9 Aquatic Ecology

9.1 Introduction

This section of the EIS describes the ecological values of aquatic habitat and communities within the Project Site and neighbouring areas. The potential impact of the Project on the local and regional aquatic environment is presented using a range of standard indices to assess the condition of aquatic environments. The results presented in this report are based on a desktop analysis of background information and field surveys completed from 8 to 11 April 2008. Relevant mitigation strategies are also presented.

The tasks and objectives of the assessment were to:

- Review relevant background information and data related to aquatic ecology in a local and regional context;
- Complete a field survey program to census aquatic flora, macroinvertebrates and fish within the Project Site and neighbouring environs. Frogs and birds have been assessed in the terrestrial fauna section of this EIS;
- Compile a description of the aquatic habitats of the Project Site, including possible impacts resulting from the Project on these systems;
- Confirm the extent of aquatic habitats occurring within the Project Site and describe the different aquatic ecosystems present;
- Assess the values of each aquatic habitat within the Project Site;
- Assess the potential impact of the Project on aquatic flora and fauna in the context of relevant legislation, in particular the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) and the *Nature Conservation Act 1992* (Qld); and
- Provide recommendations for measures to avoid or mitigate adverse impacts on significant aquatic flora and fauna at the construction and operational phases.

9.2 Method

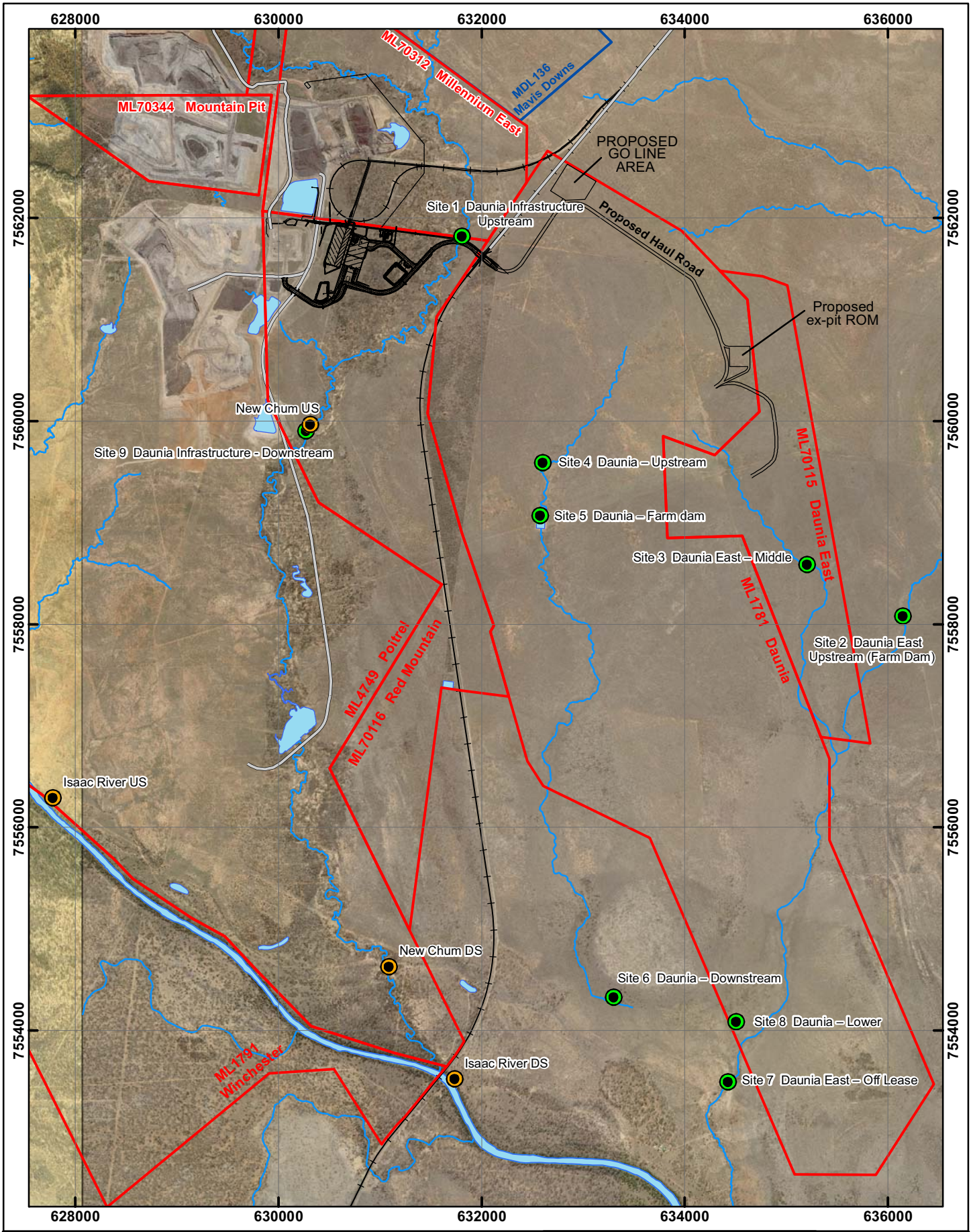
The aquatic habitat at 9 sites was assessed using the Australian River Assessment System (AusRivAS) rapid assessment technique developed under the National River Health Program by the federal government in 1994. This technique broadly defines stream morphology; available aquatic habitats; measures of water quality; and observed land use impacts. An example of the data sheets used can be found in **Appendix J.1**. A detailed description of the methodology is presented in **Appendix J.2**.

