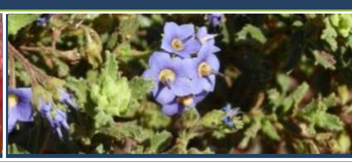
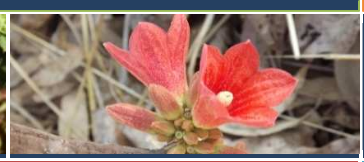
EcOz
Environmental
Services

Draft EIS – Appendix S Baseline Survey: Freshwater Macroinvertebrates

Western Desert Resources Ltd

Roper Bar Iron Ore Project

2012

WWW.ECOZ.COM.AU

Document Control Record

Prepared by:	Mike Welch
Position:	Snr Environmental Scientist
Signed:	
Date:	18/06/2012

Approved by:	Ray Hall
Position:	Principal Environmental Scientist
Signed:	
Date:	18/06/2012

REVISION STATUS

Revision No.	Description of Revision	Date	Approved
0	Draft Report	18/06/202	18/06/2012

Recipients are responsible for eliminating all superseded documents in their possession.

EcOz Pty Ltd

Trading as EcOz Environmental Services
ACN: 143 989 039
Winlow House, 3rd Floor
75 Woods Street
DARWIN NT 0800
PO Box 381, Darwin NT 0800
Telephone: +61 8 8981 1100
Facsimile: +61 8 8981 1102
Email: ecoz@ecoz.com.au

EcOz Document Reference Number: EZ12014-C0301-CM-R-0002B

Contents

Figures

Tables

Appendices

1 Introduction

1.1 Background

EcOz Environmental Services was contracted by Western Desert Resources Limited (WDRL) to undertake baseline freshwater macroinvertebrate surveys for an Environmental Impact Statement in relation to the proposed Roper Bar Iron Ore Project. The proposed project is located in the western Gulf of Carpentaria and involves open-cut mining of iron and construction of a 165km haul road for shipping of ore from the existing Bing Bong port facility. The area potentially affected by the proposed project is located between the Roper and McArthur River drainage divisions and traverses a number of major streams within the Towns River, Limmen Bight River and Rosie Creek drainage divisions (

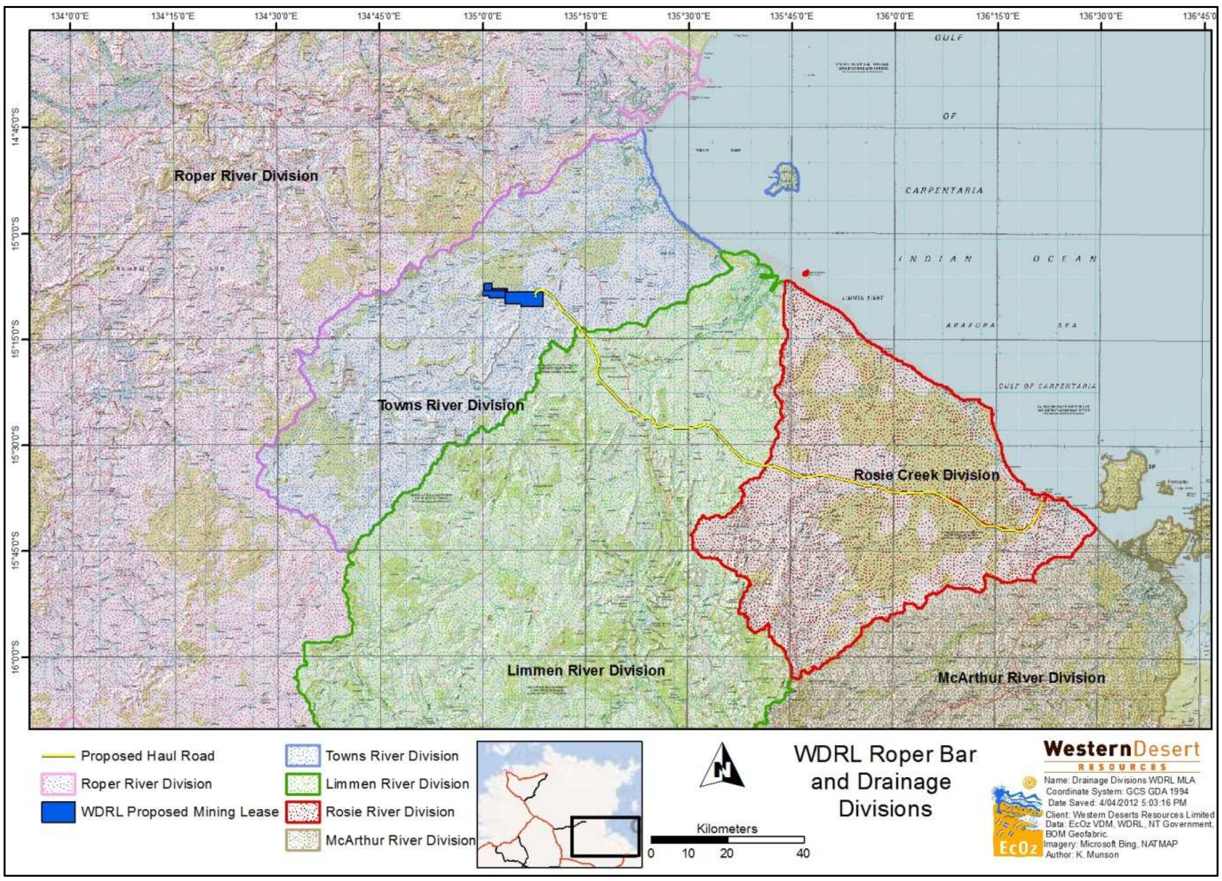


Figure 1).

The proposed mine project area is located within the middle reaches of the Towns River catchment, which is approximately 5441km^2 in extent. From its headwaters (approximately 30m AMSL), the Towns River catchment drains in a north-east direction for a total length of 130km, before it enters the Gulf of Carpentaria. The project area is located approximately 50km from the Towns River mouth and 20km upstream of the tidal influence in the vicinity of the Savannah Way road crossing.

