17B AQUATIC ECOLOGY

17B.1 INTRODUCTION

This chapter examines the existing environment, potential impacts and mitigation measures associated with aquatic ecology for the proposed western coal seam methane (CSM) water supply pipeline (proposed pipeline). The focus of aquatic ecological assessment is on waterbodies and the associated physical, chemical and biological components of identified waterbodies.

For further information on the aquatic ecology assessment, the technical report associated with this chapter is TR 17B-1-V3.5. Note that figures/documents with numbering ending in V3.5, for example, refer to figures/documents contained in Volume 3, Book 5 of the EIS. Figure 17B-1-V3.3 provides the proposed alignment of the pipeline, including locations of aquatic ecology sites sampled as part of the impact assessment.

17B.2 METHODOLOGY OF ASSESSMENT

17B.2.1 RELEVANT LEGISLATION

Commonwealth legislation

Commonwealth Environment Protection and Biodiversity Conservation Act 1999

Any actions that are likely to have a significant impact on a Matter of National Environmental Significance (MNES) are subject to assessment under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) approval process. MNES include:

- World Heritage properties
- National Heritage places
- wetlands of international importance
- threatened species and ecological communities
- migratory species
- Commonwealth marine areas
- nuclear actions.

Where relevant, MNES are further described below.

World Heritage Properties (Great Barrier Reef)

The EPBC Act regulates actions that will have, or are likely to have, a significant impact on the World Heritage values of a World Heritage property. This includes relevant actions that occur outside the boundaries of a World Heritage Area.

The Fitzroy Basin drains to the Great Barrier Reef World Heritage Area, approximately 600 km downstream from the proposed pipeline alignment. The proposed pipeline is not expected to result in a significant impact on the values of the Great Barrier Reef World Heritage Area.

Wetlands of International Importance (Ramsar Wetlands)

The EPBC Act regulates actions that will have, or are likely to have, a significant impact on the ecological character of a Ramsar wetland. This includes relevant actions that occur outside the boundaries of a Ramsar wetland. There are no Ramsar wetlands or wetlands of national importance in the proposed pipeline area.

The Fitzroy Basin drains into the Shoalwater and Corio Bays Ramsar site, a Wetland of International Significance (Department of Environment, Water, Heritage and Arts (DEWHA), 2008a). The Ramsar wetland is approximately 620 km downstream from the proposed pipeline alignment. The proposed pipeline is not expected to result in a significant impact on the values or on the ecological character of this Ramsar Wetland.

Threatened ecological communities and species

Boggomoss Communities

On the Dawson River, approximately 100 km downstream from the pipeline alignment, mound springs from the Great Artesian Basin (Boggomoss Areas 1 & 2) are listed on the Register of the National Estate. The boggomoss communities are dependent on natural discharge of groundwater from the Great Artesian Basin and are listed as an Endangered Ecological Community under the EPBC Act.

The boggomoss snail (*Adclarkia dawsonensis*), or Dawson River snail, is listed as Critically Endangered under the EPBC Act. This snail lives in the boggomoss habitat on the Dawson River, approximately 100 km downstream of the creeks of the proposed pipeline alignment (DEWHA 2008b).

Potential impacts of the proposed pipeline on these species are addressed in Section 17B.5.7.

Fitzroy River Turtle

The Fitzroy River turtle (*Rheodytes leukops*) is listed as vulnerable under the EPBC Act. Its distribution is restricted to the Fitzroy Basin, and it has been recorded from the Dawson River (Environmental Protection Agency (EPA), 2007b).

Potential impacts of the proposed pipeline on these species are addressed in Section 17B.5.7.

State Legislation

Water Act 2000

The *Water Act 2000* provides for the sustainable management of water and other resources. Under S. 266, a Riverine Protection Permit is required from the Department of Natural Resources and Water (NRW) to:

- destroy vegetation in a watercourse

- excavate in a watercourse
- place fill in a watercourse.

The proposed pipeline alignment crosses a number of watercourses and permits will therefore be required for works associated with these crossings.

Additionally, where waters are to be taken from a watercourse, lake, spring or underground water (e.g. for use in dust suppression during construction works), a Water Permit may be required pursuant to S. 237.

Fisheries Act 1994

All waters of the State are protected against degradation by direct or indirect impact under S. 125 of the *Fisheries Act 1994* (Fisheries Act).

Under Division 8 of the Fisheries Act, a Waterway Barrier Works Approval is needed to build any structure across a freshwater waterway. The purpose of this part of the Act is to provide a balance between the need to construct dams and weirs and the need to maintain fish movement. Such structures include temporary culverts and road crossings. The Chief Executive (DPI&F) may direct the building of a specified fishway for the barrier, if required.

Nature Conservation Act 1992

The Fitzroy River turtle (*Rheodytes leukops*) is also recognised as Vulnerable under the *Nature Conservation Act 1992* (NC Act), as listed in the *Nature Conservation (Wildlife) Regulation 2006* (NCWR).

Potential impacts of the proposed western CSM water supply pipeline on this species are addressed in Sections 17.3.6 and 17.5.7.

17B.2.2 DESCRIPTION OF STUDY AREA

The proposed pipeline crosses eight creeks, along with several smaller tributaries and gullies, which are all part of the Dawson River Catchment (Southern Tributaries or 'Taroom' Subcatchment) (refer Figure 17B-1-V3.3). The pipeline crosses the following creeks:

- Eurombah Creek and several major tributaries including Kurrajong Gully, Slatehill Creek, Barton Creek, Kangaroo Creek and Canal Creek
- a tributary of Nine-Mile Creek, which may connect to Eurombah Creek during periods of rainfall
- Horse Creek, Spring Creek, Mud Creek and Woleebee Creek, which are each tributaries of Juandah Creek.

Eurombah Creek and Juandah Creek both flow into the Dawson River approximately 100 km downstream from the pipeline alignment.

17B.2.3 STUDY METHODOLOGY

Survey timing

For the Eurombah Creek catchment, aquatic floral and faunal surveys and collection of water quality data was undertaken during the dry season, from the 11 to the 15 August 2008.

Sites on Spring Creek, Mud Creek and Woleebee Creek (tributaries of Juandah Creek) were surveyed from the 10 to the 14 March 2008 as part of the aquatic ecology assessment for the MLA areas.

Study sites

Thirteen waterways crossed by the proposed pipeline alignment were surveyed (refer Figure 17B-1-V3.3). Whenever possible, surveys were conducted at the proposed crossing location, however, due to land access issues, some creeks were assessed at nearby road crossings. Sites surveyed during the March 2008 survey event (sites 3, 5, and 6) were close to, but not at, the proposed pipeline crossing locations.

At all sites, with the exception of sites B and Gi, the broad habitat type, channel pattern, water level and flow, substrate character and cover, bed and bank stability, and riparian cover were described using AusRivAS protocols. Site B was a small farm dam that was dry, and site Gi was a gully with no defined channel bed or banks; only brief observations and photographs were taken at these sites. Water was present at eight of the sites surveyed, and water quality measurements were done at each of these sites. Flora and fauna surveys were completed at six of the thirteen sites. Details of surveys at each site are summarised in Table 17B-1.

