R E P O R T

Batchelor Magnesium Project
Aquatic Ecology

Prepared for

Mt Grace Resources Limited

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Burswood WA 6100

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URS

Prepared By	Keith Martin Senior Environmental Scientist	URS Australia Pty Ltd PO Box 444 Trinity Beach QLD 4879 Australia Tel: 61 8 8981 2195 Fax: 61 8 8941 3920
Reviewed By	Paul Barden Environmental Scientist	
Authorised By	Peter Mueller Principal – Manager Northern Territory	Date: **28 November 2001** Reference: Type Reference Here Status: Type Status Here

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Introduction

SECTION 1

URS Australia has been commissioned by Mt. Grace Resources Limited to prepare an Environmental Impact Statement (EIS) for the proposed Batchelor Magnesium Project, near Batchelor NT. A requirement of this study is to document the aquatic ecology (aquatic habitats, plants, fishes and aquatic macroinvertebrates) of the area, with particular reference to the occurrence of threatened species, and to assess the environmental impacts, management issues and monitoring requirements for the aquatic ecology of the area.

This report presents the finding of a baseline aquatic ecology study conducted in July 2001. It has been prepared in compliance with guidelines set by the Department of Lands, Planning and Environment (DLPE) for the Batchelor Magnesium Project EIS.

2.1 Objectives

The objectives of the aquatic ecology study were to:

- describe the aquatic habitats, fishes and aquatic macroinvertebrates of streams and sites likely to be affected by the proposed project;
- identify the occurrence or expected occurrence of any species or species groups of high conservation value, and the habitats or areas in which they are present;
- assess the status of introduced aquatic species in the area; and
- describe the aquatic ecology of the area in regional terms, including the importance of the area or its habitats for conservation.

2.2 Survey Methods

Existing published and unpublished information on the aquatic environment of the Batchelor area was gathered and interpreted. Following this, a field survey was carried out in July 2001.

Six sites were sampled during the survey. Detailed habitat descriptions were recorded at all sites where sampling was carried out. Parameters noted were site location, turbidity, pH, conductivity, water temperature, depth (maximum and average in sampled area), width and length of sampled habitat, habitat class, bank incline, substrate type, stream flow, aquatic vegetation, bankside vegetation, weather and the current level of disturbance and land use.

Data on fish, large crustacean and mollusc diversity were collected by a variety of netting and observation methods, depending on the site characteristics. Fine mesh seining was carried out at most sites, as it was suitable for the range of conditions. The seine was operated by two persons, one of whom held the net near the bank, while the other performed a circular sweep of 5 metres diameter. The seine net dimensions were 5 m long x 1.5 m drop with 2 mm mesh. Cast netting was used at most sites. The cast net was operated by one person, who threw the net from the bank into the stream. The net was thrown to a different location each cast. The cast net dimensions were 3.5 m diameter with 10 mm (knot to knot) mesh.

Two types of traps were used. Small, fine meshed "Gansel" traps were set for small species, while larger "Opera House" style yabby traps were set to target larger fish, crustaceans and turtles. All collected specimens were returned to the water as soon as they could be identified.

Due to the excellent water clarity, visual observations of aquatic life were possible at all sites. Methods used included bankside observations during the daytime (assisted by polarised sunglasses) and spotlighting at night. Diving observations, using a mask and snorkel, were conducted at two sites.

Aquatic plants were identified in situ if possible, or taken to the NT Herbarium for identification.

Macroinvertebrate samples were collected using a standard 250 micron mesh macroinvertebrate net. Four samples were taken at each site from pool bed or riffle habitats. An area with specific habitat qualities was selected at each site. In general riffle sample sites were characterised by shallow riffle areas with rocky substrate greater than 10 m in length with flowing water, while pool bed sites were located in pools with slow or no obvious flow, with a depth of between 0.3 m and 1 m. Samples were limited to the pool bed habitat type at two of the sites sampled that displayed limited structural/habitat diversity (Sites A2 and A5). At all other sites, two samples each from the two habitats were taken. Sampling involved disturbing an area of sediment/cobble/instream vegetation along a 10 m transect with the net held downstream to capture organisms present in the water column and/or dislodged from substrates.

