6. Methodology for the assessment of impacts on matters of national environmental significance

Table of contents

6. Methodology for the assessment of impacts on matters of national environmental significance i
6.1 Overview 6-1
6.2 Migratory species, threatened species and ecological communities 6-1
6.2.1 Overview 6-1
6.2.2 Identification of relevant species and ecological communities 6-1
6.2.2.1 Overview 6-1
6.2.2.2 Desktop assessment 6-2
6.2.2.3 Nomenclature 6-4
6.2.3 Field surveys 6-4
6.2.3.1 Overview 6-4
6.2.3.2 Flora survey 6-5
6.2.3.3 Aquatic habitat and fauna surveys 6-8
6.2.3.4 Terrestrial habitat and fauna surveys 6-17
6.2.4 Future studies and surveys 6-28
6.2.5 Likelihood of occurrence determination 6-28
6.2.6 Impact assessment methodology 6-30
6.2.6.1 Significant impact guidelines 6-30
6.3 Surface water flows and water quality 6-31
6.3.1 Overview 6-31
6.3.2 Stream flow hydrology 6-32
6.3.3 Integrated Quantity Quality Model 6-33
6.3.4 Water quality data analysis 6-34
6.3.4.1 Desktop assessment 6-34
6.3.4.2 Data analysis 6-35
6.3.4.3 Potential nutrient loads 6-36
6.4 Social impact assessment 6-37
6.5 Cumulative and consequential impacts 6-38

Table index

Table 6-1 Summary of survey effort 6-8
Table 6-2 Summary of literature reviewed and field survey effort for aquatic fauna and macrophytes 6-14
Table 6-3 Survey effort, techniques and locations – Eden Bann Weir Project footprint 6-20
Table 6-4 Survey effort, techniques and locations – Rookwood Weir Project footprint 6-21

Table 6-5 Summary of nest survey effort....6-22
Table 6-6 Terrestrial fauna survey sites within the Eden Bann Weir Project footprint....6-24
Table 6-7 Terrestrial fauna survey sites within the Rookwood Weir Project footprint....6-25
Table 6-8 Key to likelihood of occurrence – flora....6-29
Table 6-9 Key to likelihood of occurrence – fauna....6-30
Table 6-10 Summary of water quality datasets....6-34

Figure index

Figure 6-1 EPBC Act Protected Matters Search Tool search extent.... 6-3
Figure 6-2 Eden Bann Weir flora field survey sites.... 6-6
Figure 6-3 Rookwood Weir flora field survey sites.... 6-7
Figure 6-4 Eden Bann Weir aquatic fauna survey sites....6-11
Figure 6-5 Rookwood Weir aquatic fauna survey sites....6-12
Figure 6-6 Eden Bann Weir terrestrial fauna survey sites....6-18
Figure 6-7 Rookwood Weir terrestrial fauna survey sites....6-19
Figure 6-8 Catchment study area....6-40
Figure 6-9 Bio-subregion study area....6-41

6.1 Overview

This chapter describes methods used in the assessment of impacts on matters of national environmental significance (MNES) for the Lower Fitzroy River Infrastructure Project (Project). This includes a description of desktop assessments, field surveys and the impact assessment methodology. The information provided in the chapter addresses the requirements of Part C of the terms of reference (ToR) for the environmental impact statement (EIS) in relation to information sources and technical data.

6.2 Migratory species, threatened species and ecological communities

6.2.1 Overview

A description of the existing environmental values of the Project area was achieved using a combination of desktop assessments and field studies. The desktop assessment comprised a review of relevant literature, database searches and existing technical reports. Field studies were conducted to obtain ecological information relevant to the Project and to ground truth results from desktop assessments. For conservation significant flora and fauna species and ecological communities, a likelihood of occurrence assessment was undertaken to focus assessment on those taxa that are known or likely to occur within the Project footprint. The significance of residual impacts, post-mitigation, was evaluated with consideration to the significance criteria provided in the Matters of National Environmental Significance - Significant impact guidelines 1.1.

6.2.2 Identification of relevant species and ecological communities

6.2.2.1 Overview

Listed threatened species and ecological communities are declared under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) and include the following categories:

- Species that are extinct in the wild
- Species that are critically endangered
- Species that are endangered
- Species that are vulnerable
- Ecological communities that are critically endangered
- Ecological communities that are endangered.

Migratory species listed under the EPBC Act include species listed under the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), the China-Australia Migratory Bird Agreement and the Japan-Australia Migratory Bird Agreement.

The potential for migratory species, listed threatened species and ecological communities to occur within or adjacent to the proposed Project footprint was determined based on desktop searches and review of previous studies and reports as described in Section 6.2.2.2.

6.2.2.2 Desktop assessment

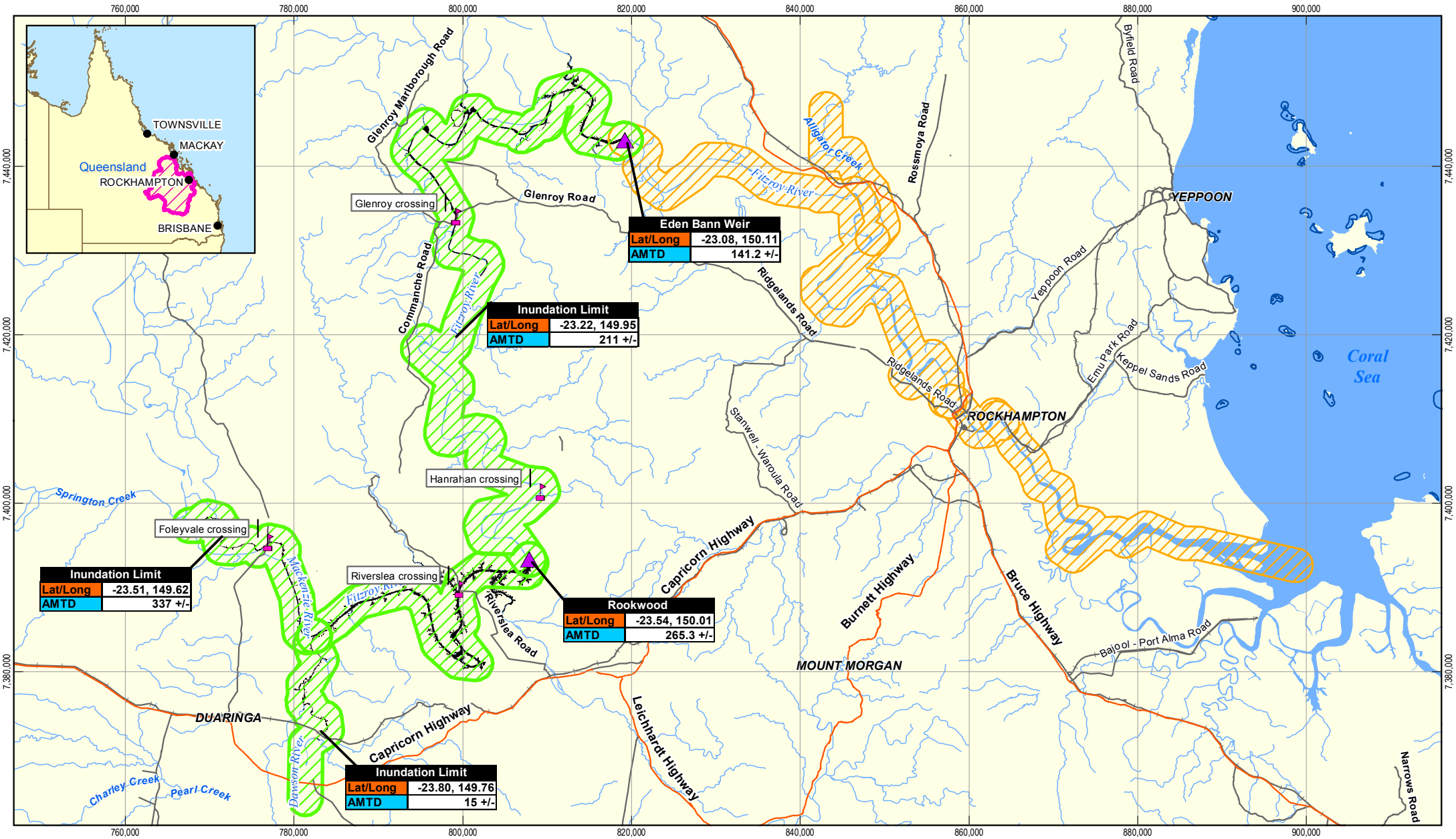
The desktop assessment undertaken to identify MNES and associated threatening processes included a review of the following:

- EPBC Act Environmental Reporting Tool (2009) and Protected Matters Search Tool (2013): The search area was defined by a 2 km buffer following watercourses upstream and downstream from Eden Bann Weir and Rookwood Weir. Five searches were conducted to cover the direct impact area upstream of Eden Bann Weir and Rookwood Weir as shown in Figure 6-1. These searches included:
  - The Eden Bann Weir impoundment
  - Upstream of the Eden Bann Weir impoundment to the proposed Rookwood Weir site
  - The proposed Rookwood Weir site to the junction of the Dawson and Mackenzie rivers
  - The section of the Mackenzie River to be impounded
  - The section of the Dawson River to be impounded.

  Three searches were conducted to cover the indirect impact area downstream of Eden Bann Weir. These searches included Eden Bann Weir to the Fitzroy Barrage, Alligator Creek and the Fitzroy River Estuary downstream of the Fitzroy Barrage (Figure 6-1). The search results are provided in Appendix U.
- The former Environmental Protection Agency WildNet database for conservation significant flora records in the shires of Duaringa, Fitzroy and Livingstone (informed flora assessment undertaken by Nangura Environmental Services 2007 (Section 6.2.3.2))
- The Queensland Government Wildlife Online database search 2008 and 2013. The search area was defined by search rectangles encompassing a 2 km buffer following watercourses upstream of Eden Bann Weir and Rookwood Weir to the maximum proposed impoundment extent and approximately 20 km downstream of Eden Bann Weir
- The Queensland Department of Natural Resources and Mines (DNRM) Regional Ecosystem (RE) (Version 6.1, 2011), Regrowth Vegetation (Version 2.1, 2011) and Essential Habitat (Version 3.1, 2009) mapping databases
- Queensland Museum's Specimen Database. Search rectangles encompassing the area around Eden Bann Weir and Rookwood Weir Project footprint were queried
- The Queensland Herbarium HERBRECS database
- Threatened species profiles and field guides
- Directory of Important Wetlands database
- Birds Australia Atlas database (BirdLife Australia 2005-2007)
- Back on Track Actions for Biodiversity document for the Fitzroy Natural Resource Management region (DERM 2008)
- Commonwealth recovery plans and threat abatement plans.

Previous studies and reports conducted for the Project were also reviewed, details of these reports are provided in:

- Appendix J Eden Bann Weir baseline aquatic fauna report
- Appendix K Rookwood Weir baseline aquatic fauna report



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

N

LEGEND

- Weir Location
- River Crossing
- Highway
- Major Road
- Waterway
- Impoundment Area
- Fitzroy Basin
- Protected Matters Direct Search
- Protected Matters Indirect Search

Gladstone Area Water Board, SunWater
Lower Fitzroy River Infrastructure Project

Job Number 41-20736
Revision G
Date 17 Feb 2014

EPBC Act Protected Matters Search Tool search extent

Figure 6-1

G:\41\20736\GIS\Projects\MXD\200_Report\4120736_204_Rev_G.mxd

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

- Appendix N Eden Bann Weir baseline terrestrial fauna report
- Appendix O Rookwood Weir baseline terrestrial fauna report.

Scientific and grey literature on flora and fauna species likely to occur and / or previously recorded in the study area was also reviewed.

6.2.2.3 Nomenclature

Nomenclature for flora species followed Henderson (2002) with the *Eucalyptus* / *Corymbia* group following Commonwealth Scientific and Industrial Research Organisation (2006). Plant identification was assisted by the Queensland Herbarium identification service and through general Queensland flora texts and other local area plant books, local botanists and local plant enthusiasts (Nangura 2007).

Scientific names for aquatic species are consistent with those used in the following sources:

- A Field Guide to the Freshwater Fishes of Australia (Allen et al. 2003)
- Freshwater Fishes of North-Eastern Australia (Pusey et al. 2004)
- A Field Guide to Reptiles of Queensland (Wilson 2005)
- A Complete Guide to Reptiles of Australia (Wilson and Swan 2008)
- Australian Freshwater Turtles (Cann 1998)
- Mayfly Nymphs of Australia. A Guide to Genera. No. 7. (Dean and Suter 1996)
- The Mammals of Australia (Van Dyck and Strahan 2008).

Scientific and common names for terrestrial fauna are consistent with those used in the following sources:

- Handbook of Australian, New Zealand and Antarctic Birds Book Series, Volumes 1 – 7 (Marchant and Higgins 1990-2006)
- The Field Guide to the Birds of Australia (Pizzey and Knight 2007)
- Field Guide to Mammals of Australia (Menkhorst and Knight 2004)
- Australian Bats (Churchill 2008)
- A Field Guide to Reptiles of Queensland (Wilson 2005)
- A Complete Guide to Reptiles of Australia (Wilson and Swan 2008)
- A Field Guide to Australian Frogs (Barker et al. 1995).

6.2.3 Field surveys

6.2.3.1 Overview

A number of field surveys were conducted within the Eden Bann Weir and Rookwood Weir Project footprint, firstly to identify species and communities present, and secondly to supplement and ground truth the information acquired from the desktop searches and the literature review. The field surveys also enabled any knowledge gaps regarding the existing fauna and flora values of the Project footprint to be filled, and the verification of the likely occurrence of significant flora and fauna species and ecological communities listed under the EPBC Act.