9.3 Aquatic Environment

9.3.1 Locality Description

The Project Site, and the sites assessed during the EIS, are shown in **Figure 9-1**. The Project Site is located 2 km to the north the Isaac River. The Isaac River is part of the Isaac-Connors River catchment forming a major northern tributary of the Fitzroy River.

The entire Project Site has been significantly altered by agricultural practices, predominantly low density cattle grazing. The impacts of land clearing, pasture improvement, weed invasion, and exacerbated erosion processes were observed throughout the Project Site.



LEGEND

- Sample Site Location
- BMA Water Monitoring Sites
- Proposed Mine Infrastructure
- Road
- Existing Railway
- Drainage
- Waterbody
- Mining Lease
- Mineral Development Licence

FIGURE 9-1

DAUNIA COAL MINE EIS

WATER QUALITY AND AQUATIC FLORA AND FAUNA SAMPLE SITES

0 0.5 1 1.5 2

Kilometres

Scale 1:50,000 on A4

Projections: Australian Map Grid - Zone 55 (AGD84)

BMA

BHP Billiton Mitsubishi Alliance

I:\QENV\Projects\QE06458\Spatial\Arc_MXD\Fig_9-1_Water_Quality_and_Aquatic_Flora_Fauna_v2.mxd Produced: 10/10/2008 This figure should be read in conjunction with the data disclaimer at the front of this report.

The Project Site experiences a high level of temporal variability in rainfall. Over the past five years the region has experienced an extended period of severe drought. However, in the three months immediately prior to undertaking the aquatic assessments described within this EIS, average or higher than average rainfall was received across the region. An additional 40 mm of rainfall occurred over the Project Site two weeks prior to the site visit. This pattern of rainfall and the potential resulting ecological change in the aquatic communities and water quality, must be considered in reviewing the information presented in this report.

9.3.2 Site Descriptions

The 9 sites assessed can be divided into those occurring in the Project Site mining areas (Daunia ML1781 and Daunia East ML 70115) and Project Site infrastructure areas (Red Mountain ML 70116). This distinction is made due to the differing impact the Project will have on these two areas.

9.3.3 Project Site Mining Areas

The Project Site mining areas are drained by two unnamed drainage paths (ephemeral waterways) that drain in a north-south direction within the Project Site (**Figure 9-1**). These drainage paths are named Daunia and Daunia East for the purposes of this assessment. Daunia and Daunia East converge adjacent to the far south-western boundary of the Project Site (Note: Site 7 is located at the confluence of these drainage paths) before flowing in a south-easterly direction, ultimately joining the Isaac River a further 7 to 10 km downstream. The two drainage paths have limited ecological value and are highly degraded from cattle grazing. Agricultural practices have left little to no riparian vegetation around drainage paths.

In total, nine sites were selected based upon desktop analyses of the local geography, recent rainfall data, aquatic habitats, and through direct consultation with local landholders. Comprehensive site descriptions are detailed in **Appendix J.2**. Of these 9 sites, 7 were located within the drainage paths affected by the Project Site mining areas as shown in **Table 9-1** below.

Of these 7 sites, three are located outside the Project Site (**Table 9-1**). Two of the sites (Sites 2 and 7) were located on properties currently running livestock. Site 6 was also located off the Project Site.