Table 17B-1: Date and type of survey completed at watercourses on the proposed western CSM water supply pipeline alignment

Crossing number	Channel name	Date survey completed			
		Aquatic habitat	Water quality	Macrophytes	Fauna
A	Eurombah Creek	14/08/08	14/08/08	14/08/08	14/08/08
B	—	14/08/08	—	—	—
C	Kurrajong Gully	13/08/08	13/08/08	13/08/08	13/08/08
D	Slatehill Creek	11/08/08	11/08/08	—	—
E	Barton Creek	11/08/08	11/08/08	12/08/08	12/08/08
F	Kangaroo Creek	11/08/08	Dry	Dry	Dry
G	Tributary to Canal Creek	13/08/08	Dry	Dry	Dry

Crossing number	Channel name	Date survey completed			
		Aquatic habitat	Water quality	Macrophytes	Fauna
Gi	—	12/08/08	—	—	—
H	Tributary to Nine-Mile Creek	12/08/08	Dry	Dry	Dry
I	Horse Creek	13/08/08	Dry	Dry	Dry
3	Woleebee Creek	12/03/08	12/03/08	12/03/08	12/03/08
5	Mud Creek	13/03/08	13/03/08	13/03/08	13/03/08
6	Spring Creek	13/03/08	13/03/08	13/03/08	13/03/08

Methods

Aquatic habitat

Sites were described and scored using AusRivAS protocols (DNRM 2001).

Regionally, the typical aquatic habitat and other relevant attributes of streams and creeks in the Southern Tributaries subcatchment of the Dawson River were described via literature review.

Water quality

Water quality data was collected on water temperature, electrical conductivity, pH and dissolved oxygen.

No turbidity meter was available at the time of survey, so where practical, turbidity in NTU (Nephelometric Turbidity Units) was estimated at the sites, based on the experience of the field team, who had each previously surveyed water quality in the region.

No Water Quality Objectives (WQOs) have been prescribed for the waterways within the study area. Water quality parameters at each of the sites have therefore been compared to Queensland Water Quality Guidelines (QWQG) values for upland (altitude >150 m) streams in the central coast region (EPA 2007a).

Aquatic flora

Aquatic flora data was recorded for each site as follows:

- the presence of all native and exotic macrophytes and their growth form
- the percent cover of each species at each site (cover may exceed 100% due to overlap).

Aquatic macro-invertebrate communities

At each site, a macro-invertebrate sample from each aquatic habitat found was collected in accordance with the procedures set out in the Queensland AusRivAS Sampling Manual (DNRM 2001).

Sample processing

Samples were frozen and returned to frc environmental's Brisbane benthic laboratory for processing.

Data analysis

At each site and for regional data available from NRW, taxonomic richness, PET richness and Signal 2 scores were calculated.

Fish communities

Sample collection

Fish communities were surveyed using a combination of backpack electrofishing, seine and set nets, baited traps and dip nets. Electrofishing was the preferred method and was attempted at all sites where conditions were appropriate.

At each site, the presence and abundance of each species by life history stage (juvenile, intermediate, adult) and the apparent health of individuals was recorded. Specimens that were unable to be identified in the field were euthanized, preserved and returned to the laboratory for later identification.

Sampling of fishes was conducted under General Fisheries Permit No. 54790 and Animal Ethics Approval No. CA 2006/03/106.

Data analysis

Taxonomic richness, total abundance, abundance of rare and threatened species, abundance of exotic species and the abundance of each life history stage was determined.

Turtles

Turtles were sampled by trapping or by incidental observation and were identified to species level. The sampling was conducted under Scientific Purposes Permit WISP05080608 and Animal Ethics Approval No. CA 2006/03/106.

Other aquatic vertebrate communities

The likely presence of other aquatic vertebrates in the study area and throughout the region was described through literature review and database searches, specifically: the Commonwealth *Protected Matters Search Tool* (DEWHA 2008a); and the State *Wildlife Online* database (EPA 2007b).

17B.3 EXISTING ENVIRONMENT

17B.3.1 AQUATIC HABITAT

The sites surveyed within the proposed western CSM water supply pipeline study area typically had moderate River Bioassessment Program habitat assessment scores. These relatively low scores were generally related to low habitat variability (no riffles observed), moderate to extensive bank erosion and substrates dominated by finer sediments (e.g. sand and silt).

However, Eurombah Creek (site A) was in good condition, as it has good riparian vegetation cover, and it contained a variety of habitat types (deep pools and shallow pools), physical habitat for fauna (such as woody debris and overhanging banks) and substrate types (including sand, bedrock, and boulders).

Reach environs

Overall, the reach environs of the creeks surveyed have been moderately impacted by human activities and overall condition at each of the sites ranged between poor and good. Land-use throughout the study area is dominated by cattle grazing on pastures, together with some cropping. There has been some riparian vegetation clearing across the study area, although large trees still grow on the creek banks at many sites (and in particular at sites on higher order streams). Cattle access to the creeks has also caused some disturbance to bed and bank habitats, particularly in Kurrajong Gully (site C), Canal Creek (site G), tributary to Nine-mile Creek (site H), Horse Creek (site I), and Mud Creek (site 5).

Road crossings were a mix of gravel crossings without culverts, concrete crossings with culverts and bridges. Lower order streams tended to have gravel crossings without culverts (sites C, H, I, and 6), or concrete fords (site F). A box culvert was used at the road crossing at Barton Creek (site E). A pipe culvert was used to cross Woleebee Creek (site 3). Slatehill Creek (site D) was the only stream with a bridge crossing. No road crossings were present along the alignment at Eurombah Creek (site A) or Canal Creek (site G).

Road crossings can alter flows and may prevent or restrict fish and turtle passage. All of the ford crossings are likely to restrict aquatic fauna passage during low flow events, as the road forms a physical barrier. During periods of medium to high flow, the creek would flow over the road. The crossings at Barton Creek (site E) and Woleebee Creek (site 3) are likely to restrict aquatic fauna passage during periods of low to moderate flow, as the water must flow through undersized culverts.

The bridge crossing at Slatehill Creek (site D) would not generally inhibit aquatic fauna movement. During flood events however, pylons can alter flow patterns and trap debris that can potentially restrict aquatic fauna passage. Fences also cross some sites and are likely to restrict water flows and potentially aquatic fauna passage, if they become blocked with debris.

Riparian vegetation

Across the study area, riparian zones were generally 5–10 m wide, but ranged from being more than 20 m wide at Eurombah Creek to almost entirely cleared in some places, such as Barton Creek and Horse Creek. Grasses typically dominated the riparian zone of the creeks, although shrubs and trees also grew at most sites.

Riparian vegetation throughout the study area was dominated by native species, although exotic grasses were found. Prickly pear, a declared class 2 pest in Queensland, was noted at several sites including sites C and F. Giant sensitive tree (*Mimosa pigra*), a declared class 1 pest, was noted throughout the study area and particularly along the roadside. The class 2 declared pest parthenium (*Parthenium hysterophorus*) is likely to grow adjacent to Mud Creek and its tributaries, and adjacent to Juandah Creek and its tributaries towards the north of the MLAs.

Bank stability

Banks were eroded at all but one site. Steep banks were common and appeared to be the result of water scouring during periods of high flow. Bank stability was maintained despite steep banks in some places by a relatively high cover of bank vegetation. At several sites, disturbance caused by cattle access or riparian vegetation clearing had negatively affected bank stability. This was particularly evident at Kurrajong Gully (site C), Canal Creek (site G), Horse Creek (site I), and Mud Creek (site 5).

Bed and bar stability

Overall, stream beds throughout the study area were relatively stable, but there was evidence of scouring on the outside of bends or downstream of obstructions. High embeddedness of sediment was common at sites where eroding banks had deposited fine material into the stream bed.

Channel diversity

Channel diversity was extremely low across the study area; isolated pools were the dominant habitat category. Bends and changes in water depth are likely to provide some channel diversity during periods of flow. The only run and riffle habitat was observed was approximately 1 km downstream from site A on Eurombah Creek, where water from the Spring Gully RO plant was being discharged.

Aquatic habitat

The condition of aquatic habitats was variable, but some physical aquatic habitat was found at most of the sites. Habitat was generally in the form of small stick piles, fallen logs, tree roots, boulders and undercut banks. In higher order creeks, there was generally greater habitat availability, as there was more water present and large trees on the banks provided tree roots and logs as habitat.

