methodology

The area of land potentially developed for the facilitated agricultural development scenario equates to approximately 0.044 per cent of the monitored and/or modelled areas within the Fitzroy Basin. Total mean annual flow at Rockhampton with the weirs in operation is in the order of 5 million ML. The mean annual flow contribution from the potentially facilitated agricultural development is in the order of 2,226 ML.

TSS, TN and TP concentrations associated with existing gazing on native pastures and potentially facilitated agricultural development land uses are presented in Table 11-2.

TSS, TN and TP loads generated from the potentially facilitated agricultural development scenario has been estimated proportionally for each alternate agricultural land and use is shown in Table 11-6.

A comparison of the existing land use and facilitated agricultural development land uses in terms of loads was undertaken. To enable the comparison, the change in pollutant concentration in mg/L has been converted to a change in load contribution in t/a.

The change in load is compared to monitored and modelled loads as presented in Garzon-Garcia et al (2015) and Dougall et al (2014), respectively.

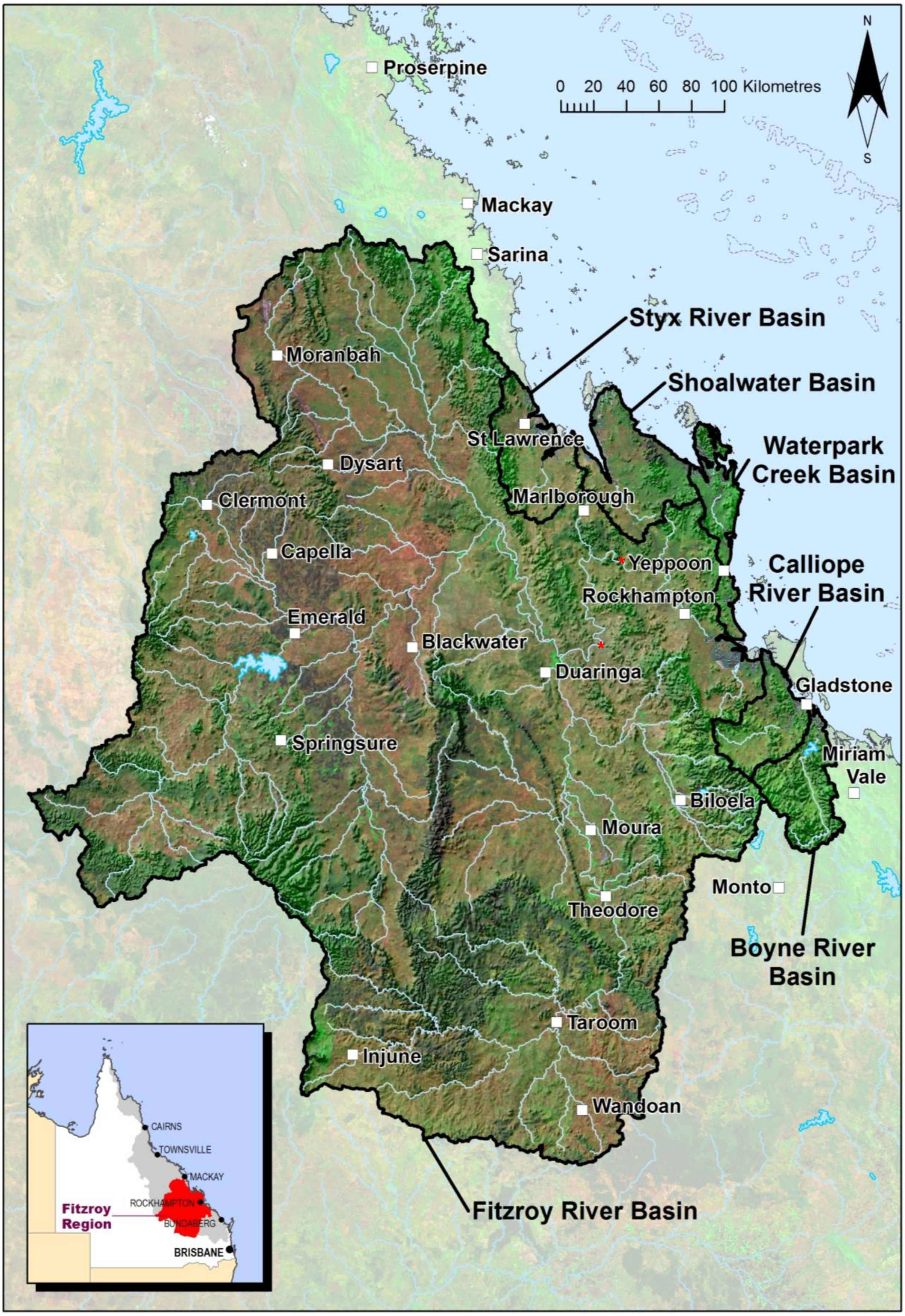

Figure 11-4 Fitzroy NRM region modelling areas

* Location of the existing Eden Bann Weir and the proposed Rookwood Weir

Source: Dougall et al (2014) Figure 1 Fitzroy NRM region and six reporting basins

Table 11-6 Pollutant loads – existing and facilitated agricultural development scenario land uses

Land use classification		Contribution	Pollutant contribution		
Bartley and Speirs (2010)	**Facilitated development scenario**	**%**	**TSS**	**TN**	**TP**
			t/a	**t/a**	**t/a**
Existing					
Grazing native pastures	n/a	100	1,863	4	1
Facilitated agricultural development					
Cotton	Irrigated broadacre crops	25	414	3.64	0.14
Horticulture	Irrigated horticultural crops	11	1470	7.80	0.80
Grazing modified pastures	Feedlots and irrigated green fodder/silage crops	63	362	9.56	0.80
Total facilitated agricultural development			2,246	21.00	1.73
Change in load			**+383**	**+17**	**+1**

TSS, TN and TP results and discussion

Table 11-6 shows TSS, TN and TP loads potentially arising as a result of a facilitated change in land use from the existing grazing native vegetation to the facilitated agricultural development scenario.

Marginal increases in TSS, TN and TP loads are predicted as follows:

- TSS: 383 t/an
- TN 17 t/an
