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BULLI SEAM OPERATIONS

APPENDIX D

AQUATIC ECOLOGY ASSESSMENT

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ILLAWARRA COAL - BULLI SEAM OPERATIONS

AQUATIC ECOLOGY ASSESSMENT

PREPARED FOR
ILLAWARRA COAL HOLDINGS PTY LTD

August 2009

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1.0 INTRODUCTION

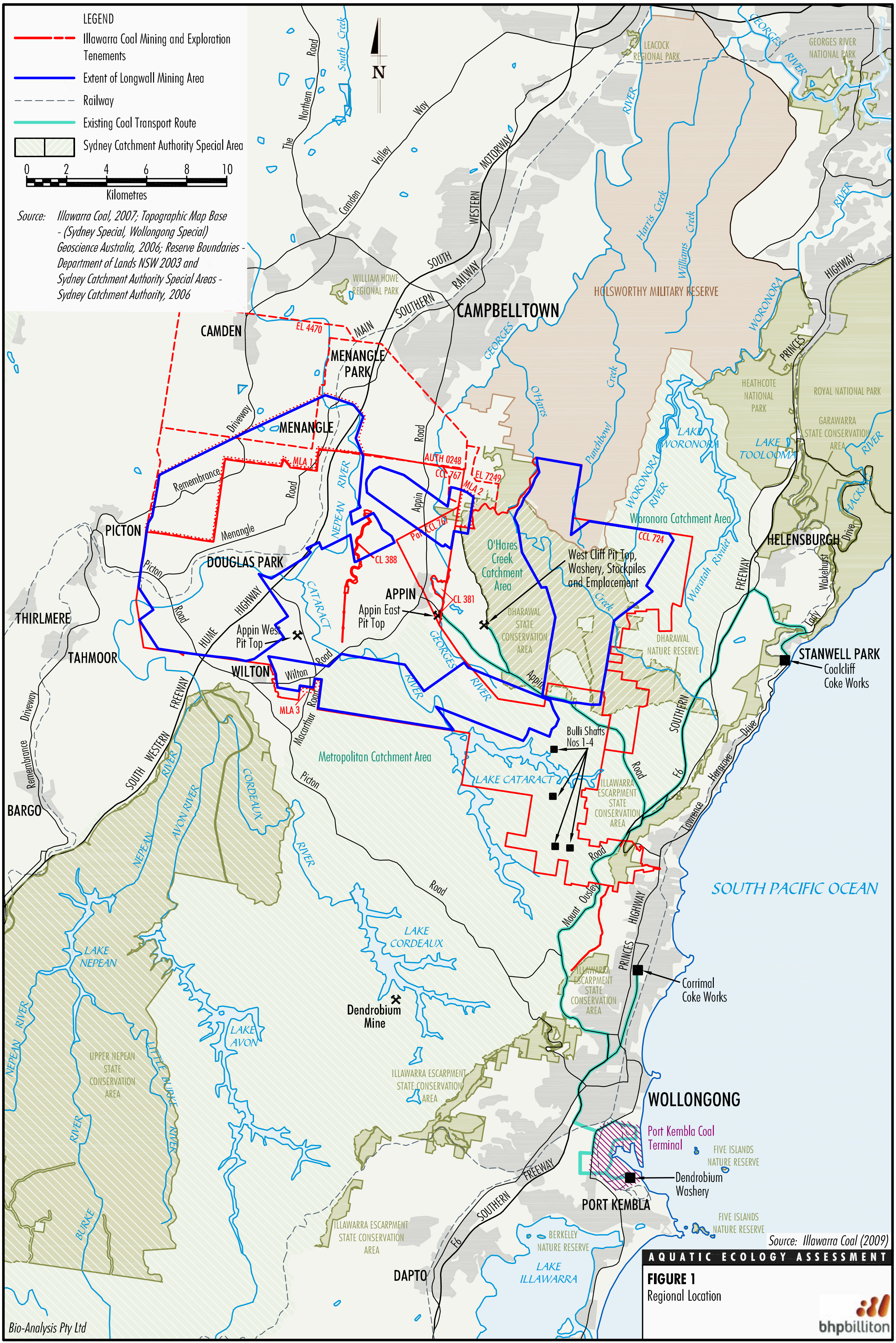
Illawarra Coal Holdings Pty Ltd (ICHPL) proposes to continue and expand its longwall mining operations at the West Cliff Colliery and Appin Colliery (the Bulli Seam Operations) (the Project) in the Southern Coalfield, New South Wales (NSW) (Figure 1). Bio-Analysis was commissioned by ICHPL to carry out an aquatic ecology assessment for the Project.

The main activities associated with the development of the Project would include:

- continued development of underground mining operations within existing coal leases and new mining leases to facilitate a total run-of-mine (ROM) coal production rate of up to 10.5 million tonnes per annum (Mtpa);
- ongoing exploration activities within existing exploration tenements;
- upgrade of the existing West Cliff Colliery Washery to support the increased ROM coal production;
- continued mine gas drainage and capture for beneficial utilisation at the West Cliff Ventilation Air Methane Project (WestVAMP) and Appin-Tower Power Project;
- continued use of electricity generated by the existing Appin-Tower Power Project (owned and operated by Energy Developments Limited [EDL] power stations) utilising coal bed methane drained from the Bulli Seam;
- upgrade of existing surface facilities and supporting infrastructure at the Bulli Seam Operations (e.g. service boreholes, gas drainage equipment, waste water treatment and waste water disposal);
- continued and expanded placement of coal wash at the West Cliff Colliery Coal Wash Emplacement;
- continued road transport of ROM coal between the Bulli Seam Operations (i.e. from the Appin Colliery pit top to the West Cliff Colliery Washery) and the Dendrobium Washery at Port Kembla;
- continued road transport of product coal from the West Cliff Colliery Washery via the public road network to BlueScope Steelworks and Port Kembla Coal Terminal;
- ongoing surface rehabilitation (including rehabilitation of mine related infrastructure areas that are no longer required) and remediation works; and
- other associated minor infrastructure, plant, equipment and activities.

The main activities associated with the development of the Project are described in detail in Sections 1 and 2 in the Main Report of Project Environmental Assessment (EA).

The Project would include the current and completed underground mining areas, as well as the extent of longwall mining area shown on Figures 2 to 5. ICHPL is currently conducting underground mining at the Appin Mine within Appin Area 7 and at the West Cliff Colliery within West Cliff Area 5 (Figure 2).

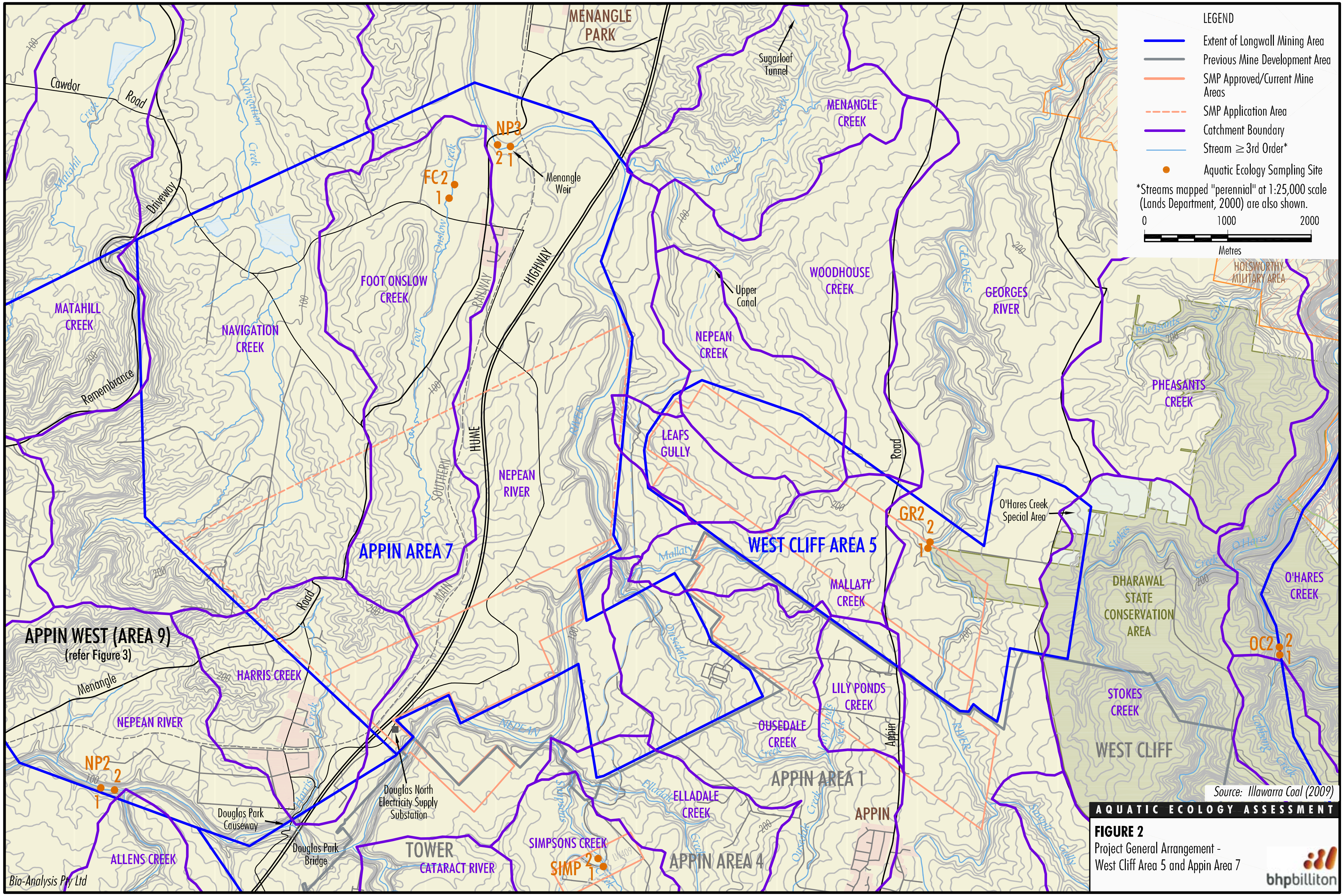


Source: Illawarra Coal, 2007; Topographic Map Base - (Sydney Special, Wollongong Special) Geoscience Australia, 2006; Reserve Boundaries - Department of Lands NSW 2003 and Sydney Catchment Authority Special Areas - Sydney Catchment Authority, 2006

Source: Illawarra Coal (2009)

AQUATIC ECOLOGY ASSESSMENT

FIGURE 1
Regional Location



Source: Illawarra Coal (2009)