Regional perspective

The following is drawn from the *State of the Rivers* report for the Southern Tributaries subcatchment of the Dawson River (Telfer 1995).

The proposed western CSM water supply pipeline alignment crosses many of the waterways of the Southern Tributaries Subcatchment (Telfer 1995).

Reach environs

Most subcatchment streams are in poor to moderate condition. Of 54 sites surveyed, 43% were classed as highly disturbed and 15% were classed as extremely disturbed. Most of the land adjacent to the surveyed sites had been cleared and converted to native pasture for cattle grazing. Other disturbances included road infrastructure and forestry activities.

Bank stability

Most stream banks in the subcatchment were rated as stable. Cattle, land clearing, infrastructure, scouring and eroded walking tracks negatively affected bank stability.

Bed and bar stability

Factors reducing stream bed stability throughout the subcatchment included the presence of stock, bank erosion and bed deepening. Fallen trees, rock outcrops and man-made structures provided stream bed stabilisation.

Channel diversity and habitat types

Channels across the subcatchment lacked diversity (diversity ratings ranged from low to moderate).

Sediments in the upper banks and stream beds of the subcatchment varied from boulders to fine silt, while lower banks were composed of sand and fine silt.

Riparian vegetation

Across the subcatchment, riparian vegetation included trees, shrubs, vines, rushes, grasses and mosses. The most dominant structural types were grasses (97%), trees 10–30 m (85%), trees <10 m (81%), rushes (62%) and herbs and forbs (59%). Native species included *Eucalyptus* spp., cypress pines (*Callitris* spp.), *Lomandra* spp., *Acacia* spp., *Melaleuca* spp., *Brigalow* spp. and *Callistemon* spp.

Most of the riparian zones in the subcatchment were in very poor condition due to agricultural clearing and grazing. Weed species were recorded from most sites.

Aquatic habitat

Most aquatic habitats in the subcatchment were rated as poor or very poor.

Conservation values

Only 2% of sites were deemed to have aquatic habitats of very high conservation values and no sites were regarded as very high value for riparian habitat or wildlife corridors. Approximately 40–46% of sites were deemed to be of low conservation value for aquatic habitat, riparian habitat or as wildlife corridors.

Overall, 7% of the subcatchment was in very poor condition, 63% was in poor condition, 23% was in moderate condition, 7% was in good condition and no sites were regarded as being in very good condition.

Summary

Six of the nine sites surveyed had moderate River Bioassessment Program habitat scores, and sites G and H had poor habitat scores. Aquatic habitat condition at Eurombah Creek (site A) was good.

Overall, the reach environs of the creeks surveyed have been moderately affected by human activities. Cattle-grazing is the dominant surrounding land-use and cattle access to the creeks has caused some disturbance. There has been some clearing of riparian vegetation across the proposed western CSM water supply pipeline alignment, although large trees still grow on the creek banks at many sites. Several road and fence crossings of creeks in the study area are likely to cause alterations of flow and restrict aquatic fauna passage under particular flow regimes. Similar impacts were observed throughout the Southern Tributaries subcatchment.

Riparian zone condition throughout the current study area was poor and characteristic of the region. Riparian zones were generally 5–10 m wide and dominated by grasses. Riparian vegetation was dominated by native species, although exotic species were found at all sites. Erosion was prominent in waterways throughout the region and at most sites in the study area.

Stream beds were relatively stable, however there was scouring along outside meanders or downstream of obstructions, and deposition of sediments in pools or upstream of obstructions. Channel diversity is generally low to moderate in the region, and was extremely low across the proposed western CSM water supply pipeline alignment.

In-stream physical habitat was typically in the form of undercut banks and woody debris. In-stream habitat diversity was highest at sites with a higher cover of trees in the riparian zone and a higher cover of bank overhang vegetation. Throughout the region, disturbances to the riparian zone have led to a reduction in the cover and diversity of in-stream habitat such as large woody debris.

17B.3.2 WATER QUALITY

Water temperature

Across the sites surveyed, water temperature ranged between 11.6 °C at site C to 29.1 °C at site 6 on Spring Creek. Water temperatures were much higher at sites 3, 5, and 6, which were sampled in March 2008. There are no guidelines available for water temperature (ANZECC & ARMCANZ 2000; EPA 2007a).

Dissolved oxygen

Dissolved oxygen (DO) concentrations were highly variable among sites, ranging from 54% saturation (sat.) at Slatehill Creek (site D) to 123% sat. at Kurrajong Gully (site C). Eurombah Creek (site A), Mud Creek (site 5) and Spring Creek (site 6) were the only sites with DO concentrations that fell within the Queensland Water Quality Guidelines (QWQG) range (90–110% sat.) (EPA 2007a), although the DO concentrations at Barton Creek (site E) and Woleebee Creek (site 3) were close to the guideline range.

pH

pH tended to be basic (> 7) across most sites, but it ranged from 6.1 at Woleebee Creek (site 3) to 9.38 at Kurrajong Gully (site C). Mud Creek (site 5) was the only creek with a pH value within the QWQG range (6.5–7.5), Woleebee (site 3) and Spring (site 6) creeks were well below the QWQG range, and the remainder were well above the QWQG upper limit (EPA 2007a).

Electrical conductivity

Electrical conductivity ranged from 110 μS/cm at Slatehill Creek (site D) to 388 μS/cm at Mud Creek (site 5). Electrical conductivity was below the QWQG upper limit (340 μS/cm) for all sites except Mud Creek. It should be noted that the QWQG value for electrical conductivity is a preliminary guideline only (EPA 2007a).

Turbidity

Water at Eurombah and Slatehill Creeks was relatively clear, and turbidity was estimated to be below the guideline value. High turbidity at Kurrajong Gully, Barton, Woleebee, Mud and Spring Creeks (sites C, E, 3, 5, and 6) was typical of the study area, probably related to local sediment composition, clearing of riparian vegetation, and bank erosion and cattle access to the creek bed.

Regional perspective

Dawson River Catchment

Agricultural land uses occupy approximately 84% of the Dawson River catchment (EPA 2001). In comparison with other Dawson River subcatchments, the Taroom subcatchment is a moderate emitter of phosphorus and a light emitter of nitrogen (EPA 2001). Estimates indicate a total nitrogen (TN) emission rate of approximately 0.95 kg/ha/year and a total phosphorus (TP) emission rate of approximately 0.33 kg/ha/year (EPA 2001). It is estimated that the Taroom subcatchment contributes only 1.6% of the TN and 1.4% of the TP exported out of the Dawson River catchment annually.

Fitzroy River Catchment

Water quality in this catchment is compromised by:

- pesticide and herbicide contamination, particularly in irrigation areas
- erosion and runoff increasing sedimentation and nutrients levels in waterways and the GBR
- high risk of blue-green algal bloom in still waters
- rising salinity, particularly in streams between Theodore and Rockhampton
- acid mine drainage in localised areas including Blackwater Creek, Crinum Creek, Don River and Dee River
- heavy metal contamination, mostly from cadmium and copper in parts in of the Mackenzie, Nogoa and lower Dawson catchments
- substantial areas of poor riparian vegetation cover, particularly in the Dawson catchment and Central Highlands (Meecham 2003).

Land use in the Fitzroy River catchment is primarily agricultural (grazing — 90%; cropping — 6% (Noble et al 1996)). Accordingly, levels of TN and TP are elevated and exceed the QWQG values at times (Noble et al, 1996; EPA 2007a), especially during periods of moderate and high flows.

The results of aquatic invertebrate sampling suggested that the streams within the catchment possessed relatively diverse invertebrate communities. Noble (et al 1996) concluded that life within the river system was fairly healthy, but that the significant flow events moved millions of tonnes of soil, and hence any nutrients and pesticides present in the soil, into the GBR lagoon.