6.2.3.2 Flora survey

Nangura vegetation assessment methodology

A detailed report prepared by Nangura (2007) forms the basis of this assessment (Appendix H). Nangura undertook a vegetation assessment following the Queensland Herbarium methodology as outlined by Neldner et al. (2004). This was undertaken to refine the accuracy of RE mapping in the Eden Bann Weir and Rookwood Weir study areas. The 2007 Nangura report is still considered valid as land use practices and development within the survey area have not materially changed and therefore the survey results are considered consistent with what was assessed in 2007.

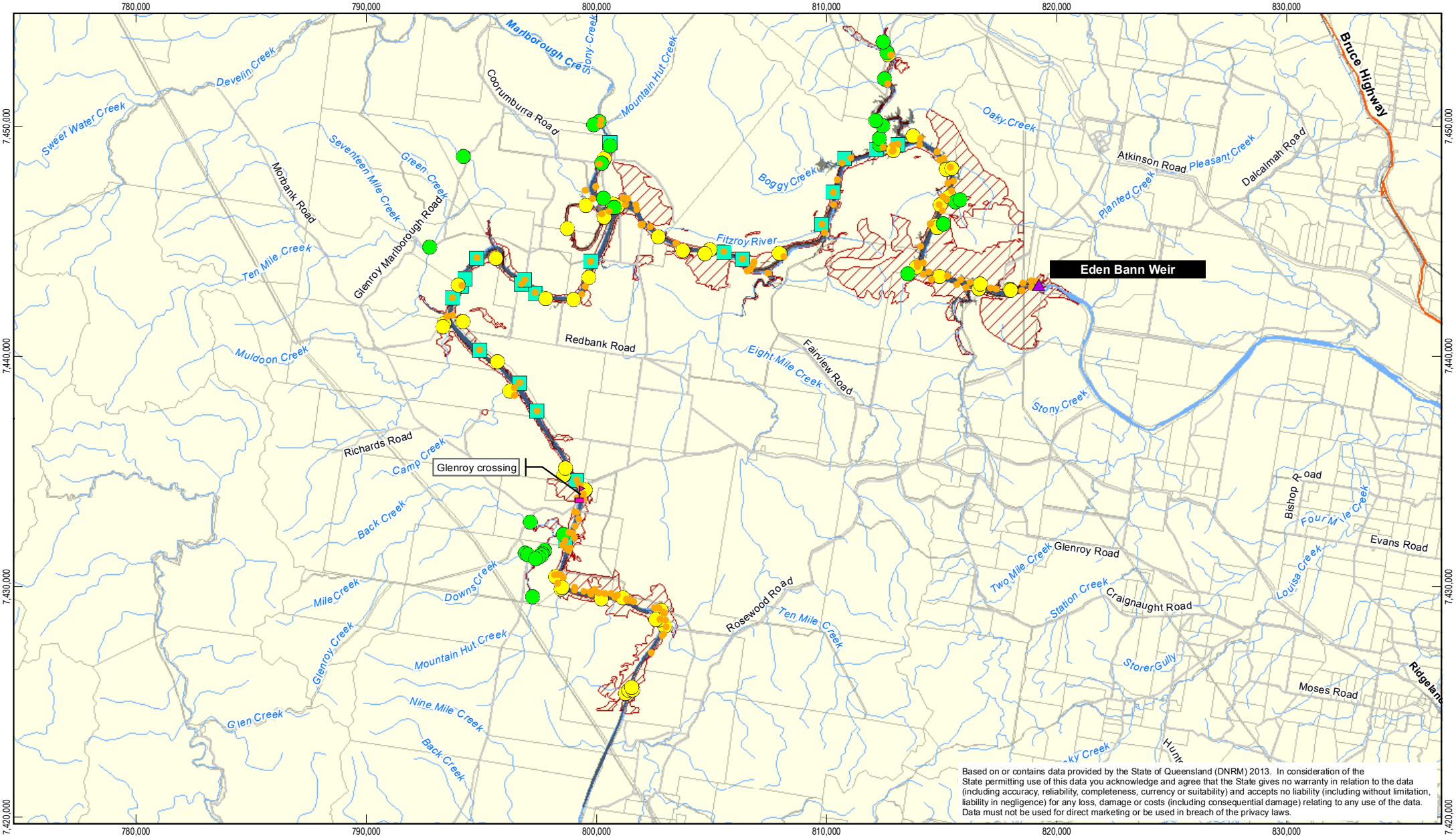
Aerial photo interpretation identified discernible vegetation mapping units. These vegetation mapping units produced a geographic information system layer of REs for the study area. Based on the results of the literature review and the vegetation mapping produced through aerial photo interpretation, dry season field surveys of the Eden Bann Weir and Rookwood Weir study areas were conducted by Nangura.

Four-wheel drive vehicle, quad, pedestrian and speedboat traverses were conducted at 0.5 km to 4 km spacing depending upon property access and soil / weather conditions. A total of 135 vegetation plots and an additional 300 observational stops were examined. Site data was assembled in a CORVEG compatible database.

Habitat condition was assessed for each vegetation community within the Eden Bann Weir and Rookwood Weir study areas using a bio-condition analysis methodology as outlined by Eyre et al. (2006). Bio-condition habitat assessment provides a method of evaluating a terrestrial ecosystem through examination of characteristics of a selected subset of habitat elements. Sites were sampled at selected locations representative of relevant RE subtypes. Local benchmark values were generated for a key subset of alluvial habitats. Field surveys conducted by Nangura assessed 160 bio-condition sampling sites with a further 28 riparian offset zones examined against their respective bio-condition RE benchmarks. Figure 6-2 and Figure 6-3 show the locations of field survey sites and bio-condition sites for Eden Bann Weir and the proposed Rookwood Weir study areas, respectively.

Disturbed habitat zones were identified during aerial photo interpretation and adjusted during subsequent field surveys. Primarily, disturbed habitat zones were located within the greater river bank, below the adjoining alluvial plain and they were either (a) not identified within any RE polygon in the Queensland Herbarium RE Mapping or (b) would not be considered mappable as remnant vegetation at 1:25,000 in this study. Small areas of 'disturbed habitat' were omitted from this assessment as they were included within RE polygons and thus were technically considered remnant vegetation under the *Vegetation Management Act 1999* (Qld).

Endangered, vulnerable and near threatened flora species under the *Nature Conservation Act 1992* (Qld) (NC Act) and EPBC Act (referred to as conservation significant flora) were identified through database searches in 2006. These species were filtered further with targeting of known conservation significant flora associated with the adjoining serpentinite landscapes, selected targeting of known vine thicket species potentially present within the surrounding district and otherwise selecting species potentially relating to the alluvial plains and riverine ecosystems of the study areas. On-ground searching for conservation significant species was conducted, with any relevant specimens sent to Queensland Herbarium as voucher specimens.



1:220,000 (at A4)

0 2 4 6

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
- Highway
- Major Road
- Streets (Local)
- Railway
- Waterway
- Impoundment Area
- Field Survey Site
- Disturbed Zone
- Biocondition Site
- EVR Flora Site
- Cadastre
- Nangura Mapping Extent

GHD
CLIENTS | PEOPLE | PERFORMANCE

Gladstone Area Water Board

SunWater
Making Water Work

Gladstone Area Water Board, SunWater
Lower Fitzroy River Infrastructure Project

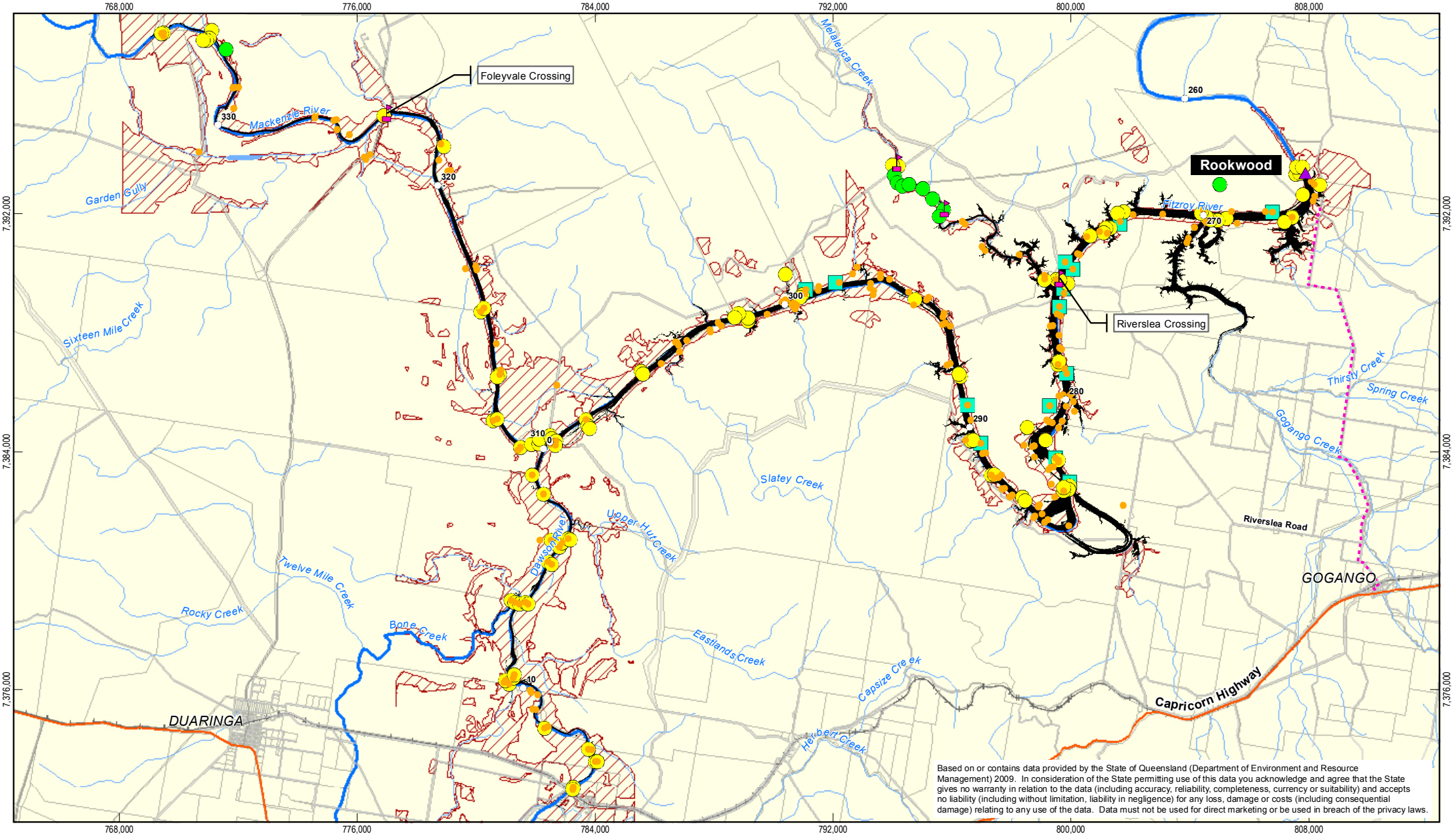
Job Number 41-20736
Revision A
Date 17 Feb 2014

Eden Bann Weir
flora field survey sites

Figure 6-2

G:\41\20736\GIS\Projects\MXD\200_Report\4120736_287_rev_a.mxd
Level 9, 145 Ann St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com.au **W** www.ghd.com.au

Data Source: Sunwater: Waterways, Weir Locations - 2008; NES: Survey Sites, Study Area - 2007; DNRM: Cadastre - 2013, Road - 2011.*See Appendix for disclaimers and copyrights.



1:170,000 (at A4)

0 2 4 6

Kilometres

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

N

LEGEND

- AMTD (km)
- River Crossing
- Weir Location
- Highway
- Major Road
- Streets (Local)
- Railway
- Access Road
- Waterway
- Impoundment Area
- Cadastre
- Nangura Mapping Extent
- Field Survey Site
- Biocondition Site
- Disturbed Zone
- EVR Flora Site

Gladstone Area Water Board, SunWater
Lower Fitzroy River Infrastructure Project

Job Number 41-20736
Revision A
Date 17 Feb 2014

Rookwood Weir flora field survey sites

Figure 6-3

G:\41\20736\GIS\Projects\MXD\200_Report\4120736_268_Rev_A.mxd

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: Sunwater: Waterways, Weir Locations - 2008; NES: Survey Sites, Study Area - 2007; DNRM: Cadastre - 2013, Road - 2011.*See Appendix for disclaimers and copyrights.

Population estimates for black iron box (*Eucalyptus raveretiana*) were obtained by recording stem counts over a series of 8 x 100 m sampling transects for specimens over 5 m in height, with sampling events at roughly 400 m spacing running along the bed and banks of Melaleuca Creek where a significant population of black iron box was identified.

Remnant vegetation calculations

To calculate regional ecosystems affected by the Project footprint, a combined dataset was produced where DNRM RE mapping (Version 6.1, 2011) was used in areas that were not covered by Nangura's mapping. Figure 6-2 and Figure 6-3 show the Nangura mapping extent and the impoundment areas that occur outside this extent for Eden Bann Weir and Rookwood Weir, respectively.

6.2.3.3 Aquatic habitat and fauna surveys

Overview

Field surveys were conducted to ground-truth information acquired through the desktop assessment and to verify species expected to occur within the Project footprint including the likely occurrence of EPBC Act listed aquatic fauna species. Detailed descriptions of the aquatic fauna assessments undertaken for the Project are provided in Appendix J and Appendix K.

Verification was based on direct and indirect (e.g. suitable habitat) observations and areas of focus for the field survey effort included:

- Assessments of aquatic habitat characteristics and values throughout the Project footprint
- Assessment and mapping of potential turtle nesting banks throughout the Project footprint, including ranking of potential value
- Fish trapping to sample species diversity in impounded habitats to be impacted by increased inundation, as a supplement to information acquired through the literature review
- Opportunistic recordings of conservation significant fauna including the Fitzroy River turtle (*Rheodytes leukops)* and the estuarine crocodile (*Crocodylus porosus)*
- Macroinvertebrate sampling to supplement information acquired through the literature review.