AQUATIC ECOLOGY ASSESSMENT

FIGURE 2
Project General Arrangement -
West Cliff Area 5 and Appin Area 7

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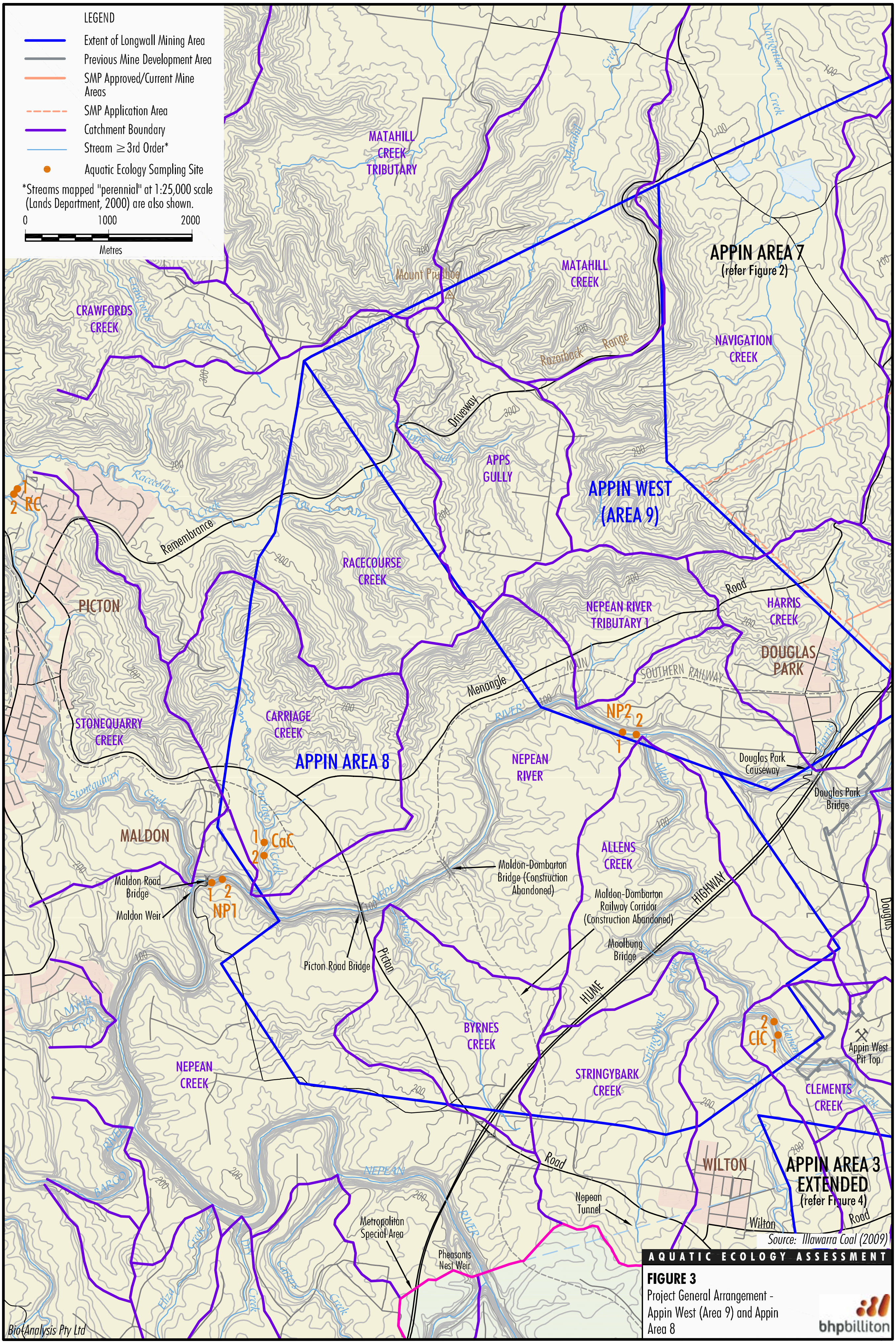
BHPIC-07-01 EA Aq Ecology_104D



AQUATIC ECOLOGY ASSESSMENT

FIGURE 3
Project General Arrangement - Appin West (Area 9) and Appin Area 8

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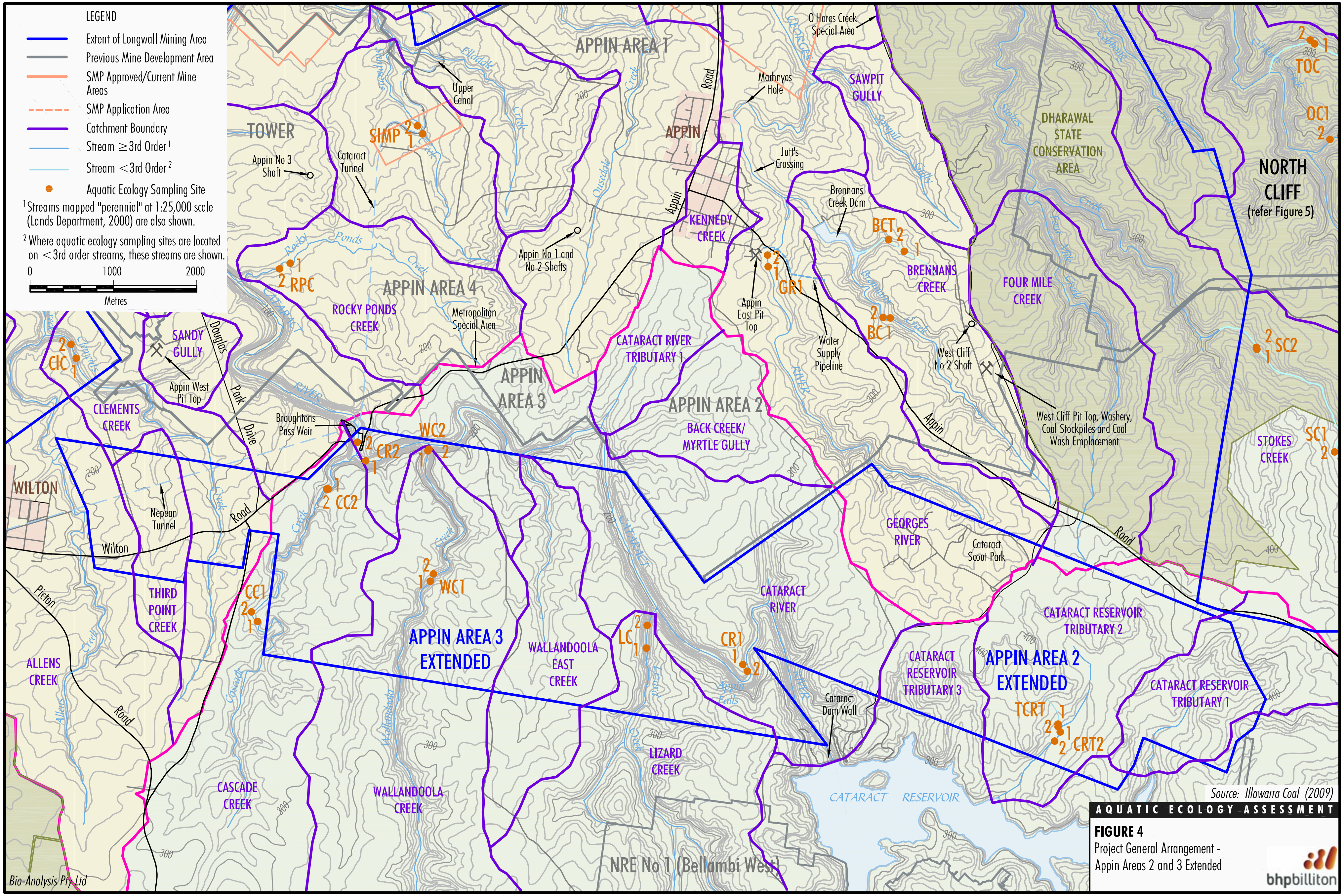

Source: Illawarra Coal (2009)

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FIGURE 4
Project General Arrangement - Appin Areas 2 and 3 Extended

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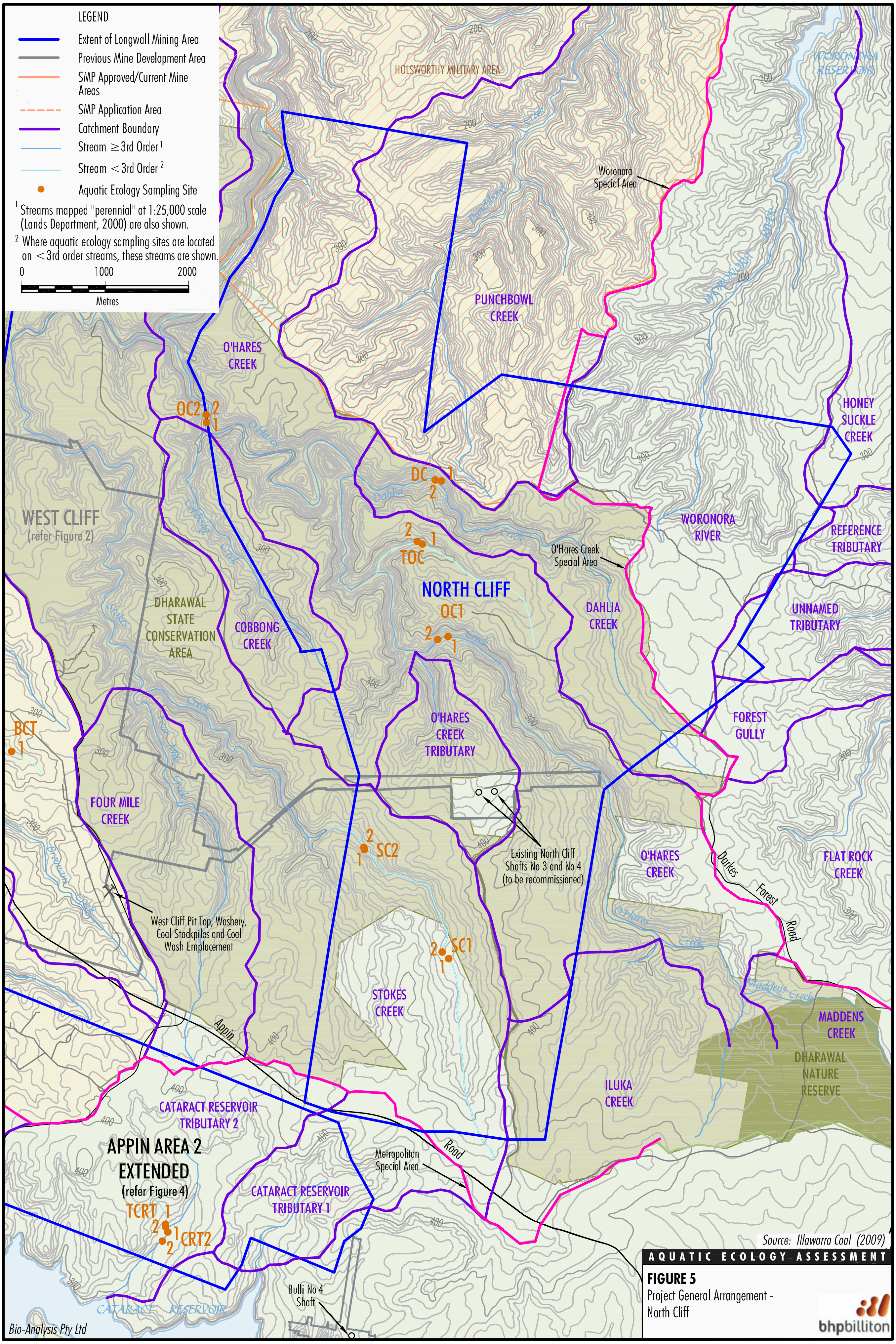


Source: Illawarra Coal (2009)

FIGURE 5
Project General Arrangement - North Cliff

BHPIC-07-01 EA Aq Ecology_107F

The aims of this assessment were to:

- review existing literature relevant to the aquatic ecology of the study area and wider surrounds;
- undertake field work to complement existing surveys to provide a baseline assessment of stream characteristics, aquatic biota and aquatic habitat within the study area;
- assess the potential impacts of the Project on aquatic habitats and biota; and
- provide recommendations for mitigation, management and monitoring of potential impacts associated with the Project.

2.0 DESCRIPTION OF THE STUDY AREA

The Project underground mining area and surrounds are located within the Campbelltown, Wollongong and Wollondilly Local Government Areas. Portions of the Project are located within the Metropolitan, O'Hares Creek and Woronora Special Areas and the Dharawal State Conservation Area, which are largely undeveloped and covered predominantly by native vegetation. Public access to these areas is restricted and managed by the Sydney Catchment Authority (SCA) and/or the NSW Department of Environment and Climate Change (DECC).

For ease of reference and discussion, the Project underground mining area and surrounds has been divided into five domains, namely (Figures 2 to 5):

- West Cliff Area 5 and Appin Area 7 (north domain);
- Appin West (Area 9) and Appin Area 8 (west domain);
- Appin Areas 2 and 3 Extended (south domain); and
- North Cliff (east domain);
- Historic Mining Areas (central domain).

