12. Cumulative and consequential impacts

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12.1 Introduction

12.1.1 Overview

The purpose of this chapter is to provide an assessment of the cumulative and consequential impacts of the Lower Fitzroy River Infrastructure Project (Project) on matters of national environmental significance (MNES). Project impacts are assessed with consideration to existing and proposed activities in the region and methods by which these impacts can be reduced are identified. Potential consequential impacts resulting from developments that may be facilitated by the Project are also addressed. The assessment addresses Part C of the terms of reference (ToR) for the environmental impact statement (EIS) in relation to cumulative and consequential impacts. A table cross-referencing the ToR requirements is provided in Appendix B.

12.1.2 Objective

The objective of this assessment is to identify the potential cumulative impacts upon existing environmental values as a result of constructing and operating the Project and other proposed projects within relevant study areas. The assessment is to be undertaken considering the following:

- Impacts on a local and regional level
- Accumulation of impacts over time
- Exacerbation of impacts in intensity or scale, frequency or duration
- Consideration of the Project either in isolation or combination with other known existing or planned projects.

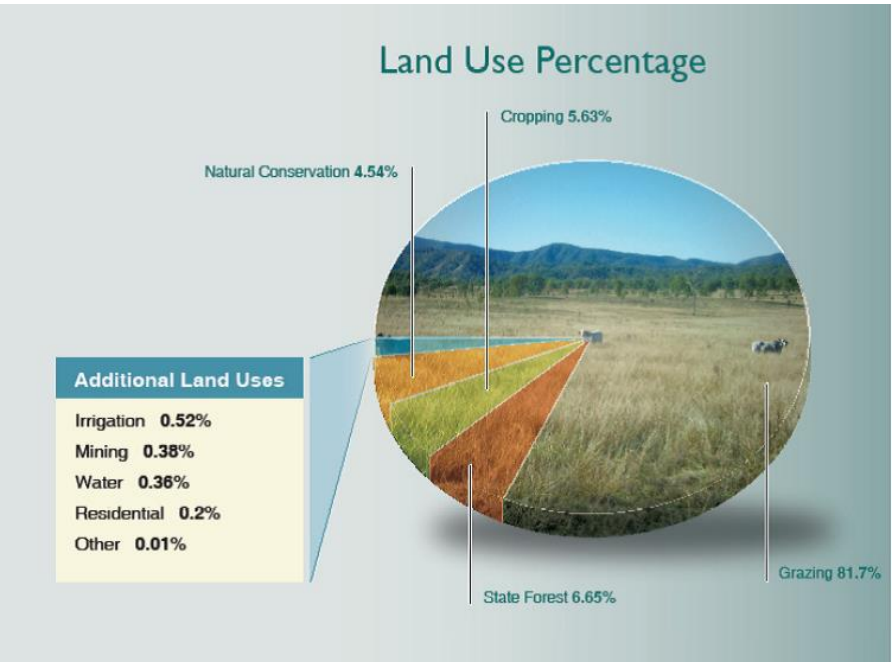
Further detail on the cumulative impact assessment methodology is provided in Chapter 6.

12.2 Existing pressures

12.2.1 Catchment pressures

The Fitzroy Basin catchment extends over approximately 142,000 km^2 of central and eastern Queensland near the Tropic of Capricorn. The catchment is the second largest in Australia and opens onto the world heritage protected area of the Great Barrier Reef. The catchment is dominated by agriculture which accounts for almost 90 per cent of land use. Figure 12-1 provides an overview of land use in the catchment. Water resources within the catchment are highly regulated with seven dams (large and small), 13 weirs and a large tidal barrage. The catchment is home to significant terrestrial floral and faunal assemblages with populations of threatened species and internationally significant wetlands.

Figure 12-1 Land use in the Fitzroy Basin catchment

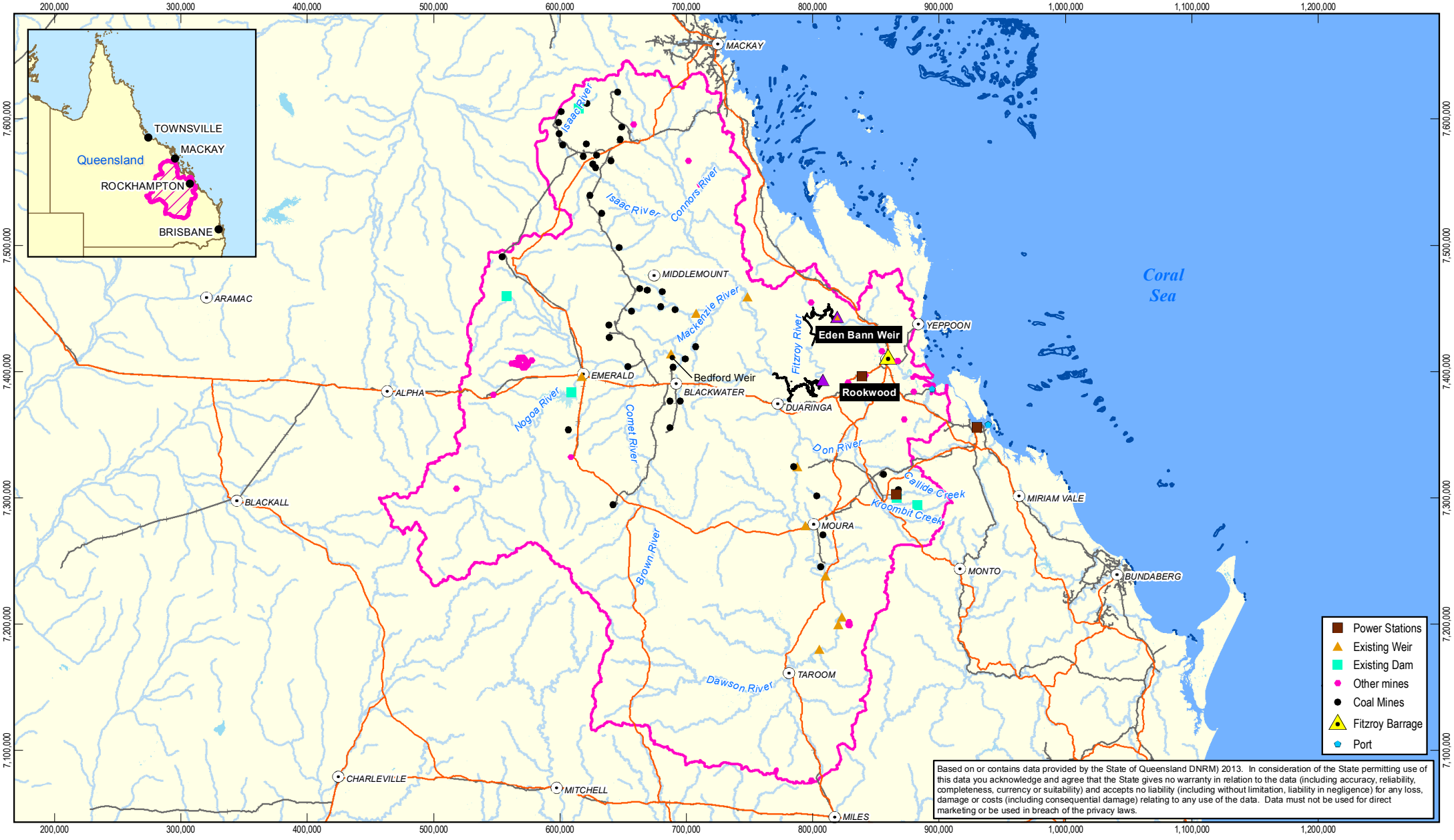


Source: FBA 2008

Current pressures on the catchment have been well documented in the literature (Hart 2008; FBA 2008; Coastal CRC Technical Reports). Many pressures are the result of land clearing and degradation impacts including all forms of soil erosion by water and soil fertility decline. The decline in water quality is also a concern with the Fitzroy River occasionally experiencing high levels of sediment (turbidity), pesticide and nutrient levels, toxic algal blooms and widespread occurrence of exotic weeds (Millar et al. 2001). Riverine and riparian areas in the Fitzroy Basin catchment have been disturbed by agricultural and extraction activities and the estuary hinterlands have generally been cleared for grazing and urban development.

Existing developments and activities within the catchment are shown in Figure 12-2 and summarised as follows:

- In the order of 46 coal mines and 12 other mines including limestone, gold, chrysoprase, bentonite, salt, sapphire, sandstone, marble and zeolite mines
- Coal seam gas (CSG) extraction and associated pipelines within the Bowen Basin CSG area
- Two coal-fired power stations
- Seven dams, 13 weirs and a large tidal barrage
- Existing road transport infrastructure
- Rail infrastructure including the Blackwater System, Central West System, Goonyella System, Moura System and North Coast Line
- Gracemere Industrial Area.



