ALS Laboratory Group

Environmental

HOLCIM Australia

Rooty Hill Environmental Monitoring Program

2009 Annual Report

Adelaide - Brisbane - Canberra - Melbourne - Perth - Sydney - Regional offices

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Table of Contents

Table of Figures

List of Tables

List of Appendices

1 Introduction

1.1 Background

HOLCIM (formerly CEMEX and Readymix) proposes to build and operate a Regional Distribution Centre (RDC) in Rooty Hill, near Blacktown, in Western Sydney. The RDC would facilitate the logistics of receiving, blending and distributing bulk construction products, such as sand and aggregate. Raw materials would be transported by rail to the site, blended and then transported in smaller loads via the motorway network to the Sydney market (Readymix, 2005b).

The majority of building material used in the Sydney region is sourced from the Penrith Lakes Development Scheme, which is in the process of winding down production. Material will therefore need to be externally sourced and there is likely to be a greater reliance on bulk import and redistribution.

The proposed development has been designated as a 'Major Project' under NSW *State Environment Planning Policy, 2005*. The development application for the RDC was approved in 2006, with conditions set out to minimise the Centre's impact on the local community and the environment (NSW Department of Planning, 2006).

The development includes:

- storage silos for a range of building materials including sand and aggregate
- a concrete batching plant
- a concrete testing laboratory
- a conveyor system linking a rail unloading station with the storage facilities
- bridges at two locations across Angus Creek
- workshops, office buildings, weighbridges and truck parking.

The construction phase is expected to take approximately 2 years and would employ about 220. Once operational, the proposed RDC would have the capacity to handle up to 4 million tonnes of construction materials per annum and is proposed to operate 24 hours a day, 7 days a week. It is expected that the RDC facility would employ approximately 230 – 270 people at full production (Readymix, 2005b).

1.2 Scope of work

In 2008 the Australian Laboratory Services (ALS) Water Resources Group (formerly Ecowise Environmental) was commissioned to conduct baseline monitoring of water quality, aquatic ecology, riparian vegetation and ambient air quality in the lead-up to construction. Additional investigative work was also conducted outside the specified proposal, to gain information on local soil, geology and landform characteristics.

This report presents the findings of initial baseline environmental monitoring, completed during 2009 and early 2010. The objective of this project is to provide information on the natural environment that will be used in the development of a site management plan for construction and operation of the RDC.

This management plan will assist with the sustainable development of the site, considering environmental, social and economic values.

2 Study Area

This section provides an overview of the study area, following a literature review of available sources of information. Information relating to the current investigation is covered in the following sections.

2.1 General overview

The proposed development area for the RDC includes a large parcel of land adjoining the main western railway line, where the main construction activities will take place and a separate site to the north, where the administration and laboratory facilities would be located (Readymix, 2005b). These areas are outlined in red in Figure 1 below.

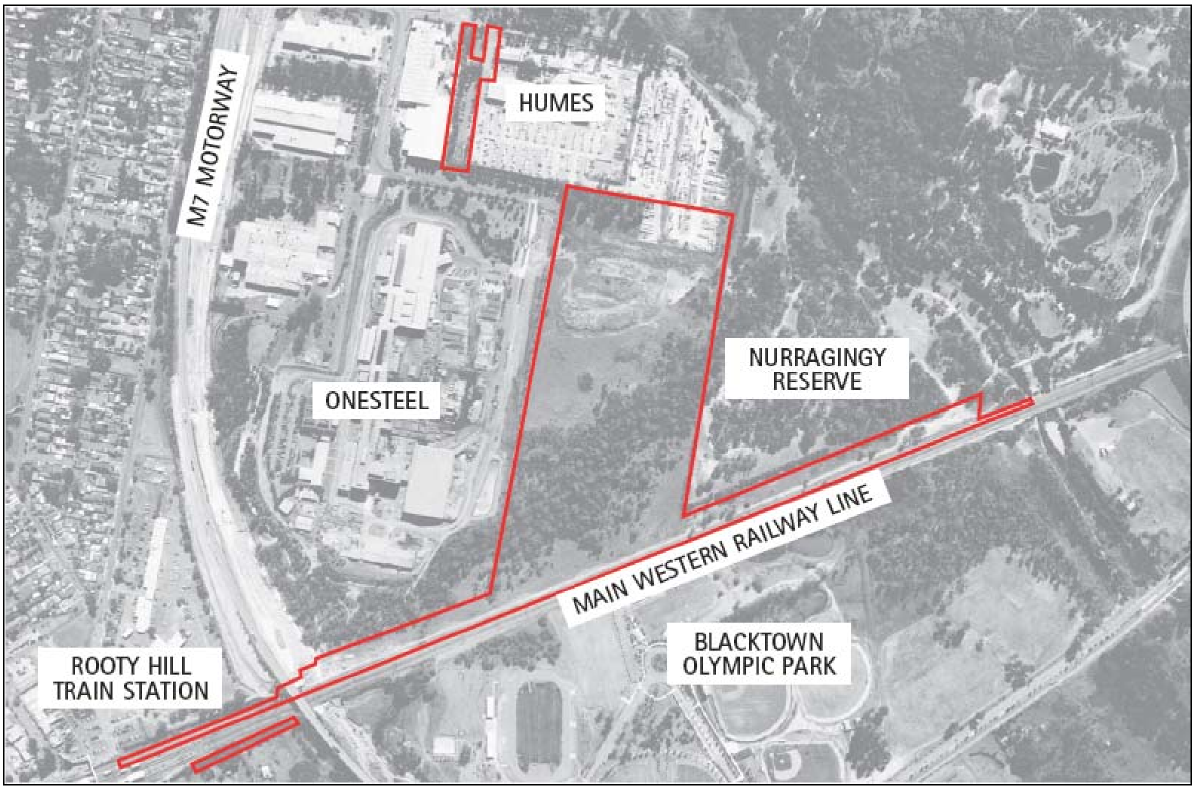

Figure 1 – Proposed Development Area (Readymix 2005b)

The study area is bounded by: the Humes concrete product site to the north; the Onesteel 'mini mill' to the west; the main western railway line to the south; and Nurragingy Reserve to the east. Other significant local land use in the vicinity, include the Blacktown Olympic Park on the southern side of the railway line and the Rooty Hill town centre to the south west (Figure 1).

The site is within the Blacktown Local Government Area (LGA), on the Cumberland Plain approximately 37 km west of the Sydney CBD. Blacktown is one of the most populous LGAs in NSW (Blacktown City Council 2010a quoting ABS Census, 2006) with a total population of 271 710 and a land area covering 246.9 km^2.

2.2 Catchment area

2.2.1 North-western Sydney region (downstream)

In a regional context, the proposed RDC site is part of the greater Hawkesbury-Nepean catchment, which is managed by the Hawkesbury-Nepean Catchment Management Authority (HNCMA). The HNCMA has a statutory obligation under the *NSW Catchment Management Authorities Act, 2003*, for responsible planning and management of environmental values within the catchment.

The Hawkesbury Nepean catchment extends from the upper Warragamba, in the Blue Mountains to the west; and from the upper Nepean in the Southern Highlands in the south; down to the mouth of the Hawkesbury River at Broken Bay.

The RDC site is located on Angus Creek in the upper South Creek sub-catchment, which is close to the centre of the Cumberland Plain, in western Sydney (Figure 2). Eastern Creek meets several other north-flowing creeks in the area, which drain the north western part of the Sydney Basin.

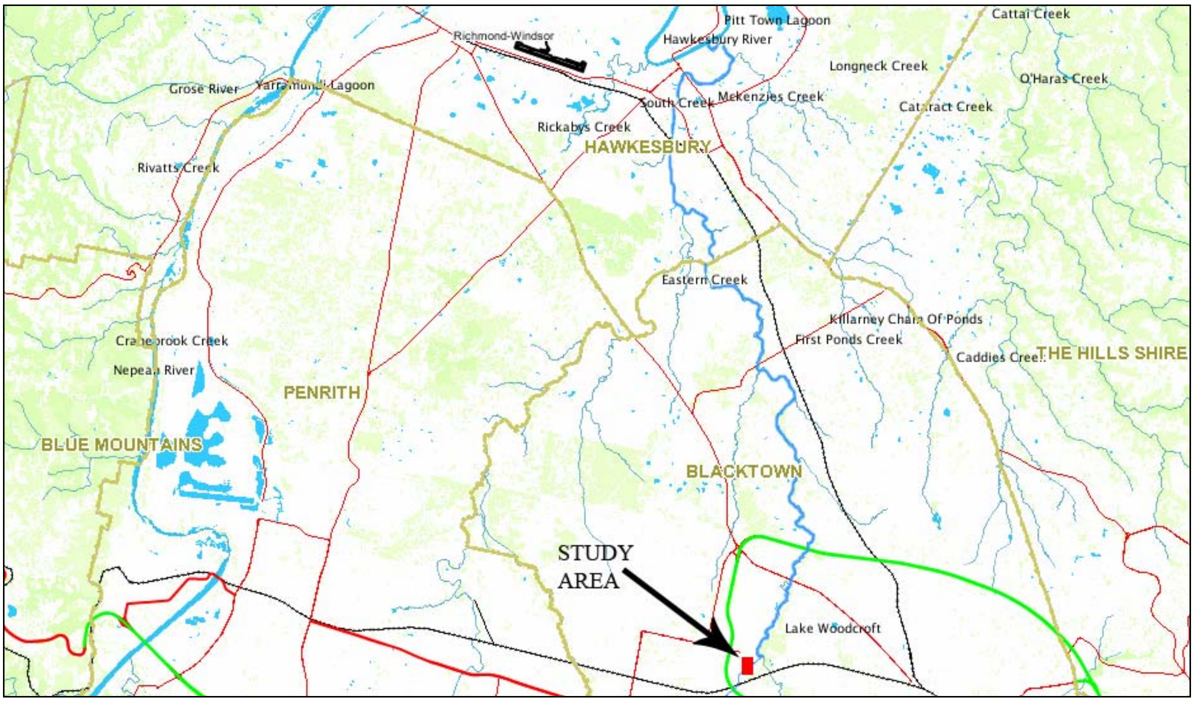

Figure 2 – Regional catchment area visualisation (modified from the NSW Dept. Lands, 2010)

Water quality and aquatic ecosystem values of the Eastern Creek and South Creek catchment areas are generally low, due mostly to the extensive deforestation and urbanization of the region (HNCMA, 2010). Nevertheless, construction and operation activities on site need to be performed in an ecologically sustainable manner, so as not to further degrade the aquatic environment and complying with NSW State's environmental protection legislation, such as the *Protection of the Environment Operations Act, 1997*.

In the case of a major pollution event originating from the Angus Creek catchment, significant impacts on the receiving aquatic environment could extend along Eastern Creek and South Creek as far as the Hawkesbury estuary.

2.2.2 Local Catchment Area (upstream)

Figure 3 below illustrates the position of the main area of the RDC site within the Angus Creek catchment. The map features and watershed boundaries were defined using information from the NSW Department of Lands (2010) and Blacktown City Council (2005).

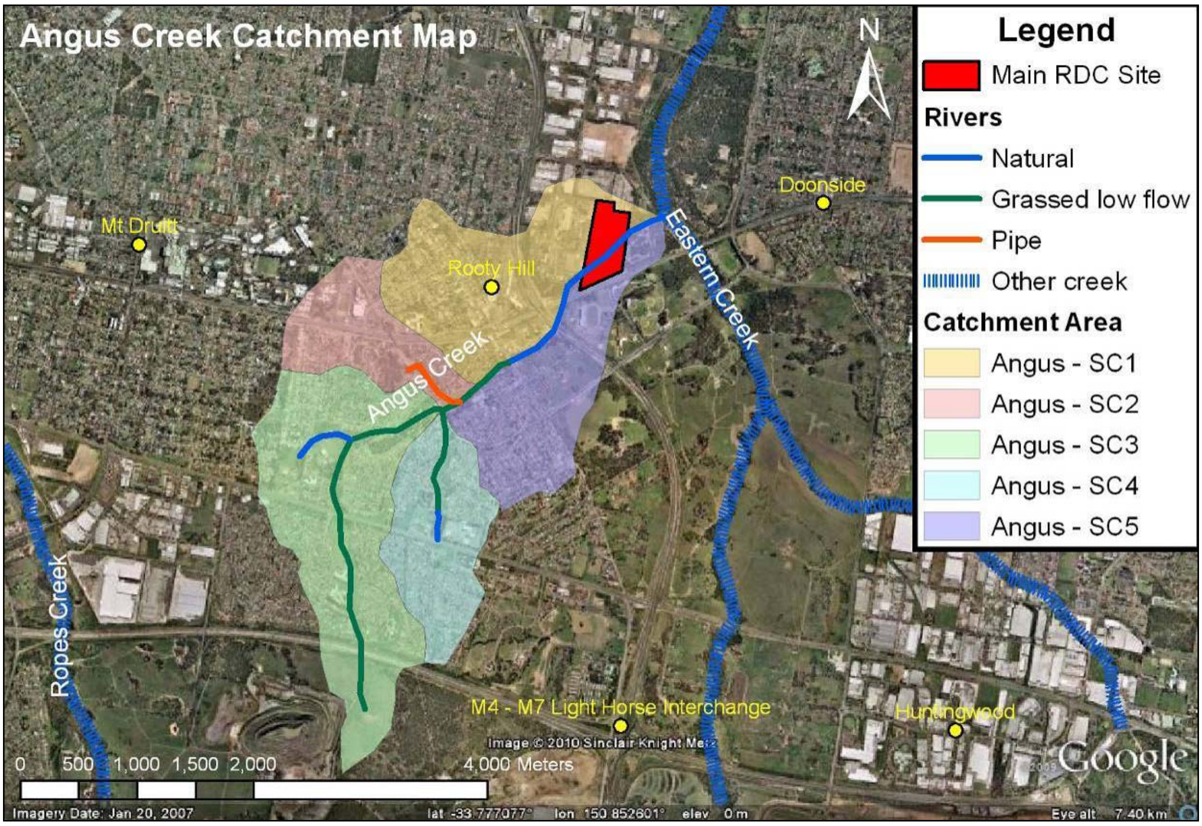

Figure 3 – Angus Creek catchment area visualisation (modified from Google Earth)

Blacktown City Council (2005) ranked the Angus Creek catchment as the 2nd highest polluting catchment and 13th for overall waterway condition, out of 22 catchments under study for the City's 2005 State of the Waterways Management Plan. The catchment is heavily developed, with a percentage imperviousness of approximately 58%.

The Angus Creek sub-catchment 1 (SC1 from Figure 3), which encapsulates the majority of the RDC site, was rated as the poorest of the 5 sub-catchments studied for pollutant export (Blacktown City Council, 2005). This rating reflects the higher proportion of industrial land use in this sub-catchment. The adjacent sub-catchment 5 (SC5 from Figure 3) was rated as having a comparatively lower pollutant export.

Of the total catchment area (635 ha), the largest proportion of land use is residential (36% or 231 ha); followed by roads and railways (23% or 165 ha); and open space, pasture and bushland (26% or 145 ha). The remaining land is made up of commercial and industrial activities (13% or 46.1 ha) and special areas (2% or 11 ha).

Catchment management actions recommended by Blacktown council include revegetation and rehabilitation actions, removal of dumped rubbish, erosion control, re-snagging, consultation with local communities and industries and enforcing industry regulation (Blacktown City Council, 2005)

3 Study Methods

3.1 Monitoring sites and regime

Figure 4 below illustrates the sampling locations for air, water and ecological parameters. Sites were selected after a feasibility assessment was conducted in late 2008 (Ecowise, 2008), having originally been specified by HOLCIM.

Monitoring generally follows the standard BACI (Before-After, Control-Impact) approach, with baseline data currently being collected before construction and operation activities commence on site, for comparisons over time.

Figure 4 – Air, water and ecology sample locations map (modified from Google Earth)

A total of six sites were located along local watercourses (site names preceded by 'AE'). Four of these sites were located on Angus Creek and two were located on Eastern Creek. Three sites were positioned upstream of potential impacts from the proposed RDC development (two on Angus Creek and one on Eastern Creek) and three sites were positioned in downstream locations.

Three air quality sites were also located in the area, two within the proposed RDC site boundaries and one within the Blacktown Olympic Park grounds. High Volume Air Samplers (HVAS) collected samples from two sites and depositional dust (DD) gauges collected samples from all three sites.

The indicators selected for the study were therefore:

a) air quality

b) water quality

c) aquatic ecosystem

d) riparian vegetation

Table 1 presents the site codes and location coordinates (World Geodetic System, 1984), for each aquatic monitoring (AE) site. The sample frequency and number of events per annum is also presented.

Table 1 – Site descriptions and sample regime for aquatic monitoring sites

Site Code	Sample Type	Frequency	Events p/a	Latitude	Longitude
AE1	Surface Water	Quarterly	4	33.76806	150.85173
	Aquatic Ecology	Spring & Autumn	2		
	Riparian Vegetation	Bi-annually	2		
AE2	Surface Water	Quarterly	4	33.76519	150.85497
	Aquatic Ecology	Spring & Autumn	2		
	Riparian Vegetation	Bi-annually	2		
AE3	Surface Water	Quarterly	4	33.76490	150.85567
	Aquatic Ecology	Spring & Autumn	2		
	Riparian Vegetation	Bi-annually	2		
AE4	Surface Water	Quarterly	4	33.76360	150.85655
	Aquatic Ecology	Spring & Autumn	2		
	Riparian Vegetation	Bi-annually	2		
AE5	Surface Water	Quarterly	4	33.76434	150.85748
	Aquatic Ecology	Spring & Autumn	2		
	Riparian Vegetation	Bi-annually	2		
AE6	Surface Water	Quarterly	4	33.77207	150.84926
	Aquatic Ecology	Spring & Autumn	2		
	Riparian Vegetation	Bi-annually	2		

Table 2 presents the site codes and location coordinates (World Geodetic System, 1984), for each air quality monitoring site (HVAS and DD). The frequency and proposed number of sampling events per annum for 2009 is also presented (not considering samples missed due to equipment failure).