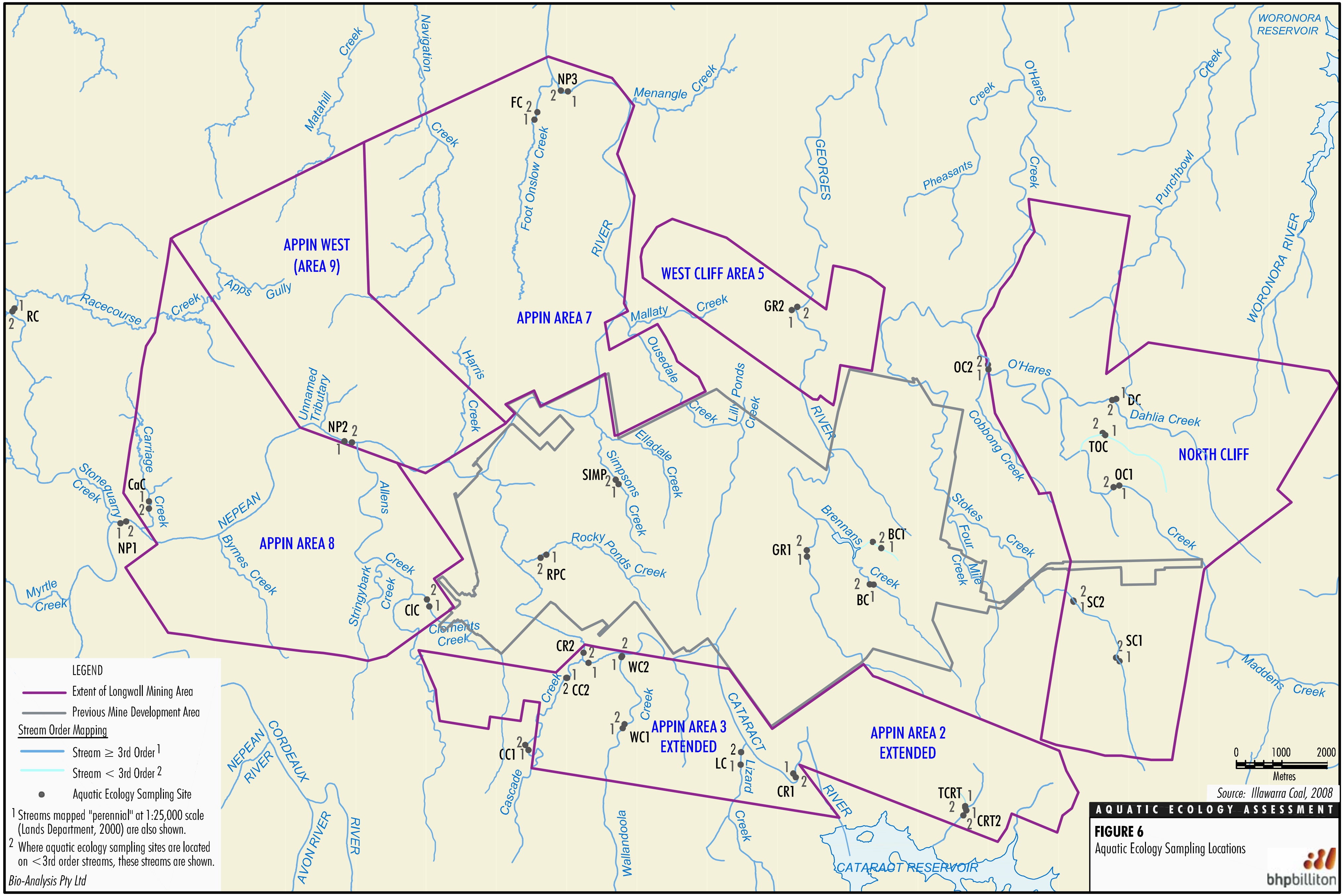
A number of streams occur within the Project underground mining area and surrounds. These streams fall within the catchments of four main river systems (Nepean River, Cataract River, Georges River and Woronora River catchments) (Figure 6) and range from 1st to 7th order streams. Third order and above streams within the study area are described in Section 2.1 and shown in Table 1, grouped by main catchment area. Section 2.2 provides a description of the three pit tops (i.e. Appin West, Appin East and West Cliff) and their relevant downstream environments.

2.1 Streams within the Project Underground Mining Area

2.1.1 Nepean River Catchment

Nepean River

The Nepean River is a 7th order stream. The Hawkesbury-Nepean system is the second largest river system in NSW (Gehrke and Harris, 1996). The upper reaches of the major tributaries supply 97% of Sydney's drinking water (NSW Department of Primary Industries [DPI], 2007). Weirs at Pheasants Nest, Maldon, Douglas Park and Menangle on the Nepean River, and at Broughtons Pass on the Cataract River, have significantly reduced the flow in the upper Nepean River (Williams, 1994), transforming the river from a free-flowing watercourse into a series of long, slow flowing pools. The NSW government plan the release of new environmental flows from dams on the Hawkesbury-Nepean River (including the Avon, Cataract and Nepean Dams), commencing in 2009 (DPI, 2007). Investigations of measures to improve fish passage at the Pheasants Nest Weir and the Maldon Weir are also being undertaken (DPI, 2007; 2009).



LEGEND

Extent of Longwall Mining Area

Previous Mine Development Area

Stream Order Mapping

Stream ≥ 3rd Order[1]

Stream < 3rd Order[2]

● Aquatic Ecology Sampling Site

[1] Streams mapped "perennial" at 1:25,000 scale (Lands Department, 2000) are also shown.

[2] Where aquatic ecology sampling sites are located on <3rd order streams, these streams are shown.

Bio-Analysis Pty Ltd

Source: *Illawarra Coal, 2008*

AQUATIC ECOLOGY ASSESSMENT

FIGURE 6
Aquatic Ecology Sampling Locations

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BHPIC-07-01 EA Aq Ecology_103K

Table 1 Third Order and Above Streams Located within the Project Underground Mining Area

Stream	Relevant Figure(s)	Mining Domain	Stream Order*
Nepean River Catchment			
Nepean River (and un-named tributaries)	2 and 3	West and North Domains	7th order (tributaries 3rd/4th order)
Allens Creek	2 and 4	West Domain	4th order
Carriage Creek (and un-named tributaries)	3	West Domain	4 th order (tributaries 3rd order)
Menangle Creek	2	North Domain	4th order
Ousedale Creek	2	North Domain	4th order
Racecourse Creek (including Apps Gully)	3	West Domain	4 th order (tributaries 3rd order)
Navigation Creek	2 and 3	North Domain	3rd/4th order
Byrnes Creek	3	West Domain	3rd order
Clements Creek	3	South and West Domains	3rd order
Elladale Creek	2 and 4	North Domain	3rd order
Foot Onslow Creek	2	North Domain	3rd order
Harris Creek	2	North Domain	3rd order
Mallaty Creek	2	North Domain	3rd order
Simpsons Creek	2 and 4	North and South Domains	3rd order
Stringybark Creek	3	West Domain	3rd order
Unnamed Tributaries of Navigation Creek	2 and 3	North Domain	3rd order
Cataract River Catchment			
Cataract River (and un-named tributaries)	2 and 4	South Domain	6th order (tributaries 3rd order)
Lizard Creek	4	South Domain	5th order
Wallandoola Creek	4	South Domain	4th order
Cascade Creek	4	South Domain	3rd order
Wallandoola East Creek	4	South Domain	3rd order
Rocky Ponds Creek	4	South Domain	3rd order
Un-named Tributary of Cataract Reservoir 1	4	South Domain	3rd order
Un-named Tributary of Cataract Reservoir 2	4	South Domain	3rd order
Georges River Catchment			
Georges River	2 and 4	North Domain	4th order
Brennans Creek	4 and 5	Stage 4 Emplacement Area	3rd order
O'Hares Creek (and un-named tributary)	5	North Domain	4th order (tributary 3rd order)
Cobbong Creek	5	North Domain	3rd order
Dahlia Creek	5	North Domain	3rd order
Stokes Creek	5	North Domain	4th order
Woronora River Catchment			
Woronora River	5	East Domain	2nd order
Punchbowl Creek (and un-named tributary)	5	North Domain	3rd order (tributary 3rd order)

* After Appendix C of the EA.

The upper reaches of the Nepean River are set in a deep sandstone gorge. The immediate catchment of the gorge is pasture, some residential buildings and native bushland. Releases from the Cataract Reservoir occur via the Cataract River (Section 2.1.2). The river between Maldon Weir and Menangle Weir is characterised by:

- A series of continuous, slow moving, pools formed in bedrock, punctuated in some stretches by chokes of large boulders. Substratum of the pools is predominantly bedrock, boulders, sand and silt.
- Aquatic habitat in the Nepean River between Douglas Park Weir and Menangle Weir can be characterised as a series of continuous, deep, slow flowing pools, created by the damming effect of the weirs.
- During dry weather, releases to the Nepean River from the Upper Nepean Water Supply Scheme dams comprise almost entirely water released for water supply and for environmental purposes (Gilbert and Associates, 2009 provided as Appendix C of the EA).
- The banks of the pools are comprised of boulder habitat and sandbars which support riparian vegetation.
- Several large beds of submerged macrophytes, including *Hydrilla verticillata* and the introduced species *Elodea canadensis* are present.
- Third order and above tributaries of the Nepean River located within this area include Apps Gully (3rd order), Byrnes Creek (3rd order), Elladale Creek (3rd order), Foot Onslow Creek (3 rd order), Harris Creek (3 rd order), Simpsons Creek (3 rd order), Mallaty Creek (3rd order), Stringybark Creek (3 rd order), Allens Creek (4th order), Clements Creek (3 rd order), Carriage Creek (4th order), Navigation Creek (4th order), Ousedale Creek (4th order), Menangle Creek (4th order), Racecourse Creek (4th order), Cataract River (6th order), Unnamed Tributaries (3rd and 4th order) and a number of 1st and 2nd order streams.
- Riparian vegetation consisted of a mixture of native and exotic species, with some areas being dominated by grasses and others having over-hanging trees.
- Several large beds of submerged macrophytes (*Elodea canadensis*, *Hydrilla verticillata* and *Vallisneria americana*) were present in shallower (< 2 metres [m]) sections of the river.
- The upper reaches of the Nepean River are affected by high levels of diverse anthropogenic inputs (Appendix C of the EA). Discharges licensed by the DECC enter into the Nepean River and its tributaries from various sources including mining, industrial sources including food processing, cement manufacturing and animal processing facilities (Appendix C of the EA). Non-licensed discharges including urban runoff from the towns of Picton and Bargo, and agricultural runoff also affects water quality (Appendix C of the EA).
- The Nepean River commands a catchment area of some 945 square kilometres (km^2) at Maldon Weir upstream of the general Project area (Appendix C of the EA).
- Within the Project extent of longwall mining area, the Nepean River stretches for approximately 25.2 kilometres (km) (Appendix C of the EA).
- The Nepean River stretches for approximately 1.0 km over previously mined areas (Appendix C of the EA).

- The mean annual flow along the Nepean River has been calculated as 68,486 megalitres (ML) (i.e. 72.5 millimetres per year [mm/yr]) at Maldon Weir and 78,405 ML (i.e. 60 mm/yr) at Menangle Weir (Appendix C of the EA).
- Within the Project extent of longwall mining area, the stream gradient of the Nepean River is less than 1 metre per kilometre (m/km) (Appendix P of the EA).
- Within the Project extent of longwall mining area, the length of the Nepean River comprises approximately 95% pools, 1% rock bars and 4% boulder fields (Appendix C of the EA). Stream mapping is provided in the Stream Risk Assessment (Appendix P of the EA).
- No upland swamps are present on the Nepean River within the Project extent of longwall mining area (Appendix O of the EA).

The Project design criteria at Appin Area 7, Appin West (Area 9) and Appin Area 8 would minimise impacts such as cliff falls along the Nepean River.

