PEABODY ENERGY

WILPINJPONG COAL MINE

STREAM HEALTH MONITORING

AQUATIC MACROINVERTEBRATE SURVEY

SEPTEMBER 2011

JANUARY 2012

Landline Consulting

1 Jack St. Atherton Qld, 4883 Australia

Ph (07) 40916364, Fax 07 40916465 Mobile 0407 955496

Email: admin@landlineconsulting.com

Landline Consulting

1 Jack St. Atherton Qld, 4883 Australia

Ph (07) 40916364, Fax 07 40916465 Mobile 0407 955496

Email: admin@landlineconsulting.com

EXECUTIVE SUMMARY

A survey of the aquatic macroinvertebrate fauna at sites in Wilpinjong Creek, Cumbo Creek and Wollar Creek was undertaken in September 2011. Sites sampled were those which had been established during previous macroinvertebrate studies plus one extra site in Wollar Creek downstream of the confluence with Wilpinjong Creek. Sampling and sample processing were undertaken in compliance with AusRivAs methodology and standards.

A variety of interpretive indices were applied to the sampling data to evaluate environmental quality at the sample sites. There was a high degree of correspondence between the outputs from these indices.

All stream reaches sampled have suffered physical disturbance of the habitat ranging from moderate to extreme over a long time period and salinity levels in the streams are naturally high. The various biotic indices showed that all sites, including the reference sites upstream of the mine are moderately to severely impacted. The greatest level of environmental impairment was exhibited at sites WC3 (in Wilpinjong Creek near the upstream end of the mining lease) and CC3 (in Cumbo Creek within the lease area).

Electrical conductivity and pH values within the creek systems showed little obvious correlation with stream health indicator values and it is quite possible that the degree of physical habitat degradation is the major factor determining stream health index values at some or all sites. There is a possibility that a water quality parameter other than salinity or pH may be impacting on environmental quality in stream reaches near WC3 and WC4 however further results will be required to clarify this possibility.

The biotic indices showed an improvement in environmental quality at Wilpinjong Creek sites downstream from site WC3 and the results from Wollar Creek downstream of the junction with Wilpinjong Creek indicate that there is little or no impact on environmental quality as a result of the inflow from Wilpinjong Creek.

Contents

Introduction 1
Background 1
Study area 1
General 1
Surface Water Receiving Environment 4
Sampling Sites 4
Biomonitoring with macroinvertebrates 18
Number of animals 19
Number of taxa 19
Shannon Diversity Index (H) and Shannon Equitability Index (E_H) 19
SIGNAL2 index 20
AUSRIVAS modelling system 20
Methodology 21
Sampling Dates 21
Field Sampling 21
Laboratory procedures 21
Data analysis 22
Results 23
General 23
Water Quality and Stream Conditions 27
Discussion 28
References 33

Introduction

Background

Wilpinjong Coal Pty Ltd, a wholly owned subsidiary of Peabody Energy Australia (Peabody) operates the Wilpinjong Coal project in the upper Hunter Valley region of NSW. The Project is in the Western Coalfield near the margin of the Sydney-Gunnedah Basin.

The project mining lease covers 2800 hectares and recoverable coal reserves are in excess of 200 million tonnes. The resource is part of the Ulan Coal seam and two other large coal mines are located within a few kilometres of Wilpinjong, at Ulan and Moolarben,

The project is an open-cut thermal coal operation with mining carried out under contract by Thiess. Mining commenced in late 2006 and current annual production is approximately 8 million tonnes, the bulk of which goes to supply the Liddell and Bayswater power stations and the remainder (2 to 2.5 million tonnes per annum) being exported through Newcastle.

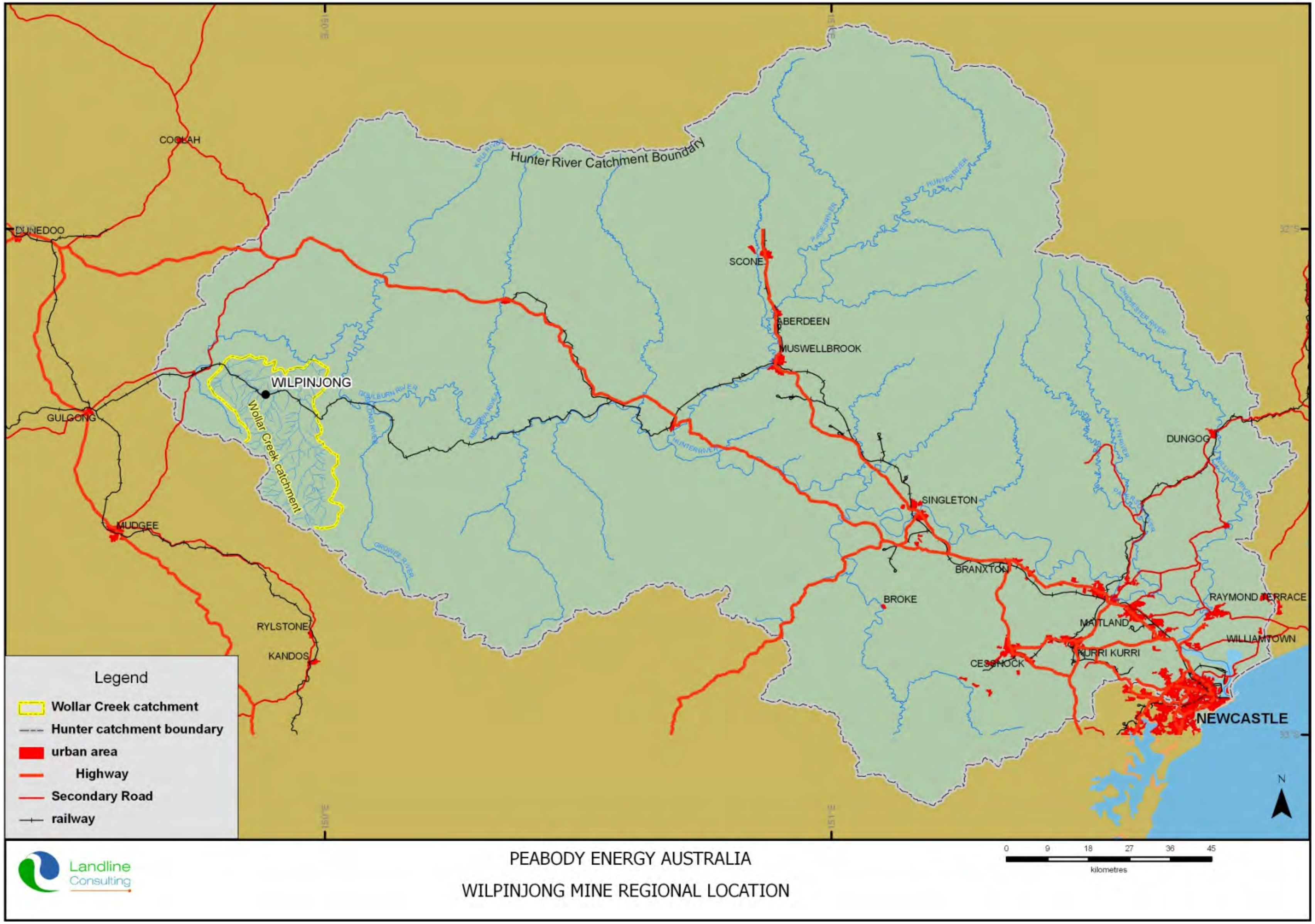
Peabody undertakes annual Stream Health Monitoring in the receiving environment as part of its Surface Water Management Plan. Landline Consulting was commissioned to conduct monitoring and report on stream health during the spring period of 2011.

Study area

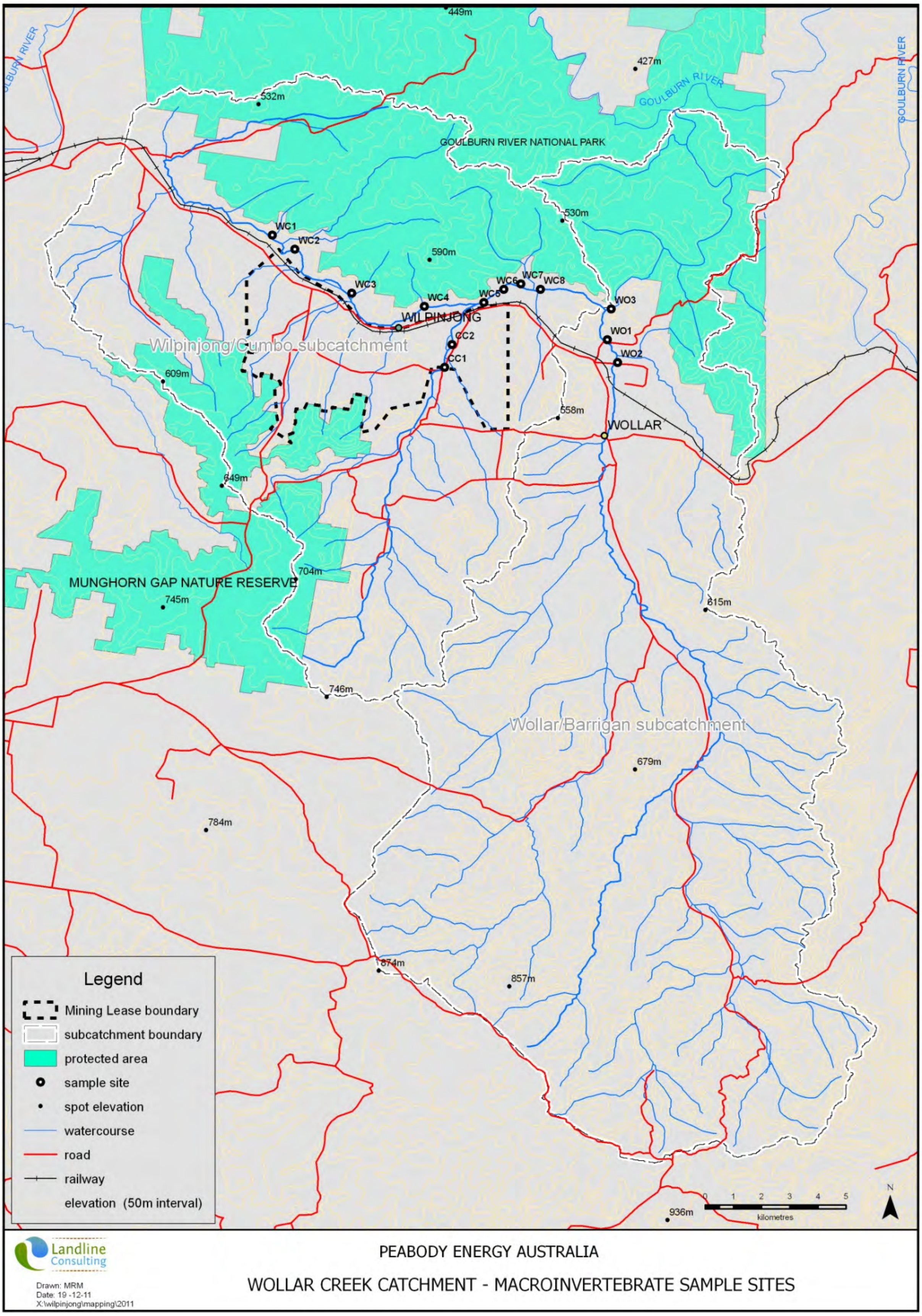
General

Wilpinjong coal mine is located in the upper Hunter River catchment approximately 40km northeast of Mudgee via Ulan Road and Ulan–Wollar Road. The location is shown on a regional scale in Map 1.

Local landforms include narrow flood plains along the middle and lower reaches of tributaries of the Goulburn River, undulating foothills, ridges and escarpments of the Great Dividing Range in the south west and the dissected landforms of the Goulburn River National Park in the northeast. The local coals are part of the Permian Illawarra coal measures and are overlain by Triassic Wollar Sandstones which dominate the surface geology of the Goulburn River National Park and the Munghorn Gap Nature Refuge to the north and south respectively of Wilpinjong. Local relief ranges from approximately 340 m AHD at the junction of Wilpinjong and Wollar Creeks to 870 metres in the headwaters of Wollar Creek. Elevations within the mining lease range from approximately 360m to 550m. Local relief and drainage features are shown in Map 2.



Map 1 Location of Wilpinjong Coal Mine showing Hunter River drainage and local population centres



-Map 2 Wollar Creek catchment showing sample sites and Wilpinjong lease boundary

Surface Water Receiving Environment

As shown in Map2 the Wilpinjong mining lease drains to Wilpinjong Creek and its tributary Cumbo Creek which lie to the north and east respectively of the current mining operations. As coal mining proceeds eastwards across the lease it will ultimately be necessary to divert the Cumbo Creek channel. From its junction with Cumbo Creek near the north-eastern corner of the mining lease, Wilpinjong Creek flows eastward to enter Wollar Creek approximately 5km downstream of the mining lease. The study area covers the portion of the Wilpinjong/Cumbo Creek catchments from upstream of the mining lease boundary to the junction with Wollar Creek as well as a short section of the Wollar Creek catchment upstream and downstream of the confluence with Wilpinjong Creek (see Map 2).

Most of the watercourses in the study area have been degraded over a long period of time by physical disturbance including riparian and floodplain clearing, grazing by cattle and kangaroos, and the activities of wombats, rabbits and pigs which have affected bank stability. Wilpinjong and Cumbo Creeks flow intermittently and salinity is naturally high under base flow conditions.

Sampling Sites

Thirteen sampling sites were sampled in the 2011 survey (Map 2). These included the twelve sites sampled in the 2010 survey and an additional site (WO3) located in Wollar Creek downstream of the junction with Wilpinjong Creek. Sites are coded according to the creek they are located on (WC= Wilpinjong Creek, CC= Cumbo Creek, WO= Wollar Creek) and numbered consecutively from upstream to downstream. Further information on individual sites follows.

Site WC1 MGA Coordinates E767680 N6422970 Stream Order 3

This reach of Wilpinjong Creek is situated approximately 500metres north of the western boundary of the mining lease boundary and two channel kilometres upstream of the junction with Planter Creek, which is the first surface inflow from the mining lease area. The site displays reasonable bank stability and riparian vegetation cover. The flow channel is reasonably well defined with shallow pools and small riffles that are largely dominated by *Phragmites* cover.

Site WC2 MGA Coordinates E768350 N6422450 Stream Order 3

This reach of Wilpinjong Creek is located approximately 1kilometre downstream of site WC1 and 1 kilometre upstream of Planters Creek. Its physical condition is similar to that of WC1 although the pool/riffle sequence is better preserved at this site.

Site WC3 MGA Coordinates E770010 N6420860 Stream Order 3

This site is located on Wilpinjong Creek approximately 2 kilometres downstream of the Planters Creek junction and upstream of the junction with Narrow Creek. The creek at this site has a poorly defined channel and conforms to the "chain of ponds" type of morphology. It is almost entirely covered by thick growth of *Typha/Phragmites* and the "riffles" available for sampling have a sand/gravel substrate with little cobble or boulder present.

Site WC4 MGA Coordinates E772180 N6420330 Stream Order 3

This site is located on Wilpinjong Creek approximately 1.5 kilometres downstream of the confluence with Narrow Creek and approximately the same distance upstream of the Cumbo Creek junction. The creek banks in this area have been cleared and severely eroded and the poorly defined channel has migrated between the high banks, with swampy edges covered with a dense growth of *Phragmites.* Shallow riffles are largely confined to the stream edges where the channel is controlled by rock bars. The substrate is largely bedrock with limited cobbles and gravel.

Site WC5 MGA Coordinates E773970 N6420420 Stream Order 4

This site is located on Wilpinjong Creek immediately downstream of the Cumbo Creek confluence. The creek here is aggraded and forms a chain of ponds separated by poorly developed riffles with little cobble or rock present. The riparian zone has been entirely cleared for some distance upstream of this site.

Site WC6 MGA Coordinates E774580 N6420860 Stream Order 4

This site is located on Wilpinjong Creek at the downstream flow gauging station close to the eastern extremity of the mining lease. The channel is controlled at this point by a natural bar and weir associated with the gauging station. Riffles are largely bedrock with some cobbles, sand and gravel.

Site WC7 MGA Coordinates E775100 N6421050 Stream Order 4

This site is located on Wilpinjong Creek approximately 500m downstream of WC6 and the riparian vegetation between the two sites is relatively intact. There is reasonable definition of the flow channel with riffles having a mixed substrate of bedrock, cobble, gravel and sand

Site WC8 MGA Coordinates E775680 N6420830 Stream Order 4

This site is the furthest downstream site in Wilpinjong Creek being located approximately 1.5 kilometres east of the mining lease and 2.5 km upstream of the confluence with Wollar Creek. Riparian vegetation in this section of creek is largely absent and the stream bed is sedimented and clogged with reeds and rushes. There are no clearly defined riffles and sampling was carried out mainly along the edges and in small flow paths through the reeds.

Site CC1 MGA Coordinates E772730 N6418150 Stream Order 3

This site is located on Cumbo Creek approximately 1 kilometre upstream of Site CC2 at the place where the creek enters the mining lease. Samples were collected upstream and downstream of the road crossing on the Old Wilpinjong Road. The creek upstream is clogged with *Typha* and the channel bed downstream is muddy and heavily trampled by cattle. There are no riffles. Sampling was mainly along the edges of the creek crossing and the creek margins.

Site CC2 MGA Coordinates E772970 N6418950 Stream Order 3

This site is located in Cumbo Creek approximately 2 kilometres upstream of the confluence with Wilpinjong Creek. There is little habitat complexity as the creek is severely degraded with no riparian vegetation, few ponded sections and the narrow flow channel resembles a constructed drain. There are no defined riffles and the substrate is muddy to sandy.

Site WO1 MGA Coordinates E777930 N6418180 Stream Order 4

The site is located at where Araluen Lane crosses Wollar Creek approximately 1kilometre above site WO2 and 2.5 kilometres downstream of the township of Wollar. No accessible riffles were present at the site and sampling was restricted to the edges.

Site WO2 MGA Coordinates E777640 N6419000 Stream Order 4

This site is located on Wollar Creek approximately 2 kilometres upstream of the junction with Wilpinjong Creek where Mogo Road crosses the creek. There is little riparian vegetation at this site and bank stability is poor. The creek is largely clogged with rushes and reeds. The main riffle zones are located downstream of the road crossing and have a rocky sandy substrate.

Site WO3 MGA Coordinates E777640 N6419000 Stream Order 5

This site is located in Wollar Creek approximately 100 metres downstream of the junction with Wilpinjong Creek. While grazing has had some effect on the creek banks the flow channel is relatively intact and there is a good sequence of riffles with cobble and rock substrate.

