17B AQUATIC ECOLOGY

17B.1 INTRODUCTION

This chapter provides further assessment and information on aquatic flora and fauna for the Supplementary Environmental Impact Statement (EIS), in response to the completion of seasonal aquatic flora and fauna surveys, various submissions on the EIS and refinements/modifications to the Project. The information presented builds on the EIS Volume 1, Chapter 17B Aquatic Ecology and should be read in conjunction with the EIS chapter

Chapter 6 Project Operations of the Supplementary EIS provides further details on changes to the Project.

Further detailed information is located in an Addendum to the aquatic ecology technical report, presented in STR 17B-1-SV1.5 MLA Areas and Gas Supply Pipeline, Aquatic Ecology.

17B.2 METHODOLOGY OF ASSESSMENT

17B.2.1 RELEVANT LEGISLATION

The legislation and guidelines relevant to aquatic ecology were described in the EIS and aquatic ecology technical report TR 17B-1-V1.5.

Wetlands of international importance (Ramsar Wetlands)

None of the wetlands within the study areas are recognised by the Department of Environment and Resource Management (DERM) (formerly the Environmental Protection Agency) as being of National, State or Regional Significance.

The Fitzroy River Basin does not drain into Shoalwater Bay, but drains into Keppel Bay. However, Keppel Bay forms part of the Shoalwater and Corio Bay Ramsar wetland site, as stated in the EIS Volume 1, Chapter 17B, section 17B.2.1 and the associated technical report V17B-1-V1.5, section 2.1.2. The EIS environmental impact assessment concluded that the Project is not expected to result in a significant impact on the Ramsar wetland.

Queensland legislation

Water Act 2000

Under the provisions of the *Water Act 2000,* an approval will be obtained for the construction of each creek diversion and pipeline crossing of watercourses, where required.

Fisheries Act 1994

Where required, approvals will be obtained for each of the proposed creek diversion works (construction of waterway barrier works, as outlined in Division 8 of the *Fisheries Act 1994*) under the *Integrated Planning Act 1997*.

17B.2.2 DESCRIPTION OF STUDY AREA

The study area is as described in the EIS Volume 1, Chapter 17B Aquatic Ecology, section 17B.2.2.

17B.2.3 STUDY METHODOLOGY

Survey timing

To fulfil the requirements of the Terms of Reference for conducting seasonal surveys, the aquatic floral and faunal surveys were repeated in the wet season to describe seasonal patterns in flora and fauna abundance, and the likely presence of species throughout the year.

For the MLA areas, aquatic floral and faunal surveys were replicated in the early wet season, from the 28 January to the 1 February 2009. The weather was fine during the survey.

For the proposed gas supply pipeline area, aquatic floral and faunal surveys were undertaken in the early wet season, from 2 and 3 February 2009.

In the months preceding the surveys, a total of 183 mm of rain fell in the region between November 2008 and January 2009, based on rainfall records from the Taroom Post Office, BOM 2009. In the week prior to the surveys, 36 mm of rain had fallen (BOM 2009).

Study sites

MLA study area

Most of the sites surveyed for aquatic flora and fauna in March 2008 were resurveyed in the early wet season in January 2009. Table 17B-1 and Figure 17B-1-SV1.3 indicate the sites surveyed. However, three sites were dry during the January 2009 surveys. The dry site on One-arm Man Creek (Site 2) was replaced with a site downstream on Woleebee Creek (Site 2a) that holds near-permanent water. In addition, three artificial dams (Sites 11, 12 and 13) that are likely to hold permanent water and are mapped as lacustrine wetlands under the EPA's *Wetlands Mapping Programme* were also surveyed in January 2009.

Table 17B 1: Sites surveyed for aquatic flora and fauna in the late wet season (March 2008) and early wet season (January 2009) in the MLA study area

Site description	Site number	Survey completed		Location (UTM Zone 55J, GDA 94)	
		Late wet-season (March 2008)	Early wet-season (January 2009)	Easting	Northing
Within the MLA areas					
Frank Creek at Jackson Wandoan Road	1	X	Dry	792788	7107102
One-arm Man Creek at Jackson Wandoan Road	2	X	Dry	785971	7104359
Woleebee Creek on the Westman property	2a	—	X	787055	7109431
Woleebee Creek at Grosmont Road	3	X	X	786692	7111286
Woleebee Creek at Booral Road	4	X	X	787663	7115676
Mud Creek on the 'Ellen Vale' property	5	X	X	779288	7120297
Spring Creek at Kabunga Road	6	X	X	772324	7120294
Juandah Creek at the Leichhardt Highway	7	X	X	792951	7113180
Farm dam on the 'Ellen Vale' property	11	—	X	779583	7118691
Farm dam on the 'Pecos Valley' property	12	—	X	789359	7104987
Upstream of the MLA areas					
Mount Organ Creek at Bundi Road	8	X	X	773822	7111491
Artificial Dam adjacent to Mount Organ Creek	13	—	X	773963	7111328
Downstream of the MLA areas					
Juandah Creek at Booral Road	9	X	X	789131	7117431
Juandah Creek at Roma Taroom Road	10	X	X	781537	7156708

X = Habitat assessment, fauna and flora surveys, and *in situ* water quality.