Appropriate design criteria for the Menangle Weir and the Douglas Park Weir on the Nepean River would maintain the structural integrity of the weir and therefore avoid significant impact to the upstream pools.

Further detail on the stream characteristics of the Nepean River, including stream mapping, is provided in the Stream Risk Assessment (Appendix P of the EA).

Carriage Creek

Carriage Creek is a relatively small (i.e. < 4 km in length) stream that runs through steep valleys from the west into the Nepean River. Carriage Creek is a 4th order stream. Like most streams in the Picton and Appin area, the catchment of this stream is mostly devoted to grazing with some industrial and residential buildings and native bushland. The channel of this stream can be characterised by:

- The section to be undermined contains a series of narrow and relatively shallow pools (Appendix C of the EA). Two long pools were mapped between 100 m and 120 m long, and 22 shorter pools between 10 m and 40 m long (Appendix C of the EA). Six prominent, rock bar controlled pools were mapped near the centre of the extent of longwall mining area (Appendix C of the EA). Further upstream, the pools became longer and narrower and were separated by less pronounced boulders and small rock bars (Appendix C of the EA).
- Stock induced erosion of the banks and channel in many places along the upper and middle reaches.
- Steep lower reaches which create significant barriers to upstream migration of many species of fish.
- Relatively little in-stream vegetation.
- Carriage Creek is approximately 3.3 km long and covers an associated catchment area of some 5.8 km^2 (Appendix C of the EA).
- Within the Project extent of longwall mining area, Carriage Creek stretches for approximately 3.3 km (Appendix C of the EA).

- Within the Project extent of longwall mining area, the stream gradient of Carriage Creek is approximately 40 m/km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the length of Carriage Creek comprises approximately 50% pools, 10% rock bars and 15% boulder fields (Appendix C of the EA). Stream mapping is provided in the Stream Risk Assessment (Appendix P of the EA).
- No upland swamps are present on Carriage Creek within the Project extent of longwall mining area (Appendix O of the EA).

Further detail on the stream characteristics of Carriage Creek, including stream mapping, is provided in the Stream Risk Assessment (Appendix P of the EA).

Menangle Creek

Menangle Creek is a 4th order stream. Only a small section of Menangle Creek (where it meets the Nepean River) is located within the Project extent of longwall mining area. Menangle Creek flows from the north into the Nepean River, upstream of the Menangle Weir. Like most streams in the Picton and Appin area, the catchment of this stream is mostly devoted to grazing with some industrial and residential buildings and native bushland also present. The channel of this stream can be characterised by:

- A channel form which typically comprises a few, small permanent pools.
- A sediment/shale based substratum at the top of the catchments.
- Stock induced erosion of the banks and channel in many places along the upper and middle reaches.
- Farm-dams along the channel of the stream and/or its tributaries, which interrupt downstream flow.
- Relatively little in-stream vegetation.
- No upland swamps are present along Menangle Creek within the Project extent of longwall mining area (Appendix O of the EA).

Further detail on the stream characteristics of Menangle Creek is provided in Appendix P of the EA.

Ousedale Creek

Ousedale Creek is a 4th order stream. The catchment area of this stream includes pasture, chicken farms and some semi-urban development. Some areas over which the stream flows have been subjected to mine subsidence impacts in the past. The upper reaches of this stream are also subject to modified flow due to construction of farm dams.

Within the general Project area, Ousedale Creek is characterised by:

- Numerous small pools, boulders and boulder fields and rock bars (Appendix C of the EA). Stream mapping indicates it is a typical tributary formed in the Hawkesbury Sandstone although with significant fluvial processes in its upper reaches (Appendix C of the EA).
- Within the Project extent of longwall mining area, the pools are mapped as being a near continuous feature between the rock bars and boulder fields (Appendix C of the EA). The most notable features mapped are a series of prominent rock bars and associated pools located some 700 m to 1,000 m upstream of the Nepean River confluence, and a second series further upstream near the southern boundary of Appin Area 7 (Appendix C of the EA).
- Historical mining has been undertaken beneath approximately 5.1 km of Ousedale Creek (Appendix C of the EA).
- Ousedale Creek is approximately 7.5 km long and has an associated catchment area of some 11.5 km^2 (Appendix C of the EA).
- Within the Project extent of longwall mining area, Ousedale Creek stretches for approximately 1.6 km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the stream gradient of Ousedale Creek is 35 m/km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the length of Ousedale Creek comprises approximately 40% pools, 30% rock bars and 10% boulder fields (Appendix C of the EA). Stream mapping is provided in the Stream Risk Assessment (Appendix P of the EA).
- No upland swamps are present along Ousedale Creek within the Project extent of longwall mining area (Appendix O of the EA).

Further detail on the stream characteristics of Ousedale Creek, including stream mapping, is provided in the Stream Risk Assessment (Appendix P of the EA).

Racecourse Creek and Apps Gully

Racecourse Creek (including Apps Gully) flows into Stonequarry Creek, which flows into the Nepean River downstream of the Maldon Weir. The immediate catchment of Racecourse Creek and Apps Gully is mostly pasture, residential buildings, a golf-course and the western slopes of the Razorback Range. Racecourse Creek is a 4th order stream.

Racecourse Creek and Apps Gully are formed in moderately incised valleys, draining the flanks of the Razorback Range (Appendix C of the EA). The headwaters of Racecourse Creek and Apps Gully are generally characterised by small ephemeral alluvial gullies with some remnant small pools within sequences of pools and riffles (Appendix C of the EA). Racecourse Creek meanders through Wianamatta Group shale terrain (Appendix C of the EA).

The channel form of Racecourse Creek typically comprised a series of small pools interspersed by short runs. The substratum was observed to be predominantly soft silt and clay sediments. A few patches of in-stream macrophytes were present in pools in the lower reaches (i.e. near Picton) of the stream. The banks of the channel (where surveyed) were heavily eroded, probably associated with removal of riparian vegetation and access by cattle. Within the general study area, Racecourse Creek is characterised by:

- Racecourse Creek (including Apps Gully) is approximately 4 km long and covers an associated catchment area of some 11.4 km^2 (Appendix C of the EA).
- Within the Project extent of longwall mining area, Racecourse Creek stretches for approximately 3.7 km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the stream gradient of Racecourse Creek is 25 m/km (Appendix C of the EA).
- Within the Project extent of longwall mining area, Racecourse Creek and Apps Gully are likely to have some remnant small pools within the sequences of pools and riffles at their headwaters (Appendix C of the EA).
- No upland swamps are present along Racecourse Creek or Apps Gully within the Project extent of longwall mining area (Appendix O of the EA).

Further detail on the stream characteristics of Racecourse Creek and Apps Gully is provided in the Surface Water Assessment (Appendix C of the EA) and the Stream Risk Assessment (Appendix P of the EA).

Allens Creek, Clements Creek, Stringybark Creek

Allens Creek is a 3rd/4th order stream that flows in a north-westerly direction from the town of Wilton, through Appin Area 8. Allens Creek becomes a 4th order stream downstream of its confluence with Clements Creek within the Project extent of longwall mining area. Allens Creek is fed by two 3rd order tributaries (Clements and Stringybark Creeks) and several 1st and 2nd order streams. Allens Creek flows into the Nepean River approximately 1 km upstream of the Douglas Park Weir. The channel of Allens Creek cuts through a steep, well-vegetated gorge. Beyond the gorge, the middle and lower reaches of the stream are gently sloping, forming shallow pools separated by rock bars and vegetated chokes.

The catchments of these watercourses do not contain upland swamps (Appendix O of the EA). Land-use within the catchment of Allens Creek is mixed rural, residential and industrial. For example, the Appin Colliery (Appin West pit top) (formerly known as the Tower Colliery and Douglas Project) is located in the upper reaches of the catchment.

The Appin West Colliery discharges mine water from the Appin West pit top via Environment Protection Licence (EPL) 398 into an unnamed tributary that flows to Sandy Gully (2nd order) from where it flows into Clements Creek, then Allens Creek, then the Nepean River. Discharge of mine water (~ 1 ML per day) has turned Allens Creek (downstream of the confluence with Clements Creek) from ephemeral to constantly flowing (The Ecology Lab [TEL], 2006a).

Within the general Project area, Allens Creek, Clements Creek and Stringybark Creek are characterised by:

- Numerous boulder fields and small shallow pools (between 0.1 m and 0.3 m deep) above the Stringybark Creek confluence (Appendix C of the EA).
- Downstream of the Stringybark Creek confluence there was a predominance of long pools which formed a nearly continuous water body stretching to within 500 m of the Nepean River confluence (Appendix C of the EA). Water depth observations along this section were typically between 0.5 m and 0.75 m and occasionally greater than 1 m (Appendix C of the EA). A series of short boulder field and bounder clusters were mapped along the water body with through flow noted (Appendix C of the EA).
- Allens Creek is approximately 9.5 km long and covers an associated catchment area of some 32.1 km^2 (Appendix C of the EA).
- Within the Project extent of longwall mining area, Allens Creek stretches for approximately 6.8 km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the stream gradient of Allens Creek is 14 m/km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the length of Allens Creek comprises approximately 50% pools, 20% rock bars and 30% boulder fields (Appendix C of the EA).
- No upland swamps are present along Allens Creek within the Project extent of longwall mining area (Appendix O of the EA).

It is expected that the stream impact minimisation criteria applied to the Nepean River would account for reduced subsidence effects at Allens Creek at its confluence with the Nepean River.

Further detail on the stream characteristics of Allens Creek, Clements Creek and Stringybark Creek, including stream mapping, is provided in the Stream Risk Assessment (Appendix P of the EA).

Navigation Creek

Navigation Creek is a relatively small 4th order stream (< 6 km in length) which meanders through pasture in a north-east direction into the Nepean River, downstream of the Menangle Weir. Like most streams in the Picton and Appin area, the catchment of Navigation Creek is mostly devoted to grazing with some industrial and residential buildings and native bushland.

The headwater tributaries of Navigation Creek are formed in moderately incised valleys, draining the flanks of the Razorback Range (Appendix C of the EA). Navigation Creek flows through the Wianamatta Group Shale formation. The headwater tributaries of Navigation Creek are characterised by small ephemeral alluvial gullies with some remnant small pools within sequences of pools and riffles (Appendix C of the EA).

The channel of this stream can be characterised by:

- A channel form which typically comprises a few, small (< 8 m wide), permanent pools.
- Stock induced erosion of the banks and channel in many places along the upper and middle reaches.
- Farm-dams along the channel of the streams and/or their tributaries, which interrupt downstream flow.
- Navigation Creek is approximately 5.4 km long and covers an associated catchment area of some 15 km^2 (Appendix C of the EA).
- Within the Project extent of longwall mining area, Navigation Creek stretches for approximately 5.4 km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the stream gradient of Navigation Creek is 31 m/km (Appendix C of the EA).
- No upland swamps are present along Navigation Creek within the Project extent of longwall mining area (Appendix O of the EA).

Further detail on the stream characteristics of Navigation Creek is provided in the Surface Water Assessment (Appendix C of the EA).

Byrnes Creek

Byrnes Creek is a typical small incised stream in Hawkesbury Sandstone. Byrnes Creek is a 3rd order stream. Byrnes Creek is predominantly boulder strewn with a series of small and isolated pools. There were six small rock bars mapped, however only one was mapped downstream of a pool (Appendix C of the EA). The channel of this stream can be characterised by:

- Byrnes Creek flows through the Wianamatta Group Shale formation (Appendix C of the EA).
- Byrnes Creek is approximately 2.9 km long and has an associated catchment area of some 3.9 km^2 (Appendix C of the EA).
- Within the Project extent of longwall mining area, Byrnes Creek stretches for approximately 1.6 km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the stream gradient of Byrnes Creek is 42 m/km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the length of Byrnes Creek comprises approximately 25% pools, 10% rock bars and 50% boulder fields (Appendix C of the EA).
- No upland swamps are present along Byrnes Creek within the Project extent of longwall mining area (Appendix O of the EA).