Samples were washed through a 250 micron sieve to remove fine silt and transferred to a white sorting tray (250mm x 300mm x 20mm). Each sample was hand picked for 30 minutes, with all macroinvertebrates easily detected without magnification removed for identification. Smaller taxa such as the microcrustacea and water mites were not included in the analysis. Samples were then preserved in 70% ethanol solution for laboratory sorting. Specimens were subsequently identified to family level using a dissecting microscope and appropriate keys.

A summary of sampling effort is presented in Table 1.

Table 1 - Summary of Sampling Effort at Aquatic Sites

	Site Number					
	A1	**A2**	**A3**	**A4**	**A5**	**A6**
Bankside visual obs. (person/hrs)	2	2	4	2	2	1
Diving obs. (person/hrs)	-	1	-	-	-	2
Night spotlighting (person/hrs)	1	1	1	-	1	-
Macroinvertebrate netting (no. samples)	4	4	4	4	4	4
Cast netting (no. casts)	6	3	-	-	2	2
Seine netting (no. drags)	4	-	6	2	-	-
Gansel traps (hrs)	4	2	12	-	-	-
Yabby traps (hrs)	4	2	12	-	-	-

3.1 Habits and Sample Sites

The Batchelor Magnesium Project site is located along the upper reaches of the "right branch" of Coomalie Creek, which has its headwaters near the town of Batchelor. The right and left branches (the left branch is the more significant of the two) join downstream at Coomalie Billabong, near the Stuart Highway. Coomalie Creek then flows a further 20km or so before entering the Adelaide River downstream of Tortilla Flats. The Adelaide River is a major river, which traverses extensive coastal floodplains before entering the sea at Adam Bay, to the east of Darwin.

The Coomalie Creek right branch flows right through the Project Area, from west to east, and is the only water body within the Project Area. In this area, Coomalie Creek is a small, semi-permanent stream with a clearly defined channel. In the western (upstream) portion of the Project Area, the stream is intermittent, and flows through a series of braided channels. Further downstream, the banks are clearly defined, and water flows appear to be nearly permanent. Several small permanent waterholes are present in the eastern portion of the Project Area, and the stream flows through rocky country with scattered dolomite outcrops. About 500 m downstream of the eastern boundary of the Project Area, the stream crosses Crater Lake Road. At this point, there is a large permanent rock pool, which is used by the public for recreational swimming, picnics and informal camping.

Six sites were sampled along Coomalie Creek during the course of the field survey (Figure 1 – this relates to Figure 3.6 in the main body of the EIS).

Figure 1 – Batchelor Magnesium Project: Locations of aquatic sample sites

(refer to Figure 3.6 in the main body of the EIS for sampling locations)

Habitat Types

Habitat and environmental parameters recorded at each site are presented in Table 2. The six sites sampled covered three main habitat types, which are described in the following section.

Semi-permanent Stream lines

Two sites were sampled in this habitat: site A1 (Figure 2), which was located near the western (upstream) boundary of the Project Area, and site A4, located near the mine test pit. This habitat occurs along the main channel of Coomalie Creek through the project area. At the time of the field survey in the mid dry season, the creek was flowing well through most of its length along a channel of about four meters wide, and incised about 1.5 metres below the surrounding countryside. Depths along the stream were less than 1 metre, and only about 0.3 m in most areas. Substrates were a black clay or gravel. Turbidity was very low at both sites (<15 NTU).

Conductivity (395-408 µs) and pH (7.65-7.76) at both sampled sites was similar, reflecting normal conditions to be expected in a stream of this nature. Aquatic plants were sparse along the stream line, and included only occasional clumps of the aquatic fern, *Helminthostachys zeylanica*.

Figure 2

Semi-permanent stream line at site A1

Fringing vegetation along the creek was a narrow band (often constituting only one tree width) of riverine trees such as *Nauclea, Pandanus* and *Ficus*. Part of the stream at site A1 had been previously diverted during construction of the Sundance mine pit. The channel in the diverted section had reduced habitat diversity.