Biomonitoring with macroinvertebrates

Aquatic macroinvertebrates include such animals as worms, prawns, crayfish, molluscs and many types of insect larvae. They are commonly used for biomonitoring of water quality for several reasons including the fact that are fairly ubiquitous and are found in almost every water body, even rivers and ponds that dry from time to time. They are also relatively easy to catch and identify.

Macroinvertebrates have differing water quality requirements. Some require very good water quality for survival while others are capable of living in severely polluted environments. Because most stream macroinvertebrates are relatively sedentary examining the animals at a given site can indicate what the water quality has been like over the weeks or even months prior to the sample. A major advantage of biomonitoring is the fact that the record of short term pollution is "stored" in the stream biota for some time after an event causes an impact on the system. This gives a considerable advantage over chemical sampling which can only detect water quality conditions at the time of sampling.

Community diversity is one simple way of assessing water quality. In a sample from a diverse community there is a low probability that any two individual specimens drawn at random from the sample will be of the same type. A sample from a site with low diversity may contain just as many individual animals as the high diversity sample but there is a relatively high probability that two animals drawn sequentially will be of the same type. Sites with good water quality usually have a great variety of animals and the different types of animals are relatively evenly represented in the habitat (high diversity) as compared to sites with poor water quality where the fauna is likely to consist of a few numerically dominant and pollution-tolerant species (low diversity). Various indices can be used to measure the diversity in the sample and assess environmental quality.

Another approach is to produce a biotic index in which categories of animals are ranked on the basis of their tolerance to pollution and rankings of the animals in the sample are used to assess water quality at the site.

A third approach is to rank sites on the basis of the taxa present at the site as compared to the probability of occurrence of a standard list of taxa from suitably selected reference sites. This approach is taken by the AUSRIVAS modelling system.

This survey has used a range of indicators based on community diversity and biotic indices to assess the condition of macroinvertebrate communities. A brief summary of the major indicators used follows.

Number of animals

In non-impacted environments numbers of animals present in samples will normally be reasonably uniform between samples (usually in the order of ±50% around the median value). Large increases or decreases in animal abundance between sites may either indicate significant changes in physical habitat diversity or effects of an environmental stressor.

Number of taxa

In non-impacted environments numbers of taxa present in samples will normally be reasonably uniform between samples (usually in the order of ±25% around the median value). Significant environmental stressor levels are usually accompanied by a significant decrease in the number of taxa present at impacted sites.

Shannon Diversity Index (*H*) and Shannon Equitability Index (E_H)

The Shannon diversity index (Shannon 1949) which measures community diversity is one of the most commonly used tools in rapid assessment biomonitoring. The Shannon index includes information on species richness and abundance values in a single number. It measures the degree of uncertainty of predicting the group to which of an individual specimen, picked at random from the community will belong. The value of the Shannon index (H) is calculated using the following equation:

$$H = \sum_{n=1}^{s} (p_i . \ln(p_i))$$

Where:

p_i = proportional abundance of a species/taxon, (simply the number of an individual taxon present divided by the total number of specimens in the sample)

s= species/taxon richness, the total number of different categories of organisms present.

The related equitability (evenness) index measures how evenly the individuals within the sample are distributed between the taxa that make up the sample. Maximum equitability is 1 which is achieved when each taxon in the sample is represented by the same number of individuals. The equation is:

$$E_H = H/H_{max} = H/\ln s$$

It is important that comparisons of these indices are made at the same level of taxonomic resolution. In this study data processing was carried out at the family level even though some organisms could be identified to the genus or species level.

SIGNAL2 index

The SIGNAL2 Index (Chessman, 2003) is a biotic index which is based on a system of pollution sensitivity grading for macroinvertebrate families which ranks the individual taxa from 1-10 on the basis of their tolerance to pollution (1 being most tolerant and 10 being least tolerant). SIGNAL is an acronym for **S**tream **I**nvertebrate **G**rade **N**umber **A**verage **L**evel.

The abundance-weighted family version of the SIGNAL2 index was used in this study with the modification that water mites (hydracarina) were identified only to the suborder level.

To obtain a SIGNAL ranking sensitivity grade scores for each family present in a sample are recorded and a weighting factor, based on the number of individuals sampled is calculated for each family and applied to the individual grades. The sum of weight factors for all taxa is calculated and the products of grade numbers and weight factors are summed. The second of these totals is divided by the first to produce the abundance-weighted SIGNAL 2 score. Full details of the index can be found at

http://www.environment.gov.au/water/publications/environmental/rivers/nrhp/signal.html

A variation of the SIGNAL index system Signal (-1) in which taxa represented by a single individual are excluded from the calculation of the SIGNAL2 score was also adopted in this study. This modification can reduce the contribution by animals which are drifting or transient rather than resident. The effect of such non resident animals can be important under high flow conditions.

AUSRIVAS modelling system

The Australian River Assessment System (AusRivAS) is a set of computer models that compare a macroinvertebrate family list from a sampling site (test site) with a data base from a large number of reference sites throughout Australia. The reference sites are those in each region of Australia that are believed to be least altered by human activity. The AusRivAS models match the test site to reference sites for similar types of streams in the same State or region. If the test site is lacking the macroinvertebrate families that are expected to occur, according to the reference site data base, it is likely that the test site is more affected by human influences than the reference sites. Operation of AUSRIVAS models requires accreditation and allocation of a password to run the internet based models using downloaded software. Further information on the AUSRIVAS models can be obtained at:

http://ausrivas.canberra.edu.au/Bioassessment/Macroinvertebrates/Man/Pred/

Methodology

Sampling Dates

Sampling was conducted in the period 12-17 September. There had been a minor fresh in the creeks a few days prior to sampling and flow rates were still decreasing to a relatively steady base flow during the sampling period.

Field Sampling

Sampling followed the protocols outlined in the NSW AUSRIVAS manual (Turak and Waddell, 2002).

At each site three replicate kick samples were obtained in different riffle/edge sections using a standard 250μm sampling net. Attention was paid to ensuring that the full range of substrates including edge substrates, and the range of current velocities represented in the riffle were sampled. Each replicate sample covered approximately 10 square metres of riffle area. The composition of sampled substrates was recorded. Samples were transferred to a bucket and live-picked from a white sorting tray by two experienced persons for at least 60 minutes and in most cases until all visible macroinvertebrates had been picked from the sample. Individual rocks and coarse plant material in the sample were removed first and individually scrubbed to remove animals adhering to them. Forceps, probes and Pasteur pipettes were used to transfer animals from the sample tray to a sampling vial containing methylated spirits and a label detailing site number, date and replicate number.

Invertebrate samples were returned to the laboratory for sorting, identification and data entry.

A photograph was taken of each sampling site and the ambient temperature, pH and salinity at the time of sampling was measured with a portable field meter. Turbidity was estimated using a turbidity tube.

Laboratory procedures

To minimise risks of data corruption individual replicate samples were treated sequentially and sorting, identification and data entry procedures relating to each individual sample were completed prior to commencing work on the next sample.

Samples were transferred bit by bit from the sample vial to a Petri dish and examined under a zoom stereomicroscope. Individual animals were sorted into taxa and identified to family level with the exception of cladocera, collembola, hydracarina, oligochaeta and ostracoda. As each animal was identified it was entered on a tally sheet listing the number of individuals for all families present in the sample. At the completion of each sample the data from the tally sheet was copied into the data entry section of a spreadsheet model which was used to calculate various biotic indices. Specimens from each sample were transferred to a new labelled sample vial for storage.

The primary identification keys used were the web-based Keys to Australian Aquatic Invertebrate Families hosted on the LUCID central web site (http://keys.lucidcentral.org/keys/lwrrdc/public/Aquatics) with reference to supplementary printed keys where necessary.

Data analysis

Data was entered into a spread sheet which calculated the following values for each individual sample:

- Abundance weighted SIGNAL-2 value
- Number of animals
- Number of families
- Shannon Diversity index at family level
- Shannon evenness value

Data was also exported from the spreadsheet in a format suitable for input to AUSRIVAS river health modelling software (AusRivAS Macroinvertebrate Predictive Modelling Ver. 3.1.1, CRCFE/LWA 2003) and the New South Wales spring riffle model was run. Habitat variables necessary for running the appropriate AUSRIVAS macroinvertebrate model included distance from source, slope, mean annual rainfall, latitude and longitude. Where necessary these variables were calculated from externally sourced data.

Results

General

The study processed a total of 7781 animals from 57 identified taxa. The presence and abundance of individual taxa at each sample site are presented in Table 1.

Ubiquitous taxa which were found at all sample sites included flatworms (Dugesiidae), chironomid midge larvae, planorbid snails and scirtid beetle larvae. These ubiquitous taxa accounted for about a quarter of all animals collected. Simuliid and tipulid fly larvae, leptocerid trichopterans and ostracods were all collected at twelve sites and altogether accounted for another thirty percent of animals collected.

The fauna assemblage in 2011 was similar to that in the last annual survey ion 2010. Five families which were collected in 2010 were not detected in 2011, while 11 families collected in 2011were not identified in 2010. None of these taxa were present in large numbers and most were only found at one or two sites.

The values of the various biotic indices from individual replicate samples are tabulated together with site values for AUSRIVAS in Table 2. To facilitate easy comparison the results are also presented graphically in Figure 1.

Combined site values for the biotic indices and AUSRIVAS modelling are presented in Table 3

Raw data from individual samples are presented in Appendix A and tables generated during AUSRIVAS modelling are presented in Appendix B.

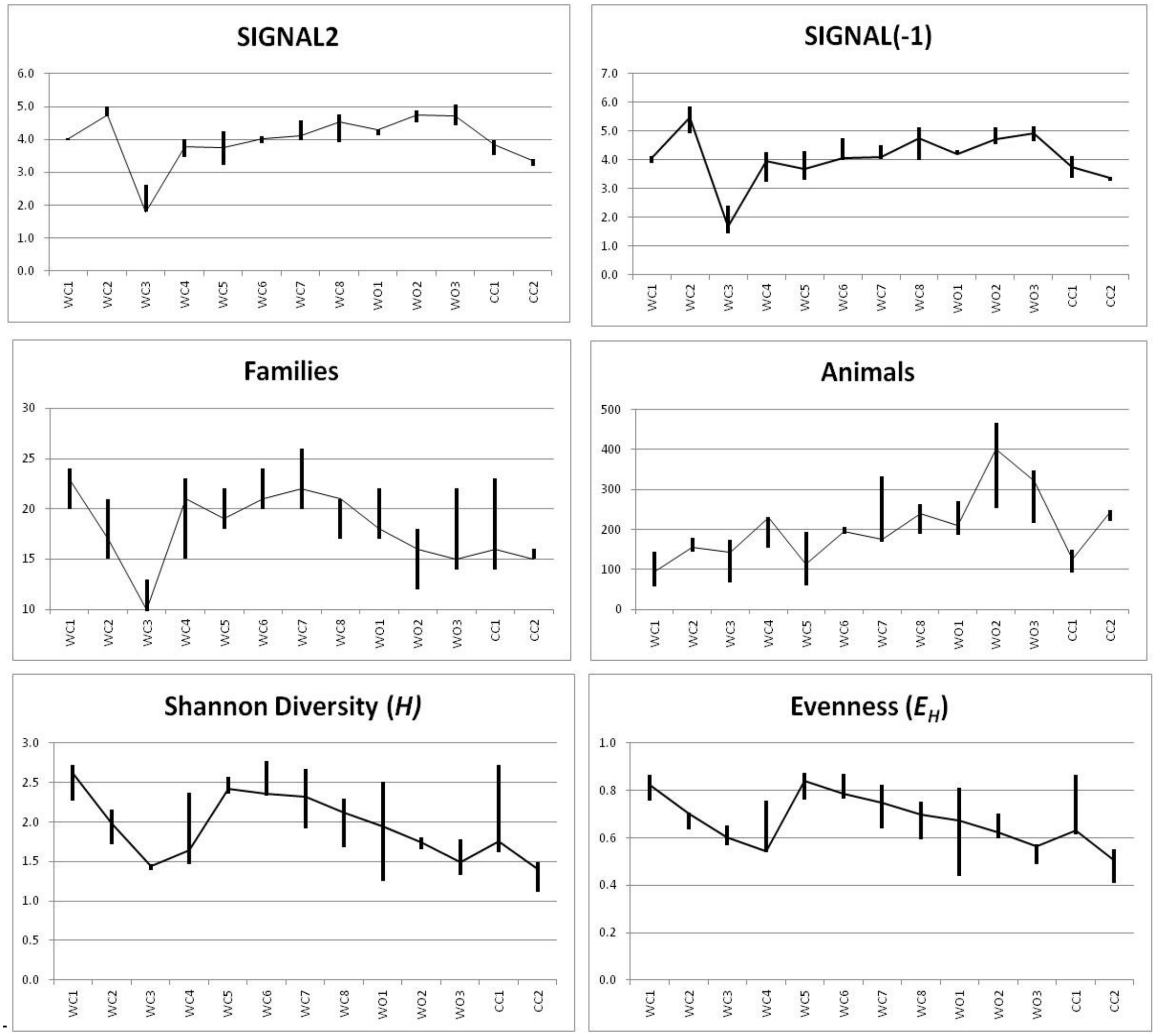
Table 1 Distribution and abundance of invertebrates collected during the study

Family	WC1	WC2	WC3	WC4	WC5	WC6	WC7	WC8	WO1	WO2	WO3	CC1	CC2
Aeshnidae	0	0	0	0	0	0	0	0	0	0	0	0	1
Atyidae	2	41	0	3	25	21	21	13	0	1	19	0	0
Baetidae	1	5	0	9	0	0	0	4	15	297	59	1	0
Caenidae	0	5	0	64	16	41	66	22	37	14	1	2	0
Calamoceratidae	6	81	0	4	18	4	4	5	5	1	0	0	0
Carabidae	0	0	0	1	0	0	0	0	0	0	0	0	0
Ceratopogonidae	8	0	2	7	4	5	0	6	0	1	2	0	3
Chironominae	44	20	14	330	94	100	6	43	130	206	96	61	43
Chrysomelidae	0	0	0	0	0	0	0	1	0	0	0	0	0
Cladocera	0	0	0	0	0	0	0	0	1	0	0	0	0
Coenagrionidae	6	3	0	1	12	12	6	10	1	0	0	0	8
Collembola	0	0	2	0	1	0	1	0	1	0	0	0	1
Copepoda	0	0	0	1	0	0	0	0	0	0	0	0	0
Corduliidae	5	0	0	0	5	0	5	0	0	0	0	2	2
Corixidae	0	0	3	1	4	50	23	12	17	0	0	0	0
Culicidae	0	0	17	1	1	0	0	0	0	0	0	0	0
Curculionidae	0	0	1	0	0	0	0	0	0	0	0	0	0
Dixidae	1	1	0	1	1	2	0	0	1	0	0	0	0
Dolichopodidae	0	0	0	0	0	0	0	0	0	0	0	0	1
Dugesiidae	3	1	3	27	1	5	5	8	4	9	3	20	1
Dytiscidae	13	0	61	9	12	27	6	14	0	0	1	6	4
Ecnomidae	3	12	0	2	5	11	5	6	24	14	28	0	0
Elmidae	0	0	0	0	0	0	2	0	0	1	4	0	0
Empididae	1	0	0	0	0	0	0	0	0	0	0	0	0
Gerridae	0	1	0	0	0	0	0	0	0	0	0	0	0
Gomphidae	9	3	0	0	0	1	9	0	1	0	1	0	0
Gripopterygidae	0	1	0	0	0	0	0	0	0	1	0	0	0
Gyrinidae	0	7	0	0	0	1	3	3	1	2	1	0	0
Glossiphoniidae	0	0	0	0	0	1	0	0	0	0	0	0	0
Hydracarina	1	0	0	5	2	0	3	1	3	0	0	2	0
Hydraenidae	14	2	5	3	6	2	0	0	7	0	0	7	1
Hydrobiosidae	2	0	0	0	0	1	2	0	5	22	27	1	0
Hydrometridae	2	1	0	0	0	0	0	0	0	0	0	0	0
Hydrophilidae	32	5	12	8	12	6	0	5	8	3	0	12	3
Hydropsychidae	5	63	0	0	0	53	124	216	185	353	516	11	0
Hydroptilidae	2	0	0	4	0	1	1	1	0	0	3	0	0
Leptoceridae	16	59	0	12	24	24	29	40	26	16	16	10	16
Leptophlebiidae	4	127	0	4	3	1	0	3	9	1	1	0	0
Libellulidae	6	0	0	5	3	14	6	0	0	0	0	1	5
Lumbriculidae	0	2	1	0	0	0	0	1	33	13	13	0	0
Lymnaeidae	0	0	19	13	1	1	5	2	6	3	1	32	20
Muscidae	0	0	0	0	0	0	0	0	0	0	1	0	0
Notonectidae	1	0	3	2	1	7	0	0	6	0	0	0	0
Ostracoda	5	4	223	12	6	22	78	0	115	25	1	11	370
Palaeomonidae	0	1	0	0	0	1	0	0	0	0	5	0	0
Philopotamidae	0	8	0	0	0	0	0	0	0	0	0	0	0
Planorbidae	13	3	16	22	7	5	21	5	3	3	1	6	9
Pyralidae	0	0	0	0	0	0	1	0	0	0	0	0	0
Sciomyzidae	3	0	0	0	0	0	0	0	0	0	0	0	4
Scirtidae	19	1	2	27	35	67	74	98	15	3	63	6	2
Simuliidae	43	7	0	32	33	50	148	54	6	122	10	267	201
Staphylinidae	0	1	0	0	0	0	0	0	0	0	0	0	0
Stratiomyidae	0	0	0	1	29	2	1	0	0	2	3	2	15
Synlestidae	0	2	0	0	2	0	0	0	0	0	0	2	0
Tabanidae	0	7	0	0	0	1	3	0	0	0	1	0	0
Tipulidae	11	5	1	3	1	8	7	6	2	10	8	1	0
Veliidae	11	0	0	1	2	2	2	1	0	0	1	0	0

Table 2 Values of biotic indicators for individual replicate samples

site	replicate	SIGNAL2	SIGNAL-1	no families	no animals	shannon	evenness
WC1	a	4.0	3.9	24	143	2.6	0.8
WC1	b	4.0	4.0	20	56	2.3	0.8
WC1	c	4.0	4.1	23	93	2.7	0.9
WC2	a	4.7	4.9	17	145	2.0	0.7
WC2	b	4.8	5.9	21	178	2.2	0.7
WC2	c	5.0	5.5	15	156	1.7	0.6
WC3	a	2.6	2.4	9	67	1.4	0.7
WC3	b	1.8	1.4	10	144	1.4	0.6
WC3	c	1.8	1.7	13	174	1.5	0.6
WC4	a	3.8	4.0	21	232	1.6	0.5
WC4	b	3.5	3.2	15	229	1.5	0.5
WC4	c	4.0	4.3	23	153	2.4	0.8
WC5	a	3.2	3.3	19	59	2.6	0.9
WC5	b	4.2	4.3	22	194	2.4	0.8
WC5	c	3.7	3.7	18	113	2.4	0.8
WC6	a	3.8	4.7	24	206	2.8	0.9
WC6	b	4.1	4.1	20	194	2.4	0.8
WC6	c	4.0	4.0	21	190	2.3	0.8
WC7	a	4.6	4.5	20	333	1.9	0.6
WC7	b	4.1	4.0	26	170	2.7	0.8
WC7	c	4.0	4.1	22	175	2.3	0.7
WC8	a	4.8	4.8	17	263	1.7	0.6
WC8	b	3.9	4.0	21	188	2.3	0.8
WC8	c	4.5	5.1	21	240	2.1	0.7
WO1	a	4.1	4.2	18	271	1.9	0.7
WO1	b	4.3	4.3	22	187	2.5	0.8
WO1	c	4.3	4.2	17	209	1.2	0.4
WO2	a	4.5	4.5	18	468	1.8	0.6
WO2	b	4.9	5.1	16	401	1.7	0.6
WO2	c	4.7	4.7	12	254	1.7	0.7
WO3	a	5.1	5.2	15	322	1.3	0.5
WO3	b	4.4	4.6	14	217	1.5	0.6
WO3	c	4.7	4.9	22	347	1.8	0.6
CC1	a	3.5	3.4	16	150	1.8	0.6
CC1	b	3.8	3.8	14	126	1.6	0.6
CC1	c	4.0	4.1	23	93	2.7	0.9
CC2	a	3.3	3.4	15	220	1.1	0.4
CC2	b	3.4	3.3	15	248	1.5	0.6
CC2	c	3.2	3.4	16	242	1.4	0.5

-Figure 1. Median values (represented by line) and range (high and low values at extremities of bar) of replicate samples



-

Indicator values calculated from the total collection at each site are presented in Table 3.