Table 2 – Site descriptions and sample regime for air quality monitoring sites

Site Code	Sample Type	Frequency	Events p/a	Latitude	Longitude
HVAS1	HVAS – TSP	Every 6 days	61	33.76539	150.85437
DD1	Depositional Dust	Monthly	12		
HVAS2	HVAS – TSP	Every 6 days	61	33.76934	150.76934
DD2	Depositional Dust	Monthly	12		
DD3	Depositional Dust	Monthly	12	33.76793	150.85411

3.2 Ambient air quality monitoring

Ambient air quality was measured on site by collection of Total Suspended Particulates (TSP) samples from two High Volume Air Samplers (HVAS). Total deposited matter was also measured at three Depositional Dust Gauges (DDGs).

3.2.1 TSP sampling using HVAS

All sampling and analysis for the measurement of TSP, was conducted in accordance with the Australian Standards AS/NZS 3580.9.3 (2003).

Calibration is required every two months and is performed by field staff to ensure that the units are operating effectively and conforming to the required flow rate. Calibration of both HVAS units was completed immediately after installation (30.01.09) and is performed at 2 monthly intervals thereafter.

3.2.2 Depositional dust sampling

All sampling and analysis for the measurement of depositional dust, was conducted according to the Australian Standard AS/NZS 3580.10.1 (2003).

Samples were collected as close as possible to the first day of each month. Any potential contamination of the sample was noted on a field sheet. Common contaminants include insects, bird droppings and vegetation, although gauges can also be vandalised if not adequately protected.

3.2.3 Air quality assessment guidelines

HVAS and DDG results were evaluated against the air quality goals outlined in the statement of commitments in the Director Generals Environmental Assessment Report (NSW Department of Planning, 2006). The specific air quality goals are presented in Table 3 below.

Table 3 – NSW Department of Planning Air Quality Goals

Pollutant	Averaging Period	Concentration Guideline
HVAS - TSP	Annual	90 $\mu g/m^3$
Dust Deposition	Annual	2 $grams/m^2/month$

3.3 Water quality monitoring

Water quality data was collected through measurement of in-situ physicochemical parameters and by ex-situ (laboratory) analysis of water samples. All water sampling was conducted during base flow conditions.

3.3.1 Water quality sampling and laboratory analysis

All water sampling was conducted in accordance with the Australian/New Zealand standards for water quality sampling (AS/NZS S667:1:1998). Samples were collected in the appropriate bottles and subject to the appropriate preservation techniques for the analysis required.

The following analytes were measured through ex-situ analysis of water samples.

- Total nitrogen;
- Total phosphorus;
- Total alkalinity; and,
- Turbidity.

3.3.2 In-situ physical and chemical measurement

A fully calibrated Hydrolab multi-parameter water quality meter was used to measure the following parameters in-situ at each site: Calibration of the meter was completed prior to deployment. Measurements were taken from just below the waters surface in areas where water was flowing (if applicable).

- pH.
- Dissolved oxygen.
- Temperature.
- Electrical conductivity.

3.3.3 Quality assurance / quality control

A field duplicate and a trip blank sample were collected during the august sampling event for quality assurance purposes. Both samples were within an acceptable range from the expected values. Information on the quality assurance samples can be provided on request.

3.3.4 Water quality assessment guidelines

Water quality data was evaluated using default trigger values for aquatic ecosystems of south-east Australian lowland rivers, as outlined in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000). The relevant guidelines are displayed in Table 4.

Table 4 – ANZECC guidelines for South East Australian aquatic ecosystems

Parameter	Units	ANZECC (2000) aquatic ecosystem guidelines for southeast Australian lowland rivers
Conductivity	µS/cm	125 - 2200
pH	pH units	6.5 - 8.0
Dissolved Oxygen	% sat	85 - 110
Turbidity	NTU	6 - 50
Total Phosphorous	mg/L	0.025
Total Nitrogen	mg/L	0.35

3.4 Freshwater macroinvertebrate sampling

Sample collection, processing and habitat assessment was undertaken by ALS in strict accordance with the protocols defined in the *NSW AUSRIVAS Sampling and Processing Manual* (Turak *et al.,* 2004).

Freshwater macroinvertebrate sampling involved the collection of samples from 10 metres of suitable edge habitat at each site. Sampling was undertaken with sweep nets with a mesh size of 250µm. Nets were washed thoroughly in creek water between sampling events to remove any invertebrates retained on them.

3.4.1 Habitat and physical description

Descriptions of sites included visual estimates of streambed composition (percentage of total for each substrate category), amount/type of in-stream organic material, and basic riparian vegetation characteristics. The width, depth and general geomorphologic characteristics were also recorded at each site.

A plan and cross sectional map were drawn at each sample event, with specific features and record locations noted. Field sheets containing field data can be provided on request.

3.4.2 Macroinvertebrate sampling

A sample of macroinvertebrates inhabiting the littoral or 'edge habitat' (area along creek bank with little or no current) was collected at each site by disturbing substrate and other material in this zone to dislodge organisms. The net was swept around overhanging vegetation, against snags, where present and in backwaters to include all habitats present in the sample. This process was continued, working upstream, until 10 metres of edge habitat had been sampled.

3.4.3 Sample processing

For each sample, the collected material was placed into a sorting tray and macroinvertebrates were picked using forceps and pipettes for a minimum of 40 minutes by experienced AUSRIVAS accredited aquatic ecologists. Picking ceased when no new taxa were being found after 40 minutes.

Samples were preserved in 100% methylated spirits and clearly labelled with information including site, habitat, sampling method, date and sampler. Samples were transported to the ALS Brisbane laboratory for identification to family level using microscopy.

3.4.4 Data analysis

After the identification and enumeration of the macroinvertebrates samples, the data was analysed using a number of techniques.

Richness

Richness refers to the number of different taxa contained in the sample. Unlike some biological indices, a higher number does not always indicate better in-stream conditions. Higher values may indicate favourable conditions in terms of availability of food and/or the quality of habitat. However, in some cases, high richness values can also occur when altered conditions provide habitats that may not occur naturally (e.g. riffle habitats due to altered flow conditions).

EPT

The EPT richness is calculated by summing the number of taxa belonging to the orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) in each sample. The presence of organisms belonging to these orders is used as an indicator of good water quality due to their generally low sensitivity to pollution.

AUSRIVAS

AUSRIVAS (Australian River Assessment System) is a national model based on the distribution of macroinvertebrates in relatively undisturbed systems that is used to assess the health of Australian rivers. AUSRIVAS provides spatial predictions of the macroinvertebrate fauna expected to be present in the absence of environmental stress. The model also incorporates habitat and water quality variables in the prediction of the hypothetical control community. The macroinvertebrates expected to occur in the absence of environmental stress are then compared with the collected data to provide information on the level of perceived ecological impairment.

To run the AUSRIVAS model for NSW 'edge habitat' a number of habitat variables are required. These are presented in Table 5 overleaf.

Please note that the AUSRIVAS outputs for autumn would not have been available without adjustment of the input alkalinity values. The original run of the model resulted in no outputs, due to the alkalinity inputs being outside the experience of the model. This was rectified by adjusting the input alkalinity value to 150 mg/L for all samples that were above this value, which then allowed the model to provide outputs. This may have altered the outputs slightly, although this was deemed that the alteration would be relatively insignificant considering the low output values obtained across all sites.

Table 5 – Required NSW Spring AUSRIVAS habitat variables

Habitat Descriptor	Description
ALKALINITY	Total carbonates (mg/L)
ALTITUDE	Height above sea level (m)
BEDROCK	Percent bedrock in habitat (%)
BOULDER	Percent boulder in habitat (%)
COBBLE	Percent cobble in habitat (%)
LATITUDE	Latitude of site (decimal degrees to 4dp)
LOGDFSM	Log 10 (x) Distance from source
LOGSLOPE1KUS	Log 10 (x) Slope: Elevation difference in metres between the middle of the site and a point 1km upstream.
LONGITUDE	Longitude of site (decimal degrees to 4dp)
RAINFALL	Mean annual rainfall (mm)

The AUSRIVAS model output is in the form of an Observed to Expected (OE) ratio, and ranges from zero (0), when none of the expected taxa are found at a site, to around one (1), when all the expected taxa are present.

The value can also be greater than one (>1) when more families are found at the site than expected by the model. The O/E scores derived from the model are placed in bands (Table 6), which relate to the level of environmental impairment at a site.

Table 6 – Key to AUSRIVAS O/E family scores and bands for NSW edge habitats.

Band Label	Band Name	OE50 upper limit	Comments
Band X	More biologically diverse than reference sites.	Infinity	More taxa found than expected. Potential biodiversity hot-spot. Possible mild organic enrichment.
Band A	Reference condition.	1.16	Most/all of the expected families found. Water quality and/or habitat condition roughly equivalent to reference sites. Impact on water quality and habitat condition does not result in a loss of macroinvertebrate diversity.
Band B	Significantly impaired.	0.83	Fewer families than expected. Potential impact either on water quality or habitat quality or both, resulting in loss of taxa.
Band C	Severely impaired.	0.51	Many fewer families than expected. Loss of macroinvertebrate biodiversity due to substantial impacts on water and/or habitat quality.
Band D	Extremely impaired.	0.19	Few of the expected families remain. Extremely poor water and/or habitat quality. Highly degraded.

SIGNAL2

SIGNAL2 (Stream Invertebrate Grade Number Average Level - Version 2) (Chessman, 2003) is a simple scoring system for macroinvertebrates of Australian rivers. Each taxon is assigned a grade from 1 (tolerant) to 10 (sensitive) based on eco-toxicity assessment data.

The average of the grades for each site is used as the SIGNAL2 score. The SIGNAL2 score has been calculated using family grades with exclusion of microcrustacea and organisms not able to be identified to family level. The calculation of the SIGNAL2 score has not been weighted in regards to the abundance of organisms.

For easier interpretation, SIGNAL 2 scores and the number of macroinvertebrate taxa have been graphed using a biplot (Figure 5). The resulting biplot is placed into context using a quadrat diagram that divides the results into four general realms described in Figure 5.

The quadrat boundaries have been set at a SIGNAL2 score of 4 and at 20 for the number of macroinvertebrate families, after consideration of suggested NSW interim SIGNAL2 boundaries.

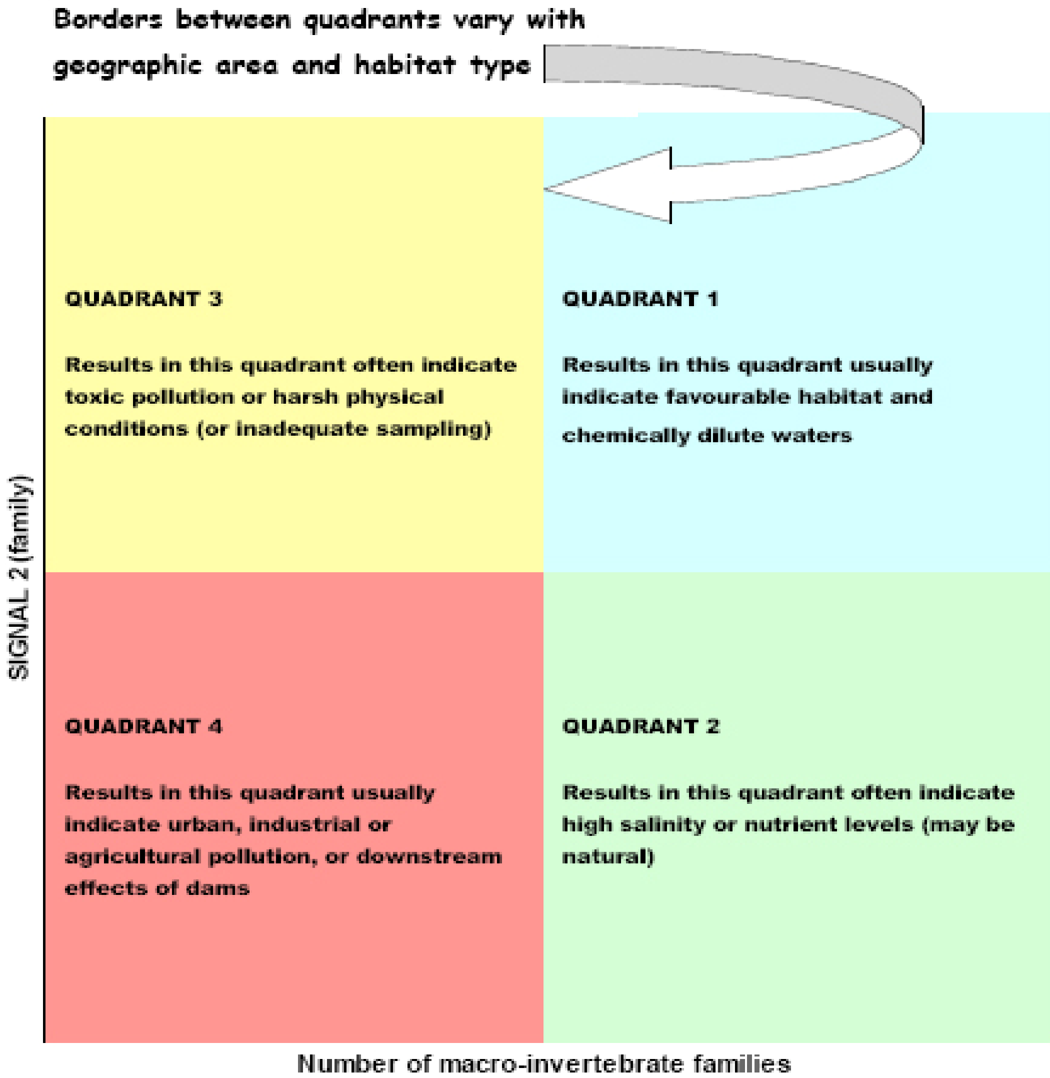

Figure 5 – SIGNAL2 biplot for the assessment of outputs (Chessman, 2003)

3.5 Riparian vegetation

The assessment of riparian vegetation was conducted at two locations (upstream and downstream) of each AE site. The line intercept method was used to collect data along transects running perpendicular to the water course.

All transects extended from the waters edge to a distance of 20m from each bank and included observations of in-stream vegetation. Transect lines were placed in areas most representative of the vegetation in the local vicinity.

The line intercept method allows the frequency of occurrence to be recorded along the transect. The frequency of occurrence reflects the cover and abundance of individual species along the line transect and is assumed to be representative of the area that the transect is located.

The line also allows the occurrence of species to be described in relation to the water course (i.e. the distance from the water) and provides a simple and quantitative assessment of the riparian vegetation that can then be used to assess any change in the vegetation community within the designated transects over time.

The location of each transect was marked on both banks by yellow wooden marker posts and by recording GPS coordinates at the waters edge. A measuring tape was then placed along the transect and all species within 0.5m of the tape were recorded (to account for zigzag in the tape).

In addition to the transects, incidental observations of plants were also recorded in the vicinity of each site, particularly when these observations were deemed to be of importance. These observations were recorded separately to the transect information and were not used in the data analysis.

If plants could not be identified in the field, specimens were collected and marked with jewellers' tags describing the site and plant information and were later identified using appropriate reference material and magnification. Around 90% of plants recorded were identified in the field to either genus, or in many cases, to the species level.

Discussion on the overall condition of the riparian vegetation at each site has been provided in this report along with a complete species list for each site in the appendix.

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Photo 1 – Transect marker post and tape

3.6 Aquatic habitat

A brief description of the aquatic habitat in each creek is provided below.

3.6.1 Angus Creek

The natural aquatic habitat in Angus Creek appeared severely restricted by the stress of a heavily urbanised catchment. Large amounts of gross pollutants exist within the stream and on riparian vegetation and snags, including general litter, car batteries and vehicle parts. Anoxic sediment odour and the presence of algae blooms are indicative of poor submerged habitat conditions. Iron precipitate was observed in several areas seeping out of banks, and as build-up in slow moving water.

High peak flows are evident and have removed some in-stream edge habitat and littoral vegetation, with limited detritus and large woody debris available for biological activity. Increased peak flows can be directly attributed to an increase in catchment imperviousness and stormwater interconnectivity.

Little bank-side vegetation and trailing debris were present at most sites. Some submerged and emergent vegetation was present, although this was generally sparse. A moderate amount of in-stream vegetation was present at site AE6, perhaps due to a reduced canopy at this site.

The substrate in Angus Creek was primarily silt/clay with limited sand and some areas of pebble and gravel build-up. The banks of the creek were generally steep and around 1 - 2 m high. The width of the creek varied between 0.5 - 5 m, with a mean width of around 1m.

3.6.2 Eastern Creek

The aquatic habitat in Eastern Creek was similarly disturbed by the impacts of urbanisation. Large amounts of gross pollutants were observed, as well as significant algae blooms, covering large sections of the waterway. The most obvious difference between the two creeks was the consistently low water visibility in Eastern Creek and a larger quantity of large woody debris.

High peak flows and some erosion was evident, with little vegetation present with 1m of the waterline. Large woody debris has generally been retained in the channel, as well as a thick layer of Casuarina needles in some areas. No submerged macrophytes were observed in the creek and are likely to be sparse because of limited light penetration of the waters surface.

The substrate in Eastern Creek was difficult to observe due to high turbidity, yet high silt/clay content was evident from sediment plumes during macroinvertebrate sampling. Some large boulders were also noted protruding from the water at various places in the channel.

The channel width in this section of the Eastern Creek was about 6 -12 m, with an average of approximately 10 m. The banks were higher and steeper than those of Angus Creek, being closer to 4 m high.

Photo 2 – Typical Angus Creek habitat

Photo 3 – Typical Eastern Creek habitat

4 Results

This section presents the results from the environmental assessment of air, water, aquatic ecology and vegetation during 2009, at the specified sample sites. All raw data and field sheets are provided in the appendix.

4.1 Air quality

Air quality results from 2009 HVAS and Depositional Dust gauges are depicted in the figures below. The TSP results recorded at both HVAS gauges in 2009 were within the NSW Dept. Planning guidelines (see Table 3, section 3.2.3), although equipment failure limited data from the HVAS1 site. The depositional rolling annual mean for DD2 and DD3 sites crept above the guideline value due to exceptional conditions.