The main Towns River channel passes through the centre of the proposed mine project area, which is joined by two major tributaries about 20km downstream; Magaranyi River to the south-east and Yumanji Creek (Little Towns River) to the north (Figure 2). The catchment area of the main Towns River channel is relatively small (503km^2), compared to that of Magaranyi (2068km^2) and Yumanji (1213km^2) sub-catchments. Stream flows are restricted to during and just after the wet season (November to April) and surface waters are confined to remnant pools or completely dry during the dry season (May to October). During the wet season, the Towns River has been observed to cease flowing for a week or more during periods of low rainfall. Although hydrographic data is not available for the Towns River or its tributaries, their catchment sizes and observations during baseline water quality surveys suggest that Magaranyi River contributes the highest flows, followed by the Towns River and Yumanji Creek.

The proposed haul road crosses a number of major streams along its 165km route, including the Magaranyi River, Cox River, Limmen Bight River, Nathan River, Rosie Creek, Pine Creek and Bing Bong Creek. Of these waterways, the Limmen Bight River, Rosie Creek and Pine Creek are perennial and the remainder are ephemeral. The Limmen Bight River and Bing Bong Creek are influenced by tidal conditions in the vicinity of the proposed haul road crossing locations; therefore they were not sampled for freshwater macroinvertebrates as part of this study.

The following report includes a description of the methodologies employed, a description of the aquatic habitats sampled, a list of macroinvertebrate taxa recorded and analysis of the data to compare community composition between sampling sites. Fish surveys were also conducted in the vicinity of the proposed mine site and results of these surveys are reported separately.

1.2 Objectives and Scope

The purpose of this study was to collect baseline macroinvertebrate data that will contribute to the description of the existing aquatic environments that may be influenced by the proposed project, to enable the future assessment of potential impacts associated with mining activities.

Specific objectives of the study were to:

- conduct a late wet-season survey of freshwater macroinvertebrate communities in streams that may be influenced by mining activities and construction of the haul road;
- provide a list of taxa recorded during the survey;
- compare community composition at sites upstream and downstream of potential sources of impact; and
- provide recommendations for on-going monitoring to assess the potential impacts of the proposed development on macroinvertebrate communities.