Gas supply pipeline study area

Three sites were surveyed for aquatic flora and fauna in both the dry season (August 2008) and the early wet season (February 2009), and the aquatic habitat of other waterways crossed by the proposed pipeline route are described as shown in Table 17B-2 and Figure 17B-2-SV1.3. Dry crossing locations were revisited, and it was confirmed that aquatic habitat characteristics had not changed at these sites.

Table 17B-2: Sites surveyed for aquatic flora and fauna in the dry season (August 2008) and wet season (February 2009) in the gas supply pipeline study area

Site	Channel name	Survey completed		Location (UTM Zone 55J, GDA 94)	
		Dry season (August 2008)	Early Wet season (February 2009)	Easting	Northing
1*	Unnamed tributary to Bullock Creek	Dry with undefined channel, brief observations only	—	204962	7126958
2*	Stakeyard Creek	Dry, habitat observations only	Dry, no changes to habitat	202926	7127010
3	Unnamed tributary to Roche Creek	Dry, habitat observations only	Dry, no changes to habitat	800129	7123616
4	Roche Creek	Habitat, water quality and aquatic flora and fauna	Habitat, water quality and aquatic flora and fauna	798408	7120029
4b	Roche Creek Anabranch	Habitat, water quality and aquatic flora and fauna	—	798292	7119399
5	Roche Creek	—	Habitat, water quality and aquatic flora and fauna	799080	7119512
6	Unnamed tributary to Roche Creek	Dry, habitat observations only	Dry, no changes to habitat	797468	7116955
7	Juandah Creek	Habitat, water quality and aquatic flora and fauna	Habitat, water quality and aquatic flora and fauna	794977	7112625

* UTM Zone 56J, GDA 94

Methods

Unless otherwise noted, the methods adopted for the wet season aquatic flora and fauna survey, encompassing aquatic habitat, water quality, aquatic flora, aquatic macro-invertebrates, fish, turtles and other aquatic vertebrate communities, are the same as those applied for previous surveys and described in the EIS Volume 1, Chapter 17B Aquatic Ecology, section 17B.2.3, and the associated technical report. A detailed description of all variations to the study methods is provided in the Addendum to the technical report, STR 17B-1-SV1.5.

Water quality

Water quality data was collected during the conduct of the flora and fauna surveys primarily to aid in the interpretation of the biological data. At the time of the surveys the surface water flow in the study area was low or negligible and the waterways were characterised by a series of isolated pools. Thus, an assessment of water quality under baseflow conditions could not be made in this section. For a full description of the water quality, refer to Chapter 11 Water Supply & Management, section 11.3.6 and the associated Addendum to the surface water quality impact assessment technical report, TR 11-1-SV1.5, Attachment B.

To clarify following submissions on the EIS, the Queensland Water Quality Guidelines (QWQG) apply to water quality sampled under normal baseflow conditions and that these guidelines are not appropriate for physical water quality and other parameters such as nutrient levels in small isolated pools (EPA 2007a).

A water quality monitoring program, which considers the low-flow conditions that characterise the MLA areas, is described in the surface water quality technical report EIS Volume 1, TR 11-1-V1.5 and Supplementary EIS Volume 1, STR 11-1-SV1.5. Three of the sites used in the water quality monitoring program (Frank Creek

upstream, Mt Organ Creek upstream, and Spring Creek downstream) overlap with sites used for biological monitoring (Sites 1, 8 and 6 respectively).

Aquatic macro-invertebrate communities

A standard AusRivAS macro-invertebrate sample from each aquatic habitat found was collected at each site, using the same methods as previous surveys (EIS Volume 1, TR 17B-1-V1.5) and as set out in the Queensland AusRivAS sampling manual (DNRM 2001).

Quantitative, replicated macro-invertebrate data were collected from the MLA study area during this survey period, to provide a statistically robust assessment of the differences in macro-invertebrate communities between habitats, sites and waterways. This component of the survey provides baseline data for future aquatic ecology monitoring, which was recommended as a mitigation measure in the EIS.