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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

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LEGEND

- Weir Location
- Populated places
- Waterway (Major)
- Highways (National)
- Railway
- Fitzroy Catchment
- Impoundment Area
- Lakes

Gladstone Area Water Board, SunWater
Lower Fitzroy River Infrastructure Project

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Date 23 Sep 2014

Existing activities

Figure 12-2

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It should be noted that small projects, agricultural development and urban centres and associated pressures are not captured in this list however the impacts from these activities are a significant contributor to pressures on the catchment and are considered in Section 12.3.3.

While there are a large number of mines operating within the Fitzroy Basin catchment, mining only accounts for 0.38 per cent of land use within the catchment as shown in Figure 12-1. Nevertheless, mining within the catchment is an important external influence particularly in regard to fragmented land clearing, erosion and water quality impacts.

No existing mines are located in close proximity to either the proposed Eden Bann Weir or Rookwood Weir Project footprints. The closest operating mines are the Baralaba coal mine approximately 70 km south west of the Rookwood Weir site and the Cook, Yarrabee and Jellinbah coal mines located approximately 110 km west of the Rookwood Weir site near Blackwater.

Existing water storage infrastructure within the Fitzroy Basin catchment has reduced the connectivity of aquatic fauna habitat by restricting the upstream and downstream movement past in-stream structures. As a result, aquatic habitat within the Fitzroy, Dawson and Mackenzie sub-catchments is now fragmented between storages. Existing infrastructure currently impacting aquatic fauna movement and habitat within each river is detailed in Table 12-1.

Table 12-1 Current level of impoundment (Fitzroy, Dawson and Mackenzie rivers)

River	Existing infrastructure	Length of river (km AMTD)	Level of impoundment (km AMTD)	Percentage (%)
Dawson River	Neville Hewitt Weir, Moura Weir, Theodore Weir, Orange Creek Weir, Gyranda Weir, Glebe Weir	356. 5	125.2	35
Nogoa and Mackenzie Rivers	Tartrus Weir, Bingegang Weir, Bedford Weir, Fairbairn Dam	427.2	143.7	34
Fitzroy River	Eden Bann Weir, Fitzroy Barrage	250.7	97.6	39

12.2.2 Bio-subregion pressures

The Brigalow Belt bioregion contains a variety of landscapes ranging from rugged ranges and undulating hills to valleys and flat alluvial plains. This bioregion is characterised by the presence of Brigalow (*Acacia harpophylla*). The bioregion is also characterised by a high level of habitat loss. In particular, the lowlands (e.g. alluvial and clay plains) and riparian zones have been extensively cleared for agriculture. Vegetation and fauna communities associated with these landscapes have therefore declined significantly. Threatening processes identified within the bioregion include: vegetation clearing, linear infrastructure development, urban development, mining, road maintenance, grazing, altered water flows, impoundments, reduced water quality, altered fire regimes, weeds and pests (DERM 2008).

Within the Brigalow Belt bioregion, the Project footprint is located within five subregions: the Marlborough Plains, Mount Morgan Ranges, Boomer Range, Isaac-Comet Downs and the Dawson River Downs subregions. Table 12-2 provides the pre-clear, 2001 and 2011 extent of endangered, of concern and least concern regional ecosystems within the bio-subregion study area. The area and percent loss between 2001 and 2011 shows a continued decrease in extent remnant vegetation which supports MNES species and ecological communities.

Table 12-2 Extent of regional ecosystems within the bio-subregion study area

Regional ecosystems	Pre-clear area (ha)	Remaining 2001		Remaining 2011		Loss since 2001	
		ha	%	ha	%	ha	%
Endangered	2,069,892	129,847	6.3	125,766	6.1	4,081	3.1
Of concern	1,228,070	247,745	20.2	243,278	19.8	4,467	1.8
Least concern	3,054,162	1,481,110	48.5	1,453,355	47.6	27,755	1.9

Source: Accad et al. 2012

12.3 Cumulative impacts

12.3.1 Overview

Cumulative impacts can be defined as successive and combined impacts (positive or negative) of one or more projects upon the society, economy and the environment (Franks et al. 2010). Cumulative impacts are defined in the Part C of the ToR as project impacts that are in addition to existing impacts of other activities. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time or from a combination of concurrent effects from a single action or from the cumulative impacts resulting from a range of projects. Impacts may arise from other projects being developed within the same area or over a similar timeframe of operation to the project being assessed. Cumulative impacts may be positive or negative.

12.3.2 Proposed developments within the Fitzroy Basin catchment

All proposed developments listed in Table 12-3 occur, at least in part, within the catchment study area and the bio-subregion study area as shown in Figure 12-3. These include:

- Approximately 30 mining projects, mainly around Moranbah (Isaac River) or Blackwater (Mackenzie River) but with one approved large mine in the Upper Dawson sub-catchment (Wandoan)

- CSG resource extraction (Bowen Gas Project and the Santos GLNG Gas Development Project) and gas pipelines (Central Queensland Gas Pipeline and Arrow Bowen Pipeline Project)
- Central Queensland Integrated Rail Project (CQIRP) and the Surat Basin Rail Project
- Connors River Dam and Pipelines Project, Nathan Dam and Pipelines Project and Gladstone-Fitzroy Pipeline (GFP) Project.

Of these, approximately 15 mining projects, all four gas projects and the GFP Project are located, at least in part, within the bio-subregion study area. Approximately 13 mining projects, all four gas projects and the GFP Project are located, at least in part, within the regional study area.

While there are a large number of proposed mining projects within the catchment, bio-subregion and regional study area, only the Marlborough mine project (approved under Environmental Authority MIM800078102) occurs within proximity to the Project, ML80074 is granted to Marlborough Nickel Pty Ltd on land adjacent to the present Eden Bann Weir impoundment and ML80134 has been applied for in relation to a pipeline that would traverse the Fitzroy River. Mining has not commenced and it noted that the EIS related to the slurry pipeline and refinery associated with the proposed mine (albeit under separate environmental approvals) has lapsed. Further no publically available project details are available in relation to the proposal.

The development of mines and associated infrastructure depends largely on market factors so it is difficult to assess the possible temporal overlap with the Project. Consequently, it is expected that many of the projects proposed (Table 12-3) will not eventuate, or have or will be delayed as is currently evident.