- TP 1 t/an.

The contribution that the facilitated agricultural development land uses may have on monitored and/or modelled TSS, TN and TP loads are shown in Table 11-7 and summarised below:

- TSS load may increase by up to 0.02 per cent
- TN load may increase by up to 0.46 per cent
- TP load may increase by up to 0.10 cent.

Based on the above calculations the changed land use through facilitating development of irrigated broadacre cropping, irrigated horticulture and feedlots has the potential to result in negligible increases in TSS, TN and TP to the GBR compared to the existing land use.

The predicted change in pollutant loads is considered conservative as it assumes limited advances in best practice management. It is noted that generated runoff is estimated as at 2010 and since this time the Commonwealth and State governments have spent significant resources in developing and implementing best practice land management methods and are working with NRM groups and landholders in this regard.

Further, it assumes that all generated runoff enters the watercourse and is output to the GBR. This is unlikely as storages are known to act as a sink and retain some levels of TSS, TN and TP at times.

11.5.2 Impacts on World Heritage Properties and National Heritage Places

The Project is located on the Fitzroy River which flows into the GBR. The GBR is listed as both a World Heritage property and a National Heritage place. No other World Heritage properties or National Heritage places occur in proximity to the study area.

Potentially facilitated agricultural development potentially within the Fitzroy WRP plan area through the provision of 42,000 ML/a of high-security water from the Project would contribute:

- Three per cent to the current level of irrigated cropping
- Thirty per cent to the total number of animals produced by feedlots.

Agricultural development potentially facilitated by the Project (Section 11.4.2) has the potential to impact on water quality by marginally increasing the TSS, TN and TP loads within the system.

Existing pressures on the GBRWHA relevant to potentially facilitated agricultural development and the associated effects of water quality and nutrient export in the Fitzroy Basin have been identified based on a literature review, modelling and current monitoring outputs (Section 11.4.2). An assessment of the extent to which facilitated agricultural impacts may contribute to each of these pressures is in Table 11-8.