Central Queensland

Overall, Central Queensland's water quality is in moderate condition. Key issues that require attention include (Meecham 2003):

- erosion and runoff increasing sedimentation, nutrient, pesticide and herbicide levels
- toxic blue-green algae blooms in still waters
- contamination or pollution in industrial and mining areas
- rising salinity
- poor riparian vegetation cover
- changes to river flows.

Summary

DO concentrations levels did not comply with the QWQG except at Eurombah, Mud and Spring Creeks (sites A, 5, and 6). Turbidity was variable, and was estimated to have exceeded QWQG levels at all sites except for Eurombah (site A) and Slatehill (site D) creeks. Sites that were highly turbid were also cleared of riparian vegetation and were affected by cattle access. By their nature, ephemeral streams such as those in the study area are commonly subject to a range of severe (natural) stresses, and as such the water quality of the creeks within the study area may be characterised by elevated turbidity, salinity and nutrient enrichment (Chessman, B. [Centre for Natural Resources NSW] pers. comm. 2003, 21 October).

Similarly, water quality across the wider catchment is also characterised by high turbidity and fluctuating DO concentrations. Due to surrounding land uses, waterways within the region are impacted by relatively high inputs of nutrients, pesticides and other contaminants.

17B.3.3 AQUATIC FLORA

Up to 14 species were recorded across the eight sites that held water. Ten species had an emergent growth form and the remaining two were submerged. No floating species were recorded.

At all sites, cover by any one species was less than or equal to 10%. No macrophytes were recorded from Kurrajong Gully (site C), which contained several pools of water.

Several macrophytes could only be identified to genus level, due to the absence of seeds or flowers. The most abundant and common macrophyte was *Lomandra longifolia*, which covered 10% of the substrate at Slatehill Creek (site D). It was present at five of the eight sites where macrophytes were observed.

Submerged macrophytes are limited in distribution throughout the region by high turbidity, as it reduces light penetration through the water column, essential for the growth of macrophytes. Submerged macrophytes were only found at Eurombah Creek, where the water was relatively clear. All of the emergent forms in this study were found growing above the current water level.

Algae

Filamentous algae were also observed at Eurombah Creek (site A) and had an estimated cover of 2%.

Regional perspective

Very little information is available regarding macrophytes of the region.

Many sites surveyed in the subcatchment were dry at the time of sampling (91%), while sites with water did not support macrophytes. Similar observations were made during the initial field reconnaissance of the study area in August 2007.

A recent study in the upper Dawson River catchment (frc environmental 2007) reported a similar result to the proposed pipeline study area survey. frc environmental (2007) reported ten different species of macrophyte from seven sites, with richness ranging from zero to eight species at any one site. All macrophytes had an emergent growth form.

17B.3.4 AQUATIC MACRO-INVERTEBRATE COMMUNITIES

Study area

Water fleas were by far the most abundant macro-invertebrates across the sites surveyed, although non-biting midge larvae were also very abundant. Macro-crustaceans (freshwater prawns and crayfish) were also common throughout the sites surveyed.

The calculated index scores indicate the following:

- taxonomic richness was generally higher in edge habitats (7–20 taxa recorded) than in bed habitats (2–15 taxa recorded). This is a reflection of more diverse habitat existing in edge habitat
- PET richness was generally low and indicated degraded or moderate quality water and habitat quality
- SIGNAL 2 results suggest that the surveyed waterways may be impacted by urban, industrial or agricultural pollution.

Macro-crustacean communities

Four macro-crustacean species were recorded in the study area, as given in Table 17B-2.

Cherax depressus (orange-fingered yabby) was the most abundant species captured and was recorded at all sites surveyed. Adult, intermediate and juvenile orange-fingered yabbies were captured at each site, except for Eurombah Creek (A) where only juveniles were captured. *Macrobrachium* sp. (river prawn) were also present at sites A and E. *Caridina* sp. and *Paratya* sp. (freshwater shrimp) were also collected from Eurombah Creek (A), which had the highest species richness.

Table 17B-2: Abundance of macro-crustaceans at each site (all survey methods combined)

Family	Latin name	Common name	Site					
			A	C	E	3	5	6
Atyidae	*Caradina* sp.	freshwater shrimp	9			28	33	20
Atyidae	*Paratya* sp.	freshwater shrimp	3					
Palaemonidae	*Macrobrachium* sp.	river prawn	28		2	23	83	
Parastacidae	*Cherax depressus*	orange-fingered yabby	3	8	4	42	76	17
Total			**43**	**8**	**6**	**93**	**192**	**37**

Regional perspective

Richness

Sandy pool habitats sampled by NRW (2007) in the Dawson River supported between 7–18 families per sample, and rocky pool habitats supported between 10–25 families per sample. That is, macro-invertebrate richness was similar to the Dawson River site surveyed by NRW at Eurombah Creek (site A), but lower at Kurrajong Gully (site C) and Barton Creek (site E). Some of this variation may be attributable to temporal variation, as NRW surveys were done between 4 and 13 years ago. Similarities between Eurombah Creek and the Dawson River site are probably related to the perennial nature of the streams, which offer more stable habitat for macro-invertebrates.

Similar to the pattern observed in the present study area, macro-invertebrate community richness for edge habitats in the Dawson River was higher than the richness found in bed communities. Taxonomic richness ranged between 17 and 32 at the NRW sampling site on the Dawson River at Taroom (Site 130302A) from 1994–2004. This is a relatively high richness, and is likely to be indicative of relatively good quality edge habitat and water quality at this site.

PET richness

The PET richness of bed and edge habitats in the Dawson River at Taroom was indicative of moderate to good habitat and/or water quality. PET richness varied over time, but was generally higher than the PET richness recorded in the proposed western CSM water supply pipeline study area during the present surveys.

SIGNAL 2/family bi-plots

The SIGNAL 2/family bi-plots for communities sampled from the Dawson River are indicative of fair to good habitat and water quality in the Dawson River at Taroom. However, the macro-invertebrate communities may be affected by high nutrient or salinity levels, urban or agricultural pollution and/or harsh physical conditions.

Macro-crustacean communities

Macro-crustaceans were abundant in a recent study in the upper Dawson River catchment (frc environmental 2007), where a variety of Australian river prawns, freshwater shrimps and orange-fingered yabbies were caught.

Aquatic macro-invertebrate summary

Aquatic macro-invertebrate community structure within the study area was generally indicative of poor to moderate habitat and/or water quality and reflected the results of water quality and aquatic habitat assessments. Differences in macro-invertebrate community structure appeared to be related to site-specific differences in habitat availability and diversity. However, the composition of macro-invertebrate communities indicates that Eurombah Creek is in relatively good condition, and in particular provides diverse and stable edge habitat. Crayfish and prawns/shrimp were common in the study area.

In general, the macro-invertebrate communities of the downstream Dawson River were more diverse and contained more taxa sensitive to pollution and disturbance than corresponding communities within the study area. Sites on the Dawson River at Taroom are likely to have permanent water and therefore offer more stable habitat for macro-invertebrates. In contrast, the communities of the study area are influenced by harsh physical conditions, such as the drying of pools.

17B.3.5 FISH COMMUNITIES

Study area

In total, five species were captured across the six sites surveyed. The abundance of fish varied from no fish at Kurrajong Gully (site C) to 79 fish at Mud Creek (site 5), as given in Table 17B-3.

Species richness was highest at Mud Creek (site 5) with four species captured, followed by Woleebee Creek (site 3) and Eurombah Creek (site A), where three species were captured.