Table 3 Combined site values for environmental quality indicators at Wilpinjong invertebrate sample sites

Site	Taxa	Animals	SIGNAL2	SIGNAL(-1)	Shannon *H'*	E_H	AUSRIVAS OE50	AUSRIVAS BAND
WC1	29	270	4.4	4.0	2.9	0.84	0.49	B (0.44-0.8)
WC2	28	467	4.8	4.9	2.4	0.69	0.49	B (0.44-0.8)
WC3	16	384	2.1	2.0	1.6	0.55	0.17	C (0.06-0.43)
WC4	29	611	3.8	3.8	2.0	0.57	0.35	C (0.06-0.43)
WC5	28	363	3.8	3.7	2.7	0.79	0.27	C (0.06-0.43)
WC6	29	537	3.8	3.7	2.7	0.79	0.36	C (0.06-0.43)
WC7	27	655	4.0	4.1	2.5	0.72	0.36	C (0.06-0.43)
WC8	24	573	4.1	4.3	2.2	0.68	0.55	B (0.44-0.8)
CC1	27	665	4.1	4.6	2.2	0.67	0.46	B (0.44-0.8)
CC2	23	1113	4.6	4.9	1.9	0.58	0.09	C (0.06-0.43)
WO1	25	876	4.5	4.7	1.5	0.45	0.6	B (0.44-0.8)
WO2	20	462	3.7	3.9	1.6	0.54	0.60	B (0.44-0.8)
WO3	20	710	3.1	3.2	1.5	0.49	0.55	B (0.44-0.8)

Water Quality and Stream Conditions

During the sampling period local streams had a moderate flow declining to a fairly steady base flow over the sampling period. This flow followed approximately 30mm of rainfall from 18-20 August and 27mm of rain on 9-10 September.

Table 4 presents water quality data collected simultaneously with invertebrate sampling. Electrical conductivity and pH were highest in Cumbo Creek and Wollar creek downstream of the junction with Cumbo Creek.

Table 4 Values for water quality parameters measured at sampling sites, September 12th-17th 2011

site	date	time	Temp(˚C)	pH(units)	EC(µS/cm)	Turbidity (NTU)
WC1	17.09.11	1200	26.2	6.5	1210	<10NTU
WC2	16.09.11	1430	19.4	7.2	970	<10NTU
WC3	16.09.11	1300	21.7	7.4	1250	<10NTU
WC4	15.09.11	1615	14.1	7.8	2090	<10NTU
WC5	14.09.11	1630	19.2	8.2	3920	<10NTU
WC6	14.09.11	1230	14.7	8	3340	<10NTU
WC7	14.09.11	0910	9.1	8.3	3310	<10NTU
WC8	13.09.11	1500	12.6	7.6	3190	<10NTU
WO1	12.09.11	1400	14.7	7.7	1320	<10NTU
WO2	12.09.11	1000	11.7	7.3	1210	<10NTU
WO3	13.09.11	930	9.0	7.5	2160	<10NTU
CC1	15.09.11	1130	11.1	7.9	3370	<10NTU
CC2	15.09.11	1400	13.0	8.0	3700	<10NTU

Discussion

Wilpinjong Creek, Cumbo Creek and Wollar Creek are all significantly degraded ecosystems which have been adversely affected by loss of riparian vegetation, physical damage to banks, and erosion of watersheds over a long period. Both the SIGNAL 2 and AUSRIVAS analyses indicate that all sites have at least "significantly" impaired environmental conditions with some sites being "severely" impaired. Taxon richness and values for Shannon diversity and evenness generally support the findings of the abovementioned indices.

The inclusion of site WO3 in the 2011 survey improves the overall value of the monitoring program. Previously there was no site to assess the potential impacts of inflow from Wilpinjong Creek on the receiving stream Wollar Creek. Initial results suggest a minor, barely discernible, impact on environmental quality in Wollar Creek as a result of the Wilpinjong Creek discharge.

The indices are consistent at identifying sites with the best and worst environmental quality. Sites WC1 and WC2 (upper Wilpinjong Creek), Site WC8 (lower Wilpinjong Creek) and the three Wollar Creek sites are the least impaired according to both SIGNAL and AUSRIVAS results. Sites WC3 and CC2 stand out in both SIGNAL and AUSRIVAS as the most degraded sites.

Sites WC3 and CC2 are probably the most physically degraded habitats of all sites and it is difficult to evaluate how much of the degradation to attribute to physical habitat degradation and how much to chemical water quality issues. In Wilpinjong Creek there appears to be little correlation between the measured chemical water quality parameters and biological indicators of environmental quality. The chemical environment at site WC3, where the macroinvertebrate community is severely impaired, appears to be relatively benign with near neutral pH and relatively low salinity. The biotic indices indicate a general improvement in environmental quality downstream of site WC3 in the middle reaches of Wilpinjong Creek (WC5, WC6, WC 7) although these sites were the ones where pH and electrical conductivity values were highest.

The marked loss of taxa and drop in SIGNAL value at site WC3 suggests that other unmonitored chemical factors may be impacting this site. Alternatively the results might simply reflect the extreme degree of physical degradation. Future surveys should relocate this sampling site to the closest accessible downstream point at which habitat degradation is not so extreme.

The SIGNAL2 index is often interpreted with the aid of a biplot quadrant diagram which helps to place the results in context to the local biogeography. The use of the quadrant biplot is discussed in the SIGNAL2 manual which can be accessed at:

(http://www.environment.gov.au/water/publications/environmental/rivers/nrhp/signal.html

In order to accurately set the quadrant boundaries for the biplot it is necessary to have data from undisturbed habitat and no such sites were sampled for the current survey. Fortunately the example biplot quadrant in the SIGNAL manual is based on sites in the upper Macquarie River catchment which is adjacent to the Wollar Creek catchment on the opposite side of the Great Divide. Based on the assumption that quadrant boundaries in neighbouring catchments on either side of the divide will be similar the quadrant boundaries from the SIGNAL manual have been applied to the biplot of site data shown in Figure 2.

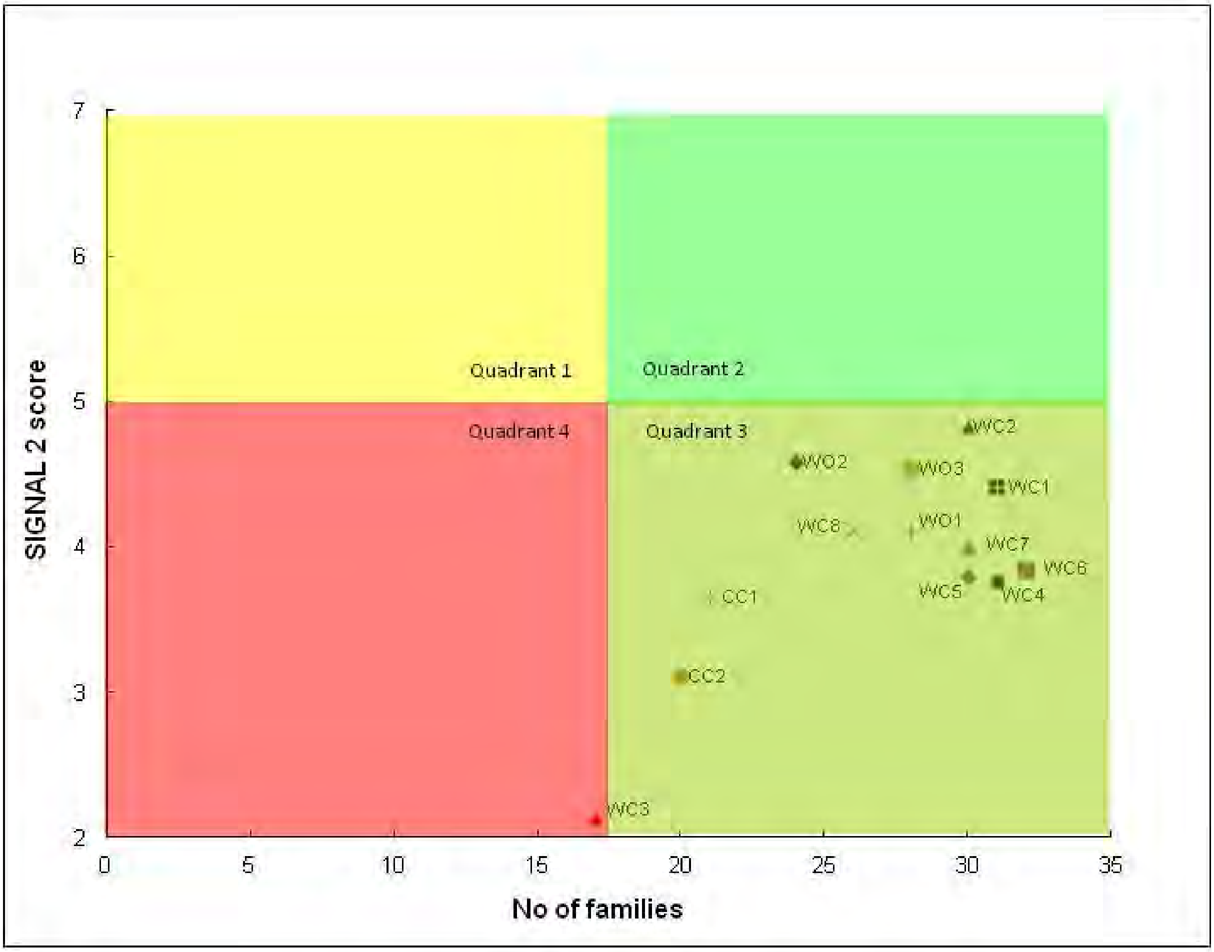


Figure 2 SIGNAL2 quadrant diagram showing 2011 sampling results (combined site values)

With the exception of site WC3 all the sample sites fit within Quadrant 2 (lower right quadrant) of the diagram. This quadrant generally indicates the presence of environmental stressors such as elevated levels of turbidity, salinity or nutrients. Relatively low SIGNAL score indicates that the extremely sensitive taxa found in pristine environments do not make up a large proportion of the assemblage. The number of families present is still quite high however, suggesting that acutely toxic chemicals or depressed oxygen concentrations are not likely to be an issue.

Site WC3 falls just inside quadrant 4. Sites placed in this quadrant are often subject to urban pollution or downstream effects from point sources of organic pollution or dams. None of the above factors would apply to this site. With the exception of planorbid snails all the taxa present at the site have Chessman sensitivity ratings of 5 or below i.e. the fauna is composed almost entirely of pollution tolerant animals. The habitat at this site is extremely degraded and it is recommended that future sampling for this site should be carried out at the nearest available location with a more defined flow channel.

Comparison of 2010 and 2011 results

2010 was an extremely wet year with rainfall for the months January to August being 1.5 times the long term average. In contrast the early part of 2011 was drier than normal with January-August rainfall total being 63 % of the long term average for these months. Resultant differences in flow regime during the winter months preceding sampling are illustrated below in Figure 3.

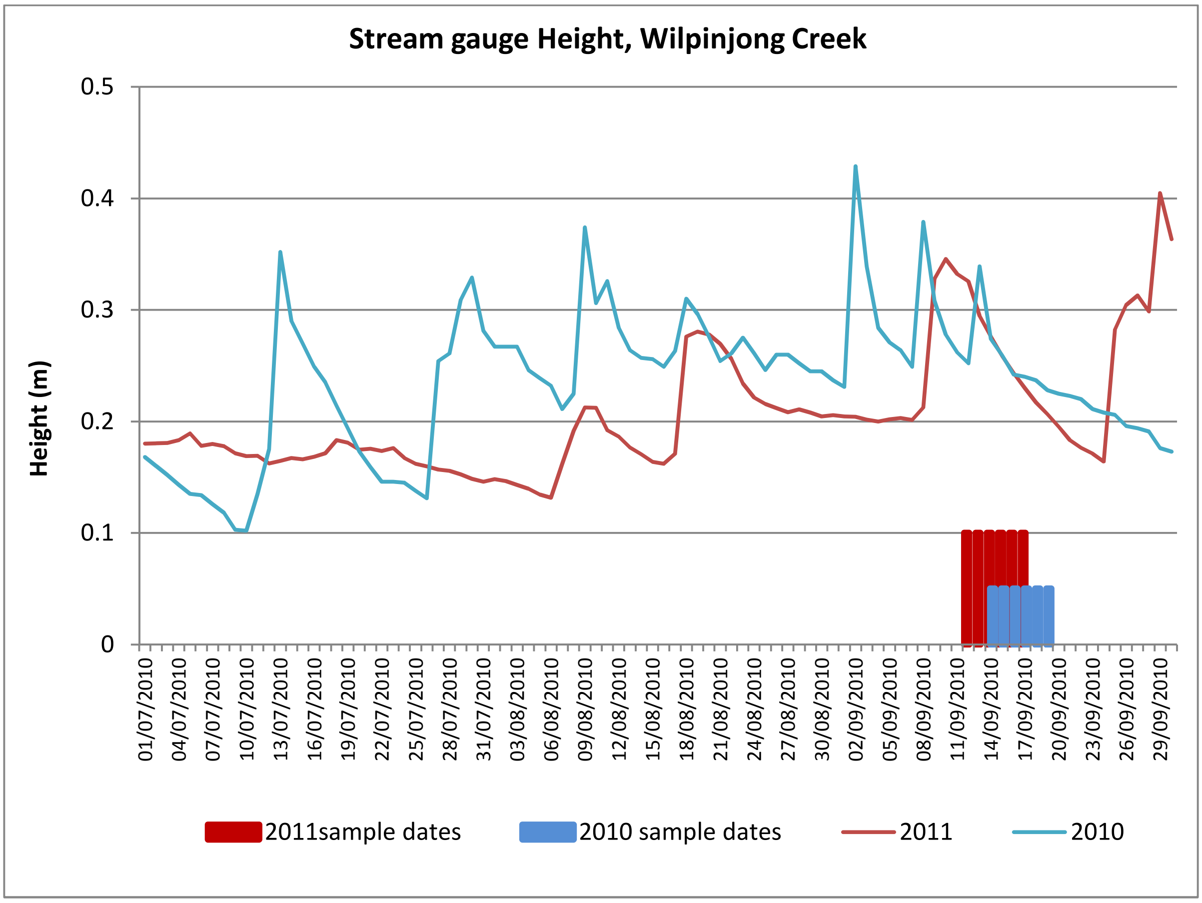


Figure 3 Comparison of stream flow conditions in Wilpinjong Creek for months July –September in 2010 and 2011

Chemical and biological results from the two years are compared in Figure 4 and reflect the differing flow patterns between the two years. In 2010 high flows were sustained over a long period and values for electrical conductivity, pH and the SIGNAL2 biotic index were generally lower with less variability between sites than in 2011 (Figure 4).

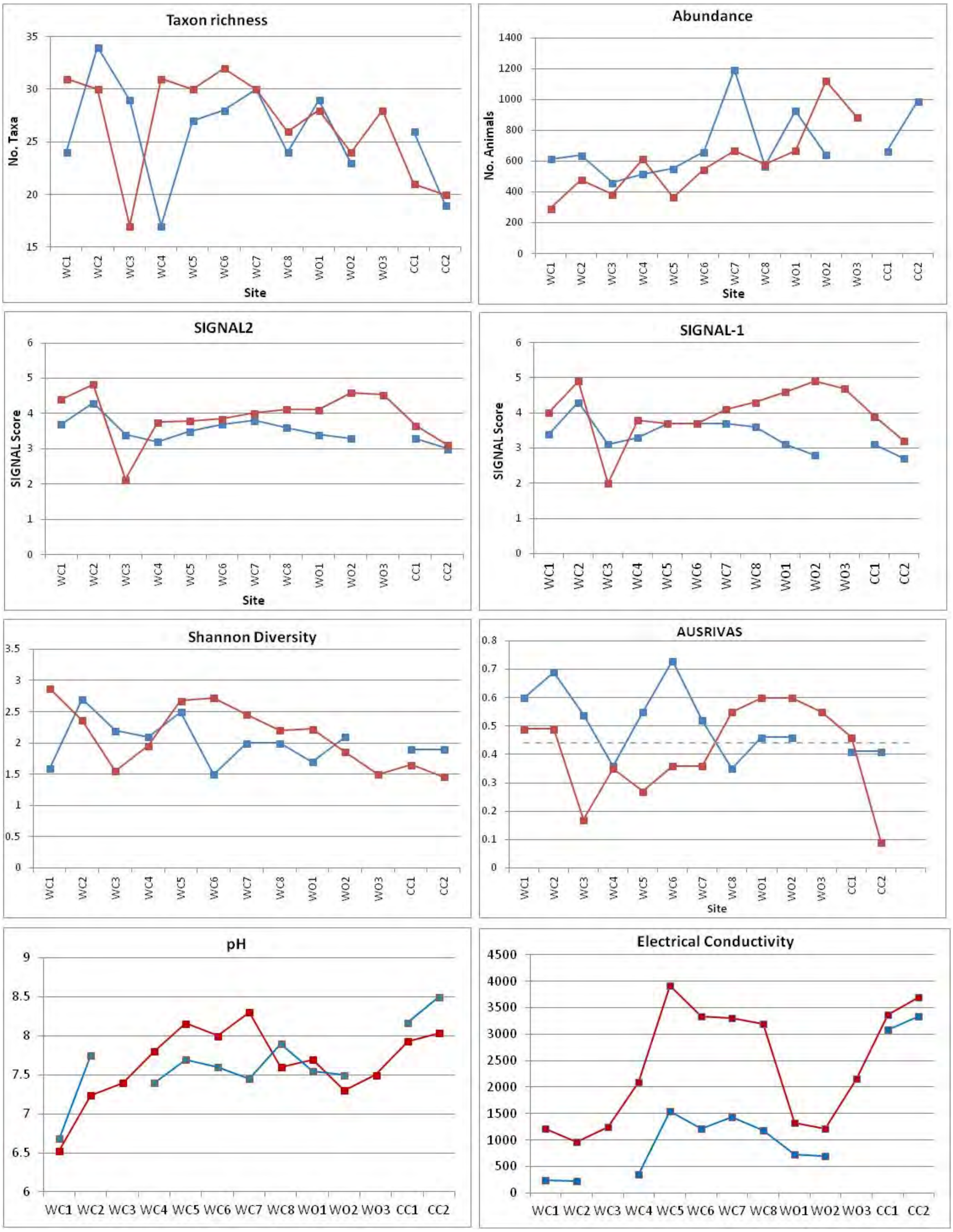


Figure 4 Comparison between selected chemical parameter and bioindicator site values in 2010 (blue series) and 2011 (red series).