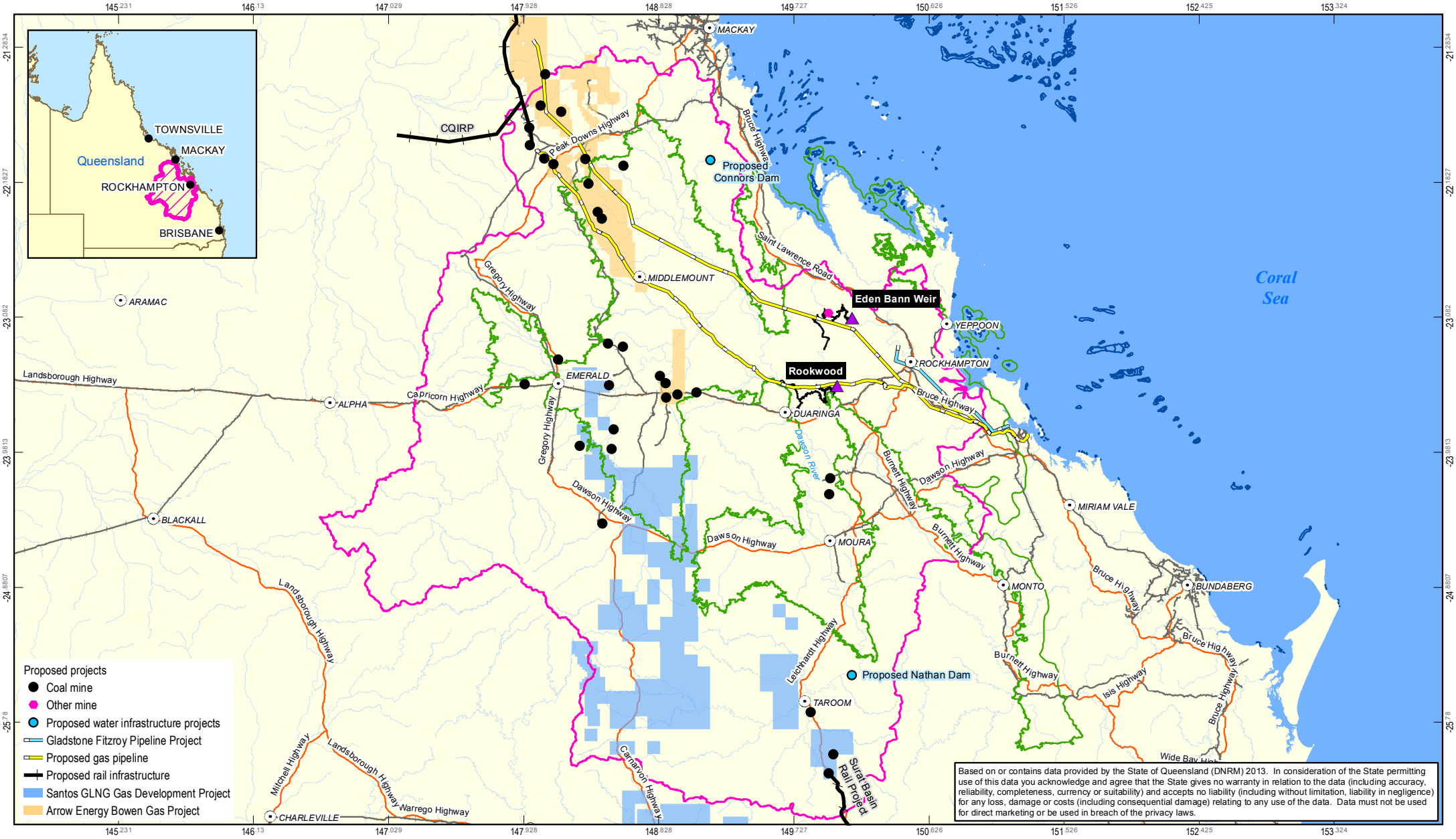
Table 12-3 Proposed projects

Project^	Approximate distance from Project*	Proponent	Project type	Project status/ timing
Mining projects proposed				
Baralaba North Continued Operations	70 km south west	Cockatoo Coal Limited	Open-cut coal mine expansion	2015
Baralaba South Coal Project	80 km south	Wonbindi Coal Pty Ltd	Open-cut coal mine (4.7 Mtpa)	Unknown
Belview Project	105 km west	Stanmore Coal	Underground coal mine	2017
Bluff Coal Project	95 km west	Carabella Resources Ltd	Open-cut coal mine (1.5 Mtpa)	2014
Codrilla Coal Mine Project	195 km north west	Coppabella and Moorvale Joint Venture	Open-cut coal mine (4 Mtpa)	Approved
Curragh South	115 km west	Peabody Energy Corp	Open-cut coal mine	Unknown
Curragh West	120 km west	Westfarmers Resources	Open-cut coal mine	Unknown
Dysart East Coal Project	185 km north west	Dysart Coal Management	Coal mine	2014
Ellensfield Coal Mine Project	250 km north west	Ellensfield Coal Management Pty Ltd	Underground coal mine (3 Mtpa)	Unknown

Project^	Approximate distance from Project*	Proponent	Project type	Project status/ timing
Fairhill Coking Coal	150 km west	Fairhill Coking Coal Pty Ltd	Open-cut coal mine	2015
Marlborough mine project	Adjacent to the Project footprint	Gladstone Pacific Nickel (Marlborough Nickel)	Nickel and cobalt laterite mine	Unknown
Grosvenor West Project	255 km north west	Carabella Resources Limited	Coal mine (3.5 Mtpa)	2015
Integrated Isaac Plains Project	235 km north west	Vale Australia	Coal mine expansion (+2 Mtpa)	Approved
Mackenzie North	155 km west	Jellinbah Group	Open-cut coal mine (2 Mtpa)	Unknown
Minyango Project	115 km west	Caledon Resources	Underground coal mine (7.5 Mtpa)	Approved
Moorvale West	220 km north west	Peabody Energy Corp	Coal mine	Unknown
Moranbah South Project	240 km north west	Anglo American Metallurgical Coal	Underground coal mine (18 Mtpa)	2020
New Lenton Coal Project	280 km north west	New Hope Corp. Ltd	Open-cut /underground coal mine (5 Mtpa)	2016
North Surat-Collingwood Coal Project	270 km south west	Cockatoo Coal Limited	Open-cut coal mine (6 Mtpa)	2015
North Surat – Taroom Coal	240 km south west	Cockatoo Coal Limited	Open-cut coal mine (8 Mtpa)	2018
Olive Downs North	205 km north west	Peabody Energy Ltd	Coal mine (2 Mtpa)	Unknown
Meteor Downs South (Orion Downs)	160 km south west	U & D Mining Industry Pty Ltd	Open-cut/underground coal mine (2.5 Mtpa)	Unknown
Red Hill Mine	260 km north west	BHP Billiton Mitsubishi Alliance	Open-cut/underground coal mine (+8 Mtpa)	2020
Rolleston Coal Expansion Project	190 km south west	Rolleston Coal Joint Venture	Open-cut coal mine expansion (+10 Mtpa)	2020
Springsure Creek Coal Project	180 km south west	Springsure Creek Coal Pty Ltd	Underground coal mine (11 Mtpa)	Approved
Talwood Coal Project	265 km north west	Aquila Resources Ltd	Underground coal mine (3.6 Mt)	Unknown
Taroborah Coal Project	210 km west	Shenhuo International Group	Open-cut/underground coal mine (5.1 Mtpa)	2017
Teresa Coal Project	190 km west	Linc Energy	Underground coal mine (8 Mtpa)	2015
Togara North Project	155 km south west	Xstrata Coal Ltd	Underground coal mine (up to 6 Mtpa)	2015

Project^	Approximate distance from Project*	Proponent	Project type	Project status/ timing
Wandoan Coal Project	285 km south	Wandoan Joint Venture	Open-cut coal mine (30 Mtpa)	On hold
Willunga	190 km north west	Peabody Energy Ltd	Open-cut coal mine (3 Mt)	2015
Wilton Coal Project	160 km west	Wilton Coking Coal Pty Ltd	Open-cut mine	2015
Proposed gas projects				
Arrow Bowen Pipeline Project	Project footprint	Arrow Energy Pty Ltd	CSG pipeline	Approved
Arrow Bowen Gas Project	90 km west	Arrow Energy Pty Ltd	CSG extraction	Approved
Central Queensland Gas Pipeline	Project footprint	Central Queensland Gas Pipeline Pty Ltd	Gas pipeline	Approved
Santos GLNG Gas Development Project	125 km south west	Santos GLNG	CSG extraction	2016
Proposed transport infrastructure projects				
Surat Basin Rail Project	Wandoan to Banana	Surat Basin Rail Pty Ltd	Railway line	On hold
Central Queensland Integrated Rail Project	260 km north west	Aurizon Holdings Limited	Railway line	Unknown
Proposed water infrastructure projects				
Connors River Dam and Pipeline	200 km upstream	SunWater Ltd	Dam and pipelines	Approved
GFP	70 km downstream	Gladstone Area Water Board	Water pipeline (buried)	Approved
Nathan Dam and Pipelines	200 km upstream	SunWater Ltd	Dam and pipelines	Draft EIS complete

*Approximate distance from nearest weir site



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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

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LEGEND

- Weir Location
- Populated Places
- Railway
- Waterway (Major)
- Highways (National)
- Impoundment Area
- Reef
- Catchment study area
- Bio-subregion study area

Gladstone Area Water Board

Gladstone Area Water Board, SunWater
Lower Fitzroy River Infrastructure Project

Job Number 41-20736
Revision C
Date 23 Sep 2014

Proposed developments

Figure 12-3

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12.3.3 Potential cumulative impacts on MNES

The assessment will discuss the likely cumulative impacts that the Project may have on MNES. This will include the following:

- The World Heritage values and National Heritage values of the Great Barrier Reef
- Habitat for listed threatened, migratory and marine species and ecological communities.

12.3.3.1 World Heritage properties and National Heritage places

The Project is located on the Fitzroy River which flows into the Great Barrier Reef. The Great Barrier Reef 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 Project. As described in Chapter 9 World Heritage properties and National Heritage places, the Project will not significantly impact directly or indirectly on the world or national heritage values of the Great Barrier Reef World Heritage Area (GBRWHA).

Assessment of the extent to which impacts of the Project may contribute to existing pressures on the GBRWHA draws on ecosystem health assessment criteria identified in the Great Barrier Reef Outlook Report (GBRMPA 2014). Existing pressures relevant to the Project were identified and an assessment of the extent to which indirect impacts of the Project may contribute to each of these pressures was undertaken as presented in Table 12-4.