Table 17B-3: Abundance of fish species at each site (all survey methods combined)

Family	Latin name	Common name	Site					
			A	C	E	3	5	6
Ambassidae	Ambassis agassizii	Agassiz's glassfish				2	50	
Eleotridae	*Hypseleotris* sp.	Carp gudgeon	3		21		16	7

Family	Latin name	Common name	Site					
			A	C	E	3	5	6
Melanotaeniidae	*Melanotaenia splendida*	eastern rainbowfish				1	6	
Percichthyidae	*Macquaria ambigua*	golden perch	3					
Terapontidae	*Leiopotherapon unicolor*	spangled perch	1		3	10	7	6
Total			**7**	**0**	**24**	**13**	**79**	**13**

Spangled perch was the most widely distributed species in the study area, and it was found at all sites where fish were present. Carp gudgeons were also widely distributed, and were found at four of six sites. Agassiz's glassfish were the most abundant species, although they only found at two sites (50 individuals were collected from Mud Creek (site 5)). Three intermediate golden perch (*Macquaria ambigua*) were collected from Eurombah Creek (site A).

Overall, fish were more abundant at sites surveyed during March 2008 than August 2008, this is likely to reflect the seasonal variation in fish communities throughout the study area.

Indicators of stream health

No introduced species were captured during the survey. No listed threatened species were captured during the survey. All fish appeared healthy.

Regional perspective

The fish communities within the proposed pipeline study area have not been previously sampled.

Berghuis & Long (1999) sampled two sites along the upper Dawson River during surveys of the Fitzroy Basin undertaken between 1994 and 1996 and captured ten species. More recently, a dry season survey of four sites in the upper Dawson River catchment captured eight species (frc environmental 2007) and a wet season survey of eight sites captured a total of 20 species (Ecowise, 2008). The results of these studies are listed in Table 17B-4.

Table 17B-4: Number and species of fish caught in the upper Dawson River catchment during previous studies

Family *Species*	Common name	Study		
		Berguis and Long (1999)	frc environmental (2007)	Ecowise 2008
Ambassidae				
Ambassis agassizii	Agassiz's glassfish	52	0	3
Antherinidae				
Craterocephalus stercusmuscarum	fly-specked hardyhead	88	0	2

Family *Species*	Common name	Study		
		Berguis and Long (1999)	frc environmental (2007)	Ecowise 2008
Clupeidae				
Nematolosa erebi	bony bream	214	196	211
Cyprinidae				
Carassius auratus	goldfish	0	0	5
Eleotridae				
Hypseleotris sp. A	Midgley's gudgeon	89	8	2
Hypseleotris klunzingeri	western carp gudgeon	23	0	20
Mogurnda adsepersa	purple-spotted gudgeon	0	0	8
Oxyeleotris lineolata	sleepy cod	0	4	8
Philypnodon grandiceps	flathead gudgeon	0	0	3
Melanotaeniidae				
Melanotaenia s. splendida	eastern rainbowfish	224	3	26
Osteoglossidae				
Scheropages leichardti	Southern saratoga	0	0	4
Percichthyidae				
Macquria ambigua oriens	golden perch	16	0	20
Plotosidae				
Neosilurus hyrtlii	Hyrtl's tandan	0	8	22
Porochilus rendahli	Rendahl's catfish	0	0	1
Tandanus tandanus	eel-tailed catfish	6	1	9
Poecillidae				
Gambusia holbrooki	mosquitofish	0	16	32
Pseudomugilidae				
Pseudomugil signifer	pacific blue eye	56	0	0
Terapontidae				
Leiopotherapon unicolor	spangled perch	7	31	76
Scortum hillii	leathery grunter	0	0	13

The most abundant fish species captured in the upper Dawson River catchment during these studies were bony bream and eastern rainbowfish (Berghuis & Long 1999). Conversely, spangled perch and glassfish were the most abundant species captured within the study area during the present survey. Bony bream were only caught at the most downstream site in Juandah Creek.

Berghuis & Long (1999) did not report any exotic species in the Dawson Catchment, although *Poecilia reticulata* (guppy) and goldfish were recorded in the Fitzroy Basin. Since then, goldfish have been caught in Juandah Creek and the Dawson River (refer Volume 1 Chapter 17B Aquatic ecology; Ecowise 2008), and *Gambusia holbrooki* (mosquitofish) have been captured in the Dawson River in November 2007 (frc environmental 2007). Mosquitofish are declared noxious species in Queensland under the *Fisheries Regulation 2008*.

Fish movement

Of the fish likely to be found in the study areas, most undertake freshwater migrations. Adult golden and spangled perch move upstream to spawn while juveniles move downstream for dispersal. This movement is typically triggered by large flow events (Cotterell 1998). Glassfish, rainbowfish and gudgeons move within freshwaters to disperse to new habitats. This movement also typically occurs following flow events and in the case of the study area, could only occur when the creeks are flowing.

The habitat preferences, diet and migrations of each of the fish species captured in the study area (including the timing of critical movements of these fishes) are described in Appendix 17B-1-V3.4. Each of the native fish species found in study area requires some physical in-stream habitat to provide shelter or suitable spawning habitat. A variety of physical aquatic habitat such as woody debris and substrate diversity also support diverse macro-invertebrate communities, which are prey to many of the fish found in the study area.

Most of the species that were captured from the study area can tolerate a large range of water quality conditions (refer Table 17B-5). Spangled perch, glassfish and carp gudgeons are tolerant species that can live in water characterised by low dissolved oxygen levels, high conductivity and relatively high turbidity. Golden perch have narrower water quality tolerances than the other species collected, however the pH at Eurombah Creek exceeded the upper limit observed for this subspecies.

17B.3.6 TURTLE COMMUNITIES

Study area

Along the pipeline route, turtle traps were set at two of the twelve sites (sites 3 and 6). Turtle traps could not be set at the other sites along the pipeline alignment, due to insufficient water depths. No turtles were captured or observed.

Regional perspective

Only Krefft's river turtle were captured from the MLA study area and during a recent survey of the upper Dawson River catchment (frc environmental 2007). During the frc environmental (2007) survey, adult turtles were more abundant than intermediate or juveniles. Krefft's river turtle inhabits rivers, creeks and lagoons through eastern Queensland from just north of Brisbane to Princess Charlotte Bay (Wilson & Swan 2008). Turtles from the *Emydura* genus are omnivorous, feeding on macrophytes, invertebrates, small vertebrates and carrion (Wilson & Swan 2008). They are often observed basking on protruding rocks or logs (Wilson & Swan 2008).

Other freshwater turtle species that may occur in the Dawson Catchment include the eastern snake-necked turtle (*Chelodina longicollis*) and the saw-shelled turtle (*Elseya latisternum*) (Cogger 1996). The eastern snake-necked turtle has been recorded from within 20 km of the MLA area (EPA 2007b) but as they generally only inhabit larger waterways (Cogger 1996), they are considered unlikely to be abundant in the ephemeral creeks of the study area.

Fitzroy River turtles (*Rheodytes leukops*) are only found in the Fitzroy River and its tributaries. This species is listed as Vulnerable under the Queensland *Nature Conservation Act 1992* (NCA), the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the International *IUCN Red List of Threatened Species 2007* (IUCN 2007).

Fitzroy River turtles are found in shallow, fast-flowing riffle zone habitats characterised by well-oxygenated water (Cann 1998, Tucker et al. 2001). Female Fitzroy River turtles nest on sandy banks with a deep layer of sand and a low vegetative cover. Nests are typically laid in deep chambers situated from 1–4 m above the water level, and have been observed up to 15 m back from the waters edge (Cogger et al. 1993, Cann 1998).

No fast-flowing habitats or turtle nesting banks were observed during surveys of the proposed pipeline study area. Due to a lack of suitable habitat, the Fitzroy River turtle is unlikely to occur within the study area. However, this species may be present downstream in the upper Dawson River as it has previously been recorded in the Dawson River (EPA 2007b).

17B.3.7 OTHER VERTEBRATES

The survey did not target other aquatic vertebrates, but several echidnas were observed within the study area including at Eurombah Creek (site A) and Slatehill Creek (site D). Wallaby and kangaroo prints and droppings were also observed at most crossings.