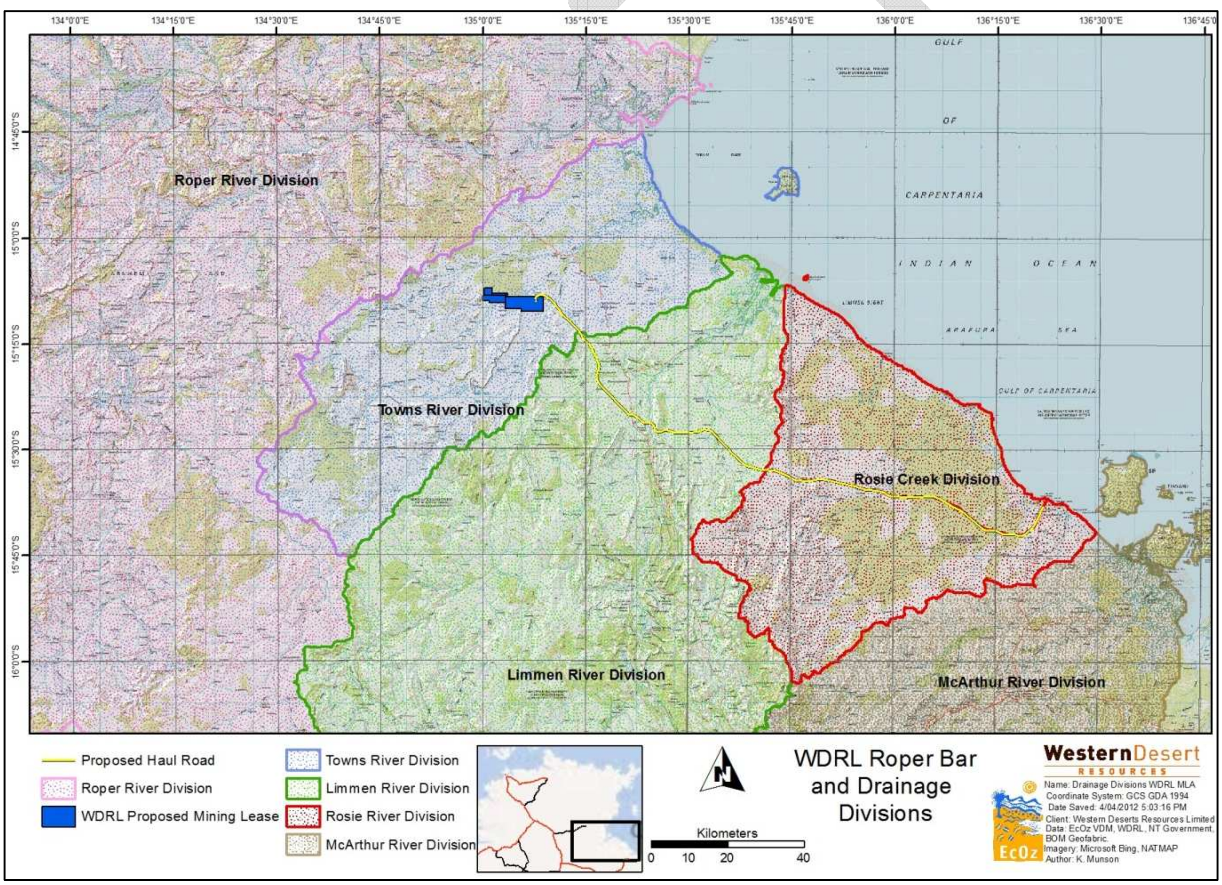


Figure 1. Project Location and Regional Catchments

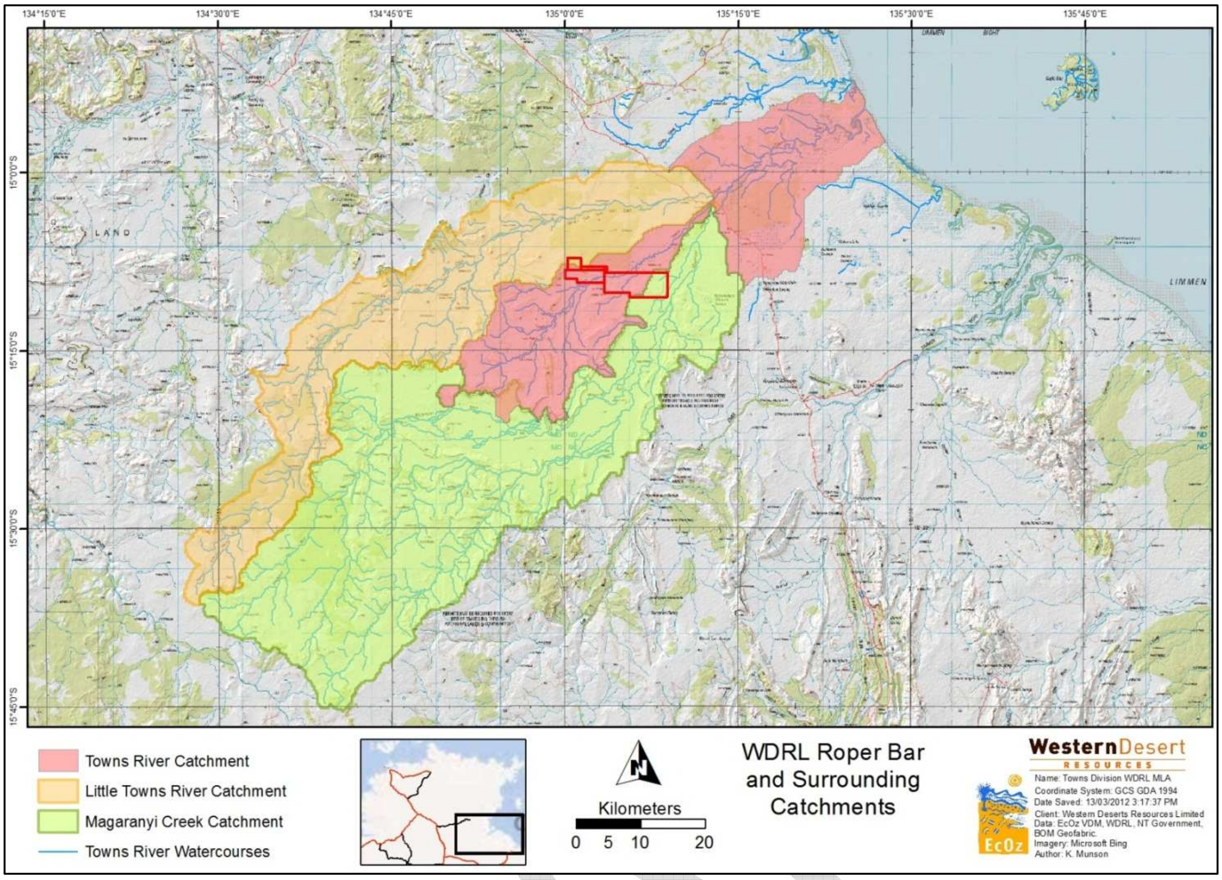


Figure 2. Location of mine project area within Towns River catchment.

2 Methodology

2.1 Survey Design, Locations and Timing

The survey design was based on the 'Before After Control Impact' (BACI) design (Faith *et al.* 1991), which involves sampling macroinvertebrates at paired sites on each stream; downstream (i.e. potential future impact) and upstream (i.e. control/reference) of potential disturbances associated with the proposed mining activities.

Sites were selected in accordance with the NT 'AUSRIVAS' (Australian Rivers Assessment Scheme) User Manual (Lamche 2007) for sampling of macroinvertebrates, which specifies that a suitable stream bank 'edge' habitat should be selected for sampling. A sampling locality for this habitat is chosen where the edge is as close to vertical as possible, ideally contains abundant trailing root material and is in an area with low flow velocity (but importantly, must be flowing). The most suitable sample locations possible were chosen as close as possible to proposed areas of disturbance by helicopter survey at the time of sampling.

In the vicinity of the proposed mine site, macroinvertebrate sample locations were selected at four locations on the Towns and Magaranyi Rivers (Figure 3), as follows:

- Towns River upstream (TUS) and downstream (TDS)
- Magaranyi River upstream (MUS) and downstream (MDS)

As a result of the project location in the upper reaches of the Towns River catchment and corresponding highly-ephemeral nature of the stream, the site selected upstream of the project area (TUS) was not flowing (i.e. drying, intermittent pools) at the time of sampling and there are likely to be limited (if any) locations in this area that are suitable for the sampling of freshwater macroinvertebrates, according to the AUSRIVAS protocol described above. It is also noted that the Towns River downstream site (TDS) is located approximately 5km downstream of the mine project area, as this was the closest downstream location with suitable habitat for sampling.

In the vicinity of the proposed haul road route, ten sites were sampled (including Magaranyi River upstream and downstream, as above) on five major streams (Figure 4) as follows:

- Cox River upstream (CUS) and downstream (CDS)
- Nathan River upstream (NUS) and downstream (NDS)
- Rosie Creek upstream (RUS) and downstream (RDS)
- Pine Creek upstream (PUS) and downstream (PDS)

Sites sampled in the vicinity of proposed haul road stream crossings were located approximately 1km upstream and downstream of the crossing location. It is noted that subsequent to the survey being undertaken, the alignment of the proposed haul road route was modified in several locations, although only the Cox River crossing location was modified to the extent that the two sites sampled on this stream are now both upstream of the proposed crossing (Figure 4).

Macroinvertebrate sampling was undertaken from 17-19 April 2012, coinciding with the late wet season/ early dry season recessional flow period (i.e. 4-6 weeks after last storm event), which is considered that optimal time as specified in the NT AUSRIVAS User Manual (Lamche 2007).