Table 9-1 Mining Area Site Locations

Site Number	Site Name	Within Project Site	Easting	Northing
Site 2	Daunia East – Upstream (Farm Dam)	No	636146	7558079
Site 3	Daunia East – Middle	Yes	635201	7558588
Site 4	Daunia – Upstream	Yes	632599	7559589
Site 5	Daunia – Farm dam	Yes	632574	7559068
Site 6	Daunia – Downstream	No	633297	7554326
Site 7	Daunia East – Off Lease	No	634425	7553489
Site 8	Daunia – Lower	Yes	634410	7554086

Coordinates are in Australia Map Grid (ADG 84)

Photographs of each of these sites are shown in **Figure 9-2** to **Figure 9-8**.

The drainage paths within the mining areas of the Project Site will be removed due to the Project.

Figure 9-2 Site 2 – Daunia East Upstream – Farm Dam

Figure 9-3 Site 3 – Daunia East – Middle

Figure 9-4 Site 4 – Daunia Upstream

Figure 9-5 Site 5 – Daunia – Farm Dam

Figure 9-6 Site 6 Daunia Downstream – Dry Site

Figure 9-7 Site 7 Daunia East Off Lease

Figure 9-8 Site 8 Daunia - Lower

9.3.4 Project Site Infrastructure Areas

The infrastructure area of the Project Site is drained by New Chum Creek. The land around New Chum Creek has also been heavily affected by grazing. However, the riparian vegetation has not been affected to the same degree as riparian vegetation associated with the Project Site mining areas.

Two sites were assessed on New Chum Creek with the locations tabulated in **Table 9-2**. Photographs of these sites are shown in **Figure 9-9** and **Figure 9-10**.

Table 9-2 Infrastructure Area Site Locations

Site Number	Site Name	Within Project Site	Easting	Northing
Site 1	Daunia Infrastructure - Upstream	Yes	631802	7561818
Site 9	Daunia Infrastructure - Downstream	Yes	630269	7559903

Coordinates are in Australia Map Grid (ADG 84)

Figure 9-9 Site 1 – Daunia Infrastructure Upstream

Figure 9-10 Site 9 Daunia Infrastructure - Downstream

New Chum Creek will be not be diverted or significantly altered as part of the Project. The infrastructure areas will drain to New Chum Creek and there will be a haul road constructed to cross New Chum Creek to connect the mining areas to the infrastructure area. The impact that the haul road crossing has on flooding is discussed in **Section 6** of the EIS.

9.4 Existing Environment

9.4.1 Habitat Description

All sites surveyed were highly impacted by land clearing, historical and current agricultural practices, invasive weed species and nearby mining operations. Each of these factors have significantly impacted on the local biodiversity including the aquatic ecosystems. More specifically, the primary impacts on the aquatic system have arisen from altered water flow patterns due to the construction of in-stream dams, addition of bore water into farm dams, the removal of in-stream woody debris and riparian vegetation, and significant increases in sediment deposition resulting from exacerbated erosion processes. These longer-term impacts tend to be consistent throughout the catchment.

The aquatic habitat at sites associated with mining areas was highly disturbed. The most severely impacted sites surveyed were on the Daunia and Daunia East lease areas (Site 3, 4 and 5). The flow regime at each of these sites is negatively impacted by large in-stream dams restricting the downstream movement of surface flows.

No aquatic habitats on these streams could be described as natural or near natural.

9.4.2 Aquatic Flora

9.4.2.1 Riparian Vegetation

The riparian vegetation at all sites was generally in poor to very poor condition.

The unrestricted access of livestock to the waterways has contributed significantly to bank instability at all sites in the mining areas, resulting in the loss of riparian vegetation. Remnant trees have died and now provide limited functionality within the riparian community. The loss of the riparian vegetation, invasion of weeds, and cultivation of introduced species as fodder for livestock (e.g. Buffel Grass) has resulted in the significant loss of functional ephemeral aquatic habitat.

The riparian zones at all sites, associated with the mining areas, have been replaced by Buffel Grass, which is the dominant ground cover along the margins of the aquatic habitats surveyed in this area.

The riparian zone at the two sites on New Chum Creek, within the infrastructure area, was in a moderate condition, providing some shading, bank stability, and in-stream structural complexity due to protruding roots and woody debris. The riparian community at these sites consisted of Dawson Gum and Poplar Box with Bauhinia and Sally Wattle.

9.4.2.2 Macrophytes

In-stream aquatic vegetation was observed at few of the assessed sites (Site 2, 5, 7 and 8) (**Table 9-3**). The limited vegetative cover and low species diversity is characteristic of ephemeral waterways within this region (Smith *et al.* 2004). The highest in-stream cover was found at Site 5 and Site 7 where in-stream obstructions have been constructed. These impoundments provide large areas of shallow water where the light attenuation is sufficient to support the growth of aquatic macrophytes and algae. The in-stream

impoundments at these sites hold water during periods of low rainfall thereby providing artificial refugia which may result in the rapid dispersal and re-colonisation of macrophytes and algae following rainfall events.