No conservationally significant aquatic amphibians or reptiles have been recorded from, or are likely to occur in, the study area (DEWHA 2007a; EPA 2007b).

17B.3.8 SUMMARY OF AQUATIC ENVIRONMENTAL VALUES

The Environmental Values (EVs) of aquatic ecosystems within the study area are relatively low and consistent with those of the wider catchment. EVs are influenced primarily by the ephemeral nature of the waterways and agricultural development within the region which has significantly influenced water quality and the physical characteristics of aquatic habitat (Telfer 1995). Degraded creeks in the study area and regionally are characterised by riparian vegetation loss, erosion, invasion of weed species, poor water quality and sedimentation (Telfer 1995).

Table 17B-5: Reported water quality tolerances of fish species captured in the study area (data sourced from Pusey at al. 2004)

Family	Latin name	Common name	Water temperature (° C)	Dissolved oxygen (mg/L)	pH	Conductivity (µS/cm)	Turbidity
Ambassidae	*Ambassis agassizii*	Agassiz's glassfish	11–33	0.3–19.5	6.3–9.9	19.5–15 102	0.2–144
Eleotridae	*Hypseleotris* spp.[A]	carp gudgeons	8.4–31.2	0.3–19.5	4.4–8.9	51–4123	0.1-331.4
Melanotaeniidae	*Melanotaenia splendida*[C]	eastern rainbowfish	15–32.5	1.1–10.8	6.8–8.5	49–790	0.6–16, but up to 600 (frc pers obs)
Terapontidae	*Leiopotherapon unicolor*	spangled perch	5–41	≥ 0.4	4–8.6	0.2–35.5 ppt salinity	1.5–260
Percichthyidae	*Macquaria ambigua oriens*[B]	golden perch	24–31	3.6–10.0	7.2–8.8	NA	4–40 cm secchi depth

A environmental data from captures during surveys in south-east Queensland

B environmental data from captures during surveys in the Fitzroy river systems

C environmental data from captures during surveys in the Burdekin River system

NA not available

Water quality was generally poor throughout the study area, but was typical of the region. Biodiversity was relatively low, with only fish and macro-invertebrate species that are tolerant of varying and often harsh conditions inhabiting the study areas at the time of survey. Nevertheless, the creeks along the proposed pipeline alignment do provide 'upstream' dispersal habitat for the fish species that were recorded in the study area (and possibly breeding habitat for some species).

No rare or threatened species of aquatic flora or fauna have been recorded from, or are likely to occur in, the waterways of the study areas.

17B.4 DESCRIPTION OF PROPOSED DEVELOPMENT

The proposed pipeline will be 91 km long and aligned predominately along the northern side of the road reserves of the Roma-Taroom Road and Goldens Bimbadeen Road in order to minimise vegetation clearing along the alignment.

A 600 mm diameter underground pipeline is proposed from the Origin Energy Reverse Osmosis (RO) Plant and associated infrastructure to the Project MLA areas.

Installation and operation of the pipeline has the potential to impact on aquatic ecology through:

- operation of vehicles and equipment along the pipeline alignment. No vehicle or equipment maintenance, or permanent fuel storage facilities are to be undertaken along the pipeline alignment
- vegetation clearing and earth moving along a 20 m wide footprint of the alignment, including adjacent to creeks, and within the bed and banks
- construction of creek crossings for temporary access roads, and the proposed pipeline, including obstructions to flow and aquatic fauna passage. The proposed pipeline alignment crosses the following creeks:
  - Eurombah Creek, and two minor tributaries (first order streams) of this creek
  - Slatehill Creek, and tributary Kurrajong Gully and two minor tributaries (first order streams)
  - Barton Creek, and three minor tributaries (first order streams) of this creek
  - Kangaroo Creek, and two minor tributaries (first order streams) of this creek
  - Canal Creek, and two minor tributaries (first order streams) of this creek
  - two minor tributaries (first order streams) of Nine-Mile Creek
  - Horse Creek, and tributaries Duck and Spring Creeks
  - Mud Creek, and three minor tributaries (first order streams) of this creek
  - Woleebee Creek and three minor tributaries (first order streams) of this creek.
- supply and storage of raw water from outside of the catchment of the MLA areas. Raw water will be supplied as CSM by-product water, consisting of up to 4,000 mg/L total dissolved solids (TDS). Scour outlets will be placed in the proposed pipeline sags, approximately one every 1 km to 2 km, to minimise the volume of water that needs to be emptied during maintenance. Water released from scour outlets will be directed into

mobile water tankers (via 'cam-loc' coupling) and trucked to the mine site for release into either the raw water storage dam (if the water quality meets water quality requirements), or the tailings dam.

17B.5 POTENTIAL IMPACTS

Due to the nature of the activity, potential impacts are generally restricted to the construction phase.

17B.5.1 OPERATION AND MAINTENANCE OF VEHICLES AND EQUIPMENT

Fuel spills

Fuels and oils are toxic to aquatic flora and fauna at relatively low concentrations.

Spilt fuel is most likely to enter the creeks via an accidental spill on the access route near creek crossings or when there are construction activities adjacent to creeks. The proposed pipeline crosses the major creeks in the area and a significant fuel spill to any of these creeks is likely to have a significant impact.

The risk to aquatic flora and fauna is reduced as the creeks are ephemeral and therefore many spills could be effectively cleaned up before they can disperse throughout the waterways.

17B.5.2 VEGETATION CLEARING AND EARTHMOVING

Increased turbidity

Vegetation clearing and/or soil disturbance can increase sediment run off to creeks and elevate turbidity. The pipeline alignment proposed is generally straight and traverses several hills, and as a result clearing along the alignment has the potential to direct stormwater runoff directly along the pipeline route and into creeks. This has the potential to drastically increase turbidity within the local drainages, and result in sediment deposition in the waterways.

Increased turbidity may impact on aquatic flora and fauna. Increased turbidity may also adversely affect submerged macrophytes as light availability (required for photosynthesis) is reduced. Reduced light penetration, caused by increased turbidity, can also lead to a reduction in temperature throughout the water column (DNR 1998).

At the time of survey, waterways along the pipeline route were generally highly turbid and substrates were generally dominated by silt. Faunal communities of the study area are adapted to living in turbid water. Given these background conditions, the introduction of small amounts additional sediment is unlikely to have ecologically significant impacts on faunal communities; however, substantial increases may have a significant impact on the aquatic flora and fauna communities.

Input of nutrients or contaminants

Aquatic biota could also be impacted by nutrients or contaminants washed into the waterways. Nutrient inputs can lead to algal or macrophyte blooms, which may lead to harmful DO 'crashes' during the night.

Nutrient-laden runoff is likely to be low compared to that associated with agricultural practices, as fertilisers will only be used in association with rehabilitation and revegetation of disturbed areas. In any case, the highly turbid water of the creeks is likely to prevent significant algae blooms for much of the year. Eutrophication of the waterways is therefore considered to be a low risk to aquatic ecology.

Alteration of aquatic habitat

Vegetation clearing and earth moving near and within the creeks will decrease the amount of available habitat for aquatic fauna.

Instream habitat is an important habitat component and territory marker for many fish and macroinvertebrates. Many species live on or around instream habitat as they provide shelter from temperature, current and predators; contribute organic matter to the system; and are important for successful reproduction. Australian fish species typically spawn either on instream vegetation or on hard surfaces like cobbles, boulders, and woody debris. The impacts of decreased habitat structures will be localised but on a linear scale the impacts may be unacceptable in both a local and regional context, given the length of the pipeline.