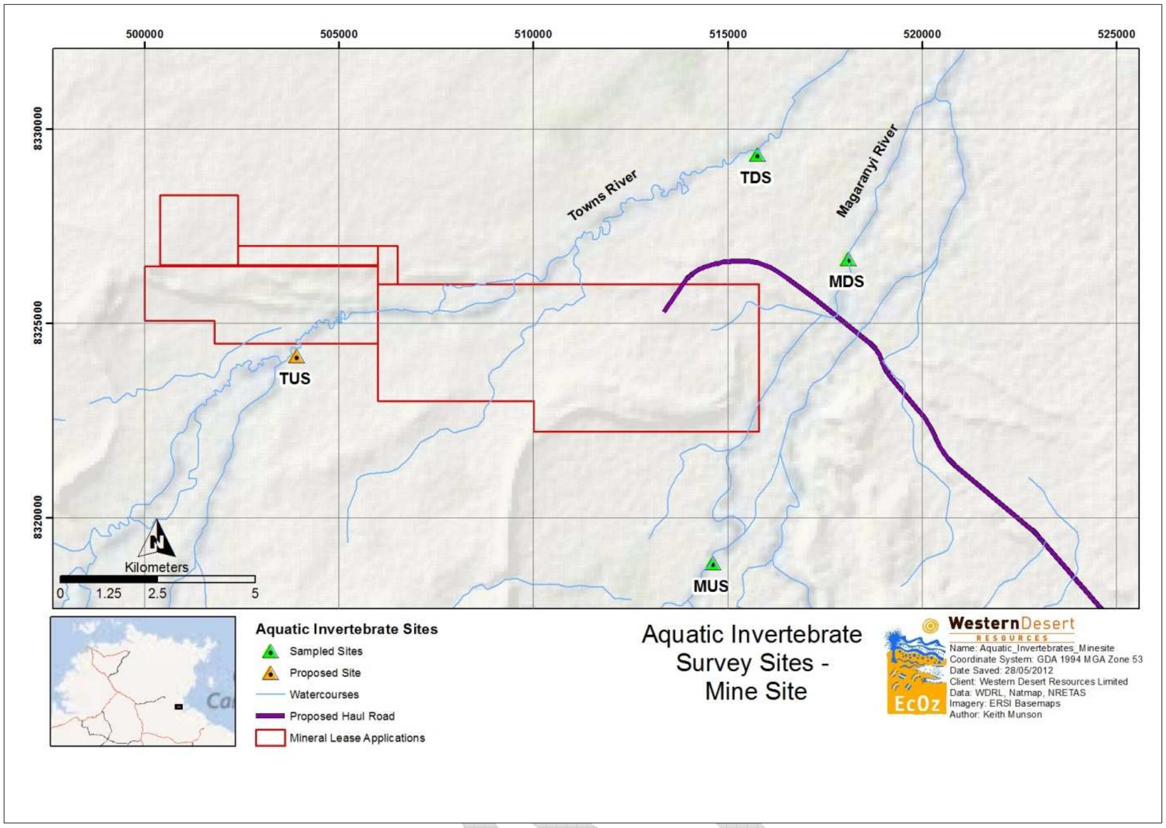


Figure 3. Locations of macroinvertebrate sampling sites in vicinity of proposed mine site.

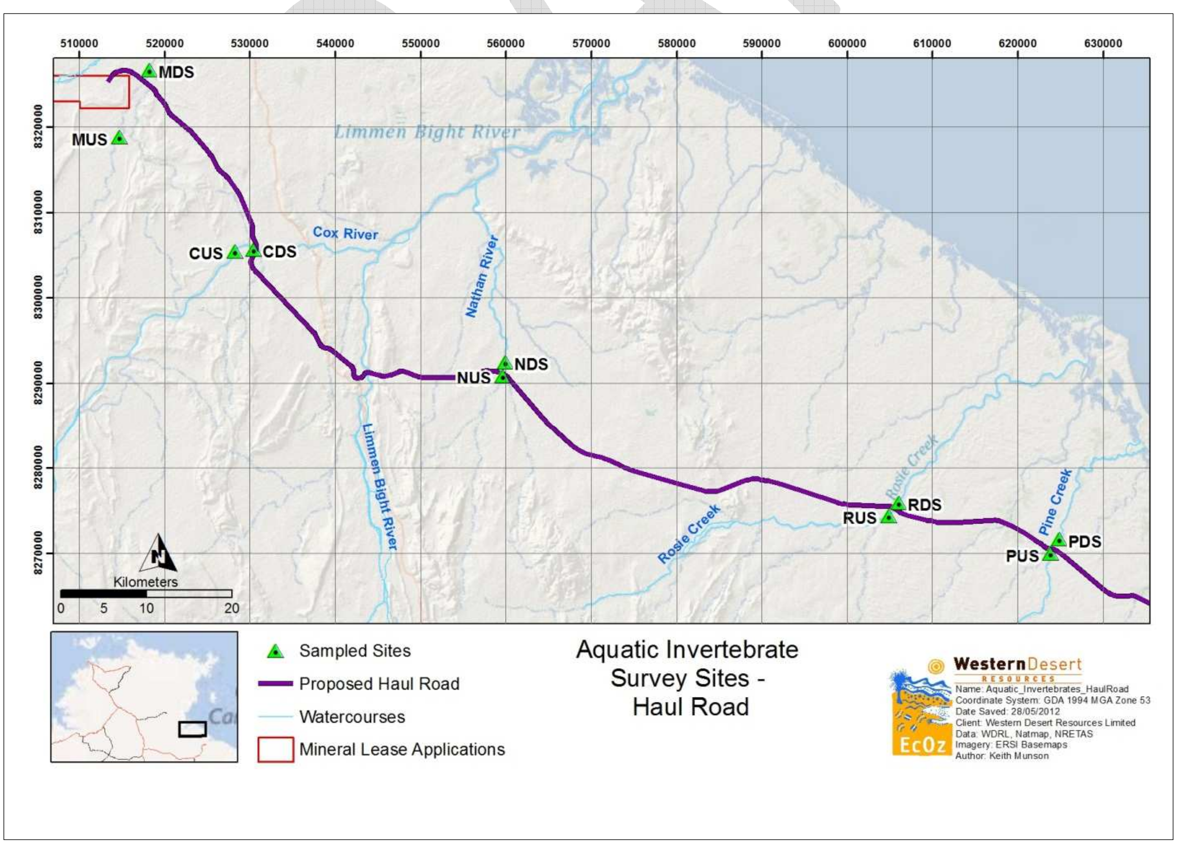


Figure 4. Locations of macroinvertebrate sampling sites in vicinity of proposed haul road.