Taxonomic richness, PET richness and Signal 2 scores were calculated for each site, and compared with the results of previous surveys, as provided in EIS aquatic ecology technical report TR 17B-1-V1.5.

Fish communities

Fish communities were surveyed using a combination of backpack or boat electrofishing, baited traps and dip nets.

Limitations

The sites chosen for survey within the MLA study area generally represent the range of aquatic habitats present throughout the MLA areas. Due to access constraints and the location of water holes, monitoring sites were predominantly located at road crossings. It is noted that turbidity can be influenced by proximity to obstructions such as culverts and road crossings. However, the study area is characterised by high turbidity and the influence of such obstructions on turbidity is considered negligible.

17B.3 EXISTING ENVIRONMENT

Unless otherwise noted, the wet season aquatic floral and faunal environment encompassing aquatic habitat, water quality, aquatic flora, aquatic macro-invertebrates, fish, turtles and other aquatic vertebrate communities, is generally the same as that described for previous surveys described in EIS Volume 1, TR 17B-1-V1.5. A detailed description of the wet season aquatic environment is provided in the Addendum to the technical report (Supplementary EIS Volume 1, STR 17B-1-SV1.5).

17B.3.1 AQUATIC HABITAT

The sites surveyed within the MLA and gas supply pipeline study areas during the aquatic flora and fauna survey in the late wet (March 2008) and early wet (January and February 2009) season surveys typically had a moderate River Bioassessment Program habitat assessment score. These relatively low scores resulted from low habitat variability with only pool habitat was observed, moderate to extensive bank erosion, and substrates dominated by finer sediments such as sand and silt.

Overall, the aquatic habitats of the creeks surveyed along the gas supply pipeline route were similar to those within the MLA areas. Riparian vegetation clearing, cattle access to the creeks and construction of creek crossings has negatively affected aquatic habitats.

Bioassessment scores were poor at one of the off-stream dam sites (Site 13), which was partially due to the fact that the bioassessment program is primarily designed for use in streams, rather than wetland habitats. However, the dam at Site 13 had no trees in the riparian zone, and low in-stream habitat coverage. Bioassessment scores at the other dams (Sites 11 and 12) were moderate.

17B.3.2 WATER QUALITY

There was no or negligible flow during either the early wet season (January and February 2009) and late wet season (March 2008) baseline surveys, and the sites sampled were characterised by isolated pools. Dissolved oxygen, electrical conductivity, turbidity were highly variable across sites both in the early and late wet season surveys; while water temperature and pH were similar at most sites.

A description of the early wet season water quality results (for temperature, dissolved oxygen, pH and electrical conductivity) for both the MLA and gas supply pipeline study areas and a comparison with the late wet season results is provided in the Addendum to the technical report (Supplementary EIS Volume 1, STR 17B-1-SV1.5).

17B.3.3 AQUATIC FLORA

Within the MLA study area, the late wet season survey (March 2008), recorded fifteen emergent species and one floating species (EIS Volume 1, TR 17B-1-V1.5). In the early wet season survey (January 2009), eleven emergent species, two floating species and three submerged species were recorded. The additional submerged and floating species recorded in the early wet season survey were in farm dams, which were previously not sampled in the late wet season survey.

Across the study areas, aquatic vegetation was dominated by native species. Reed sweetgrass (*Glyceria maxima*) was the only introduced species recorded and was only found at two sites (Site 8 and Site 13). Aquatic macrophytes covered between 3% and 29% at on-stream sites. Coverage was higher (between 27% and 50%) at off-stream sites (dams) which typically hold permanent water and have lower turbidity levels than the streams.

In the late wet season survey (March 2008), lesser joyweed (*Alternanthera denticulate*) was common at most sites, however, in the early wet season survey (January 2009), this species was only found at three of the eleven sites sampled. The most common emergent macrophyte in the early wet season survey was the common rush (*Juncus usitatus*), which grew at five on-stream sites. Sedges (*Cyperus* sp.), smartweed (*Persicaria decipiens*), *Lomandra* sp. (rush) and water couch (*Paspalum distichum*) were also relatively common.

Macrophytes were uncommon throughout the gas supply pipeline study area both in the dry and wet season surveys. *Lomandra* spp. was the most common macrophyte in the study area in the early wet season survey.

17B.3.4 AQUATIC MACRO-INVERTEBRATE COMMUNITIES

Macrocrustaceans (freshwater prawns and crayfish), diving beetles water bugs and non-biting midge larvae dominated the invertebrate communities of the MLA study area. The richness and distribution of taxa found within the study area varied among sites, largely due to the availability of aquatic habitats found at each site.