It is expected that the design criteria applied to the Nepean River would account for reduced subsidence effects at Byrnes Creek at its lower reach near the confluence with the Nepean River (Appendix C of the EA).

Further detail on the stream characteristics of Byrnes Creek, including stream mapping, is provided in the Stream Risk Assessment (Appendix P of the EA).

Elladale Creek

Elladale Creek is not located within the Project extent of longwall mining area. Within previously mined areas, Elladale Creek stretches for approximately 3.3 km (Appendix C of the EA).

Elladale Creek flows through agricultural areas, which have been subjected to mine subsidence in the past. Elladale Creek is subject to modified flow due to construction of farm dams and leakage from the Sydney Water Supply Canal, where it crosses the stream's channels. Leakage from the supply canal has been observed to contribute flow and available aquatic habitat, particularly during long periods without rain (TEL, 2004e). At its confluence with the Nepean River, the channel of Elladale Creek is flooded by the river due to the damming effect of the Menangle Weir. Riparian vegetation comprises mostly grasses in the upper reaches and a mixture of native and exotic trees further downstream.

Further detail on the stream characteristics of Elladale Creek, including stream mapping, is provided in the Stream Risk Assessment (Appendix P of the EA).

Foot Onslow Creek

Foot Onslow Creek is a relatively small 3rd order stream (< 8 km in length), which meanders through pasture in a northerly direction into the Nepean River, downstream of the Menangle Weir. Like most streams in the Picton and Appin area, the catchment of this stream is mostly devoted to grazing with some industrial and residential buildings and native bushland.

Foot Onslow Creek flows through the Wianamatta Group Shale formation and the headwaters are characterised by small ephemeral alluvial gullies with some remnant small pools within sequences of pools and riffles (Appendix C of the EA). The channel of the stream can be characterised by:

- A channel form which typically comprises a few, small (< 8 m wide), permanent pools.
- Stock induced erosion of the banks and channel in many places along the upper and middle reaches.
- Farm-dams along the channel of the streams and/or their tributaries, which interrupt downstream flow.
- Relatively little in-stream vegetation.
- Foot Onslow Creek is approximately 6.0 km long and covers an associated catchment area of some 5.6 km^2 (Appendix C of the EA).
- Within the Project extent of longwall mining area, Foot Onslow Creek stretches for approximately 5.6 km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the stream gradient of Foot Onslow Creek is 17 m/km (Appendix C of the EA).
- Within the Project extent of longwall mining area, Foot Onslow Creek is likely to have some remnant small pools within sequences of pools and riffles within its headwaters (Appendix C of the EA).
- No upland swamps are present along Foot Onslow Creek within the Project extent of longwall mining area (Appendix O of the EA).

It is expected that the design criteria applied to the Nepean River would account for reduced subsidence effects at Foot Onslow Creek at its lower each near the confluence with the Nepean River.

Further detail on the stream characteristics of Foot Onslow Creek is provided in the Surface Water Assessment (Appendix C of the EA).

Harris Creek

Harris Creek is a relatively small 3rd order stream (i.e. < 3 km in length) that flows through steep valleys in its lower reaches as it approaches the Nepean River. Like most streams in the Picton and Appin area, the catchment of Harris Creek is mostly devoted to grazing with some industrial and residential buildings and native bushland. The channel of the stream can be characterised by:

- A channel form which typically comprises a few, small, permanent pools.
- Significant lengths of the middle reaches of Harris Creek were mapped as comprising boulder fields with isolated rock bars and vegetated beds. The most notable feature was a prominent rock bar and pool which was mapped upstream of a prominent bend in the stream.
- Harris Creek flows through the Wianamatta Group Shale formation in its upper reaches and Hawkesbury Sandstone in its lower reaches (Appendix C of the EA).
- Stock induced erosion of the banks and channel in many places along the upper and middle reaches.
- Farm-dams along the channel of the streams and/or their tributaries, which interrupt downstream flow.
- Steep lower reaches in the Nepean River gorge, which create significant barriers to upstream migration of many species of fish.
- Relatively little in-stream vegetation.
- Harris Creek is approximately 2.8 km long and covers an associated catchment area of some 3.6 km^2 (Appendix C of the EA).
- Within the Project extent of longwall mining area, Harris Creek stretches for approximately 2.9 km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the stream gradient of Harris Creek is 18 m/km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the length of Harris Creek comprises approximately 10% pools, 15% rock bars and 25% boulder fields (Appendix C of the EA).
- No upland swamps are present along Harris Creek within the Project extent of longwall mining area (Appendix O of the EA).

Further detail on the stream characteristics of Harris Creek, including stream mapping, is provided in the Stream Risk Assessment (Appendix P of the EA).

Mallaty Creek

Mallaty Creek is a 3rd order stream that flows from the east into Ousedale Creek, approximately 500 m upstream from its confluence with the Nepean River. The catchment area includes pasture, chicken farms and some semi-urban development. Areas over which the stream flows have been subjected to mine subsidence impacts in the past. The upper reaches of the stream are also subjected to modified flow due to farm dams. In the lower reaches, the watercourse features steep gullies as it approaches the Nepean River and these are covered with a mixture of native and exotic riparian vegetation. Steep grades in the lower sections are likely to constitute a barrier to upstream migration of some species of fish. Mallaty Creek comprises a series of prominent rock bars and small pools interspersed with boulder fields (Appendix P of the EA).

Approximately 200 m of Mallaty Creek was undermined by West Cliff Colliery longwall panel LW32 in 2007 (Appendix C of the EA). Reported monitoring and inspections carried out along Mallaty Creek revealed one small fracture in a rock bar (Appendix C of the EA). There was, however, no evidence of flow loss, changes to water or iron staining associated with the fracture (Appendix C of the EA). Observed iron staining was limited to a small stain attributed to a groundwater spring which was possibly associated with subsidence movements (Appendix C of the EA). Extensive water quality monitoring along Mallaty Creek prior to mining confirmed the presence of a saline spring within the reach which was subsequently undermined (Appendix C of the EA). The spring was the major determinant for salinity in the lower reaches of Mallaty Creek (Appendix C of the EA). During mining there was a localised and temporary increase in pH which was attributed to subsidence effects on the spring (Appendix C of the EA). There were no other water quality effects that were attributed to subsidence (Appendix C of the EA). Release of strata gas was observed in Mallaty Creek during mining of Longwall 32 (Appendix C of the EA). Release of strata gas ceased within six months of its initial detection and prior to completion of the longwall (Appendix C of the EA).

The channel of the stream can be characterised by:

- Mallaty Creek flows through the Wianamatta Group Shale formation.
- Within the Project extent of longwall mining area, Mallaty Creek stretches for approximately 0.3 km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the stream gradient of Mallaty Creek is 33 m/km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the length of Mallaty Creek comprises approximately 20% pools, 25% rock bars and 15% boulder fields (Appendix C of the EA).
- No upland swamps are present along Mallaty Creek within the Project extent of longwall mining area (Appendix O of the EA).

Further detail on the stream characteristics of Mallaty Creek is provided in the Surface Water Assessment (Appendix C of the EA) and in the Stream Risk Assessment (Appendix P of the EA).

Simpsons Creek

Simpsons Creek is not located within the Project extent of longwall mining area. Simpsons Creek flows into Elladale Creek approximately 500 m upstream of its confluence with the Nepean River. Simpsons Creek flows from the east through agricultural areas, which have been subjected to mine subsidence impacts in the past. Simpsons Creek is subject to modified flow due to construction of farm dams and leakage from the Sydney Water Supply Canal, where it crosses the stream channel. Leakage from the supply canal has been observed to contribute flow and available aquatic habitat, particularly during long periods without rain (TEL, 2004e). Riparian vegetation comprises mostly grasses in the upper reaches and a mixture of native and exotic trees further downstream. This stream can be characterised by:

- Simpsons Creek flows through the Wianamatta Group Shale formation.
- Within previously mined areas, Simpsons Creek stretches for approximately 2.2 km (Appendix C of the EA).
- Outside the Project extent of longwall mining area, the length of Simpsons Creek comprises approximately 15% pools, 5% rock bars and 35% boulder fields (Appendix C of the EA).
- No upland swamps are present along Simpsons Creek within the Project extent of longwall mining area (Appendix O of the EA).

Further detail on the stream characteristics of Simpsons Creek is provided in the Surface Water Assessment (Appendix C of the EA).

First and Second Order Tributaries

Numerous 1st and 2nd order tributaries are also located within the Nepean River catchment. Tributary pools are generally much smaller, in plan area, depth and volume relative to runoff flow rates, than those in the larger tributaries of the Nepean River. Aquatic habitat within the unnamed tributaries is generally ephemeral and often considered highly disturbed because they drain rural and urban areas and most are subject to modified flow due to farm dams.

2.1.2 Cataract River Catchment

Cataract River

The Cataract River is a 6th order stream which flows into the Nepean River approximately 1 km downstream from the Douglas Park Weir. The Cataract River is set in a deep gorge, which is naturally very rocky with steep sandstone cliffs. The river banks consist of sandy soil amongst sandstone bedrock and boulders. Land-use within the Cataract River catchment has resulted in relatively undisturbed native bushland in the upper section (i.e. upstream of Broughtons Pass Weir) with some pasture in the low section (in the vicinity of Wilton). A large proportion of the catchment is inaccessible to the public as it contributes to Sydney's water supply. The SCA transfers flows from the Cataract Dam to Broughtons Pass Weir. As such, the Cataract River is subject to highly variable flows associated with the water supply releases. The proposed longwalls do not extend beneath the Cataract Reservoir.

Longwall mining has occurred in the Cataract River catchment since March 1990 (Appendix C of the EA). An intensive programme of paired flow rate observations and water quality sampling upstream and downstream of the area adjacent to the longwall panel were unable to provide any evidence of flow loss or any clear evidence of effects on water quality (Appendix C of the EA). Water quality in this reach of Cataract River was dominated by periods of variable and at times significant releases of water from the Cataract Dam during the monitoring period (Appendix C of the EA).

Relevant points regarding this stream include:

- A series of large pools interspersed by large sandstone rock bars over which rapid, shallow flow occurs forming numerous riffles and cascades.
- Substratum of the pools is predominantly bedrock and boulders, with some pockets of sand and silt in areas of low flow.
- There is relatively little in-stream vegetation, with the exception of a few small patches of the floating attached macrophyte *Triglochin procerum* (Water Ribbons).
- 3rd order or above tributaries of the Cataract River within the Project extent of longwall mining area include Cascade Creek, Wallandoola Creek, Lizard Creek and Wallandoola East Creek.
- 3rd order or above tributaries (within the Project extent of longwall mining area) upstream of the Cataract Dam that flow into the Cataract Reservoir include Catchment Reservoir Tributary 1 and 2.
- The Cataract Dam commands a catchment area of some 130 km^2, Jordans Crossing commands a catchment area of some 167 km^2 and Broughtons Pass Weir commands a catchment area of some 211 km^2 (Appendix C of the EA).
- Flow duration below the Cataract Dam is typical of a highly regulated river system. Recorded mean annual flows include 39,789 ML/yr at Cataract Dam, 41,384 ML/yr at Jordans Crossing and 9,081 ML/yr at Broughtons Pass Weir (Appendix C of the EA).
- Within the Project extent of longwall mining area, the stream gradient of the Cataract River is 18 m/km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the length of the Cataract River comprises approximately 70% pools, 15% rock bars and 15% boulder fields (Appendix C of the EA). Stream mapping is provided in the Stream Risk Assessment (Appendix P of the EA).
- No upland swamps are present along the Cataract River within the Project extent of longwall mining area, however, swamps do occur on minor tributaries of the Cataract River (Appendix O of the EA).

The Project design criteria would avoid impacts such as significant fracturing of rock bars that could result in surface flow diversion and draining of pools along the Cataract River.

Appropriate design criteria regarding the Cataract Reservoir dam wall and the Broughtons Pass Weir would maintain the structural integrity of these infrastructure.