Table 2 - Summary of Habitat and Environmental Parameters at Aquatic Sampling Sites in the Batchelor Magnesium Project Area

	A1	A2	A3	A4	A5	A6
Date	21-Jul-01	21-Jul-01	21-Jul-01	21-Jul-01	22-Jul-01	22-Jul-01
River system	Coomalie Ck.	Coomalie Ck.	Coomalie Ck.	Coomalie Ck.	Coomalie Ck.	Coomalie Ck.
Locality	Creek line near Sundance mine pit.	Sundance Mine Pit	Tungu Rockhole	Creek line near mine test pit.	Mine test pit	Crater Lake Rd Crossing
GPS Coordinates	722914E 8556269N	722871E 8556307N	724374E 8557152N	723271E 8556810N	723460E 8556870N	725702E 8557426N
Habitat	Semi-permanent stream	Man-made open water pit	Permanent waterhole	Semi-permanent stream	Man-made open water pit	Permanent Refuge Pool
pH	7.65	8.5	6.93	7.76	8.21	8.65
Conductivity (µs)	408	258	407	395	375	358
Water Temperature (^{o}C)	21.6	26.5	25.2	24.8	25.1	21.1
Turbidity (NTUs)	15	9	9	8	8	10
Average width (m)	4	100	60	2	50	40
Average depth (m)	0.3	1 (edge)	1	0.3	1 (edge)	1
Maximum depth (m)	0.5	20	2	0.5	<10	2
Bank Incline (o)	70	45	70	45	80	<45
Aquatic vegetation cover	None	None	Lilies covering 60% of surface; submerged plant covering 50%	Sparse	None	Very sparse
Aquatic vegetation structure	-	-	Emergent and submerged attached non-feathery	Submerged non-feathery	-	Submerged non-feathery

	A1	A2	A3	A4	A5	A6
Dominant aquatic plant species	-	-	*Nymphaea violacea* *Vallisneria sp.* *Hydrilla verticillata*	*Helminthostachys zeylanica*	-	*Helminthostachys zeylanica*
Bankside vegetation	Eucalyptus woodland; very narrow band of riverine vegetation, mainly *Nauclea, Pandanus, Ficus*.	Grassed banks	Thin band of *Nauclea, Acacia, Pandanus*. Gambar grass	Thin band of trees - *Nauclea, Acacia, Melaleuca*.	-	Low open forest; Sparse *Acacia,Pandanus & Eucalyptus*
Substrate	Fine black soil; dense leaf litter.	Fine yellow clay with larger rocks	Gravel/rocks in stream, black clay in waterhole.	Gravel	Clay	Rocks, gravel and leaf litter
Stream Flow	Slow	Lentic	Lentic	Slow	Lentic	Slow
Disturbance	Road crossing; creek diversion; some pig damage.	Highly disturbed	Minimal	Minimal	Highly disturbed	Road crossing
Land Use	Nearby mine pit	Mine pit	Unused.	Nearby mining activity	Mine test pit	Recreational use picnic & camping sites.

Permanent Refuge Pools

Two permanent refuge pools were sampled, although several more occurred in the reach of the stream between the proposed mine pit and the eastern boundary of the Project Area. The largest permanent refuge pool was at site A3, Tungu Rocks (Figure 3). This site was a large, lily-covered lagoon with a width of 60 m and a maximum depth of 2 m. This site had the lowest pH of all sites, probably due to the amount of aquatic and terrestrial vegetation present. Conductivity was 407 µs, which was slightly higher than most other sites.

Aquatic vegetation was profuse at this waterhole. The lily Nymphaea violacea covered approximately 60% of the water surface, while large areas of the waterhole were covered with submerged vegetation such as Vallisneria and Hydrilla.

One other permanent waterhole was sampled, a deep (2 m) rockpool below the Crater Lake Road crossing (site A6). This site is used for recreational swimming and camping by the public. The site had a very high pH value of 8.65, possibly caused by the dolomite formations through which the stream flows. Aquatic vegetation was sparse at this site and turbidity was a clear 10 NTUs

Figure 3

Permanent refuge pool at Tungu Rocks

Man-made Pits

Two man-made pits filled with water were sampled. Both pits are linked to the main stream during the wet season, so aquatic fauna can readily populate these habitats at that time.

