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9. SENSITIVE ENVIRONMENTAL AREAS

This section addresses Section 3.3.1 of the ToR by identifying areas that are environmentally sensitive in proximity to the Project or which may potentially be impacted by the Project. Information on these areas is summarised in the sections below, and addressed in more detail in Chapter 10 Terrestrial Flora, Chapter 11 Terrestrial Fauna and Chapter 12 Aquatic Flora and Chapter 13 Aquatic Fauna.

9.1. Methodology

Sensitive environmental areas were identified through a desktop review of relevant databases and mapping as well as from results of previous field surveys of the Project area. Environmentally sensitive areas include those designated or zoned under legislation or a planning scheme, such as nature refuges, national parks, conservation parks, declared fish habitat areas, wilderness areas, aquatic reserves, heritage/historic areas or items, national estates, world heritage areas and sites covered by international treaties or agreements (e.g. Ramsar), areas of cultural significance and scientific reserves.

Areas which are not specifically proclaimed but which would be regarded as sensitive with regard to the natural environment have one or more of the following features:

- regional ecosystems recognised as 'endangered' or 'of concern' under State legislation and/or ecological communities listed as threatened under the EPBC Act;
- important habitats of species listed as threatened under the *Nature Conservation Act 1992* (Qld) or *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- wetlands or flight paths of importance to migratory birds protected under international agreements; and
- ecosystems which provide important ecological functions, such as riparian vegetation, buffers to a protected area, refugia or important habitat corridor between areas (such as determined by the EPA's Biodiversity Planning Assessment (BPA) process).

9.2. Terrestrial environments

9.2.1. Protected areas

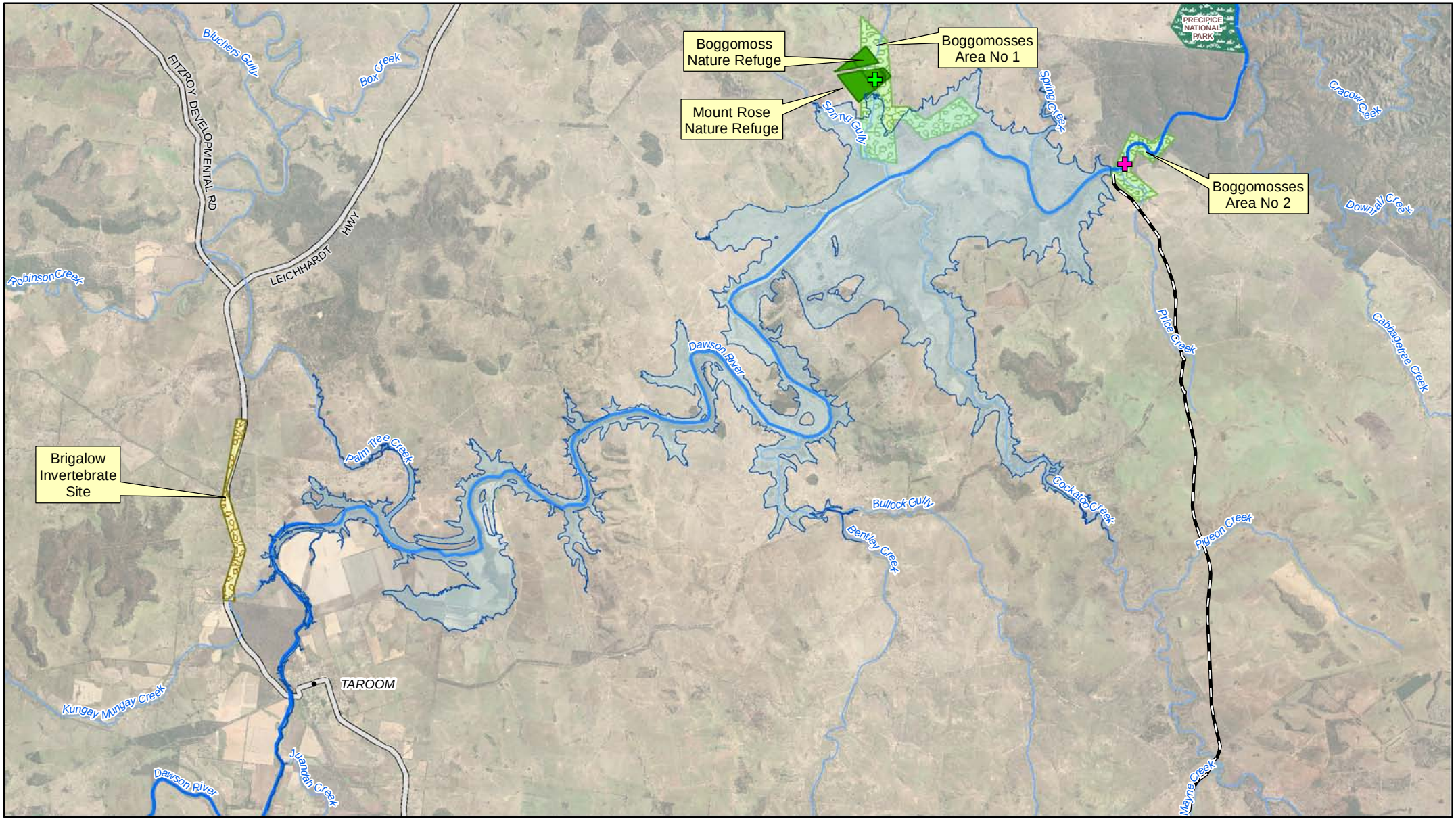
A number of protected areas are located in the vicinity of the Project area (Table 9-1).

The location and extent of protected areas within the vicinity of the dam and Pipeline study areas are shown in Figure 9-1 and Figure 9-2, respectively. The Project will not impact on the Brigalow Invertebrate Site or any national parks. Inundation to FSL will affect the Mt Rose and Boggomoss Nature Reserves and Boggomosses Areas No. 1 and No. 2. Impacts on the spring communities associated with these boggomoss areas are discussed in Section 10.2.1.2 for the dam and surrounds and Section 10.2.2.2 for the pipeline.

Table 9-1 Protected areas located in the vicinity of the Project area

Protected area	Name
National Parks (NP)	Precipice NP and Isla Gorge NP
State Forests (SF)	Cherwondah SF, Gurulmundi SF, Binkey SF, Barakula SF and Braemar SF
Conservation Areas	Lake Murphy Conservation Area; also listed in the Directory of Important Wetlands
National Estates	Places on the Register of the National Estate (RNE)*, including Brigalow Invertebrate Site (road reserve along Leichhardt Highway), Boggomoss Area No. 1 and Boggomoss Area No. 2
Nature Refuges	Boggomoss Nature Refuge, Mount Rose Nature Refuge
Wilderness Areas	None
Scientific Reserves	None

* Note: Following amendments to the *Australian Heritage Council Act 2003* (AHC Act), the RNE was frozen on 19 February 2007, which means that no new places can be added, or removed. The Register will continue as a statutory register until February 2012. During this period the Environment Minister is required to continue considering the Register when making some decisions under the EPBC Act. This transition period also allows states, territories, local and the Australian Government to complete the task of transferring places to appropriate heritage registers where necessary and to amend legislation that refers to the RNE as a statutory list. From February 2012 all references to the Register will be removed from the EPBC Act and the AHC Act. The RNE will be maintained after this time on a non-statutory basis as a publicly available archive (DSEWPC, 2010).