Table 6-1 provides a summary of the survey effort.

Table 6-1 Summary of survey effort

Task description	Rookwood Weir		Eden Bann Weir	
	Wet season	Dry season	Wet season	Dry season
Aquatic habitat assessment	3	14	23	4
Turtle nesting bank surveys (targeted)	11	7	19	0
Fyke trap nights	7	15	10	10
Baited trap nights	15	30	14	0
Artificial substrates	1		2	4

It is considered that surveys were undertaken using methodologies consistent with relevant EPBC Act Survey Guidelines for Nationally Threatened Species (DSEWPaC 2011).

Timing of field surveys

Surveys were conducted in the wet and dry season to document seasonal changes in aquatic fauna assemblages, habitat condition and utilisation. Survey timing and design considered seasonal variation and the ecology of targeted threatened species. A reconnaissance of the both the Eden Bann Weir Project footprint and Rookwood Weir Project footprint was undertaken on the 20 January 2009.

Subsequent wet season surveys of the Eden Bann Weir Project footprint were conducted between 28 January and 2 February 2009 (habitat assessments) and 13 to 14 February 2009 (aquatic fauna trapping). The dry season survey for aquatic fauna in the Eden Bann Weir Project footprint was undertaken between 12 and 14 July 2009. Turtle nesting bank surveys were also conducted between 15 and 18 December 2008 in addition to during the wet and dry season surveys.

Wet season surveys of the Rookwood Weir Project footprint were conducted between 29 April and 1 May 2009. The dry season surveys of the Rookwood Weir Project footprint were undertaken between 25 and 30 July 2009. Turtle nesting bank surveys were also conducted between 9 and 12 December 2008 and 25 and 30 July to coincide with turtle nesting / hatching seasons.

Constraints and limitations

Detail on limitations that influenced field survey methodologies and effort is provided in Appendix J and Appendix K and summarised as follows:

- Flooding events and heavy rainfall leading up to and during the wet season fauna trapping surveys restricted road access and created significant difficulties in launching and retrieving the survey boat. Flooding and high flows also resulted in high turbidity in the Fitzroy River, thereby limiting survey options for freshwater turtles
- During the dry season, the ability to traverse by boat was hampered by the lack of water in the river (particularly in shallow runs and riffles), snags and submerged structures, particularly in the often shallow and narrow Dawson and Mackenzie Rivers
- The occurrence of estuarine crocodiles in the Project footprint represented a safety concern when conducting aquatic habitat assessments and fauna trapping. Access to very remote areas, requiring long travel times over unsealed roads was also not undertaken for safety reasons
- Landholder permission was required to access launching sites and riparian habitats throughout the Project footprint, and while in most cases this was granted, where it was not, survey could not be undertaken.

Animal ethics and approvals

Aquatic fauna surveys were conducted under Section 52 of the *Animal Care and Protection Act 2001* (Qld) (General Fisheries Permit – 113990) and supported by the former Queensland Department of Employment, Economic Development and Innovation animal ethics committee (CA 2008/07/280).

Aquatic survey site selection

Aquatic survey sites (for habitat assessments, turtle nesting bank surveys and aquatic fauna trapping) were selected based on a review of digital topography, georeferenced aerial

photographs, streambed geology, road and boat access, safety constraints and field reconnaissance including an aerial overflight.

Habitat assessments were conducted at sites representing major aquatic habitats within the Project footprint including impounded pools, pools, riffles, runs, off-stream water bodies and creeks. Where possible, sites for deployment of nets and traps were selected to sample aquatic fauna in each of the habitat types, and in locations that allowed safe operation and had suitable structures (e.g. projecting branches or roots for attachment).

Turtle nesting bank surveys were conducted at targeted sites based on the current knowledge of species preferences for particular substrate, slope, elevation and vegetation cover (refer to section on freshwater turtles below). Locations of habitat assessment, turtle nesting bank surveys and fauna trapping sites are provided in Figure 6-4 and Figure 6-5 Eden Bann Weir and Rookwood Weir Project footprints, respectively.

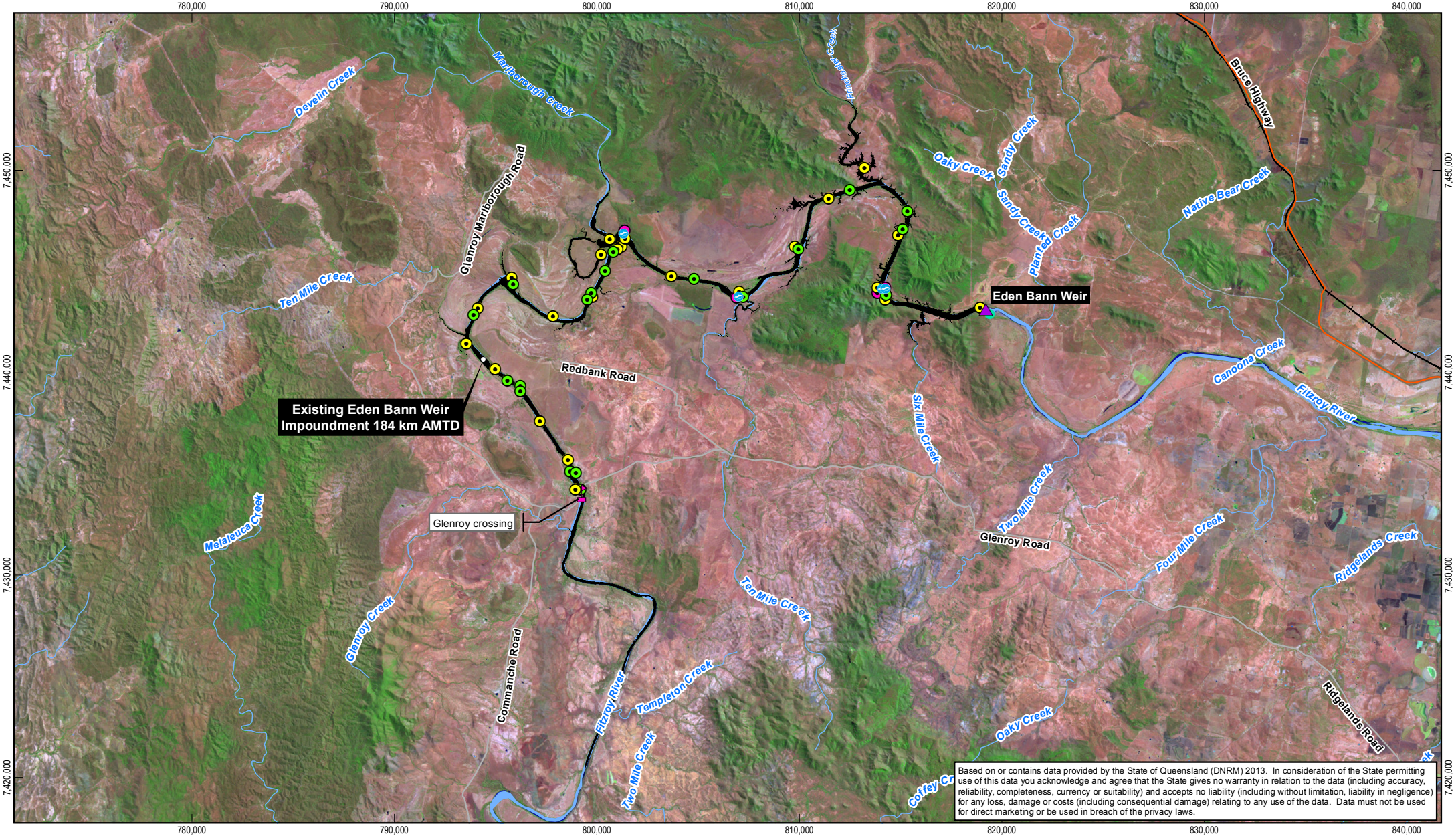
Habitat assessment

Habitat assessments were undertaken at accessible sites representing major aquatic habitats throughout the Project footprint. Each survey site was identified in relation to habitat type and the following parameters were recorded:

- Stream channel and bank morphology (e.g. channel width, depth and bank height)
- Bank profile
- Substrate description (e.g. bedrock, gravel, sand or silt)
- Presence of plant material (e.g. aquatic plants, algae and submerged logs)
- Riparian vegetation description (e.g. width and length of stream side vegetation, overhanging and native vegetation)
- Adjacent land use
- Water velocity (e.g. deep and shallow areas)
- Position in relation to existing or proposed impoundment.

Creek and off-stream water body habitats were assessed where access permitted. Where these habitats could not be accessed in the field, a desktop approach to assessing the spatial distribution/extent of these habitat types was undertaken. Specifically, this involved an assessment of Queensland Government's WetlandInfo Mapping Service in conjunction with satellite imagery of the study area.

Habitat assessment was undertaken at 23 sites within the Eden Bann Weir Project footprint and 17 sites within the Rookwood Weir Project footprint as shown in Figure 6-4 and Figure 6-5. Habitat characteristics of each survey site were assessed from excellent to poor according to criteria of the Queensland Australian River Assessment System (AusRivAS) River Bioassessment Program from which a sub sample of habitat variables relevant to the Project were selected (AusRivAS 2001).



1:250,000 (at A4)

0 2.5 5 7.5 10

Kilometres

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

N

LEGEND

- Weir Location
- River Crossing
- Highway
- Minor Road
- Railway
- Impoundment Area
- Waterway
- Aquatic Fauna Trapping Site (GHD)
- Turtle Nesting Bank Survey Site (GHD)
- Habitat Assessment Site (GHD)
- Macroinvertebrate articial substrate sites (GHD)
- Principal study sites (Limpus et al 2011)

GHD
CLIENTS | PEOPLE | PERFORMANCE

Gladstone Area Water Board

SunWater
Making Water Work

Gladstone Area Water Board, SunWater
Lower Fitzroy River Infrastructure Project

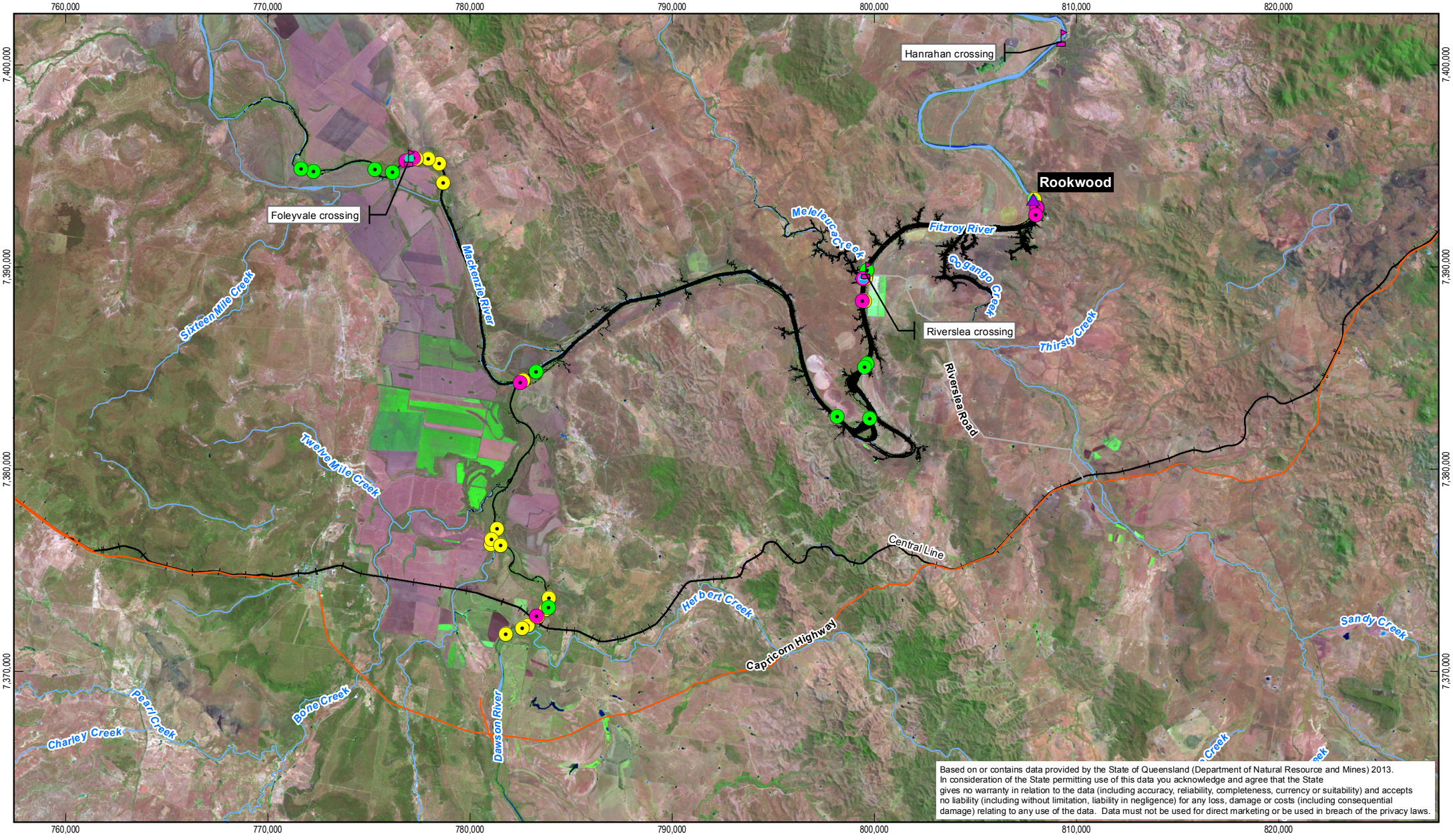
Job Number 41-20736
Revision C
Date 08 Aug 2014

Eden Bann Weir Aquatic Ecology Footprint and Aquatic Survey Sites

Figure 6-4

G:\41\20736\GIS\Projects\MXD\900_Baseline Terrestrial Fauna Report\4120736_909_Eden_Bann_Survey_Sites_Rev_C.mxd

Level 9, 145 Ann St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com.au **W** www.ghd.com.au



1:250,000 (at A4)

0 2.5 5 7.5 10

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
- Highway
- Minor Road
- Railway
- Impoundment Area
- Waterway
- Aquatic Fauna Trapping (GHD)
- Habitat and Turtle Nesting Bank Assessment (GHD)
- Turtle Nesting Bank Assessment (GHD)
- Macroinvertebrate articial substrate sites (GHD)
- Principal study sites (Limpus et al 2011)

GHD
CLIENTS | PEOPLE | PERFORMANCE

Gladstone Area Water Board

SunWater
Making Water Work

Gladstone Area Water Board, SunWater
Lower Fitzroy River Infrastructure Project

Job Number 41-20736
Revision C
Date 08 Aug 2014

Rookwood Aquatic Ecology Project Footprint and Aquatic Survey Sites

Figure 6-5

G:\41\20736\GIS\Projects\MXD\900_Baseline Terrestrial Fauna Report\4120736_912_Rookwood_Survey_Sites_Rev_C.mxd

Level 9, 145 Ann St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com.au **W** www.ghd.com.au

Aquatic habitat segment analysis

In the absence of being able to access all habitats, habitat segment analysis was utilised to assess the extent of aquatic habitats, within and downstream of the Project footprint. The distribution and linear extent of aquatic habitat types within the Project footprints were quantified and mapped from aerial photographs, and where possible, verified in the field. Habitat boundaries were subsequently estimated based on the visual characteristics observed.