Figure 4 also illustrates a number of common trends evident in the data from both years. In Wilpinjong Creek there was a general downstream trend towards reduced taxon richness and diversity and increase in number of animals per sample.

It is noteworthy that, in the current survey, site WC4 exhibited taxon richness and SIGNAL values very similar to the nearby downstream sites SW5 and SW6. Contrastingly, in the 2010 survey WC4 exhibited low index values and depauperate fauna and was located inside quadrant 4 of the SIGNAL 2 quadrant diagram. The 2010 results for WC4 were therefore very similar to the 2011 results for WC3. There is no immediately obvious explanation for the apparent transfer of environmental impairment between these two sites. Nonetheless in both years the data suggest a possible toxic influence in the middle reaches of Wilpinjong Creek above the confluence with Cumbo Creek which is followed by a downstream improvement in environmental quality. Moving the location of site WC3 to a more representative type of habitat as suggested above could help elucidate this issue.

References

Bio- Analysis Pty Ltd (2009). Macroinvertebrate and water quality (stream health) monitoring for Wilpinjong Creek and Cumbo Creek - Spring 2009. Unpublished Report prepared for Wilpinjong Coal Pty Ltd.

Chessman, B. C. (2003) SIGNAL 2.iv – A Scoring System for Macroinvertebrates ('Water Bugs') in Australian Rivers. User Manual. Monitoring River Health Initiative Technical Report Number 31. Dept Environment and Heritage , Canberra.

Peabody Pacific Pty Ltd (2010). Annual Environmental Management Report 1 January 2009 - 31 December 2009. Peabody Pacific Pty Ltd.

Turak, E, and Waddell,N. (2002) Australia-Wide Assessment of River Health: New South Wales AusRivAS Sampling and Processing Manual. Monitoring River Health Initiative Technical Report Number 13. Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Wilpinjong Coal Pty Ltd (2006). Surface Water Management and Monitoring Plan. Wilpinjong Coal Pty Ltd

Malcolm MacKinnon

Landline Consulting

APPENDIX A

SAMPLE DATA SHEETS

Sample Site	**WC1A**	**Indicator Values**	
Date sampled	**17-Sep-11**	**SIGNAL 2**	**4.0**
Replicate No.	1	**No.of families**	**24**
		No.of animals	**143**
		Shannon H	**2.6**
		EH	**0.82**

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensitiv. grade	weight factor	Grade*Weight	Value	Pi	Pi.Ln(Pi)
Acarina	Hydracarina		1	0					1	*6*	*1*	6	0.09	0.007	-0.03
Coleoptera	Dytiscidae	*adults3 larvae2*	5		0				5	*2*	*2*	4	0.06	0.035	-0.12
Coleoptera	Hydraenidae	*adult*	9			0			9	*3*	*3*	9	0.13	0.063	-0.17
Coleoptera	Hydrophilidae	*adult*	12				0		12	*2*	*4*	8	0.12	0.084	-0.21
Coleoptera	Scirtidae	*larvae*	14				0		14	*6*	*4*	24	0.36	0.098	-0.23
Decapoda	Atyidae		2	0					2	*3*	*1*	3	0.04	0.014	-0.06
Diptera	Ceratopogonidae		3		0				3	*4*	*2*	8	0.12	0.021	-0.08
Diptera	Chironominae		29					0	29	*3*	*5*	15	0.22	0.203	-0.32
Diptera	Dixidae		1	0					1	*7*	*1*	7	0.10	0.007	-0.03
Diptera	Sciomyzidae		1	0					1	*2*	*1*	2	0.03	0.007	-0.03
Diptera	Simuliidae		23					0	23	*5*	*5*	25	0.37	0.161	-0.29
Diptera	Tipulidae		9			0			9	*5*	*3*	15	0.22	0.063	-0.17
Ephemeroptera	Leptophlebiidae		2	0					2	*8*	*1*	8	0.12	0.014	-0.06
Gastropoda	Planorbidae		6			0			6	*2*	*3*	6	0.09	0.042	-0.13
Hemiptera	Hydrometridae		2	0					2	*3*	*1*	3	0.04	0.014	-0.06
Hemiptera	Veliidae		8			0			8	*3*	*3*	9	0.13	0.06	-0.16
Odonata	Coenagrionidae		1	0					1	*2*	*1*	2	0.03	0.01	-0.03
Odonata	Corduliidae		1	0					1	*5*	*1*	5	0.07	0.01	-0.03
Odonata	Gomphidae		1	0					1	*5*	*1*	5	0.07	0.01	-0.03
Ostracoda	Ostracoda		4		0									0.03	-0.10
Trichoptera	Ecnomidae		1	0					1	*4*	*1*	4	0.06	0.01	-0.03
Trichoptera	Hydrobiosidae		1	0					1	*8*	*1*	8	0.12	0.01	-0.03
Trichoptera	Hydroptilidae		1	0					1	*4*	*1*	4	0.06	0.01	-0.03
Trichoptera	Leptoceridae		6			0			6	*6*	*3*	18	0.27	0.04	-0.13

Sample Site	**WC1B**	**SIGNAL 2**	**4.0**
Date sampled	**17-Sep-11**	**No.of families**	**20**
Replicate No.	2	**No.of animals**	**56**
		Shannon H	**2.3**
		EH	**0.76**

Indicator Values

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensitiv. grade	weight factor	Grade*Weight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Dytiscidae	*adult*	4		0				4	*2*	*2*	4	0.06	0.071	-0.19
Coleoptera	Hydraenidae	*adult*	3		0				3	*3*	*2*	6	0.09	0.054	-0.16
Coleoptera	Hydrophilidae	*adult*	9			0			9	*2*	*3*	6	0.09	0.161	-0.29
Coleoptera	Scirtidae	*larvae*	3		0				3	*6*	*2*	12	0.18	0.054	-0.16
Diptera	Ceratopogonidae		4		0				4	*4*	*2*	8	0.12	0.071	-0.19
Diptera	Chironominae		1	0					1	*3*	*1*	3	0.04	0.018	-0.07
Diptera	Empididae		1	0					1	*5*	*1*	5	0.07	0.018	-0.07
Diptera	Simuliidae		11				0		11	*5*	*4*	20	0.30	0.196	-0.32
Diptera	Tipulidae		1	0					1	*5*	*1*	5	0.07	0.018	-0.07
Gastropoda	Planorbidae		3		0				3	*2*	*2*	4	0.06	0.054	-0.16
Hemiptera	Veliidae		2	0					2	*3*	*1*	3	0.04	0.036	-0.12
Odonata	Corduliidae		1	0					1	*5*	*1*	5	0.07	0.018	-0.07
Odonata	Gomphidae		2	0					2	*5*	*1*	5	0.07	0.01	-0.06
Odonata	Libellulidae		3		0				3	*4*	*2*	8	0.12	0.02	-0.08
Ostracoda	Ostracoda		1	0										0.01	-0.03
Trichoptera	Calamoceratidae		2	0					2	*7*	*1*	7	0.10	0.01	-0.06
Trichoptera	Hydrobiosidae		1	0					1	*8*	*1*	8	0.12	0.01	-0.03
Trichoptera	Hydroptilidae		1	0					1	*4*	*1*	4	0.06	0.01	-0.03
Trichoptera	Leptoceridae		2	0					2	*6*	*1*	6	0.09	0.01	-0.06
Turbellaria	Dugesiidae		1	0					1	*2*	*1*	2	0.03	0.01	-0.03

Sample Site	**WC1C**	**Indicator Values**	
Date sampled	**17-Sep-11**	**SIGNAL 2**	**4.0**
Replicate No.	3	**No.of families**	**23**
		No.of animals	**93**
		Shannon H	**2.7**
		EH	**0.87**

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensitiv. grade	weight factor	Grade*Weight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Dytiscidae	*adult*	4		0				4	*2*	*2*	4	0.06	0.043	-0.14
Coleoptera	Hydraenidae	*adult*	2	0					2	*3*	*1*	3	0.04	0.022	-0.08
Coleoptera	Hydrophilidae	*adult*	11				0		11	*2*	*4*	8	0.12	0.118	-0.25
Coleoptera	Scirtidae	*adult*	2	0					2	*6*	*1*	6	0.09	0.022	-0.08
Diptera	Ceratopogonidae		1	0					1	*4*	*1*	4	0.06	0.011	-0.05
Diptera	Chironominae		14				0		14	*3*	*4*	12	0.18	0.151	-0.29
Diptera	Sciomyzidae		2	0					2	*2*	*1*	2	0.03	0.022	-0.08
Diptera	Simuliidae		9			0			9	*5*	*3*	15	0.22	0.097	-0.23
Diptera	Tipulidae		1	0					1	*5*	*1*	5	0.07	0.011	-0.05
Ephemeroptera	Baetidae		1	0					1	*5*	*1*	5	0.07	0.011	-0.05
Ephemeroptera	Leptophlebiidae		2	0					2	*8*	*1*	8	0.12	0.022	-0.08
Gastropoda	Planorbidae		4		0				4	*2*	*2*	4	0.06	0.043	-0.14
Hemiptera	Notonectidae		1	0					1	*1*	*1*	1	0.01	0.011	-0.05
Hemiptera	Veliidae		1	0					1	*3*	*1*	3	0.04	0.011	-0.05
Odonata	Coenagrionidae		5		0				5	*2*	*2*	4	0.06	0.054	-0.16
Odonata	Corduliidae		3		0				3	*5*	*2*	10	0.15	0.032	-0.11
Odonata	Gomphidae		6			0			6	*5*	*3*	15	0.22	0.065	-0.18
Odonata	Libellulidae		3		0				3	*4*	*2*	8	0.12	0.032	-0.11
Trichoptera	Calamoceratidae		4		0				4	*7*	*2*	14	0.21	0.043	-0.14
Trichoptera	Ecnomidae		2	0					2	*4*	*1*	4	0.06	0.022	-0.08
Trichoptera	Hydropsychidae		5		0				5	*6*	*2*	12	0.18	0.03	-0.12
Trichoptera	Leptoceridae		8			0			8	*6*	*3*	18	0.27	0.06	-0.16
Turbellaria	Dugesiidae		2	0					2	*2*	*1*	2	0.03	0.01	-0.06

Sample Site	**WC2**	**Indicator Values**	
Date sampled	**16-Sep-11**	**SIGNAL 2**	**4.7**
Replicate No.	1	**No.of families**	**17**
		No.of animals	**145**
		Shannon H	**2.0**
		EH	**0.70**

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensiti grade	weight factor	Grade*Weight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Hydraenidae	*adult*	1	0					1	*3*	*1*	3	0.10	0.007	-0.03
Coleoptera	Hydrophilidae	*adult*	5		0				5	*2*	*2*	4	0.14	0.034	-0.12
Coleoptera	Staphylinidae	*adult*	1	0					1	*3*	*1*	3	0.10	0.007	-0.03
Decapoda	Atyidae		33					0	33	*3*	*5*	15	0.52	0.228	-0.34
Diptera	Chironominae		6			0			6	*3*	*3*	9	0.31	0.041	-0.13
Diptera	Dixidae		1	0					1	*7*	*1*	7	0.24	0.007	-0.03
Ephemeroptera	Caenidae		2	0					2	*4*	*1*	4	0.14	0.014	-0.06
Ephemeroptera	Leptophlebiidae		13				0		13	*8*	*4*	32	1.10	0.090	-0.22
Gastropoda	Planorbidae		1	0					1	*2*	*1*	2	0.07	0.007	-0.03
Odonata	Coenagrionidae		3		0				3	*2*	*2*	4	0.14	0.021	-0.08
Odonata	Gomphidae		1	0					1	*5*	*1*	5	0.17	0.007	-0.03
Ostracoda	Ostracoda		1	0										0.007	-0.03
Trichoptera	Calamoceratidae		32					0	32	*7*	*5*	35	1.21	0.221	-0.33
Trichoptera	Ecnomidae		2	0					2	*4*	*1*	4	0.14	0.014	-0.06
Trichoptera	Hydropsychidae		2	0					2	*6*	*1*	6	0.21	0.014	-0.06
Trichoptera	Leptoceridae		40					0	40	*6*	*5*	30	1.03	0.276	-0.36
Turbellaria	Dugesiidae		1	0					1	*2*	*1*	2	0.07	0.007	-0.03

Sample Site	**WC2**	**SIGNAL 2**	**5.3**
Date sampled	**16-Sep-11**	**No.of families**	**21**
Replicate No.	2	**No.of animals**	**178**
		Shannon H	**2.2**
		EH	**0.71**

Indicator Values

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensiti grade	weight factor	Grade*Weight		Pi	Pi.Ln(Pi)
Coleoptera	Gyrinidae	*adult*	6			0			6	*4*	*3*	12	0.41	0.034	-0.11
Coleoptera	Hydraenidae	*adult*	1	0					1	*3*	*1*	3	0.10	0.006	-0.03
Decapoda	Palaeomonidae		1	0					1	*4*	*1*	4	0.14	0.006	-0.03
Diptera	Chironominae		14				0		14	*3*	*4*	12	0.41	0.079	-0.20
Diptera	Simuliidae		5		0				5	*5*	*2*	10	0.34	0.028	-0.10
Diptera	Tabanidae		4		0				4	*3*	*2*	6	0.21	0.022	-0.09
Diptera	Tipulidae		1	0					1	*5*	*1*	5	0.17	0.006	-0.03
Ephemeroptera	Baetidae		2	0					2	*5*	*1*	5	0.17	0.011	-0.05
Ephemeroptera	Caenidae		3		0				3	*4*	*2*	8	0.28	0.017	-0.07
Ephemeroptera	Leptophlebiidae		57					0	57	*8*	*5*	40	1.38	0.320	-0.36
Gastropoda	Planorbidae		1	0					1	*2*	*1*	2	0.07	0.006	-0.03
Hemiptera	Gerridae		1	0					1	*4*	*1*	4	0.14	0.006	-0.03
Hemiptera	Hydrometridae		1	0					1	*3*	*1*	3	0.10	0.006	-0.03
Odonata	Gomphidae		2	0					2	*5*	*1*	5	0.17	0.011	-0.05
Odonata	Synlestidae		2	0					2	*7*	*1*	7	0.24	0.011	-0.05
Oligachaeta	Lumbriculidae		1	0					1	*3*	*1*	3	0.10	0.006	-0.03
Ostracoda	Ostracoda		3		0									0.017	-0.07
Trichoptera	Calamoceratidae		45					0	45	*7*	*5*	35	1.21	0.253	-0.35
Trichoptera	Hydropsychidae		5		0				5	*6*	*2*	12	0.41	0.028	-0.10
Trichoptera	Leptoceridae		15				0		15	*6*	*4*	24	0.83	0.084	-0.21
Trichoptera	Philopotamidae		8			0			8	*8*	*3*	24	0.83	0.045	-0.14

Sample Site	**WC2**		
Date sampled	**16-Sep-11**		
Replicate No.	3		

Indicator Values

SIGNAL 2	**5.3**
No.of families	**15**
No.of animals	**156**
Shannon H	**1.7**
EH	**0.63**

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensiti grade	weight factor	Grade*Weight		Pi	Pi.Ln(Pi)
Coleoptera	Gyrinidae	*larvae*	1	0					1	*4*	*1*	4	0.14	0.006	-0.03
Coleoptera	Scirtidae	*larvae*	1	0					1	*6*	*1*	6	0.21	0.006	-0.03
Decapoda	Atyidae		8			0			8	*3*	*3*	9	0.31	0.051	-0.15
Diptera	Simuliidae		2	0					2	*5*	*1*	5	0.17	0.013	-0.06
Diptera	Tabanidae		3		0				3	*3*	*2*	6	0.21	0.019	-0.08
Diptera	Tipulidae		4		0				4	*5*	*2*	10	0.34	0.026	-0.09
Ephemeroptera	Baetidae		3		0				3	*5*	*2*	10	0.34	0.019	-0.08
Ephemeroptera	Leptophlebiidae		57					0	57	*8*	*5*	40	1.38	0.365	-0.37
Gastropoda	Planorbidae		1	0					1	*2*	*1*	2	0.07	0.006	-0.03
Oligochaeta	Lumbriculidae		1	0					1	*3*	*1*	3	0.10	0.006	-0.03
Plecoptera	Gripopterygidae		1	0					1	*8*	*1*	8	0.28	0.006	-0.03
Trichoptera	Calamoceratidae		4		0				4	*7*	*2*	14	0.48	0.026	-0.09
Trichoptera	Ecnomidae		10			0			10	*4*	*3*	12	0.41	0.064	-0.18
Trichoptera	Hydropsychidae		56					0	56	*6*	*5*	30	1.03	0.359	-0.37
Trichoptera	Leptoceridae		4		0				4	*6*	*2*	12	0.41	0.026	-0.09