LEGEND

- Town
- Major Road
- Proposed Pipeline
- Major Watercourse
- Watercourse
- Full Supply Level (183.5m AHD)
- Nature Refuges
- Brigalow Invertebrate Site
- Bogomosses Area
- Park, Forest or Reserve

National Estate Site

- Boggomoss Area 1
- Boggomoss Area 2

Projection: GDA94 Zone 56

Figure 9-1

0 1 2 4 Kilometres

N

Scale 1:200,000 (at A4)

SKM SunWater Making Water Work

NATHAN DAM AND PIPELINES EIS

Protected areas in the vicinity of the dam study area

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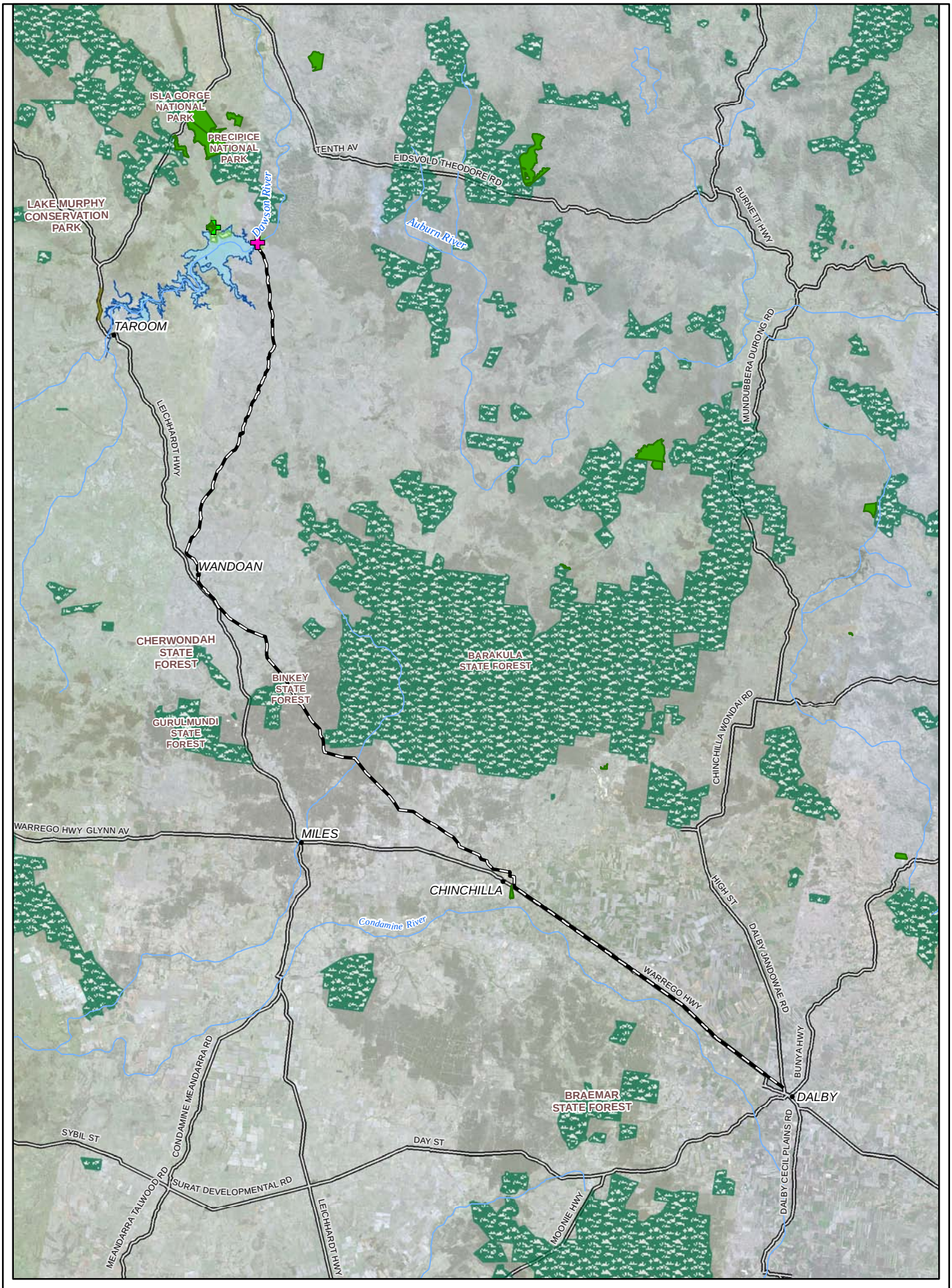

LEGEND

- Town
- Major Road
- Proposed Pipeline
- Watercourse
- Full Supply Level (183.5m AHD)
- Nature Refuges
- Brigalow Invertebrate Site
- Bogomosses Area
- Park, Forest, Reserve

National Estate Site

- Boggomoss Area 1
- Boggomoss Area 2

Projection: GDA94 Zone 56

Figure 9-2

0 5 10 20
Kilometres

N

Scale 1:1,100,000 (at A4)

SKM SunWater Making Water Work

NATHAN DAM AND PIPELINES EIS

Protected areas in the vicinity of the pipeline corridor

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9.2.2. Significant regional ecosystems

There are five Of Concern and nine Endangered Regional Ecosystems (REs) mapped by Chenoweth (2009) as occurring within the Project area. A description of these REs and their distribution within the dam impact area, pipeline corridor and road upgrade areas is provided in Table 9-2. The location of these REs within the dam study area and pipeline corridor is shown in Figure 10-4 and Appendix 10-A, respectively in Chapter 10. REs that will be impacted by the Project are assessed in Section 10.2.1.1 for the dam and surrounds, Section 10.2.2.1 for the pipeline and Section 10.2.3.1 for the associated infrastructure.

Table 9-2 Significant regional ecosystems

Regional Ecosystem	VM Act Status	Biodiversity Status	Short Description	Distribution		
				Dam Impact Area	Pipeline Corridor	Road Upgrades
11.3.1	Endangered	Endangered	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	X	X	
11.3.2	Of concern	Of concern	*Eucalyptus populnea* woodland on alluvial plains	X	X	X
11.3.3	Of concern	Of concern	*Eucalyptus coolabah* woodland on alluvial plains	X		X
11.3.4	Of concern	Of concern	*Eucalyptus tereticornis* and/or *Eucalyptus* sp. tall woodland on alluvial plains	X	X	X
11.3.21	Endangered	Endangered	*Dichanthium sericeum* and/or *Astrebla sp.* grassland on alluvial plains. Cracking clay soils		X	
11.3.22	Of concern	Endangered	Springs associated with recent alluvia, but also including those on fine-grained sedimentary rocks, basalt, ancient alluvia and metamorphic rocks	X		
11.3.25	Least concern	Of concern	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	X		X
11.4.3	Endangered	Endangered	*Acacia harpophylla* and/or *Casuarina cristata* shrubby open forest on Cainozoic clay plains		X	
11.9.1	Endangered	Endangered	*Acacia harpophylla-Eucalyptus cambageana* open forest to woodland on fine-grained sedimentary rocks	X		X
11.9.4a	Endangered	Endangered	Semi-evergreen vine thicket, generally dominated by a low tree layer (5-10m high) which is floristically diverse and variable. Common co dominant species include *Croton insularis*, *Denhamia oleaster*.		X	

Regional Ecosystem	VM Act Status	Biodiversity Status	Short Description	Distribution		
				Dam Impact Area	Pipeline Corridor	Road Upgrades
11.9.5	Endangered	Endangered	*Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks	X	X	X
11.9.5a	Endangered	Endangered	*Acacia harpophylla* predominates and forms a fairly continuous canopy (10-18m high). Other tree species such as *Eucalyptus populnea, Casuarina cristata, Cadellia pentastylis* and *Brachychiton sp.* may also be present in some areas and form part of the canopy or emerge above it.	X		X
11.9.6	Endangered	Endangered	*Acacia melvillei* ± *A. harpophylla* open forest on fine-grained sedimentary rocks		X	
11.9.7	Of concern	Of concern	*Eucalyptus populnea*, *Eremophila mitchellii* shrubby woodland on fine-grained sedimentary rocks	X	X	
11.9.10	Of concern	Endangered	*Acacia harpophylla*, *Eucalyptus populnea* open forest on fine-grained sedimentary rocks	X	X	

X = RE mapped by Chenoweth (2009) within the impact area

9.2.3. Threatened ecological communities

Four ecological communities in the vicinity of the Project area are regarded as threatened under the EPBC Act:

- native grasslands of the Queensland Central Highlands and the northern Fitzroy Basin;
- Brigalow (*Acacia harpophylla* dominant and co-dominant);
- the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin (GAB discharge spring wetlands); and
- semi-evergreen vine thickets (SEVT) of the Brigalow Belt (North and South) and Nandewar Bioregions.