The extent of each habitat type within the main river channel in the Project footprints was then calculated based on the percentage of river length covered by each habitat (off-stream water bodies and adjoining creeks not included). As habitat boundaries (e.g. the difference between a riffle and a run) vary between seasons, the percentages of each habitat type within the Project footprint provide an example of aquatic habitat extent. These values are likely to fluctuate substantially in response to seasonal variability in water flows.

Habitat quality was inferred to be similar to that of the aquatic habitats assessed within the Project footprints, given the similarity of surrounding land uses up and downstream.

Freshwater turtles

As shown in Table 6-2 there is a significant body of literature on freshwater turtles of the Fitzroy Basin catchment. An assessment of freshwater turtle populations within the Fitzroy Basin catchment was conducted by the former Department of Environment and Resource Management (DERM) in 2007, specifically focusing on the proposal for raising Eden Bann Weir and constructing a new weir at Rookwood (Limpus et al. 2007). The DERM assessment involved field studies and sampled an extensive range of habitats throughout the Fitzroy Basin catchment including: isolated spring fed pools, farm dams, backwaters, weir pools and natural river habitats. The field surveys involved a combination of snorkelling, dip netting, trapping, seine netting, muddling and nesting habitat surveys and were undertaken in accordance with the Commonwealth Department of the Environment survey guidelines for threatened reptiles (Commonwealth of Australia 2011).

Targeted surveys for the threatened Fitzroy River turtle focussed on the identification, assessment and mapping of potential turtle nesting in the Project footprint. Where access permitted, stream bank margins throughout the Project footprint were assessed for potential Fitzroy River turtle nesting habitat. Accessible potential nesting areas (i.e. those comprising sand and / or loam banks) were identified and parameters recorded including bank length, bank width, approximate slope, substrate type, percent vegetation cover, evidence of turtle activity and nesting and evidence of disturbance (e.g. from cattle and pigs).

In the absence of nesting habitat survey guidelines, nesting habitat surveys were conducted in accordance with standard DERM methodology (Limpus et al. 2007) and as discussed with Department of Environment and Heritage Protection's (DEHP) Chief Scientist, Aquatic Threatened Species Division, Dr Col Limpus. Potential nesting banks were examined for signs of nesting (which included the presence of turtle tracks, diggings and predated egg shells) using single strip transects parallel to the water's edge. Transect length and width varied according to bank morphology. Nest locations were described in relation to distance and height from the water.

Table 6-2 Summary of literature reviewed and field survey effort for aquatic fauna and macrophytes

Parameter	Information in literature	References	Current knowledge gaps	Field effort
Freshwater turtles (including the Fitzroy River turtle)	Species diversity Distribution in catchment Aquatic habitat requirements Breeding ecology Threatening processes	**Key reference:** Limpus et al. 2007 **Other references:** Cann 1998; Clark 2008; Clark et al. 2008; frc environmental 2007; frc environmental 2008; Gordos 2004; Gordos et al. 2003a,b; Gordos et al. 2007; Hamann et al. 2007; Legler and Cann 1980; Legler and Georges 1993; Limpus et al. 2006; Mathie and Franklin 2006; Priest 1997; Priest and Franklin 2002; Rogers 2000; SunWater 2008b; Thomson et al. 2006; Tucker 2000; Tucker et al. 2001; Venz et al. 2002	Specific nesting bank requirements Nesting bank locations (including locations of any aggregated nesting sites) Movement behaviours	Aquatic habitat assessments Opportunistic recordings of species (including conservation significant species) Identification, assessment and mapping of potential nesting banks for conservation significant turtles
Estuarine crocodile	Distribution in catchment Relative abundance in catchment Aquatic habitat requirements Breeding ecology Threatening processes	**Key reference:** Britton 2007a; Britton 2007b **Other references:** DERM 2009; EPA 2007; frc environmental 2008; Walsh and Whitehead 1993	Movement behaviours Recruitment into population	Aquatic habitat assessments Opportunistic recordings of crocodiles (including characteristic slides on banks) and nests
Fish	Species diversity in catchment General habitat preferences of fish species Barriers to movement in the Fitzroy River / use of fish passage devices	**Key reference:** Berghuis and Long 1999; Long and Meager 2000; Marsden and Power 2007; Pusey et al. 2004; Stuart et al. 2007 **Other references:** Allen, et al. 2003; DEEDI 2009; Earth Tech 2007; frc environmental 2008; Heindenreich and Broadfoot 2001; Stuart and Mallen-Cooper 1999; Stuart 1997; SunWater 2008a	Species assemblages in specific aquatic habitat types	Aquatic habitat assessments Fish sampling within, immediately upstream and immediately downstream of the Project footprint
Macroinverte-brates	General characterisation of diversity of macroinvetrebrate taxa in the study area Non-occurrence of listed threatened species in the study area	**References:** Duivenvoorden et al. 2000; Duivenvoorden and Roberts 1997; frc environmental 2008	Description of species assemblages occurring in specific aquatic habitat types within the Rookwood Weir Project footprint Habitat requirements of key species	Opportunistic sampling for large macroinvertebrates during fish trapping Non-systematic deployment of artificial substrates in various aquatic habitat types throughout Project footprint

Parameter	Information in literature	References	Current knowledge gaps	Field effort
Macrophytes	General description of macrophytes and pest species known to occur in the study area	**References:** Duivenvoorden 1992; Noble et al. 1997; frc environmental 2008; Houston and Duivenvoorden 2002	Species presence, diversity and distribution in various aquatic habitat types Temporal patterns in macrophyte distribution	Aquatic habitat assessments

Based on an assessment of nesting bank slope, substrate type and vegetation cover, each sand/loam bank identified was assigned a broad nesting habitat suitability rating as follows:

- Low – nesting banks with a relatively low gradient slope and/or predominantly unsuitable substrate (e.g. gravel)
- Medium – nesting banks with a relatively medium to steep slope, predominantly sand/loam substrate and/or medium to high vegetation cover
- High – nesting banks with a relatively steep slope, sand/loam substrate and low vegetation cover
- Confirmed – nesting banks in which direct evidence of turtle nesting was observed (e.g. predated egg shell)
- Historical – nesting banks in which direct evidence of turtle nesting has been confirmed in previous studies.

The nesting suitability ratings were selected based on current data available on the optimal nesting conditions of both the Fitzroy River turtle. It is important to note that the classification of a bank as potential turtle nesting habitat does not guarantee that turtle nesting does / will occur in that area. Turtle nesting may also occur in areas not identified as potential habitat however, the occurrence of this is expected to be low. All incidental observations of turtle nesting were recorded. Nesting bank conditions are also subject to change over time, for example as a result of flooding events, and as such the suitability of the habitat for turtle nesting may vary.

The direct impact to nesting habitat as a result of the Project was then calculated based on the area of historical, confirmed and high potential turtle nesting habitat that will be impounded within the Project footprints (Appendix L Fitzroy River Turtle (*Rheodytes leukops*)).

Fish species

The fish diversity of the Fitzroy Basin catchment has been studied in detail (Table 6-2). No EPBC Act listed-threatened species have been previously recorded or are predicted to occur in the study area.

Fish species in riverine habitats were surveyed using single wing fyke nets, with the cod end protruding from the water to allow any inadvertently captured turtles and platypus access to the surface. Fyke nets were deployed by boat to allow the wing panel to be deployed 10-15 m into the stream, perpendicular to the bank. At each site, a minimum of two fyke nets were deployed in the afternoon, left overnight, and checked the following morning.

Small collapsible baited traps were deployed along the margins of lentic habitats to sample small and cryptic fish species that were less likely to be captured in fyke nets. Three to four bait traps were deployed at the same location as the fyke nets, thereby allowing different microhabitats to be sampled within the same lotic habitat. These traps were also left overnight and checked the following morning.

Captured fish were placed in a bucket of water and identified to species. The number of individuals of each species level was recorded and all individuals were subsequently returned live to the water body.

Crocodiles

Two comprehensive studies were undertaken to describe potential impacts (and associated mitigations) on estuarine crocodiles from existing and proposed water infrastructure development

on the Fitzroy River (Britton 2007a; Britton 2007b). These studies provide a thorough description of estuarine crocodile populations and habitat utilisation in the Fitzroy River, based upon the results of detailed field assessments. As such, specific targeted field surveys as part of the EIS investigations were not deemed necessary for this species. Aquatic fauna habitat assessments as described above documented potentially suitable habitat and any opportunistic recordings were noted.

6.2.3.4 Terrestrial habitat and fauna surveys

Overview

Field surveys were conducted to ground-truth information acquired through the literature review regarding species and communities expected to occur within the Project footprint and to verify the likely occurrence of conservation significant terrestrial fauna species. Habitat assessments were also undertaken to determine the relative ecological value (REV) of terrestrial habitats along the impacted areas of the Fitzroy, Dawson and Mackenzie rivers.

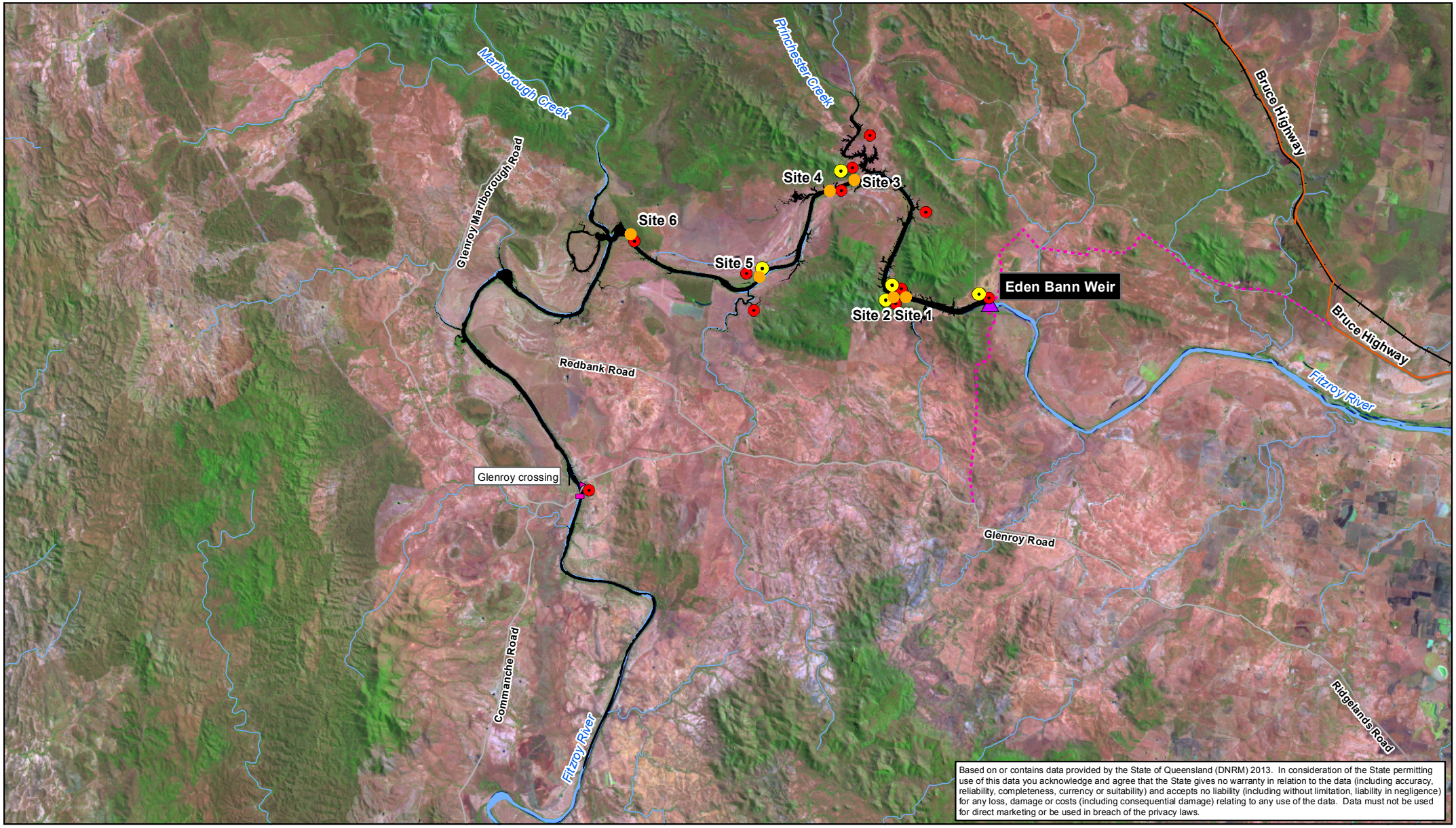
Fauna surveys

Six fauna survey trapping sites were selected for seasonal field surveys undertaken in late January/early February 2009 (wet season) and in August 2009 (dry season) across the Eden Bann Weir Project area (Figure 6-6). Seasonal field surveys were conducted in April 2009 (end of the wet season) and July 2009 (dry season) for Rookwood Weir across six fauna survey trapping sites (Figure 6-7). Sites were selected following a review of satellite imagery, regional ecosystem mapping and field reconnaissance of the study area. Systematic and targeted surveys were undertaken at the sites. Fauna values of downstream habitats between Rookwood Weir and the upstream limits of the Eden Bann Weir impoundment area and downstream of Eden Bann Weir were primarily assessed through a desktop analysis.