Table 11-7 Comparison of changed land use pollutant loads relative to monitored and modelled catchment loads

Data source area	Pollutant		Land use contribution					
	Type	Load (t)	Existing		Alternate scenario		Change	
			tonnes	%	tonnes	%	tonnes	%
Total monitored load – NRM regions and catchments[1]	TSS	8,710,000	1,863	0.02	2,246	0.03	383	0.00
	TN	40,800	4	0.01	21	0.05	17	0.04
	TP	12,060	1	0.01	2	0.02	1	0.01
Monitored load – Fitzroy NRM area – Fitzroy catchment[1]	TSS	2,883,117	1,863	0.06	2,246	0.08	383	0.01
	TN	13,120	4	0.03	21	0.16	17	0.13
	TP	5,376	1	0.02	2	0.04	1	0.02
GBR total modelled load[2]	TSS	8,545,000	1,863	0.02	2,246	0.03	383	0.00
	TN	36,699	4	0.01	21	0.06	17	0.05
	TP	6,294	1	0.02	2	0.03	1	0.01
Modelled loads – Fitzroy NRM area[2]	TSS	1,948,000	1,863	0.10	2,246	0.12	383	0.02
	TN	4,244	4	0.09	21	0.49	17	0.40
	TP	1,093	1	0.09	2	0.18	1	0.09
Modelled loads – Fitzroy Basin[2]	TSS	1,740,000	1,863	0.11	2,246	0.13	383	0.02
	TN	3,688	4	0.11	21	0.57	17	0.46
	TP	983	1	0.10	2	0.20	1	0.10

1 as per Garzon-Garcia et al (2015) (Table 11-3); 2 as per Dougall et al (2014) (Table 11-3).

Table 11-8 Existing pressures and assessment of potential consequential agricultural impacts

Component^	Existing pressures^	Current condition ^*	Potential impacts from agricultural development potentially facilitated by the Project
Physical processes			
Freshwater inflow	Patterns of freshwater flow onto the GBRWHA have changed through river and land management practices. Dams, weirs and drainage in most catchments have altered freshwater flows into the GBRWHA.	Good	The impact of potential altered freshwater flows has been assessed for the Project. It is not expected that fresh water flows to the GBRWHA will be significantly impacted by the Project. *High-security water available as a result of the Project will be abstracted upstream of the GBRWHA as assessed. Extraction of water for agricultural use is therefore included within the assessment of freshwater flow impacts to the GBRWHA. Potentially facilitated agricultural development will not further impact freshwater flows to the GBRWHA.*
Sedimentation	The area of the GBR affected by sedimentation is increasing substantially as a result of land management practices. Sediment inflow to the GBR has significantly increased since European settlement as a result of soil erosion from land clearing, overgrazing and extensive forest clearing.	Poor	Intensive animal husbandry has the potential to increase sedimentation during construction and operation. These activities are highly regulated and are required to implement effective management practices to limit off-site impacts under Queensland legislation. While broadacre cropping may reduce groundcover and expose soils during times of harvest and before the next crop has established, it will also promote groundcover during the growing season. Areas of remnant vegetation were included as a high level constraint when defining the potential agricultural development areas and were excluded as suitable sites within potential agricultural zones. It is expected that clearing impacts are likely to be on areas that are currently sparsely vegetated, already cleared and degraded for other purposes (likely grazing). The PDAs of irrigated broad-acre cropping and horticulture attributable to the Project represents a three per cent increase in this land use for the region. Furthermore, it is evident from the extensive monitoring being undertaken within GBR catchments that improved land management practices are being implemented by landholders. This is expected to demonstrate a long-term reduction in overall impact to inshore areas associated with sedimentation. *Having regard to the scale of potential agricultural development, the environmental permitting requirements for intensive agricultural activities, the land management practices being adopted throughout the region and collaboration between stakeholders with regard to data sharing and reporting it is considered that impacts on the GBRWHA from potentially facilitated agricultural development arising from the Project are unlikely to be significant.*
Light	Levels of light control the depth range of marine plants (e.g. seagrass meadows, algae) as well as all animals which have a symbiotic dependence on plants (e.g. corals). Light decreases in the water column according to the amount of sediment in the water. Loss of light from increases in sedimentation is affecting inshore areas.	Good	