4.1.1 TSP

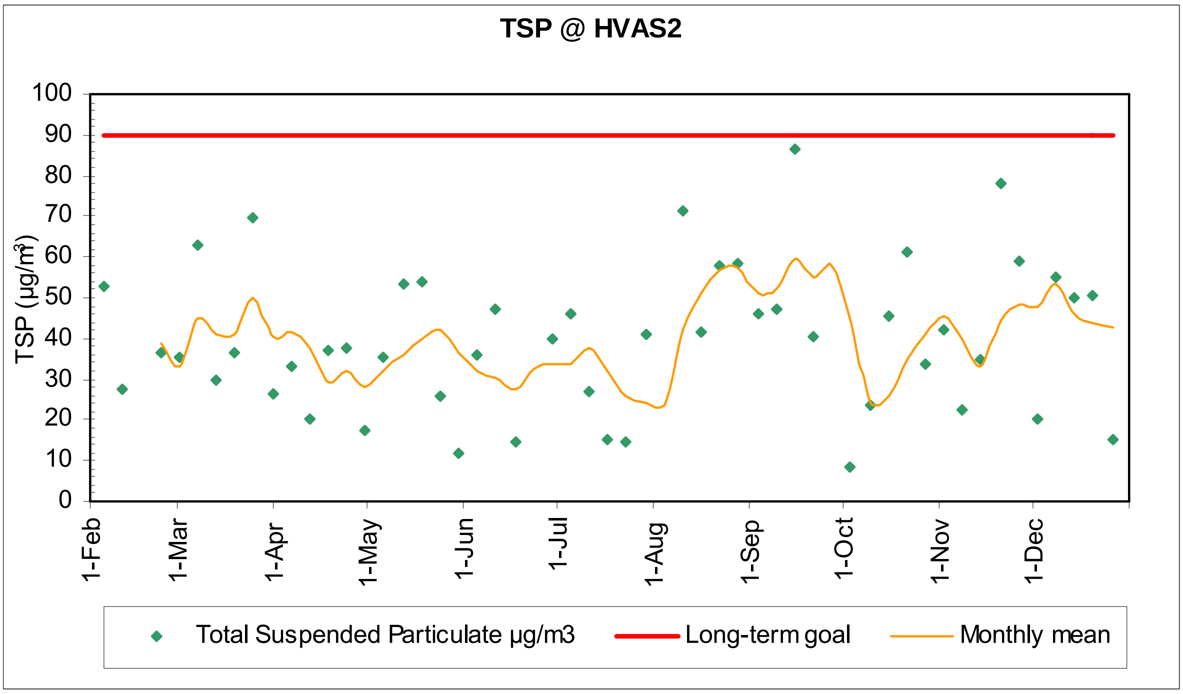

Figure 6 – TSP results at HVAS2 site, February to December 2009

TSP results from the HVAS2 site between February and December 2009 (Figure 6) shows no measurements exceeding the 90 µg/m^3 threshold, with the maximum level recorded on the 15th of September (86.5 µg/m^3). The monthly mean, calculated from the preceding four weeks, stays within the range of 25 to 60 µg/m^3. The average value for all measurements throughout the monitoring period depicted is 39.9 µg/m^3, well below the annual target[1] of 90 µg/m^3.

The TSP results for the HVAS1 have not been plotted due to the lack of data. The HVAS1 site has had ongoing power failures since installation and only six samples were collected at the start of the year. The few results from the HVAS1 site were comparable to, or lower than those collected from the HVAS2 site. The average of the six measurements collected from the HVAS1 site between February and March 2009 was 32.5 µg/m^3

[1] NSW Department of Planning, 2006

4.1.2 Depositional dust

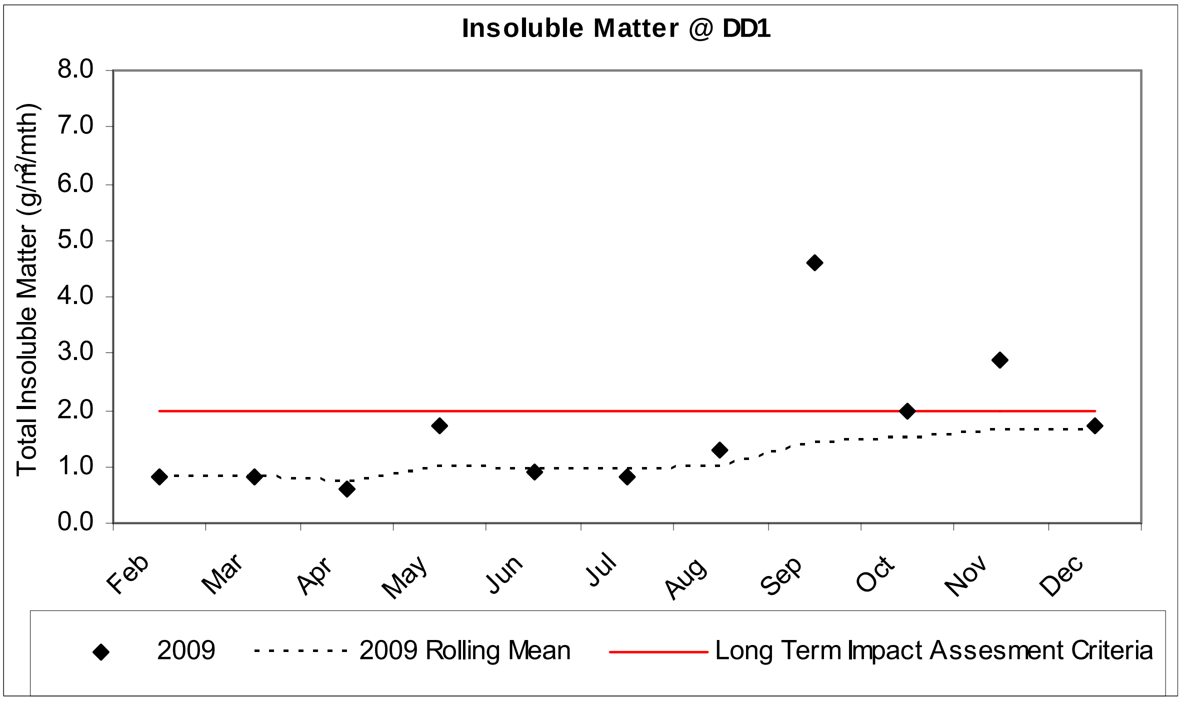

Figure 7 – Total insoluble matter at DD1 site, February to December 2009

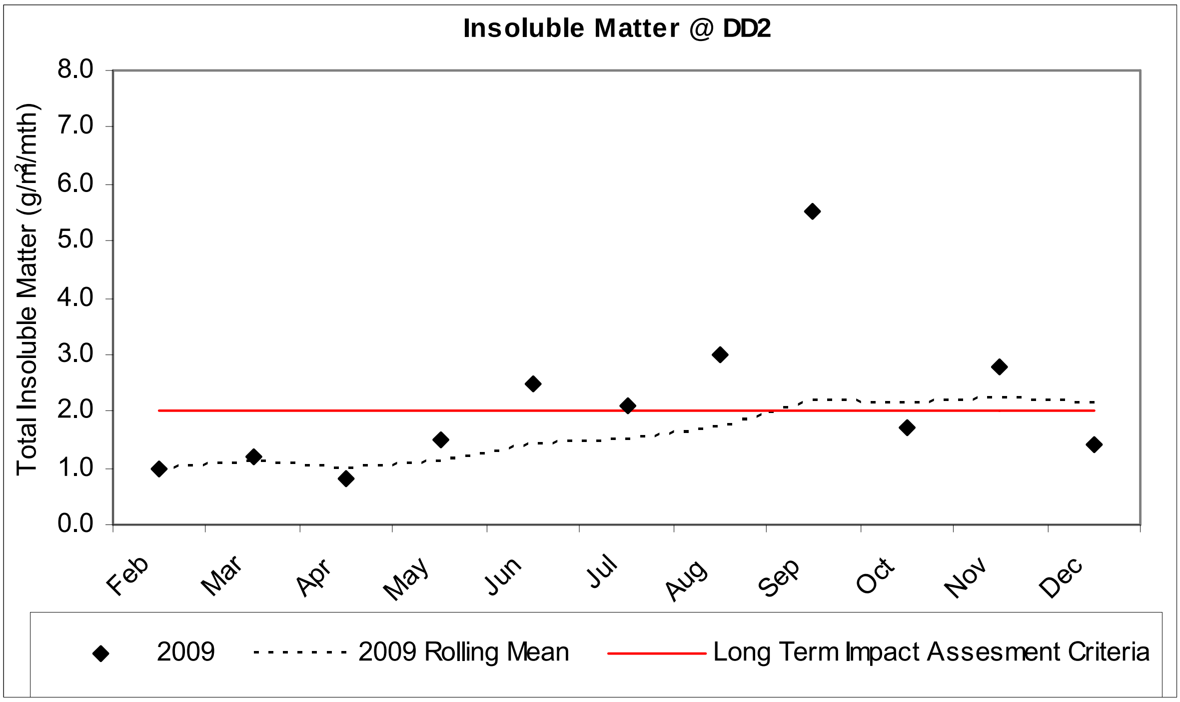

Figure 8 – Total insoluble matter at DD2 site, February to December 2009

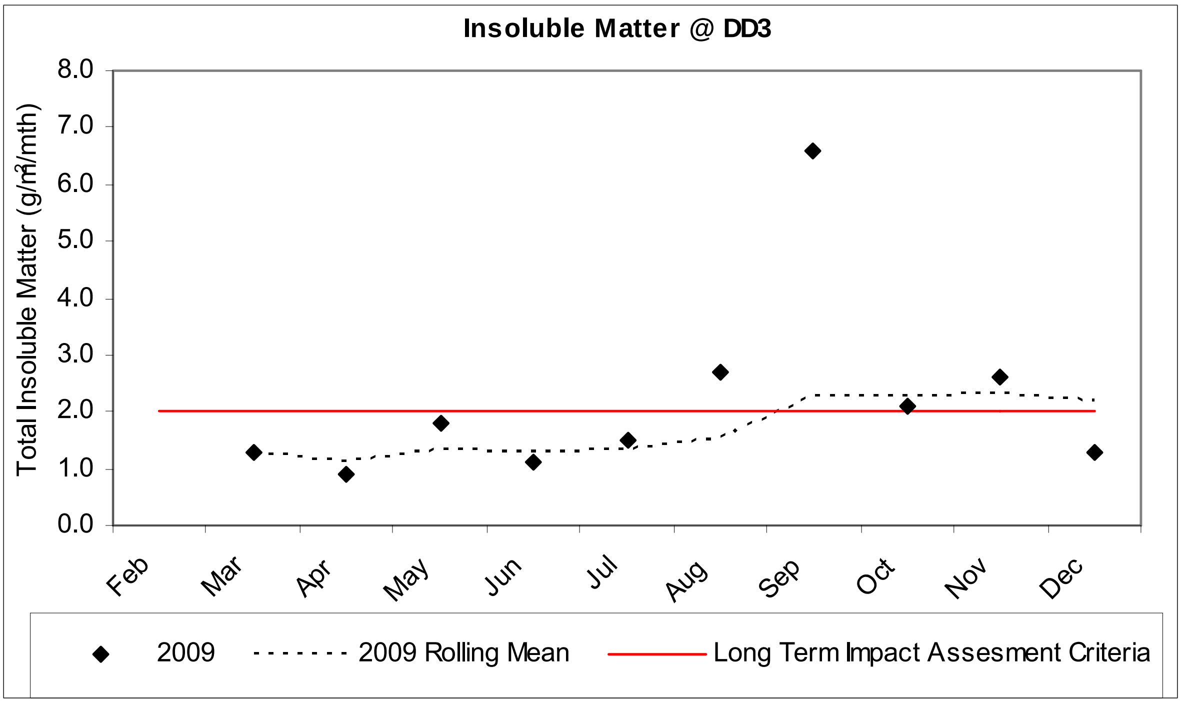

Figure 9 – Total insoluble matter at DD3 site, February to December 2009

Total Insoluble Matter results from the three depositional dust gauges are displayed in Figure 7, Figure 8 and Figure 9 above. The results from all three sites show a general increase in values throughout the year, and the associated increase in the rolling average. Site DD2 and DD3 (Figure 8 and Figure 9) show the rolling average exceeding the LTIAC (Long Term Impact Assessment Criteria) after the high reading in September. This exceptionally high reading at all sites in September was due to a dust storm that swept across Sydney that month.

4.2 Water quality

Water quality was poor across the study area. The algal blooms, oily slicks, gross pollutants and erosion observed during the sampling and habitat assessment are indicative of low quality, eutrophic water in both creeks.

Table 7 – Mean water quality characteristics for 2009

Analyte	Units	AE1	AE2	AE3	AE4	AE5	AE6	*ANZECC Guidelines*
Total alkalinity	**mg/L**	291	248	226	123	119	291	-
Total nitrogen	**mg/L**	**0.88**	**0.60**	**0.98**	**1.78**	**1.97**	**0.65**	***0.35***
Total phosphorus	**mg/L**	**0.09**	**0.10**	**0.09**	**0.21**	**0.22**	**0.12**	***0.025***
Temperature	**°C**	14.69	14.79	15.39	15.24	14.96	15.23	-
pH	**units**	7.61	7.38	7.39	7.31	7.23	7.66	***6.5 - 8.0***
Electrical conductivity	**µS/cm**	**2973**	**2375**	2009	1180	994	**4163**	***125 - 2200***
Dissolved oxygen	**mg/L**	**3.29**	**1.91**	**3.17**	**3.02**	**5.50**	**6.16**	-
Dissolved oxygen	**% sat.**	**31.7**	**18.1**	**31.2**	**28.7**	**53.0**	**60.0**	***85 - 110***
Turbidity	**NTU**	3.0	3.7	5.2	**91.3**	**103.1**	10.5	***6 - 50***
Number of samples	**No.**	4	4	4	4	4	4	-

Mean water quality data during base flow conditions, for each of the aquatic sample sites is depicted in Table 7 above. Red highlight indicates values above the ANZECC (2000) water quality guidelines.

Turbidity results for the Eastern Creek sites (Sites AE4 and AE5), were consistently about an order of magnitude higher than those from the Angus Creek sites (Table 7) indicating a substantially higher suspended colloidal material load in this creek.

An illustration of the mean total alkalinity, electrical conductivity, total nitrogen and total phosphorus data is provided in Figure 10, Figure 11, Figure 12 and Figure 13 respectively below, along with standard error bars. Comments on any observed trends are also included. Further interpretation of these results is provided in the discussion section.

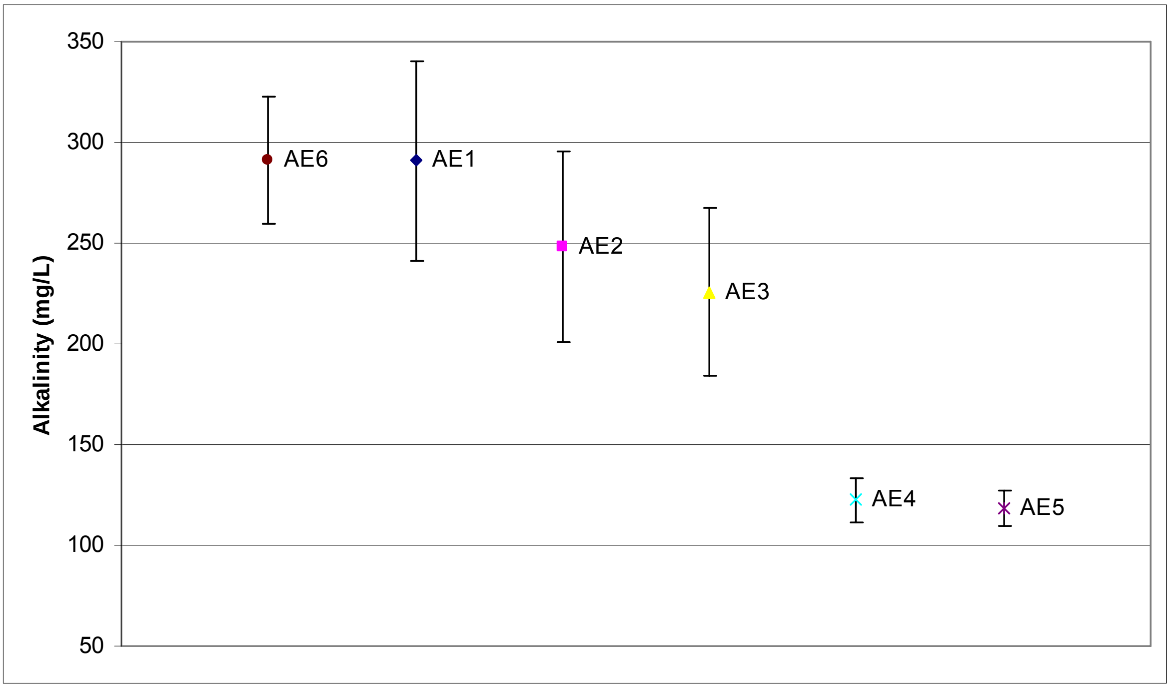

Figure 10 – Mean total alkalinity at water quality sample sites, with standard error bars

Total alkalinity (bicarbonate dominated) in the Angus Creek sites generally decreased, moving downstream (Sites AE6, AE1, AE2 and AE3 in Figure 10). In contract, total alkalinity was much lower and less varied at the Eastern Creek sites (Sites AE4 and AE5 in Figure 10).