Both pits were very clear (8-9 NTUs) with relatively high pH (8.2-8.5). The pits were characterised by their steeply sloping banks, exposed edges and very deep open water habitat. Aquatic vegetation was absent from both sites although some algae (stoneworts) were seen at site A2 (Figure 4) at the Sundance Mine Pit.

Figure 4

Open water pit habitat at Site A2

3.1.1 Aquatic Plants

Aquatic plants were abundant along Coomalie Creek during the survey, especially in the permanent waterholes such as near Tungu Rocks, where the most species were found, and growth was profuse (Table 3). In other areas, such as along the stream line and in the man-made pits, aquatic vegetation was sparse or non-existent. Of note was the very attractive aquatic fern, *Helminthostachys zeylanica* which was common throughout the area in slow flowing reaches.

Table 3 – Aquatic plants recorded in the Batchelor Magnesium Project Area

Common Name	Scientific Name	Life Form	Site Number					
			A1	A2	A3	A4	A5	A6
Native Waterlily	*Nymphaea violacea*	Floating attached			x			
Aquatic Fern	*Helminthostachys zeylanica*	Submerged, non-feathery			x	x		x
Ribbonweed	*Vallisneria sp.*	Submerged, non-feathery			x			
Hydrilla	*Hydrilla verticillata*	Submerged, non-feathery			x			
Curly Pondweed	*Potamogeton sp.*	Submerged, non-feathery			x	x		
Stonewort	*Chara sp.*	Submerged, feathery		x	x	x		
	Pogostemon stellatus	Submerged/emergent, non feathery			x			
	Persicaria barbata	Submerged/emergent, non feathery			x			

3.2 Fishes

A total of 16 species of freshwater fishes were recorded during the survey (Table 4). The two refuge pool sites (A3 and A6) had the highest variety of fish species, with 13 and 11 species respectively. The two mine pit sites had the lowest species variety, with only five and six species respectively. The most frequently observed species were Ox-eyed Herring, Chequered Rainbowfish and Spangled Grunter, which were recorded at all sites. Hyrtl's Catfish, Black-banded Rainbowfish and Purple-spotted Gudgeon were recorded on four or more of the sites.

All but three of the species recorded were found at the Tungu Rockhole site, reflecting the permanent nature of this waterhole, and the higher diversity of available habitats.

All fishes observed in all species were adults or subadults, and there was no evidence that recent breeding had taken place in any species. This is not unusual considering the timing of the survey mid dry season, as most freshwater fishes breed mainly during the wet season (Larson & Martin 1990).

Table 4 – Freshwater fishes recorded in the Batchelor Magnesium Project Area

		Site Number					
		A1	**A2**	**A3**	**A4**	**A5**	**A6**
Ox-eye Herring	*Megalops cyprinoids*	x	x	x	x	x	x
Bony Bream	*Nematolosa erebi*		x				
Black Catfish	*Neosilurus ater*			x			x
Hyrtl's Catfish	*Neosilurus hyrtlii*	x		x	x	x	x
Freshwater Longtom	*Strongylura kreffti*			x			
Black-banded Rainbowfish	*Melanotaenia nigrans*	x	x	x	x		
Chequered Rainbowfish	*Melanotaenia splendida inornata*	x	x	x	x	x	x
Fly-specked Hardyhead	*Craterocephalus stercusmuscarum*			x	x		x
Sail-fin Glassfish	*Ambassis agrammus*	x	x				
Reticulated Glassfish	*Ambassis macleayi*						x
Banded Grunter	*Amniataba percoids*			x			
Sooty Grunter	*Hephaestus fuliginosus*	x		x			x
Spangled Grunter	*Leiopotherapon unicolour*	x	x	x	x	x	x
Sharp-nosed Grunter	*Syncomistes butleri*			x			x
Mouth Almighty	*Glossamia aprion*	x		x			x
Purple-spotted Gudgeon	*Mogurnda mogurnda*	x		x	x	x	x
Total fish spp.		**9**	**6**	**13**	**7**	**5**	**11**

The largest species observed in the survey were Mouth Almighty and Ox-eye Herring. Although the Sooty Grunter and Sharp-nosed Grunter can grow to a large size, only sub-adult individuals were recorded in the survey.