Table 9-3 Combined list of macrophytes that were recorded at the nine assessed sites

Scientific Name	Common Name
Cyperus digitatus	Finger Flat Sedge
Persicaria attenuata	N/A
Cyperus polystachyos	Bunchy Sedge
Cyperus difformis	Rice Sedge
Monochoria cyanea	N/A
Ammannia multiflora	Jerry-Jerry
Juncus planifolius	Broad-leaf Rush
Cyperus unioloides	Uniola Flatsedge
Cyperus esculentus	Yellow Nutgrass
Marsilea drummondii	Common Nardoo
Marsilea hirsuta	Hairy Nardoo
Nitella spp	Stonewarts

In the absence of significant in-stream macrophyte beds and large woody debris (due to the absence of mature riparian zones), most sites on the Project Site and neighbouring areas, lack physically complex aquatic habitat. The low diversity of fish and macroinvertebrate sensitivity indices may be influenced at these sites as a result.

The State of the Rivers report for the Fitzroy and Isaac Rivers and Capricorn Coastal Tributaries (2005), details that the condition of aquatic vegetation for the Isaac Northern and Centrals Floodplains sub-catchment (in which the Project Site lies) was very poor for 100% of the stream length. Although the aquatic vegetation was classified as very poor, this is not to say that there has been a reduction in quality or quantity from its original state. The present poor condition may be a natural feature in some streams, particular if they are ephemeral (State of the Rivers, 2005). The condition of aquatic vegetation in the State of the Rivers Report is consistent with what was recorded at the Project Site. The presence of macrophyte communities outside the Project Site and results from the State of the Rivers indicates that there are considerable macrophyte communities elsewhere within the catchment.

No threatened species of macrophytes were found on the Project Site or neighbouring areas.

9.4.3 Fish

Of the 21 species of fish known to occur within the Fitzroy River catchment, four species were caught in the present assessment in the Project Site and neighbouring areas (**Table 9-4**). The presence of these species is typical of highly intermittent streams within the Fitzroy catchment particularly within the Isaac River sub-catchment.

Table 9-4 Presence/absence of fish within the Project Site and neighbouring areas

Site	Spangled Perch *Leiopotherapon unicolor*	Agassiz's Glassfish *Ambassis agassizii*	Eastern Rainbowfish *Melanotaenia splendida*	Hyrtl's Tandan Neosilurus hyrtlii
Site 1	1	-	-	-
Site 2	-	-	-	-
Site 3	-	-	-	-
Site 4	-	20	3	-
Site 5	-	-	-	-
Site 6	-	-	-	-
Site 7	1	10	1	1
Site 8	1	43	26	
Site 9	-	1	-	-

None of the fish listed in **Table 9-4** are listed under the EPBC Act or the Nature Conservation Wildlife Regulation.

9.4.4 Macroinvertebrates

The presence/absence of aquatic macroinvertebrates across the eight assessed sites is shown in **Table 9-5** (no macroinvertebrate samples were obtained from Site 6 as a result of the absence of surface water). The figures represent the sum of specimens collected at each site and are a guide to relative abundance of taxa per site (Note: in line with suggested protocols a maximum of 30 specimens only of any taxon were counted). A total of 26 family or higher level taxa were recorded over the four sites.

Further information on the derivation and significance of the sensitivity analysis (SIGNAL2 and NT data) presented in **Table 9-5** and **Table 9-6**, can be found in **Appendix J.**

Table 9-5 Presence/absence data and average SIGNAL2 score for the eight sites following Chessman (2003a, b)

Family Name	Site 1	Site 2	Site 3	Site 4	Site 5	Site 7	Site 8	Site 9
Bithyniidae (3)		30+	1	19		30+	5	
Viviparidae (4)						2	1	
Planorbidae (2)		6				2		
Atyidae (3)								1
Parathelphusidae (3)			1					
Acarina (6)		5				1		
Baetidae (5)	6	14	4	4	30+		11	8
Caenidae (4)		19	2	13		6	6	30+
Corduliidae (5)			1					
Libellulidae (4)		3		5		1	1	
Coenagrionidae (2)							2	
Notonectidae (1)	1	30+	8		15			3
Corixidae (2)	1	6	2		30+	1	2	30+