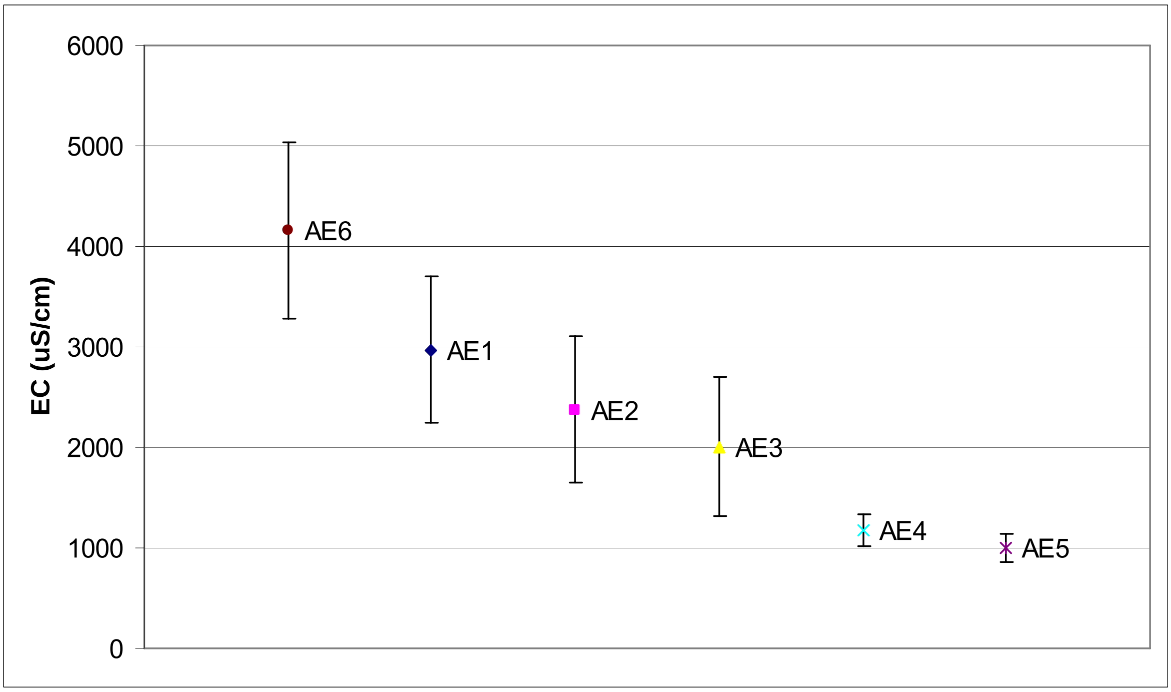

Figure 11 – Mean electrical conductivity at water quality sample sites, with standard error bars

Electrical conductivity in the Angus Creek sites (Sites AE6, AE1, AE2 and AE3 in Figure 11) decreased moving downstream. On the other hand, both Eastern Creek sites (AE4 and AE5) had lower mean EC, close to 1000 μS/cm.

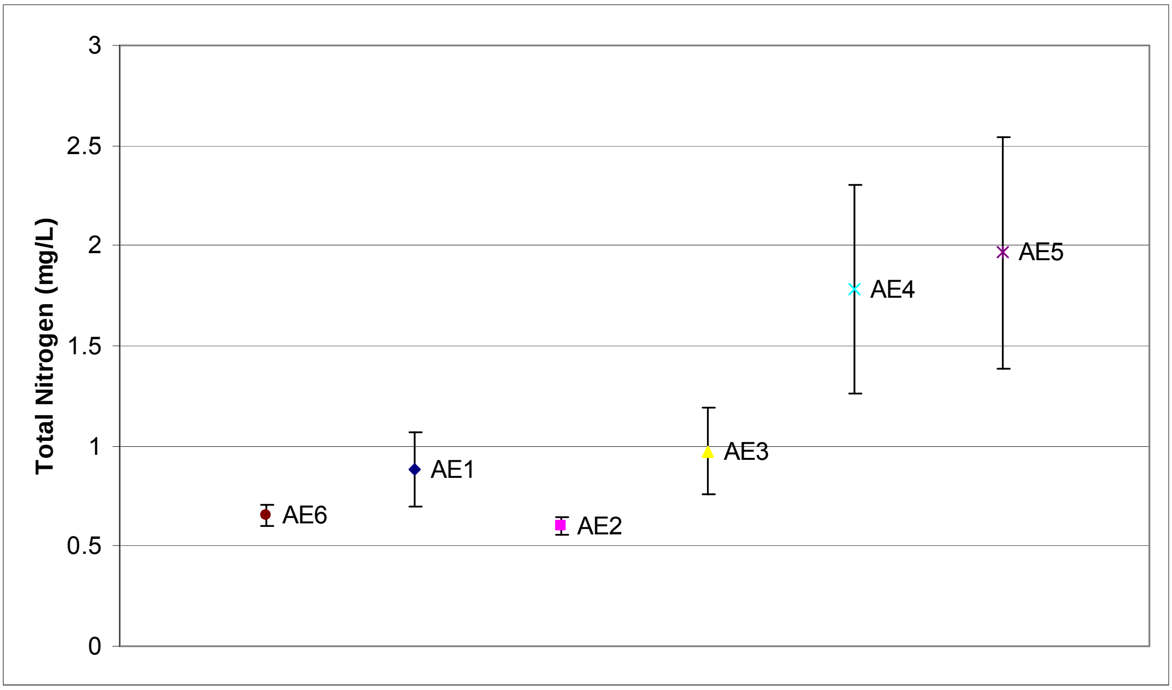

Figure 12 – Mean total nitrogen at water quality sample sites, with standard error bars

Total nitrogen concentrations at the Angus Creek sites (Sites AE6, AE1, AE2 and AE3) were generally lower and less variable than in those collected from the Eastern Creek sites (Sites AE4 and AE5). All mean values were above the ANZECC (2000) guidelines for total nitrogen.

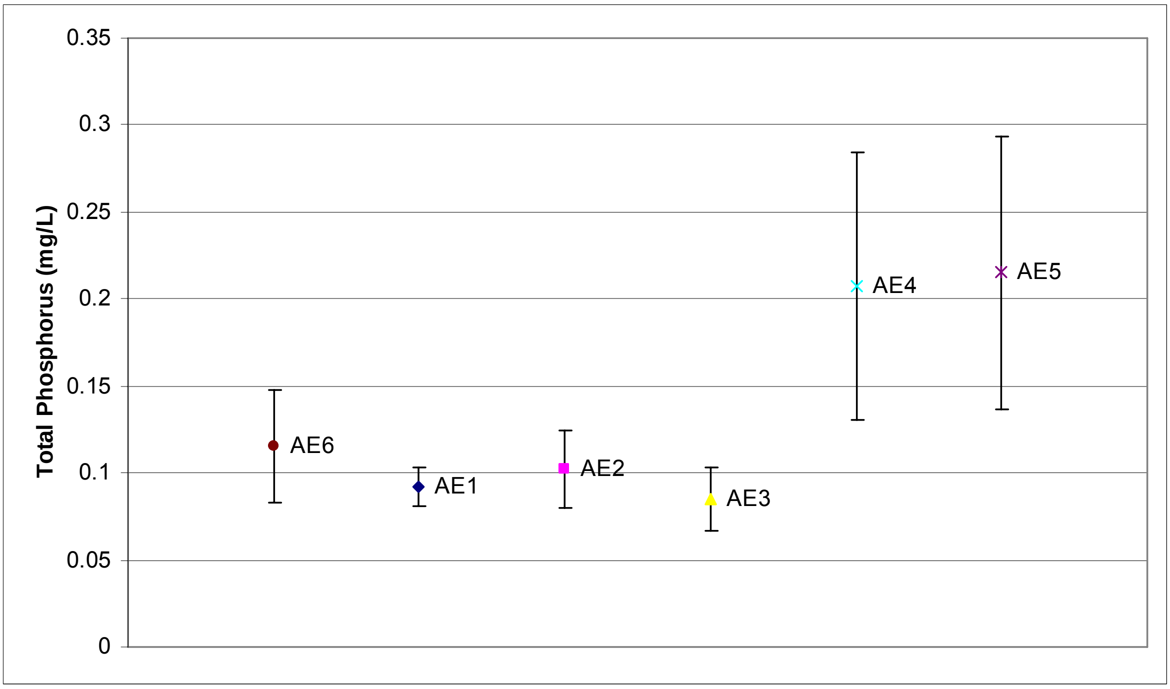

Figure 13 – Mean total phosphorus at water quality sample sites, with standard error bars

Total phosphorus concentrations were similarly higher and more variable at the Eastern Creek sites than in the Angus Creek. Concentrations in both creeks were well in excess of the ANZECC (2000) guidelines for TP.

4.3 Aquatic ecology

The complete dataset from the macroinvertebrate sampling completed during autumn and spring, 2009 is provided in Appendix A, along with descriptive statistics and field sheets.

AUSRIVAS OE50 outputs for spring and autumn sampling are depicted in the Figure 14 below. SIGNAL2 outputs for spring and autumn are also depicted in Figure 15 and Figure 16 respectively.

Aquatic ecosystem health was poor across the study area, with exceptionally degraded habitat and water quality in all sites along Angus Creek. A more detailed interpretation of these results is provided in the discussion.

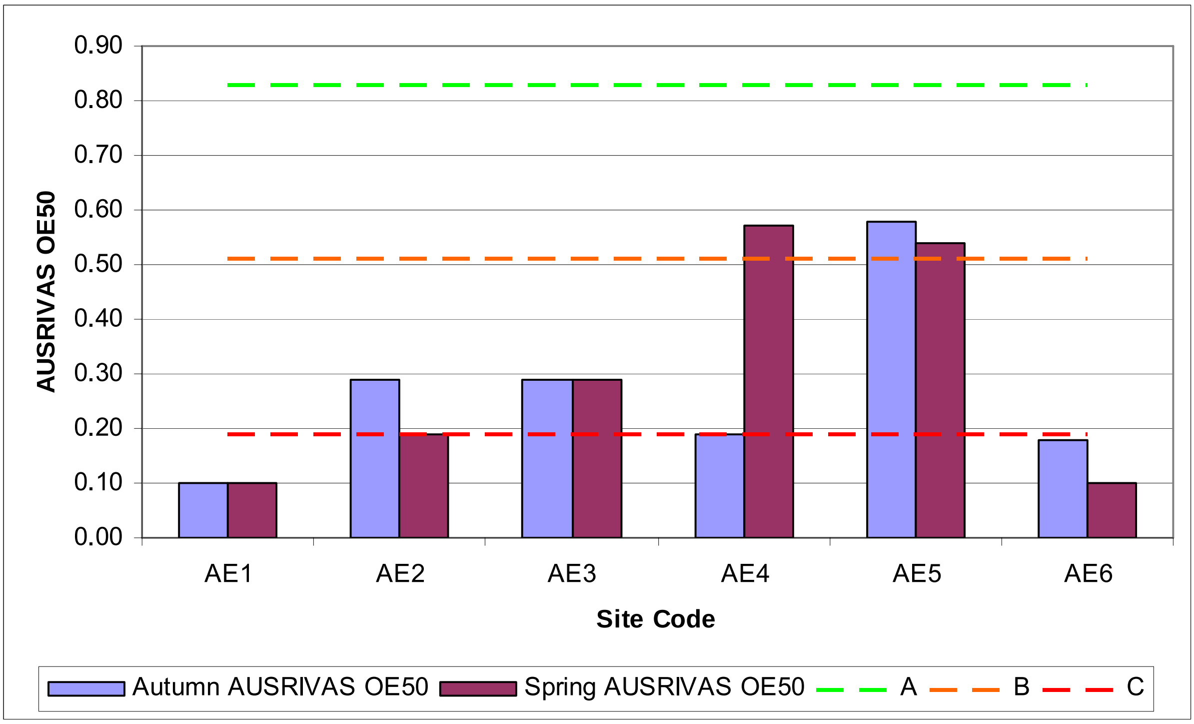

Figure 14 – AUSRIVAS OE50 Scores for 2009 spring and autumn sampling events

AUSRIVAS OE50 outputs for all sites (Figure 14) indicate significant to extreme aquatic ecosystem degradation (AUSRIVAS grades B to D, see Table 6 in section 3.4.4 for more information). This output is based on the ratio of number of macroinvertebrate families observed in the samples, to the number that are predicted to occur by the AUSRIVAS model, based on the input variables (given in Table 5, section 3.4.4).

Most of the macroinvertebrate taxa expected to occur in Angus Creek sites (AE1 and AE6) were not observed in the samples collected, with OE50 scores indicating as little as 10% of the families predicted, actually occurring. Moving downstream on Angus Creek, sites AE2 and AE3 show slightly more families present that the upstream sites.

In terms of the number of expected taxa observed, the Eastern Creek sites (AE4 and AE5) appeared less degraded than the Angus Creek sites, with the exception of the sample from AE4 in autumn 2009. This is likely to be a reflection of differences in water quality, as explained below, although it may also be due to subtle differences in micro-habitat characteristics.

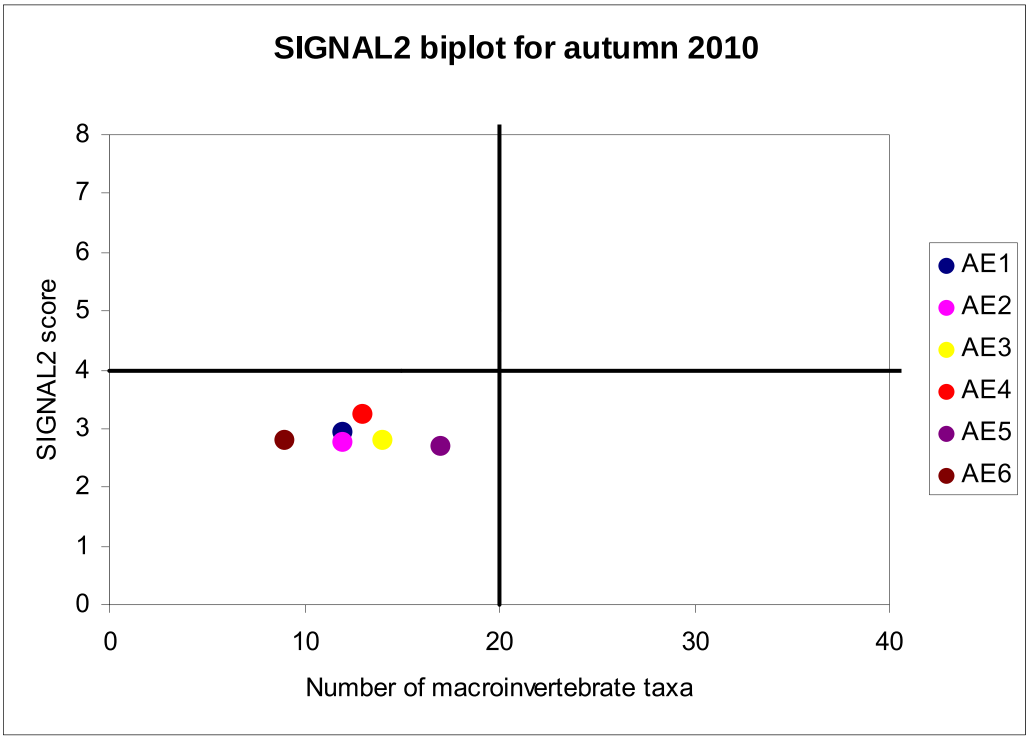

Figure 15 – Autumn 2009 SIGNAL2 outputs for aquatic sample sites

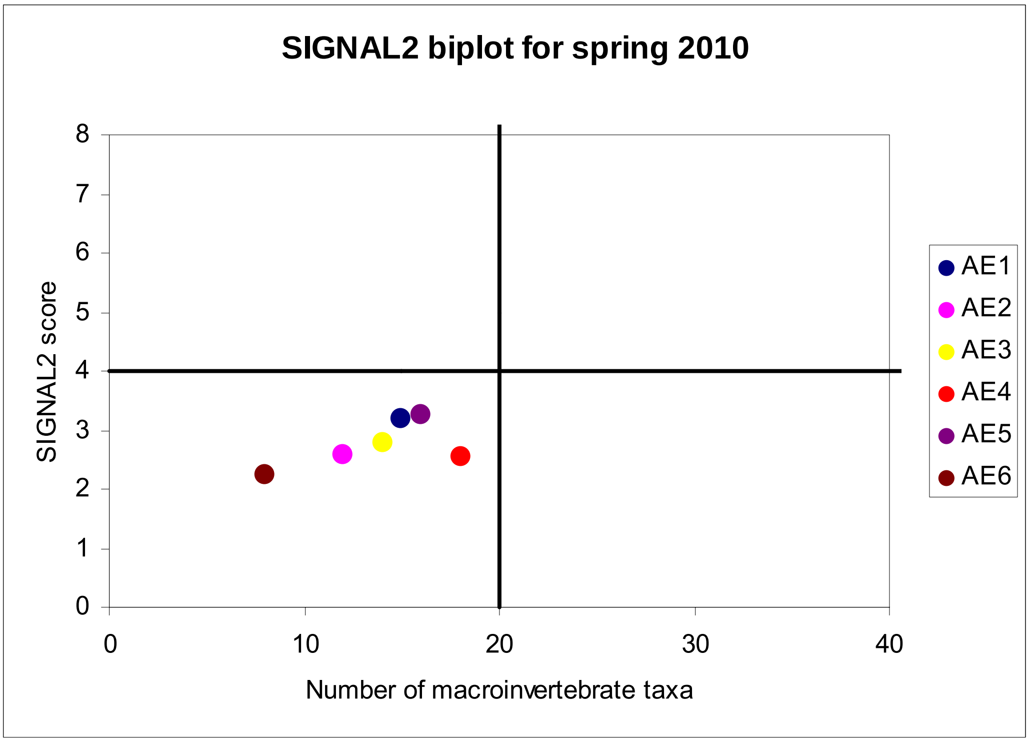

Figure 16 – Spring 2009 SIGNAL2 outputs for aquatic sample sites

All SIGNAL2 outputs from samples collected in spring and autumn 2009 are within quadrant 4, (see Figure 5 in section 3.4.4) indicating some form urban, industrial or agricultural water pollution. This observation is supported by water quality results from all sites, recording elevated concentrations of common pollutants (Table 7).

In particular, site AE6, the most upstream on Angus Creek, scored poorly in both seasonal SIGNAL2 results (Figure 15 and Figure 16) and also displayed the highest electrical conductivity values (Figure 11). Both Eastern Creek sites (AE4 and AE5 in Figure 15 and Figure 16) also recorded poor SIGNAL2 scores, although generally had slightly higher taxa richness, edging towards quadrant 2. This would indicate slightly more tolerable water quality characteristics in the Eastern Creek sites and points out the potentially limiting factor on aquatic health, being due to higher electrical conductivity (dissolved salts) in the upstream Angus Creek sites.