2.2 Field Sampling Techniques

2.2.1 Macroinvertebrates

Macroinvertebrate sampling was undertaken in accordance with the NT 'AUSRIVAS' (Australian Rivers Assessment Scheme) User Manual (Lamche 2007). This is a two-person operation, which involves the disturbance of a 5-10m section of stream bank 'edge' habitat with a 3-pronged rake by the first person, followed by the second person who passes a 500 µm mesh net (D-shaped opening with 35cm diameter) through the disturbed water in a sweeping motion.

Following sampling, the net contents are emptied into a bucket of water and the net washed thoroughly, to remove any remaining debris and macroinvertebrates. The organic fraction is separated from the inorganic sediments by stirring the bucket contents and slowly pouring the suspended mixture from the bucket into nested coarse (i.e. 10 mm) and fine (i.e. 500 µm) sieves. The coarse fraction is discarded following an inspection of the sieve contents to check for any invertebrates. The contents of the fine sieve is washed into a 500 ml plastic wide mouth jar and preserved in the field using ethanol to a concentration of 70%.

2.2.2 Habitat Descriptions

In addition to photographs taken at each site, information on habitats sampled and surrounding in-stream and riparian areas was recorded, including the following:

- Stream width (i.e. at water level)
- Bank full widths and depths (i.e. levy banks)
- Water depth at sample location
- Stream discharge (estimated visually)
- Flow at sample location (estimated visually)
- Dominant substrates at sample location
- Riparian canopy cover (estimated visually)
- Riparian disturbance (i.e. weeds, ferals, fire)

2.2.3 Water Quality

In-situ water quality variables were measured at each site, including pH, electrical conductivity (EC), total dissolved solids (TDS) and dissolved oxygen (DO). Readings were taken using calibrated TPS instruments.

Water quality samples were also collected at each downstream site for analyses of the following parameters:

- Total suspended solids (TSS)
- Nutrients (total nitrogen, total phosphorus, nitrate, nitrite, ammonia)
- Dissolved metals (As, Cd, Co, Mn etc)

Water quality samples were generally only collected at the downstream site on each stream, following confirmation that there were no inputs from other streams between the sites and that in-situ variables were consistent. One exception was the Magaranyi River, which had a much greater distance between the upstream and downstream sites than other streams (Figure 4) and in-situ water quality data indicated a difference in water quality between the sites.

2.3 Macroinvertebrate Laboratory Techniques

Samples were sub-sampled so that at a minimum of 200 animals or 10 % of the sample is examined using a sub-sampler as described by Marchant (1989). Where samples were shown to have low abundances the sorting time was limited to a maximum of 4 hours. At the completion of the sub-sampling a general scan of the remaining sample was completed and any additional species not initially collected were added to the taxa list. The abundances of the taxa collected from the sub-sample were corrected depending upon the percentage of the subsample that was examined.

Taxonomic resolution followed AusRivAS protocols (Lloyd and Cook 2002). The majority of taxa were identified to family level however some groups were identified to class or order (e.g. Mites and worms). Any damaged or immature taxa were identified to the lowest level possible. As per the protocol Cladocerans, Copeopds and Ostracods are not included in the animal counts.

2.4 Data Analysis

Multivariate analysis was used assess macroinvertebrate community data at each site. All abundance data was transformed to binary data (i.e. presence/absence) to reduce artificial variance resulting from the Rapid Bioassessment sampling technique. All multivariate analyses were conducted using the PRIMER software package (Clarke and Gorley 2007). Macroinvertebrate assemblage data was described using ordination and cluster techniques. The basis of the analyses was Bray-Curtis similarity matrices. The clustering techniques uses a hierarchical agglomerative where samples of similar assemblages are grouped and the groups themselves from clusters at levels of similarity. The ordination method used was Multidimensional scaling (MDS) (Clarke and Warwick 2001). The data is presented as an ordination with overlays of the clustering technique to show the similarity of samples. Samples with similar community structure are positioned closer together in the ordinal space. A stress level is also indicated and it is a measure of the distortion produced by compressing multi-dimensional data into a reduced set of dimensions and will increase as the number of axes (i.e. dimensions) is reduced. Low stress levels (*i.e.* <0.1) indicate that the relative position of site samples in ordination space is a good reflection of the similarity of their macroinvertebrate communities. High stress levels (i.e. >0.25) indicate that there is little confidence that the ordination is explaining the community.

An analysis of similarity (ANOSIM) was conducted to determine if there is significant difference between locations of the sites (i.e. upstream versus downstream). ANOSIM is effectively an analogue of the univariate ANOVA. The ANOSIM statistic reflects the observed differences between groups with the differences among replicates within the groups. The test is based upon rank similarities between samples in the underlying Bray-Curtis similarity matrix.

There are two values important for the ANOSIM test these are the significance value and Global R values. The significant value that disproves the null hypothesis (i.e. there is no difference between groups) used in the analysis is for P< 5%.

R values can vary between -1 and 1, and values usually fall between 0 and 1. Values less than 1 indicate the situation of lower levels of similarity within treatments or groups than between them (Clarke and Warwick, 2001). R-values approximating 0 indicate that the null hypothesis is true and that there are no differences between the assessed factors. As values increasingly depart from zero, there is an increasing indication of differences between the groups/factors being assessed. A value of 1 indicates that all replicates within a treatment/group are more similar to each other than to any others from different treatments/groups (or for –1, that all replicates within a treatment/group are more similar to those from different treatments/groups).