The Brigalow community was recorded within the water storage and pipeline corridor. Although the SEVT community was recorded within the pipeline corridor, it will be avoided in construction of the pipeline easement. Currently 0.07 ha of Natural grassland are likely to be impacted if further alignment changes are not possible.

No GAB discharge spring wetlands were identified throughout the dam study area, in either the water storage and dam construction footprint.

The extent of the Brigalow ecological community within the dam study area is mapped in Figure 10-6. The GAB springs are mapped in Figure 10-7. Impacts on threatened ecological communities are discussed in Section 10.2.1.2 for the dam and surrounds, Section 10.2.2.2 for the pipeline and Section 10.2.3.2 for the associated infrastructure.

9.2.4. Important habitats for threatened flora

Six threatened flora species were recorded during the field surveys, but only five of these are located within the impact area. These are presented in Table 9-3. The extent of known and potential habitat for these species is illustrated in Figure 9-3. Mapped potential habitat is based on the extent of REs within the study area where the species may occur based on previous records. Impacts on threatened flora are discussed in Section 10.2.1.3 for the dam and surrounds, Section 10.2.2.3 for the pipeline and Section 10.2.3 for associated infrastructure. Full lists of threatened flora species potentially occurring in the Project area are provided in Chapter 10.

Table 9-3 Important habitats for threatened flora recorded in the study area

Species Name	Common Name	Status	Habitat	Distribution	
				Dam Impact Area	Pipeline Corridor
Acacia tenuinervis	Scrub Wattle	NT (NC)	REs 11.10.7, 11.9.5		**Known** Recorded within REs 11.10.7/11.9.5 at one location along pipeline corridor between dam wall site and Wandoan and has historically been recorded in RE 11.5.1/11.7.7.
Arthraxon hispidus	Hairy Joint Grass	V (NC, EPBC)	GAB spring wetlands (RE 11.3.22)	**Likely** Recorded in GAB springs 1, 24 and 27 in RE 11.3.22/11.3.4 outside FSL. Given the historical record of this species in GAB springs within the water storage by Fensham and Wilson (1997) it is likely to occur within the impact area.	
Cryptandra ciliata		NT (NC)	REs 11.10.9, 11.10.9/11.10.7, 11.3.3/11.3.4/11.9.1/11.3.1	**Known** Recorded near the dam wall and along Spring Gully in REs 11.10.9, 11.10.9/11.10.7 and 11.3.3 /11.3.4 /11.9.1 /11.3.1.	**Known** Recorded at two locations along pipeline corridor between Wandoan and Chinchilla within communities with a heath understorey dominated by *Corymbia bloxsomei*.
Livistona nitida	Carnarvon Fan Palm	NT (NC)	REs 11.3.22, 11.3.25, 11.3.3	**Known** Recorded in several locations across the water storage in waterways in REs 11.3.25, 11.3.3 and 11.3.22.	**Known** Recorded at one location along pipeline corridor in a non-remnant patch with *Eucalyptus populnea*.
Rutidosis crispata		V (NC)	REs 11.10.9/11.9.1, 11.10.7, 11.10.9	**Known** Recorded in REs 11.10.9/11.9.1, 11.10.7, 11.10.9 on the north and south sides of the Dawson River in the water storage.	
Rutidosis lanata		E (NC)	RE 11.4.3		**Known** Recorded within RE 11.4.3 at one location along pipeline corridor between Wandoan and Chinchilla.

Species Name	Common Name	Status	Habitat	Distribution	
				Dam Impact Area	Pipeline Corridor
Thelypteris confluens		V (NC)	GAB spring wetlands (RE 11.3.22)	**Likely** No survey records but previously recorded by Fensham and Wilson (1997) in GAB spring 23 (RE 11.3.4/11.3.22). This is outside the impact area, but suitable habitat (GAB springs) exists within the impact area.	

E= Endangered; V= Vulnerable; NT= Near Threatened

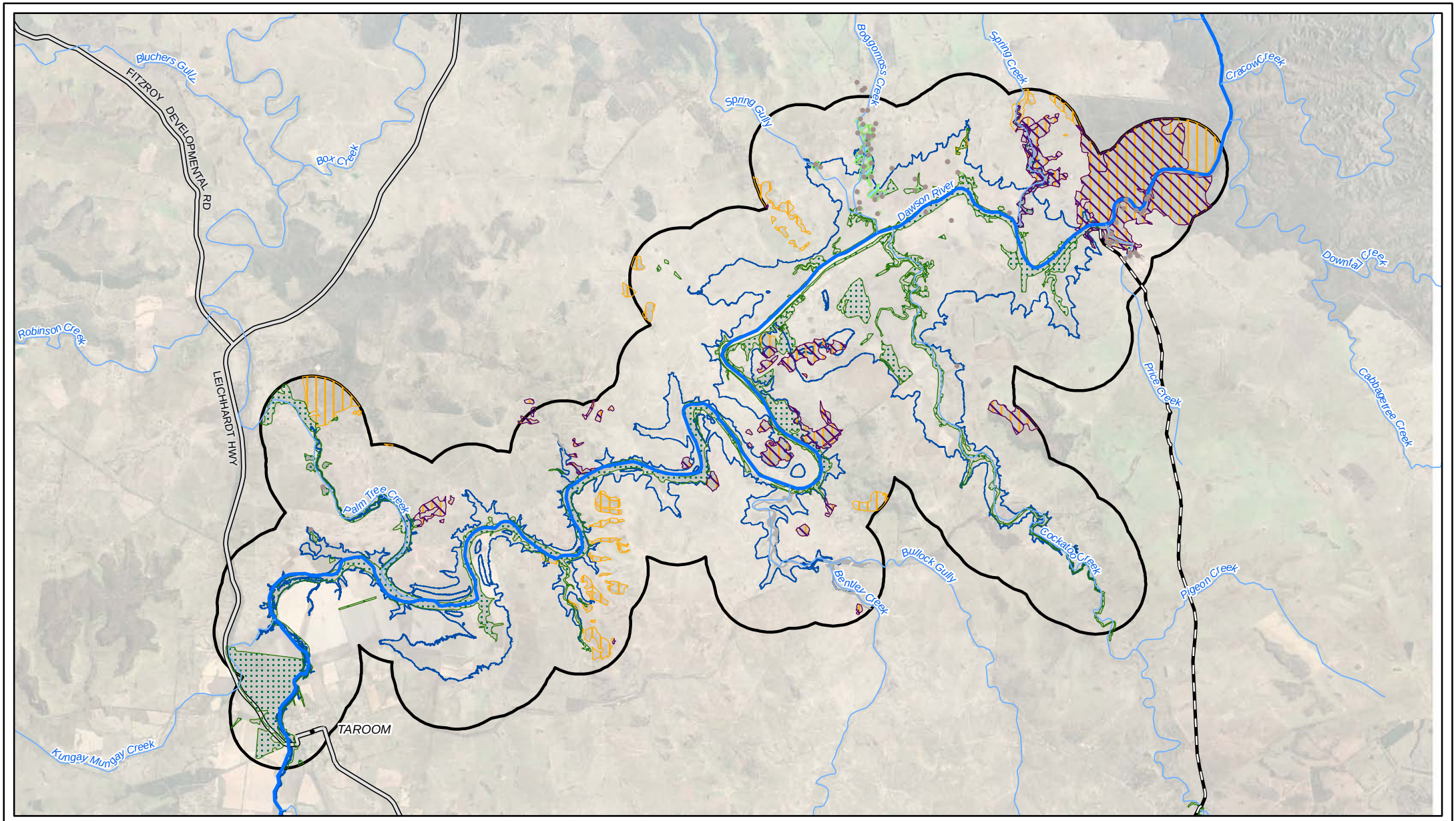
NC = *Nature Conservation (Wildlife) Regulation 2006*