Family Name	Site 1	Site 2	Site 3	Site 4	Site 5	Site 7	Site 8	Site 9
Hydrometridae (3)		1						
Veliidae (3)								6
Mesoveliidae (2)						1		
Pleidae (2)						1		
Gyrinidae (4)	1		2	1		4	21	
Dytiscidae (2)	1	9	4	9	5	9	4	9
Hydrophilidae (2)		11		3		1		
Tipulidae (5)	1							
Culicidae (1)		3	4	3			2	
Chironomidae (3)	30+	30+	6	30+	30+	30+	30+	17
Ceratopogonidae (4)	1	2		3				
Leptoceridae (6)		12						
No. of Taxa	8	15	11	10	5	13	11	8
Total Signal Score	26	48	35	32	13	47	34	23
Av. Signal Score	3.25	3.20	3.18	3.20	2.60	3.62	3.09	2.88

Note: Figures in brackets denote SIGNAL2 values following Chessman (2003a, b).

It must be noted that the Queensland sampling protocol for AusRivAS requires a minimum of two sample sets in one year (one in autumn and one in spring). Due to annual rainfall patterns, the ephemeral nature of these creeks and drainage lines and timeframes, the spring sample set was unable to be obtained. As such the following results are limited to one season only (late wet season) and therefore the interpretation of data needs to be undertaken with this in mind. Subsequent sampling over a longer time period would provide a much more detailed understanding of the macroinvertebrate community.

The data was fed into the AusRivAS model and the results can be seen in **Table 9-6**. Site 5 was considered to have the lowest environmental value out of the 8 sampled sites. With a Band label of C, this site is considered to be severely impaired (**Table 9-7**), indicating a potential impact either on water quality and/or habitat quality which has resulted in a loss of taxa. All other sites have a Band label of B and are considered to be significantly impaired, indicating a loss of taxa due to substantial impacts on water and/or habitat quality.

Whether or not the number of taxa recorded in the survey is an under representation in terms of local environments and indicative of environmental perturbation is difficult to say without more extensive survey work. However, even when compared with some disturbed freshwater environments in eastern Queensland the numbers are relatively low (Arthington et al. 1992; Duivenvoorden 1995; Stanisic 2004a, b).

Table 9-6 Results of the AusRivAS model – Observed/Expected Results

Site	NTE50	NTP50	NTC50	OE50	E50Signal	O50Signal	OE50Signal	E0Signal	O0Signal	OE0Signal	Band
1	7.96	12.00	3.00	0.38	4.67	3.67	0.78	4.36	3.00	0.69	B
2	8.01	12.00	6.00	0.75	4.66	4.50	0.96	4.35	3.07	0.70	B
3	8.01	12.00	3.00	0.37	4.67	3.67	0.79	4.36	2.80	0.64	B
4	8.01	12.00	3.00	0.37	4.66	4.33	0.93	4.35	3.00	0.69	B
5	8.00	12.00	2.00	0.25	4.66	3.50	0.75	4.35	2.20	0.51	C
7	7.97	12.00	3.00	0.38	4.66	4.00	0.86	4.35	2.92	0.67	B
8	7.98	12.00	3.00	0.38	4.66	3.67	0.79	4.35	2.92	0.67	B
9	7.94	12.00	3.00	0.38	4.68	3.67	0.78	4.36	2.57	0.59	B

NTE50 – The **N**umber of inver**T**ebrate families **E**xpected with greater than a 50% probability of occurrence, NTE50, is the sum of the probabilities of all the families predicted with greater than a 50% chance of occurrence.

NTP50 – NTP50 is a count of the **N**umber of inver**T**ebrate families **P**redicted with greater than a 50% probability of occurrence.

NTC50 – The inver**T**ebrate families that were predicted above the threshold probability of 50% and which were also **C**ollected at the test site are counted to form the observed (collected) indice, NTC50.

OE50 – The **O**bserved to **E**xpected ratio, OE50, is the ratio of the number of invertebrate families observed at a site (NTC50) to the number of families expected (NTE50) at that site. OE50 provides a measure of biological impairment at the test site.

E50Signal – is the expected signal score for taxa that have a probability of occurrence of greater than or equal to 50%. It is calculated by weighting the probability of occurrence of each **predicted** taxa (those taxa that have a probability of occurrence of greater than or equal to 50%) by the taxon's SIGNAL Grade, summing these and then dividing the total by the sum of the (unweighted) probabilities of occurrence.

O50Signal – is the observed signal score for taxa that have a probability of occurrence of greater than or equal to 50%. It is calculated by averaging the SIGNAL Grade's for all observed taxa with P(Taxa) >= 0.5.