Table 12-4 Cumulative impacts on the Great Barrier Reef

Component^	Existing pressures^	Current condition^*	Additional pressures as a result of the Project and other proposed developments
Physical processes			
Freshwater inflow	Patterns of freshwater flow into 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	Modelling and statistical analysis has shown that with the Fitzroy Basin Resource Operations Plan (Fitzroy ROP) in place there is no significant difference between current modelled freshwater flow regimes and the flow regimes projected with any additional infrastructure associated with the Project in place (Chapter 8 General impacts). In-flow data to the modelling undertaken accounted for the presence of proposed water storage infrastructure, namely the approved Connors River Dam and the proposed Nathan Dam. As such, negligible cumulative impacts on freshwater inflow to the GBRWHA are anticipated.
Sedimentation	Sediment inflow to the GBRWHA has significantly increased since European settlement as a result of soil erosion from land clearing, overgrazing and extensive forest clearing. However, the Great Barrier Reef Outlook Report (GBRMPA 2014) indicates that a reduction in sediment load is expected in the longer term due to improved land management practices.	Poor	Proposed developments within the catchment study area have the potential to increase sedimentation due to erosion associated with land clearing and disturbance. Project construction impacts will be managed through the development and implementation of a construction environmental management plan inclusive of erosion and sediment controls. Given the composition, temporary nature and localised extent of potential impacts during construction and the distance to estuarine and marine waters (more than 80 km) it is not expected that water quality within Keppel Bay or the GBRWHA will be impacted as a result of construction activities. While it is possible that some localised erosion may occur at the weir sites during operation it is considered that the potential contribution to current sediment load entering the GBRWHA is negligible. Erosion protection works downstream of the weirs will reduce the potential for scour and erosion thereby minimising the potential to increase sediment loads. As the Project's potential contribution to sediment load entering the GBRWHA is considered negligible, loss of light in inshore areas from increases in sedimentation is not expected.
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 increased sedimentation primarily affects inshore areas. As indicated above a long term reduction in sediment loads is predicted and this will have a positive impact on light levels as well.	Good	

Component^	Existing pressures^	Current condition^*	Additional pressures as a result of the Project and other proposed developments
Chemical processes			
Nutrient cycling	Within the GBRWHA, both normal and above normal nutrient levels are closely associated with terrestrial runoff. The total nutrient load delivered to the GBRWHA is now greater than before agricultural development; however an overall reduction in average annual dissolved inorganic nitrogen load has been indicated in the period 2009 – 2013 (GBRMPA 2014).	Poor	During initial years, decaying vegetation in the impoundments will contribute nutrients to water within the impoundments (Chapter 8 General impacts). Nutrients may then be conveyed downstream and output to the Fitzroy River estuary, particularly during flood events. Other than decaying vegetation, the Project will not directly contribute nutrients downstream of the Fitzroy River and subsequently the GBRWHA. 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 reduce the potential for the release of poor quality water, through measures such as multi-level offtakes. The Project will not contribute significantly to cumulative impacts on nutrient levels resulting from existing and proposed developments.
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 Project is not expected to cause any measurable change to pH levels downstream of the Project.
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	As described above there is no significant difference between current modelled freshwater flow regimes and the flow regimes projected with any additional infrastructure associated with the Project in place. The Project is not expected to impact salinity levels (Chapter 8 General impacts).

^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

12.3.3.2 Listed threatened, migratory and marine species and ecological communities

One threatened ecological community, Brigalow (*Acacia harpophylla* dominant and co-dominant) (Brigalow TEC), is known to occur within the Project footprint. In addition, three vulnerable species and four migratory species are known to occur within the Project footprint as follows:

- Listed vulnerable species:
  - Squatter pigeon (southern) (*Geophaps scripta scripta*)
  - Black ironbox (*Eucalyptus raveretiana*)
  - Fitzroy River turtle (*Rheodytes leukops*).
- Listed migratory and marine species:
  - Estuarine crocodile (Crocodylus porosus)
  - White-bellied sea-eagle (Haliaeetus leucogaster)
  - Rainbow bee-eater (Haliaeetus leucogaster)
  - Great egret, white egret (Ardea alba).

Table 12-5 provides an assessment of the Project's contribution to cumulative impacts on the Brigalow TEC and the above threatened, migratory and marine species.

Through the assessment it was determined that there is the potential for the Project to contribute to the cumulative impacts on MNES as follows:

- A cumulative loss of Brigalow TEC
- Cumulative impacts on the Fitzroy River turtle as a result of:
  - Cumulative loss/alteration of aquatic habitat within the catchment study area including the loss of turtle nesting habitat and the conversion of riffle-run habitat to impounded habitat
  - Cumulative risk of injury and mortality to aquatic fauna from the operation of water infrastructure within the catchment
  - Cumulative impact on aquatic fauna movement in the catchment.

No significant impacts to downstream marine and estuarine ecosystems are anticipated as a result of the Project .The Project would not result in downstream loss or fragmentation of habitats, increased predation or the introduction or spread of invasive weeds. The Project's contribution to cumulative impacts on downstream threatened, migratory or marine species is considered negligible.

Table 12-5 Project's contribution to cumulative impacts on threatened, migratory and marine species

Environmental value		Potential cumulative impacts	Pressure from current and other planned activities	Project's contribution to cumulative impacts
Threatened ecological communities	Brigalow TEC	Loss of ecological community	Over most of its range the Brigalow TEC has been extensively cleared for cropping and/or pasture and been subject to altered fire regimes and the introduction of exotic plant and animal species (DoE 2014). This community is currently threatened by any activities that further reduce its extent, cause a decline in the condition of the vegetation, or impede its recovery (Butler 2007). Current and planned activities within the Brigalow Belt bioregion including mining, gas and linear infrastructure projects have the potential to impact on this ecological community.	The unavoidable loss of vegetation within the Project footprint includes the loss of Brigalow TEC (Chapter 10 Threatened species and ecological communities). Based on an assessment of publically available information for approved projects identified in Table 12-3*, the Project will contribute to a cumulative loss of Brigalow TEC within the catchment and bio-subregion study area: TEC: Brigalow — Project total: Construction 1.6 ha, Impoundment 18.5 ha — Other projects: 348 ha — Cumulative total: 368 ha It is likely that the total area of Brigalow TEC impacted by impoundment will be substantially less than the estimated 18.5 ha as described in Chapter 10. The Project's contribution to the loss of Brigalow TEC is five per cent and where loss due to impoundment and clearing is unavoidable an offset is proposed (Chapter 14 Offsets). As such the Project's contribution to cumulative impacts on Brigalow TEC is considered to be minor.
Threatened species	Squatter pigeon (southern)	Loss of suitable habitat Injury and mortality Habitat degradation Increased weed and pest species	The main threats to the squatter pigeon are the loss and fragmentation of habitat due to clearing for agricultural purposes, the degradation of habitat due to overgrazing by domesticated herbivores, the degradation of habitat by invasive weeds and predation by numerous avian and terrestrial predators (DoE 2014). The historical decline in squatter pigeon (southern) numbers has slowed and the subspecies remains common north of the Carnarvon Ranges in Central Queensland (DoE 2014).	Impoundment associated with the Project will result in loss of habitat for this species however suitable habitat will persist in large fragments on low rocky hills and uncleared alluvial plains (Chapter 10 Threatened species and ecological communities). This species is common in the region and has the potential to occur in woodland and grassland wherever there is tall grass interspersed with cleared areas. Based on an assessment of publically available information for approved projects identified in Table 12-3*, the squatter pigeon is commonly found within and surrounding project areas within both grassy woodland habitat and cleared or disturbed areas. It is unlikely that small, localised losses of habitat along the largely disturbed riparian fringe will adversely impact the regional viability of this species and as such, the Project's contribution to cumulative impacts is considered negligible.