4.4 Riparian vegetation

Raw data from riparian vegetation assessments, conducted in September and November 2009, are provided in Appendix C, along with illustrations depicting the relative abundance of each species observed at each transect. The following description highlight key features of the vegetation across the study area.

The upper and lower riparian vegetation found at all sites is heavily degraded from the originally existing River Flat Eucalypt Forest community. This ecological community is listed as endangered under the *NSW Threatened Species Conservation Act 1995*.

However, the quality of the community was determined as low; because of the dominance of the understorey by intrusive, exotic species (e.g. Wandering Jew - *Tradescantia fluminensis* and Privets - *Ligustrum* spp.).

The canopy layer was relatively intact at most sites, with *Melaleuca* assemblages along Eastern Creek and a mixture of *Melaleuca* sp. *Eucalyptus* sp. and *Casuarina* sp. dominating the community along Angus Creek.

Photo 4 – Cumberland Plain Woodland within the RDC site

Photo 5 – Degraded River Flat Forest along the banks of Eastern Creek

Further from the watercourse, Cumberland Plain Woodland became the dominant vegetation community. Where present, this community existed with varying levels of disturbance. The Cumberland Plain Woodland Ecological Community is listed as endangered under the *NSW Threatened Species Conservation Act 1995*.

The quality of the vegetation community was variable, with the least disturbed patches occurring on both banks of Angus Creek within the Cemex RDC site.

Significant alteration of the terrestrial understorey was apparent within Nurrigingy reserve and within the RDC site; yet a tall canopy of *Eucalyptus* sp. has been retained in both areas. Upstream of the main western railway line and across the centre of the RDC site, severe alteration of the native vegetation and canopy trees has occurred.

Submerged and emergent macrophytes were sparse across the sites surveyed. *Potamogeton pectinatus* and *Vallisneria* sp. were the only submerged aquatic plants observed in Angus Creek, with no observations in Eastern Creek, due to the high turbidity. Emergent macrophytes were locally abundant in shallow areas of both creeks. Large sections of the banks of both creeks show evidence of bank scouring from high velocity flows.

One vulnerable species (*Grevillia juniperina*) and a swath of noxious weeds were identified as part of the assessment. These are outlined in Table 8 below, along with the location of observation and the control class outlined in the *NSW Noxious Weed Act 1993*, where applicable. Further information on the type of weed and an example of control requirements are provided in the Appendix.

Table 8 – Vulnerable species and noxious weeds recorded

Scientific Name	Common Name	Observed	Significance	Noxious Class
Grevillia juniperina	Grevillia	AE2 / DD1	Vulnerable [1]	-
Areratina adenophora	Croftons Weed	AE5	Noxious Weed [2]	4
Bryophyllum delagoense	Mother of millions	AE2	Noxious Weed [2]	3
Cortaderia selloana	Pampas Grass	AE2	Noxious Weed [2]	3
Ligustrum lucidum	Broadleaf Privet	All AE sites	Noxious Weed [2]	4
Ligustrum sinense	Small leaf privet	All AE sites	Noxious Weed [2]	4
Myrsiphyllum asparagoides	Bridal Creeper	All AE sites	Noxious Weed [2 3]	5
Olea europea	European Olive	AE5	Noxious Weed [2]	4
Opuntia stricta	Prickly Pear	AE2	Noxious Weed [2]	4
Romulea rosea	Onion Grass	AE6	Noxious Weed [2]	5
Rubus fruiticosus	Blackberry	AE2, AE3	Noxious Weed [2 3]	4
Sonchus sp.	Sowthistles	AE6	Noxious Weed [2]	5

[1] NSW Threatened Species Act, 1995
[2] NSW Noxious Weed Act, 1993, database query for the Blacktown LGA
[3] Weed of National Significance, NSW Noxious Weed Act, 1993

The results of the two transects at each aquatic monitoring site, one downstream and one upstream, are summarised below with notes on any significant observations.

4.4.1 AE1 – Angus Creek at western boundary of Cemex RDC site

- Aquatic Vegetation – *Potamogeton pectinatus* was the only submerged aquatic plant present at this site, being sparse within the creek. Bank scouring was evident through the site and no significant stands of emergent macrophytes were observed.
- Riparian Vegetation – Shrub weeds, mainly Privet (*Ligustrum sinense* and *L. lucidum*) dominated the riparian zone of the site, up to 10 m or more from the bank on either side. Wandering Jew (*Tradescantia fluminensis*) was the most common ground cover observed, forming dense mats throughout the riparian zone. The canopy layer was relatively intact, consisting of *Casuarina* sp. and *Melaleuca* sp. close to the waterway and large *Eucalyptus* spp. extending throughout the riparian zone and into the terrestrial environment.
- Terrestrial Vegetation – Cumberland Plain Woodland was present on both banks moving away from the creek line, to a distance of 50 m or so. The ground cover consisted mostly of grasses with several flowering native forbs observed outside the transect (*Dichopogon fimbricatus, Bulbine bulbosa* and *Wurmbea dioica*). Shrubs included *Bursaria spinosa* and *Acacia parramattensis*. Various medium to large, smooth and tessellated barked *Eucalyptus* spp. dominated the canopy,

most apparent was *E. amplifolia*. Some weed intrusion from *Myrsiphyllum asparagoides* (listed as a noxious weed, Table 8) and other exotic species was present, but these were less significant than at other sites.

4.4.2 AE2 – Angus Creek at western boundary of Nurragingy Reserve

- Aquatic Vegetation – *Potamogeton pectinatus* was again the only submerged aquatic plant observed at this site, being sparse within the creek. The banks were generally devoid of emergent vegetation, showing evidence of scouring during high flows.
- Riparian Vegetation – Numerous weedy species dominated the riparian vegetation, including a ground cover of *Tradescantia fluminensis*, *Rubus fruiticosus* and numerous other common weeds such as *Bidens pilosa, Sida rhombifolia* and *Solanum pseudocapsicum*. *Casuarina* sp. was present along the stream banks, along with a moderate cover of unidentified grasses.
- Terrestrial Vegetation – Various *Eucalyptus* spp. formed the canopy further from the waters edge, including ironbark *Eucalyptus* sp. on the right bank (south side). Limited vegetation cover was reached on both banks, moving away from the transect end points. The south was the semi-cleared land of Nurragingy Reserve and the north was the disturbed land of the Cemex RDC site. Some native shrubs and grasses were present, including: thick *Bursaria spinosa* on the terrestrial margin of the left bank (north side) with some *Themeda australis* also present; sparse *Acacia parramattensis* occurring among weed species on the right bank; and, *Grevillea juniperina* just outside the transect on the left bank. *Grevillia juniperina*, (subsp. *juniperina* is listed as a vulnerable species, Table 8), occurred directly south of the DD1 / HVAS1 site.

4.4.3 AE3 – Angus Creek downstream of the Nurragingy Reserve road bridge

- Aquatic Vegetation – No submerged macrophytes were noted at this site and a significant bloom of microscopic algae (possibly blue-green algae) was observed on the waters surface. Emergent vegetation was not observed, with banks being heavily scoured and devoid of plants other than larger trees.
- Riparian Vegetation – A ground cover of weeds dominated the riparian zone, including *Tradescantia fluminensis*, *Pennisetum clandestinum*, *Cestrum aurantiacum*, *Solarnum pseudocapsicum*, *Sida rhombifolia*, *Bidens pilosa*, *Galium aparine* and *Ligustrum sinense*. *Acacia parramattensis* was the most common native shrub, while the canopy layer consisted of *Casuarina* sp. closer to the stream and various *Eucalyptus* spp. throughout the transect on both banks.
- Terrestrial Vegetation – The riparian vegetation at this site extended out to around 15 m from the right bank (south side) and 25 m from the left bank (north side), with mown grass present thereafter in the terrestrial zone.

4.4.4 AE4 – Eastern Creek downstream of Angus Creek confluence

- Aquatic Vegetation – High turbidity restricted light penetration of the water in Eastern Creek and no submerged vegetation was observed. The banks of Eastern Creek at this site were relatively steep and were largely devoid of vegetation within 1m of the waters edge, with evidence of scouring during high flows. Some sprouting plants were observed in this area, which were difficult to identify due to limited floristic structures, although were thought to be *Cyperus eragrostis* and were recorded as such.
- Riparian Vegetation – *Tradescantia fluminensis* and a canopy of large *Melaleuca stypheliodies* and *Casuarina* sp. dominated the riparian vegetation at this site, ,extending to 10 m on the right bank (east side) and 20 m on the left bank (west side). Other common exotic plants observed within the transect included *Sida rhombifolia*, *Clematis glycyinoides* and *Ligustrum sinense*. No native shrubs were noted within the riparian vegetation at this site.
- Terrestrial Vegetation – Managed parkland grass dominated the terrestrial vegetation at a distance greater than 10 m from the right bank, with larger canopy trees present, primarily

Eucalyptus sp. Open woodland with an unmanaged grass understorey and sparse *Eucalyptus* sp. canopy was present at a distance greater than 20 m from the water on the left bank, extending out into the parklands.

4.4.5 AE5 – Eastern Creek upstream of the Angus Creek confluence

- Aquatic Vegetation – High turbidity again restricted observation of any submerged vegetation at the upstream Eastern Creek site. A large stand of emergent macrophytes was present upstream of the transect locations, where the creek narrowed, with *Phragmites australis* and *Typha* sp. most common.
- Riparian Vegetation – *Tradescantia fluminensis* and *Casuarina glauca* were the most common plants observed in the riparian zone, with numerous other understorey weeds also present. Downstream of the site, a weed infested understorey existed, including *Ligustrum* sp., and relatively intact native canopy of *Melaleuca* sp. *Eucalyptus* sp. and *Casuarina glauca*. Upstream of the site, both banks were relatively devoid of trees and shrubs, being mown down to the waters edge.
- Terrestrial Vegetation – Mown grass was present greater than around 10m from the waters edge on both banks. After this point the ground cover was limited to small grasses and weeds. Common plants observed in the terrestrial zone included *Soliva sessilis*, *Geranium* sp, *Anagallis arvensis* and unidentified grasses.

4.4.6 AE6 – Angus Creek upstream of Cemex RDC site

- Aquatic Vegetation –*Typha* sp., *Persicaria* sp. and *Baumea articulata* were the main emergent macrophytes present at this site. The submerged *Potamogeton pectinatus* and *Vallisneria* sp. were also observed in the stream. Macrophytes were also present further upstream of the transect, within the swamp area, and further downstream towards the M7 overpass.
- Riparian Vegetation – Significant alteration of the riparian vegetation has occurred at this site and elsewhere upstream of the Cemex RDC site. Riparian vegetation on the left bank was primarily mown grass up to the waters edge, with some small *Casuarina glauca* present. A small swamp on the left bank maintains some larger native *Melaleuca decora* and a variety of weeds. The riparian vegetation on the right bank was also heavily disturbed, being dominated by a variety of weeds and some *Casuarina glauca* closer to the waters edge. Common weeds encountered included *Pennisetum clandestinum*, *Foeniculum vulgare*, *Anredera cordifolia* and *Chloris* sp.
- Terrestrial Vegetation – Mown grass and urban land dominated the terrestrial vegetation at this site, with some fruit trees observed on the north bank.

Photo 6 - Algae bloom in Angus Creek

Photo 7 – Emergent vegetation at site AE6

4.5 Rainfall

Rainfall data were compiled from the Bureau of Meteorology station at nearby Horsley Park and are presented in Figure 17 below. Rainfall data are important in the interpretation of water quality and aquatic ecosystem monitoring, due to the effect it has on the quantity and quality of the river water.

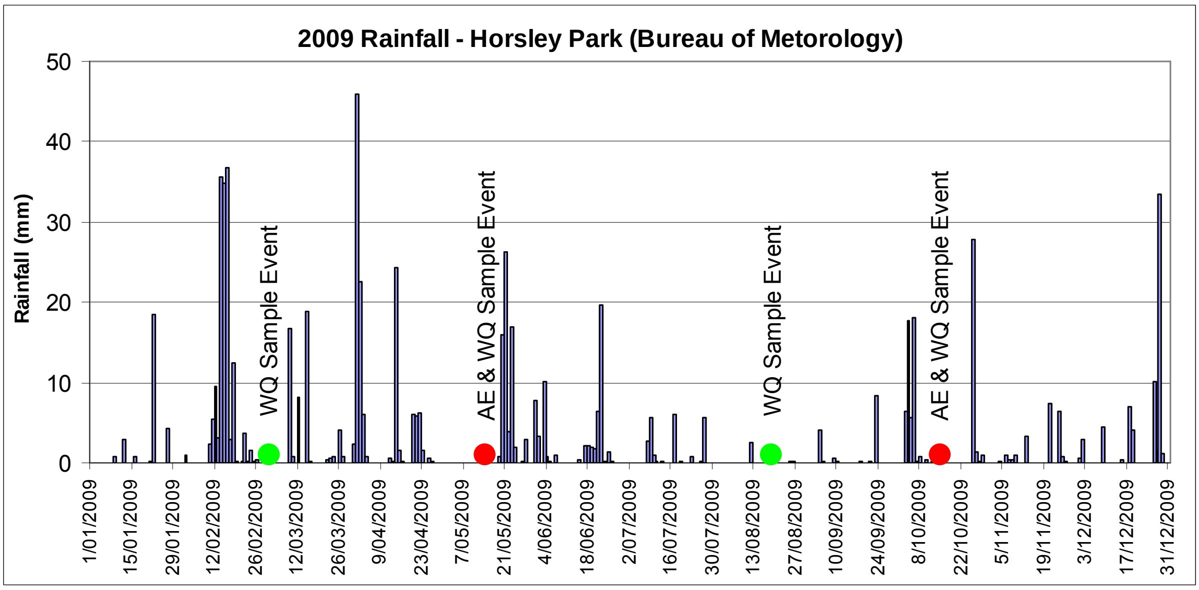

Figure 17 – Rainfall data for 2009 from Horsley Park (Bureau of Meteorology)

All water and macroinvertebrate samples were collected under base flow conditions, although heavy rainfall was recorded in the weeks before the February water quality sample and before the October (spring) water and macroinvertebrate sampling. Rainfall was generally limited in the weeks leading up to the May (autumn) and August sampling events.

5 Discussion

5.1 Air quality

Ambient air quality monitoring indicated that TSP levels were below the recommended guideline level of 90 µg/m^3 in the vicinity of the RDC site. Most measurements from the HVAS2 site fell within the range of 25 to 60 µg/m^3. Samples from the HVAS1 site have not been collected since early 2009 due to ongoing power failure. Attempts have been made to rectify the problem, although all have failed so far. The issue is apparently due to the length of the underground power line from the mains connection on the north of the site. The line may be leaking voltage due to the extended length, resulting in insufficient power to the unit.

No make 'up-runs' (samples scheduled to make-up for lost data), have been completed for the lost samples, as current power issues are preventing unit operation. Calibration on the HVAS1 unit has also not been completed since the 30th of March 2009 and this will need to be completed before sampling at the site recommences, and once the power issue is rectified.

The HVAS1/DD1 site is also very close (within 5 m) of a patch of the vulnerable plant (*Grevillia juniperina*) identified on site. It would be advisable, therefore, to relocate this site, in an attempt to solve both the power issue, and to create a buffer around the endangered plants.

Depositional dust measurements have increased throughout the year, with both the DD2 and DD3 sites recording rolling mean values exceeding the recommended guideline of 2 grams/m^2/month. This was partly due to the very high measurements collected around September, due to a dust storm that month.

5.2 Aquatic ecosystem and water quality

Water quality and aquatic ecosystem assessments have indicated an unhealthy aquatic environment at all sites. Both SIGNAL and AUSRIVAS calculations indicate moderate to severe degradation of the aquatic ecosystem. Different water quality issues in each of the creeks (high turbidity and nutrients in Eastern Creek and high electrical conductivity in Angus Creek) are likely to be key factors explaining the differences observed in the macroinvertebrate communities in each creek.

Further investigation of soil characteristics and potential pollution sources in the catchment may provide some insight into the surface water quality measurements collected. These show a reduction in both alkalinity and electrical conductivity in Angus Creek moving downstream through the site (Figure 10 and Figure 11 respectively). The reduction in alkalinity may be due to the acidic properties of the local soils or due to some existing pollutant discharge. Seepage of acidic water into the creek would involve utilising carbonate ions to buffer against pH change, which would reduce the alkalinity.

Relatively fresh water from sub-surface interflow water is likely to be a main contributor to decreasing electrical conductivity. Precipitation of metals such as aluminium and iron (iron precipitate observed at the site) occur at pH close to neutral and may also be contributing to the reduced electrical conductivity.

5.3 Vegetation

The Cumberland Plains Woodland community present on the site is of moderate to high conservation value and should be protected during and after construction operations. The *Grevillea juniperina* observed on site also needs to be protected due to its status. The littoral forest community is heavily degraded, yet maintains an intact canopy, providing habitat for local fauna. All vegetation on creek banks provides an important buffer for potential erosion and contaminant transport arising from activities on site.

Numerous noxious weeds have been identified across the site, two of which (Bridal Creeper - *Myrsiphyllum asparagoides* and Blackberry - *Rubus fruiticosus*) are weeds of national significance.

A management plan is being prepared by HOLCIM for the Rooty Hill RDC project. Plans for the development have also been provided to the community via newsletters (Readymix, 2005a, 2005b and 2007). An overlay of the proposed development plans with the existing 'forest' area and the location of the *Grevillea juniperina*, provided in Figure 18.

Some obvious overlap of the 'forest' area occurs around the DD1 sample site, where storage silos are proposed. The conveyor bridge across Angus Creek and the truck entry at the northwest of the site also present areas of significant overlap.

Further planning could eliminate the need to remove some areas of vegetation and prevent habitat fragmentation, such as the entry to the site being moved to share the roadway with the neighbouring steel mill, or the conveyor belt being raised to prevent obstruction.

Some vegetation will probably need to be removed, and therefore, revegetation sites could be located upstream and along the railway corridor. Vegetation mapping in the terrestrial environment would provide further information on the value of the community in different areas of the site.