Sample Site	**WC3A**										**Indicator Values**		**SIGNAL 2**		**2.6**
Date sampled	**16-Sep-11**												**No.of families**		**9**
Replicate No.	1												**No.of animals**		**67**
													Shannon H		**1.4**
														E_H	**0.65**
				Abundance grade						Sensiti	weight	Grade*W			
Order	Family	Type	Count	1	2	3	4	5		grade	factor	eight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Dytiscidae	*adult1 larvae3*	4		0				4	*2*	*2*	4	0.31	0.060	-0.17
Coleoptera	Hydraenidae	*adult*	5		0				5	*3*	*2*	6	0.46	0.075	-0.19
Coleoptera	Hydrophilidae	*adult*	5		0				5	*2*	*2*	4	0.31	0.075	-0.19
Coleoptera	Scirtidae	*larvae*	2	0					2	*6*	*1*	6	0.46	0.030	-0.10
Diptera	Chironominae		2	0					2	*3*	*1*	3	0.23	0.030	-0.10
Diptera	Tipulidae		1	0					1	*5*	*1*	5	0.38	0.015	-0.06
Gastropoda	Lymnaeidae		4		0				4	*1*	*2*	2	0.15	0.060	-0.17
Gastropoda	Planorbidae		3		0				3	*2*	*2*	4	0.31	0.045	-0.14
Ostracoda	Ostracoda		41					0						0.612	-0.30

Sample Site	**WC3B**										**Indicator Values**			**SIGNAL 2**		**1.8**
Date sampled	**16-Sep-11**													**No.of families**		**10**
Replicate No.	2													**No.of animals**		**144**
														Shannon H		**1.4**
															E_H	**0.60**
				Abundance grade						Sensiti	weight	Grade*W				
Order	Family	Type	Count	1	2	3	4	5		grade	factor	eight	Value		Pi	Pi.Ln(Pi)
Coleoptera	Dytiscidae	*adult1 larvae32*	33					0	33	*2*	*5*	10	0.77		0.229	-0.34
Coleoptera	Hydrophilidae	*adult*	3		0				3	*2*	*2*	4	0.31		0.021	-0.08
Collembola	Collembola		2	0					2	*1*	*1*	1	0.08		0.014	-0.06
Diptera	Chironominae		9			0			9	*3*	*3*	9	0.69		0.063	-0.17
Diptera	Culicidae		4		0				4	*1*	*2*	2	0.15		0.028	-0.10
Gastropoda	Lymnaeidae		8			0			8	*1*	*3*	3	0.23		0.056	-0.16
Gasropoda	Planorbidae		3		0				3	*2*	*2*	4	0.31		0.021	-0.08
Hemiptera	Corixidae		1	0					1	*2*	*1*	2	0.15		0.007	-0.03
Hemiptera	Notonectidae		1	0					1	*1*	*1*	1	0.08		0.007	-0.03
Ostracoda	Ostracoda		80					0							0.556	-0.33

Sample Site	**WC3C**		
Date sampled	**3-Jan-00**		
Replicate No.	3		

Indicator Values

SIGNAL 2	**1.8**
No.of families	**13**
No.of animals	**174**
Shannon H	**1.5**
E_H	**0.57**

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensiti grade	weight factor	Grade*W eight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Curculionidae		1	0					1	*2*	*1*	2	0.15	0.006	-0.03
Coleoptera	Dytiscidae	*adult2 larvae22*	24					0	24	*2*	*5*	10	0.77	0.138	-0.27
Coleoptera	Hydrophilidae	*adult*	4		0				4	*2*	*2*	4	0.31	0.023	-0.09
Diptera	Ceratopogonidae		2												
Diptera	Chironominae		3		0				3	*3*	*2*	6	0.46	0.017	-0.07
Diptera	Culicidae		13				0		13	*1*	*4*	4	0.31	0.075	-0.19
Gastropoda	Lymnaeidae		7			0			7	*1*	*3*	3	0.23	0.040	-0.13
Gastropoda	Planorbidae		10			0			10	*2*	*3*	6	0.46	0.057	-0.16
Hemiptera	Corixidae		2	0					2	*2*	*1*	2	0.15	0.011	-0.05
Hemiptera	Notonectidae		2	0					2	*1*	*1*	1	0.08	0.011	-0.05
Oligochaeta	Lumbriculidae		1	0					1	*3*	*1*	3	0.23	0.006	-0.03
Ostracoda	Ostracoda		102					0						0.586	-0.31
Turbellaria	Dugesiidae		3		0				3	*2*	*2*	4	0.31	0.017	-0.07

Sample Site	**WC4A**										**Indicator Values**		**SIGNAL 2**		**3.8**
Date sampled	**15-Sep-11**												**No.of families**		**21**
Replicate No.	1												**No.of animals**		**232**
													Shannon H		**1.6**
														E_H	**0.54**
				Abundance grade						Sensitivity grade	weight factor	Grade*Weight			
Order	Family	Type	Count	1	2	3	4	5					Value	Pi	Pi.Ln(Pi)
Acarina	Hydracarina		1	0					1	*6*	*1*	6	0.18	0.004	-0.02
Coleoptera	Carabidae	*adult*	1	0					1	*3*	*1*	3	0.09	0.004	-0.02
Coleoptera	Dytiscidae	*adult2 larvae2*	4		0				4	*2*	*2*	4	0.12	0.017	-0.07
Coleoptera	Hydraenidae	*adult*	2	0					2	*3*	*1*	3	0.09	0.009	-0.04
Coleoptera	Hydrophilidae	*adult*	2	0					2	*2*	*1*	2	0.06	0.009	-0.04
Coleoptera	Scirtidae	*larvae*	2	0					2	*6*	*1*	6	0.18	0.009	-0.04
Copepoda	Copepoda		1	0										0.004	-0.02
Diptera	Ceratopogonidae		6			0			6	*4*	*3*	12	0.35	0.026	-0.09
Diptera	Chironominae		128					0	128	*3*	*5*	15	0.44	0.552	-0.33
Diptera	Culicidae		1	0					1	*1*	*1*	1	0.03	0.004	-0.02
Diptera	Simuliidae		11				0		11	*5*	*4*	20	0.59	0.047	-0.14
Diptera	Tipulidae		2	0					2	*5*	*1*	5	0.15	0.009	-0.04
Ephemeroptera	Caenidae		44					0	44	*4*	*5*	20	0.59	0.190	-0.32
Gastropoda	Lymnaeidae		1	0					1	*1*	*1*	1	0.03	0.004	-0.02
Gastropoda	Planorbidae		2	0					2	*2*	*1*	2	0.06	0.009	-0.04
Hemiptera	Veliidae		1	0					1	*3*	*1*	3	0.09	0.004	-0.02
Odonata	Libellulidae		1	0					1	*4*	*1*	4	0.12	0.004	-0.02
Ostracoda	Ostracoda		11				0							0.047	-0.14
Trichoptera	Calamoceratidae		1	0					1	*7*	*1*	7	0.21	0.004	-0.02
Trichoptera	Hydroptilidae		2	0					2	*4*	*1*	4	0.12	0.009	-0.04
Trichoptera	Leptoceridae		8			0			8	*6*	*3*	18	0.53	0.034	-0.12
Turbellaria	Dugesiidae		1	0					1	*2*	*1*	2	0.06	0.004	-0.02

Sample Site	**WC4B**	**SIGNAL 2**	**3.5**
Date sampled	**15-Sep-11**	**No.of families**	**15**
Replicate No.	2	**No.of animals**	**229**
		Shannon H	**1.5**
		E_H	**0.54**

Indicator Values

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensitivity grade	weight factor	Grade*Weight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Hydrophilidae	*adult*	4		0				4	*2*	*2*	4	0.12	0.017	-0.07
Coleoptera	Scirtidae	*larvae*	10			0			10	*6*	*3*	18	0.53	0.044	-0.14
Diptera	Ceratopogonidae		1	0					1	*4*	*1*	4	0.12	0.004	-0.02
Diptera	Chironominae		146					0	146	*3*	*5*	15	0.44	0.638	-0.29
Diptera	Simuliidae		15				0		15	*5*	*4*	20	0.59	0.066	-0.18
Diptera	Stratiomyidae		1	0					1	*2*	*1*	2	0.06	0.004	-0.02
Diptera	Tipulidae		1	0					1	*5*	*1*	5	0.15	0.004	-0.02
Ephemeroptera	Caenidae		11				0		11	*4*	*4*	16	0.47	0.048	-0.15
Ephemeroptera	Leptophlebiidae		1	0					1	*8*	*1*	8	0.24	0.004	-0.02
Gastropoda	Lymnaeidae		11				0		11	*1*	*4*	4	0.12	0.048	-0.15
Gastropoda	Planorbidae		10			0			10	*2*	*3*	6	0.18	0.044	-0.14
Odonata	Libellulidae		3		0				3	*4*	*2*	8	0.24	0.013	-0.06
Trichoptera	Ecnomidae		2	0					2	*4*	*1*	4	0.12	0.009	-0.04
Trichoptera	Leptoceridae		1	0					1	*6*	*1*	6	0.18	0.004	-0.02
Turbellaria	Dugesiidae		12				0		12	*2*	*4*	8	0.24	0.052	-0.15

Sample Site	**WC4C**										**Indicator Values**			**SIGNAL 2**	**4.0**
Date sampled	**15-Sep-11**													**No.of families**	**23**
Replicate No.	3													**No.of animals**	**153**
														Shannon H	**2.4**
														E_H	**0.76**
				Abundance grade						Sensitivity grade	weight factor	Grade*Weight			
Order	Family	Type	Count	1	2	3	4	5					Value	Pi	Pi.Ln(Pi)
Acarina	Hydracarina		4		0				4	*6*	*2*	12	0.35	0.026	-0.10
Coleoptera	Dytiscidae	*adult3 larvae2*	5		0				5	*2*	*2*	4	0.12	0.033	-0.11
Coleoptera	Hydraenidae	*adult*	1	0					1	*3*	*1*	3	0.09	0.007	-0.03
Coleoptera	Hydrophilidae	*adult*	2	0					2	*2*	*1*	2	0.06	0.013	-0.06
Coleoptera	Scirtidae	*larvae*	15				0		15	*6*	*4*	24	0.71	0.098	-0.23
Decapoda	Atyidae		3		0				3	*3*	*2*	6	0.18	0.020	-0.08
Diptera	Chironominae		56					0	56	*3*	*5*	15	0.44	0.366	-0.37
Diptera	Dixidae		1	0					1	*7*	*1*	7	0.21	0.007	-0.03
Diptera	Simuliidae		6			0			6	*5*	*3*	15	0.44	0.039	-0.13
Ephemeroptera	Baetidae		9			0			9	*5*	*3*	15	0.44	0.059	-0.17
Ephemeroptera	Caenidae		9			0			9	*4*	*3*	12	0.35	0.059	-0.17
Ephemeroptera	Leptophlebiidae		3		0				3	*8*	*2*	16	0.47	0.020	-0.08
Gastropoda	Lymnaeidae		1	0					1	*1*	*1*	1	0.03	0.007	-0.03
Gastropoda	Planorbidae		10			0			10	*2*	*3*	6	0.18	0.065	-0.18
Hemiptera	Corixidae		1	0					1	*2*	*1*	2	0.06	0.007	-0.03
Hemiptera	Notonectidae		2	0					2	*1*	*1*	1	0.03	0.013	-0.06
Odonata	Coenagrionidae		1	0					1	*2*	*1*	2	0.06	0.007	-0.03
Odonata	Libellulidae		1	0					1	*4*	*1*	4	0.12	0.007	-0.03
Ostracoda	Ostracoda		1	0										0.007	-0.03
Trichoptera	Calamoceratidae		3		0				3	*7*	*2*	14	0.41	0.020	-0.08
Trichoptera	Hydroptilidae		2	0					2	*4*	*1*	4	0.12	0.013	-0.06
Trichoptera	Leptoceridae		3		0				3	*6*	*2*	12	0.35	0.020	-0.08
Turbellaria	Dugesiidae		14				0		14	*2*	*4*	8	0.24	0.092	-0.22

Sample Site	**WC5A**	**SIGNAL 2**	**3.2**
Date sampled	**14-Sep-11**	**No.of families**	**19**
Replicate No.	1	**No.of animals**	**59**
		Shannon H	**2.6**
		E_H	**0.87**

Indicator Values

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensiti grade	weight factor	Grade*W eight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Dytiscidae	*adult3 larvae4*	7			0			7	*2*	*3*	6	0.21	0.119	-0.25
Coleoptera	Hydraenidae	*adult*	1	0					1	*3*	*1*	3	0.10	0.017	-0.07
Coleoptera	Hydrophilidae	*adult*	1	0					1	*2*	*1*	2	0.07	0.017	-0.07
Coleoptera	Scirtidae	*larvae*	1	0					1	*6*	*1*	6	0.21	0.017	-0.07
Decapoda	Atyidae		4		0				4	*3*	*2*	6	0.21	0.068	-0.18
Diptera	Chironominae		12				0		12	*3*	*4*	12	0.41	0.203	-0.32
Diptera	Culicidae		1	0					1	*1*	*1*	1	0.03	0.017	-0.07
Diptera	Stratiomyidae		3		0				3	*2*	*2*	4	0.14	0.051	-0.15
Ephemeroptera	Caenidae		8			0			8	*4*	*3*	12	0.41	0.136	-0.27
Gastropoda	Planorbidae		1	0					1	*2*	*1*	2	0.07	0.017	-0.07
Hemiptera	Notonectidae		1	0					1	*1*	*1*	1	0.03	0.017	-0.07
Odonata	Coenagrionidae		5		0				5	*2*	*2*	4	0.14	0.085	-0.21
Odonata	Corduliidae		2	0					2	*5*	*1*	5	0.17	0.034	-0.11
Odonata	Libellulidae		3		0				3	*4*	*2*	8	0.28	0.051	-0.15
Ostracoda	Ostracoda		2	0										0.034	-0.11
Trichoptera	calamoceratidae		1	0					1	*7*	*1*	7	0.24	0.017	-0.07
Trichoptera	Ecnomidae		1	0					1	*4*	*1*	4	0.14	0.017	-0.07
Trichoptera	Leptoceridae		4		0				4	*6*	*2*	12	0.41	0.068	-0.18
Turbellaria	Dugesiidae		1	0					1	*2*	*1*	2	0.07	0.017	-0.07

Sample Site WC5B

Date sampled 14-Sep-11

Replicate No. 2

Indicator Values

SIGNAL 2	**4.2**
No.of families	**22**
No.of animals	**194**
Shannon H	**2.4**
E_H	**0.76**

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensitivity grade	weight factor	Grade*Weight	Value	Pi	Pi.Ln(Pi)
Acarina	Hydracarina		2	0					2	*6*	*1*	6	0.21	0.010	-0.05
Coleoptera	Dytiscidae	*adult2 larvae1*	3		0				3	*2*	*2*	4	0.14	0.015	-0.06
Coleoptera	Scirtidae	*larvae*	28					0	28	*6*	*5*	30	1.03	0.144	-0.28
Decapoda	Atyidae		4		0				4	*3*	*2*	6	0.21	0.021	-0.08
Diptera	Ceratopogonidae		4		0				4	*4*	*2*	8	0.28	0.021	-0.08
Diptera	Chironominae		55					0	55	*3*	*5*	15	0.52	0.284	-0.36
Diptera	Simuliidae		33					0	33	*5*	*5*	25	0.86	0.170	-0.30
Diptera	Stratiomyidae		18				0		18	*2*	*4*	8	0.28	0.093	-0.22
Diptera	Tipulidae		1	0					1	*5*	*1*	5	0.17	0.005	-0.03
Ephemeroptera	Caenidae		5		0				5	*4*	*2*	8	0.28	0.026	-0.09
Ephemeroptera	Leptophlebiidae		2	0					2	*8*	*1*	8	0.28	0.010	-0.05
Gastropoda	Lymnaeidae		1	0					1	*1*	*1*	1	0.03	0.005	-0.03
Gastropoda	Planorbidae		2	0					2	*2*	*1*	2	0.07	0.010	-0.05
Hemiptera	Corixidae		2	0					2	*2*	*1*	2	0.07	0.010	-0.05
Hemiptera	Veliidae		1	0					1	*3*	*1*	3	0.10	0.005	-0.03
Odonata	Coenagrionidae		4		0				4	*2*	*2*	4	0.14	0.021	-0.08
Odonata	Corduliidae		3		0				3	*5*	*2*	10	0.34	0.015	-0.06
Odonata	Synlestidae		2	0					2	*7*	*1*	7	0.24	0.010	-0.05
Ostracoda	Ostracoda		4		0									0.021	-0.08
Trichoptera	Calamoceratidae		7			0			7	*7*	*3*	21	0.72	0.036	-0.12
Trichoptera	Ecnomidae		3		0				3	*4*	*2*	8	0.28	0.015	-0.06
Trichoptera	Leptoceridae		10			0			10	*6*	*3*	18	0.62	0.052	-0.15

Sample Site	**WC5C**										**Indicator Values**			**SIGNAL 2**		**3.7**
Date sampled	**14-Sep-11**													**No.of families**		**18**
Replicate No.	3													**No.of animals**		**113**
														Shannon H		**2.4**
															E_H	**0.84**
				Abundance grade						Sensiti	weight	Grade*W				
Order	Family	Type	Count	1	2	3	4	5		grade	factor	eight	Value		Pi	Pi.Ln(Pi)
Coleoptera	Dytiscidae	*adult*	2	0					2	*2*	*1*	2	0.07		0.018	-0.07
Coleoptera	Hydraenidae	*adult*	5		0				5	*3*	*2*	6	0.21		0.044	-0.14
Coleoptera	Hydrophilidae	*adult*	11				0		11	*2*	*4*	8	0.28		0.097	-0.23
Coleoptera	Scirtidae	*larvae*	6			0			6	*6*	*3*	18	0.62		0.053	-0.16
Collembola	Collembola		1	0											0.009	-0.04
Decapoda	Atyidae		17				0		17	*3*	*4*	12	0.41		0.150	-0.28
Diptera	Chironominae		27					0	27	*3*	*5*	15	0.52		0.239	-0.34
Diptera	Dixidae		1	0					1	*7*	*1*	7	0.24		0.009	-0.04
Diptera	Stratiomyidae		8			0			8	*2*	*3*	6	0.21		0.071	-0.19
Ephemeroptera	Caenidae		3		0				3	*4*	*2*	8	0.28		0.027	-0.10
Ephemeroptera	Leptophlebiidae		1	0					1	*8*	*1*	8	0.28		0.009	-0.04
Gastropoda	Planorbidae		4		0				4	*2*	*2*	4	0.14		0.035	-0.12
Hemiptera	Corixidae		2	0					2	*2*	*1*	2	0.07		0.018	-0.07
Hemiptera	Veliidae		1	0					1	*3*	*1*	3	0.10		0.009	-0.04
Odonata	Coenagrionidae		3		0				3	*2*	*2*	4	0.14		0.027	-0.10
Trichoptera	Calamoceratidae		10			0			10	*7*	*3*	21	0.72		0.088	-0.21
Trichoptera	Ecnomidae		1	0					1	*4*	*1*	4	0.14		0.009	-0.04
Trichoptera	Leptoceridae		10			0			10	*6*	*3*	18	0.62		0.088	-0.21