EPBC = *Environment Protection and Biodiversity Conservation Act 1999*

Likelihood of occurrence:

– Known – Species has been positively recorded in this survey or other survey by qualified ecologists during past 30 years; and

– Likely - Remnant vegetation or sites likely to support the species because there is habitat containing essential resources of a size capable of supporting a significant number of individuals. Available habitat which is proximal to and buffering a known occurrence of a population.



LEGEND

- Town
- Major Road
- Proposed Pipeline
- Major Watercourse
- Watercourse
- FSL183_5_MGA56
- Study Area

Flora Habitat

- *Arthraxon hispidus*
- *Cryptandra ciliata*
- *Livistona nitida*
- *Rutidosis crispata*
- *Thelypteris confluens*

Projection: GDA94 Zone 56

Figure 9-3

0 1 2 4
Kilometres

N

Scale 1:200,000 (at A4)

SKM SunWater Making Water Work

NATHAN DAM AND PIPELINES EIS

Potential habitat for threatened flora in the dam study area

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9.2.5. Biodiversity planning assessment

Review of the Biodiversity Planning Assessment (BPA) data for the Brigalow Belt South (BBS) Bioregion showed that very few vegetation patches within the dam study area are ascribed a high corridor value (Figure 11-3). In the vicinity of the dam study area, notable patches include Nathan Gorge and Precipice NP, Taroom Town Common and the Dawson River. North-south connections are generally absent and east-west connections are primarily along the Dawson River. A major north-south connection is located approximately 10 km downstream of the dam wall which encompasses Precipice NP and Isla Gorge NP.

The BPA data for the pipeline study area revealed that a number of bioregional wildlife corridors are intersected by the pipeline corridor (Figure 11-5). Barakula SF lies approximately 5 km to the north east of the pipeline route (at its closest point) and is considered a 'core' area by the Department of Environment and Resources Management (DERM). Two corridors of state significance emanate from Barakula SF and are crossed by the pipeline route. These include the corridor that runs from Western Creek/Dunmore to Barakula SF through Kogan, and the corridor that links Barakula SF to Yuleba (west of Miles on the Warrego Highway). In addition, a number of creeks crossed by the pipeline route are mapped as bioregional wildlife corridors, including Charleys Creek, Rocky Creek, Dogwood Creek, Bottle Tree Creek, Juandah Creek and Cockatoo Creek. Rocky Creek and Charleys Creek are mapped as corridors of state significance and provide essential connections between large areas of core habitat (e.g. Barakula SF). Juandah Creek and Cockatoo Creek are considered to be of regional significance and provide movement opportunities through the fragmented landscape.

9.2.6. Important habitats for threatened fauna

Eleven threatened fauna species were recorded during the field surveys, but only six of these species are located within the impact area. These are listed in Table 9-4. The extent of known and potential habitat for these species (with the exception of the Boggomoss Snail) is illustrated in Figure 9-4. Records of the Boggomoss Snail and locations of confirmed breeding sub-populations in the region are shown on Figure 11-6. This is based on the collective survey efforts by BAAM (2008), SKM (2009) and JKR Ecological (2010). Mapped habitat is based on the extent of REs within the study area which provide suitable habitat for this species. Potential impacts on threatened fauna are discussed in Section 11.2.1.3 for dam and surrounds, Section 11.2.2.3 for pipeline and Section 11.2.3 for associated infrastructure. Full lists of threatened fauna species potentially occurring in the Project area are provided in Chapter 11.

Table 9-4 Important habitats for threatened fauna recorded in the Project area

Scientific Name	Common Name	Status	Habitat	Distribution	
				Dam Impact Area	Pipeline Corridor
Cyclorana verrucosa	Rough-collared Frog	R (NC)	REs 11.3.25, 11.3.2, 11.3.3, 11.3.4	**Known** This species was recorded immediately adjacent to the Dawson River downstream of Glebe Weir in RE 11.3.25 within the water storage, and along Spring Creek in RE 11.3.3/11.3.4 outside the impact area.	
Strophurus taenicauda	Golden-tailed Gecko	NT (NC)	REs 11.3.18, 11.3.19, 11.10.7a, 11.10.9, 11.10.11	**Likely** Recorded along Cracow Road between Taroom and Price Creek outside the impact area.	**Likely** Recorded from three sites along Leichardt Highway between Miles and Wandoan during May 2008 study of superseded pipeline route. However similar habitat is present throughout the middle section of the pipeline corridor.
Paradelma orientalis	Brigalow Scaly-foot	V (NC and EPBC)	REs 11.3.1, 11.9.1, 11.9.5, 11.9.5a, 11.9.10, 11.10.7, 11.10.7a, 11.10.9	**Likely** Recorded from Callitris woodland on sand to the north of the dam wall site outside the impact area.	
Hemiaspis damelii	Grey Snake	E (NC)	Pastureland on cracking clay soils (land zone 4)	**Known** A single individual was recorded crossing Glebe Road in the vicinity of Cockatoo Creek in the water storage.	
Geophaps scripta scripta	Squatter Pigeon (Southern)	V (NC; EPBC)	REs 11.3.2, 11.3.3, 11.3.4, 11.3.18, 11.3.25, 11.3.39, 11.10.7, 11.10.7a, 11.10.11, 11.10.13a	**Known** Species detected in woodland of Dawson River and GAB springs in the water storage.	
Falco hypoleucos	Grey Falcon	NT (NC)	REs 11.3.25, 11.3.2, 11.3.3, 11.3.4	**Known** Limited suitable habitat exists throughout the impact area, however this species was observed along the Dawson River.	
Nettapus coromandelianus	Cotton pygmy-goose	NT (NC)	Wetlands and waterbodies	**Likely** Recorded from Lake Murphy Conservation Area, west of the study area. Suitable habitat exists within the impact area.	
Ephippiorhynchus asiaticus	Black-necked stork	NT (NC)	Wetlands and waterbodies	**Likely** Recorded from Lake Murphy Conservation Area, west of the study area. Suitable wetland habitat exists within the impact area.	
Melithreptus gularis	Black-chinned Honeyeater	NT (NC)	Woodland dependent birds, generally absent from small habitat patches.	**Likely** An individual was observed in riparian River Red Gum woodland on the Chain Lagoons located off the Leichhardt Highway west of the dam study	

Scientific Name	Common Name	Status	Habitat	Distribution	
				Dam Impact Area	**Pipeline Corridor**
				area. Potential habitat occurs in the water storage, within riparian woodlands along the Dawson River and tributaries which are relatively connected.	
Chalinolobus picatus	Little Pied Bat	NT (NC)	REs 11.3.2, 11.3.3, 11.3.4, 11.3.18, 11.3.19, 11.3.25, 11.3.39, 11.9.1, 11.9.1, 11.9.10, 11.10.1, 11.10.7, 11.10.7a, 11.10.9, 11.10.11, 11.10.13a	**Known** Detected at 11 of 14 survey sites with Anabat and captured at site 3. Most of these sites located within the water storage.	
Adclarkia dawsonensis	Boggomoss Snail	CE (EPBC)	GAB springs and riparian habitat at Mt Rose, Isla-Delusion Camping Reserve, Southend	**Known** Known to occur at 3 boggomosses at Mt. Rose Station within the water storage.	