Anecdotal evidence from locals suggests that some species may have been introduced to the Sundance Mine Pit for angling purposes. However, results of the survey show that all but one species recorded there were locally common in the adjacent stream, and none of the species recorded overall are highly regarded as angling species.

A previous survey of the Coomalie Creek (left branch) in the vicinity of Woodcutter's Mine recorded thirteen fish species (Bywater et al 1991). Two of these species, Spotted Blue-eye (*Pseudomugil gertrudae*) and Sleepy Cod (*Oxyeleotris lineolata*) were not recorded in the current survey, but may well be present within the Project Area. Additionally, anecdotal evidence suggests that Barramundi (*Lates*

calcarifer), Archer Fish (*Toxotes chatareus*) and Saratoga (*Scleropages jardini*) are seasonally present at the Batchelor Road crossing of Coomalie Creek (left branch) (Bywater et al 1991).

The sixteen species recorded in the survey from Coomalie Creek (right branch) within and near the Project Area (and the likely seasonal presence of a further five species) is a comparatively rich variety considering the total known fish fauna for the nearby Litchfield National Park is just 21 species (Griffiths et al 1997). Litchfield National Park is in a different drainage system (Finniss River) to the Project Area.

3.3 Other Aquatic Vertebrates

Individual Freshwater Crocodiles (*Crocodylus johnstoni*) were observed at two sites, site A2, in the Sundance Mine Pit, and at site A3, the permanent waterhole at Tungu Rocks. No freshwater turtles were recorded during the survey. Two species of aquatic monitor lizards (*Varanus mertensi* and *V. mitchelli*) were recorded in the area. Evidence of the Water Rat (*Hydromys chrysogaster*) was observed at the Tungu Rockholes.

3.4 Macroinvertebrates

3.4.1 Crustaceans and Molluscs

A list of crustaceans and molluscs recorded in the survey is presented in Table 5. The list includes species collected by various netting and trapping methods, and by hand collecting. The survey recorded five species of crustacean and two molluscs. Sites A1, A3 and A6 had the highest number of taxa. These sites were in the semi-permanent stream line and refuge pool habitats. The two open pit habitats had a poor diversity of molluscs and crustaceans.

Giant Freshwater Prawns were commonly observed at most riverine sites, and were observed to be particularly active at night. This species (as juvenile examples) was also commonly collected by macroinvertebrate netting. Other crustaceans recorded included Red-claw Crayfish, Freshwater Crab and two species of shrimp. The only molluscs recorded were the Freshwater Mussel, and a species of small gastropod.

Table 5 – Crustaceans and molluscs recorded in the Batchelor Magnesium Project Area

		Site Number					
		A1	**A2**	**A3**	**A4**	**A5**	**A6**
Crustaceans							
Giant Freshwater Prawn	*Macrobrachium rosenbergii*	22		3	5		10
Red-claw Crayfish	*Cherax quadricarinatus*			x			
Freshwater Crab	*Holthusiana transversa*						2
Shrimp	*Caridina typus*	15		67	1		7
Shrimp	*Caridina gracilirostris*	6			1		
Molluscs							
Freshwater Mussel	*Velesunio angasi*	x		x			
Gastropod	Ancylidae	1		17			5

Note: Numbers represent totals collected in macroinvertebrate sampling; x = present

3.4.2 Aquatic Insects

A total of 28 taxa of aquatic insects representing six orders and 18 families were recorded during this survey (Table 6). The most diverse orders were Ephemeroptera and Trichoptera, with six taxa each, and Coleoptera and Diptera, with five taxa each.