As a general guide, R values can be categorised into 3 broad groups (Clarke and Gorley, 2001):

R > 0.75: indicates that there are large differences and the treatments/groups are well separated;

R > 0.5: indicates clear differences, but the treatments/groups are 'overlapping';

R < 0.25: indicates little/no difference and the treatments/groups are barely separable.

The SIMPER routine was then used to determine which taxa were contributing to the differences in community structure between upstream and downstream zones. The procedure calculates the percentage contribution that each taxon is making to form dissimilarities between groups listing the taxa in decreasing order. The procedure may also determine indicator taxa (i.e. single taxa make up a large percentage of difference between the groups).

The Bray Curtis Similarity measures are also provided to indicate the natural variation between the paired upstream and downstream sites. Future potential impacts upon the sites can be based on these indices where they should not differ greatly from that observed in the baseline data.

3 Results and Discussion

3.1 Habitat Descriptions

Details of habitats sampled and surrounding areas are provided in Table 1 and photographs of each sample site are provided in Appendix A1. Stream channel sizes were generally similar between sites (especially upstream-downstream sites on the same system), although the Towns River Downstream site was notably smaller than any of the other sites sampled. This was reflected in the stream discharge, with most sites having good flows, whereas the Towns River Downstream site was only just flowing. This is likely to be due to the relatively small upstream catchment size of the Towns River at the sample location and indicates that groundwater inflows to the stream are minimal or non-existent.

Stream velocities at sample locations were generally consistent (i.e. none/negligible), although the Cox River upstream site (CUS) and both sites on Pine Creek (PUS and PDS) had obvious flow. This was unavoidable, given the character of the streams in these locations (i.e. generally narrow and fast flowing).

Edge habitats sampled were generally consistent between sites (i.e. vertical banks with trailing root material, sandy substrate), although the Towns River downstream site (TDS) had a silt/clay substrate with limited trailing root material.

Riparian (stream-side) canopy cover was generally low at most sites (i.e. < 40%) and there was no substantial disturbance (i.e. from weeds, fire or feral animals) at any of the sites, with the exception of the Nathan River upstream site (NUS), which had high levels of weed infestation (mainly *Hyptis suaveolens*) and moderate impact by feral animals (i.e. soil disturbance from cattle/horses).

3.2 Water Quality

Water quality data for sample sites is provided in Table 2.

Discussion - incomplete

Table 1. Habitat Data.

Site	Stream Width (m)	Levee Bank Width (m)	Levee Bank Height (m)	Water Depth (m)	Stream Discharge (m^3/s)	Flow at sample location	Dominant Substrate	Riparian Canopy Cover (%)	Riparian Disturbance (weeds, fire, ferals)
TDS	8	15	3	0.8	0.001	None	Silt/Clay	30	Nil
MUS	25	80	3	0.5	0.05	Negligible	Sand	45	Nil
MDS	6	50	5	0.8	0.05	None	Sand	25	Nil
CUS	11	100	8	1.0	2.0	Obvious	Sand	85	Low ferals
CDS	22	150	5	0.8	2.0	None	Sand	35	Low ferals
NUS	20	150	8	0.5	0.1	Negligible	Sand	40	High weeds, moderate ferals
NDS	25	100	3	0.8	0.1	None	Sand	35	Moderate weeds
RUS	17	80	4	0.6	1.0	Negligible	Sand	25	Low ferals
RDS	25	170	8	1.6	1.0	None	Sand	70	Low ferals
PUS	10	60	3	0.9	1.5	Obvious	Sand	60	Low ferals
PDS	12	60	2.5	0.3	1.5	Obvious	Sand	25	Low ferals

Table 2. Water Quality Data

Site	Field Parameters							Dissolved Major Anions						Dissolved Major Cations			
	pH	DO	EC	TDS	Temp	Turbidity	Suspended Solids	Hydroxide CaCO3	Carbonate CaCO3	Bicarbonate CaCO3	Total CaCO3	SO4	Cl	Ca	Mg	Na	K
		%	uS/cm	g/L	°C	FTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
TDS	7.04	68	230	0.144	27.3	20.2	<5	<1	<1	54	54	6	31	9	10	18	2
MUS	7.01	70	66.2	0.041	28.2	16.7	9	<1	<1	12	12	<1	15	1	2	9	2
MDS	7.04	89	75.6	0.046	28.6	12.7	<5	<1	<1	11	11	<1	13	1	2	8	2
CDS	7.04	79	78.6	0.049	27.6	53	10	<1	<1	20	20	1	11	3	3	6	2
NDS	7.85	98	184	0.107	31.6	4.1	<5	<1	<1	74	74	<1	9	12	10	6	2
RDS	7.92	98	242	0.139	31.9	2.6	<5	<1	<1	93	93	<1	14	15	12	10	3
PDS	7.73	86	169	0.103	28.5	1.3	<5	<1	<1	68	68	<1	12	9	10	8	2

Site	Dissolved Metals									Nutrients						
	As	Cd	Cr	Cu	Mn	Ni	Pb	Zn	Fe	Ammonia	Nitrite	Nitrate	Nitrite+Nitrate	Total Kjeldahl Nitrogen	Total Nitrogen	Total Phosphorus
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
TDS	<0.001	<0.0001	<0.001	<0.001	0.312	<0.001	<0.001	<0.005	0.98	0.11	<0.01	<0.01	<0.01	0.3	0.3	<0.01
MUS	<0.001	<0.0001	<0.001	<0.001	0.002	<0.001	<0.001	<0.005	0.72	0.04	<0.01	<0.01	<0.01	0.3	0.3	<0.01
MDS	<0.001	<0.0001	<0.001	<0.001	0.002	<0.001	<0.001	<0.005	0.8	0.02	<0.01	<0.01	<0.01	0.3	0.3	<0.01
CDS	<0.001	<0.0001	<0.001	<0.001	0.008	<0.001	<0.001	<0.005	0.55	0.02	<0.01	<0.01	<0.01	0.2	0.2	<0.01
NDS	<0.001	<0.0001	<0.001	<0.001	0.036	<0.001	<0.001	<0.005	0.18	0.03	<0.01	<0.01	<0.01	0.2	0.2	0.05
RDS	Not available									0.02	<0.01	<0.01	<0.01	0.1	0.1	0.04
PDS	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	0.28	0.02	<0.01	<0.01	<0.01	0.1	0.1	<0.01

3.3 Macroinvertebrate Communities

3.3.1 Taxonomic composition

A total of 39 taxa were recorded across all sampling sites, with the most abundant taxa including fly larvae (Chironomidae), mayflies (Caenidae) and beetles (Dytiscidae). The average number of taxa across the sites was 18, with the lowest taxonomic richness (13) at the Towns River downstream site (TDS) and the highest (24) at the Nathan River downstream site (NDS). Macroinvertebrate data for each site is provided in Appendix S2.