Within the gas supply pipeline study area, diving beetles, water bugs, mayfly nymphs and non-biting midge larvae dominated the macro-invertebrate communities of the sites during both the early wet (February 2009) and dry season (August 2008) surveys.

The calculated index scores for both the early and late wet season surveys indicate that:

- within the MLA study area, taxonomic richness was generally higher in edge habitats (7 – 20 taxa recorded) than in bed habitats (2 – 15 taxa recorded)
- within the gas supply pipeline study area, taxonomic richness was generally higher in edge habitats (10 – 22 taxa recorded) than in bed habitats (3 – 9 taxa recorded)
- within the MLA and gas pipeline study areas, PET richness for both bed and bank habitats was low and indicative of degraded or moderate water and habitat quality
- SIGNAL 2 results for the early wet season survey confirmed that the surveyed waterways are probably impacted by agricultural pollution associated with surrounding land uses
- replicated baseline results indicate that the composition of macro-invertebrate communities for both bed and edge habitat is highly spatially variable, even among sites on the same creek.

Marco-Crustacean communities

More than three times the number of macro-crustaceans were sampled in the early wet season survey (January 2009) (approximately 1889), than in the late wet season survey (March 2008) (approximately 515) in the MLA study area. The extremely high abundance of macro-crustaceans caught in the early wet season survey is almost entirely due to high abundance in dams, which were not sampled in the late wet season survey. The abundance at each site was similar to that found in the late wet season survey.

Table 17B-3: Relative abundance of macro-crustaceans at each MLA study area site (all survey methods combined) in the early wet season (January 2009)

Family	Latin name	Common name	Site										
			2	3	4	5	6	7	8	10	11	12	13
Atyidae	*Caridinides sp.*	freshwater shrimp	****	***	***	****	***	***	**	***	—	*****	—
	Paratya sp.	freshwater shrimp										***	
Palaemonidae	*Macrobrachium australiense*	Australian river prawn	**	**	**	***	**	***	—	**	**	***	*
Parastacidae	*Cherax destructor destructor*	common freshwater yabby	***	**	**	***	***	***	***	—	—	—	—

(log_{10} abundance categories: * 1; ** <10; ***<100; **** < 1,000; ***** >1,000)

For the gas supply pipeline study area, a total of 88 macro-crustaceans were captured across the three sites in the early wet season survey (February 2009). A greater number of macro-crustaceans were captured in the early wet season survey, than in the dry (August 2008), likely due to higher water levels, and therefore greater habitat availability in the wet season.

Table 17B-4: Relative abundance of macrocrustaceans at each site surveyed in the gas supply pipeline study area (February 2009)

Family	Latin name	Common name	Site			
			4	4b	5	7
Atyidae	*Caradina sp.*	freshwater shrimp	—	—	**	**
Atyidae	*Paratya sp.*	freshwater shrimp	—	—	**	—
Palaemonidae	*Macrobrachium australiense*	Australian river prawn	**	—	—	—
Parastacidae	*Cherax d. destructor*	common freshwater yabby	***	—	***	***

17B.3.5 FISH COMMUNITIES

In the MLA study area, 1,311 fish from twelve species were captured across sites surveyed in the early wet season survey (January 2009). Abundance in on-stream pools was generally < 50 fish at any one site, however 144 and 101 fish were caught in Woleebee Creek (Site 3) and Juandah Creek (Site 10) respectively. Generally, more fish were caught in off-stream dams (sites 11, 12 and 13), with up to 422 fish caught in the dam at Site 13; although species richness in dams was often quite low.

The greatest number of species were caught both in the early and late wet season surveys at Juandah Creek downstream of the MLA areas (site 10), which is close to the perennial waters of the Dawson River (approximately 2 km downstream).

In the gas supply pipeline area, 181 fish from five species were captured across the three sites surveyed in the early wet season survey. The species richness and abundance of fish caught in the early wet season survey (February 2009), was much greater than that caught in the dry season survey (August 2008).

Life history stages

All life history stages (juvenile, intermediate and adult) were captured for all species except southern saratoga, with only one adult was captured at Site 10 in the early wet season survey. Across the study area, juveniles and intermediates were the most abundant life history stages for most species (bony bream, eastern rainbowfish, golden perch, Agassiz's glassfish, carp gudgeons and spangled perch).

Indicators of stream health

Mosquitofish and goldfish were the only introduced species captured during the surveys. No fish caught in this study are listed as threatened species under State or Commonwealth legislation.