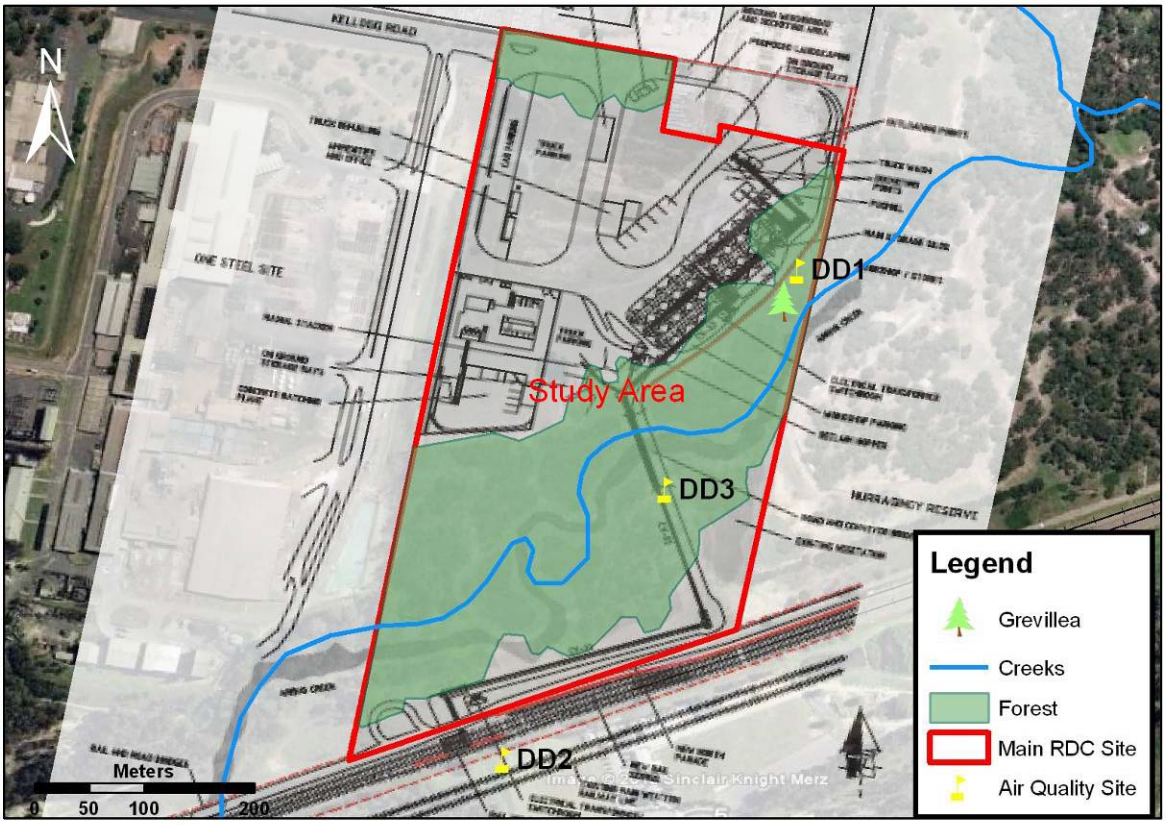

Figure 18 – Basic spatial overlay of development plan with existing vegetation

6 Conclusions and Recommendations

The 2009 environmental monitoring has identified several items that should be prioritised for protective measures during the construction and operation of the RDC. The most important of these are characteristics of the local vegetation, which are specifically covered in environmental protection legislation. Additionally, air and water quality needs to be maintained through effective management, to avoid further degradation.

Monitoring is continuing through 2010 and will further enhance knowledge of local environmental values and characteristics. This additional data will aid planning and management decisions for site development and operation.

The following are recommended from the monitoring results collected to date:

- Relocate the HVAS1 site in order to rectify power issues and enforce a buffer around the patch of vulnerable *Grevillea juniperina*. Make-up runs may also be required to make up for lost data.
- Change the location of vegetation assessment to focus attention on existing Cumberland Plain Woodland, further from the creek line. Vulnerable species are more likely to be recorded in this area, than if the assessment was replicated using the current sites and methods. This change would add value to the project, as further replication at this stage is unlikely to yield new results.
- Commission a detailed soil investigation prior to construction in order to identify potential limitations of the site with regards to the proposed construction activity. This may include the potential for shrink/swell soils, saline conditions and potential acid sulphate soils. Preliminary soil investigations have been carried out as part of a postgraduate research assignment on the site, and can be provided on request.
- Consider inclusion of groundwater sampling in the monitoring program to help understand the interaction of groundwater and interflow with the local surface water. This investigation may help in understanding the elevated alkalinity results and the decrease in electrical conductivity along Angus Creek.
- Water sampling during and after significant flow events may also provide a clearer picture of the fluctuation in water quality as it varies after rainfall. Some other analytes could also be added to the routine suite currently being analysed to identify potential contaminants of concern. For example, common heavy metals and other ionic constituents of the water would be valuable for the Angus Creek sites.
- Continue sampling water quality and macroinvertebrates to increase the precision of data and to allow for increased certainty in the conclusions drawn. Replicate sampling of macroinvertebrates could also be considered to allow for more sophisticated multivariate data analysis, although current sampling appears to be sufficient in identifying basic trends in the data.
- Review the monitoring objectives in order to focus future environmental assessments on those aspects of the local environment most prone to further degradation (as documented in this report) and those that can be improved.
- Focus future planning on ameliorating the impacts that are likely to cause further decline in local water quality and/or degradation of the vegetation buffers.
- Initial investigations have identified patches of Cumberland Plains Woodland (an endangered ecological community), which may be further degraded during site development, unless monitored and managed effectively.

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Appendix A – Water quality data

2009 water quality data from all sample sites

Sample Information				Alkalinity	Nutrients		Phys Chem					
Date	Sample No.	Site	Time	Total (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Temperature (°C)	pH (units)	Electrical Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% sat.)	Turbidity (NTU)
2/03/2009	681181	AE1	1400	240	0.55	0.11	21.8	7.44	1737	1.76	20.2	4.2
2/03/2009	681182	AE2	1245	190	0.74	0.15	21.76	7.26	1281	0.72	8.2	5.3
2/03/2009	681183	AE3	1320	180	0.79	0.13	21.91	7.33	1100	2.13	24.4	2.7
2/03/2009	681184	AE4	1345	130	2.1	0.33	22.38	7.21	822.5	1.53	17.153	110
2/03/2009	681185	AE5	1335	130	2.7	0.40	22.57	7.25	791.6	3.97	46	120
2/03/2009	681186	AE6	1430	320	0.63	0.16	22.35	7.39	3218	2.6	31.3	3.8
14/05/2009	694067	AE1	1400	410	1.2	0.1	12.02	7.58	4677	3.41	31.3	0.8
14/05/2009	694068	AE2	1130	390	0.59	0.07	11.59	7.42	4508	1.72	15.8	0
14/05/2009	694069	AE3	1015	350	0.59	0.05	11.61	7.45	4054	3.27	29.9	0
14/05/2009	694070	AE4	1240	100	0.83	0.07	11.48	7.15	1450	2.46	22.1	83.8
14/05/2009	694071	AE5	900	120	0.96	0.09	10.97	7.18	914.2	6.36	56.8	37.3
14/05/2009	694072	AE6	1515	340	0.54	0.05	11.85	7.65	6714	8.03	74.5	6.6
19/08/2009	709541	AE1	1615	330	0.58	0.06	11.1	7.69	3707	4.19	38	2.1
19/08/2009	709542	AE2	1545	220	0.53	0.06	11.2	7.5	2034	4.01	36.8	2.4
19/08/2009	709543	AE3	1535	190	0.92	0.06	13.24	7.5	1417	5.11	48.4	6.2
19/08/2009	709544	AE4	1555	150	1.1	0.08	11.14	7.48	1457	5.27	47.5	31
19/08/2009	709546	AE5	1520	130	1	0.08	11.53	7.21	1406	8.85	80.7	39
19/08/2009	709547	AE6	1635	200	0.65	0.07	13.15	8.16	2850	12.17	115.9	21
15/10/2009	718265	AE1	1210	184	1.2	0.1	13.83	7.73	1769	3.79	37.4	4.9
15/10/2009	718270	AE6	1030	305	0.79	0.18	13.57	7.44	3871	1.83	18.1	10.7
14/10/2009	718266	AE2	1445	193	0.54	0.13	14.6	7.32	1678	1.18	11.4	7.1
14/10/2009	718267	AE3	1205	183	1.6	0.1	14.78	7.27	1463	2.15	22	11.9
14/10/2009	718268	AE4	1330	110	3.1	0.35	15.94	7.39	990.9	2.8	28.1	140.2
14/10/2009	718269	AE5	1050	94	3.2	0.29	14.75	7.27	863.5	2.82	28.3	216.2

Appendix B – Macroinvertebrate data

Autumn 2009 macroinvertebrate data including AUSRIVAS and SIGNAL2 outputs

Order	Taxa	AE1	AE2	AE3	AE4	AE5	AE6	SIGNAL
Acarina	Acarina			1		1		6
Coleoptera	Dytiscidae		1					2
Coleoptera	Hydrophilidae		1	1		2		2
Coleoptera	Scirtidae					1		6
Collembola	sp.		2			1		1
Crustacea	Ostracoda			1	3			
Crustacea	Copepoda		1					
Crustacea	Cladocera				1	2		
Decapoda	Atyidae					4		3
Diptera	s-f Chironominae	11	37	52	33	33	86	3
Diptera	s-f Tanypodinae						1	3
Diptera	Chironomidae				1			3
Diptera	Stratiomyidae	2	2			1		3
Ephemeroptera	Baetidae					1		5
Gastropoda	Hydrobiidae	7		2	1		2	4
Gastropoda	Physidae	3		4		4		1
Gastropoda	Planorbidae			1		1		2
Hemiptera	Corixidae				3	3		2
Hemiptera	Notonectidae					1	1	1
Hirudinea	Erpobdellidae			1				1
Hirudinea	Glossiphoniidae	3	2	2	5	1	6	1
Isopoda	Oniscidae		5					2
Odonata	Epiproctophora			2				2
Odonata	Coenagrionidae	10	9	5	8	19	7	2
Odonata	Hemicorduliidae	6	4	8	2	5	4	5
Odonata	Isostictidae	7		3	22	12		3
Odonata	Libellulidae	2	1		2		1	4
Odonata	Megapodagrionidae	15	18	16	1	1		5
Odonata	Zygoptera	5	3	12	13	4	7	5
Oligochaeta	Oligochaeta	8	4	8	6	1	4	2
Trichoptera	Leptoceridae				1			6
Turbellaria	Dugesiidae	5	5	3	4	1		2
	Sum of organisms	**84**	**95**	**122**	**106**	**98**	**119**	
	Taxa richness	**14**	**16**	**18**	**17**	**21**	**11**	
	EPT Families	**0**	**0**	**0**	**1**	**1**	**0**	
SIGNAL2	**SIGNAL2**	**2.9**	**2.75**	**2.8**	**3.2**	**2.7**	**2.8**	
	Taxa Used	**12**	**12**	**14**	**13**	**17**	**9**	
AUSRIVAS	**OE50**	**0.1**	**0.29**	**0.3**	**0.2**	**0.6**	**0.2**	
	BAND	**D**	**C**	**C**	**C**	**B**	**C**	
	SIGNALOE50	**0.7**	**0.56**	**0.9**	**1.1**	**0.8**	**0.8**	

Spring 2009 macroinvertebrate data including AUSRIVAS and SIGNAL2 outputs

Order	Taxa	AE1	AE2	AE3	AE4	AE5	AE6	SIGNAL
Coleoptera	Curculionidae				1			2
Coleoptera	Dytiscidae		1	5	1			2
Coleoptera	Hydrophilidae					3		2
Collembola	sp.				3			1
Crustacea	Cladocera				1	1		
Crustacea	Copepoda	1			7			
Crustacea	Ostracoda	1						
Decapoda	Atyidae				1	5		3
Diptera	s-f Chironominae	14	66	45	32	49	47	3
Diptera	s-f Orthocladiinae	3	1			2		4
Diptera	s-f Tanypodinae			1				4
Diptera	Simuliidae	1						4
Diptera	Stratiomyidae				1		2	4
Diptera	Tipulidae					1		4
Gastropoda	Hydrobiidae	7		2	2		1	4
Gastropoda	Lymnaeidae				1			1
Gastropoda	Physidae	9	1	6	8	6	1	1
Hemiptera	Corixidae				2	10		2
Hemiptera	Nepidae					1		3
Hemiptera	Notonectidae				1	3		1
Hemiptera	Veliidae				4			1
Hirudinea	Erpobdellidae	1	1	1			1	1
Hirudinea	Glossiphoniidae	3	13	1	9		13	1
Lepidoptera	Pyralidae	1						3
Odonata	Aeshnidae			1				4
Odonata	Coenagrionidae	2	18	1	9	19	19	2
Odonata	Diphlebiidae	1						6
Odonata	Hemicorduliidae	7	21	3	2	1		5
Odonata	Isostictidae	4	2	6	27	4		3
Odonata	Libellulidae				1			4
Odonata	Megapodagrionidae	3	1	4	3	2		5
Odonata	Zygoptera	11	12	18	7	6	6	
Oligochaeta	Oligochaeta	10	7	3			12	2
Trichoptera	Ecnomidae					1		4
Trichoptera	Hydroptilidae	1				2		4
Trichoptera	Leptoceridae					3		6
Turbellaria	Dugesiidae		1		1			2
Turbellaria	Temnocephalidae			1				2
	Sum of organisms	**80**	**145**	**98**	**124**	**119**	**102**	
	Taxa richness	**18**	**13**	**15**	**22**	**18**	**9**	
	EPT Families	**1**	**0**	**0**	**0**	**3**	**0**	
SIGNAL2	**SIGNAL2**	**3.2**	**2.6**	**2.8**	**2.56**	**3.25**	**2.3**	
	Taxa Used	**15**	**12**	**14**	**18**	**16**	**8**	
AUSRIVAS	**OE50**	**0.10**	**0.19**	**0.29**	**0.57**	**0.54**	**0.10**	
	BAND	**D**	**D**	**C**	**B**	**B**	**D**	
	SIGNALOE50	**0.77**	**0.64**	**0.76**	**0.61**	**0.75**	**0.77**	

Appendix C – Vegetation data

2009 riparian vegetation assessment species list

Scientific Name	Common Name	AE1	AE2	AE3	AE4	AE5	AE6	Native / Introduced
Acacia parramattensis	Parramatta Green Wattle	x	x	x	x	o		N
Acetosa sagittata	Turkey Rhubarb				o	x		I
Anagallis arvensis	Pimpernel						x	I
Anredera cordifolia	Maderia Vine						x	I
Araujia sericifera	Mothplant		x	x	x	o	x	I
Areratina adenophora	Croftons Weed					o		I
Asparagus offinalis	Garden Asparagus						x	I
Axonopus affinis	Narrow Carpet Grass					x		I
Baumea articulata	Jointed Twig-rush						x	N
Bidens pilosa	Farmers Friend		x	x		x	x	I
Brachychiton populeus ssp. populeus	Kurrajong	o						N
Brassica sp.							x	I
Bryophyllum delagoense	Mother of millions		o					I
Bulbine bulbosa	Golden Lily	o						N
Bursaria spinosa	Blackthorn	x	x	x		x		N
Callistemon / Melaleuca sp.	Paperbark			o	o			N
Carduus sp. / Cirsium sp.	Thistle		x				x	I
Casuarina glauca	Swamp She Oak	x	x	x	x	x	x	N
Cestrum aurantiacum	Orange Cestrum	x	x	x	o	x	x	I
Chloris sp.	Rhodes Grass, Windmill Grass		x	x			x	N & I
Clematis glycinoides	Headache Vine			x	x	x		N
Commelina cyana	Scurvy Weed	x				x		N

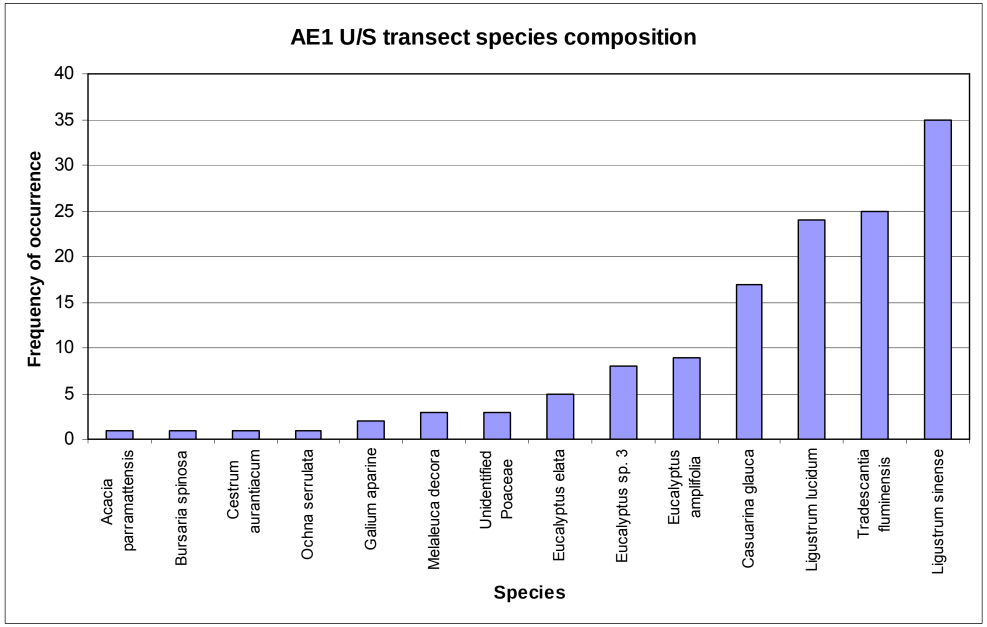
Scientific Name	Common Name	AE1	AE2	AE3	AE4	AE5	AE6	Native / Introduced
Cortaderia selloana	Pampas Grass		x					I
Crassula multicava	Shade Crassula	x						I
Cyperus eragrostis	Umbrella Sedge		x	x	x	x	x	I
Dichondra repens	Kidney Weed		o					N
Dichopogon fimbricatus	Nodding Chocolate Lily	o						N
Erythrina x skyesii	Coral Tree		x		x	o		I
Eucalyptis sp. 1	Ironbark		x					N
Eucalyptus amplifolia	Cabbage Gum	x	x	x	x	x		N
Eucalyptus elata	River Peppermint	x						N
Eucalyptus moluccana	Grey Box	x	x	x			o	N
Eucalyptus sp. 2	Stringybark Gum			x				N
Eucalyptus sp. 3	Smooth Bark Gum	x						N
Foeniculum vulgare	Fennel					o	x	I
Fumaria sp.	Fumitory						x	I
Galium aparine	Cleavers	x	x	x				I
Geranium solanderi	Native Geranium				x	x		N
Geranium sp.	Geranium					x		N / I
Glycine microphylla	Small-leaf Glycine		x	x				N
Grevillia juniperina	Grevillia		o					N
Hydrocotyle peduncularis						x		N
Juncus bufonius	Toad rush		x					N
Juncus cognatus	Juncus	x		x				I
Juncus sp.	Juncus					o		N & I
Ligustrum lucidum	Broadleaf Privet	x	o	x	o		x	I