Further detail on the stream characteristics of the Cataract River, including stream mapping, is provided in the Stream Risk Assessment (Appendix P of the EA).

Lizard Creek

Lizard Creek is located within the SCA's Metropolitan Special Area and flows into the Cataract River between the Cataract Dam and the Broughton's Pass Weir. Lizard Creek is an incised stream cut into Hawkesbury Sandstone and is classed as a 5th order stream (Appendix C of the EA). Lizard Creek is typical of similar higher order drainages in the Hawkesbury Sandstone terrain (Appendix C of the EA). This stream has a diverse mix of large prominent rock bars (some leading to waterfalls and cascades, short pools and ponds), prominent rock shelves and boulder fields (Appendix C of the EA). Within the Project area, this stream is rock bar controlled. Relevant points regarding this stream include:

- Limited bed sediment deposits, which are restricted to areas with locally flatter bed slopes and in the bottom of some of the larger, deeper pools.
- The stream has dense riparian vegetation but generally relatively little in-stream vegetation.
- The Project design criteria at Appin Areas 2 and 3 Extended would avoid significant fracturing of rock bars that could result in surface flow diversion and draining of pools along Lizard Creek.
- Lizard Creek stretches for approximately 8.5 km. The whole of the Lizard Creek catchment covers an area of some 21 km^2 (Appendix C of the EA).
- Within the Project extent of longwall mining area, the stream gradient of Lizard Creek is 46 m/km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the length of Lizard Creek comprises approximately 65% pools, 20% rock bars and 15% boulder fields (Appendix C of the EA).
- No upland swamps are present along Lizard Creek within the Project extent of longwall mining area, however, swamps do occur on minor tributaries of Lizard Creek further upstream (Appendix O of the EA).

The Project design criteria would avoid impacts such as significant fracturing of rock bars that could result in surface flow diversion and draining of pools along Lizard Creek.

Further detail on the stream characteristics of Lizard Creek, including stream mapping, is provided in the Stream Risk Assessment (Appendix P of the EA).

Wallandoola Creek

This stream is located within the SCA's Metropolitan Special Area and flows into the Cataract River between the Cataract Dam and the Broughton's Pass Weir. Wallandoola Creek is an incised stream cut into Hawkesbury Sandstone and classed as a 4th order stream (Appendix C of the EA). Within the study area, Wallandoola Creek is rock bar controlled and has a diverse mix of rock bars, pools, rock shelves and boulder fields (Appendix C of the EA). Mapped pools were typically shallow (< 1m) and had sandstone substrates (Appendix C of the EA). Areas of iron staining and through flow/underflow have also been noted (Appendix C of the EA). Relevant points regarding this stream include:

- Limited bed sediment deposits, which are restricted to areas with locally flatter bed slopes and in the bottom of some of the larger, deeper pools.
- Dense riparian vegetation but generally relatively little in-stream vegetation.
- Within the Project extent of longwall mining area, Wallandoola Creek stretches for approximately 3.4 km. The whole of the Wallandoola Creek catchment covers an area of some 32.4 km^2 (Appendix C of the EA).
- Within the Project extent of longwall mining area, the stream gradient of Wallandoola Creek is 13 m/km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the length of Wallandoola Creek comprises approximately 50% pools, 25% rock bars and 25% boulder fields (Appendix C of the EA).
- No upland swamps are present along Wallandoola Creek within the Project extent of longwall mining area, however, swamps do occur on minor tributaries of Wallandoola Creek further upstream (Appendix O of the EA).

Further detail on the stream characteristics of Wallandoola Creek, including stream mapping, is provided in the Stream Risk Assessment (Appendix P of the EA).

Cascade Creek

This stream is located within the SCA's Metropolitan Special Area and also flows into the Cataract River between the Cataract Dam and the Broughton's Pass Weir. Cascade Creek is an incised stream cut into Hawkesbury Sandstone and is classed as a 3rd order stream (Appendix C of the EA). Within the study area, the stream is rock bar controlled with a series of pools, rock bars, waterfalls and boulder fields. Relevant points regarding this stream include:

- Limited bed sediment deposits, which are restricted to areas with locally flatter bed slopes and in the bottom of some of the larger, deeper pools.
- The stream has dense riparian vegetation but generally relatively little in-stream vegetation.
- Within the Project extent of longwall mining area, Cascade Creek stretches for approximately 3.9 km. The whole of the Cascade Creek catchment covers an area of some 11.4 km^2 (Appendix C of the EA).
- Within the Project extent of longwall mining area, the stream gradient of Cascade Creek is 40 m/km (Appendix C of the EA).

- Within the Project extent of longwall mining area, the length of Cascade Creek comprises approximately 45% pools, 25% rock bars and 30% boulder fields (Appendix C of the EA).
- No upland swamps are present along Cascade Creek within the Project extent of longwall mining area, however, swamps do occur on minor tributaries of Cascade Creek further upstream (Appendix O of the EA).

Further detail on the stream characteristics of Cascade Creek, including stream mapping, is provided in the Stream Risk Assessment (Appendix P of the EA).

Wallandoola East Creek

This stream flows into the Cataract River between Lizard Creek and Wallandoola Creek. Wallandoola East Creek is an incised stream cut into Hawkesbury Sandstone and is classed as a 3rd order stream (Appendix C of the EA). Relevant points regarding this stream include:

- Within the Project extent of longwall mining area, Wallandoola East Creek stretches for approximately 2.6 km. The whole of the Wallandoola East Creek catchment covers an area of some 4 km^2 (Appendix C of the EA).
- Within the Project extent of longwall mining area, the stream gradient of Wallandoola East Creek is 43 m/km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the distribution of pools, rock bars and boulder fields within Wallandoola East Creek is expected to be similar to Cascade Creek (Appendix C of the EA).
- No upland swamps are present along Wallandoola East Creek within the Project extent of longwall mining area, however, swamps do occur on minor tributaries of Wallandoola East Creek further upstream (Appendix O of the EA).

Further detail on the stream characteristics of Wallandoola East Creek is provided in the Surface Water Assessment (Appendix C of the EA) and the Stream Risk Assessment (Appendix P of the EA).

Rocky Ponds Creek

Rocky Ponds Creek is not located within the Project extent of longwall mining area. The Rocky Ponds Creek flows into the Cataract River, downstream of the Broughtons Pass Weir. The catchment of this stream is mostly pasture. Farm dams have been built across the channel in the upper reaches. In the upper and middle reaches, many sections of the stream bed are dry during extended periods without rain and cattle have access to the stream channel.

In the lower reaches, near the Cataract gorge, the slope of the stream bed and surrounding catchment steepens. A waterfall, approximately 50 m high at the confluence of the Rocky Ponds Creek with the Cataract River, was noted during a survey done by TEL (2003c). The substratum consisted of mostly bedrock, boulders and sand. Riparian vegetation was dominated by *Lomandra longifolia* and a number of species of weeds, including *Cynodon dactylon*, *Cyperus eragrostis*, *Lolium perenne*, *Paspalum dilatatum* and *Plantago lanceolata*.

The whole of the Rocky Ponds Creek catchment covers an area of some 4.1 km^2 (Appendix C of the EA). Further detail on the stream characteristics of Rocky Ponds Creek is provided in the Surface Water Assessment (Appendix C of the EA).

Un-named Tributaries of Cataract Reservoir

Stream mapping of the two 3rd order tributaries that flow into the Cataract Reservoir indicate that these tributaries are predominantly composed of rock bars, rock shelves, pools and several waterfalls (Appendix P of the EA). Upland swamps are present along Un-named Tributaries 1 and 2 of the Cataract Reservoir within the Project extent of longwall mining area (Appendix O of the EA).

Further detail on the stream characteristics of the Un-named Tributaries 1 and 2 of the Cataract Reservoir, including stream mapping, is provided in the Stream Risk Assessment (Appendix P of the EA).

First and Second Order Tributaries

A number of 1st and/or 2nd order tributaries drain directly into the Cataract River. The catchments of tributaries that occur within the Project extent of longwall mining area are largely undisturbed. The upper sections of tributaries not within the Project extent of longwall mining area commonly run through agricultural areas and have small farm dams. Channels of these small, ephemeral systems have been observed to consist of a series of small pools. The substratum is predominantly bedrock and boulders with sand and clay. These channels are well shaded by dense riparian vegetation but have little in-stream vegetation.

In the lower sections of these tributaries, the drainage lines mostly run through native bush and cascade over the sandstone gorge before continuing a short distance to the Cataract River. Tributary pools are much smaller, in plan area, depth and volume relative to runoff flow rates, than those in the larger tributaries of the Cataract River.

Upland swamps are present along some of these minor tributaries of the Cataract River within the Project extent of longwall mining area (Appendix O of the EA).

2.1.3 Georges River Catchment

Georges River

The upper reach of the Georges River is classified as a 3rd order stream until the confluence with Brennans Creek where it becomes a 4th order stream The upper reaches of the river are set in a sandstone gorge where land-use is largely undisturbed native bushland with some areas that are mixed rural and residential. The Appin East pit top and West Cliff pit top are located within the catchment of the Georges River and discharge mine water into the river. The discharge from the Appin East pit top consists of mostly stormwater runoff that accumulates on the site, which is moderately saline due to exposure to stock-piled coal and other on-site run-off (TEL, 2006b).

The West Cliff pit top pumps groundwater from the underground coal mine into Brennans Creek Dam, which is used as a major water storage and recycling facility (TEL, 2006c). The water pumped from the mine is moderately saline (TEL, 2006c). During significant rainfall events, the dam spills into Brennans Creek and then into the Georges River (TEL, 2006c).

Longwall mining has occurred in the Georges River catchment since August 1982 (Appendix C of the EA). Documented impacts from mining under the Georges River include fracturing of rock bars, localised loss of surface flow, reduction in pool water levels and minor, transient water quality changes (Appendix C of the EA). ICHPL has also undertaken remediation activities along the Georges River including extensive grouting operations which have successfully restored surface flows and pool function in the affected areas (Appendix C of the EA).

Discharge licences issued on the Georges River and its tributaries include discharges from masonry works, the West Cliff pit top and Appin East pit top discharges, poultry processing discharges, and hazardous and waste disposal discharges (Appendix C of the EA). Other known discharges into the Georges River associated with land use in the vicinity of the Project include runoff from Appin township and agricultural areas (Appendix C of the EA). Fourteen water extraction licences along the Georges River have been issued within the general Project area (Appendix C of the EA). Unregulated volumes amounting to some 316 ML/year are registered with the NSW Department of Water and Energy (DWE) on the Georges River which support irrigation, industrial, stock, bank revegetation, environmental rehabilitation, recreation and domestic usage (Appendix C of the EA).

Long, deep pools with frequent short riffles flowing over sandstone bedrock define the channel in this area of the river. The channel gradually widens from 6 m to 20 m and deepens from 0.2 m to 2 m. Substratum of the channel is predominantly bedrock with deposits of sand in deeper areas. Sandstone boulders and logs occur throughout the channel. The banks of the channel are mostly soft sediment and are generally well vegetated by trees (including *Eucalyptus* spp. and *Acacia* spp.), ferns (i.e. *Gleichenia* sp. and *Sticherus flabellatus*), emergent macrophyte species including *Eleocharis sphacelata*, *Juncus* spp. and *Typha orientalis*. Some species of weeds (i.e. *Cynodon dactylon* and *Hypochaeris radicata*) were recorded near the town of Appin. The submerged species of macrophyte, *P. sulcatus*, was present in some of the pools sampled.

Downstream of the confluence with Brennans Creek, the sandstone bedrock provided for short, infrequent riffles, separating long reaching pools. The substratum of the pools was predominantly bedrock, soft-sediment and boulders. A number of small tributaries flow into this section of the river. These tributaries drain rural properties, urban development and native bushland.