3.3.2 Multivariate analysis

The stress of the 2 dimensional plot is 0.18, indicating that the ordination provides a useful picture (Clark & Warwick 2001). However, the similarity overlays provide essential clarification of the groupings. The MDS shows that sites on the same stream are closely associated with each for all sites except those in the Magaranyi River. Sites on the Cox River and Nathan River indicated the upstream and downstream sites within the rivers are more similar than other river pairings where a dissimilarity of less than 40% was observed (Figure 5).

The bubble plots indicate differences in the observed abundances between sites with Rosie Creek upstream (RUS) and Pine River upstream (PUS) have the lower abundances. The bubble plot of the taxa richness indicates little difference in taxa richness between sites (Figure 5).

An ANOSIM was also used to test if there was a significant difference in macroinvertebrate communities between upstream and downstream sites (Table 3). The test showed no significant difference (p=59.7 %) between upstream or downstream of the discharge. Importantly the inferences from the ordination are supported through the ANOSIM test.

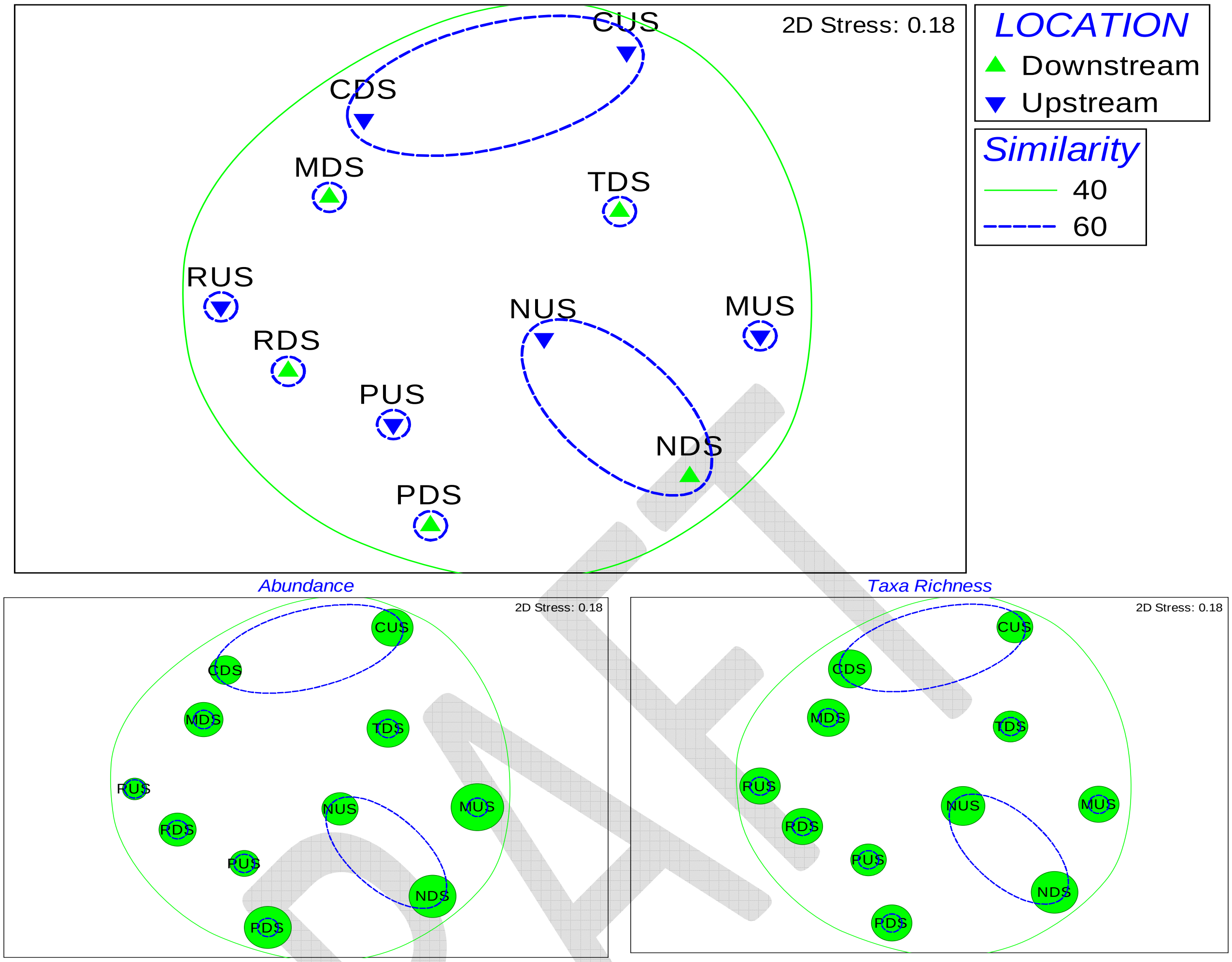


Figure 5. Ordination of macroinvertebrate community data

Table 3. ANOSIM Results

Test	Significance	Global R
Location (Upstream v Downstream)	59.7%	-0.035

SIMPER analysis indicated Caenidae (Ephemeroptera) contributed the greatest percentage to community composition across all upstream and downstream sites with a contribution of 6.37% and were in greater abundance in the upstream sites (Table 4). Oligocheata (Annelida) contributed the least of the taxa contributing to the first 50% of similarity to community composition across all sites with 3.2%. Caenidae (Ephemeroptera), Gomphidae (Odonata) and Baetidae (Ephemeroptera) were in higher average abundances in the upstream zone.