Sample Site	**WC6A**	**Indicator Values**	
Date sampled	**14-Sep-11**	**SIGNAL 2**	**3.9**
Replicate No.	1	**No.of families**	**24**
		No.of animals	**206**
		Shannon H	**2.8**
		E_H	**0.87**

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensitivity grade	weight factor	Grade*Weight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Dytiscidae	*adult10 larvae13*	23					0	23	*2*	*5*	10	0.38	0.112	-0.24
Coleoptera	Scirtidae	*larvae*	18				0		18	*6*	*4*	24	0.92	0.087	-0.21
Decapoda	Atyidae		10			0			10	*3*	*3*	9	0.35	0.049	-0.15
Diptera	Ceratopogonidae		2	0					2	*4*	*1*	4	0.15	0.010	-0.04
Diptera	Chironominae		30					0	30	*3*	*5*	15	0.58	0.146	-0.28
Diptera	Simuliidae		13				0		13	*5*	*4*	20	0.77	0.063	-0.17
Diptera	Stratiomyidae		2	0					2	*2*	*1*	2	0.08	0.010	-0.04
Diptera	Tabanidae		1	0					1	*3*	*1*	3	0.12	0.005	-0.03
Diptera	Tipulidae		3		0				3	*5*	*2*	10	0.38	0.015	-0.06
Ephemeroptera	Caenidae		10			0			10	*4*	*3*	12	0.46	0.049	-0.15
Ephemeroptera	Leptophlebiidae		1	0					1	*8*	*1*	8	0.31	0.005	-0.03
Gastropoda	Planorbidae		5		0				5	*2*	*2*	4	0.15	0.024	-0.09
Hemiptera	Corixidae		14				0		14	*2*	*4*	8	0.31	0.068	-0.18
Hemiptera	Veliidae		2	0					2	*3*	*1*	3	0.12	0.010	-0.04
Hirudinea			1	0										0.005	-0.03
Odonata	Coenagrionidae		9			0			9	*2*	*3*	6	0.23	0.044	-0.14
Odonata	Libellulidae		9			0			9	*4*	*3*	12	0.46	0.044	-0.14
Ostracoda	Ostracoda		8			0								0.039	-0.13
Trichoptera	Ecnomidae		3		0				3	*4*	*2*	8	0.31	0.015	-0.06
Trichoptera	Hydrobiosidae		1	0					1	*8*	*1*	8	0.31	0.005	-0.03
Trichoptera	Hydropsychidae		20				0		20	*6*	*4*	24	0.92	0.097	-0.23
Trichoptera	Leptoceridae		16				0		16	*6*	*4*	24	0.92	0.078	-0.20
Trichoptera	Unknown		1	0										0.005	-0.03
Turbellaria	Dugesiidae		4		0				4	*2*	*2*	4	0.15	0.019	-0.08

Sample Site	**WC6B**											**Indicator Values**		**SIGNAL 2**	**4.1**
Date sampled	**14-Sep-11**													**No.of families**	**20**
Replicate No.	2													**No.of animals**	**194**
														Shannon H	**2.4**
														E_H	**0.79**
				Abundance grade						Sensiti	weight	Grade*W			
Order	Family	Type	Count	1	2	3	4	5		grade	factor	eight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Dytiscidae	*adult1 larvae2*	3		0				3	*2*	*2*	4	0.15	0.015	-0.06
Coleoptera	Hydraenidae	*adult*	1	0					1	*3*	*1*	3	0.12	0.005	-0.03
Coleoptera	Scirtidae	*larvae*	35					0	35	*6*	*5*	30	1.15	0.180	-0.31
Decapoda	Atyidae		11				0		11	*3*	*4*	12	0.46	0.057	-0.16
Decapoda	Palaeomonidae		1	0					1	*4*	*1*	4	0.15	0.005	-0.03
Diptera	Chironominae		16				0		16	*3*	*4*	12	0.46	0.082	-0.21
Diptera	Dixidae		1	0					1	*7*	*1*	7	0.27	0.005	-0.03
Diptera	Simulliidae		40					0						0.206	-0.33
Diptera	Tipulidae		3		0				3	*5*	*2*	10	0.38	0.015	-0.06
Ephemeroptera	Caenidae		13				0		13	*4*	*4*	16	0.62	0.067	-0.18
Gastropoda	Lymnaeidae		1	0					1	*1*	*1*	1	0.04	0.005	-0.03
Hemiptera	Corixidae		20				0		20	*2*	*4*	8	0.31	0.103	-0.23
Odonata	Libellulidae		4		0				4	*4*	*2*	8	0.31	0.021	-0.08
Ostracoda	Ostracoda		9			0								0.046	-0.14
Trichoptera	Calamoceratidae		1	0					1	*7*	*1*	7	0.27	0.005	-0.03
Trichoptera	Ecnomidae		5		0				5	*4*	*2*	8	0.31	0.026	-0.09
Trichoptera	Hydropsychidae		27					0	27	*6*	*5*	30	1.15	0.139	-0.27
Trichoptera	Hydroptilidae		1	0					1	*4*	*1*	4	0.15	0.005	-0.03
Trichoptera	Leptoceridae		1	0					1	*6*	*1*	6	0.23	0.005	-0.03
Turbellaria	Dugesiidae		1	0					1	*2*	*1*	2	0.08	0.005	-0.03

Sample Site	**WC6C**	**SIGNAL 2**	**4.0**
Date sampled	**14-Sep-11**	**No.of families**	**21**
Replicate No.	3	**No.of animals**	**190**
		Shannon H	**2.3**
		E_H	**0.77**

Indicator Values

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensitivity grade	weight factor	Grade*Weight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Dytiscidae	*adult*	1	0					1	*2*	*1*	2	0.08	0.005	-0.03
Coleoptera	Gyrinidae	*adult*	1	0					1	*4*	*1*	4	0.15	0.005	-0.03
Coleoptera	Hydraenidae	*adult*	1	0					1	*3*	*1*	3	0.12	0.005	-0.03
Coleoptera	Hydrophilidae	*adult*	6			0			6	*2*	*3*	6	0.23	0.032	-0.11
Coleoptera	Scirtidae	*larvae*	14				0		14	*6*	*4*	24	0.92	0.074	-0.19
Diptera	Ceratopogonidae		3		0				3	*4*	*2*	8	0.31	0.016	-0.07
Diptera	Chironominae		54					0	54	*3*	*5*	15	0.58	0.284	-0.36
Diptera	Dixidae		1	0					1	*7*	*1*	7	0.27	0.005	-0.03
Diptera	Simuliidae		37					0	37	*5*	*5*	25	0.96	0.195	-0.32
Diptera	Tipulidae		2	0					2	*5*	*1*	5	0.19	0.011	-0.05
Ephemeroptera	Caenidae		18				0		18	*4*	*4*	16	0.62	0.095	-0.22
Hemiptera	Corixidae		16				0		16	*2*	*4*	8	0.31	0.084	-0.21
Hemiptera	Notonectidae		7			0			7	*1*	*3*	3	0.12	0.037	-0.12
Odonata	Coenagrionidae		3		0				3	*2*	*2*	4	0.15	0.016	-0.07
Odonata	Gomphidae		1	0					1	*5*	*1*	5	0.19	0.005	-0.03
Odonata	Libellulidae		1	0					1	*4*	*1*	4	0.15	0.005	-0.03
Ostracoda	Ostracoda		5		0									0.026	-0.10
Trichoptera	Calamoceratidae		3		0				3	*7*	*2*	14	0.54	0.016	-0.07
Trichoptera	Ecnomidae		3		0				3	*4*	*2*	8	0.31	0.016	-0.07
Trichoptera	Hydropsychidae		6			0			6	*6*	*3*	18	0.69	0.032	-0.11
Trichoptera	Leptoceridae		7			0			7	*6*	*3*	18	0.69	0.037	-0.12

Sample Site	**WC7A**	**SIGNAL 2**	**4.6**
Date sampled	**14-Sep-11**	**No.of families**	**20**
Replicate No.	1	**No.of animals**	**333**
		Shannon H	**1.9**
		E_H	**0.64**

Indicator Values

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensiti grade	weight factor	Grade*Weight	Value	Pi	Pi.Ln(Pi)
Acarina	Hydracarina		1	0					1	*6*	*1*	6	0.16	0.003	-0.02
Coleoptera	Dytiscidae	*larvae*	2	0					2	*2*	*1*	2	0.05	0.006	-0.03
Coleoptera	Elmidae	*adult*	1	0					1	*7*	*1*	7	0.19	0.003	-0.02
Coleoptera	Scirtidae	*adult3 larvae67*	70					0	70	*6*	*5*	30	0.81	0.210	-0.33
Collembola	Collembola		1	0					1	*1*	*1*	1	0.03	0.003	-0.02
Decapoda	Atyidae		7			0			7	*3*	*3*	9	0.24	0.021	-0.08
Diptera	Chironominae		2	0					2	*3*	*1*	3	0.08	0.006	-0.03
Diptera	Simuliidae		79					0	79	*5*	*5*	25	0.68	0.237	-0.34
Diptera	Tabanidae		1	0					1	*3*	*1*	3	0.08	0.003	-0.02
Diptera	Tipulidae		2	0					2	*5*	*1*	5	0.14	0.006	-0.03
Ephemeroptera	Caenidae		21					0	21	*4*	*5*	20	0.54	0.063	-0.17
Gastropoda	Lymnaeidae		1	0					1	*1*	*1*	1	0.03	0.003	-0.02
Gastropoda	Planorbidae		6			0			6	*2*	*3*	6	0.16	0.018	-0.07
Odonata	Corduliidae		1	0					1	*5*	*1*	5	0.14	0.003	-0.02
Odonata	Gomphidae		2	0					2	*5*	*1*	5	0.14	0.006	-0.03
Ostracoda	Ostracoda		21					0						0.063	-0.17
Trichoptera	Ecnomidae		1	0					1	*4*	*1*	4	0.11	0.003	-0.02
Trichoptera	Hydrobiosidae		2	0					2	*8*	*1*	8	0.22	0.006	-0.03
Trichoptera	Hydropsychidae		102					0	102	*6*	*5*	30	0.81	0.306	-0.36
Trichoptera	Leptoceridae		10			0			10	*6*	*3*	18	0.49	0.030	-0.11

Sample Site	**WC7B**		
Date sampled	**14-Sep-11**		
Replicate No.	2		

Indicator Values

SIGNAL 2	**4.1**
No.of families	**26**
No.of animals	**170**
Shannon H	**2.7**
E_H	**0.82**

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensiti grade	weight factor	Grade*Weight	Value	Pi	Pi.Ln(Pi)
Acarina	Hydracarina		2	0					2	*6*	*1*	6	0.16	0.012	-0.05
Coleoptera	Dytiscidae	*adult1 larvae1*	2	0					2	*2*	*1*	2	0.05	0.012	-0.05
Coleoptera	Elmidae	*larvae*	1	0					1	*7*	*1*	7	0.19	0.006	-0.03
Coleoptera	Gyrinidae	*adult*	2	0					2	*4*	*1*	4	0.11	0.012	-0.05
Coleoptera	Scirtidae	*larvae*	1	0					1	*6*	*1*	6	0.16	0.006	-0.03
Decapoda	Atyidae		10			0			10	*3*	*3*	9	0.24	0.059	-0.17
Diptera	Chironominae		4		0				4	*3*	*2*	6	0.16	0.024	-0.09
Diptera	Simuliidae		37					0	37	*5*	*5*	25	0.68	0.218	-0.33
Diptera	Tabanidae		2	0					2	*3*	*1*	3	0.08	0.012	-0.05
Diptera	Tipulidae		1	0					1	*5*	*1*	5	0.14	0.006	-0.03
Ephemeroptera	Caenidae		8			0			8	*4*	*3*	12	0.32	0.047	-0.14
Gastropoda	Lymnaeidae		3		0				3	*1*	*2*	2	0.05	0.018	-0.07
Gastropoda	Planorbidae		9			0			9	*2*	*3*	6	0.16	0.053	-0.16
Hemiptera	Corixidae		20				0		20	*2*	*4*	8	0.22	0.118	-0.25
Hemiptera	Veliidae		2	0					2	*3*	*1*	3	0.08	0.012	-0.05
Lepidoptera	Pyralidae		1	0										0.006	-0.03
Odonata	Coenagrionidae		1	0					1	*2*	*1*	2	0.05	0.006	-0.03
Odonata	Corduliidae		3		0				3	*5*	*2*	10	0.27	0.018	-0.07
Odonata	Gomphidae		5		0				5	*5*	*2*	10	0.27	0.029	-0.10
Odonata	Libellulidae		5		0				5	*4*	*2*	8	0.22	0.029	-0.10
Ostracoda	Ostracoda		16				0							0.094	-0.22
Trichoptera	Calamoceratidae		2	0					2	*7*	*1*	7	0.19	0.012	-0.05
Trichoptera	Ecnomidae		3		0				3	*4*	*2*	8	0.22	0.018	-0.07
Trichoptera	Hydropsychidae		21					0	21	*6*	*5*	30	0.81	0.124	-0.26
Trichoptera	Hydroptilidae		1	0					1	*4*	*1*	4	0.11	0.006	-0.03
Trichoptera	Leptoceridae		8			0			8	*6*	*3*	18	0.49	0.047	-0.14

Sample Site	**WC7C**
Date sampled	**14-Sep-11**
Replicate No.	3

Indicator Values

SIGNAL 2	**4.0**
No.of families	**22**
No.of animals	**175**
Shannon H	**2.3**
E_H	**0.75**

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensiti grade	weight factor	Grade*W eight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Dytiscidae	*larvae*	2	0					2	*2*	*1*	2	0.05	0.011	-0.05
Coleoptera	Gyrinidae	*adult*	1	0					1	*4*	*1*	4	0.11	0.006	-0.03
Coleoptera	Scirtidae	*larvae*	3		0				3	*6*	*2*	12	0.32	0.017	-0.07
Decapoda	Atyidae		4		0				4	*3*	*2*	6	0.16	0.023	-0.09
Diptera	Chironomidae		11				0							0.063	-0.17
Diptera	Simuliidae		32					0	32	*5*	*5*	25	0.68	0.183	-0.31
Diptera	Stratiomyidae		1	0					1	*2*	*1*	2	0.05	0.006	-0.03
Diptera	Tipulidae		4		0				4	*5*	*2*	10	0.27	0.023	-0.09
Ephemeroptera	Caenidae		37					0	37	*4*	*5*	20	0.54	0.211	-0.33
Gastropoda	Lymnaeidae		1	0					1	*1*	*1*	1	0.03	0.006	-0.03
Gastropoda	Planorbidae		6			0			6	*2*	*3*	6	0.16	0.034	-0.12
Hemiptera	Corixidae		3		0				3	*2*	*2*	4	0.11	0.017	-0.07
Odonata	Coenagrionidae		5		0				5	*2*	*2*	4	0.11	0.029	-0.10
Odonata	Corduliidae		1	0					1	*5*	*1*	5	0.14	0.006	-0.03
Odonata	Gomphidae		2	0					2	*5*	*1*	5	0.14	0.011	-0.05
Odonata	Libellulidae		1	0					1	*4*	*1*	4	0.11	0.006	-0.03
Ostracoda	Ostracoda		41					0						0.234	-0.34
Trichoptera	Calamoceratidae		2	0					2	*7*	*1*	7	0.19	0.011	-0.05
Trichoptera	Ecnomidae		1	0					1	*4*	*1*	4	0.11	0.006	-0.03
Trichoptera	Hydropsychidae		1	0					1	*6*	*1*	6	0.16	0.006	-0.03
Trichoptera	Leptoceridae		11				0		11	*6*	*4*	24	0.65	0.063	-0.17
Turbellaira	Dugesiidae		5		0				5	*2*	*2*	4	0.11	0.029	-0.10

Sample Site	**WC8A**									**Indicator Values**			**SIGNAL 2**		**4.8**
Date sampled	**13-Sep-11**												**No.of families**		**17**
Replicate No.	1												**No.of animals**		**263**
													Shannon H		**1.7**
														E_H	**0.59**
				Abundance grade						Sensiti grade	weight factor	Grade*Weight			
Order	Family	Type	Count	1	2	3	4	5					Value	Pi	Pi.Ln(Pi)
Coleoptera	Gyrinidae	*larvae*	1	0					1	*4*	*1*	4	0.13	0.004	-0.02
Coleoptera	Scirtidae	*larvae*	44					0	44	*6*	*5*	30	1.00	0.167	-0.30
Decapoda	Atyidae		2	0					2	*3*	*1*	3	0.10	0.008	-0.04
Diptera	Ceratopogonidae		1	0					1	*4*	*1*	4	0.13	0.004	-0.02
Diptera	Chironominae		43					0	43	*3*	*5*	15	0.50	0.163	-0.30
Diptera	Simuliidae		30					0	30	*5*	*5*	25	0.83	0.114	-0.25
Diptera	Tipulidae		4		0				4	*5*	*2*	10	0.33	0.015	-0.06
Ephemeroptera	Baetidae		1	0					1	*5*	*1*	5	0.17	0.004	-0.02
Ephemeroptera	Caenidae		1	0					1	*4*	*1*	4	0.13	0.004	-0.02
Ephemeroptera	Leptophlebiidae		1	0					1	*8*	*1*	8	0.27	0.004	-0.02
Hemiptera	Corixidae		4		0				4	*2*	*2*	4	0.13	0.015	-0.06
Trichoptera	Calamoceratidae		1	0					1	*7*	*1*	7	0.23	0.004	-0.02
Trichoptera	Ecnomidae		3		0				3	*4*	*2*	8	0.27	0.011	-0.05
Trichoptera	Hydropsychidae		118					0	118	*6*	*5*	30	1.00	0.449	-0.36
Trichoptera	Hydroptilidae		1	0					1	*4*	*1*	4	0.13	0.004	-0.02
Trichoptera	Leptoceridae		7			0			7	*6*	*3*	18	0.60	0.027	-0.10
Turbellaria	Dugesiidae		1	0					1	*2*	*1*	2	0.07	0.004	-0.02

Sample Site	**WC8B**	**Indicator Values**	
Date sampled	**13-Sep-11**		
Replicate No.	2		
		SIGNAL 2	**3.9**
		No.of families	**21**
		No.of animals	**188**
		Shannon H	**2.3**
		E_H	**0.75**