17B.3.6 TURTLE COMMUNITIES

In the MLA study area, only one species of turtle was captured or observed throughout the study area during both surveys. Three juvenile *Emydura macquarii krefftii* (Krefft's river turtle) were captured in Juandah Creek downstream of the MLA areas (Site 10) in the early wet season (January 2009), where this species had previously been recorded in the late wet season survey (March 2008). In the early wet season (January 2009), four adults were also captured in the farm dam at Site 11.

In the gas supply pipeline study area, no turtles were caught or observed at any of the sites.

17B.3.7 OTHER AQUATIC VERTEBRATES

Refer to the Addendum to the technical report, STR 17B-1-SV1.5 for other aquatic vertebrates observed during the early wet season surveys.

17B.3.8 SUMMARY OF AQUATIC ENVIRONMENTAL VALUES

The results of surveys in the early wet season were consistent with those in the late wet season. While the aquatic flora and fauna communities are spatially and temporally variable, the assessment of aquatic ecological environmental values remains unchanged and consistent with that presented in the previous technical report (EIS Volume 1, TR 17B-1-V1.5). No listed rare or threatened aquatic species were recorded in either survey.

17B.4 DESCRIPTION OF PROPOSED DEVELOPMENT

Recent refinements/modifications to the Project scope following submission of the EIS that have the potential to affect the aquatic ecology of the study area include:

- development of Wubagul Pit to the south of Frank Creek Pit
- changes to the number and location of environmental and sediment dams due to changes to pit configuration
- changes to the coarse and fine (tailings) rejects disposal
- upgrade of the existing Wandoan wastewater treatment plant (WWTP) and associated effluent management strategy
- changes to road alignments (Jackson-Wandoan Road, the Booral Road and Grosmont Road intersection, and the Western deviation) including the mine access road and haul roads, which cross numerous waterways in the study area.

The general layout of the site is shown on Figures 6-1-SV1.3 with Chapter 6 Project Operations and Chapter 11 Water Supply and Management, providing further information on changes to the Project.

Table 17B-5: Abundance of fish species at each site in the MLA study area (all survey methods combined) (Early wet: February 2009; Late Wet: March 2008)

Family	Species	Common name	1		2	2a	3		4		5		6		7		8		9		10		11		12		13	
			Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet
Ambassis	*Ambassis agassizi*	Agassiz's glassfish	11				2	42		5	50	15		24				7				1						10
Clupeidae	*Nematalosa erebi*	bony bream																			15	59						
Cyprinidae*	*Carassius auratus*	goldfish														2						1						
Eleotridae	*Hypseleotris* spp.^	carp gudgeon	4			12		67	2	1	16	5	7	3	6	10		8				18		336		416		96
Eleotridae	*Oxyeleotris lineolata*	sleepy cod																			1							
Melanotaeniidae	*Melanotaenia splendida*	eastern rainbowfish	1			2	1	19			6			1	3	10			2			13		4				
Osteoglossidae	*Scleropages leichardti*	southern saratoga																				1						
Percichthyidae	*Macquaria ambigua*	golden perch																	3		4	1				1		
Poecliidae*	*Gambusia holbrooki*	Mosquitofish																				6						
Plotosidae	*Neosilurus hyrtlii*	Hyrtl's tandan							2						1				3		20							
	Tandanus tandanus	common catfish																								4		

Family	Species	Common name	1		2	2a	3		4		5		6		7		8		9		10		11		12		13	
			Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet	Late Wet	Early Wet
Terapontidae	*Leiopotherapon unicolor*	spangled perch	19		4	2	10	16	26	14	7	22	6	23	8	1	8	8	4		1	1				1		21
		unidentified juvenile													1													

* Introduced species

Table 17B-6: Abundance of fish species at each site surveyed along the gas supply pipeline route (all survey methods combined) (Early wet: February 2009; Dry: August 2008)

Family	Species	Common name	4		4b	5		7
			Dry	Early Wet	Dry	Early Wet	Dry	Early Wet
Ambassis	*Ambassis agassizii*	Agassiz's glassfish	1	55	1	2	—	1
Cyprinidae*	*Carassius auratus*	goldfish	—		—		10	2
Eleotridae	*Hypseleotris* spp.^	carp gudgeons	—	1	10	75	3	5
Terapontidae	*Leiopotherapon unicolor*	spangled perch	3		—	26	—	4
Melanotaeniidae	*Melanotaenia splendida splendida*	eastern rainbowfish		6				3

* Introduced species

17B.5 POTENTIAL IMPACTS

The assessment of impacts presented in the EIS Volume 1, Chapter 17B Aquatic Ecology, section 17B.5, for the late wet season survey are considered to be accurate and current based on the results of the early wet season survey (January 2009), except where discussed in the following sub-sections.