Relevant points regarding this stream include:

- The average flow released from the Brennans Creek Dam Weir between 2002 and 2007 was 0.63 ML/day (Appendix C of the EA). The maximum flow released over the period was 4.8 ML/day, with numerous days of low flow (Appendix C of the EA). Recent changes to the operational procedures at West Cliff pit top have resulted in small controlled discharges occurring more regularly to maintain freeboard in the Brennans Creek Dam and to reduce the frequency of spills (Appendix C of the EA).
- The Georges River commands a catchment area of some 26.8 km^2 upstream of the point where it leaves the Project extent of longwall mining area (i.e. West Cliff Area 5) (Appendix C of the EA).
- Within the Project extent of longwall mining area, the Georges River stretches for approximately 3.4 km (Appendix C of the EA).

- Within the Project extent of longwall mining area, the stream gradient of the Georges River is 18 m/km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the length of the Georges River comprises approximately 50% pools, 20% rock bars and 10% boulder fields (Appendix C of the EA). Stream mapping is provided in the Stream Risk Assessment (Appendix P of the EA).
- No upland swamps are present along the Georges River within the Project extent of longwall mining area, however swamps are present on minor tributaries of the Georges River (Appendix O of the EA).

The Project longwall design criteria would avoid significant fracturing of rock bars that could result in surface flow diversion and draining of pools along the Georges River.

Further detail on the stream characteristics of the Georges River, including stream mapping, is provided in the Stream Risk Assessment (Appendix P of the EA).

Brennans Creek

Brennans Creek is classified as a 3rd order stream. Brennans Creek is not located within the Project extent of longwall mining area, however, the majority of Brennans Creek has been highly modified by works associated with approved coal wash emplacements at the West Cliff pit top. Brennans Creek is dammed downstream of the existing coal wash emplacements to provide water management for the West Cliff pit top and a supply of water for use at West Cliff.

At the sampling location (BC), the stream consisted of a series of pools up to approximately 4 m wide and 1.5 m deep. The substratum was predominantly bedrock with some boulders and pockets of sand in areas of low flow. Noticeably, a large proportion of the substratum was covered in a thin (i.e. <0.5 cm) layer of coal fines and visibility of the water was poor. No fish were recorded at this location. Dominant riparian vegetation included *Lepidosperma filiforme*, *J. polygalifolium*, *Lomandra longifolia*, *H. muelleri*, *Gahnia* sp. and the weeds *Cynodon dactylon* and *Hypochaeris radicata*.

O'Hares Creek

O'Hares Creek is a tributary of the Georges River. O'Hares Creek flows generally northward from its headwaters to its confluence with the Georges River downstream of the study area (Appendix C of the EA). The headwaters of this 4th order stream originate in an upland swamp. The stream is set in a sandstone gorge and natural rock bars and waterfalls are common. The sandstone bedrock provides for short, infrequent riffles separating long reaching pools. The substratum is predominantly bedrock with some boulders and deposits of sand in areas of low flow. The immediate catchment is the Dharawal State Conservation Area. A weir is situated downstream of where Firetrail 10D crosses the stream.

Historic mine workings at the Darkes Forest Colliery (late 1800s – early 1900s) undermined a small portion of the upper catchment of O'Hares Creek (Appendix C of the EA).

Existing North Cliff shafts No.3 and No.4 and associated surface infrastructure are within the upper catchment of O'Hares Creek (Appendix C of the EA). The O'Hares Creek catchment is relatively undisturbed and provides an indication of baseline stream water quality and flow behaviour in the North Cliff domain (Appendix C of the EA).

The majority of the upstream catchment of O'Hares Creek comprises the Dharawal State Conservation Area and Dharawal Nature Reserve (Appendix C of the EA). The rural settlement of Darkes Forest is located at the headwaters of the O'Hares Creek catchment. The middle reach of O'Hares Creek is composed of relatively undisturbed land part of which is located within the SCA's O'Hares Creek Special Area and the DECC's Dharawal State Conservation Area (Appendix C of the EA). Parts of the eastern margins of the upstream O'Hares Creek catchment are situated within land used by the Australian Government Department of Defence as Holsworthy Military Area (Appendix C of the EA).

Flows during and following rainfall events are likely to be characteristically chaotic with high energy and high velocity. During dry periods, flow is likely to be characterised by non-turbulent flow in the flatter sections and pools interspersed by narrow, shallow fast moving flows over the steeper inter-connecting cascades and rock bars (Appendix C of the EA). Relevant points regarding this stream include:

- Within the Project extent of longwall mining area, O'Hares Creek stretches for approximately 9.8 km (Appendix C of the EA). The whole of the O'Hares Creek catchment covers an area of some 73 km^2 upstream of DWE gauging station GS210200 (Appendix C of the EA).
- Within the Project extent of longwall mining area, the stream gradient of O'Hares Creek is 7.5 m/km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the length of O'Hares Creek comprises approximately 70% pools, 20% rock bars and 15% boulder fields (Appendix C of the EA).
- No upland swamps are present along O'Hares Creek within the Project extent of longwall mining area, however swamps are present on tributaries of O'Hares Creek (Appendix O of the EA).

The Project design criteria would avoid significant fracturing of rock bars that could result in surface flow diversion and draining of pools along O'Hares Creek.

Further detail on the stream characteristics of O'Hares Creek, including stream mapping, is provided in the Stream Risk Assessment (Appendix P of the EA).

Cobbong Creek

Cobbong Creek is classified as a 3rd order stream which occurs within the Dharawal State Conservation Area. Cobbong Creek flows along the western side of the proposed North Cliff domain area. The stream originates within an upland swamp and then flows through a steep sandstone gorge before joining with O'Hares Creek between Dahlia Creek and Stokes Creek.

The natural bed profile of Cobbong Creek is expected to be similar to that of other tributaries of O'Hares Creek. In the plateau areas these streams are typically in the form of an open dish shaped drainage line with ill-defined bed and banks (Appendix C of the EA). Upland swamps frequently occur within these areas often culminating at a low rock bar or shelf (Appendix C of the EA). Relevant points regarding this stream include:

- Within the Project extent of longwall mining area, Cobbong Creek stretches for approximately 0.5 km. The whole of the Cobbong Creek catchment covers an area of some 3.5 km^2 (Appendix C of the EA).
- Within the Project extent of longwall mining area, the stream gradient of Cobbong Creek is 46 m/km (Appendix C of the EA).

- Within the Project extent of longwall mining area, the distribution of pools, rock bars and boulder fields within Cobbong Creek is expected to be similar to other tributaries of O'Hares Creek (Appendix C of the EA).
- Upland swamps are present in the headwaters of Cobbong Creek within the Project extent of longwall mining area. Swamps are also present on minor tributaries of Cobbong Creek (Appendix O of the EA).

Further detail on the stream characteristics of Cobbong Creek is provided in the Surface Water Assessment (Appendix C of the EA).

Dahlia Creek

Dahlia Creek is classified as a 3rd order stream and is located within the Dharawal State Conservation Area. The stream originates within an upland swamp and then flows through a steep sandstone gorge before joining with O'Hares Creek, approximately 5 km upstream of its confluence with Stokes Creek.

Dahlia Creek is typical of other similar 3rd order streams in the Stokes and O'Hares Creek catchments. It contains a series of prominent rock bars and associated pools – mostly relatively short and shallow. There were also several small (2 m to 5 m high) waterfalls mapped and areas where there was noticeable underflow and iron staining in rock bars and pools.

There are several swamps mapped in the upper reaches of Dahlia Creek (Appendix O of the EA).

The natural bed profile is also typical of these smaller headwater tributaries which rise in the Hawkesbury Sandstone plateau (Appendix C of the EA). In the plateau areas, these streams are typically in the form of an open dish shaped drainage line with ill-defined bed and banks (Appendix C of the EA). Further downstream, Dahlia Creek plunges into the incised sections of the catchment, often via a series of drops and waterfalls (Appendix C of the EA).

The lower reaches of Dahlia Creek are characterised by a series of rock bars, pools and boulder strewn reaches (Appendix P of the EA). The bed in these reaches is dominated by hard exposed rock with loose alluvium limited to the longer and deeper pools where flow energy is lower (Appendix C of the EA and Appendix P of the EA). Significant rainfall events result in rapid flashy runoff which results in highly turbulent, shallow flows with high velocity particularly over and downstream of rock bars (Appendix C of the EA and Appendix P of the EA). Velocities would reduce in the deeper longer pools which would act as sediment traps (Appendix C of the EA).

Rock bars with larger drops and waterfalls tend to occur in the upper reaches with pools becoming longer and shallower behind smaller rock bars with lower drops in the lower sections of the stream further downstream (Appendix C of the EA). The lower flatter reaches also contain long boulder fields (often extending over 100 m or more) (Appendix C of the EA). Relevant points regarding this stream include:

- A series of small, shallow pools interrupted by boulder chokes.
- The substratum was predominantly bedrock, boulders and deposits of sand in areas of low flow.
- Dense riparian vegetation but with relatively little in-stream macrophytes.

- Within the Project extent of longwall mining area, Dahlia Creek stretches for approximately 6.9 km (Appendix C of the EA). The whole of the Dahlia Creek catchment covers an area of some 6 km^2 (Appendix C of the EA).
- Within the Project extent of longwall mining area, the stream gradient of Dahlia Creek is 21 m/km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the length of Dahlia Creek comprises approximately 50% pools, 15% rock bars and 35% boulder fields (Appendix C of the EA).
- Upland swamps are present in the headwaters of Dahlia Creek within the Project extent of longwall mining area and also occur within minor tributaries of Dahlia Creek (Appendix O of the EA).

Further detail on the stream characteristics of Dahlia Creek, including stream mapping, is provided in the Stream Risk Assessment (Appendix P of the EA).

Stokes Creek

Stokes Creek flows in a northerly direction through the Dharawal State Conservation Area and then into O'Hares Creek, near Wedderburn. Stokes Creek is classified as a 4th order stream. In the upper reaches of the stream, the channel is comprised of pools (up to 6 m wide and 1 m deep), separated by rock bars. Cascades in the stream (up to 5 m) provide natural barriers to the upstream migration of some species of fish. The substratum was observed to be predominantly bedrock although deposits of sand were noted in areas with locally flatter bedslopes and in the bottoms of deeper pools.

Stokes Creek was undermined by longwall mining associated with the historic West Cliff Colliery workings (Appendix C of the EA). The longwall panels resulted in some 3.3 km of Stokes Creek being directly undermined (Appendix C of the EA).

Back-predicted subsidence predictions from historic West Cliff Colliery mine workings indicate that valley closure at a rock bar on Stokes Creek was within the range where fracturing of bedrock (and the consequent diversion of a portion of the total stream flow) could occur (Appendix C of the EA). The lower section of Stokes Creek in the vicinity of West Cliff Area 5 comprises a long continuous pool some 800 m long (Appendix C of the EA). The pool has a sandy substrate and is controlled by a single rock bar which was at the time of the mapping, partially dry indicating the presence of underflow (Appendix C of the EA).

The stream channel is characterised by:

- Dense riparian vegetation but with relatively little in-stream macrophytes.
- Within the Project extent of longwall mining area, Stokes Creek stretches for approximately 6.3 km (Appendix C of the EA). The whole of the Stokes Creek catchment covers an area of some 31 km^2 (Appendix C of the EA).
- Within the Project extent of longwall mining area, the stream gradient of Stokes Creek is 22 m/km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the length of Stokes Creek comprises approximately 60% pools, 25% rock bars and 15% boulder fields (Appendix C of the EA).

- Upland swamps are present in the headwaters of Stokes Creek within the Project extent of longwall mining area and swamps also occur within minor tributaries of Stokes Creek (Appendix O of the EA).

The Project design criteria would avoid significant fracturing of rock bars that could result in surface flow diversion and draining of pools along Stokes Creek (downstream of Longwall 5a – refer to Appendix A of the EA).

Further detail on the stream characteristics of Stokes Creek, including stream mapping, is provided in the Stream Risk Assessment (Appendix P of the EA).