E= Endangered; V= Vulnerable; NT= Near Threatened; R = Rare; CE = Critically Endangered

NC = *Nature Conservation (Wildlife) Regulation 2006*

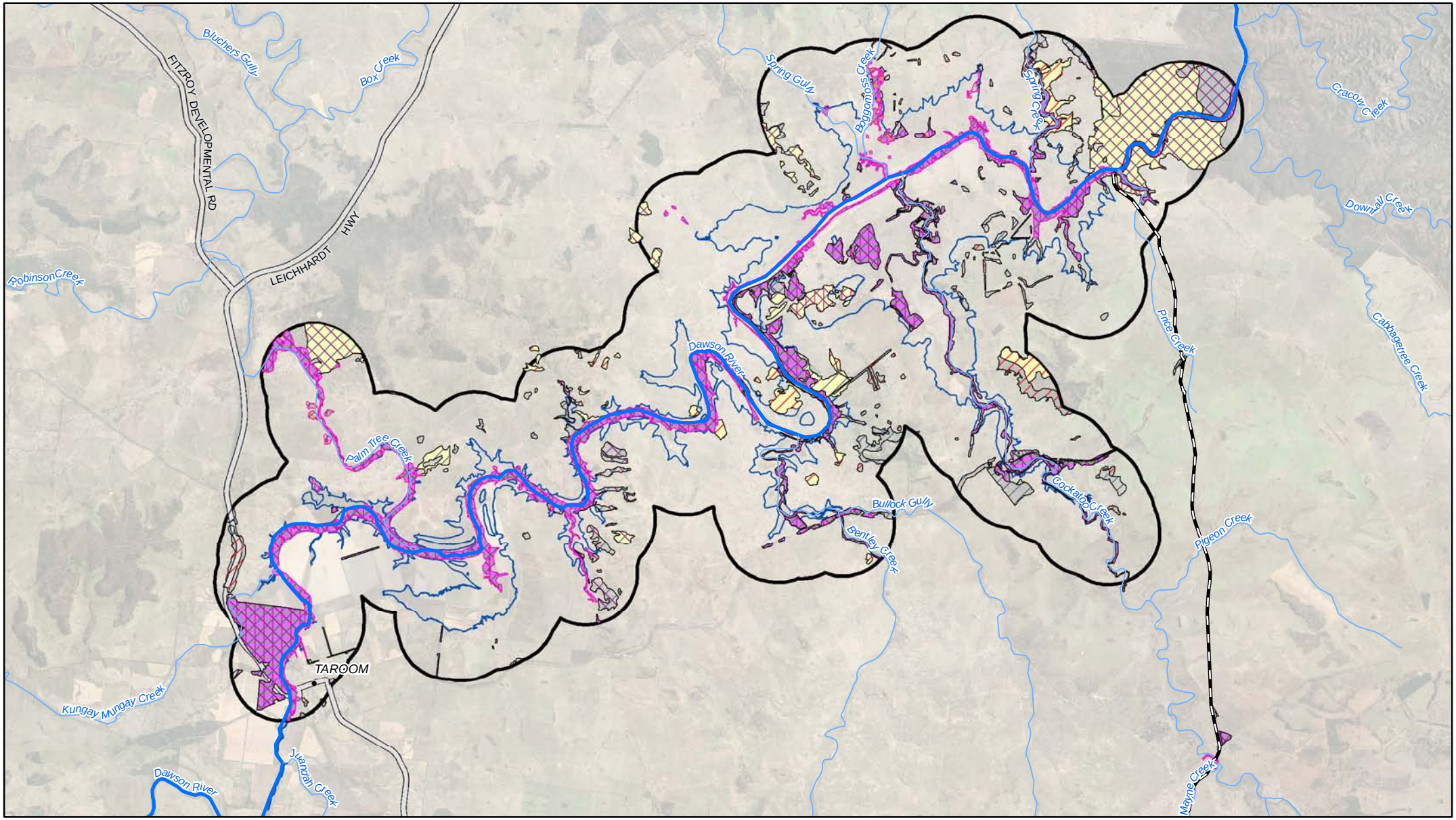
EPBC = *Environment Protection and Biodiversity Conservation Act 1999*

RE = Regional Ecosystem; GAB = Great Artesian Basin

Likelihood of occurrence:

– Known – Species has been positively recorded in this survey or other survey by qualified ecologists during past 30 years; and

– Likely - Remnant vegetation or sites likely to support the species. Suitable habitat is proximal to and buffering a known occurrence of a population.



LEGEND

- Town
- Major Road
- Proposed Pipeline
- Major Watercourse
- Watercourse
- Full Supply Level (183.5m AHD)
- Study Area

Fauna Habitat

- *Chalinolobus picatus*
- *Cyclorana verrucosa*
- *Ephippiorhynchus asiaticus*
- *Falco hypoleucos*
- *Geophaps scripta scripta*
- *Hemiaspis damellii*
- *Melithreptus gularis*
- *Nettapus coromandelianus*
- *Paradelma orientalis*
- *Strophurus taenicauda*

Projection: GDA94 Zone 56

Figure 9-4

0 1 2 4
Kilometres

N

Scale 1:200,000 (at A4)

SKM SunWater Making Water Work

NATHAN DAM AND PIPELINES EIS

Potential habitat for threatened fauna in the dam study area

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9.3. Aquatic environments

9.3.1. Freshwater ecosystems

The environmental values of all waterways in Queensland are protected under the *Environmental Protection (Water) Policy 1997* (EPP Water), and include the biological integrity of aquatic ecosystems. Protection of the health of natural ecosystems is a sought 'environmental outcome' of the *Water Resource (Fitzroy Basin) Plan 1999* (Fitzroy Basin WRP). It should be noted that the Fitzroy WRP2011 was under review at the time of drafting the EIS and therefore the 1999 WRP plan has been used in the assessment of potential impacts and associated compliance. The revised WRP was approved on 8 December 2011 and will be assessed prior to the Project's approval. The beds and banks of watercourses in Queensland are protected under the *Water Act 2000*.

9.3.2. Declared fish habitat areas

Within the Fitzroy River estuary there is a Declared Fish Habitat Area (FHA) – Management level 'A' (DPI&F, 2008b). Management level 'A' is designed to protect critical fish habitat for the purpose of productive and sustainable fishing, short and long term, maintain the ecological character and integrity of undisturbed fisheries habitat and maintain the biodiversity of fisheries resources. The habitat values the declaration seeks to protect are: extensive saltpans; saline grasslands fed by mangrove lined creeks; closed mangrove forests of mixed-species dominated by *Avicennia marina*, *Rhizophora stylosa* and *Ceriops tagal*; mud and sand flats; rocky headlands and brackish lagoons (DPI&F, 2008b).

The nearest point of the Fitzroy River FHA is approximately 750 km downstream of the dam (Figure 9-5). The FHA will not be affected by the Project.