17B.5.2 VEGETATION CLEARING AND EARTHMOVING

The planned development of Wubagul Pit from Years 3 to 5 is likely to result in the removal of a small un-named tributary of Juandah Creek, and has the potential to indirectly impact on the adjacent Two Mile Creek via runoff of sediment-laden or potentially contaminated water into this creek.

17B.5.3 WASTEWATER AND STORMWATER

Stormwater

Although the number and configuration of sediment dams has changed, the design and operation of these dams, and the assessment of impacts of these planned discharges on aquatic ecology, is consistent with that described in the EIS Volume 1, Chapter 17B Aquatic Ecology, section 17B.5.3.

Industrial wastewater

The proposed changes to the tailings disposal strategy are unlikely to directly impact on aquatic ecology, and is unlikely to have indirect impacts to aquatic ecology if groundwater quality is not adversely affected by tailings disposal. Refer to Supplementary EIS Chapter 10 for a discussion of potential impacts associated with Groundwater.

Domestic wastewater

Although the scope for the Wandoan WWTP upgrade and operation has been refined, the assessment of impacts remains consistent with that presented the EIS Volume 1, Chapter 17B Aquatic Ecology, section 17B.5.3.

17B.5.5 LOSS OF CATCHMENT AREA

Construction of the mine, including Wubagul Pit, and expansion of the Austinvale North and Leichhardt Pits, will result in the loss of up to 100 km of natural streams, which may be lost to pits, replaced by diversion channels or directed into sediment and environmental dams. The total area of catchment directed to the site water management system is 10,560 ha by Year 30 of the Project, not including natural buffer areas adjacent to disturbance areas within the MLA areas. However, this loss of catchment area is unlikely to have a regionally significant impact on aquatic ecology, as there are over 868,000 ha of similar catchment area within the Southern Tributaries Sub-catchment of the Dawson River alone, that is only 1.2% of the subcatchment area will be impacted.

Flow regime

Changes to the flood regime, and the timing and magnitude of flows in watercourses, have the potential to impact on aquatic ecology.

An increase in flood levels due to watercourse diversions and flood levees is unlikely to affect aquatic ecology *per se*; rather, the associated increase in water velocities draining the flooded areas is more likely to have an impact, from waterway scouring and erosion. The potential impacts of increased erosion and sedimentation on aquatic ecology are discussed in the original technical report (EIS Volume 1, TR 17B-1-V1.5). An increase in water velocity in some watercourses may also inhibit fauna migration and movement upstream, and may result in some flora and fauna being swept downstream. However, biota would be expected to re-colonise such watercourses after flow velocities subside.

Stranding of fish and other aquatic fauna

Farm dams within the MLA study area, provide habitat for turtles and a number of fish species, including those of recreational fisheries significance. The potential loss of these farm dams in association with the construction of pits or mine infrastructure will cause turtles and fish to perish unless these fauna are relocated.

17B.5.6 CREEK DIVERSIONS

The creeks to be diverted provide fish habitat, and a movement/migration pathway for aquatic fauna. Poorly designed diversion channels have the potential to impact on fish habitats and movement/migration, which in turn could affect the fisheries productivity of the catchment upstream. There may be increased water velocities in the diversion channels compared with natural channels.

17B.5.9 SIGNIFICANT CONSERVATION HABITAT

There are no predicted impacts to matters of National Environmental Significance. Background to this assessment is presented in the EIS and associated technical report (EIS Volume 1, TR 17B-1-V1.5).

17B.6 MITIGATION MEASURES

The assessment of appropriate measures to avoid, minimise and mitigate impacts of the Project as presented in the EIS Volume 1, Chapter 17B Aquatic Ecology, section 17B.6 is considered to be accurate and current based on the results of seasonal surveys and the nature of the refinements/modifications to the Project, except where discussed below.

17B.6.2 VEGETATION CLEARING AND EARTHMOVING

Impacts from vegetation clearing and earth moving associated with construction of Wubagul Pit, and expansion of Austinvale North and Leichhardt Pits, can be minimised and avoided where the recommendations presented in the EIS Volume 1, Chapter 17B Aquatic Ecology, section 17B.6.2 are followed, and water management principles being applied to other pits, such as the construction of sediment and environmental dams in association with these disturbed areas, are used.