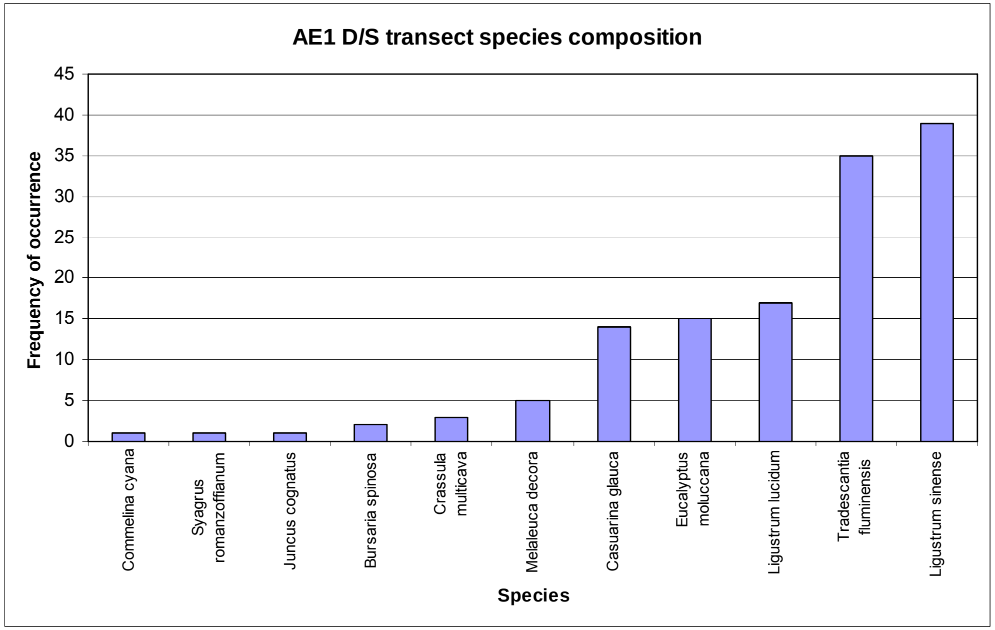
Scientific Name	Common Name	AE1	AE2	AE3	AE4	AE5	AE6	Native / Introduced
Ligustrum sinense	Small leaf privet	x	x	x	x	x	x	I
Lomandra sp.	Lomandra	o		x	x			N
Lotus angustissimus	Slender bird's foot trefoil		x				x	I
Lotus sp.						x		N / I
Melaleuca decora	White Feather Honeymyrtle	x					x	N
Melaleuca styphelioides	Prickely Leaved Paperbark				x	x		N
Melia azedarach	White Cedar		x			o		N
Morus alba	Mulberry				o	x		I
Myrsiphyllum asparagoides	Bridal Creeper	x	x	x	o		x	I
Ochna serrulata	Ochna	x						I
Olea europea	European Olive					x		I
Opuntia stricta	Prickly Pear		o					I
Paspalum dilatatum	Caterpillar Grass						x	I
Passiflora edulis	Passionfruit		x					I
Pennisetum clandestinum	Kikuyu grass			x			x	I
Persicaria sp.	Knotweed					x	x	N & I
Phragmites australis	Common reed					o	x	N
Phyllanthus tenellus	Hen and Chicken				x			I
Pittosporum undulatum	Sweet Pittosporum			x				N
Plantago lanceolata	Lambs Tounge						x	I
Poa sp.					x			N / I
Potamogeton pectinatus	Sago pondweed	o	x				x	N
Prostasparagus aethiopicus	Asparagus Fern			x				I
Ranunculus muricatus	Sharp Buttercup						x	I

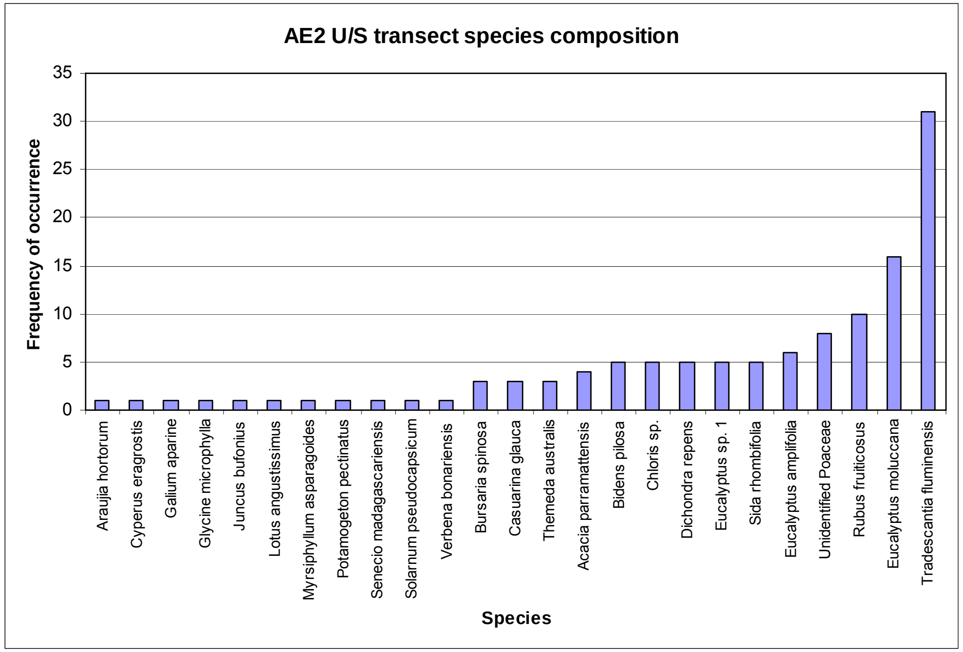
Scientific Name	Common Name	AE1	AE2	AE3	AE4	AE5	AE6	Native / Introduced
Ranunculus sp.					x	x		N / I
Ricinus communis	Caster Oil Plant		o				x	I
Romulea rosea	Onion Grass						x	I
Rosa rubiginosa	Sweet Briar		x					I
Rubus fruiticosus sp. agg.	Blackberry		x	x				I
Rumex sp.	Dock						x	I
Senecio madagascariensis	Fireweed		x				x	I
Senna sp.	Senna			o			x	N & I
Sida rhombifolia	Paddy's Lucerne		x	x	x	x	x	I
Sigesbeckia orientalis	Sticky weed		x	x	x			N
Solanum mauritianum	Wild tobacco tree		x		o	o		I
Solanum nigrum	Blackberry Nightshade			x		x		I
Solanum pseudocapsicum	Jerusalem cherry	o	x	x	x	x		I
Soliva sessilis	Bindi					x		I
Sonchus sp.	Sowthistles						x	I
Syagrus romanzoffianum	Cocos palm	x	o				x	I
Themeda australis	Kangaroo Grass		x					N
Tradescantia fluminensis	Wandering Jew	x	x	x	x	x	x	I
Typha sp.	Cumbungi						x	N / I
Unidentified Forb						x		
Unidentified Poaceae			x	x	x	x	x	
Unidentified Poaceae 1			o			x	x	N / I
Unidentified Poaceae 2			x					N / I
Unidentified Poaceae 3		x						N / I

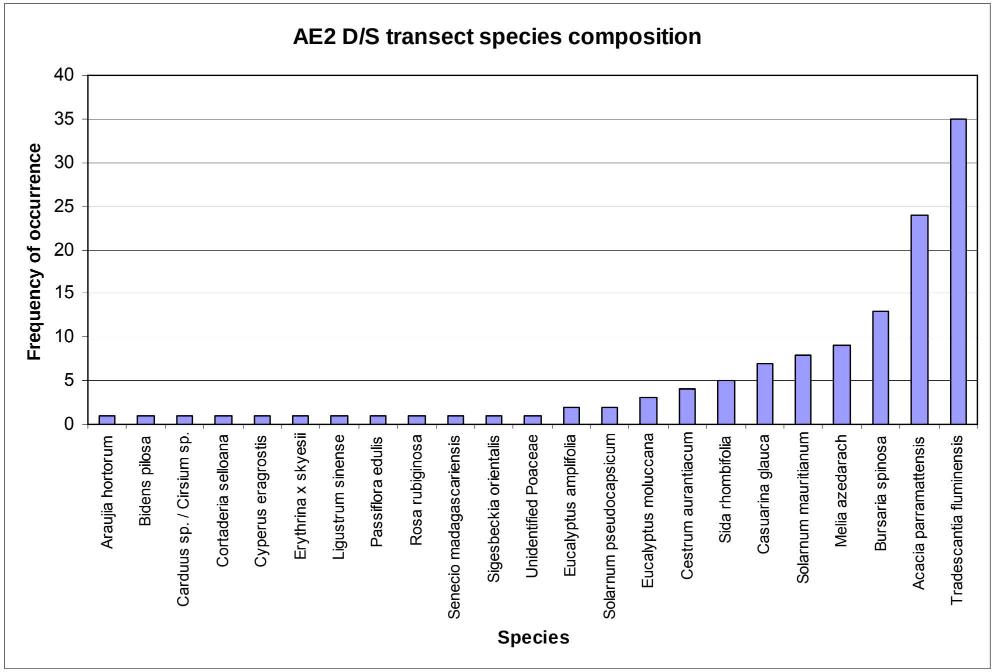
Scientific Name	Common Name	AE1	AE2	AE3	AE4	AE5	AE6	Native / Introduced
Vallisneria sp.							o	N
Verbena bonariensis	Purple Top		x		x		x	
Vicia sp.	Vetch						x	I
Wahlenbergia gracilis	Australian bluebell						x	N
Wurmbea dioica ssp. dioica	Early Nancy	o						N

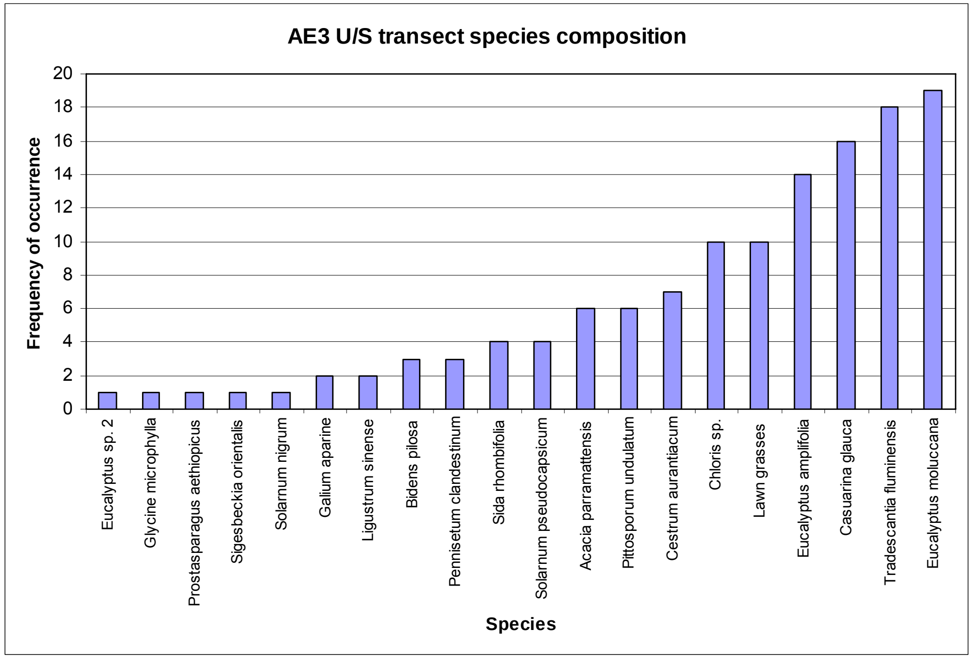
Individual data from upstream and downstream transects at each site

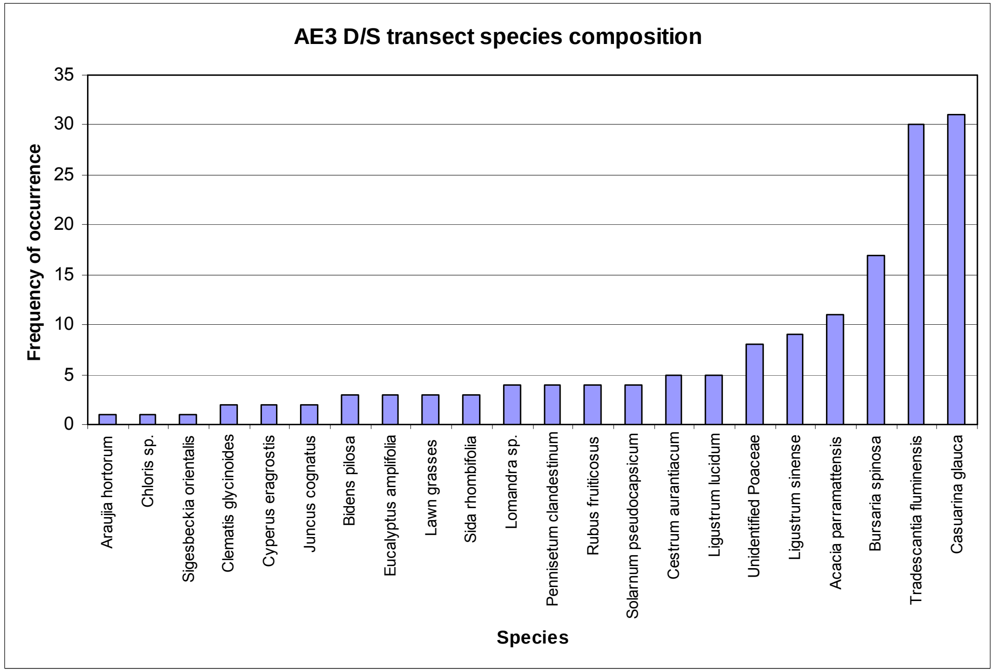


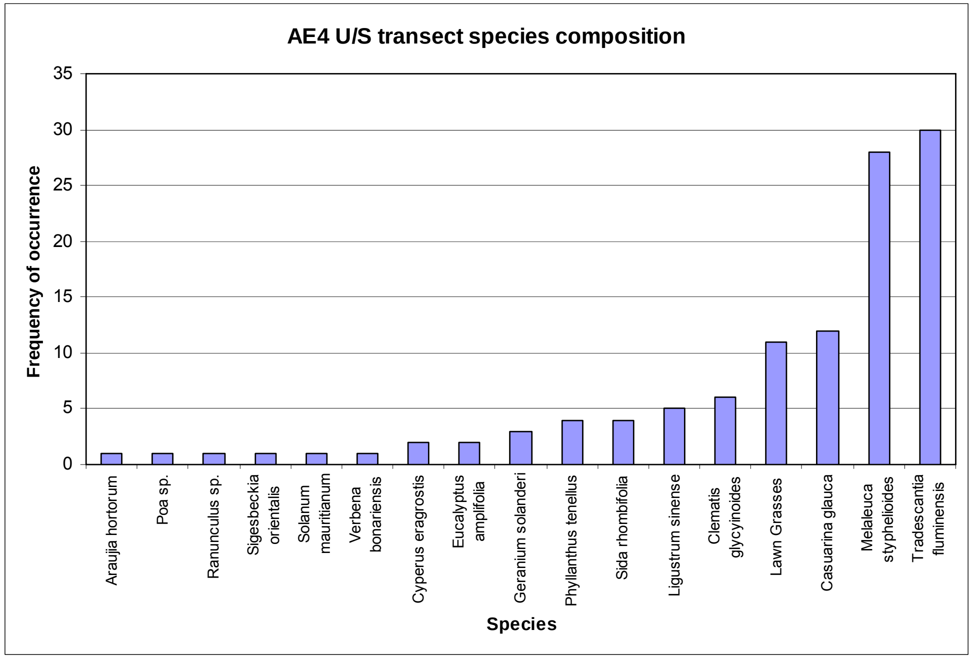


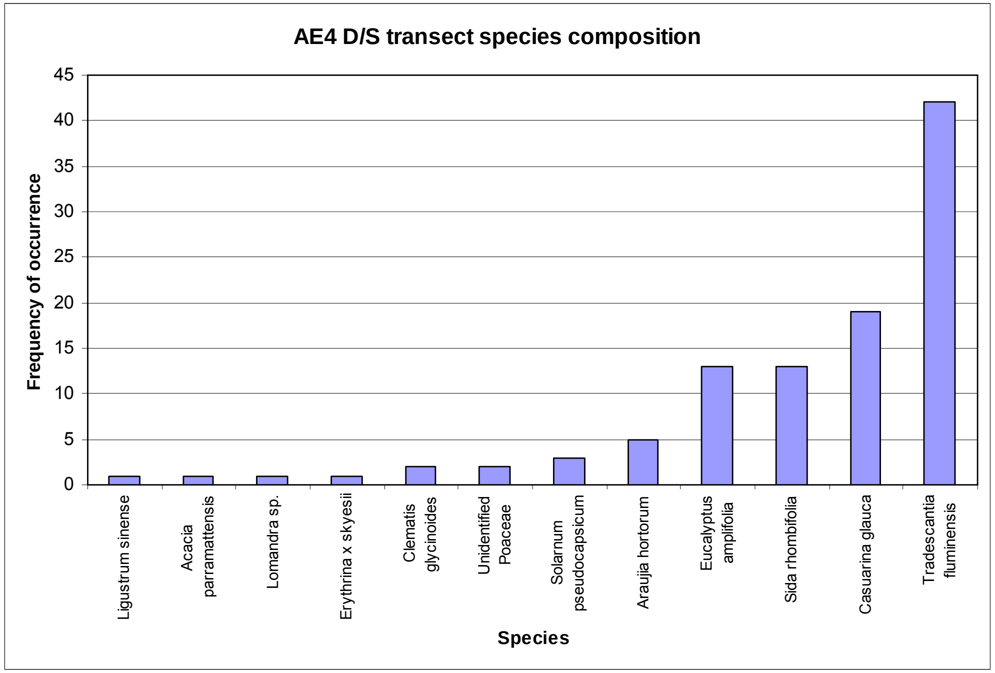

AE2 U/S transect species composition
Frequency of occurrence
Species
Araujia hortorum
Cyperus eragrostis
Galium aparine
Glycine microphylla
Juncus bufonius
Lotus angustissimus
Myrsiphyllum asparagoides
Potamogeton pectinatus
Senecio madagascariensis
Solarnum pseudocapsicum
Verbena bonariensis
Bursaria spinosa
Casuarina glauca
Themeda australis
Acacia parramattensis
Bidens pilosa
Chloris sp.
Dichondra repens
Eucalyptus sp. 1
Sida rhombifolia
Eucalyptus amplifolia
Unidentified Poaceae
Rubus fruiticosus
Eucalyptus moluccana
Tradescantia fluminensis