A total of 606 individual animals were collected at the six sites. The numbers of individuals in each sample ranged from several catches of only one animal, up to 55 at site A6. The orders Ephemeroptera (mayflies) and Coleoptera (beetles) were the most numerous groups in terms of overall numbers collected. The mayfly Leptophlebiidae sp 3 was the most common, occurring at four sites in large numbers. Other common taxa were two species of Coleoptera found at four sites, and a Chironomid (midge) found at all sites.

Sites A1 and A6 had the highest number of taxa (21 & 18 respectively) and highest numbers of individuals (189 & 220 respectively). These sites were both in semi-permanent flowing stream habitats. Site A3, a permanent refuge pool, also had high numbers of species (15) and individuals (102). These sites also had the highest ranking Diversity indices. The two open pit sites had very low diversity by comparison, with a total of only 5 individuals from two species at both sites.

Cluster analysis of the six aquatic sample sites, based on similarities in community structure of the aquatic insect fauna is presented in Figure 6. This figure clearly shows the close relationship between the

permanent stream sites, especially A1 and A6, and also the refuge pool site. The two open pit sites cluster together with only 10% similarity to the other sites.

Table 6 – Aquatic Insects recorded in the Batchelor Magnesium Project Area

			Site Number					
Order	**Family**	**Genus/species**	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**
Ephemeroptera	Baetidae	sp. 1	9		10	2		9
Ephemeroptera	Baetidae	sp. 2	2					
Ephemeroptera	Leptophlebiidae	sp. 1	9					
Ephemeroptera	Leptophlebiidae	*Thraulis sp.*	2					5
Ephemeroptera	Leptophlebiidae	sp. 2	1					2
Ephemeroptera	Leptophlebiidae	sp. 3	35		24	9		55
Odonata	Gomphidae	sp. 1		1		2		1
Odonata	Gomphidae	sp. 2	1					
Odonata	Libellulidae	*Zyxomna sp?*	2		3			1
Coleoptera	Dytiscidae	sp. 1 (adult)			1	4		
Coleoptera	Gyrinidae	sp. 1 (larvae)	6		2			2
Coleoptera	Hydrophilidae	sp. 1 (adult)	17		3	34		15
Coleoptera	Elmidae	sp. 1 (larvae)	11		8	31		14
Coleoptera	Elmidae	sp. 2 (larvae)	1		2			
Diptera	Chironomidae	unident	16	1	19	6	3	12
Diptera	Simuliidae	sp. 1	6		21			41
Diptera	Tabanidae	sp. 1	11					11
Diptera	Tabanidae	sp. 2	3					8
Diptera	Tipulidae	sp. 1						9
Trichoptera	Philopotamidae	sp. 1	1					
Trichoptera	Ecnomidae	sp. 1	36		1	1		14
Trichoptera	Hydropsychidae	sp. 1	11		4			18
Trichoptera	Hydropsychidae	sp. 2	8					1
Trichoptera	Leptoceridae	sp. 1				1		
Trichoptera	Hydroptilidae	sp. 1	1					
Lepidoptera	Pyralidae	sp. 1			1			2
Lepidoptera	Pyralidae	sp. 2			1			
Lepidoptera	Pyralidae	sp. 3			2			
Total Taxa (28)			**21**	**2**	**15**	**9**	**1**	**18**
Total Ind (606)			**189**	**2**	**102**	**90**	**3**	**220**
Diversity Index			**2.54**	**0.69**	**2.15**	**1.55**	**0.00**	**2.38**