Environmental value		Potential cumulative impacts	Pressure from current and other planned activities	Project's contribution to cumulative impacts
	Black ironbox	Loss of species and suitable habitat	The main threat to black ironbox is habitat disturbance and smothering by rubber vine. Water infrastructure developments in the past have contributed to loss and degradation of habitat for this species and planned water infrastructure activities and other proposed developments in proximity to or traversing waterways have the potential to further impact this species.	The unavoidable loss of vegetation within the Project footprint includes the loss of up to 100 individual black ironbox plants. Impacts on black iron box are addressed through the provision of offsets (Chapter 14 Offsets). Based on an assessment of publically available information for approved projects identified in Table 12-3*, project's has sought to avoid impacts on black ironbox through planning, design and alignment of infrastructure. Residual impacts of these projects have been assessed as insignificant and therefore the Project the will not contribute to a cumulative impact.
	Fitzroy River turtle	Loss/alteration of aquatic habitat Inundation of turtle nesting habitat Habitat degradation Injury and mortality Restriction of movement	Nest predation (greatest current threat), loss of habitat, alteration of natural flow regime, movement barriers, physical injury and mortality; poor water quality, and trampling by cattle currently threaten the Fitzroy River turtle. The approved Connors River Dam would impact on Fitzroy River turtle habitat at the upper extent of the species range.	In combination with existing infrastructure and the approved Connors River Dam, the Project would contribute to a cumulative loss/alteration of aquatic habitat for the Fitzroy River turtle including the loss of turtle nesting habitat and the conversion of riffle-run habitat to impounded deep water habitat (Appendix L). Currently approximately 36 per cent of the Fitzroy, Dawson and Mackenzie sub-catchments have been impounded as a result of in-stream water infrastructure (Table 12-1). The Project will result in the inundation of an additional 113 km, increasing the area of impacted habitat within the sub-catchment by approximately 10 per cent. In combination with the approved Connors River Dam (5 per cent increase) the total increase in impoundment of Fitzroy River turtle habitat would be approximately 15 per cent. The Project will create an additional barrier for movement of aquatic fauna and will contribute to a cumulative impact on aquatic fauna movement in the catchment. Proposed pipeline projects traversing the Fitzroy and Mackenzie rivers propose to use trenchless techniques at river crossings to avoid significant disturbance to aquatic and riparian habitats. The Project in combination with the approved Connors River Dam will contribute to cumulative impacts on the Fitzroy River turtle. The approved Connors River Dam is not assessed as having a significant residual impact. Project impacts on the Fitzroy River turtle are addressed through the species management program developed for the Project and the provision of offsets (Appendix M and Chapter 14 Offsets).

Environmental value		Potential cumulative impacts	Pressure from current and other planned activities	Project's contribution to cumulative impacts
Migratory and marine species	Estuarine crocodile	Barrier to movement Alteration of habitat	The Fitzroy River represents marginal habitat for the estuarine crocodile, and is at the southern extreme of the species' range in eastern Queensland. Poor nesting success has been identified as the primary factor limiting population growth in the Fitzroy River estuarine crocodile population (Britton 2007). This is as a result of limited suitable nesting habitat, flooding of nest sites and nest predation.	The Project is not considered likely to have a significant impact on the estuarine crocodile. The inundation of vegetated islands and riparian fringes may further reduce nesting habitat resources in the short-term. However, inundation of terrestrial environments is likely to create new islands which are likely to support crocodile nesting when suitable habitat (i.e. vegetation) establishes. The existing Eden Bann Weir impoundment is a highly productive system that supports the most notable estuarine crocodile population in the Fitzroy Basin (Appendix J). Habitat modification as a result of the Project may in fact benefit the species by increasing the availability of permanent, deep water and shelter and foraging resources (Chapter 11 Migratory and marine species). Based on an assessment of publically available information for approved projects identified in Table 12-3*, potential impacts to estuarine crocodile from other projects are negligible. Proposed pipeline projects traversing the Fitzroy and Mackenzie rivers propose to use trenchless techniques at river crossings to avoid significant disturbance to aquatic and riparian habitats. The Project will not contribute to a cumulative impact on the estuarine crocodile.
	White-bellied sea eagle	Loss of habitat	The main threats to the white-bellied sea-eagle are loss of habitat due to land development and the disturbance of nesting pairs by human activity (DoE 2014).	While utilised, the Project footprint is unlikely to constitute critical breeding, foraging, roosting or shelter habitat for the species (Appendix J and Appendix K). Loss of riparian vegetation upstream of the proposed weir sites is considered unlikely to impact on these species (Chapter 11 Migratory and marine species) Based on an assessment of publically available information for approved projects identified in Table 12-3*, projects have sought to avoid impacts on white-bellied sea eagle nests through planning, design and alignment of infrastructure. Residual impacts of these projects have been assessed as insignificant and therefore the Project the will not contribute to a cumulative impact.
	Rainbow bee-eater	Increased pest species	Other than the introduced cane toad (*Bufo marinus*), no actual threats to the rainbow bee-eater have been identified (DoE 2014).	This rainbow bee-eater is a habitat generalist and highly mobile. While utilised, the Project footprint is unlikely to constitute critical breeding, foraging, roosting or shelter habitat for the species (Appendix J and Appendix K). Loss of riparian vegetation upstream of the proposed weir sites is considered unlikely to impact on these species (Chapter 11 Migratory and marine species). Significant impacts on this species from the Project and other proposed projects* in the study area are not anticipated.

Environmental value		Potential cumulative impacts	Pressure from current and other planned activities	Project's contribution to cumulative impacts
	Great egret, white egret	Alteration of flows	The most important issue for the conservation of the great egret in inland regions of Australia is the allocation of water from regulated rivers in sufficient quantity and at appropriate times to maintain suitable wetland conditions (DoE 2014). The Fitzroy Basin catchment is highly regulated and planned water infrastructure activities within the catchment have the potential to contribute to impacts associated with the impoundment and regulated release of water.	The operation of the Project will meet environmental flow objectives in accordance with the Fitzroy ROP. Modelling has shown that with the Fitzroy ROP in place there is no significant difference between current modelled flow regimes and the flow regimes projected with any additional infrastructure associated with the Project in place. Inflow data to the model also accounted for the presence of proposed water storage infrastructure, namely the approved Connors River Dam and Nathan Dam. Significant impacts on this species from the Project and other proposed projects* in the study area are not anticipated (Chapter 8 General impacts).

* Codrilla Coal Mine Project, Minyango Project, Springsure Creek Coal Project, Arrow Bowen Pipeline Project, Arrow Bowen Gas Project, Central Queensland Gas Pipeline and the GFP Project

12.4 Consequential impacts

12.4.1 Overview

Consequential impacts arise where a project may create a requirement for additional development or additional development may be facilitated to a significant extent by a project. The Project forms part of a broader commitment by the Queensland Government to the National Water Initiative Agreement (2004). In December 2004, the Queensland Government committed to developing the Central Queensland Regional Water Supply Strategy (CQRWSS) (Chapter 1 Description of the action), a long term water supply strategy for the region to address the following key issues:

- Continued urban growth and industrial development, particularly in the Lower Fitzroy and Gladstone areas, and mining development in the Bowen and Surat coal basins
- Entitlements in some existing regional water supply systems are at or approaching full usage
- Some existing water supply schemes are performing below water user requirements
- Water demand projections indicate regional supply shortfalls exist to meet urban, industrial, coal mining and agricultural requirements through to 2020.

The Project is integrally linked to the existing Fitzroy Barrage and the approved GFP Project (Chapter 1 Description of the action) to meet the current and immediate demands for water within the region. The GFP Project pipeline will transport water from an extraction point within the Fitzroy Barrage impoundment to Gladstone, connecting with existing water infrastructure in the Gladstone State Development Area (GAWB 2008). Two other related projects include the approved Connors River Dam and Pipeline Project and the proposed Nathan Dam and Pipeline Project which are subject to separate assessment and approval. Neither the approved Connors River Dam and Pipeline Project nor the proposed Nathan Dam and Pipeline Project, or the projects identified in Section 12.3.2 (excluding the GFP Project) are reliant upon the development of the Project and as such do not represent a consequential impact. The GFP Project has undergone separate environmental assessment. The EIS for the GFP Project was approved by the Queensland Coordinator-General in February 2010 and by the Commonwealth Minister for Environment in November 2011.

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; a nominal volume of 76,000 ML (for supplemented allocations).

The 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 Project is included. 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:

- Gladstone Area Water Board: 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).

The following assessment is based on an estimate of potential development which could be influenced or facilitated through the development of the Project. In the absence of specific proposals for development a high level assessment is provided indicating reasonable assumptions in regard to the scale and class of development.

12.4.2 Potential consequential developments within the region

12.4.2.1 Industrial development

Industrial development within the Gladstone and Rockhampton areas is predicted and planned for through local and regional statutory planning documents and include the Gladstone State Development Area and the Gracemere-Stanwell Industrial Corridor. The Gladstone State Development Area (SDA) comprises some 29,000 ha of land set aside for the development of major industries. Land uses considered suitable for the Gladstone SDA include (Department of State Development, 2015):

- Large-scale, large-footprint industrial development
- Industrial development requiring access to strategic port logistics and maritime facilities
- Port-related activities and industries necessary to support major industrial development
- Liquefied natural gas processing, storage and export facilities
- Materials transportation infrastructure and utility and service infrastructure
- Gas transportation infrastructure and other compatible infrastructure.