A standardised combination of hair tubes, pitfall traps, funnel traps, Elliot box traps and cage traps were used. Bats were surveyed using Anabat II Detectors and harp traps. Bird surveys were also undertaken. Opportunistic diurnal and nocturnal searches were conducted at each site, in order to detect rare or threatened species that may not be identified within traps. Scats that were found during opportunistic searches and trapping checks were collected and sent for independent analysis. A summary of the terrestrial fauna survey effort is provided in Table 6-3 and Table 6-4 for Eden Bann Weir and the proposed Rookwood Weir, respectively. A summary of bird nest survey effort is provided in Table 6-5.

It is considered that surveys were undertaken using methodologies consistent with those described in the Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland (Eyre et al. 2012) and the relevant EPBC Act Survey Guidelines for Nationally Threatened Species (DSEWPaC 2011) including:

- Survey guidelines for Australia's threatened bats
- Survey guidelines for Australia's threatened birds
- Survey guidelines for Australia's threatened mammals
- Survey guidelines for Australia's threatened reptiles.



1:250,000 (at A4)

0 2 4 6 8 10

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
- Highway
- Streets (Local)
- Access Road
- Railway
- Waterway
- Impoundment Area
- Anabat
- Bird Census
- Trapping Site

GHD
CLIENTS | PEOPLE | PERFORMANCE

Gladstone Area Water Board

SunWater Making Water Work

Gladstone Area Water Board, SunWater
Lower Fitzroy River Infrastructure Project

Job Number 41-20736
Revision C
Date 17 Feb 2014

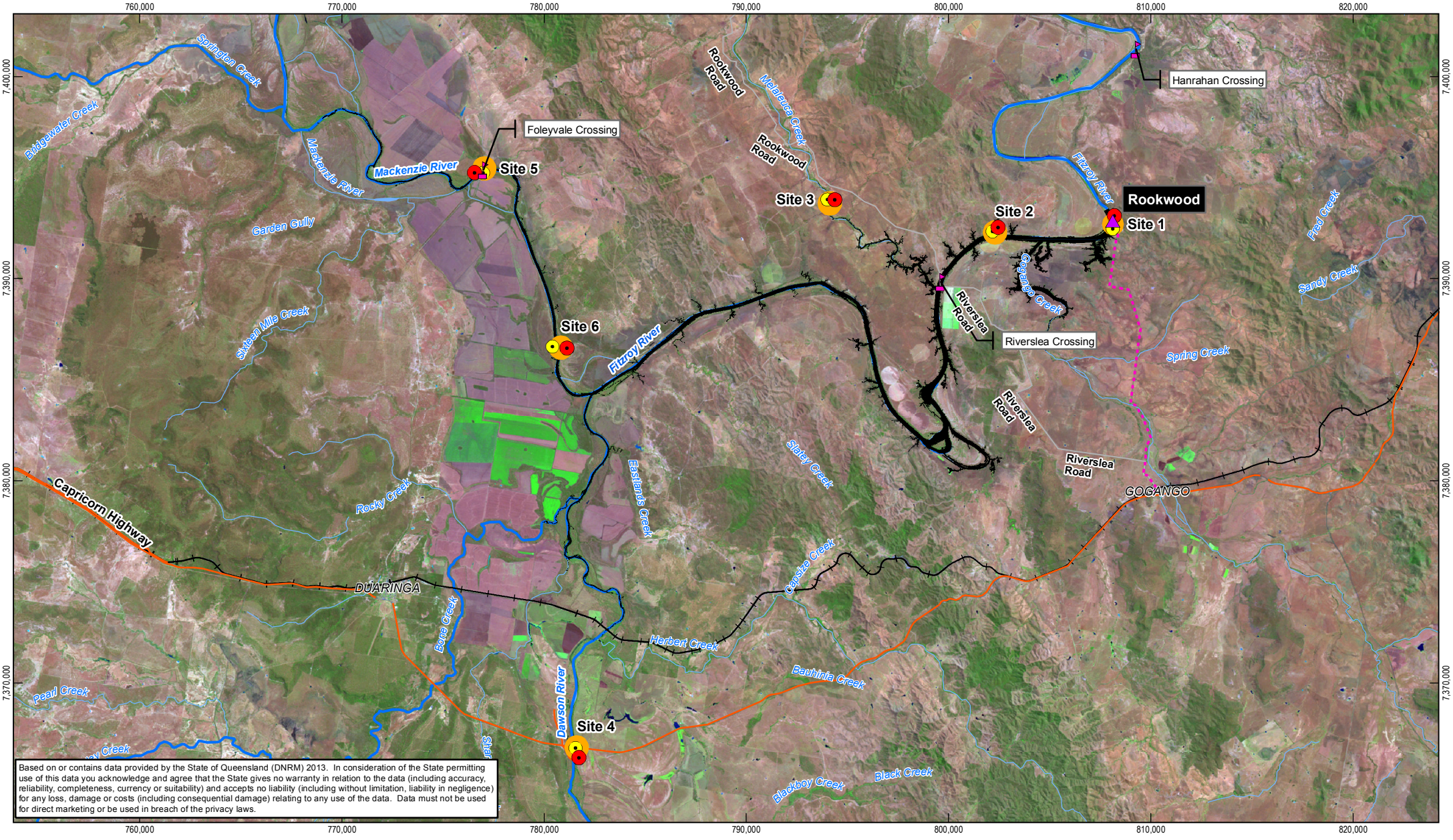
Eden Bann Weir terrestrial fauna survey sites

Figure 6-6

G:\41\20736\GIS\Projects\MXD\900_Baseline Terrestrial Fauna Report\4120736_902_Eden_Bann_Fauna_Survey_Sites_Rev_C.mxd

Level 9, 145 Ann St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com.au **W** www.ghd.com.au

Data Source: © Copyright Commonwealth of Australia (Geoscience Australia): Waterways, State (2007); Sunwater: Waterways, Weir Locations - 2008; DNRM: Roads - 2010, Railways - 2010, Imagery - 2005; GHD Fauna Survey - 2009. Created by IH



1:250,000 (at A4)

0 2 4 6 8 10

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
- Highway
- Streets (Local)
- Access Road
- Railway
- Waterway
- Impoundment Area
- Anabat
- Bird Census
- Trapping Site

GHD
CLIENTS | PEOPLE | PERFORMANCE

Gladstone Area Water Board

SunWater Making Water Work

Gladstone Area Water Board, SunWater
Lower Fitzroy River Infrastructure Project

Job Number 41-20736
Revision C
Date 13 Feb 2014

Rookwood terrestrial fauna survey sites

Figure 6-7

G:\41\20736\GIS\Projects\MXD\900_Baseline Terrestrial Fauna Report\4120736_906_Rookwood_Survey_Sites_Rev_C.mxd

Level 9, 145 Ann St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com.au **W** www.ghd.com.au

Data Source: © Copyright Commonwealth of Australia (Geoscience Australia): Waterways, State (2007); Sunwater: Waterways, Weir Locations - 2008; DNRM: Roads - 2010, Railways - 2010, Imagery - 2005; GHD Fauna Survey - 2009. Created by IH

Table 6-3 Survey effort, techniques and locations – Eden Bann Weir Project footprint

Systematic									Non-systematic	
Site	Number of traps*						Anabat detector (no. of nights#)	Bird survey (mins^)	Diurnal searches (mins^)	Nocturnal searches (mins^)
	Pit-fall trap	Funnel trap	Cage trap	Elliot box trap	Hair tube	Harp trap**				
Wet season										
1	16	32	40	80	80	2	1	100	90	90
2	16	32	40	80	80	2	1	100	90	90
3	8	32	40	80	80	-	-	100	90	
4	16	32	40	80	80	-	-	100	90	
5	16	32	40	80	80	-	1	100	90	
6	16	32	40	80	80	-	1	100	90	
Dry season										
1	16	32	40	80	80	-	-	100	90	-
2	16	32	40	80	80	2	-	100	90	-
3	8	32	40	80	80	-	1	100	90	-
4	16	32	40	80	80	4	-	100	90	-
5	16	32	40	80	80	-	-	100	90	-
6	16	32	40	80	80	-	-	100	90	-

*Number of nights in which traps were deployed multiplied by the number of traps at each site.

**Safety constraints limited nocturnal surveying upstream of Eden Bann Weir. This was exacerbated in the dry season by lower water levels in the impoundment. Due to suitability and abundance of habitat for bats at the boat ramp upstream of Eden Bann Weir, Anabat detectors and harp traps were deployed at this location in addition to the listed surveys sites. Nocturnal searches were also undertaken at this location.

#Number of nights Anabat detectors were deployed to remotely detect microchiropteran bat echolocation calls.

^Minimum time in person minutes spent surveying.

Table 6-4 Survey effort, techniques and locations – Rookwood Weir Project footprint

Systematic									Non-systematic	
Site	Number of traps*						Anabat detector (no. of nights#)	Bird survey (mins^)	Diurnal searches (mins^)	Nocturnal searches (mins^)
	Pit-fall trap	Funnel trap	Cage trap	Elliot box trap	Hair tube	Harp trap				
Wet season										
1	16	32	40	80	80	6	1	100	90	90
2	16	32	40	80	80		1	100	90	90
3	16	32	40	80	80		1	100	90	90
4	16	32	40	80	80		1	100	90	90
5	16	32	40	80	80	2	1	100	90	90
6	16	32	40	80	80		1	100	90	90
Dry season										
1	16	32	40	80	80	2	1	100	90	90
2	16	32	40	80	80	-	1	100	90	90
3	16	32	40	80	80	-	1	100	90	90
4	16	32	40	80	80	-	1	100	90	90
5	16	32	40	80	80	2	1	100	90	90
6	16	32	40	80	80	-	1	100	90	90

*Number of nights in which traps were deployed multiplied by the number of traps at each site

#Number of nights Anabat detectors were deployed to remotely detect microchiropteran bat echolocation calls

^Minimum time in person minutes spent surveying

Table 6-5 Summary of nest survey effort

Method	Location	Description	Estimated effort
On foot	Eden Bann Weir and Rookwood Weir	As part of habitat assessments, targeted nest searches were undertaken at 17 fixed bird census sites (Figure 6-6 and Figure 6-7)	28 hours (100 minutes per site at 17 sites)
Boat-based	Eden Bann Weir	Boat-based nest searches were undertaken along the stretch of river between the existing Eden Bann Weir and Site 6 (Figure 6-6). This included all adjoining tributaries within this stretch of river	72-96 hours (two boats for 12 days, 3-4 hours per day)
Canoe-based	Rookwood Weir	Canoe-based surveys were undertaken between the confluence of the Dawson and Mackenzie rivers and the proposed Rookwood Weir site	24 hours (one canoe for six days, four hours per day)
Vehicle-based	Rookwood Weir	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 (three teams for 12 days, two hours per day)

Timing of field surveys

Surveys were replicated throughout both the wet and dry seasons in order to document seasonal changes in fauna assemblages, habitat condition and utilisation and to maximise the potential of encountering seasonal and migratory species. Survey timing and design also considered the ecology of targeted threatened species, accessibility and safety.

An initial reconnaissance was undertaken between 15 December and 18 December 2008 for the Eden Bann Weir Project footprint and between 9 December and 12 December 2008 for the Rookwood Weir Project footprint. An aerial survey was also undertaken on 20 January 2009 (aerial overflight). The wet season survey within the Eden Bann Weir Project footprint was conducted between 28 January and 2 February 2009, and the dry season surveys were undertaken between 6 August and 11 August 2009. The wet season survey within the Rookwood Weir Project footprint was conducted between 22 April and 27 April 2009 and the dry season survey was undertaken between 22 July and 28 July 2009.

Animal ethics and approvals

Terrestrial fauna surveys were conducted under Section 52 of the *Animal Care and Protection Act 2001* (Qld) (Scientific Purposes Permit – WISP-02740805, Registration No. 132) and supported by the former DERM animal ethics committee (CA 2006/11/159).

Terrestrial survey site selection

Six fauna survey trapping sites were selected for seasonal field surveys within the Eden Bann Weir Project footprint and the Rookwood Weir Project footprint (Table 6-6 and Table 6-7). Sites were selected following a review of satellite imagery, regional ecosystem mapping and field reconnaissance of the Project footprint. The following criteria were considered when selecting survey site locations:

- Representative of major fauna habitats within the Project footprint
- Covered a geographical range of habitats
- Corresponded with proposed impoundments

- Were accessible by vehicle or boat (to maximise survey effort without compromising animal welfare).

Note: Rookwood Weir Site 4 on the Dawson River is slightly upstream of the proposed maximum inundation extent (e.g. slightly upstream of the Project footprint). It was selected as a trapping site as it is representative of the terrestrial fauna habitats of the lower Dawson River, and was readily accessible by vehicle.