Component^	Existing pressures^	Current condition ^*	Potential impacts from agricultural development potentially facilitated by the Project
Chemical processes			
Nutrient cycling	Within the GBRWHA, above normal nutrient levels are closely associated with terrestrial runoff. An overall reduction in average annual dissolved inorganic nitrogen load has been indicated in the period 2009 – 2013 (GBRMPA 2014), however the time-lag between reduction in loads and impacts is several decades. The 2013 scientific consensus statement concluded that 'water quality modelling, supported by appropriate validation, indicates that early adopters of best practice land management have reduced total pollutant loads — a significant step towards the goal of halting and reversing the decline in water quality to the reef.' (Brodie et.al. 2013).	Poor	Intensive animal husbandry has the potential to contribute to nutrient loads within surface runoff. However, these activities are highly regulated and are required to implement effective management practices to limit off-site impacts and achieve environmental conditions. Feedlot sites are largely closed systems with limited runoff outside of extreme events. Widely adopted best practice management measures are demonstrated to be effective in limiting off-site impacts. Studies undertaken as part of the investigations into the development of the Fitzroy Agricultural Corridor provide valuable recommendations with regard to soil and cropping constraints and offset/buffer distances to watercourses and minimum effluent irrigation areas to minimise environmental impacts. Irrigated broadacre cropping and intensive horticulture activities have the potential to contribute to the nutrient and pesticide load entering the GBRWHA. Farming practices within the GBRWHA catchment are becoming more regulated and the Queensland Government is working with the industry to support the development of best management practice programmes. The Reef 2050 Plan (Commonwealth of Australia 2015) together with the RWQPP is focused on halting and reversing the decline in water quality entering the reef from broad scale land use and seeks to move land management to best practice in as wide an area as possible. It is expected that the WQIP for the Fitzroy/Capricorn Coast region will also contribute to the implementation of best practise management strategies and contribute to the improvement of water quality within the Project area. *Having regard to the scale of agricultural development potentially facilitated by the Project, the environmental permitting requirements for intensive activities and the land management practices being adopted throughout the region, it is considered that the Project is unlikely to have a significant consequential impact on the GBRWHA.*

Component^	Existing pressures^	Current condition ^*	Potential impacts from agricultural development potentially facilitated by the Project
Ocean acidity	The world's oceans are becoming more acidic affecting the growth of corals. Ocean pH is changing and is projected to decline in the future under climate change scenarios.	Good	The principal contributor to ocean acidity identified for the GBRWHA is climate change. The development of potential agricultural areas is not expected to contribute to changes in ocean pH. Impacts to water quality as a result of changes in agricultural land uses is predicted to be marginal. Further, it is considered likely that water storages will become more important for the purpose of water supply, mitigating drought and for maintaining environmental flows as climate change impacts are realised. *As the potential consequential development is not expected to measurably contribute to climate change, no additional consequential impact associated with ocean acidity is expected to occur.*
Ocean salinity	The salinity of the GBRWHA waters is generally stable with local short term fluctuations after flood events, mostly close to the coast. Heavy rainfall in recent years has temporarily affected ocean salinity in some parts of the Region.	Good	The downstream flooding and resultant freshwater flows that could contribute to changes in ocean salinity has been assessed for the Project in the draft EIS. Point source salinity within the Fitzroy catchment is largely a result of mine dewatering activities elsewhere in the catchment. Programmes and initiatives being developed through the Fitzroy Partnership (amongst others) to monitor and manage these impacts. *As the potential consequential development is not expected to alter flood regimes nor contribute to point source releases no additional consequential impact associated with ocean salinity is expected to occur.*

^Component, pressures and current condition taken from GBRMPA (2014) *Great Barrier Reef Outlook Report*

* Current condition:

Very good - There is no evidence of significant change in physical, chemical or ecological processes

Good - Some physical or chemical process have changed in some areas, but not to the extent that the changes are significantly affecting ecosystem function

Poor – Physical or chemical processes have changed substantially in some areas to the extent that ecosystems function is significantly affect in some parts of the region

Very poor – Physical or chemical processes have changed substantially and over a wide area. Ecosystem function is seriously affected in much of the region.

The current condition of nutrient cycling in the GBRWHA is considered poor and heavily influenced by land management practices (for example, clearing of vegetation and the associated terrestrial run-off from activities such as agricultural development). The latest 2014 Outlook Report (GBRMPA 2014) however, concludes that threats to the GBRWHA such as nutrients, sediment and pesticide loads are beginning to be addressed.