Table 4. SIMPER Analysis of Upstream and Downstream Similarity Results of All Macroinvertebrates Contributing to the Top 50% of Community Composition

Taxa	Average Abundance Downstream	Average Abundance Upstream	Percent Contribution	Cumulative Contribution
Caendiae	8.24	**9.96**	6.37	6.37
Chironominae	**9.02**	4.85	5.19	11.56
Choncostraca	**3.5**	2.73	5.16	16.72
Ceratopogonidae	**5.95**	3.14	4.82	21.53
Corixidae	**4.24**	2.13	4.53	26.06
Tanypodinae	**4.21**	3.12	4.19	30.25
Dytiscidae	**4.16**	3.27	4.08	34.33
Gomphidae	3.14	**3.31**	3.71	38.04
Baetidae	5.10	**5.27**	3.63	41.67
Dytiscidae (Larva)	**0.45**	0.00	3.4	38.14
Dytiscidae	**0.73**	0.67	3.35	41.49
Notonectidae	**0.36**	0.33	3.28	44.76
Planorbidae	**0.45**	0.00	3.22	47.98
Oligochaeta	**0.73**	0.67	3.2	51.18

Bold implies higher average abundance

Bray Curtis similarity parings are provided below for future reference to assess potential impacts. As highlighted in the in the ordination, upstream and downstream sites on the Cox River and also for the Nathan River are more similar than for the other waterways (Table 5).

Table 5. Bray Curtis Similarity pairings

Waterway	Bray Curtis Similarity
Towns River	No pairing
Magaranyi River	48.43
Cox River	66.16
Pine River	57.80
Rosie Creek	54.20
Nathan River	61.48

4 Conclusions and Recommendations

4.1 Conclusions

Incomplete

Reporting will be annual based on timing of the sampling according to the correct environmental conditions.

4.2 Recommendations

This macroinvertebrate sampling program will be performed annually. Review and revision of the program will also take place annually so as to ensure that the potential impacts associated with the project are being monitored.

5 References

Clarke, K.R. and Gorley, R.N. (2006) *Primer v6: User Manual/Tutorial.* Plymouth Marine Laboratory, Plymouth, U.K.

Clarke, K.R. and Warwick, R.M. (2001) *Change in Marine Communities: an approach to statistical analysis and interpretation.* 2nd Edition. Plymouth Marine Laboratory, Plymouth, U.K.

Faith, D., Humphrey, C., and Dostine, P. (1991). Statistical power and BACI designs in biological monitoring: comparative evaluation of measures of community dissimilarity based on benthic macroinvertebrate communities in Rockhole Mine Creek, Northern Territory, Australia. In: *Australian Journal for Marine and Freshwater Research* 42: 589-602.

Lamche, G. (2007): The Darwin-Daly regional AUSRIVAS models – Northern Territory. User Manual. Report 06/2007D. Aquatic Health Unit, Department of Natural Resources, Environment and the Arts, Darwin.

Lloyd, J. and Cook, S. (2002) Australia-Wide Assessment of River Health: Northern Territory AusRivAS Sampling and Processing Manual, Monitoring River Health Initiative Technical Report no. 19, Commonwealth of Australia and Department of Lands, Planning and Environment.

Marchant, R. 1989. A subsampler for samples of benthic invertebrates. Bull. Aust. Soc. Limnol. 12: 49-52

Appendix S1: Site Photographs

Plate 1. Towns River Downstream Site

Plate 2. Magaranyi River Upstream Site

Plate 3. Magaranyi River Downstream Site

Plate 4. Cox River Upstream Site

Plate 5. Cox River Downstream Site

Plate 6. Nathan River Upstream Site

Plate 7. Nathan River Downstream Site

Plate 8. Rosie Creek Upstream Site

Plate 9. Rosie Creek Downstream Site

Plate 10. Pine Creek Upstream Site

Plate 11. Pine Creek Downstream Site

Appendix S2: Macroinvertebrate Data

	TDS	MDS	MUS	CUS	CDS	PUS	PDS	RDS	RUS	NUS	NDS
Hyriidae				1	1						
Ancylidae		8									
Hydrobiidae											5
Planorbidae			8					8		20	20
Oligochaeta	17		17	8	7	28	27	25	4		20
Choncostraca	33	25	183							8	45
Atyidae		33	42					17			15
Palaemonidae	25	25		33	78			8	20	32	30
Hydracarina	8		17			12	20	25	14		20
Baetidae	33	50	50	75	28		73	17	28	28	
Caenidae	83	42	350	267	53	36	173	17	6	80	70
Leptophlebiidae		8							2	20	30
Coenagrionidae	8		17	8							10
Gomphidae		50		42	2	44	13	25	4	12	
Hemicorduliidae		8	8			16	13			28	25
Gerridae											20
Belostamatidae											5
Corixidae		67			5	16	80	17	14	8	
Notonectidae			17	8	3	16				12	15
Veliidae								8			
Pleidae				8	10	4	13			4	20
Gelastocoridae							7				
Dytiscidae (adult)	25			17	10	8	47		26	20	80
Dytiscidae (larvae)	8	8	17	8	12						
Elmidae										12	10
Haliplidae							20			4	
Hydrophilidae (adult)		8			2		7	17			
Hydrophilidae (larvae)									2		
Noteridae				8	7						
Hydrochidae		8			22			8	6		10
Hydraenidae				17	22			17			10
Culicidae			58				7		4		15
Tanypodinae			25		12	24	40	25	2	16	95
Orthocladiinae		33			8		13				
Chironominae	67	25	17	8	18	32	127	125	28	48	90
Ceratopogonidae	192	17	42		3	8	20	8	6	28	20
Tabanidae										8	
Ecnomidae	33	17	8			16		42	14	20	35
Hydroptilidae		17	8		10	4	7		6		
Leptoceridae	33	25	8	17	15	12		33		4	
Pyralidae										4	
Total Taxa Richness	**13**	**19**	**18**	**15**	**21**	**15**	**18**	**18**	**17**	**21**	**24**