Fitzroy Basin Association Interim Water Quality Target 2007 Technical Report Section Target RA11 aims to 'Cumulatively reduce sediment delivered to in-stream aquatic habitats by 4,100,000 tonnes over 10 years'. As discussed in the EIS Volume 1, Chapters 9, 11 and 17B, a sediment and erosion control plan will be prepared for the Project to manage sediment release offsite, including aquatic habitat-related measures contained in the EIS Volume1, Chapter 17B Aquatic Ecology, section 17B.6.2.

17B.6.3 WASTEWATER AND STORMWATER

Where water discharged from the MLA areas and associated infrastructure meets the site-specific Water Quality Objectives (WQOs) for the Project, which are described in Supplementary EIS Chapter 11 Water Supply and Management and the associated Addendum to the Surface Water Quality Technical Report, no significant impacts to the aquatic flora and fauna communities of the region are expected.

17B.6.4 WATER SUPPLY

Transfer of exotic fish species

To minimise the risk of aquatic disease or exotic species transfer, water supplied from other catchments should be free of micro- and macro-algae, macrophytes and aquatic fauna, including seeds, eggs and larvae. Further information is presented in Supplementary EIS Volume 2, STR 17B-1-SV2.5.

17B.6.6 CREEK DIVERSIONS

Many of the planned diversions described in the EIS and associated technical reports will not be constructed for a number of years. While the creek diversions will be carried out in accordance with the general principles described in Chapter 11 Water Supply and Management, specific design guidelines for the design and management of each of the diversions will be developed as part of the water licence application process under the *Water Act 2000*. These guidelines will consider the impact that the diversions will have on water flow regimes, provision of fish habitat and habitat connectivity and provide mitigation measures to minimise and manage the impact of each creek diversion.

The diversion channels will provide an adequate diversity of habitat types, will not be heavily affected by channel alteration (such as from erosion etc.) and will allow for adequate fish passage if the design considerations presented in the EIS and associated technical report (EIS Volume 1, TR 17B-1-V1.5) are

followed. The ability of the constructed diversion channels to provide adequate aquatic habitats and fish passage will be monitored as part of the aquatic ecology monitoring program (as described in EIS Volume 1, TR 17B-1-V1.5).

Impacts of increased flows on fish passage will be mitigated where diversion channels are designed to have water velocities of ≤0.3 m/s, and >1 m/s during flood flows, as far as practical (Cotterell 1998). Design features that will reduce flows in the diversion channel include the incorporation of:

- instream habitat structures such as large woody debris and boulders, to baffle flows
- bends and meanders
- variations in water depth, including regular deep pools
- dense riparian vegetation, to buffer against overland flows into the diversion channel.

Stranding of fish and other aquatic fauna

Stranded turtles and fish in farm dams to be lost or creeks to be diverted will be captured and translocated, following the *Fish Salvage Guidelines* (DPI&F 2004), as outlined in detail in the EIS Volume 1, Chapter 17B Aquatic Ecology, section 17B.6.6 and associated technical report. Captured turtles and fish will be relocated to suitable waterholes in the same waterway to prevent the transfer of exotic fish or aquatic disease.

17B.6.7 CREEK CROSSINGS

Construction to temporary vehicle creek crossings

Where possible, temporary creek crossings will be constructed in accordance with DEEDI's guidelines for permanent creek crossings (Cotterell 1998, described in detail in the EIS TR 17B-1-V1.5), and may require waterway barrier works permits.

Gas supply pipeline

The construction of permanent creek crossings will be undertaken in accordance with AS2885 and the Australian Pipeline Industry Association Code of Environmental Practice. In addition to the mitigation measures discussed in the EIS and aquatic ecology technical report, additional mitigation measures include:

- use of infrastructure corridors, being that the gas supply pipeline falls within a proposed railway corridor
- avoid sensitive or problematic soils/geotechnical areas (such as contaminated soil) to the extent possible
- recontour, revegetate and rehabilitate pipeline corridors and the banks of watercourse crossings
- observation of flood and severe weather warnings on a daily and longer term basis during construction.

Pipeline installation should avoid drought refuge pools, and waterway barrier works approvals are likely to be required for the construction of temporary crossings and pipeline crossings where construction requires the use of coffer dams etc, as will potentially be done for small-order streams.

The WJV has committed to using underground (trenchless) pipeline installation techniques (such as drilling) for crossing of larger waterways holding water, which may include Roche and Juandah Creeks. The use of these techniques will not impact on fish passage or aquatic ecology where the recommended mitigation measures outlined in the EIS (Volume 1, TR 17B-1-V1.5) are followed, in addition to the following (APIA 2009):

- drilling muds shall consist of approved water based products or synthetic lubricants and shall be contained within the fluid circulation system during drilling
- drilling muds shall be recycled where practicable, or disposed of in accordance with regulatory requirements
- sediment and erosion control measures should be in place around bellholes and drill exit points.