Systematic surveys

The systematic surveys were comprised *of* six trapping sites that utilised a variety of trap types. The surveys were targeted, such that trap sites were selected on the basis of their potential to act as habitat for the mammals, reptiles and amphibians identified in the desktop reviews.

Trapping for terrestrial mammals, reptiles and amphibians was undertaken using a standardised combination of pit-fall traps, funnel traps, Elliott box traps, hair tubes, cage traps and drift fence complexes. At each trap site, traps were set in a single or split linear transect. Transects were split at certain sites in order to position traps in optimal microhabitats. Single linear transects consisted of a line of 20 Elliott box traps, 20 hair tubes and 10 cage traps. Split linear transects consisted of two lines each with 10 Elliott box traps, 10 hair tubes and five cage traps.

Pit-fall trap, funnel traps and drift fence complexes were placed in four areas with suitable microhabitat, adjacent to the linear transects at each survey site. Traps were set and checked each morning for four consecutive nights. The trap configuration comprised:

- **Pit-fall trap, funnel traps and drift fence complexes**: four pit-fall traps and eight funnel traps were established at each trap site. These were configured in four separate pit-fall, funnel and drift fence complexes. Each complex consisted of a 6 m long (30 cm high) flywire drift fence with a pit-fall trap (20 L plastic bucket) in the centre and two funnel traps along the fence line either side of the bucket. Wet sponges were placed in each pit and funnel trap and vegetation was positioned in or over the traps to provide shade and protection
- **Elliott box traps:** each survey site contained 20 Elliot traps prepared with universal bait[1]. Traps were positioned in shady areas or covered with vegetation to minimise heat exposure to trapped animals
- **Hair tubes:** twenty hair tubes were placed at each trap site and prepared with universal bait. Hair tubes were positioned approximately 10 m parallel to the Elliott box traps. Half the hair tubes were set at ground level and the remainder on tree trunks in order to target both ground and arboreal mammals. Hair traces recorded in hair tubes were sent to a specialist for analysis and identification
- **Cage traps:** ten cage traps were set at each trap site. These were interspersed with Elliott box traps along linear or split liner transects. Traps were covered with hessian sacks to minimise cold or heat exposure, and to provide security and protection from harassment by predators. Cages were prepared with universal bait and/or a single raw chicken neck.

[1] Universal bait consists of a mixture of peanut butter, rolled oats and sardines and / or honey.

Table 6-6 Terrestrial fauna survey sites within the Eden Bann Weir Project footprint

Site number	Habitat description	Photos	
1	Open woodland with grassy understorey and Melaleuca riparian fringe		
2	Open woodland on rocky hillside		
3	Open woodland on rocky hillside		
4	Riparian fringe with agricultural land behind		
5	Open woodland with grassy understorey and Melaleuca riparian fringe		
6	Open woodland with grassy understorey and Melaleuca riparian fringe		

Table 6-7 Terrestrial fauna survey sites within the Rookwood Weir Project footprint

Site number	Habitat description	Photos	
1	Open woodland with grassy understorey and Melaleuca riparian fringe		
2	Open woodland on rocky hillside		
3	Riparian fringe with agricultural land behind		
4	Open woodland with grassy understorey and Melaleuca riparian fringe		
5	Open woodland with grassy understorey and Melaleuca riparian fringe Off-stream water body		
6	Open woodland with grassy understorey and Melaleuca riparian fringe Brigalow		

Anabat II Bat Detectors were used to survey microchiropteran (insectivorous) bats by recording and analysing their echolocation calls. Detectors were placed on the ground with the microphone orientated upwards at a 45° angle from the ground. Anabat units were placed in potential bat 'flyways' just before dusk and left to record calls overnight. Anabats were set at each site for one night and all bat calls recorded were sent to a qualified analyst (Greg Ford), Anabat echolocation call analysis specialist) for identification. Only bat calls with definite (one or more calls where absolutely no doubt existed as to the species identified) or probable (most likely the species named, however, some probability of confusion with species that use similar calls) identification were included in the results.

Harp traps were also used for bat species identification. These were set during the late afternoon and then checked and lowered early the next morning. Up to four harp traps were used on any one night (two traps per site). Trapping locations were selected for their potential to act as bat "flyways". Captured bats were identified in the field using Churchill (2008) and Menkhorst and Knight (2004) as guides. Morphometric measurements of bats (e.g. forearm length) were taken using vernier callipers to aid identification. Bats were released at or near their site of capture in the early morning (if removed from trap at or before dawn) or at dusk the same day (if retrieved from trap after dawn). Bats released at dusk were housed near the site of capture in a cool dark environment (hanging hessian sack) until the time of their release.

Bird surveys were undertaken at each of the trapping sites. A minimum of five censuses, comprising a total of 100 minutes, were undertaken at each site by at least one observer. Using the standard methodology developed by Birds Australia for the Bird Atlas project, each survey comprised a 20 minute census of birds within an unbounded two hectare area. Birds were detected either by visual observation (including use of binoculars) and / or aurally, and identified and recorded to species level. All systematic bird surveys were undertaken within three hours of dawn or two hours of dusk. Relevant weather details and the time of the surveys were also recorded. In addition to systematic surveys, opportunistic bird observations were recorded.

Non-systematic surveys

Opportunistic observations increase the likelihood of detecting rare or threatened species, which have unique habitat requirements and may not be captured / detected within the standard transects. To provide the best opportunity to determine the presence and relative prevalence of these species, use of systematic sampling with other, non-systematic targeted approaches is optimal. To address this, habitats sampled using the systematic sampling techniques were also surveyed using non-systematic techniques. Non-systematic sampling comprised the following:

- Diurnal searching – searches were conducted at each trap site for a minimum of 90 person minutes for all amphibians, reptiles, and mammals. Surveys comprised searching the ground layer (overturning logs and leaf litter) and low vegetation (under bark and in tree stumps), and recording all individuals observed. Species presence was also determined via secondary evidence, in the form of scats, tracks, diggings, burrows and remains
- Nocturnal searching – 90 person minutes were expended performing nocturnal searches at each trap site (where safety permitted). The nocturnal searches were conducted using a combination of high-powered spotlights and head torches. Spotlighting was conducted via foot traverse on land and also from boats along the banks of the river.

In addition to the non-systematic surveys at the trap sites, non-systematic surveys were also conducted throughout the study area in the form of incidental opportunistic observations. All vertebrate species observed or heard within the study area were noted and indirect evidence

(such as scats, tracks, diggings, nests or dreys, feathers, bones and pellets) indicating the current or recent presence of species were recorded. Wherever possible, numbers of individuals, microhabitat use and other relevant information was recorded. Scat samples were sent to a specialist (Georgeanna Storey from Scats About Australia) for analysis and identification.

Habitat assessments

Individual habitat types along the length of the rivers, including the riparian fringe and adjacent 500 m, were identified and classified for the purposes of the Project. Habitat types are essentially vegetation communities with shared structural and floristic characteristics that provide a unique suite of resources for terrestrial wildlife. Habitat assessments were undertaken at each survey site and at sites representative of each habitat type throughout the Project footprint. This method provided a means of assessing the ecological value of each habitat. The following parameters were recorded during the habitat assessments:

- Structural complexity of vegetation (e.g. tree density, canopy cover and vertical structural complexity)
- Complexity of ground-level microhabitats (e.g. substrate type, vegetation cover, leaf litter, woody debris and presence of rocks)
- Habitat features (e.g. hollows, fallen logs, rock outcrops, nests, and water bodies)
- Abundance of hollow-bearing trees and the proportion of trees bearing arboreal mammal scratches
- Wildlife traces (e.g. scats, tracks, scratches, diggings, burrows, nests and bones)
- Opportunistic wildlife observations
- Sources of disturbance (e.g. adjacent land-use, feral animals, predation and weed infestation).

Indicative terrestrial habitat boundaries were mapped from aerial photographs and verified in the field.

The relative ecological value (REV) of each habitat type was assessed based on features including:

- The relative abundance and diversity of resources
- The size and relative connectivity of vegetation
- Habitat condition (e.g. the level of disturbance due to weeds, feral animals and cattle grazing)
- Species richness (e.g. the number of fauna species present)
- The presence or potential presence of conservation significant species (listed under the NC Act and / or EPBC Act) and habitat suitable for these species
- Key ecological function, such as value as a habitat corridor or breeding, nesting or roosting site.

The following three categories describe the varying degree of REV of the habitat types identified in the Project footprint (Note: not all habitat components are necessarily applicable to each of the fauna habitat types assessed):

- **High:** Ground flora containing a high number of indigenous species; vegetation community structure; ground, log and litter layer intact and undisturbed; a high level of breeding, nesting,

feeding and roosting resources available; a high richness and diversity of native fauna species; and / or habitat that supports or potentially supports conservation significant species through the provision of important foraging, breeding / nesting and / or shelter resources

- **Moderate:** Ground flora containing a moderate number of indigenous species; vegetation community structure, ground log and litter layer moderately intact and undisturbed; a moderate level of breeding, nesting, feeding and roosting resources available; a moderate richness and diversity of native fauna species; and / or potential for utilisation by conservation significant species
- **Low:** Ground flora containing a low number of indigenous species, vegetation community structure, ground log and litter layer disturbed and modified; a low level of breeding, nesting, feeding and roosting resources available; a low richness and diversity of native fauna species; and little value to conservation significant species.

6.2.4 Future studies and surveys

The following future studies and surveys will be undertaken prior to commencement of construction:

- Surveys will be undertaken to verify the area of Brigalow (*Acacia harpophylla* dominant and co-dominant) present and impacted as a result of the Project. This survey will include 'ecological equivalence' assessments of potential impact areas and offsite sites to determine their condition, which will in turn determine the quantum of offsets required and the suitability of potential offset sites
- Pre-clearance terrestrial surveys (as necessary and appropriate) will be undertaken to identify the location of breeding structures and habitats, such as ground hollows, nests, mounds and burrows, nests in tree hollows, constructed nests on branches, ant nests and hollow nests
- Pre-clearance aquatic surveys will be undertaken immediately prior to disturbance works
- All vegetation to be retained will be surveyed and clearly demarcated
- Prior to initial construction works, all river banks within the construction areas will be surveyed by a suitably trained and qualified ecologist, during the peak Fitzroy River turtle nesting (to November) and hatching (November to March) season. Pre-clearance surveys will occur during and immediately following rainfall events and will involve systematically searching banks for direct and indirect evidence of turtle nesting and hatchlings. Surveys will be repeated throughout the construction period for any new disturbance scheduled to occur during the nesting and hatching season
- A pre-clearing survey will be undertaken to inform the species management programme (SMP)
- The CHMPs inclusive of survey prior to construction and impoundment will be undertaken. Agreed management measures which may include translocation of culturally significant flora.

6.2.5 Likelihood of occurrence determination

The information acquired through the desktop and field assessments described above was used to characterise the existing terrestrial and aquatic ecological values of the Project area. For conservation significant flora and fauna species, a likelihood of occurrence assessment was undertaken to filter listed threatened or migratory species that could potentially occur within the Project footprint to focus assessment on those taxa that have a high potential to occur (are known

or considered likely to occur) within the Project footprint. As specified in Section 5.3 of the Commonwealth assessment guidelines for the Lower Fitzroy River Infrastructure Project – "*Any species or values considered likely or known to occur in areas impacted by the controlled action must be addressed.*" This was used to inform the impact identification process.

Determination of likelihood of occurrence considered information relating to:

- Habitat preferences
- Distribution
- Relative abundance
- Previous records from the region
- The occurrence of suitable habitat within the Project footprint based on field observations
- The confirmed presence of conservation significant species during field surveys.

A likelihood of occurrence ranking was attributed to each conservation significant species, based on the framework outlined in Table 6-8 for flora species and Table 6-9 for fauna species. Where a difference in likelihood of occurrence outcome exists between Eden Bann Weir and Rookwood Weir, the higher likelihood outcome has been assumed across the Project footprint to provide a conservative understanding of the potential to impact a species as a result of the Project being implemented.

Table 6-8 Key to likelihood of occurrence – flora

Likelihood	Category	Definition supporting information
High	The species or ecological has been observed within the Project footprint (known to occur) or there is a high potential that a species or ecological community occurs within the Project footprint (likely to occur)	Species / community has been recorded during field surveys in the Project footprint **OR** Species has been recorded within the Project footprint from desktop searches **AND** suitable habitat is present in the Project footprint
Moderate	Suitable habitat for a species or ecological community occurs on the site, but there is insufficient information to categorise the species or ecological community as high or low potential to occur	Species' distribution incorporates the Project footprint (or part(s) thereof) **AND** potentially suitable habitat occurs in the Project footprint
Low	A very low to low potential that a species or ecological community occurs within the Project footprint	Suitable habitat is absent from Project footprint

Table 6-9 Key to likelihood of occurrence – fauna

Likelihood	Category	Definition supporting information
High	The species or ecological has been observed on the site (known to occur) or there is a high probability that a species or ecological community occurs on the site (likely to occur)	Species / community has been recorded during field surveys in the Project footprint **OR** Species has been recorded from desktop search extent **AND** suitable habitat is present in the Project footprint
Moderate	Suitable habitat for a species or ecological community occurs on the site, but there is insufficient information to categorise the species or ecological community as high or low probability or occurring	Species has not been recorded from desktop search extent although species' distribution incorporates the Project footprint (or part(s) thereof) **AND** potentially suitable habitat occurs in the Project footprint **OR** Species has been recorded from desktop search extent **AND** suitable habitat is generally lacking from Project footprint
Low	A very low to low probability that a species or ecological community occurs on the site	Species has not been recorded from desktop search extent **AND/OR** current known distribution does not encompass Project footprint **AND** suitable habitat is absent from Project footprint

6.2.6 Impact assessment methodology

6.2.6.1 Significant impact guidelines

In consideration of construction and operational activities of the Project, potential impacts have been identified and described with respect to flora and fauna species and vegetation communities that have a high potential (known or considered likely) to occur within the Project footprint (as per the criteria nominated in Table 6-9). Mitigation measures to avoid/minimise/offset impacts to identified MNES resulting from the construction and operational activities associated with the Project have been proposed.