A number of the existing and future major industries within the Gladstone SDA require large volumes of secure water. As stated in the Fitzroy ROP, up to 30,000 ML of the strategic water infrastructure reserve is available to GAWB (on application) to supply development within the Gladstone SDA. Development within the Gladstone SDA is subject to assessment of potential impacts through State and Commonwealth legislation through implementation of the Gladstone SDA Planning Scheme and State Planning Policies as well as the provisions of the EPBC Act where matters of national environmental significance may be impacted.

Development within the Gladstone SDA has been planned for several decades and is dependent upon a number of factors including water supply.

The Gracemere-Stanwell Industrial Corridor represents the major area of proposed future industrial development within the Fitzroy region. The area encompasses approximately 940 ha. This area has been identified within the Fitzroy Shire Planning Scheme 2005 for industrial development subject to relevant planning provisions and other State and Commonwealth approval requirements. The Rockhampton Regional Council Industrial Land use Study identified the demand for future industrial land to the year 2031 as being 180 ha (GHD 2010). One of the restrictions to future growth within the industrial corridor is water supply; as such the Project has the potential to facilitate development should supply be connected.

It is anticipated that part of the 42,000 ML strategic water infrastructure reserve would be utilised to provide supply to development within the industrial corridor.

12.4.2.2 Residential development

The Central Queensland Regional Plan (DSDIP 2013a) predicts that demand for water is expected to increase in the Central Queensland region due to several factors including ongoing population growth, in particular within the key regional centres of Gladstone and Rockhampton (Appendix R).

Overall, the region has shown sustained population growth over five years to 2012 (7 per cent growth). The majority of this growth has occurred in the Gladstone area due to the growth of industry and employment opportunities there (largely associated with mining and natural gas resources). The region's population is projected to grow from 223,000 to 345,000 by 2031, representing an average annual growth rate of 2.1 per cent over the 20 year period compared with 1.8 per cent for Queensland. Urban water supply to support residential development within the Gladstone region would be supplied via the GFP project and part of the 30,000 ML reserve identified in the Fitzroy ROP for GAWB.

Rockhampton City has experienced gradual increases in residential population from 2006 to 2011. It is evident that growth is occurring inside Rockhampton City as well as outside the city in areas that still have a strong reliance on Rockhampton City for goods and services and as a base for the region (RRC 2012). Population growth is expected to be driven predominately by mining and associated industry and development. The projected population for Rockhampton City is also expected to increase. As a base for the region, the increased population will generally be people residing in Rockhampton but working elsewhere in the region.

As described in Chapter 1, one of the drivers for the Project is to increase water security for RCC which would support urban growth within the City and region. As such the Project is considered to contribute to this growth, although it is difficult to quantify the extent of this contribution. It is also clear that the development within these regions is likely to occur without development of the Project as alternate sources of water and demand management strategies could be utilised to support urban development. It is anticipated that either the nominal reserve of up to 4,000 ML or part of the 42,000 ML reserve could be utilised by local governments to provide supply to urban residential development within Rockhampton and the wider Capricorn Coast region.

12.4.2.3 Agricultural development

Agricultural development has been identified as a priority for the Fitzroy region (RDA, 2014). Previous studies, including the Fitzroy Industry Infrastructure Study (FIIS) (GHD 2006) and Queensland Agricultural Land Audit (QALA) (DAFF 2013), have identified areas of suitable land for irrigated agricultural development which could be facilitated through the provision of water supply. The areas are defined based on direct access to water from the proposed Project storages or via 'run of river' methods. The studies showed that the Lower Fitzroy Region is suitable for intensive livestock production and some horticultural activities (Department of Infrastructure, 2007). As part of the FIIS a Fitzroy Agricultural Development Area Land Suitability Study was conducted (GHD 2006). This study assessed the suitability of land west of Rockhampton for the establishment of an Agricultural Development Area to support primary industry, specifically intensive animal husbandry activities. The Commonwealth Government's White Paper on Developing Northern Australia (the Northern Australia White Paper) states that the Queensland Government supports working with proponents in respect of agricultural development, including the proposed agricultural precinct west of Rockhampton (Australian Government 2015) and that the that the Project 'facilitates the allocation of water entitlements and implements management strategies to ensure equitable sharing of the resource amongst water users including the environment'. The Agricultural Competitiveness White Paper (Commonwealth of Australia 2015) identifies the Project as 'having a strong potential for Commonwealth involvement'.

The study area defined in the FIIS report encompasses the Eden Bann Weir and Rookwood Weir inundation areas and has therefore been able to be utilised for the consequential assessment. The study identified nine areas of potential agricultural development, totalling approximately 31,000 ha of unconstrained land and a further 16,000 ha of moderately constrained land. The areas identified in the Land Suitability Study (GHD, 2006) are generally consistent in location and constraint level compared to the potential agricultural areas defined in the QALA. Where the agricultural potential was mapped by combining biophysical and socio-economic spatial data with characteristics that best match the requirements of each Agricultural Land Use Category (DAF 2015).

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. The Department of Agriculture and Fisheries (DAF) has identified a potential long term scenario for full 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.

It is anticipated that part of the 42,000 ML reserve would 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 potentially available water volumes, the economic value of development and projected growth, the following development scenario has been considered to represent the contribution the Project could have to overall agricultural development within the region:

- Two 10,000 standard cattle unit feedlots and 2,000 ha for irrigated green fodder/silage crops for use in the feedlots
- 735 ha of irrigated broad acre crops (mix of cereals, legumes and other crops that are commonly grown in Central Queensland)
- 315 ha of irrigated horticultural crops (vegetable crops, tree crops (citrus; lychee; mango)).

It is estimated that in the order of 20,000 ML of water would be required to support agricultural development associated with this scenario. It is expected that this reserve could be allocated from the 42,000 ML strategic water infrastructure reserve as part of the Project.

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). The potential consequential development attributable to the Project would therefore represent an increase of approximately 15 per cent in the number of animals.

Existing irrigated cropping within the Fitzroy WRP area is estimated to be approximately 66,000 ha (DERM 2009). The potential consequential development attributable to the Project would therefore represent a minor increase in cropping of less than five per cent.

12.4.3 Potential consequential impacts on MNES

The assessment will discuss the likely consequential impacts that facilitating industrial development, residential development and agricultural development may have on MNES. This will include the following:

- The World Heritage values and National Heritage values of the GBRWHA
- Habitat for listed threatened, migratory and marine species and ecological communities.

12.4.3.1 World Heritage Properties and National Heritage Places

The Project is located on the Fitzroy River which flows into the Great Barrier Reef. The Great Barrier Reef 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.

Assessment of the extent to which consequential impacts may contribute to existing pressures on the GBRWHA draws on ecosystem health criteria identified in the Great Barrier Reef Outlook Report (GBRMPA 2014). Existing pressures relevant to consequential development were identified and an assessment of the extent to which consequential impacts of the Project may contribute to each of these pressures was undertaken as presented in Table 12-6.

Industrial and residential development

According to the Reef 2050 Long-Term Sustainability Plan (Commonwealth of Australia 2015), one immediate, system-wide pressure facing the GBRWHA is land-based run-off including sediments; pesticides; and debris which has a negative impact to marine water quality particularly within the inshore areas. Increased industrial and residential development has the potential to contribute to this pressure through increased stormwater run-off.

Industrial development is highly regulated through the local, State and Commonwealth environmental legislation, which provides for the assessment and management of specific activities. Local and State development assessments and approvals seek to minimise potential offsite environmental effects (as defined in the *Environmental Protection Act 1994*). This can be achieved by ensuring that proposals for individual developments have, as their underlying structure, the principles of best practice environmental management. When managed correctly, environmental impacts can be kept within the accepted State and National environmental parameters for water, air, waste and noise.

Urban residential development required to accommodate population growth has the potential to increase pressures on MNES. Nonetheless, population growth and the associated land use pressure is from a relatively small base compared to land area (a significant increase in population in Rockhampton is unlikely to require a major new footprint) and the development will be subject to significant regulation. Small scale project development (including residential development) will require assessment and approval under the *Sustainable Planning Act 2009* (Qld) (amongst others) and in accordance with State planning policies and other relevant legislation. Where potential impacts to MNES are considered likely, assessment under the EPBC Act would be required.