9.3.3. Wetlands of national significance

The Lake Murphy Conservation Area, Boggomoss Springs and Palm Tree Creek are all listed in the Directory of Important Wetlands. The locations of these areas are shown in Figure 9-6. These wetlands will not be affected by the Project. The Boggomoss Springs listed in the Directory of Important Wetlands are located outside the area of groundwater impact from drawdown and inundation (Section 10.2.1.2). However, many boggomosses (GAB spring wetlands) will be affected by project; refer to Section 9.2.3.

9.3.4. Wetlands of international significance (Ramsar wetlands)

There are no wetlands of international significance within the Project area.

The Shoalwater and Corio Bays Area are Wetlands of International Importance. The dam is located approximately 620 km upstream from the mouth of the Fitzroy River and approximately 720 km from the Shoalwater and Corio Bays Area.

9.3.5. World heritage areas

The Fitzroy Basin drains to the Great Barrier Reef (GBR), which is a declared World Heritage Area (the Great Barrier Reef World Heritage Area; GBRWHA) and includes the Great Barrier Reef Marine Park (GBRMP) and the Great Barrier Reef Coastal Marine Park (GBRCMP). The nearest point of the GBRWHA is approximately 750 km downstream of the dam (Figure 9-7).

The GBRMP is a Commonwealth marine park and includes all the waters below the low water mark within the GBR. The GBRCMP is a Queensland State marine park adjacent to the GBRMP and includes inshore, intertidal and estuarine areas to the high water mark (Highest Astronomical Tide; HAT). The GBRWHA and GBRMP will not be affected by the Project and this is discussed in Section 28.4.2.

9.3.6. Important habitats for threatened aquatic species

A full list of threatened aquatic and marine fauna species that may occur in the Project area and downstream is provided in Table 13-1 (Chapter 13). The majority of threatened species identified are marine inhabitants of the Fitzroy Estuary or offshore waters zoned by the GBRWHA, situated approximately 630 km and 750 km downstream from the dam site, respectively. The likelihood for the Project to impact upon marine species is considered minimal (full details provided in Section 13.2). Endangered, Vulnerable and Near Threatened species either known, or with the potential, to inhabit waterbodies within the dam study area or pipeline corridor are listed in Table 9-5. None of the species listed in Table 9-5 were recorded during the Nathan Dam baseline surveys.

Table 9-5 Important habitat for threatened aquatic species

Scientific Name	Common Name	Status	Potential Habitat	Distribution		
				Dam Impact Area	Pipeline Corridor	Road Upgrades
Rheodytes leukops	Fitzroy River Turtle	V (NC; EPBC)	No Fitzroy River Turtles have been identified within or upstream of the Project area. There are, however, records of the Fitzroy River Turtle in the Dawson River, at the Theodore Weir, approximately 128 km downstream of the Glebe Weir (Limpus et al., 2007).	Potential (L)		
Elseya albagula	White-throated Snapping Turtle	LC (NC)	Endemic to Burnett, Fitzroy, Raglan and Mary river drainages in QLD. Prefers permanent flowing waters with high habitat complexity.	Potential		

E = Endangered; V = Vulnerable; NT = Near Threatened; LC = Least Concern.

NC = *Nature Conservation (Wildlife) Regulation 2006*

EPBC = *Environment Protection and Biodiversity Conservation Act 1999*

Known = records exist in the impact area; Potential = potential to inhabit impact area, although no records exist; L = Limpus *et al.* (2007)

LEGEND

- Towns
- Major Road
- Proposed Pipeline
- Watercourse
- Full Supply Level (183.5m AHD)
- Fish Habitat Area

Projection: GDA94 Zone 56

Figure 9-5

0 5 10 20 30
Kilometres

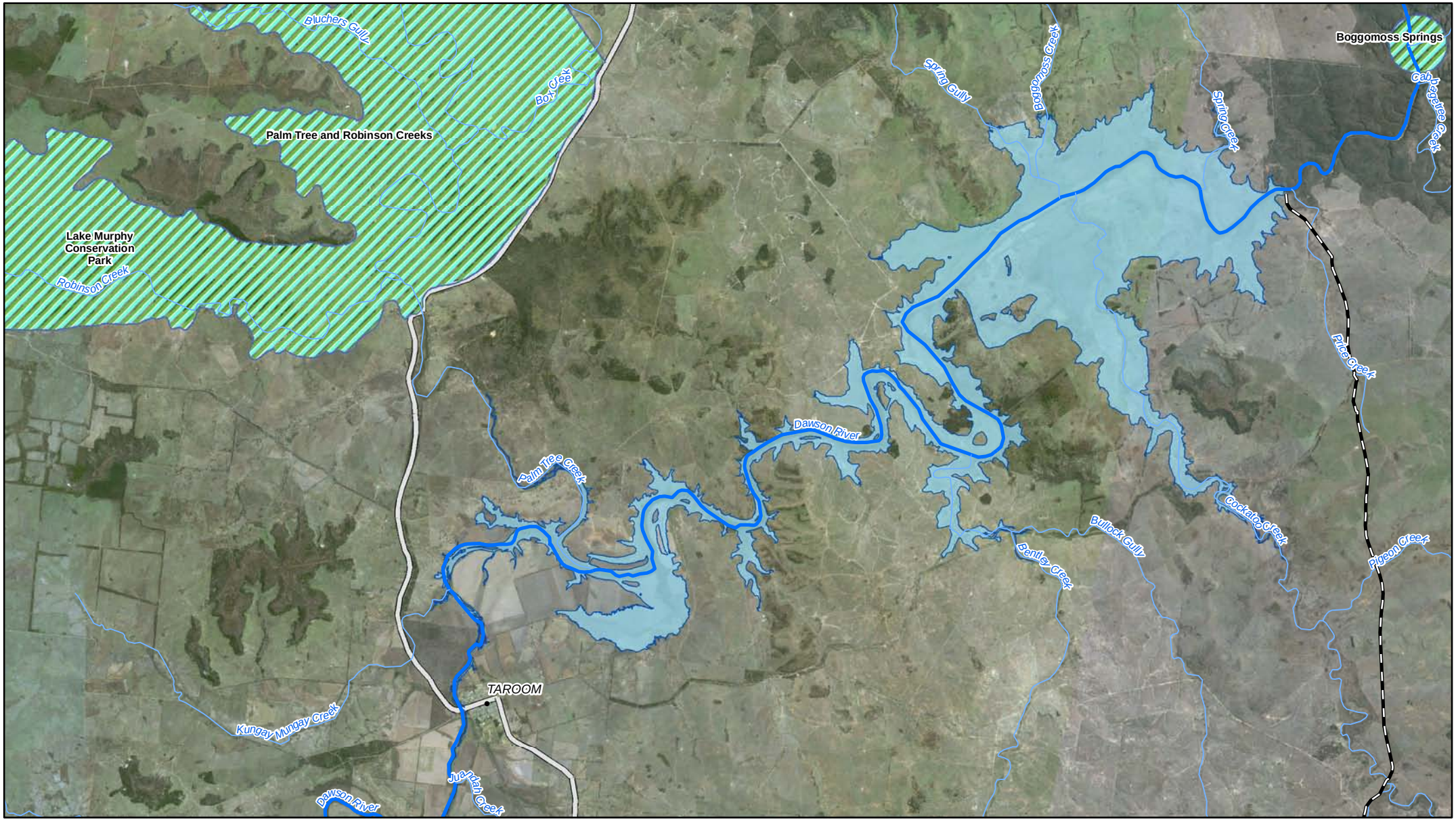
N

Scale 1:1,200,000 (at A4)

SKM SunWater Making Water Work

NATHAN DAM AND PIPELINES EIS

Declared fish habitat areas



LEGEND

- Town
- Major Road
- Proposed Pipeline
- Major Watercourse
- Watercourse
- Full Supply Level (183.5m AHD)
- Wetland of National Significance

Projection: GDA94 Zone 56

Figure 9-6

0 1 2 4
Kilometres

N

Scale 1:200,000 (at A4)

SKM SunWater Making Water Work

NATHAN DAM AND PIPELINES EIS

Wetlands of significance

I:\QENV2\Projects\QE40192\400 - Nathan - Spatial\ArcMXD\Figures\090_Sensitive_Environmental_Areas\Figure_9-6_Wetlands_of_Significance.mxd Produced: 21/06/2011

LEGEND

- Towns
- Major Road
- Proposed Pipeline
- Watercourse
- Full Supply Level (183.5m AHD)
- World Heritage Area

Projection: GDA94 Zone 56

Figure 9-7

0 5 10 20 30
Kilometres

N

Scale 1:1,200,000 (at A4)

SKM SunWater Making Water Work

NATHAN DAM AND PIPELINES EIS

World heritage properties

9.4. Cultural environments

Sites of heritage, historical or archaeological significance were identified through searches of the heritage registers and a field survey of the study area.