The significance of residual impacts, post-mitigation, was evaluated with consideration to the Commonwealth Department of the Environment significance criteria, which are provided in Matters of National Environmental Significance Significant impact guidelines 1.1 (hereafter MNES Guidelines) (DoE 2013).

These guidelines define a significant impact as an:

"impact which is important, notable, or of consequence, having regard to its context or integrity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted and upon the intensity, duration, magnitude and geographic extent of the impacts".

This assessment of impacts of the Project draws on the Significant Impact Guidelines to determine whether the proposed action will have significant impacts on the controlling provisions for the Project.

In considering impact to listed taxa and communities, assessment was also made to identify relevant matters for impact assessment in relation to the following:

- An important population – for listed vulnerable threatened species

- Habitat critical to survival – for listed threatened species
- Important habitat – for migratory species.

These are defined as follows.

Important population

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal
- Populations that are necessary for maintaining genetic diversity
- Populations that are near the limit of the species range.

Habitat critical to the survival of a species or ecological community

Areas that are necessary for:

- Activities such as foraging, breeding, roosting, or dispersal
- The long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- Maintenance of genetic diversity and long term evolutionary development
- The reintroduction of populations or recovery of the species or ecological community
- Such habitat may be, but is not limited to habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/ or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.

Important habitat

An 'important habitat' for migratory species is considered to be one or more of the following:

- Habitat used by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species
- Habitat that is of critical importance to the species at particular life-cycle stages
- Habitat utilised by a migratory species which is at the limit of the species range
- Habitat within an area where the species is declining.

6.3 Surface water flows and water quality

6.3.1 Overview

The Project is not expected to have direct impacts on the Great Barrier Reef World Heritage Area (GBRWHA) and is located approximately 141 km upstream of the GBRWHA. Indirect impacts may arise from changes in flows and water quality from the Fitzroy River.

Downstream impacts on the Fitzroy River estuary as a result of changes to flow regimes and water quality have been assessed as follows:

- Desktop assessment of existing pressures and condition from published information

- Identification and evaluation of indirect Project related impacts on the World Heritage Area and Outstanding Universal Values
- Identification of any mitigation measures required to manage impacts.

Detailed methodologies with regard to surface water analysis and assessment are provided in Appendix P.

6.3.2 Stream flow hydrology

To characterise flows within the Fitzroy, Mackenzie and Dawson rivers (as reflective of flows in the Project area) flow data from four stream gauging stations was assessed:

- The Gap (130 005A) gauging station on the Fitzroy River at 142.1 km adopted middle thread distance (AMTD), approximately 1 km upstream from the existing Eden Bann Weir and situated within the current impoundment. The associated catchment covers an area of 135,757 km^2. Records commenced in 1964 at which time the location was unregulated. Since the start of operations of the Eden Bann Weir (in 1994), the gauge has reflected a regulated impoundment. The gauge currently records time series flow and water quality data
- Riverslea (130 003B) gauging station is on the Fitzroy River at 276 km AMTD within an unregulated stretch of the river approximately 11 km upstream of the proposed Rookwood Weir. The associated catchment spans an area of 131,385 km^2. The record at Riverslea commenced in 1974 and is still current. The gauge records time series flow data only
- Coolmaringa (130 105A) gauging station is located at 376 km AMTD on the Mackenzie River, downstream of Tartrus Weir and upstream of the confluence with the Dawson River. The associated catchment area is 76,645 km^2. The gauge commenced its record in 1971 and remains current recording both time series flow and water quality data
- Beckers (130 322A) gauging station is located at 71 km AMTD on the Dawson River, downstream of the Neville Hewitt Weir (82.6 km AMTD). The associated catchment spans an area of 40,500 km^2. The gauge has been in operation since 1964 and remains current. It records both time series flow and water quality data.

Stream flow data is not available from the Bureau of Meteorology (BoM) station at Laurel Bank, located approximately 12 km upstream from the Fitzroy Barrage. This station does not record stream flow data but rather acts as a flood warning river height station.

A common historic period of data was determined as the period 1974 to 2009. That is a common period for all the available record from which data from all four sites was available. Flow patterns for a more 'current' period (that is the last ten years of data[2]) were evaluated by interrogating data for the period 1999/2000 to 2009.

For each dataset (that is at each gauging station), and for each period within the dataset (that is historic and current records), the following information has been prepared to inform discussion on stream flow characteristics in the Project area:

- Hydrographs presenting flow discharges and the longer term variability in flows (as total annual flow) for the historic and current periods, respectively at each gauging station

[2] Data analysis was undertaken in 2009. It is considered that for the purposes of the EIS the datasets interrogated reflect the historic and current flow regimes within the Fitzroy, Dawson and Mackenzie Rivers. The period analysed incorporates the recent prolonged drought years. Further, no new areas have been regulated and operational regimes of the system remain largely unchanged from 2009.

- Flow duration curves summarising the range and distribution of flows for the historic and current periods at all selected gauging stations
- The average total monthly flow (in megalitres (ML)) reflecting the seasonal variability in flow historic and current periods for each gauging station.

6.3.3 Integrated Quantity Quality Model

The Project yield is assessed using the Integrated Quantity Quality Model (IQQM). IQQM is a computer program with associated statistical analysis and reporting programs developed by the Department of Natural Resources and Mines (DNRM) and the Department of Science, Information Technology, Innovation and the Arts (DSITIA). The IQQM simulates daily stream flows, flow management, storages, releases, in-stream infrastructure, water diversions, water demands and other hydrologic events in the Fitzroy water resource plan (WRP) area.

Detailed methodologies with regard to surface water analysis and assessment are provided in Appendix P.

For the purposes of the Project, the IQQM is specifically used to determine Project yields and whether the proposed water extraction is consistent with water users and environmental flow objectives. Further simulation of flows at the end of the system (nominated at a location downstream of the Fitzroy Barrage to represent flows to the estuarine and marine environment) provided for the assessment of potential impacts of altered flow regimes on the GBRWHA.

Data was analysed using the multivariate statistical program Primer v. 6.0 (Clarke and Gorley 2006). Data were subjected to non-metric multidimensional scaling (MDS) and one-way analysis of similarities (ANOSIM). ANOSIM was employed as this is a permutation based hypothesis testing tool, used to identify significant differences between defined factors.

The data sets comprised low flow events interspersed with a small number of very large flow events. In order to examine the relatively small changes between the low flow events, the $\log_{10}(x+1)$ transformation of the data was retained. This transformation resulted in the relative importance of the very large flow events being down-weighted in favour of the typical conditions. After the data was $\log_{10}(x+1)$ transformed, similarity matrices were produced based on Euclidean distances. Each matrix, calculated to display the similarity between pairs of samples, formed the basis of both the MDS and ANOSIM analysis.

A range of flow regimes were investigated based on the total annual flow under existing conditions. To identify representative flow regimes, annual flow was graphically represented in ascending order, with the lowest (1969) and highest (1918) flow years selected. Every tenth year was then identified for analysis, resulting in a total of 13 years that capture the range of flow regimes present in the data). Non-metric MDS and ANOSIM were undertaken for each of the identified years, comparing each construction scenario to the base case scenario (Scenario 1). For these analyses data were pooled across months for each identified year under each flow scenario. Monthly flow data used in this context is considered to be the most suitable to allow for intra-annual variability in wet and dry seasons to be incorporated into the analysis. The results of the ANOSIM were tested for three significance levels (P = 0.1, 0.05, and 0.01).

6.3.4 Water quality data analysis

6.3.4.1 Desktop assessment

The desktop assessment consisted of a review of the available literature and water quality datasets. In order to assess water quality characteristics of the study area, long-term, mine dewatering event and short term datasets were obtained and evaluated to analyse the most appropriate data. This included data from four DNRM stream gauging stations as described in Section 6.3.2 and from SunWater Limited (SunWater) at Eden Bann Weir. Data was collected at Eden Bann Weir at various intervals from September 2001 to October 2013 at the following three monitoring sites:

- Fitzroy River at Wattlebank (139 km AMTD) (tailwater): located approximately 2 km downstream of Eden Bann Weir
- Fitzroy River at The Gap (130005A, 142.1 km AMTD) (headwater)
- Fitzroy River at Eden Bann Weir (inflow (Glenroy Crossing)).

Table 6-10 summaries the datasets used from each stream gauging stations.

In January and February 2008, significant rainfall events across the Fitzroy Basin resulted in the flooding of a number of coal mines which subsequently discharged water into watercourses at multiple locations within the Fitzroy Basin.

Summary statistics for water quality parameters were acquired for each of the sites over the entire period in which parameters were sampled to provide a 'snapshot' of the general water quality characteristics of each of the four monitoring sites in the decade preceding the 2008 mine dewatering event (long term dataset) as well as the short term dataset.

Table 6-10 Summary of water quality datasets

Stream gauge station	Long-term dataset	Mine dewatering event	Short-term dataset
Fitzroy River at The Gap (within Eden Bann Weir pond)	1964 – 2006	October 2008 – January 2009	March 2009 – November 2012
Fitzroy River at Riverslea	1964 – 2006	October 2008 – December 2008	September 2010 – October 2012
Dawson River at Beckers	1964 – 2006	No data (Not sampled)	April 2009 – November 2012
Mackenzie River at Coolmaringa	1972 – 2006	October 2008 – December 2008	April 2009 – October 2012

Key:

Long-term datasets:	Several decades of data
Mine dewatering event datasets:	Late 2008 / early 2009 (summary of post mine dewatering sampling)
Short-term datasets:	Recently collected data 2009 - 2012

Datasets were evaluated based on:

- Intent of original data collection
- Location of sampling points
- Time period during which samples were collected
- Reliability and representativeness of the data

- Parameters being recorded
- Method of data collection.

The desktop assessment also reviewed available literature and water quality data pertaining to the Fitzroy River estuary and GBRWHA receiving waters. The literature was used to inform a general characterisation of water quality in estuarine and marine environments downstream of the Project.

6.3.4.2 Data analysis

In order to characterise the general ambient water quality conditions in the study area prior to discharge from the flooded mines, a subset (four water stream gauging stations) of the data was analysed to describe baseline conditions.

The stream gauging station sites were selected for analysis because they are situated upstream and downstream of both Eden Bann Weir and the proposed Rookwood Weir site locations and provided the most complete and spatially appropriate datasets.

Summary statistics for water quality parameters were acquired for each of the sites over the entire period in which parameters were sampled to provide a 'snapshot' of the general water quality characteristics of each of the four monitoring sites in the decade preceding the 2008 mine dewatering event (long term dataset) as well as the short term dataset.

In addition SunWater data collected at Eden Bann Weir for various intervals between 2001 and 2013 was analysed to describe baseline conditions within and immediately downstream of the existing impoundment.

It is acknowledged that there are some gaps in water quality data where not all water quality parameters were recorded at specific sites. The datasets used in the assessment are considered sufficient for the scope of this study which is to provide a general characterisation/baseline understanding of the water quality upstream and downstream of proposed Project infrastructure. The long term dataset for Riverslea was not complete (data was missing for the period 1998-2007).

Summary statistics were provided for the following water quality parameters (as available and relevant):

- pH
- Electrical conductivity
- Water temperature
- Dissolved oxygen
- Turbidity
- Total Suspended Solids
- Total Nitrogen (TN)
- Total Phosphorus (TP)
- Chlorophyll a.

Within the summary statistics, *median* values have been assessed against the adopted guidelines. Median values were selected for assessment as these are likely to provide the most representative indication of the baseline values of each water quality parameter, and are less

likely to be impacted by extreme values. For completeness, 90th and 10th percentiles and maximum values are also presented.

Where data was available, dissolved metal concentrations were also analysed. These included:

- Aluminium
- Copper
- Iron
- Magnesium
- Manganese
- Zinc.

6.3.4.3 Potential nutrient loads

A study was conducted to determine the rate at which the nitrates and phosphates will break down within the impoundment area during the Project's operation. This was carried out to determine the Project's contribution to the nutrient load (TN and TP) of the Fitzroy system.

The above ground vegetation biomass for N and P was calculated using the Full Carbon Accounting Model (FullCAM) (Richards and Evans 2000). The FullCAM program requires a series of GPS data points to be entered into the program. For the purposes of this exercise, ten GPS points were chosen to be entered. These data points then provided an average location for the program to be simulated around. The program identifies a number of parameters, including:

- Soil data
- Regional soils list
- Maximum above ground forest biomass
- Forest productivity index (annual rate)
- Average air temperature
- Rainfall
- Open-pan evaporation
- Forest topsoil moisture deficit
- Tree species groups for Queensland.

Running the FullCAM program provided an output which shows the total dry mass of above ground biomass per hectare. Below ground biomass was calculated using the National Carbon Accounting System (Australian Greenhouse Office, 2002). The proportion of above ground biomass for coarse and fine root masses, as well as stems, bark, branches and leaves was identified. A range of literature was used to derive an approximate proportion of nutrient to dry mass for acacia woodland and eucalypt woodland (1.02 per cent nitrogen component of dry mass per hectare). A decay coefficient of 0.62 yr $^{-1}$ was adopted. The calculations for the phosphorus component also adopt literature figures for the approximate proportions of nutrient to dry mass for acacia woodland and eucalypt woodland (0.18 per cent phosphorous component of dry mass per hectare). A decay coefficient of 0.51 yr $^{-1}$ was adopted.

6.4 Social impact assessment

The Project social impact assessment (SIA) was prepared in accordance with principles outlined by the International Association for Impact Assessment (IAIA 2003). The SIA identifies and analyses the potential social impacts of the Project and proposes mitigation, management and monitoring measures with the aim of increasing the social sustainability and equity of the Project.