The potential for impacts arising from stormwater runoff from future industrial and residential development areas impacting upon the GBRWHA is considered to be negligible having regard to the stormwater management measures that are required through existing local and State planning controls for any future development. These measures are likely to effectively control run-off volumes and quality and limit any potential impact. Also potential impacts from treated sewage discharge is considered likely to be negligible, with trade waste controls of local governments and sewage treated to a tertiary standard under the control of an environmental authority as issued for an environmentally relevant activity (ERA) administered by the Queensland Government. Sewage discharge from residential areas is estimated to contribute less than four per cent of the total nitrogen load and less than one per cent of the total phosphorous load annually discharged to the GBRWHA (DSDIP 2013b).The Great Barrier Reef Coastal Zone Strategic Assessment (DSDIP 2013b) states that ‘while the urban development required to

accommodate population growth in the Great Barrier Reef coastal zone will increase pressures on MNES, it will generally be localised and of marginal significance relative to other pressures'.

Agricultural development

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, as well as adoption of management practices through the implementation of actions identified in the Reef 2050 Long Term Development Plan (Commonwealth of Australia 2015) and specific programs such as the Reef Water Quality Protection Plan (State of Queensland 2013).

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). However the latest 2014 Outlook Report (GBRMPA 2014) concludes that threats to the GBRWHA such as nutrients, sediment and pesticide loads are beginning to be addressed through improved land management practices and voluntary behavioural changes promoted by local and regional stewardship programs (for example the Fitzroy Basin Association's 'Sustainable agriculture through innovative practices in the Fitzroy' and 'Fitzroy water quality project' funded through the Queensland Regional Natural Resource Management Investment Program).

Intensive animal husbandry

Potential impacts to MNES associated with intensive animal husbandry (feedlots) include:

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

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).

Runoff, leaching or seepage from the feedlot yards, ponds or waste utilisation areas has the potential to contaminate surface water; however cattle feedlots are not generally washed down 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. 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.

Irrigated broad-acre cropping and intensive horticulture

Existing irrigated agriculture in the Fitzroy Basin mainly occurs in the Emerald and Theodore areas. Other smaller areas occur along all major rivers and streams where there are weirs or water harvesting in place (GBRMPA, 2013). An expansion of the area of irrigated agriculture due to the supply of irrigation water from the Project has the potential to cause a number of environmental impacts relevant to MNES:

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

These impacts all have the potential to place additional pressure on water quality in the GBRWHA (GBRMPA 2013). Unsustainable land management practices could lead to increased levels of suspended solids, nutrients and agrochemicals being exported to Keppel Bay and the GBRWHA. Pesticides can cause damage to marine organisms including inhibiting the growth of corals, aquatic plants, algae and seagrasses.

Land clearing and wheel tracks associated with cropping can lead to erosion, thus causing water quality impacts through sedimentation (GBRMPA, 2013). Land clearing can also lead to salinisation of groundwater. Groundwater quality within the Fitzroy River sub-catchment is slightly to moderately saline and therefore the risk of land clearing causing salinisation is reduced (Chapter 8 General impacts).

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. Recent Outlook Report results (GBRMPA 2014) indicate an overall trend of an increasing number of farms adopting improved land management practices with a resultant improvement in water quality of the GBRWHA.

In recent years an increased recognition of the need for sustainable management of natural resources has been implemented by Horticulture Australia in collaboration with the Commonwealth Department of Agriculture, Fisheries and Forestry.

Irrigated agriculture and intensive horticulture will also be subject to the expected increased pressure for adoption of management practices under the actions of the Reef Water Quality Protection Plan (State of Queensland, 2013).

Table 12-6 Potential consequential impacts on the Great Barrier Reef

Component^	Existing pressures^	Current condition^*	Potential impacts from consequential industrial, residential and agricultural development
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 altered freshwater flows has been assessed for the Project in Chapter 8 General impacts. *As the potential consequential development is utilising the water take assessed for the Project no additional consequential impact associated with freshwater flows is expected to occur.*
Sedimentation	The area of the Great Barrier Reef (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	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. *Having regard to the scale of development and the environmental permitting requirements for urban development it is considered that the Project is unlikely to have a significant consequential impact on the GBR.*
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	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. Areas of remnant vegetation were included as a high level constraint when defining the study area and are therefore not included within the potential development areas, thus any clearing impacts are likely to be on areas that are currently sparsely vegetated. The potential development area of irrigated broad-acre cropping and horticulture attributable to the Project represents a less than five per cent increase in this land use for the region. Furthermore, at the same time 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 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 consequential industrial, residential and agricultural development
Chemical processes			
Nutrient cycling	Within the GBRWHA, both normal and 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	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. Very limited pesticides will be used as a result of residential development. *Having regard to the scale of development and the environmental permitting requirements for urban development it is considered that the Project is unlikely to have a significant consequential impact on the GBR.* 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 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 for sugar cane and grazing. The Reef 2050 Long-Term Sustainability Plan (Commonwealth of Australia 2015) together with the Reef Water Quality Protection Plan 2013 (The State of Queensland 2013) 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. *Having regard to the scale of potential agricultural development, 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 GBR.*

Component^	Existing pressures^	Current condition^*	Potential impacts from consequential industrial, residential and agricultural development
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 ocean acidity identified for the GBRWHA is climate change. The development of small scale urban residential and industrial activities along with potential agricultural development is not expected to contribute to climate change in a measureable way. *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 which could contribute to changes in ocean salinity has been assessed for the Project in Volume 2 Chapter 8 General impacts. *As the potential consequential development is not expected to alter flood regimes 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.

12.4.3.2 Listed threatened, migratory and marine species and ecological communities

One threatened ecological community, Brigalow TEC, is known to occur within the Project footprint. In addition, three vulnerable species and four migratory species are known to occur within the Project footprint as follows:

- Listed vulnerable species:
  - Squatter pigeon (southern)
  - Black ironbox
  - Fitzroy River turtle.
- Listed migratory and marine species:
  - Estuarine crocodile
  - White-bellied sea-eagle
  - Rainbow bee-eater
  - Great egret, white egret.

Table 12-7 provides an assessment of the consequential impacts as a result of the Project on the Brigalow TEC and the above threatened, migratory and marine species.

Industrial development

Industrial and residential development can lead to habitat loss or modification of natural processes which can lead to loss or damage of MNES. This is due to potential for clearing and changing habitat connectivity. Industrial and residential developments are considered intensive developments however the impacts may not be significant, in the context of development occurring on already cleared or previously impacted lands and the planning measures in place to manage development outcomes.

Development areas within the Gracemere-Stanwell Industrial Area are largely comprised of existing cleared land. Studies to identify potential development areas included selection criteria based on the presence of protected vegetation and avoided these areas (GHD 2007).

Residential development

The Central Queensland Regional Plan (DSDIP 2013a) identifies Priority Living Areas for coastal areas including Yeppoon, Benaraby, Boyne Island and Tannum Sands. The remainder of Priority Living Areas are located in inland areas. These areas are generally an expansion of existing urban footprints.

Agricultural development

Agricultural development has the potential to result in clearing of vegetation and impacts to habitat. However the constraints analysis undertaken for the FIIS study (DIP 2007) included identification of protected vegetation and avoidance of these areas where designated future development areas.

Table 12-7 Potential consequential impacts on threatened, migratory and marine species and ecological communities

Environmental value		Potential impact	Pressure from current activities	Potential consequential agricultural development impacts
Threatened ecological communities	Brigalow TEC	Loss of ecological community	Over most of its range the Brigalow TEC has been extensively cleared for cropping and/or pasture and been subject to altered fire regimes and the introduction of exotic plant and animal species (DoE 2014). This community is currently threatened by any activities that further reduce its extent, cause a decline in the condition of the vegetation, or impede its recovery (Butler 2007).	It is highly unlikely that industrial and residential development would be located in areas that require clearing of the Brigalow TEC. Developments would require separate Commonwealth and State approvals and Where potential impacts to MNES are considered likely, assessment under the EPBC Act would be required. *The study area defined for Potential Agricultural Development excluded areas of threatened ecological communities. Therefore there is no significant consequential impact from potential agricultural development in the study area.*
Threatened species	Squatter pigeon (southern)	Loss of suitable habitat Injury and mortality Habitat degradation Increased weed and pest species	The main threats to the squatter pigeon are the loss and fragmentation of habitat due to clearing for agricultural purposes, the degradation of habitat due to overgrazing by domesticated herbivores, the degradation of habitat by invasive weeds and predation by numerous avian and terrestrial predators (DoE 2014). The historical decline in squatter pigeon (southern) numbers has slowed and the subspecies remains common north of the Carnarvon Ranges in Central Queensland (DoE 2014).	This species is common in the region and has the potential to occur in woodland and grassland wherever there is tall grass interspersed with cleared areas. Therefore clearing associated with agricultural development could result in loss of or degradation of suitable squatter pigeon habitat. Operation of agricultural activities has the potential to cause injury and mortality to the squatter pigeon. While considered threatened at the State and Commonwealth level, squatter pigeons (southern) appear to be relatively common within the wider study area based on survey findings (Chapter 10). Squatter pigeon (southern) present within the study area are not known to form part of an important population of the sub-species; there are three important sub-populations that have been defined (DoE 2014) and these lie outside of the study area. Whilst small numbers of individuals may be temporarily or permanently displaced due to potential agricultural development, this is unlikely to lead to a long-term decrease in the broader population. It is not considered that the study area represents habitat critical to the survival of the species. *Consequential development attributable to the Project is not expected to contribute to a significant impact on the squatter pigeon.*