Management of the effects of agricultural development within GBRWHA catchments is being improved in recent years as a result of:

- Direct regulation at local, State and National government level
- Adoption of management practices through the implementation of actions identified in the Reef 2050 Plan and specific programs such as the RWQPP
- Improved land management practices and voluntary behavioural changes promoted by local and regional stewardship programs (for example, the FBA's 'Sustainable agriculture through innovative practices in the Fitzroy' and 'Fitzroy water quality project' funded through the Queensland Regional Natural Resource Management Investment Program).

A WQIP has been developed for the Fitzroy/Capricorn Coast region by the FBA. Consistent with WQIPs in other GBRWHA catchments, the WQIP makes recommendations for the development of an implementation strategy (through consultation with government, industry and community groups) for managing water quality in the region and achieving the proposed targets, through identification of management practices and projects that can be adopted to meet targets and objectives in the most cost effective manner.

The WQIP sets short-term targets for land management and water quality outcomes that match those under the Reef 2050 Plan and is not assessed separately. An assessment of the impacts arising from potentially facilitated agricultural development against the Reef 2050 targets is included at Section 8.2.1.

The WQIP was released for comment 24 February 2016 and as Project proponents, the GAWB and SunWater welcome the opportunity to participate and collaborate with stakeholders in the development of the WQIP (and subsequent strategies) for the Fitzroy/Capricorn Coast region.

Further, the Proponents contribute to water quality enhancement initiatives within the Fitzroy Basin through participation in partnerships and collaboration with State agencies in the provision of monitoring data.

Land management practices within the region are not specifically regulated through permitting. There has, however, been an increasing adoption improved land management practices across farms with a resultant improvement in water quality of the GBRWHA (GBRMPA 2014).

Irrigated agriculture and intensive horticulture within the Fitzroy Basin will also be subject to the expected increased pressure for adoption of management practices under the actions of the RWQPP and the Reef 2050 Plan (Commonwealth of Australia 2015).

Intensive animal husbandry is a highly regulated industry which triggers an ERA under the Environmental Protection Regulation 2008 and requires an environmental authority for the operator and a development permit for the property.

There are several guidelines that regulate cattle feedlots:

- National guidelines for beef cattle feedlots in Australia, 2nd edition, (Agriculture and Resource Management Council of Australia and New Zealand 1997)
- National guidelines for beef cattle feedlots in Australia 3rd Edition (Meat and Livestock Australia Limited, 2012a)
- National beef cattle feedlot environmental code of practice 2nd Edition (Meat and Livestock Australia Limited, 2012b).

Uncontained runoff, leaching or seepage from the feedlot yards, ponds or waste utilisation areas has the potential to contaminate surface water. Cattle feedlots are not generally washed down however and therefore runoff is only generated by rainfall (GHD 2007). If nutrients and organic matter are allowed to enter surface waters then algae and aquatic weed growth is promoted (FSA 2011). This may reduce dissolved oxygen in the water which may have downstream impacts if poorly managed. Poorly managed feedlots have the potential to export nutrients through overtopping of effluent storage ponds or from irrigation of effluent over the associated forage cropping irrigation areas. The Nutrient Export Risk from Hypothetical Feedlots report (GHD 2007) showed that it is possible to construct feedlots in the Fitzroy Basin that are not expected to exceed the Queensland Water Quality Guidelines 2006 values for either overtopping or irrigation if the feedlots are appropriately designed and managed.

Due to the high level of regulation in the intensive animal husbandry industry, potential environmental impacts are likely to be controlled and monitored and therefore the risk of potential significant environmental impact is considered to be low.

Based on the development scenario presented in this report agricultural development potentially facilitated within the Fitzroy WRP plan area through the provision of 42,000 ML/a of high-security water would contribute:

- Three per cent to the current level of irrigated cropping
- Thirty per cent to the total number of animals produced by feedlots.

Existing pressures on the GBR relevant to agricultural development and the associated effects of water quality and nutrient export in the Fitzroy Basin have been identified based on a literature review and modelling and current monitoring outputs. An assessment of the extent to which impacts from potentially facilitated agricultural development may contribute to each of these pressures was undertaken and presented in Table 11-8.

Potential increases in sediment and nutrient loads associated with land use change as a result of potentially facilitated agricultural development have been identified as likely to be negligible (Section 11.5.1).

It is considered that the Project is unlikely to have a measurable impact on MNES as a result of changes to land use from the potentially facilitated agricultural development and TSS, TN and/or TP contributions to the GBR with the implementation of environmental permitting requirements for intensive activities and the land management practices being adopted throughout the region.