The deposition of fine sediments and subsequent decrease in stream bed roughness and also has the potential to completely fill in the existing pools. Within the minor (first order) tributaries throughout the study area, this would be unlikely to have a significant impact, as these streams appear to only carry flood flows, and they do not generally hold water. However, in larger watercourses such as Eurombah Creek, Slatehill Creek, Kurrajong Gully, Barton Creek, Kangaroo Creek, Canal Creek, Horse Creek, Mud Creek and Woleebee Creek, sediment deposition would lead to a decline in habitat diversity and a reduction in the number of pools available as 'refuge' habitat in the dry season. These impacts would lead to a decline in the abundance diversity of both invertebrate and fish communities in the creeks.

After construction, the newly formed bed and banks may continually erode given the high flows that occur in the region in the wet season. The potential impact will be that the creeks increase in width and lose channel definition and as a result downstream flow may be decreased. The impacts of decreased bed and bank stability will be localised but on a linear scale the impacts may be unacceptable in both a local and regional context, given the length of the pipeline.

17B.5.3 CONSTRUCTION OF CREEK CROSSINGS

Construction of temporary vehicle and permanent pipeline creek crossings will disturb bed and bank stability, leading to increases in localised erosion, potentially leading to increases in turbidity and sediment deposition.

Obstruction of fish passage

Many of the fish native to ephemeral systems of central and western Queensland migrate up and downstream and between different habitats at particular stages of their lifecycle. Fish passage is already restricted in creeks along the proposed pipeline alignment. During the installation of the pipeline, instream obstructions will be temporary. However, poorly-designed crossings have the potential to have further long term and permanent impacts on fish movement within the study area.

17B.5.4 SUPPLY AND STORAGE OF RAW WATER

Overall, the CSM by-product water is expected to be high in total dissolved solids (TDS) compared with the TDS concentration in the natural waterways. If water supplied from the proposed pipeline enters the creeks crossed by the pipeline or within the MLAs, it may impact on aquatic ecology.

17B.5.5 BITING INSECTS

Within the study area, creeks, farm dams, stock water troughs and other areas of standing water (for example along roads or in backyards of domestic dwellings) currently have the potential to provide breeding habitat for mosquitoes and biting midges.

Construction activities that result in pooled water will potentially provide an increase in mosquito and biting midge breeding habitat in the study area. An increase in the population of mosquitoes and biting midges has the potential to impact on human health.

17B.5.6 SIGNIFICANT CONSERVATION HABITAT

There is no significant conservation habitat located within, or immediately downstream of, the proposed pipeline study area.

The proposed pipeline is not likely to impact on boggomoss springs, as there are no springs within, or in the immediate vicinity of, the proposed pipeline alignment (DEWHA 2008a).

The Great Barrier Reef World Heritage Area and the Shoalwater and Corio Bays Ramsar site are unlikely to be impacted by the proposed pipeline, as they are over 300 km to the north-east and water quality that far downstream of the study area will not be impacted by the proposed pipeline.

17B.5.7 THREATENED SPECIES AND ECOLOGICAL COMMUNITIES

As discussed in Section 17B.3.6, it is unlikely that the Fitzroy River turtle inhabits the ephemeral creeks within the proposed pipeline area. The proposal is unlikely to have a significant impact on this species.

The boggomoss snail (*Adclarkia dawsonensis*) is found associated with boggomoss habitat located approximately 100 km downstream of the proposed pipeline area, on the Dawson River. Boggomoss communities are unlikely to be impacted by the proposal.

17B.6 MITIGATION MEASURES

The following mitigation measures will be considered for implementation during construction. Other additional or alternative measures may also be identified and implemented, provided that they reduce the risk of potential environmental harm to the aquatic environment.

The proposed pipeline will be constructed in accordance with AS 2885 and the Australian Pipeline Industry Association's *Code of Environmental Practice — Onshore Pipelines* (APIA, 2005) (Code of Environmental Practice).

17B.6.1 OPERATION AND MAINTENANCE OF VEHICLES AND EQUIPMENT

Risks associated with the spillage of fuels and other contaminants will be substantially reduced by:

- no vehicle maintenance being conducted in areas associated with the proposed pipeline construction, with maintenance only conducted at designated maintenance areas in the Project construction compound area of the MLAs
- bunding portable refuelling stations, for refuelling of machinery in the field, are bunded to meet AS 1940 and placed above the Q_{100} flood level of nearby waterways and dams
- reporting all spills of contaminants (such as diesel, oil, hydraulic fluid etc.) immediately reported to the Project's Environmental Officer
- having available appropriate spill containment kits used for the cleanup of spills in the field. Equipment that is susceptible to spills and/or leakages will have a spill kit onboard or within 5 m of the equipment at all times. The kits will contain equipment for clean-up of both spill on land or in dry creek beds, and spills to water (such as floating booms).

17B.6.2 VEGETATION CLEARING AND EARTHMOVING

Risks associated with the clearing of vegetation will be substantially reduced by development of a clearing plan and an erosion management plan as part of the Environmental Management Plan to minimise the quantity of area of clearing and the potential quantities of sediment run off into waterways during pipeline installation. These plans will incorporate the following elements where possible:

- minimise the footprint of clearing to the minimum for practical construction, being approximately 10 m wide in most instances, but up to 20 m
- construction of the pipeline in the dry season
- use of erosion control and sediment control measures
- monitoring turbidity during construction
- rehabilitation of vegetation after clearing, including the establishment of ground cover, with species already existing in the immediate area

- rehabilitation of instream aquatic habitat after clearing, including bed and bank rehabilitation.

Timing

The risk of sediment runoff impacting nearby waterways will be further reduced where construction of pipeline and temporary road crossings of creeks, particularly of major waterways (Kurrajong Gully and Eurombah, Slatehill, Barton, Canal, Kangaroo, Horse, Spring, Mud and Woleebee creeks) is done in the dry season.

Erosion control and sediment control measures

During and after construction, water quality and ecosystem health of nearby waterways will be protected where practicable by:

- erosion control matting (or mulch), placed along ditches and drainage lines running from all cleared areas, especially on slopes and levee banks
- diversion drains, bunds or 'whoa-boys' installed across cleared slopes to direct runoff towards surrounding vegetation and away from creeks
- monitoring water quality of creeks.

Further discussion on erosion and sediment control measures is provided in Chapter 9 Geology, mineral resources, overburden and soils.

Rehabilitation of vegetation

After construction, water quality and ecosystem health of nearby waterways will be protected by rehabilitation of the landscape by:

- salvaging and appropriately storing and maintaining selected native grass, shrubs and trees prior to clearing
- use of native vegetation of local provenance for replanting where possible
- replanting along creek margins (e.g. following construction of creek crossings). The width of the replanted riparian vegetation should match the existing riparian vegetation; however, 5 m would be the minimum width. Planted trees in the riparian zone should provide canopy cover and have root systems that can stabilise the banks and disturbed area.

17B.6.3 CREEK CROSSINGS

Construction of permanent creek crossings

Impacts associated with the construction of permanent creek crossings by the proposed pipeline will be minimised if:

Dry season

- crossings are located to result in minimal disturbance to vegetated areas
- construction is undertaken during the dry season, thereby minimising the likelihood of rainfall and runoff carrying sediment and other pollutants into the creeks

- stormwater, and erosion and sediment control measures are implemented
- crossing construction methods minimise disturbance to aquatic habitat and fish passage.

Wet season

Where practical, a trenchless crossing method is used (e.g. horizontal directional drill), in accordance with the following (AE 2001):

- the drilling is done in a manner that does not cause a disturbance in the water, to the exposed bed or shore of the waterbody, or to an area of undisturbed vegetation that measures 10 m from each bank of the active channel
- where pressurized drilling fluids or water are used, the waterbody is monitored in case drilling fluids are released into the waterbody. Contingency and monitoring measures are put in place, including:
  - instructions to monitor for potential seepage into the waterbody of drilling fluids or water used, including monitoring and recording drilling fluid volumes on a continuous basis during and after the drilling operation
  - instructions on how to mitigate for the effect of any seepage into the water body of drilling fluids or water used, depending on the specific equipment used.