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensiti grade	weight factor	Grade*Weight	Value	Pi	Pi.Ln(Pi)
Acarina	Hydracarina		1	0					1	*6*	*1*	6	0.20	0.005	-0.03
Coleoptera	Dytiscidae	*adult2 larvae4*	6			0			6	*2*	*3*	6	0.20	0.032	-0.11
Coleoptera	Gyrinidae	*larvae*	1	0					1	*4*	*1*	4	0.13	0.005	-0.03
Coleoptera	Hydrophilidae	*adult*	3		0				3	*2*	*2*	4	0.13	0.016	-0.07
Coeoptera	Scirtidae	*larvae*	9			0			9	*6*	*3*	18	0.60	0.048	-0.15
Decapoda	Atyidae		10			0			10	*3*	*3*	9	0.30	0.053	-0.16
Diptera	Ceratopogonidae		3		0									0.016	-0.07
Diptera	Chironomidae		71					0						0.378	-0.37
Diptera	Simuliidae		7			0			7	*5*	*3*	15	0.50	0.037	-0.12
Diptera	Tipulidae		1	0					1	*5*	*1*	5	0.17	0.005	-0.03
Ephemeroptera	Caenidae		5		0				5	*4*	*2*	8	0.27	0.027	-0.10
Gastropodae	Lymnaeidae		2	0					2	*1*	*1*	1	0.03	0.011	-0.05
Gastropoda	Planorbidae		2	0					2	*2*	*1*	2	0.07	0.011	-0.05
Hemiptera	Corixidae		6			0			6	*2*	*3*	6	0.20	0.032	-0.11
Odonata	Coenagrionidae		9			0			9	*2*	*3*	6	0.20	0.048	-0.15
Oligochaeta	Lumbriculidae		1	0					1	*3*	*1*	3	0.10	0.005	-0.03
Trichoptera	Calamoceratidae		2	0					2	*7*	*1*	7	0.23	0.011	-0.05
Trichoptera	Ecnomidae		3		0				3	*4*	*2*	8	0.27	0.016	-0.07
Trichoptera	Hydropsychidae		21					0	21	*6*	*5*	30	1.00	0.112	-0.24
Trichoptera	Leptoceridae		19				0		19	*6*	*4*	24	0.80	0.101	-0.23
Turbellaria	Dugesiidae		6			0			6	*2*	*3*	6	0.20	0.032	-0.11

Sample Site	**WC8C**
Date sampled	**13-Sep-11**
Replicate No.	3

Indicator Values

SIGNAL 2	**4.5**
No.of families	**21**
No.of animals	**240**
Shannon H	**2.1**
E_H	**0.70**

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensiti grade	weight factor	Grade*W eight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Chrysomelidae	*adult*	1	0					1	*2*	*1*	2	0.07	0.004	-0.02
Coleoptera	Dytiscidae	*larvae*	8			0			8	*2*	*3*	6	0.20	0.033	-0.11
Coleoptera	Gyrinidae	*adult*	1	0					1	*4*	*1*	4	0.13	0.004	-0.02
Coleoptera	Hydrophilidae	*adult1 larvae1*	2	0					2	*2*	*1*	2	0.07	0.008	-0.04
Coleoptera	Scirtidae	*larvae*	45					0	45	*6*	*5*	30	1.00	0.188	-0.31
Decapoda	Atyidae		1	0					1	*3*	*1*	3	0.10	0.004	-0.02
Diptera	Ceratopogonidae		5		0				5	*4*	*2*	8	0.27	0.021	-0.08
Diptera	Chironomidae		37					0						0.154	-0.29
Diptera	Simuliidae		17				0		17	*5*	*4*	20	0.67	0.071	-0.19
Diptera	Tipulidae		1	0					1	*5*	*1*	5	0.17	0.004	-0.02
Ephemeroptera	Baetidae		3		0				3	*5*	*2*	10	0.33	0.013	-0.05
Ephemeroptera	Caenidae		16				0		16	*4*	*4*	16	0.53	0.067	-0.18
Ephemeroptera	Leptophlebiidae		2	0					2	*8*	*1*	8	0.27	0.008	-0.04
Gastropoda	Planorbidae		3		0				3	*2*	*2*	4	0.13	0.013	-0.05
Hemiptera	Corixidae		2	0										0.008	-0.04
Hemiptera	Veliidae		1	0					1	*3*	*1*	3	0.10	0.004	-0.02
Odonata	Coenagrionidae		1	0					1	*2*	*1*	2	0.07	0.004	-0.02
Trichoptera	Calamoceratidae		2	0					2	*7*	*1*	7	0.23	0.008	-0.04
Trichoptera	Hydropsychidae		77					0	77	*6*	*5*	30	1.00	0.321	-0.36
Trichoptera	Leptoceridae		14				0		14	*6*	*4*	24	0.80	0.058	-0.17
Turbellaria	Dugesiidae		1	0					1	*2*	*1*	2	0.07	0.004	-0.02

Sample Site	**WO1**	**SIGNAL 2**	**4.1**
Date sampled	**12-Sep-11**	**No.of families**	**18**
Replicate No.	1	**No.of animals**	**271**
		Shannon H	**1.9**
		E_H	**0.67**

Indicator Values

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensiti grade	weight factor	Grade*W eight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Gyrinidae	*adult*	1	0					1	*4*	*1*	4	0.13	0.004	-0.02
Coleoptera	Hydraenidae	*adult*	5		0				5	*3*	*2*	6	0.20	0.018	-0.07
Coleoptera	Hydrophilidae	*adult*	8			0			8	*2*	*3*	6	0.20	0.030	-0.10
Coleoptera	Scirtidae	*larvae*	1	0					1	*6*	*1*	6	0.20	0.004	-0.02
Collembola	Collembola		1	0					1	*1*	*1*	1	0.03	0.004	-0.02
Diptera	Chironominae		87					0	87	*3*	*5*	15	0.50	0.321	-0.36
Diptera	Simuliidae		2	0					2	*5*	*1*	5	0.17	0.007	-0.04
Ephemeroptera	Baetidae		10			0			10	*5*	*3*	15	0.50	0.037	-0.12
Ephemeroptera	Caenidae		17				0		17	*4*	*4*	16	0.53	0.063	-0.17
Ephemeroptera	Leptophlebiidae		2	0					2	*8*	*1*	8	0.27	0.007	-0.04
Gastropoda	Lymnaeidae		1	0					1	*1*	*1*	1	0.03	0.004	-0.02
Hemiptera	Corixidae		1	0					1	*2*	*1*	2	0.07	0.004	-0.02
Oligochaeta	Lumbriculidae		9			0			9	*3*	*3*	9	0.30	0.033	-0.11
Ostracoda	Ostracoda		84					0						0.310	-0.36
Trichoptera	Calamoceratidae		2	0					2	*7*	*1*	7	0.23	0.007	-0.04
Trichoptera	Ecnomidae		24					0	24	*4*	*5*	20	0.67	0.089	-0.21
Trichoptera	Hydropsychidae		10			0			10	*6*	*3*	18	0.60	0.037	-0.12
Trichoptera	Leptoceridae		6			0			6	*6*	*3*	18	0.60	0.022	-0.08

Sample Site	**WO1**
Date sampled	**12-Sep-11**
Replicate No.	b

Indicator Values

SIGNAL 2	**4.3**
No.of families	**22**
No.of animals	**187**
Shannon H	**2.5**
E_H	**0.81**

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensiti grade	weight factor	Grade*Weight	Value	Pi	Pi.Ln(Pi)
Acarina	Hydracarina		2	0					2	*6*	*1*	6	0.20	0.011	-0.05
Cladocera	Cladocera		1	0										0.005	-0.03
Coleoptera	Hydraenidae	*adult*	2	0					2	*3*	*1*	3	0.10	0.011	-0.05
Coleoptera	Scirtidae	*larvae*	8			0			8	*6*	*3*	18	0.60	0.043	-0.13
Diptera	Chironominae		26					0	26	*3*	*5*	15	0.50	0.139	-0.27
Diptera	Dixidae		1	0					1	*7*	*1*	7	0.23	0.005	-0.03
Diptera	Simuliidae		1	0					1	*5*	*1*	5	0.17	0.005	-0.03
Diptera	Tipulidae		1	0					1	*5*	*1*	5	0.17	0.005	-0.03
Ephemeroptera	Baetidae		4		0				4	*5*	*2*	10	0.33	0.021	-0.08
Ephemeroptera	Caenidae		20				0		20	*4*	*4*	16	0.53	0.107	-0.24
Ephemeroptera	Leptophlebiidae		7			0			7	*8*	*3*	24	0.80	0.037	-0.12
Gastropoda	Lymnaeidae		3		0				3	*1*	*2*	2	0.07	0.016	-0.07
Gastropoda	Planorbidae		2	0					2	*2*	*1*	2	0.07	0.011	-0.05
Hemiptera	Corixidae		7			0			7	*2*	*3*	6	0.20	0.037	-0.12
Hemiptera	Notonectidae		1	0					1	*1*	*1*	1	0.03	0.005	-0.03
Odonata	Coenagrionidae		1	0					1	*2*	*1*	2	0.07	0.005	-0.03
Oligochaeta	Lumbriculidae		21					0	21	*3*	*5*	15	0.50	0.112	-0.25
Ostracoda	Ostracoda		29					0						0.155	-0.29
Trichoptera	Calamoceratidae		2	0					2	*7*	*1*	7	0.23	0.011	-0.05
Trichoptera	Hydropsychidae		25					0	25	*6*	*5*	30	1.00	0.134	-0.27
Trichoptera	Leptoceridae		20				0		20	*6*	*4*	24	0.80	0.107	-0.24
Turbellaria	Dugesiidae		3		0				3	*2*	*2*	4	0.13	0.016	-0.07

Sample Site	**WO1**									**Indicator Values**			**SIGNAL 2**		**4.3**
Date sampled	**12-Sep-11**												**No.of families**		**17**
Replicate No.	3												**No.of animals**		**209**
													Shannon H		**1.2**
														E_H	**0.44**
				Abundance grade						Sensiti	weight	Grade*W			
Order	Family	Type	Count	1	2	3	4	5		grade	factor	eight	Value	Pi	Pi.Ln(Pi)
Acarina	Hydracarina		1	0					1	*6*	*1*	6	0.20	0.005	-0.03
Coleoptera	Scirtidae	*larvae*	6			0			6	*6*	*3*	18	0.60	0.029	-0.10
Diptera	Chironominae		17				0		17	*3*	*4*	12	0.40	0.081	-0.20
Diptera	Simuliidae		3		0				3	*5*	*2*	10	0.33	0.014	-0.06
Diptera	Tipulidae		1	0					1	*5*	*1*	5	0.17	0.005	-0.03
Ephemeroptera	Baetidae		1	0					1	*5*	*1*	5	0.17	0.005	-0.03
Gastropoda	Planorbidae		1	0					1	*2*	*1*	2	0.07	0.005	-0.03
Gastropoda	Lymnaeidae		2	0					2	*1*	*1*	1	0.03	0.010	-0.04
Hemiptera	Corixidae		9			0			9	*2*	*3*	6	0.20	0.043	-0.14
Hemiptera	Notonectidae		5		0				5	*1*	*2*	2	0.07	0.024	-0.09
Odonata	Gomphidae		1	0					1	*5*	*1*	5	0.17	0.005	-0.03
Oligochaeta	Lumbriculidae		3		0				3	*3*	*2*	6	0.20	0.014	-0.06
Ostracoda	Ostracoda		2	0										0.010	-0.04
Trichoptera	Calamoceratidae		1	0					1	*7*	*1*	7	0.23	0.005	-0.03
Trichoptera	Hydrobiosidae		5		0				5	*8*	*2*	16	0.53	0.024	-0.09
Trichoptera	Hydropsychidae		150					0	150	*6*	*5*	30	1.00	0.718	-0.24
Turbellaria	Dugesiidae		1	0					1	*2*	*1*	2	0.07	0.005	-0.03

Sample Site	**WO2**	**Indicator Values**	
Date sampled	**12-Sep-11**	**SIGNAL 2**	**4.5**
Replicate No.	1	**No.of families**	**18**
		No.of animals	**468**
		Shannon H	**1.8**
		E_H	**0.62**

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensitivity grade	weight factor	Grade*Weight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Hydrophilidae	*adult*	2	0					2	*2*	*1*	2	0.10	0.004	-0.02
Coleoptera	Scirtidae	*larvae*	2	0					2	*6*	*1*	6	0.30	0.004	-0.02
Diptera	Ceratopogonidae		1	0					1	*4*	*1*	4	0.20	0.002	-0.01
Diptera	Chironominae		109					0	109	*3*	*5*	15	0.75	0.233	-0.34
Diptera	Simuliidae		44					0	44	*5*	*5*	25	1.25	0.094	-0.22
Diptera	Stratiomyidae		2	0					2	*2*	*1*	2	0.10	0.004	-0.02
Diptera	Tipulidae		7			0			7	*5*	*3*	15	0.75	0.015	-0.06
Ephemeroptera	Baetidae		137					0	137	*5*	*5*	25	1.25	0.293	-0.36
Ephemeroptera	Caenidae		8			0			8	*4*	*3*	12	0.60	0.017	-0.07
Gastropoda	Lymnaeidae		1	0					1	*1*	*1*	1	0.05	0.002	-0.01
Gastropoda	Planorbidae		3		0				3	*2*	*2*	4	0.20	0.006	-0.03
Oligochaeta	Lumbriculidae		8			0			8	*3*	*3*	9	0.45	0.017	-0.07
Plecoptera	Gripopterygidae		1	0					1	*8*	*1*	8	0.40	0.002	-0.01
Trichoptera	Ecnomidae		9			0			9	*4*	*3*	12	0.60	0.019	-0.08
Trichoptera	Hydrobiosidae		6			0			6	*8*	*3*	24	1.20	0.013	-0.06
Trichoptera	Hydropsychidae		123					0	123	*6*	*5*	30	1.50	0.263	-0.35
Trichoptera	Leptoceridae		3		0				3	*6*	*2*	12	0.60	0.006	-0.03
Turbellaria	Dugesiidae		2	0					2	*2*	*1*	2	0.10	0.004	-0.02

Sample Site	**WO2**	**SIGNAL 2**	**4.9**
Date sampled	**12-Sep-11**	**No.of families**	**16**
Replicate No.	2	**No.of animals**	**401**
		Shannon H	**1.7**
		E_H	**0.60**

Indicator Values

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensiti grade	weight factor	Grade*W eight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Hydrophilidae	*adult*	1	0					1	*2*	*1*	2	0.10	0.002	-0.01
Coleoptera	Scirtidae	*larvae*	1	0					1	*6*	*1*	6	0.30	0.002	-0.01
Decapoda	Atyidae		1	0					1	*3*	*1*	3	0.15	0.002	-0.01
Diptera	Chironominae		56					0	56	*3*	*5*	15	0.75	0.140	-0.27
Diptera	Simuliidae		13				0		13	*5*	*4*	20	1.00	0.032	-0.11
Diptera	Tipulidae		3		0				3	*5*	*2*	10	0.50	0.007	-0.04
Ephemeroptera	Baetidae		84					0	84	*5*	*5*	25	1.25	0.209	-0.33
Ephemeroptera	Leptophlebiidae		1	0					1	*8*	*1*	8	0.40	0.002	-0.01
Gastropoda	Lymnaeidae		1	0					1	*1*	*1*	1	0.05	0.002	-0.01
Oligochaeta	Lumbriculidae		5		0				5	*3*	*2*	6	0.30	0.012	-0.05
Ostracoda	Ostracoda		25					0						0.062	-0.17
Trichoptera	Ecnomidae		5		0				5	*4*	*2*	8	0.40	0.012	-0.05
Trichoptera	Hydrobiosidae		12				0		12	*8*	*4*	32	1.60	0.030	-0.11
Trichoptera	Hydropsychidae		185					0	185	*6*	*5*	30	1.50	0.461	-0.36
Trichoptera	Leptoceridae		7			0			7	*6*	*3*	18	0.90	0.017	-0.07
Turbellaria	Dugesiidae		1	0					1	*2*	*1*	2	0.10	0.002	-0.01

Sample Site	**WO2**										**Indicator Values**	**SIGNAL 2**		**4.7**
Date sampled	**12-Sep-11**											**No.of families**		**12**
Replicate No.	3											**No.of animals**		**254**
												Shannon H		**1.7**
													E_H	**0.70**
				Abundance grade						Sensiti	weight	Grade*W			
Order	Family	Type	Count	1	2	3	4	5		grade	factor	eight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Elmidae	*larvae*	1	0					1	*7*	*1*	7	0.35	0.004	-0.02
Coleoptera	Gyrinidae	*adult*	2	0					2	*4*	*1*	4	0.20	0.008	-0.04
Diptera	Chironominae		41					0	41	*3*	*5*	15	0.75	0.161	-0.29
Diptera	Simuliidae		65					0	65	*5*	*5*	25	1.25	0.256	-0.35
Ephemeroptera	Baetidae		76					0	76	*5*	*5*	25	1.25	0.299	-0.36
Ephemeroptera	Caenidae		6			0			6	*4*	*3*	12	0.60	0.024	-0.09
Gastropoda	Lymnaeidae		1	0					1	*1*	*1*	1	0.05	0.004	-0.02
Trichoptera	calamoceratidae		1	0					1	*7*	*1*	7	0.35	0.004	-0.02
Trichoptera	Hydrobiosidae		4		0				4	*8*	*2*	16	0.80	0.016	-0.07
Trichoptera	Hydropsychidae		45					0	45	*6*	*5*	30	1.50	0.177	-0.31
Trichoptera	Leptoceridae		6			0			6	*6*	*3*	18	0.90	0.024	-0.09
Turbellaria	Dugesiidae		6			0			6	*2*	*3*	6	0.30	0.024	-0.09

Sample Site	**WO3**	**Indicator Values**	
Date sampled	**13-Sep-11**	**SIGNAL 2**	**5.1**
Replicate No.	1	**No.of families**	**15**
		No.of animals	**322**
		Shannon H	**1.3**
		E_H	**0.49**