11.5.3 Listed threatened, migratory and marine species and ecological communities

Agricultural development has the potential to result in clearing of vegetation and impacts to habitat. The constraints analysis undertaken for the Fitzroy Agricultural Development Area Land Suitability Study (GHD 2006) identified and excluded protected vegetation and habitat areas in determining suitable land available for future agriculture development.

It is not considered likely that agricultural development potentially facilitated by the Project would impact on any habitat for MNES species as irrigated cropland and feedlot development would be likely to be primarily based on cleared grazing land. Potential water quality impacts on downstream communities and marine areas arising from facilitated agricultural development are considered to be as per the assessment undertaken for the GBRWHA above (Section 11.5.2).

12. Environmental management plan

A revised draft EMP is provided in Appendix F. Updates to the EMP address the following issues raised in submissions made on the draft EIS:

- Australian Heritage Council (024.01) – environmental management and water quality
- CCC (029.27) – environmental management
- DAF – Fisheries Queensland (007.03, 007.04, 007.09) - fish salvage and handling, fishway maintenance and fish monitoring
- DAF – Biosecurity Queensland (007.10, 007.11) – weed and pest management
- DEHP (028.01, 028.07, 028.13, 028.20, 028.26, 028.27) - air quality objectives, noise objectives and mitigation and Fitzroy River turtle and white-throated snapping turtle management measures
- DSD Regional Services (017.04, 017.05) - consultation with DSD Regional Services in development of recruitment and procurement plan
- FBA (011.05, 011.08, 011.09, 011.10, 011.11, 011.13, 011.14, 011.15, 011.16, 011.28, 011.29) – environmental management with regard to potential impacts on the Fitzroy River turtle and white-throated snapping turtle
- Public Safety and Business Agency (025.01) - bushfire hazard and risk
- QFES Community Safety Capability Branch (025.02) - compliance with hazard, health and safety legislation
- RRC (008.03) - water quality monitoring
- WWF-Australia (031.02).

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13. Project commitments

Revised Project commitments are included at Appendix D. Updates to the Project commitments address the following issues raised in submissions made on the draft EIS:

- DAF – Fisheries Queensland (007.04) – fishway maintenance
- DEHP (028.05, 028.24, 028.25, 028.26, 028.27) – water releases, Brigalow TEC offsets, black ironbox offsets and Fitzroy River turtle and white-throated snapping turtle SMP
- DEWS (037.01, 037.02) - future modelling and changes to operational rules
- DNRM (032.10, 032.12, 032.13) – tenure and compensation
- DNPSR (020.02) - consultation with DNPSR in managing impacts on Aricia State Forest
- DTMR (019.01, 019.02) – traffic count data and intersection upgrade design
- FBA (011.14, 011.16) – environmental management regarding potential impacts on the Fitzroy River turtle and white-throated snapping turtle.
- Private submitter 4 (031.01, 013.02) – land use and compensation
- Private submitter 5 (014.01) – land use and compensation
- Private submitter 6 (016.01, 016.02, 016.03, 16.04, 16.05, 016.06, 16.08) – land use and compensation
- Private submitter 7 (022.01) – land use and compensation
- Private submitter 8 (023.01) – land use and compensation
- Private submitter 9 (026.01, 026.02) – land use and compensation
- Private submitter 10 (027.01, 027.02) – land use and compensation
- Private submitter 11 (033) – land use and compensation
- Private submitter 12 (034) – land use and compensation
- Private submitter 13 (035.01) – land use and compensation
- Private submitter 14 (036.01) – land use and compensation.

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14. Conclusion

The additional information provided addresses submissions received from Commonwealth, State and local government and regulatory agencies, landholders, community groups and organisations and the general public.

No changes to the description of the Project have been made by the proponents from that described in the draft EIS. It is considered that submissions received in relation to the draft EIS have not required changes to the Project description or Project design elements nor significantly increased or altered the nature of the potential impacts as described in the draft EIS.

Additional assessments with regard to the Project have been undertaken in order to address new legislation and/or policy initiatives introduced by the Commonwealth and State governments during and since the development of the draft EIS

It is considered that this additional information together with the draft EIS can be taken to be the final EIS for evaluation by the Coordinator-General.

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