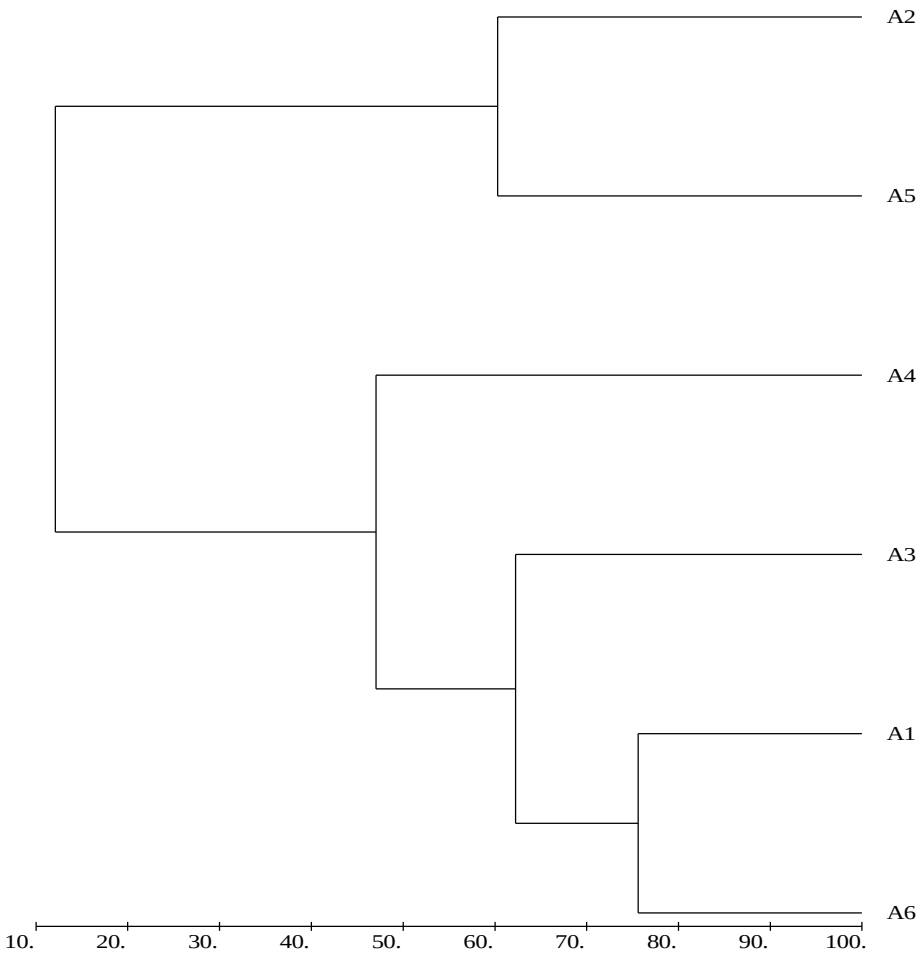

Figure 6

Clustering of aquatic sample sites according to aquatic insect communities (using Bray/Curtis similarity measure).

None of the fish species recorded during the surveys, or from other studies in the Adelaide River catchment near Coomalie Creek are regarded as threatened (Wager & Jackson 1993). The species occurring in Coomalie Creek are all common and widespread forms which are well adapted to harsh seasonal conditions (Martin & Larson 1990). None of the other aquatic fauna occurring in the area are know to be of conservation value.

The permanent waterholes along Coomalie creek in the Project Area offer refuge habitat to the aquatic fauna of the area when the stream dries late in the dry season. These pools had the highest diversity of aquatic life recorded in the survey, and are therefore of conservation interest at a local level. The refuge pool at the Crater Lake Road crossing is not only of some importance to the aquatic biota, but is also a local recreational site.

The aquatic habitats along Coomalie Creek in the vicinity of the Project Area are in relatively good condition. This is despite the high degree of historical land clearance associated with the area, the existence of the Sundance mine, and the presence of feral pigs. Part of the stream near the Sundance mine (site A1) has been previously diverted to accommodate the present mine pit. This diversion has created an artificial habitat of low diversity value, as the diverted section is deeper, less irregular and the steep banks less vegetated than parts of the stream up and downstream of the diversion. Fish species were observed to use the diversion area, but mainly as a transit area between more diverse and sheltered habitats on either side.

The survey indicated that fish populations in the area are highly diverse, although this diversity was centred mainly on the more permanent pools. Fishes, and even crocodiles had populated the artificial habitat created by the mine test pit, and the Sundance mine pit, although diversity there was lower than in the other habitats. The diversity of aquatic insects in these habitats was very low.

No introduced species of aquatic fauna were recorded during the survey.

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Limitations

SECTION 6

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