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensitivity grade	weight factor	Grade*Weight	Value	Pi	Pi.Ln(Pi)
Coleotpera	Elmidae	*larvae*	3		0				3	*7*	*2*	14	0.50	0.009	-0.04
Coleoptera	Gyrinidae	*larvae*	1	0					1	*4*	*1*	4	0.14	0.003	-0.02
Coleoptera	Scirtidae	*larvae*	8			0			8	*6*	*3*	18	0.64	0.025	-0.09
Decapoda	Atyidae		2	0					2	*3*	*1*	3	0.11	0.006	-0.03
Diptera	Ceratopogonidae		1	0					1	*4*	*1*	4	0.14	0.003	-0.02
Diptera	Chironominae		37					0	37	*3*	*5*	15	0.54	0.115	-0.25
Diptera	Tipulidae		2	0					2	*5*	*1*	5	0.18	0.006	-0.03
Ephemeroptera	Baetidae		15				0		15	*5*	*4*	20	0.71	0.047	-0.14
Oligochaeta	Lumbriculidae		5		0				5	*3*	*2*	6	0.21	0.016	-0.06
Ostracoda	Ostracoda		1	0										0.003	-0.02
Trichoptera	Ecnomidae		15				0		15	*4*	*4*	16	0.57	0.047	-0.14
Trichoptera	Hydrobiosidae		16				0		16	*8*	*4*	32	1.14	0.050	-0.15
Trichoptera	Hydropsychidae		213					0	213	*6*	*5*	30	1.07	0.661	-0.27
Trichoptera	Hydroptilidae		1	0					1	*4*	*1*	4	0.14	0.003	-0.02
Trichoptera	Leptoceridae		2	0					2	*6*	*1*	6	0.21	0.006	-0.03

Sample Site	**WO3**	**SIGNAL 2**	**4.4**
Date sampled	**13-Sep-11**	**No.of families**	**14**
Replicate No.	2	**No.of animals**	**217**
		Shannon H	**1.5**
		E_H	**0.56**

Indicator Values

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensiti grade	weight factor	Grade*W eight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Dytiscidae	*larvae*	1	0					1	*2*	*1*	2	0.07	0.005	-0.02
Coleoptera	Scirtidae	*larvae*	44					0	44	*6*	*5*	30	1.07	0.203	-0.32
Decapoda	Atyidae		1	0					1	*3*	*1*	3	0.11	0.005	-0.02
Diptera	Chironominae		16				0		16	*3*	*4*	12	0.43	0.074	-0.19
Diptera	Simuliidae		3		0				3	*5*	*2*	10	0.36	0.014	-0.06
Diptera	Stratiomyidae		2	0					2	*2*	*1*	2	0.07	0.009	-0.04
Diptera	Tipulidae		5		0				5	*5*	*2*	10	0.36	0.023	-0.09
Ephemeroptera	Baetidae		9			0			9	*5*	*3*	15	0.54	0.041	-0.13
Gastropoda	Lymnaeidae		1	0					1	*1*	*1*	1	0.04	0.005	-0.02
Oligochaeta	Lumbriculidae		8			0			8	*3*	*3*	9	0.32	0.037	-0.12
Trichoptera	Hydrobiosidae		2	0					2	*8*	*1*	8	0.29	0.009	-0.04
Trichoptera	Hydropsychidae		121					0	121	*6*	*5*	30	1.07	0.558	-0.33
Trichoptera	Leptoceridae		1	0					1	*6*	*1*	6	0.21	0.005	-0.02
Turbellaria	Dugesiidae		3		0				3	*2*	*2*	4	0.14	0.014	-0.06

Sample Site	**WO3**	**Indicator Values**	
Date sampled	**13-Sep-11**	**SIGNAL 2**	**4.7**
Replicate No.	3	**No.of families**	**22**
		No.of animals	**347**
		Shannon H	**1.8**
		E_H	**0.57**

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensitivity grade	weight factor	Grade*Weight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Elmidae	*larvae*	1	0					1	*7*	*1*	7	0.25	0.003	-0.02
Coleoptera	Scirtidae	*larvae*	11				0		11	*6*	*4*	24	0.86	0.032	-0.11
Decapoda	Atyidae		16				0		16	*3*	*4*	12	0.43	0.046	-0.14
Decapoda	Palaeomonidae		5		0				5	*4*	*2*	8	0.29	0.014	-0.06
Diptera	Ceratopogonidae		1	0					1	*4*	*1*	4	0.14	0.003	-0.02
Diptera	Chironominae		43					0	43	*3*	*5*	15	0.54	0.124	-0.26
Diptera	Muscidae		1	0					1	*1*	*1*	1	0.04	0.003	-0.02
Diptera	Simuliidae		7			0			7	*5*	*3*	15	0.54	0.020	-0.08
Diptera	Stratiomyidae		1	0					1	*2*	*1*	2	0.07	0.003	-0.02
Diptera	Tabanidae		1	0					1	*3*	*1*	3	0.11	0.003	-0.02
Diptera	Tipulidae		1	0					1	*5*	*1*	5	0.18	0.003	-0.02
Ephemeroptera	Baetidae		35					0	35	*5*	*5*	25	0.89	0.101	-0.23
Ephemeroptera	Caenidae		1	0					1	*4*	*1*	4	0.14	0.003	-0.02
Ephemeroptera	Leptophlebiidae		1	0					1	*8*	*1*	8	0.29	0.003	-0.02
Gastropoda	Planorbidae		1	0					1	*2*	*1*	2	0.07	0.003	-0.02
Hemiptera	Veliidae		1	0					1	*3*	*1*	3	0.11	0.003	-0.02
Odonata	Gomphidae		1	0					1	*5*	*1*	5	0.18	0.003	-0.02
Trichoptera	Ecnomidae		13				0		13	*4*	*4*	16	0.57	0.037	-0.12
Trichoptera	Hydrobiosidae		9			0			9	*8*	*3*	24	0.86	0.026	-0.09
Trichoptera	Hydropsychidae		182					0	182	*6*	*5*	30	1.07	0.524	-0.34
Trichoptera	Hydroptilidae		2	0					2	*4*	*1*	4	0.14	0.006	-0.03
Trichoptera	Leptoceridae		13				0		13	*6*	*4*	24	#REF!	0.037	-0.12

Sample Site	**CC1**	**Indicator Values**	
Date sampled	**15-Sep-11**	**SIGNAL 2**	**3.5**
Replicate No.	1	**No.of families**	**16**
		No.of animals	**150**
		Shannon H	**1.8**
		E_H	**0.63**

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensiti grade	weight factor	Grade*W eight	Value	Pi	Pi.Ln(Pi)
Acarina	Hydracarina		1	0					1	*6*	*1*	6	0.27	0.01	-0.03
Coleoptera	Dytiscidae	*adult1 larvae1*	2	0					2	*2*	*1*	2	0.09	0.01	-0.06
Coleoptera	Hydraenidae	*adult*	3		0				3	*3*	*2*	6	0.27	0.02	-0.08
Coleoptera	Hydrophilidae	*adult*	4		0				4	*2*	*2*	4	0.18	0.03	-0.10
Diptera	Chironominae		37					0	37	*3*	*5*	15	0.68	0.25	-0.35
Diptera	Simuliidae		70					0	70	*5*	*5*	25	1.14	0.47	-0.36
Ephemeroptera	Baetidae		1	0					1	*5*	*1*	5	0.23	0.01	-0.03
Ephemeroptera	Caenidae		2	0					2	*4*	*1*	4	0.18	0.01	-0.06
Gastropoda	Lymnaeidae		10			0			10	*1*	*3*	3	0.14	0.07	-0.18
Gastropoda	Planorbidae		3		0				3	*2*	*2*	4	0.18	0.02	-0.08
Odonata	Corduliidae		2	0					2	*5*	*1*	5	0.23	0.01	-0.06
Odonata	Libellulidae		1	0					1	*4*	*1*	4	0.18	0.01	-0.03
Odonata	Synlestidae		2	0					2	*7*	*1*	7	0.32	0.01	-0.06
Ostracoda	Ostracoda		4		0									0.03	-0.10
Trichoptera	Leptoceridae		4		0				4	*6*	*2*	12	0.55	0.03	-0.10
Turbellaria	Dugesiidae		4		0				4	*2*	*2*	4	0.18	0.03	-0.10

Sample Site	**CC1**	**SIGNAL 2**	**3.8**
Date sampled	**15-Sep-11**	**No.of families**	**14**
Replicate No.	2	**No.of animals**	**126**
		Shannon H	**1.6**
		E_H	**0.61**

Indicator Values

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensitivity grade	weight factor	Grade*Weight	Value	Pi	Pi.Ln(Pi)
Acarina	Hydracarina		1	0					1	*6*	*1*	6	0.27	0.01	-0.04
Coleoptera	Dytiscidae	*adult*	1	0					1	*2*	*1*	2	0.09	0.01	-0.04
Coleoptera	Hydraenidae	*adult*	2	0					2	*3*	*1*	3	0.14	0.02	-0.07
Coleoptera	hydrophilidae	*adult*	1	0					1	*2*	*1*	2	0.09	0.01	-0.04
Coleoptera	Scirtidae	adult	3		0				3	*6*	*2*	12	0.55	0.02	-0.09
Diptera	Chironominae		19				0		19	*3*	*4*	12	0.55	0.15	-0.29
Diptera	Simuliidae		69					0	69	*5*	*5*	25	1.14	0.55	-0.33
Diptera	Tipulidae		1	0					1	*5*	*1*	5	0.23	0.01	-0.04
Gastropoda	Lymnaeidae		8			0			8	*1*	*3*	3	0.14	0.06	-0.18
Gastropoda	planorbidae		2	0					2	*2*	*1*	2	0.09	0.02	-0.07
Ostracoda	Ostracoda		3		0									0.02	-0.09
Trichoptera	Hydropsychidae		10			0			10	*6*	*3*	18	0.82	0.08	-0.20
Trichoptera	leptoceridae		1	0					1	*6*	*1*	6	0.27	0.01	-0.04
Turbellaria	Dugesiidae		5		0				5	*2*	*2*	4	0.18	0.04	-0.13

Sample Site	**CC1**	**Indicator Values**	
Date sampled	**15-Sep-11**	**SIGNAL 2**	**3.4**
Replicate No.	3	**No.of families**	**14**
		No.of animals	**187**
		Shannon H	**1.4**
		E_H	**0.53**

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensitivity grade	weight factor	Grade*Weight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Dytiscidae	*adult*	3		0				3	*2*	*2*	4	0.18	0.02	-0.09
Coleoptera	Hydraenidae	*adult*	2	0					2	*3*	*1*	3	0.14	0.02	-0.07
Coleoptera	Hydrophilidae	*adult*	7			0			7	*2*	*3*	6	0.27	0.06	-0.16
Coleoptera	Scirtidae		3		0				3	*6*	*2*	12	0.55	0.02	-0.09
Diptera	Chironominae		5		0				5	*3*	*2*	6	0.27	0.04	-0.13
Diptera	Simuliidae		128					0	128	*5*	*5*	25	1.14	1.02	0.02
Diptera	Stratiomyidae		2	0					2	*2*	*1*	2	0.09	0.02	-0.07
Gastropoda	Lymnaeidae		14				0		14	*1*	*4*	4	0.18	0.11	-0.24
Gastropoda	Planorbidae		1	0					1	*2*	*1*	2	0.09	0.01	-0.04
Ostracoda	Ostracoda		4		0									0.03	-0.11
Trichoptera	Hydrobiosidae		1	0					1	*8*	*1*	8	0.36	0.01	-0.04
Trichoptera	Hydropsychidae		1	0					1	*6*	*1*	6	0.27	0.01	-0.04
Trichoptera	Leptoceridae		5		0				5	*6*	*2*	12	0.55	0.04	-0.13
Turbellaria	Dugesiidae		11				0		11	*2*	*4*	8	0.36	0.09	-0.21

Sample Site	**CC2**	**SIGNAL 2**	**3.3**
Date sampled	**15-Sep-11**	**No.of families**	**15**
Replicate No.	1	**No.of animals**	**220**
		Shannon H	**1.1**
		E_H	**0.41**

Indicator Values

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensiti grade	weight factor	Grade*W eight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Dytiscidae	*adult*	1	0					1	*2*	*1*	2	0.07	0.005	-0.02
Coleoptera	Hydrophilidae	*adult*	1	0					1	*2*	*1*	2	0.07	0.005	-0.02
Coleoptera	Scirtidae	*adult*	1	0					1	*6*	*1*	6	0.21	0.005	-0.02
Diptera	Ceratopogonidae		2	0					2	*4*	*1*	4	0.14	0.009	-0.04
Diptera	Chironominae		5		0				5	*3*	*2*	6	0.21	0.023	-0.09
Diptera	Dolichopodidae		1	0					1	*3*	*1*	3	0.10	0.005	-0.02
Diptera	Sciomyzidae		1	0					1	*2*	*1*	2	0.07	0.005	-0.02
Diptera	Simuliidae		28					0	28	*5*	*5*	25	0.86	0.127	-0.26
Diptera	Stratiomyidae		4		0				4	*2*	*2*	4	0.14	0.018	-0.07
Gastropoda	Lymnaeidae		6			0			6	*1*	*3*	3	0.10	0.027	-0.10
Gastropoda	Planorbidae		2	0					2	*2*	*1*	2	0.07	0.009	-0.04
Odonata	Coenagrionidae		2	0					2	*2*	*1*	2	0.07	0.009	-0.04
Odonata	Libellulidae		1	0					1	*4*	*1*	4	0.14	0.005	-0.02
Ostracoda	Ostracoda		160					0						0.727	-0.23
Trichoptera	Leptoceridae		5		0				5	*6*	*2*	12	0.41	0.023	-0.09

Sample Site	**CC2**	**SIGNAL 2**	**3.4**
Date sampled	**15-Sep-11**	**No.of families**	**15**
Replicate No.	2	**No.of animals**	**248**
		Shannon H	**1.5**
		E_H	**0.55**

Indicator Values

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensitivity grade	weight factor	Grade*Weight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Dytiscidae	*adult*	2	0					2	*2*	*1*	2	0.07	0.008	-0.04
Coleoptera	Hydraenidae	*adult*	1	0					1	*3*	*1*	3	0.10	0.004	-0.02
Coleoptera	Hydrophilidae	*larvae*	1	0					1	*2*	*1*	2	0.07	0.004	-0.02
Coleoptera	Scirtidae	*larvae*	1	0					1	*6*	*1*	6	0.21	0.004	-0.02
Diptera	Ceratopogonidae		1	0					1	*4*	*1*	4	0.14	0.004	-0.02
Diptera	Chironominae		32					0	32	*3*	*5*	15	0.52	0.129	-0.26
Diptera	sciomyzidae		2	0					2	*2*	*1*	2	0.07	0.008	-0.04
Diptera	Simuliidae		117					0	117	*5*	*5*	25	0.86	0.472	-0.35
Diptera	Stratiomyidae		6			0			6	*2*	*3*	6	0.21	0.024	-0.09
Gastropoda	Lymnaeidae		4		0				4	*1*	*2*	2	0.07	0.016	-0.07
Odonata	Coenagrionidae		4		0				4	*2*	*2*	4	0.14	0.016	-0.07
Odonata	Corduliidae		1	0					1	*5*	*1*	5	0.17	0.004	-0.02
Odonata	Libellulidae		2	0					2	*4*	*1*	4	0.14	0.008	-0.04
Ostracoda	Ostracoda		70					0						0.282	-0.36
Trichoptera	Leptoceridae		4		0				4	*6*	*2*	12	0.41	0.016	-0.07

Sample Site	**CC2**		
Date sampled	**15-Sep-11**		
Replicate No.	3		

Indicator Values

SIGNAL 2	**3.2**
No.of families	**16**
No.of animals	**242**
Shannon H	**1.4**
E_H	**0.51**

Order	Family	Type	Count	Abundance grade 1	2	3	4	5		Sensiti grade	weight factor	Grade*Weight	Value	Pi	Pi.Ln(Pi)
Coleoptera	Dytiscidae	*adult*	1	0					1	*2*	*1*	2	0.07	0.004	-0.02
Coleoptera	Hydrophilidae	*adult*	1	0					1	*2*	*1*	2	0.07	0.004	-0.02
Collembola	Collembola		1	0					1	*1*	*1*	1	0.03	0.004	-0.02
Diptera	Chironominae		6			0			6	*3*	*3*	9	0.31	0.025	-0.09
Diptera	Sciomyzidae		1	0					1	*2*	*1*	2	0.07	0.004	-0.02
Diptera	Simuliidae		56					0	56	*5*	*5*	25	0.86	0.231	-0.34
Diptera	Stratiomyidae		5		0				5	*2*	*2*	4	0.14	0.021	-0.08
Gastropoda	Lymnaeidae		10			0			10	*1*	*3*	3	0.10	0.041	-0.13
Gastropoda	Planorbidae		7			0			7	*2*	*3*	6	0.21	0.029	-0.10
Odonata	Aeshnidae		1	0					1	*4*	*1*	4	0.14	0.004	-0.02
Odonata	Coenagrionidae		2	0					2	*2*	*1*	2	0.07	0.008	-0.04
Odonata	Corduliidae		1	0					1	*5*	*1*	5	0.17	0.004	-0.02
Odonata	Libellulidae		2	0					2	*4*	*1*	4	0.14	0.008	-0.04
Ostracoda	Ostracoda		140					0						0.579	-0.32
Trichoptera	Leptoceridae		7			0			7	*6*	*3*	18	0.62	0.029	-0.10
Turbellaria	Dugesiidae		1	0					1	*2*	*1*	2	0.07	0.004	-0.02

APPENDIX B

AUSRIVAS MODEL RESULTS TABLE

PREDICTED/COLLECTED

Site	NTE50	NTP50	NTC50	OE50	E50Signal	O50Signal	OE50Signal	E0Signal	O0Signal	OE0Signal	Band
WC1	12.19	15.00	6.00	0.49	5.91	6.00	1.02	5.73	4.65	0.81	B
WC2	12.17	15.00	6.00	0.49	5.90	5.33	0.90	5.71	4.73	0.83	B
WC3	11.61	14.00	2.00	0.17	5.85	2.50	0.43	5.69	3.88	0.68	C
WC4	11.56	14.00	4.00	0.35	5.84	5.50	0.94	5.65	4.34	0.77	C
WC5	11.03	13.00	3.00	0.27	5.76	5.67	0.98	5.62	4.33	0.77	C
WC6	11.02	13.00	4.00	0.36	5.75	6.25	1.09	5.61	4.38	0.78	C
WC7	11.01	13.00	4.00	0.36	5.74	5.75	1.00	5.59	4.40	0.79	C
WC8	11.00	13.00	6.00	0.55	5.74	5.00	0.87	5.59	4.42	0.79	B
WO1	11.57	14.00	7.00	0.60	5.85	5.43	0.93	5.66	4.55	0.80	B
WO2	11.58	14.00	7.00	0.60	5.85	5.71	0.98	5.67	4.71	0.83	B
WO3	10.92	13.00	6.00	0.55	5.74	5.33	0.93	5.52	4.25	0.77	B
CC1	10.93	13.00	5.00	0.46	5.73	5.60	0.98	5.52	4.48	0.81	B
CC@	10.92	13.00	1.00	0.09	5.74	3.00	0.52	5.52	4.00	0.73	C