OE50Signal – The observed to expected SIGNAL ratio, OE50Signal, is the ratio of E50Signal to O50Signal.

E0Signal – is calculated the same way as E50Signal, except all taxa that have a probability of occurrence of greater than 0% are included in the calculation.

O0Signal – is the observed signal score for taxa that have a probability of occurrence (*P(Taxa)*) of greater than 0%. It is calculated by using the same method as for O50Signal.

OE0Signal – The observed to expected SIGNAL ratio, OE0Signal, is the ratio of E0Signal to O0Signal.

Table 9-7 Bandwidths for QLD regional – Coastal – Autumn – Pool AusRivAS model

Band label	Upper limit	Band name	Band Description
Band X	Inf	More biologically diverse than reference sites.	More taxa found than expected. Potential biodiversity hot-spot. Possible mild organic enrichment.
Band A	1.21	Reference condition.	Most/all of the expected families found. Water quality and/or habitat condition roughly equivalent to reference sites. Impact on water quality and habitat condition does not result in a loss of macroinvertebrate diversity.
Band B	0.78	Significantly impaired.	Fewer families than expected. Potential impact either on water quality or habitat quality or both resulting in loss of taxa.
Band C	0.36	Severely impaired.	Many fewer families than expected. Loss of macroinvertebrate biodiversity due to substantial impacts on water and/or habitat quality.
Band D	0	Extremely impaired.	Few of the expected families remain. Extremely poor water and/or habitat quality. Highly degraded.

These scores reflect the extensive clearing and agricultural use of land around Daunia and Daunia East. In the present situation it may also simply reflect the inherently ephemeral nature of these environments that fluctuate in water levels, and hence also trophic levels, in a seasonal cycle. In these cases, sampling design needs to account for such seasonal fluctuations in order to gain an accurate assessment of the macroinvertebrate fauna of the sites.

A number of large macroinvertebrates were caught in the baited traps, these are detailed in **Table 9-8**. The number of *A. transversa* recorded within the Project Site is not unexpected, however the large number of this species at Site 8 was unanticipated (41 in total). The ecology of this species indicates that this site would experience yearly flooding which is consistent with the site assessment. *Cherax* spp are common throughout Australia and are not considered to be regionally or nationally significant. *Macrobranchium* spp are widespread in freshwater environments and are not considered to be regionally or nationally significant.

The Moranbah area was suffering the effects of drought prior to February 2008, and it is likely that these creeks were reduced to small water holes or dried completely during this period. A significant rain event occurred in February 2008 which caused local flooding and filled creeks and dams in the area. All would have been subject to an initial period of high turbidity due to sediment run-off which favours the return of only environmentally tolerant macroinvertebrates. Hence, the numbers and species found, reflect the time of sampling. Recruitment of a fuller complement of macroinvertebrates over time would involve the re-establishment of water quality and macrophyte communities. Macrophyte communities are especially important for groups such as dragonflies (*Libellulidae*, *Corduliidae*) and damselflies (*Coenagrionidae*), which were recorded in low numbers in this assessment.

None of the macroinvertebrate species recorded had local or regional significance and none are listed as endangered, rare or vulnerable.

Table 9-8 Macroinvertebrates caught in baited traps.

Site	Freshwater Crab Austrothelphusa transversa	Yabby Cherax spp.	Macrobranchium spp.
Site 1	1	1	1
Site 2	1	-	-
Site 3	2	-	-
Site 4	6	-	-
Site 5	-	3	-
Site 6	-	-	-
Site 7	1	1	-
Site 8	41	1	-
Site 9	-	2	-

9.4.5 Turtles

During the field based aquatic surveys, the available in-stream habitat including edge, bank, macrophyte beds and riparian habitat at each site was thoroughly inspected for the presence of turtles, their nests or pathways. The presence of turtles was not confirmed at any sites. No further dedicated trapping effort was undertaken at any of the sites.

Six turtle species are known to occur within the Fitzroy River catchment. Habitat preferences include: deep permanent pools with extensive beds of macrophytes for species including the Snake-necked Turtle (*Chelodina longicollis*); and riffle habitat for both the locally endemic Fitzroy River Turtle (*Rheodytes leukops*) and Southern Snapping Turtle (*Elseya albagula*) which use cloacal breathing and show a strong preference for highly oxygenated water (Wilson and Swan, 2008). The absence of turtles within the Project Site is related to the absence of suitable permanent aquatic habitat and food sources within the highly disturbed ephemeral waterways on the Project Site and neighbouring areas.