Environmental value		Potential impact	Pressure from current activities	Potential consequential agricultural development impacts
	Black ironbox	Loss of species and suitable habitat	The main threat to black ironbox is habitat disturbance and smothering by rubber vine.	Black ironbox is found along rivers and creeks which are avoided in the study area, the Gladstone SDA and potential residential areas. A number of populations occur in areas of remnant vegetation (RE 11.3.25a) and are therefore also excluded from the study area and protected under the *Vegetation Management Act 1999*. *Consequential development attributable to the Project is not expected to contribute to a significant impact on the black ironbox.*
	Fitzroy River turtle	Loss/alteration of aquatic habitat Inundation of turtle nesting habitat Habitat degradation Injury and mortality Restriction of movement	Nest predation (greatest current threat), loss of habitat, alteration of natural flow regime, movement barriers, physical injury and mortality; poor water quality, and trampling by cattle currently threaten the Fitzroy River turtle.	Proposed industrial and residential developments are not located within Fitzroy River turtle habitat areas. Potential agricultural development is unlikely to cause a loss/alteration of aquatic habitat, inundation of turtle nesting habitat, habitat degradation or restriction of movement. Agricultural development areas identified in the FIIS were limited to an exclusion buffer of 100 m from any watercourse. Intensive animal husbandry is generally required through permitting to maintain buffer areas to watercourses. There is the potential for minor degradation impacts at the location where water supply is accessed from the Fitzroy River. *Consequential development attributable to the Project is not expected to contribute to a significant impact on the Fitzroy river turtle*.
Migratory and marine species	Estuarine crocodile	Barrier to movement Alteration of habitat	The Fitzroy River represents marginal habitat for the estuarine crocodile, and is at the southern extreme of the species' range in eastern Queensland. Poor nesting success has been identified as the primary factor limiting population growth in the Fitzroy River estuarine crocodile population (Britton 2007). This is as a result of limited suitable nesting habitat, flooding of nest sites and nest predation.	Potential consequential development will not create a barrier to movement for the estuarine crocodile within the Fitzroy River or alter aquatic and riparian habitats which are located adjacent to the river. *Consequential development attributable to the Project is not expected to contribute to a significant impact on the estuarine crocodile*.

Environmental value		Potential impact	Pressure from current activities	Potential consequential agricultural development impacts
	White-bellied sea eagle	Loss of habitat	The main threats to the white-bellied sea-eagle are loss of habitat due to land development and the disturbance of nesting pairs by human activity (DoE 2014).	Industrial and residential developments have the potential to disturb the white-bellied sea-eagle habitat. However the developments would require separate Commonwealth and State approvals and where potential impacts to MNES are considered likely, assessment under the EPBC Act would be required. The potential agricultural development areas identified are not within regional ecosystems and therefore white-bellied sea-eagle habitat within the study area should be minimal. *Consequential development attributable to the Project is not expected to contribute to a significant impact on the white-bellied sea eagle.*
	Rainbow bee-eater	Increased pest species	Other than the introduced cane toad, no actual threats to the rainbow bee-eater have been identified (DoE 2014).	This rainbow bee-eater is a habitat generalist and highly mobile. *Consequential development attributable to the Project not expected to contribute to a significant impact on the rainbow bee-eater.*
	Great egret, white egret	Alteration of flows	The most important issue for the conservation of the great egret in inland regions of Australia is the allocation of water from regulated rivers in sufficient quantity and at appropriate times to maintain suitable wetland conditions (DoE 2014). The Fitzroy Basin catchment is highly regulated and planned water infrastructure activities within the catchment have the potential to contribute to impacts associated with the impoundment and regulated release of water.	The operation of the Project will meet environmental flow objectives in accordance with the Fitzroy ROP. Modelling has shown that with the Fitzroy ROP in place there is no significant difference between current modelled flow regimes and the flow regime projected with additional water take from consequential development. *Consequential development attributable to the Project is not expected to contribute to a significant impact on the great egret.*

12.5 Summary

A cumulative impact assessment has been undertaken to identify the potential cumulative impacts upon MNES as a result of constructing and operating the Project in conjunction with other proposed projects within relevant study areas. Consequential impacts attributable to the Project development have been identified and assessed in relation to potential impacts on MNES.

Current pressures on the Fitzroy Basin catchment include land degradation, habitat disturbance and alteration and impacts to water quality resulting primarily from agricultural and mining activities. Similarly, threatening processes identified within the Brigalow belt bioregion include vegetation clearing, linear infrastructure development, urban development, mining, grazing, altered water flows, impoundments and reduced water quality.

The assessment of the Project's contribution to cumulative impacts takes into consideration the relative size, scale, proximity and nature of activities. Due to the localised and short term nature of the Project's construction impacts and the lack of other proposed projects within the vicinity of the Project footprint, the Project's contribution to cumulative impacts will mostly occur during the operational phase or as a result of impoundment. Through the assessment, it was determined that there is the potential for the Project to contribute to the cumulative impacts on MNES as follows:

- Minor contribution (approximately five per cent) to a cumulative loss of Brigalow TEC in the local area which has been minimised through mitigation and management measures and will be offset
- Cumulative impacts on the Fitzroy River turtle as a result of:
  - Cumulative loss/alteration of aquatic habitat within the catchment study area including the loss of turtle nesting habitat and the conversion of riffle-run habitat to impounded habitat (15 per cent increase in impounded habitat in combination with the approved Connors River Dam)
  - Cumulative risk of injury and mortality to aquatic fauna from the operation of water infrastructure within the catchment
  - Cumulative impact on aquatic fauna movement in the catchment.

In order to minimise its contribution to cumulative impacts, the Project has sought to avoid, mitigate, manage and, where necessary, offset the impacts associated with Project activities.

Consequential development potentially occurring as a result of the Project development relate to industrial and urban residential development within designated urban development areas and a relatively small increase in agricultural development within the region. Growth within the region will occur within the State and local government planning frameworks namely the Central Queensland Regional Plan and the local planning schemes of the Rockhampton Regional Council, Livingstone Shire Council, Central Highlands Regional Council and Woorabinda Shire Council. Each of these planning documents includes planning controls for urban (industrial and residential) and some types of intensive rural (agricultural) development within the overall context of sustainable development under the *Sustainable Planning Act 2009* (Qld). Environmental approvals will also be required under the *Environment Protection Act 1994* (Qld) (EP Act) for intensive agricultural activities such as feedlots. Where potential impacts to MNES are considered likely, assessment under the EPBC Act would be required. Larger scale development; such as intensive agriculture and/or major industrial development would be expected to trigger the

requirement for referral under the EPBC Act (where MNES had the potential to be affected) in addition to local and State approval requirements.

The Coastal Zone Strategic Assessment Program Report (DSDIP, 2014) contains components, including the SP Act, that provide a strong framework for ensuring that the planning for and development of urban areas and activities do not have a significant impact on MNES and other important natural values and resources.

Agricultural development within the GBRWHA catchment is becoming better managed as a result of direct regulation (permitting) as well as adoption of management practices through the implementation of actions identified in the Reef 2050 Long Term Development Plan and specific programs such as the Reef Water Quality Protection Plan.

The assessment of the Project's potential to facilitate consequential impacts takes into consideration: the nature of activities; the likelihood of occurrence without the Project proceeding; and the assessment and approval processes which control future development. Through the assessment, it was determined that there is the limited potential for the Project to facilitate consequential development that is not accommodated through existing planning and development schemes and could proceed through alternate means of water supply.

With the implementation of 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 relevant MNES.