9.4.1. Indigenous Heritage

Searches of the Queensland Aboriginal Cultural Heritage Database and Register (the Register) were undertaken for the dam water storage and the pipeline route.

Within the dam water storage, one Aboriginal cultural heritage site was recorded on the Register. This was at Glebe Weir, which had been used as an Aboriginal historic camp (seasonal) in the late historic period. The place was identified as a significant resource place (fish) by David Beezley (site description JD:D09). For the pipeline route, no Aboriginal cultural heritage sites were recorded on the Register within the proposed pipeline corridor.

Further information on Indigenous Cultural Heritage is presented in Chapter 22.

9.4.2. Non-indigenous heritage

On the heritage registers, three sites were identified within 5 km of the water storage, however only the Glebe Homestead is located within the Project area. No sites were identified on Commonwealth registers or that of the National Trust. During the field survey, a further 10 sites were identified as being of historic cultural heritage value and two sites of historic interest. All sites identified through the register searches or by field survey are listed in Table 9-6 and shown on Figure 23-1. A total of nine sites will be impacted by the dam.

Table 9-6 Heritage/historic sites identified in the dam study area

Place ID	Site Name	Significance	Site Components	Location within Dam Impact Area
HAS-8	Malara Homestead	State	Homestead, slab garage, tennis court, wool press, shearing shed, sheep dip, shearer's quarters, yards, site of bowling green	Outside
HAS-9	Corduroy Crossing	Local	Wood and stones	Inside
HAS-10	Barkla Camp	Local	Fence posts	Inside
HAS-11	Binghi Slab Hut	Local	Slab hut, yards	Inside
HAS-12	Spring Creek Homestead	State	Homestead, graves, site of old homestead, site of old school, generator shed	Outside
HAS-13	Taroom Aboriginal Reserve	State^	Mission site, windmill, lower cemetery, hill top cemetery, bore	Inside
HAS-14	Inscribed Rock (The Glebe)	Local		Outside
HAS-15	Baxter's Hut	Local	Slab hut, saw mill	Outside
HAS-16	Inscribed Rock (Moorang)	Local		Inside
HAS-18	Site of Barkla's Bridge	Local^	Remains of wooden bridge	Inside

Place ID	Site Name	Significance	Site Components	Location within Dam Impact Area
HAS-23*	The Glebe Homestead	State	Homestead, bark insulated shed, site of old homestead, shearer's quarters, sheep dip, site of wool shed, re-used telegraph line electric fence, saw mill, laundry	Inside
HAS-24*	Leichhardt Tree, Taroom	State		Outside
HAS-31*	Taroom Cemetery	Local		Outside
HI-2	Old Road and Telegraph Alignment	N/A		Inside
HI-3	Stone Crossing	N/A		Inside

Note: * denotes site identified through register searches. ^ denotes a site as an Archaeological Place. All other sites are Heritage Sites.

Heritage and historic sites identified within 5 km of the pipeline route are listed in Table 9-7 and shown on Figure 23-2. These sites are all located outside the pipeline easement, however there is potential for impact on four sites (HAS-6, HAS-7, HAS-1 and HAS-26).

Further detail on these sites is presented in Chapter 23.

Table 9-7 Heritage/historic sites identified within 5 km of the pipeline route

Place ID	Site Name	Significance	Site Components	Location within pipeline corridor
HAS-1	Railway Corridor	Local	Dalby Station male toilet block, Warra Subway, Chinchilla Station and roadside store, Chinchilla Rail Workers' Quarters, Charley's Creek Bridge, Rocky Creek Bridge, railway settlements such as Dalwogan, Kowguran, Gurimundi, Giligulgul and Guluguba	Outside
HAS-2	Warra Heritage Precinct	Local	Memorial to Warra Mine, Relocated Haystack School, Relocated Holmbush Windmill, Relocated Warra Station, Relocated Hitching Post from Warra Post Office, Site of Webb & Co. Filling Station, Memorial to Warra Bakery, Warra Queensland Country Women's Association building, Warra Hotel, Warra Memorial Hotel, Church	Outside
HAS-3	Leichhardt Camp (Warra)	State	Reconstruction of camp fire and camp components	Outside
HAS-4	Chinchilla Heritage Precinct	Local	Shopfronts on Warrego Highway, rail and bridge infrastructure (noted in HAS-1)	Outside
HAS-5	Telegraph Alignment (Nathan Road)	Local	Telegraph posts, some with ceramic insulators still attached	Outside
HAS-6	Survey Tree (Nathan Road)	Local	Inscribed with government broad arrow survey mark and 'MR17'	Outside
HAS-7	Survey Tree (Nathan Road)	Local	Inscribed with government broad arrow survey mark and 'MR18'	Outside
HAS-17	Warra Mine	State		Outside
HAS-25*	Chinchilla 'Digger' Statue	State	War memorial, fence	Outside

Place ID	Site Name	Significance	Site Components	Location within pipeline corridor
HAS-26*	Cactoblastis Memorial Hall	State	Memorial hall	Outside
HAS-27*	Dalby War Memorial and Gates	State	War memorial, masonry posts and gates	Outside
HAS-28*	St John's Anglican Church	State	Church building and grounds	Outside
HAS-29*	Former Dalby Town Council Chambers and Offices	State	Single storey rendered brick building	Outside
HAS-30*	Dalby Swimming Pool Complex	Local	Single storey timber building and pool	Outside
HAS-32*	Wandoan Cemetery	Local	Gravestones	Outside
HAS-33*	Downfall Creek Cemetery	Local	Gravestones	Outside
HAS-34*	Brigalow - Canaga Creek Road Cemetery	Local	Gravestones	Outside
HAS-35*	Chinchilla Cemetery	Local	Gravestones	Outside
HAS-36*	Cemetery Road, Chinchilla	Local	Gravestones	Outside
HAS-37*	Baking Board Cemetery	Local	Gravestones	Outside
HAS-41*	Macalister Cemetery	Local	Gravestones	Outside
HAS-42*	Warra Cemetery	Local	Gravestones	Outside
HI-1	Site of Old Road Bridge	N/A	Remains of timber supports	Outside

* Listed on the heritage registers

9.5. Implications of climate change for nature conservation values

9.5.1. Overview of vulnerability of biodiversity to climate change

There is generally a lack of confidence in predictions around the likely impacts of climate change on biodiversity values. Predicting the future effects of climate change on biodiversity is challenging for a variety of reasons, including the following:

- climate change will interact with other factors that influence biodiversity such as weeds, fire, vertebrate pests, habitat modification and fragmentation;
- responses to the physical and chemical changes associated with climate change are individualistic – that is, they occur at the level of the individual. Changes at the community level result from the combined impacts of changes at the individual level;
- properties of ecological systems – communities of interacting species and their abiotic environment – are often non-linear, and can be difficult to understand and predict. A change in the average value of a variable, such as temperature, may not be as important ecologically as a change in the variability or extremes of that variable; and
- basic knowledge is generally lacking about limiting factors, genetics, dispersal rates, and interactions among species that comprise Australian communities and ecosystems.