The Fitzroy River Turtle is listed as Vulnerable under the EPBC Act, however given its habitat preference, this species is not expected to occur within the Project Site.

9.4.6 Platypus

During the field based aquatic surveys, the available in-stream habitat including edge, bank, macrophyte beds and riparian habitat at each site was thoroughly inspected for the presence of platypuses and their nests. The presence of platypuses was not confirmed at any sites. No further dedicated trapping effort was undertaken at any of the sites. Given the ephemeral environments throughout the Project Site, it is not expected that any platypuses would inhabit this area, as it does not contain the appropriate habitat preferences for this species.

9.4.7 Summary

Based on the desktop assessment and the one-off site assessment conducted in April 2008, no threatened or endangered aquatic flora or fauna (macroinvertebrate, turtles, fish and platypus) could be found inhabiting the waterways within the Project Site or the surrounding water courses. No species or habitat was found

showing any special significance in terms of aquatic flora or fauna. The likelihood that rare or threatened species are occupying the Project Site is considered very low.

The Daunia and Daunia East drainage paths are ephemeral waterways and are headwaters. The available aquatic habitat is in poor condition and of low quality due to land uses, clearing of the riparian vegetation, erosion and bank stability. The aquatic habitat in the Project Site, although poor, provides habitat for a number of native aquatic species. Although the waterways are not permanent, they do provide temporary habitat for aquatic flora and fauna species such as fish. The fish assemblage is representative of an ephemeral environment within the Isaac River. Continuation of the current water quality in the Isaac River will ensure the presence of these species in both the Isaac River and its tributaries.

9.5 Potential Impacts

The Project has the potential to impact on aquatic communities, directly and indirectly.

In the mining areas of the Project Site approximately 15 km of low environmental value, highly disturbed aquatic habitat will be removed over the life of the Project.

In summary, Project activities that are likely to impact on the already highly disturbed aquatic environment of the mining areas include:

- Removal of the drainage lines, Daunia and Daunia East, within the Project Site over the life of the Project. Most of this aquatic habitat is in the headwaters of the Daunia and Daunia East drainage lines;
- Change in catchment area/reduction in surface water flow by the exclusion of the Project Site from the catchment area; and
- Surface water runoff from the Project Site mining areas, including the mine and haul roads.

The impacts from the infrastructure area of the Project Site on New Chum Creek are limited but are likely to include:

- Changes in flow conditions from the haul road over New Chum Creek;
- Short term reduction in water quality during construction of the New Chum Creek haul road crossing; and
- Surface water runoff from the Project Site infrastructure areas.

9.5.1 Impacts on Riparian Vegetation

The remaining degraded, and limited riparian vegetation along the Daunia and Daunia East will be a lost as a result of mining activities, however, given the extremely poor condition of the existing riparian vegetation, the impact will be small. Approximately 15 km of degraded in-stream habitat will be lost over the life of the Project. Although the riparian vegetation and in-stream habitat currently supports fish and macroinvertebrates, there were no significant species identified. All species that will be impacted by the removal of this habitat are found elsewhere within the Isaac River and Fitzroy River catchment.

9.5.2 Impacts on Maccrophytes

The aquatic flora within the Project Site is low in diversity and abundance, and is deemed to be of low environmental value. The Project will remove various species of macrophytes from the Project Site, however, given that no regional or national significant species could be found and their low environmental

value, the impact is deemed to be small. The macrophyte species found, also occur in other locations within the Isaac River and Fitzroy River catchment. Although numerous sites were found to be occupied by macrophytes their establishment is most likely linked to the recent rainfall as most individuals were small in size.

9.5.3 Impacts on Aquatic Fauna

The aquatic fauna within the Project Site is low in diversity and abundance, and is deemed to be of low environmental value. The long term impacts on the macroinvertebrates found within the Project Site will be small. Although the construction of the mine will result in the removal of these species and their habitats, the majority of taxa were environmentally tolerant and were found downstream and upstream of the Project Site, indicating their presence elsewhere in the catchment. The macroinvertebrate community within the Project Site is regarded as tolerant and any impacts on diversity, distribution and abundance within the Isaac catchment is considered to be highly improbable. Coupled with the presence of macroinvertebrate species in other locations within the catchment, the potential impact on macroinvertebrate communities within the Isaac catchment will not be significant.

The fish species found during the site assessment were common for highly intermittent streams and none of the species that were found on the Project Site are regionally or nationally significant. The four species that were found on the Project Site are common throughout the Fitzroy Basin. The overall impacts to the fish communities within the Isaac River catchment will not be significant.