17B.6.8 BITING INSECTS

In response to EIS submissions, the Wandoan Joint Venture (WJV) commits to developing and implementing a biting insect management plan for the Project. This will be developed prior to the commencement of construction, and in addition to the measures described in the EIS (aquatic ecology technical report TR 17B-1-V1.5) will include, as required, consideration of the:

- extent of potential mosquito and biting midge breeding habitat within the development footprint and surrounding areas
- mosquito and biting midge species likely to occur in the region

- incidence of arboviruses in the region
- extent to which construction and operation of the proposed mine and associated infrastructure will create mosquito and biting midge breeding habitat
- extent to which mosquitoes and biting midges will pose a threat to the health to construction crews, mine employees, and visitors to and residents of the region
- opportunities available to minimise the incidence of mosquitoes and biting midges on the site
- recommended guidelines for the monitoring and control of mosquitoes and biting midges on the site.

17B.6.9 THREATENED SPECIES AND ECOLOGICAL COMMUNITIES

The Project is unlikely to have a significant impact on any threatened species or ecological communities, as discussed in EIS Volume 1, TR 17B-1-V1.5.

17B.6.10 MONITORING REQUIREMENTS

A long-term aquatic ecological monitoring program will be implemented to monitor the impacts of the mine on the waterways within the MLA areas, and downstream, and to inform the mine's environmental management plan and remedial actions. The scope of the required monitoring program remains consistent with that presented in EIS Volume 1, Chapter 17B Aquatic Ecology, section 17B.6.10 and the associated technical report.

17B.7 RESIDUAL IMPACTS

Where the mitigation measures presented above are followed, the assessment of residual impacts of the Project, including the changes to the Project scope discussed above, remain consistent with those presented in the EIS Volume 1, Chapter 17B Aquatic Ecology, section 17B.7 and associated technical report (TR 17B-1-V1.5).

17B.8 CONCLUSIONS

Results of the seasonal surveys in the MLA and gas supply pipeline study areas have not altered the assessment of environmental values or potential impacts of the Project on aquatic ecology.

The assessment of potential impacts and mitigation measures is consistent with that presented in the EIS. In summary to the comments raised in EIS submissions:

- a discussion of water quality and appropriate Water Quality Objectives (WQOs) is presented in the Addendum to the surface water quality technical report
- it is acknowledged that the waterways in the study areas provide important fish habitat, and the creeks to be diverted provide a movement/migration pathway for aquatic fauna. The recommended mitigation measures have taken this into account
- changes to the flood regime, and the timing and magnitude of flows in watercourses, have the potential to impact on aquatic ecology through increased water velocities resulting in increased erosion and inhibiting fish passage. These impacts will be eliminated or substantially reduced where erosion control measures are implemented for the diversion channels, and where diversion channels are designed to have water velocities of ≤0.3 m/s, and >1 m/s during flood flows, as far as practical
- the co-location of pipeline routes with existing and proposed infrastructure, and the mitigation measures discussed in the EIS and aquatic ecology technical report, are consistent with the objectives of AS2885 and the Australian Pipeline Industry Association Code of Environmental Practice
- pipeline installation should avoid drought refuge pools, and waterway barrier works approvals are likely to be required for the construction of temporary crossings and pipeline crossings
- depending on the nature of the works required at each crossing, waterway barrier works may be either assessable or self-assessable development under the *Integrated Planning Act 1997*. This will be determined for each crossing prior to the construction of the Project, and applications will be made for development approvals, where required

- where waterways are diverted, dams are removed and if an isolation method is used for construction of waterway crossings, stranded turtles and fish will be captured and translocated, following the DPI&F Fish Salvage Guidelines (DPI&F 2004) and relocated to suitable waterholes in the same waterway to prevent the transfer of exotic fish or aquatic disease
- the WJV has committed to using underground (trenchless) pipeline installation techniques (such as drilling) for crossing of larger waterways holding water, which may include Juandah and Roche Creeks
- the WJV has committed to developing and implementing a biting insect management plan for the Project, which will be developed prior to commencement of construction of the Project.

17B.9 SUMMARY OF COMMITMENTS AND MITIGATION MEASURES

17B.10 REFERENCES

EPA 2007a, *Queensland Water Quality Guidelines 2006*, March 2006, Environmental Protection Agency, Brisbane.