If a trenchless crossing method is not possible, isolation and open-cut methods are also appropriate under wet conditions at numerous crossings (refer Appendix 17B-1-V2.4). The workspace should be isolated, irrespective of if there is an isolated pool or flowing water. The isolation should be designed such that (AE 2001):

- it is completed within one work-day, to minimise the impact on aquatic fauna
- upstream and downstream dams are installed on the edge of the temporary workspace, to maximise the workspace. These dams will:
  - be constructed of an appropriate material for each creek (e.g. steel plates, flumes, sand bags or 'aquadam')
  - be made impermeable by using polyethylene liner and sand bags
  - if flowing water is present, have 100% downstream flow maintained by using pumps with a capacity that exceeds expected flows. Backup pumps and generators should be on site and operational if required
  - have pump intakes with a screen, with openings no larger that 2.54 mm, to ensure that no fish are entrapped
  - have fish salvaged from the isolated workspace and translocated
  - have the upstream dam slowly removed, to allow water to flush the sediment from the workspace area
  - have sediment-laden water pumped into sumps or onto vegetation
  - have operation of the clean-water pump to sustain partial flow below the downstream dams continued until the downstream dam is removed.

Construction of temporary vehicle creek crossings

Impacts associated with the construction of temporary road crossings will be minimised if they:

- are constructed during the dry season
- follow the guidelines presented for permanent creek crossings
- bed and bank habitat should be rehabilitated after removal of the temporary crossing.

Due to the limited water flow within the creeks of the region, opportunities for fish to migrate should be maximised (Cotterell 1998). The construction of temporary creek crossings can minimise disruption of fish passage by having:

- the crossing structures at each site follow the mitigation measures presented in Appendix 17B-2-V3.4
- where culverts are used for temporary crossings, they will be designed such that they are (Cotterell 1998):
    - as short and wide as possible; whist being designed to allow the passage of anticipated flood volumes and associated debris, and to allow enough water depth within the culvert to facilitate fish movement (estimated at >0.5 m depth for the fish species likely to be present)
    - installed without a 'drop off' at the culvert outlet or inlet, as this impedes fish migration upstream and downstream
    - constructed with minimum disturbance to the outer banks on stream bends, as these are usually the most unstable and prone to erosion
    - removed when pipeline construction is complete, and the riparian vegetation is rehabilitated (by re-planting after construction if necessary) to stabilise banks, provide food and habitat for fauna and prevent predation of aquatic fauna by birds.

Rehabilitation of instream aquatic habitat

Prior to and following installation of the proposed pipeline and removal of a temporary crossing, impacts will be mitigated by:

- salvaging existing bed material prior to construction and placing it back into the creek at completion of construction. If the existing bed material is unable to be salvaged, a comparable sediment size material is recommended to cover the bed and should be approximately 10 cm thick. If the sediment is fine (mud and/or silt), bed material be replaced with sand, to prevent future erosion. If the sediment is coarser (gravel, cobble, pebbles and/or boulder), new material must be washed prior to placing in the creek (as usually, new coarse substrate is covered in a fine dust, which will become suspended in the water)
- rehabilitation of the bed and bank structure such that original dimensions and shape of the creek are achieved. Bank recontouring will include stabilisation methods such ascrib walls or soil wraps, where appropriate (refer Appendix 17B-1-V2.4)
- revegetation of creek banks

- aquatic habitat structures are replaced within the channel. Prior to construction, any instream structures (woody debris, large cobbles) may be salvaged. Felled trees may also be placed into creeks to create woody debris habitat.

17B.6.4 SUPPLY AND STORAGE OF RAW WATER

Water supplied by the proposed pipeline will be stored in the raw water storage dam in the MLA area. The dam will be designed so that this water, is not released into natural waterways.

The proposed pipeline will be regularly inspected and maintained so that water does not leak from the pipeline into surrounding natural waterways.

17B.6.5 BITING INSECTS

Mosquito breeding habitat may be minimised through:

- minimising the area of standing water and ensuring drainage within four days
- grading to ensure sufficient drainage
- during construction, routinely filling incidental depressions and holes that may hold standing water
- regularly clearing drainage lines to ensure that water continues to flow and no ponded areas are created.

17B.6.6 THREATENED SPECIES AND ECOLOGICAL COMMUNITIES

The proposed pipeline is highly unlikely to have an impact on any threatened aquatic species or ecological communities as none are likely to occur in the waterways along the proposed western CSM water supply pipeline.

17B.6.7 MONITORING REQUIREMENTS

Appendix 17B-2-V3.4 outlines recommended water quality monitoring during the installation of the pipeline and temporary vehicle creek crossings. The aim of this monitoring is to determine whether sediment runoff during construction is likely to impact upon aquatic fauna. As a guide, Table 17B-6 presents preliminary water quality objectives for the waterways to be crossed by the pipeline. These guidelines aim to maintain the natural fish communities of the region, based on the water quality recorded during the current studies, and published environmental tolerances.

Water quality will be measured with a hand-held probe:

- at the crossing site immediately prior to construction, to determine background conditions
- daily during construction
- daily after construction until water quality returns to background conditions.

Where water quality objectives in the creek are exceeded, construction will cease and erosion and sediment control measures be revised prior to re-commencement of construction.

Table 17B-6: Preliminary water quality objectives for the water quality required in the creeks crossed by the proposed pipeline, to maintain the natural fish communities of the region

Parameter	Range required to sustain the fish communities sampled during this study
Temperature (º C)	<34
Dissolved oxygen (mg/L)	1.5–10.0
pH	6.0–8.5
Conductivity (µS/cm)	19.5–650
Turbidity (NTU)	< 200*, or 10% above background values, whichever is higher

* However most species found in this study have been recorded from waterways with much higher turbidity (up to 600 NTU; frc environmental pers obs.)

17B.7 RESIDUAL IMPACTS

On the provision that the mitigation measures in this Chapter are followed, the residual impacts to aquatic ecology is expected to be to be very low, with no permanent local or regional impacts.

17B.8 CONCLUSIONS

Surrounding land uses, including vegetation clearing, cattle grazing and cropping, have negatively impacted the physical habitat of the study area and the wider catchment. Water quality is relatively poor, and reflects the predominantly agricultural nature of the region and the ephemeral nature of the creeks. The aquatic habitat of the creeks along the proposed pipeline alignment are considered to be in poor to moderate condition overall. However the aquatic habitats at Eurombah Creek were in good condition. Despite the surrounding impacts, many of the creeks surveyed contained large trees in the riparian zone and a variety of aquatic habitats available to fauna.

Biodiversity in the study area is slightly lower than in the more permanent waters of the region. Only fish and macro-invertebrate species that are tolerant of varying and often harsh conditions inhabit the study area. However, while typically less diverse than the faunal communities in the Dawson River downstream, macro-invertebrate and fish communities found within the creeks along the proposed pipeline alignment are likely to contribute to the success of downstream populations through migration. Freshwater turtles were not found in the study area. No Rare or Threatened aquatic floral or faunal species were found in the study area or are considered likely to occur, based on the habitats present.

The potential impacts of fuel handling and stormwater runoff on the creeks along the proposed pipeline alignment and downstream waterways, will be minimised to an acceptable level by implementation of current best-practicable practice environmental management programs.

Of the potential impacts of the proposed pipeline, the construction of creek crossings, which can affect riparian and aquatic habitats, and fish movement, poses the greatest threat to aquatic ecology. However, the significance of this impact will be reduced by implementation appropriate mitigation measures. In particular, after creek crossings are completed, the bed and banks will be constructed so that they replicate the natural channel in terms of channel morphology, sediment types and riparian vegetation.

17B.9 REFERENCES

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