Impacts to fish communities within New Chum Creek will be limited. Construction of the haul road crossing will occur when the creek is not flowing.

9.5.3.1 Catchment Size Reduction

Reduction in the catchment area will reduce the amount of surface water flowing into the remaining drainage paths during rainfall periods. The reduced surface water flow will primarily impact on the aquatic communities downstream of the Project Site. The impact of reduced surface water is limited by the small catchment and is expected to have a negligible effect on aquatic communities in the Isaac River. The reduction in the immediate catchment area equates to a loss of 60% or 26 km^2. This represents 0.1% of the total Isaac River catchment area. As no regionally or nationally significant organisms were found on the Project Site or surrounding area, the impact is expected to not be significant. The reduction in flow will change the assemblage of aquatic communities and stream dynamics within the drainage lines, however, this reduction is not expected to act detrimentally on the Isaac River catchment as a whole. By reducing the catchment size, the headwaters of the drainage paths are essentially relocated closer to the Isaac River.

9.5.3.2 Haul Road

The construction of the haul road over New Chum Creek is unlikely to have significant impacts. Construction of the haul road crossing will occur when the creek is not flowing.

Runoff from the construction work could potentially increase turbidity and sediment loads within the creek, if recommended mitigation measures are not adhered to, the resulting increase in sediment loads can reduce macrophyte and periphyton growth, which in turn, may decrease the available food for macroinvertebrates, tadpoles and some fish species. Increased sediment loads can also lead to habitat degradation as the sediment settles on the substrate filling scour holes and pools, reducing the available habitat and decreasing

the variation within the substrate. Fish passage, upstream and downstream, may be restricted during construction of the haul road if New Chum Creek is to be obstructed at any stage.

9.5.3.3 Cumulative Impacts

The removal of the Daunia and Daunia East is expected to have low ecological impacts. The cumulative effect across the Isaac River catchment is also expected to be minimal. Numerous mining operations are operating within similar ecological areas (ephemeral creeks and drainage paths) within the Isaac River and Fitzroy River catchment. These catchments are predominantly covered by either mining leases, mining claims or exploration permits (coal, petroleum and mineral) (DME, 2008). Current mining leases only cover a small portion of the catchment. Exploration permits encompass the bulk of potential mining operations within the catchment and therefore represent a potential increase in cumulative impacts on ephemeral systems.

9.6 Mitigation Measures for Aquatic Flora and Fauna

9.6.1 Construction

The following mitigation measures are recommended to minimise impacts on aquatic flora and fauna during construction in the mining areas:

- Limit disturbance as much as possible through the BMA Permit to Disturb procedure.
- Divert clean runoff, from undisturbed areas, away from mining activities.
- Design sedimentation dams to capture any runoff from disturbed areas according to the criteria outlined in **Section 6**.
- Construct sedimentation dams prior to disturbing land for other purposes to prevent runoff from disturbed areas.
- Construct components of the water management system during the dry season where possible.
- Revegetate clean water diversions to minimise potential erosion.

As there are no significant species present within the drainage lines on the Project Site, translocation of individuals is not deemed necessary.

In the infrastructure area of the Project Site, the haul road crossing over New Chum Creek will be designed, constructed and operated as per an approved Riverine Protection Permit. The design of this crossing, in accordance with the Permit, maintains flow velocities and water levels downstream. Other mitigation measures to minimise impacts on aquatic flora and fauna in the infrastructure area include:

- Limit disturbance as much as possible through the BMA Permit to Disturb procedure.
- Divert clean runoff from undisturbed areas away from infrastructure areas.
- Provide adequate bunding of chemical storage areas and other materials as outlined in **Section 19**.
- Design sedimentation dams to capture any runoff from infrastructure areas according to the criteria outlined in **Section 6**.
- Construct the two sedimentation dams in the infrastructure area during the dry season.
- Construct sedimentation dams prior to commencing construction of the CHPP and infrastructure.
- Rock apron erosion protection at either end of the haul road crossing culvert.

9.6.2 Operation

The control measures for bunding fuels, oils and other toxic substances will be implemented and maintained during the operation of the Project, especially with works near watercourses and drainage lines as outlined in **Section 19**. This will ensure that minimal impact to downstream aquatic communities occurs.

A mine water management plan, described in **Section 6**, will be developed for the operational phase of the Project to ensure the protection of surrounding waterways during operation. The plan will involve mitigation measures such as sediment dams, pit water storage, clean water runoff and a water quality monitoring program.