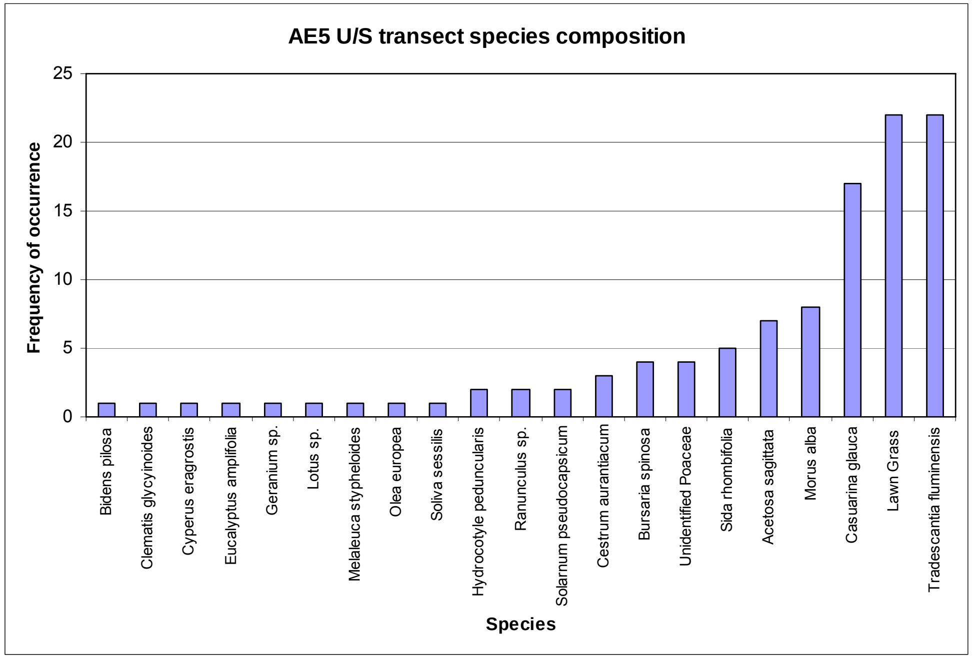

AE2 D/S transect species composition
Frequency of occurrence
Species
Araujia hortorum
Bidens pilosa
Carduus sp. / Cirsium sp.
Cortaderia selloana
Cyperus eragrostis
Erythrina x skyesii
Ligustrum sinense
Passiflora edulis
Rosa rubiginosa
Senecio madagascariensis
Sigesbeckia orientalis
Unidentified Poaceae
Eucalyptus amplifolia
Solarnum pseudocapsicum
Eucalyptus moluccana
Cestrum aurantiacum
Sida rhombifolia
Casuarina glauca
Solarnum mauritianum
Melia azedarach
Bursaria spinosa
Acacia parramattensis
Tradescantia fluminensis

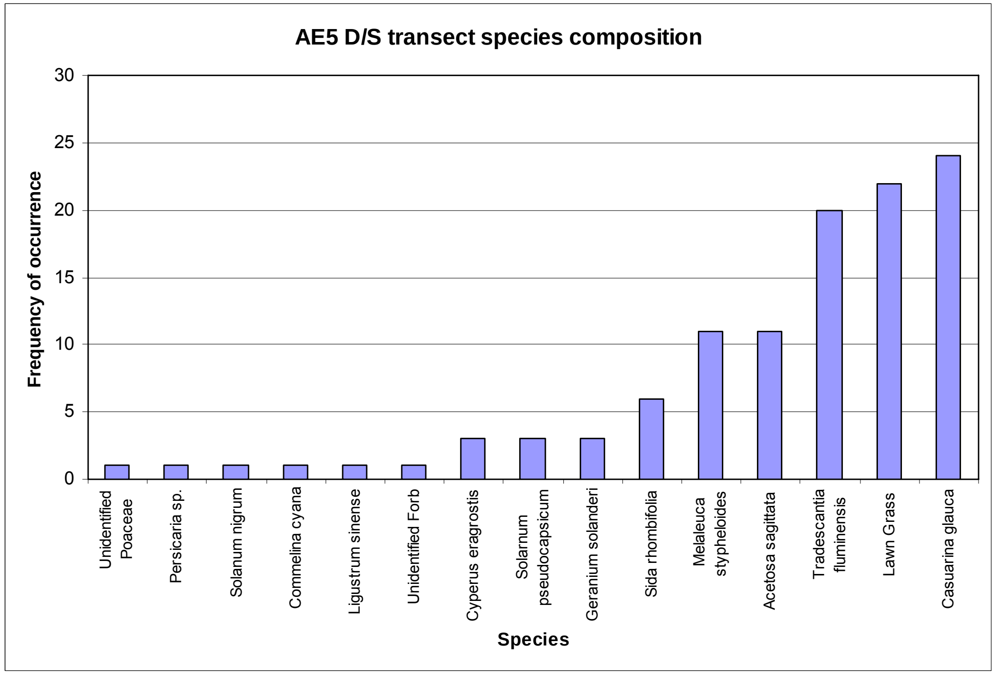

AE3 U/S transect species composition
Frequency of occurrence
0
2
4
6
8
10
12
14
16
18
20
Eucalyptus sp. 2
Glycine microphylla
Prostasparagus aethiopicus
Sigesbeckia orientalis
Solarnum nigrum
Galium aparine
Ligustrum sinense
Bidens pilosa
Pennisetum clandestinum
Sida rhombifolia
Solarnum pseudocapsicum
Acacia parramattensis
Pittosporum undulatum
Cestrum aurantiacum
Chloris sp.
Lawn grasses
Eucalyptus amplifolia
Casuarina glauca
Tradescantia fluminensis
Eucalyptus moluccana
Species

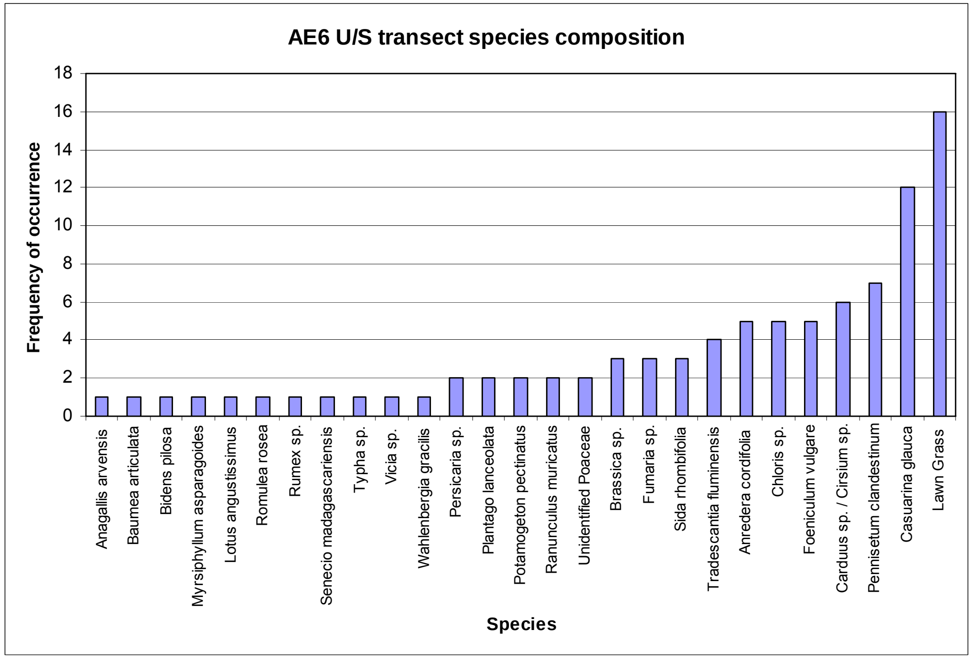

AE3 D/S transect species composition
Frequency of occurrence
0
5
10
15
20
25
30
35
Araujia hortorum
Chloris sp.
Sigesbeckia orientalis
Clematis glycinoides
Cyperus eragrostis
Juncus cognatus
Bidens pilosa
Eucalyptus amplifolia
Lawn grasses
Sida rhombifolia
Lomandra sp.
Pennisetum clandestinum
Rubus fruiticosus
Solarnum pseudocapsicum
Cestrum aurantiacum
Ligustrum lucidum
Unidentified Poaceae
Ligustrum sinense
Acacia parramattensis
Bursaria spinosa
Tradescantia fluminensis
Casuarina glauca
Species

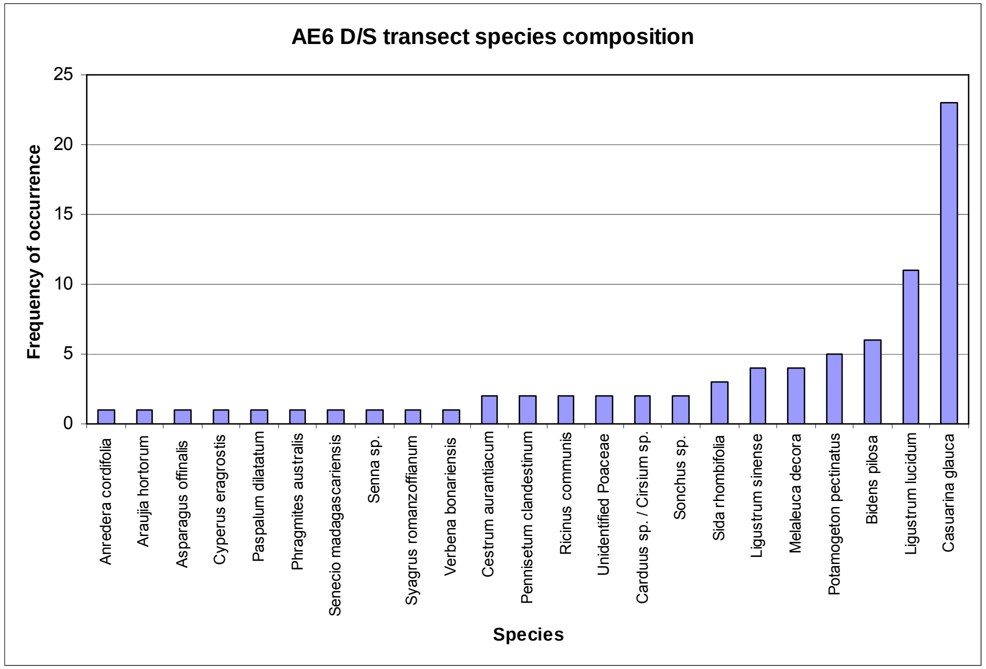

AE4 U/S transect species composition
Frequency of occurrence
0
5
10
15
20
25
30
35
Araujia hortorum
Poa sp.
Ranunculus sp.
Sigesbeckia orientalis
Solanum mauritianum
Verbena bonariensis
Cyperus eragrostis
Eucalyptus amplifolia
Geranium solanderi
Phyllanthus tenellus
Sida rhombifolia
Ligustrum sinense
Clematis glycyinoides
Lawn Grasses
Casuarina glauca
Melaleuca styphelioides
Tradescantia fluminensis
Species


AE4 D/S transect species composition
Frequency of occurrence
0
5
10
15
20
25
30
35
40
45
Ligustrum sinense
Acacia parramattensis
Lomandra sp.
Erythrina x skyesii
Clematis glycinoides
Unidentified Poaceae
Solarnum pseudocapsicum
Araujia hortorum
Eucalyptus amplifolia
Sida rhombifolia
Casuarina glauca
Tradescantia fluminensis
Species


AE5 U/S transect species composition
Frequency of occurrence
25
20
15
10
5
0
Bidens pilosa
Clematis glycyinoides
Cyperus eragrostis
Eucalyptus amplifolia
Geranium sp.
Lotus sp.
Melaleuca stypheloides
Olea europea
Soliva sessilis
Hydrocotyle peduncularis
Ranunculus sp.
Solarnum pseudocapsicum
Cestrum aurantiacum
Bursaria spinosa
Unidentified Poaceae
Sida rhombifolia
Acetosa sagittata
Morus alba
Casuarina glauca
Lawn Grass
Tradescantia fluminensis
Species


AE5 D/S transect species composition
Frequency of occurrence
30
25
20
15
10
5
0
Unidentified Poaceae
Persicaria sp.
Solanum nigrum
Commelina cyana
Ligustrum sinense
Unidentified Forb
Cyperus eragrostis
Solarnum pseudocapsicum
Geranium solanderi
Sida rhombifolia
Melaleuca stypheloides
Acetosa sagittata
Tradescantia fluminensis
Lawn Grass
Casuarina glauca
Species


AE6 U/S transect species composition
Frequency of occurrence
0
2
4
6
8
10
12
14
16
18
Anagallis arvensis
Baumea articulata
Bidens pilosa
Myrsiphyllum asparagoides
Lotus angustissimus
Romulea rosea
Rumex sp.
Senecio madagascariensis
Typha sp.
Vicia sp.
Wahlenbergia gracilis
Persicaria sp.
Plantago lanceolata
Potamogeton pectinatus
Ranunculus muricatus
Unidentified Poaceae
Brassica sp.
Fumaria sp.
Sida rhombifolia
Tradescantia fluminensis
Anredera cordifolia
Chloris sp.
Foeniculum vulgare
Carduus sp. / Cirsium sp.
Pennisetum clandestinum
Casuarina glauca
Lawn Grass
Species


AE6 D/S transect species composition
Frequency of occurrence
0
5
10
15
20
25
Anredera cordifolia
Araujia hortorum
Asparagus offinalis
Cyperus eragrostis
Paspalum dilatatum
Phragmites australis
Senecio madagascariensis
Senna sp.
Syagrus romanzoffianum
Verbena bonariensis
Cestrum aurantiacum
Pennisetum clandestinum
Ricinus communis
Unidentified Poaceae
Carduus sp. / Cirsium sp.
Sonchus sp.
Sida rhombifolia
Ligustrum sinense
Melaleuca decora
Potamogeton pectinatus
Bidens pilosa
Ligustrum lucidum
Casuarina glauca
Species

Appendix D – Incidental fauna observations and weed control classes

Incidental fauna observations recorded 2009

Blue-tongue Lizard (Tiliqua scincoides)

Eastern Water Dragon (Physignathus lesueurii)

Eastern Water Skink (Eulamprus quoyii)

Red-belly Black Snake (Pseudechis porphyriacus)

Australian White Ibis (Threskiornis molucca)

European Red Fox (Vulpes vulpes) *observed and scats

European Rabbit (Oryctolagus cuniculus)

Laughing Kookaburra (Dacelo novaeguineae)

Black-faced Cuckoo-shrike (Coracina novaehollandiae)

Tawny Frogmouth (Podargus strigoides) *feather only

Australian Magpie Lark (Grallina cyanoleuca)

Australian Magpie (Gymnorhina tibicen)

Australian Raven (Corvus coronoides)

Unidentified skink (Scincidae)

Weed control classes (NSW Noxious Weeds Act, 1993)

Control class	Weed type	Control requirements
Class 1	Plants that pose a potentially serious threat to primary production or the environment and are not present in the State or are present only to a limited extent.	The plant must be eradicated from the land and the land must be kept free of the plant. The weeds are also "notifiable" and a range of restrictions on their sale and movement exist.
Class 2	Plants that pose a potentially serious threat to primary production or the environment of a region to which the order applies and are not present in the region or are present only to a limited extent.	The plant must be eradicated from the land and the land must be kept free of the plant. The weeds are also "notifiable" and a range of restrictions on their sale and movement exist.
Class 3	Plants that pose a potentially serious threat to primary production or the environment of a region to which the order applies, are not widely distributed in the area and are likely to spread in the area or to another area.	The plant must be fully and continuously suppressed and destroyed.*
Class 4	Plants that pose a potentially serious threat to primary production, the environment or human health, are widely distributed in an area to which the order applies and are likely to spread in the area or to another area.	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.*
Class 5	Plants that are likely, by their sale or the sale of their seeds or movement within the State or an area of the State, to spread in the State or outside the State.	There are no requirements to control existing plants of Class 5 weeds. However, the weeds are "notifiable" and a range of restrictions on their sale and movement exists.

NOTE: All Class 1, 2 and 5 weeds are prohibited from sale in NSW.
* In some cases the following wording has also been inserted "the plant may not be sold, propagated or knowingly distributed."