The following activities were undertaken and sources were utilised to identify and assess potential social impacts:

- Technical studies undertaken to inform the EIS
- Consultation with key stakeholders, including directly affected landholders, interested community members and community groups and State government departments (Chapter 4 Consultation)
- Previous relevant studies undertaken in the area
- Literature reviews.

The SIA methodology involves:

- Defining the stakeholders, study areas and preliminary impacts associated with the Project
- Developing a community profile and social baseline that describes the local area, its history, characteristics of the local people and their values and aspirations
- Identifying and assessing change processes and social impacts including the significance of each impact
- Developing a social impact management plan that recommends measures to mitigate negative impacts and enhance positive impacts as well as a framework for monitoring social impacts.

A key component of the SIA process was community and stakeholder consultation. The consultation process has been ongoing since 2008 and has included a number of targeted activities which provided all stakeholders (including landholders and the wider community) opportunity to participate and provide feedback on the Project (Chapter 4 Consultation).

A systematic process was followed when assessing the significance of the identified potential impacts. This process employs a social impact significance matrix as the main tool for identifying the significance of the potential social impacts. The matrix analyses impacts in terms of the following characteristics:

- The stakeholders impacted
- The likelihood of the impact occurring
- The consequence of the impact on the affected stakeholders
- Status of the impact, that is whether it is positive of negative
- The duration of the impact
- Spatial extent of the impact
- The importance of the impact to stakeholders.

The analysis of potential social impacts informed the identification of mitigation and monitoring strategies appropriate for the nature and scale of the identified social impacts.

6.5 Cumulative and consequential impacts

Evaluation of cumulative and consequential impacts on MNES has been undertaken using existing data and data gathered as part of technical studies undertaken for the EIS. Detailed information can be found within the respective draft EIS chapters. Information on other projects in the region that are either planned, under development or in operation was drawn from information available in the public domain.

The methodology for undertaking the cumulative impact assessment is based on an internationally recognised process (Council of Environmental Quality 1997) but modified to reflect the scale of the Project in the context of current and likely future pressures on MNES values.

The following process has been developed for undertaking the assessment of cumulative impacts:

- Define relevant MNES and boundaries of the assessment
- Identify pressures on MNES from current activities within identified study areas (baseline conditions)
- Identify future pressures on MNES from proposed developments
- Assess the Project's contribution to cumulative impacts on MNES.

Boundaries necessary for adequate assessment of cumulative impacts vary between different MNES. As such, two study areas have been identified for the assessment of the Project's contribution to cumulative impacts as follows:

- Catchment study area: Defined as the Fitzroy Basin catchment comprising the Comet River, Dawson River, Fitzroy River, Isaac River, Mackenzie River and Nogoa River sub-catchments. This study area is relevant for assessing cumulative impacts on aquatic ecology, water quality and surface water resources (Figure 6-8) with a focus on areas within and downstream of the Project footprint
- Bio-subregion study area: Defined as the subregions within the Brigalow Belt bioregion which are directly impacted by the Project footprint. This includes the Marlborough Plains, Mount Morgan Ranges, Boomer Range, Isaac-Comet Downs and the Dawson River Downs subregions. Subregions not directly impacted by the Project footprint have been excluded as the assessment of impact is based on the proportion of impacted vegetation occurring in the subregion. This study area is relevant for assessing cumulative impacts on terrestrial ecology (Figure 6-9).

Existing and proposed developments were determined using a number of Queensland Government sources including:

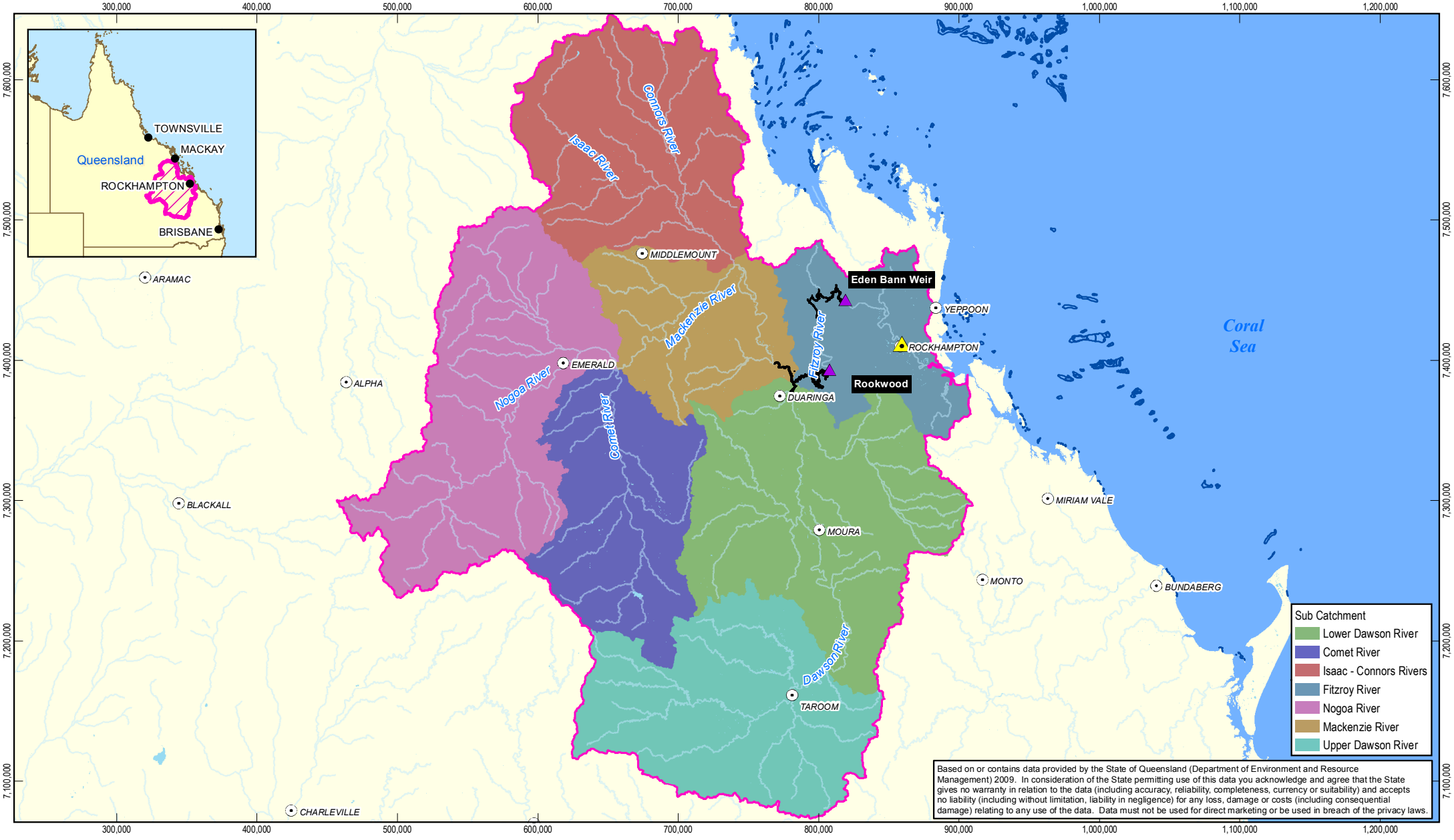
- Queensland Government Department of Natural Resources and Mines industry updates:
  - Queensland's coal seam gas overview (January 2014) (DNRM 2014a)
  - Queensland's mineral, coal and petroleum operations and resources map (2014) (DNRM 2014b)
  - Queensland's coal - mines and advanced projects (October 2013) (DNRM 2013a)
  - Queensland's coal development projects (Quarter 4, 2013) (DNRM 2013b)
  - Central Queensland energy and mineral development projects (Quarter 3, 2013) (DNRM 2013c).

- Department of State Development Infrastructure and Planning (DSDIP) 'coordinated projects' website
- Department of Environment and Heritage Protection (DEHP) current and concluded EIS processes.

Proposed projects within the study areas were identified as known potential future projects that are accessible in the public domain (mainly government websites), including those currently undergoing assessment under a statutory process such as the *State Development and Public Works Act 1971* (Qld), *Environmental Protection Act 1994* (Qld) or EPBC Act. It is important to note that not all of the listed projects are likely to proceed in the short to medium term.

Consequential impacts have been identified on the basis of the following:

- Identify projects that are either proposed or recently approved but not yet operational and are directly linked to the operation of the Project
- Identify those elements of the linked projects which would not occur unless the Project proceeds.



1:3,600,000 (at A4)

0 25 50 75 100

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
- Fitzroy Barrage
- Waterway (Major)
- Waterway (Minor)
- Fitzroy basin catchment
- Lakes
- Impoundment area

GHD
CLIENTS | PEOPLE | PERFORMANCE

Gladstone Area Water Board

SunWater Making Water Work

Gladstone Area Water Board, SunWater
Lower Fitzroy River Infrastructure Project

Job Number 41-20736
Revision D
Date 03 Nov 2014

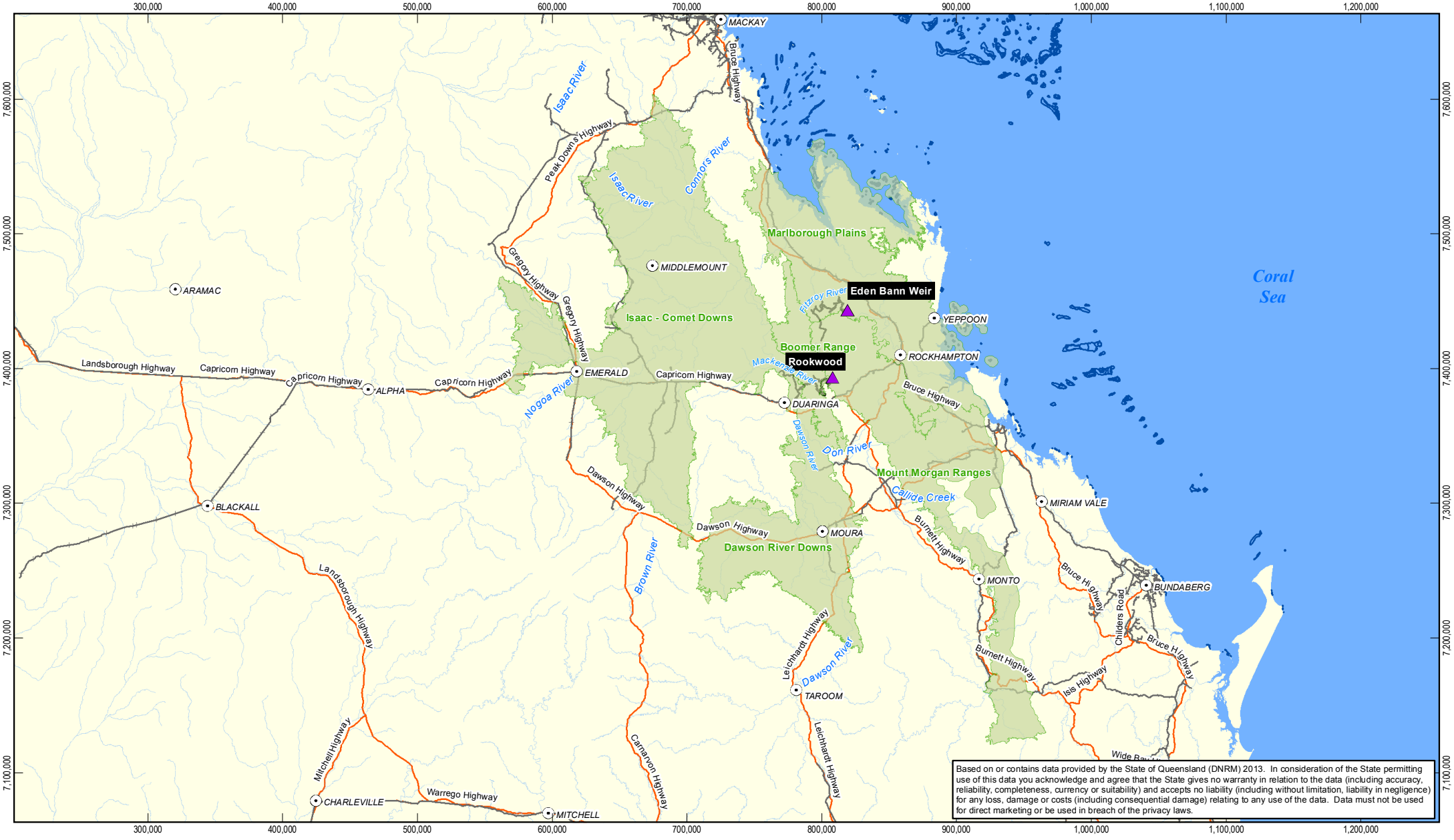
Catchment study area

Figure 6-8

G:\41\20736\GIS\Projects\MXD\200_Report\4120736_281_Rev_D.mxd

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: Weir Locations - 2008; DERM: Sub-catchments - 2012. Created by: AJ/MS *See Appendix for disclaimers and copyrights.



Based on or contains data provided by the State of Queensland (DNRM) 2013. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

1:3,750,000 (at A4)

0 25 50 75 100

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

GHD
CLIENTS | PEOPLE | PERFORMANCE

Gladstone Area Water Board

SunWater Making Water Work

Gladstone Area Water Board, SunWater
Lower Fitzroy River Infrastructure Project

Job Number	41-20736
Revision	B
Date	03 Nov 2014

Bio-subregion study area

Figure 6-9

G:\41\20736\GIS\Projects\MXD\200_Report\4120736_356_rev_b.mxd

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: Weir Locations (2008); DNRM: Railways, Roads, Bioregions (2010)
Created by: MS *See Appendix for disclaimers and copyrights.