Despite this lack of certainty, some more specific predictions of the impacts of future climate change can be inferred from the physiological and ecological characteristics of some taxa. For example, it is reasonable to assume that warming temperatures may alter sex ratios of reptiles such as crocodiles and turtles.

Although it is much more difficult to predict future climate impacts at the community or ecosystem levels, some general trends can nevertheless be anticipated. For example, for tropical rainforests, higher temperatures and changes in rainfall patterns – longer dry periods between intense rainfall events – will increase the probability that fires penetrate into rainforest vegetation. In arid and semi-arid regions, shifts in the seasonality or intensity of rainfall events could change the proportions of woody and grassy vegetation in somewhat predictable directions (Australian Government - Department of Climate Change, 2009).

The suite of traits that make a species vulnerable to disturbance generally will also predispose that species to risk from rapid climate change. Conversely, species with traits that assist in invading or colonising disturbed areas may have an advantage in a rapidly changing climate. Table 9-8 lists physiological and life history traits of species and ecosystems that influence vulnerability or resilience in response to climate-related disturbance.

Table 9-8 Life history traits which influence vulnerability to climate change

Species/systems Least at Risk	Species/systems Most at Risk
▪ Physiological tolerance to broad range of factors such as temperatures, water availability and fire ▪ High degree phenotypic plasticity ▪ High degree of genetic variability ▪ Short generation times (rapid life cycles) and short time to sexual maturity ▪ High fecundity ▪ 'Generalist' requirements for food, nesting sites, etc. ▪ Good dispersal capability ▪ Broad geographic ranges	▪ Narrow range of physiological tolerance to factors such as temperature, water availability and fire ▪ Low genetic variability ▪ Long generation times and long time to sexual maturity ▪ Specialised requirements for other species (e.g. for a disperser, prey species, pollinator or photosynthetic symbiont) or for a particular habitat that may itself be restricted (e.g. a particular soil type) ▪ Poor dispersers ▪ Narrow geographic ranges

9.5.2. Species/ecosystems at risk in the Project area

Table 9-9 provides a list of species and ecosystems that are considered most at risk from climate change in the Project area, based on recognised physiological and life history traits which are used to determine resistance and resilience to climate change (Isaac, 2009).

Table 9-9 Species and systems within the Project area vulnerable to climate change

Life History Trait	Species/Ecosystem
Narrow geographic ranges	*Livistona nitida* *Thelypteris confluens* *Rutidosis crispata* *Rutidosis lanata* Boggomoss Snail Fitzroy River Turtle
Habitat specificity – specialised habitat requirements or dependent on other species (e.g. disperser, prey species, pollinator or photosynthetic symbiont)	GAB spring communities *Arthraxon hispidus* *Thelypteris confluens* Boggomoss Snail Fitzroy River Turtle
Local abundance – low abundance and genetic variability	Boggomoss Snail
Reproductive output - long generation times and long time to sexual maturity	None known

Life History Trait	Species/Ecosystem
Poor dispersal ability	Boggomoss Snail
Climatic niche – narrow range of physiological tolerance to factors such as temperature, rainfall, precipitation, water availability, fire etc.	GAB spring communities Riparian regional ecosystems *Thelypteris confluens* *Arthraxon hispidus* Boggomoss Snail Aquatic ecosystems

9.5.3. Implications for nature conservation values in the Project area

The Australian Government (Department of Climate Change, 2009) completed a strategic assessment of the vulnerability of Australia's biodiversity to climate change. Their report suggested that a central strategy is giving ecosystems the best possible chance to adapt by enhancing their resilience. Approaches to building resilience include managing appropriate connectivity of fragmented ecosystems, enhancing the National Reserve System, protecting key refugia, implementing more effective control of invasive species, and developing appropriate fire and other disturbance management regimes. Building resilience is the principal response of the Project to the threat posed to biodiversity by climate change.

Several species and ecosystems within the Project area are considered likely to suffer detrimental impacts as a result of climate change, particularly if the rate of climate change accelerates beyond current projections and regardless of whether the Project is to proceed. Table 9-10 below summarises potential impacts of climate change on key species and ecosystems, and the contribution of the Project to those processes.

Table 9-10 Likely impacts of climate change on sensitive species within the Project area

Species/Ecosystem	Likely impacts of climate change	Contribution of the Project
GAB spring communities *Arthraxon hispidus* *Thelypteris confluens* Boggomoss Snail (GAB spring sub-populations)	Longer dry periods increasing the penetration of fire into these systems. Less rainfall affecting the rate of groundwater recharge and decreasing the level of the groundwater table.	Inundation will increase groundwater pressure at those GAB springs surrounding the inundation and buffer, thereby increasing water flows. This will offset any potential climate change impacts from a decrease in the groundwater table. The Project will protect and enhance well-functioning examples of this ecological community as part of the offsets strategy. This will manage existing threats including weeds, pests, grazing and fire.
Riparian regional ecosystems *Livistona nitida* Boggomoss Snail (riparian sub-populations)	Longer periods of no flow or low flow. Less frequent flooding events (and less frequent inundation) impacting water availability in riparian zone.	The Project will maintain critical features of the flow regime, thereby minimising variation from current conditions. There will be more opportunities for water sharing between the water storages to maintain flows. Well-functioning examples of this ecosystem type will be protected and managed in the long term as part of the offsets strategy.

Species/Ecosystem	Likely impacts of climate change	Contribution of the Project
Aquatic ecosystems	Longer periods of no flow or low flow.	The Project will maintain critical features of the flow regime, thereby minimising variation from current conditions. There will be more opportunities for water sharing between the water storages to maintain flows.
Rutidosis crispata *Rutidosis lanata*	Longer dry periods increasing the penetration of fire into potential habitat.	The Project will protect and enhance habitat for these species as part of the offsets strategy. This will manage existing threats including weeds, pests, grazing and fire.
Fitzroy River Turtle	Impacts on nesting success rates and possibly male to female ratio of offspring. Longer periods of low flow or no flow reducing prey availability.	Project will not contribute to changes in ambient temperature. The Project will maintain critical features of the flow regime, thereby minimising variation from current conditions.

The key climate change related threats to the biodiversity of the Project area are an increase in the period between rainfall events (and subsequently reduced flows), changes to mean annual rainfall and temperature and the increased incidence and intensity fire.

These impacts are likely to be unavoidable and the Project will also impact on the flow regime. It is clear from the above that the ability of the dam, via its stored water, to manage the downstream low flow regime, is a major benefit in the management of potential climate change impacts on some of those values. The overall contribution of the Project to reducing climate change related threatening processes is related to some key proposed management initiatives, particularly:

- the management and maintenance of flow regimes as per the Water Resource Plan. Subsequent, climate change related impacts are beyond the control of the Project;
- conservation of a representative array of well-functioning ecosystems surrounding the dam through the delivery of a Environmental Offset Strategy. This will ensure that representative areas which remain contain an appropriate proportion of the biodiversity of the Project area;
- removal or minimisation of existing stressors within the area managed by SunWater, particularly weeds and fire, thereby building ecosystem resilience and reducing vulnerability to long term threats; and
- conservation of a substantial area of vegetation with a high level of connectivity within the broader Project area through delivery of offsets for the Project. A well connected rehabilitation / offset area has the potential to facilitate the 'movement' of species across latitudinal and altitudinal gradients over time.