First and Second Order Tributaries

Numerous 1st and 2nd order tributaries are located within the Georges River catchment. Catchments of tributaries that occur within the Dharawal State Conservation Area are largely undisturbed. Upper sections of tributaries not within the Dharawal State Conservation Area commonly flow through agricultural areas and have small farm dams. Channels of these small, ephemeral systems commonly consist of series of small pools. The substratum is predominantly bedrock and boulders with sand and clay. Channels are well shaded by dense riparian vegetation but contain little in-stream vegetation. In the lower sections of these tributaries, the drainage lines mostly run through native forest. Upland swamps are present on some of these minor tributaries of O'Hares Creek/Georges River within the Project extent of longwall mining area (Appendix O of the EA).

2.1.4 Woronora River Catchment

Woronora River

The headwaters of the Woronora River originate in a large upland swamp (Appendix O of the EA). The Woronora River lies within the Woronora Special Area, which is largely undeveloped and covered predominantly by native vegetation. Public access to the Woronora Special Area is restricted and managed by the SCA. The Woronora River flows through a steep valley into the Woronora Reservoir, which supplies water to residents in the areas south of the Georges River including Sutherland, Helensburgh, Stanwell Park, Lucas Heights and Bundeena. Metropolitan Colliery operates under a large proportion of the Woronora Special Area.

The Woronora River is some 7.5 km in length from its headwaters to the point where it flows into the Woronora Reservoir. The 1.9 km section of the Woronora River which overlies the proposed longwalls is a 2nd order stream. The channel typically comprises a series of alternating steep chutes and cascades interspersed by small in-stream pools that form in natural depressions in the predominantly sandstone bedrock. Pools can be characterised by:

- Limited deposits of sediments which are restricted to areas with locally flatter bed slopes and in the bottom of some of the larger, deeper pools.
- Dense riparian vegetation but with relatively few in-stream macrophytes.

The stream channel is characterised by:

- Within the Project extent of longwall mining area, the Woronora River stretches for approximately 1.9 km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the stream gradient of Woronora River is 45 m/km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the length of the Woronora River comprises approximately 30% pools, 40% rock bars and 30% boulder fields (Appendix C of the EA).
- Upland swamps are present in the headwaters of Woronora River within the Project extent of longwall mining area (Appendix O of the EA).

The Project design criteria would avoid directly undermining the Woronora River which would reduce subsidence effects.

Further detail on the stream characteristics of the Woronora River, including stream mapping, is provided in the Stream Risk Assessment (Appendix P of the EA).

Punchbowl Creek

The section of Punchbowl Creek within the Project area is classified as a 2nd and rd order stream. Punchbowl Creek is mostly situated in land designated as Holsworthy Military Area. Punchbowl Creek flows generally northward from its headwaters in the North Cliff domain, eventually flowing into the Georges River near Campbelltown (Appendix C of the EA). Stream mapping indicates that it is typical of similarly sized drainages in the Hawkesbury sandstone terrain (Appendix C of the EA). Punchbowl Creek falls from the ridgelines at the top of the catchment into the more incised flatter valley areas where it flows over a series of rock bars, small pools and small waterfalls and rapids (Appendix C of the EA). Most pools observed were between less than 50 m long and were relatively shallow (Appendix C of the EA). The longest pool was mapped at about 200 m long and approximately 1 m deep (Appendix C of the EA).

Relevant points regarding this stream include:

- The surrounding gorge is relatively steep and well vegetated.
- The channel of the stream is characterised by a series of small, shallow pools interrupted by boulder chokes.
- The substratum was predominantly bedrock, boulders and deposits of sand in areas of low flow.
- Dense riparian vegetation but with relatively few in-stream macrophytes.
- Within the Project extent of longwall mining area, Punchbowl Creek stretches for approximately 0.6 km.
- Within the Project extent of longwall mining area, the stream gradient of Punchbowl Creek is 55 m/km (Appendix C of the EA).
- Within the Project extent of longwall mining area, the length of Punchbowl Creek comprises approximately 50% pools, 15% rock bars and 35% boulder fields (Appendix C of the EA).

- No upland swamps are present on Punchbowl Creek within the Project extent of longwall mining area, however, swamps are present on minor tributaries of Punchbowl Creek (Appendix O of the EA).

Further detail on the stream characteristics of Punchbowl Creek, including stream mapping, is provided in the Stream Risk Assessment (Appendix P of the EA).

First and Second Order Tributaries

A number of 1st and/or 2nd order tributaries drain directly into the Woronora River. The tributaries are situated in moderately steep incised gullies and contain numerous small in-stream pools. Flow patterns in smaller tributaries tend to be more variable than in larger systems, responding to incident rainfall over a smaller area and are therefore less affected by baseflow (i.e. have lower flow persistence), particularly at higher elevations. Upland swamps are present on these minor tributaries of the Woronora River within the Project extent of longwall mining area (Appendix O of the EA).

2.2 Pit Tops

An overview of the three pit tops (i.e. West Cliff, Appin East and Appin West) is provided below. Further detail in relation to the pit tops is provided in Section 2 in the Main Report of the EA and in Appendix C of the EA.

West Cliff Pit Top

The existing West Cliff pit top is located off Appin Road to the south-east of Appin village (Figure 4).

The main changes to the existing West Cliff pit top site water management system relate to continued development and expansion of the coal wash emplacement area (i.e. Stages 3 and 4). Coal wash from West Cliff Washery and Dendrobium Washery is to continue to be emplaced in the Brennans Creek catchment advancing northwards down the valley (Stage 3) and into an eastern tributary of Brennans Creek.

The West Cliff pit top has been subject to a series of Pollution Reduction Programs (PRPs) under EPL No. 2504 aimed at improvement of water quality management on site. These programs have included studies to determine ecological impacts of discharges on downstream receiving waters and in particular discharges from Brennans Creek Dam on Brennans Creek and the Georges River and a trial of controlled releases from Brennans Creek Dam aimed at minimising uncontrolled spills from Brennans Creek Dam. As part of the PRPs, ICHPL have proposed ecologically based studies and trials to determine a discharge limit for salinity from Brennans Creek Dam under dry weather flow conditions. The intention is that this limit would be incorporated into the EPL for West Cliff pit top. ICHPL intends to complete these assessments and trials by the end of 2009 in accordance with the PRP under EPL No. 2504.

Methods needed to achieve compliance with these limits would be the subject of another PRP following determination of the dry weather salinity limits. A plan to implement the preferred option would then follow for completion prior to July 2013 in accordance with the PRP under EPL No. 2504.

The proposed West Cliff Stage 4 Coal Wash Emplacement is situated in the headwaters of Brennans Creek, a 3rd order tributary of the Georges River. The existing Brennans Creek Dam is located approximately 600 m upstream of the confluence between Brennans Creek and the Georges River. Existing coal wash emplacements are located upstream of Brennans Creek Dam on a 1st/2nd order tributary (referred to as Brennans Creek Tributary in this report) separate to the proposed West Cliff Stage 4 Coal Wash Emplacement.

- Brennans Creek is a highly disturbed 3rd order stream that flows into the Georges River.
- Brennans Creek is dammed approximately 600 m upstream of the confluence between Brennans Creek and the Georges River.
- The West Cliff pit top (including the existing and approved coal wash emplacements) is located upstream of Brennans Creek Dam. All surface runoff for the West Cliff pit top drains into Brennans Creek Dam via Brennans Creek and its tributaries and a series of water treatment ponds and diversion dams.
- The proposed West Cliff Stage 4 Coal Wash Emplacement would be an extension/continuation of the currently approved emplacement areas and would largely remain upstream of the Brennans Creek Dam.

Appin East Pit Top

The existing Appin East pit top is located off Appin Road to the south-east of Appin village (Figure 4).

As described in Section 2 in the Main Report of the EA and in Appendix C of the EA, no significant changes are envisaged for the Appin East pit top site water management system.

A series of PRPs have also been undertaken at Appin East pit top since 2003 under EPL No. 758 including investigations aimed at assessing ecological impacts of discharge on the receiving surface waters (i.e. Georges River) and review of on-site water management including trial injection of mine waters into Bulgo Sandstone strata.

The current PRPs at Appin East would continue to be undertaken as required and relevant improvements implemented to enable future pit top water management to be undertaken in compliance with EPL conditions.

The discharge from the Appin East pit top consists of mostly stormwater runoff that accumulates on the site, which is moderately saline due to exposure to stock-piled coal and other on-site run-off (TEL, 2006b). Appin Colliery discharges excess mine water from the underground mine into the river approximately 750 m upstream of the confluence with Brennans Creek.

Appin West Pit Top

The existing Appin West pit top is located off Douglas Park Drive approximately 4 km south of Douglas Park township (Figures 3 and 4). The Appin West pit top currently provides access to the underground mining operations at Appin Area 7 for underground personnel and mine equipment and supplies. Mine water is discharged in accordance with EPL 398 into Sandy Gully which flows into Allens Creek (via Clements Creek).

As described in Section 2 in the Main Report of the EA and in Appendix C of the EA, no significant changes are envisaged for the Appin West pit top site water management system. The current PRPs under EPL No. 398 at Appin West pit top would continue to be undertaken and relevant improvements implemented to enable future pit top water management to be undertaken in compliance with EPL conditions. The Appin West pit top would continue to operate with upgrades to surface facilities as required, and no coal would be handled or transported to the Appin West pit top. The Appin West pit top would continue to provide access to the underground for men and equipment and to provide bathhouse facilities for the mine workforce and an administrative area.

3.0 PREVIOUS STUDIES

A significant number of aquatic surveys, monitoring reports and assessments have been undertaken across the Project area and surrounds over the past 20 years by the DPI-Fisheries, the DECC and on behalf of ICHPL. Substantial information on the aquatic habitats, quality of water, macroinvertebrate and fish fauna is available for the upper reaches of the Nepean River (i.e. from Pheasants Nest Weir to Menangle Weir) and Cataract River (i.e. between the Cataract Dam and Broughton's Pass Weir), the Georges River and to a lesser extent, the Woronora River. Recent studies have focused on water supply activities and the general effects of mining related activities within the study area and surrounds, including the following:

- *Georges River Pre-mining Ecology Study* (Marine Pollution Research [MPR], 2001);
- *Dendrobium Coal Project: Terrestrial and Aquatic Habitat Assessment* (Biosis Research, 2001);
- *West Cliff Workings - Effects of Mine Subsidence on Aquatic Habitat and Waterways near Appin* (TEL, 2002a);
- *Effects of Mine Subsidence on Aquatic Habitats in Upper Georges River* (TEL, 2002b);
- *Appin Workings - Effects of Mine Subsidence on Aquatic Habitat and Biota in Waterways near Appin (Revised Final)* (TEL, 2003a);
- *West Cliff Workings - Effects of Mine Subsidence on Aquatic Habitat and Biota in Waterways near Appin* (TEL, 2003b);
- *Upper Nepean Bulk Water Transfers, Environmental Assessment of Aquatic Ecology* (TEL, 2003c);
- *Ecological effects of mine water discharge from West Cliff Colliery into Brennans Creek. Interim Report: Module 2 AUSRIVAS Analysis* (TEL, 2004a);
- *Ecological effects of mine water discharge from Appin Colliery into the Georges River. Interim Report: Module 2 AUSRIVAS Analysis* (TEL, 2004b);
- *Ecological effects of mine water discharge from Tower Colliery. Interim Report: Module 1 Allens Creek Ausrivas Analysis* (TEL, 2004c);
- *Effects of Remediation of Georges River at Marhnyes Hole on Aquatic Ecology* (TEL, 2004d);
- *Appin Workings (Longwalls 701-715) Effects of Mine Subsidence on Aquatic Ecology in the Nepean River System between Douglas Park and Menangle* (TEL, 2004e);
- *Investigation of Baseline Stations for Monitoring Effects of Aquatic Ecology of Activities Associated with Coal Mining* (Biosis Research, 2004);
- *Flora and Fauna Assessment of Longwall 409* (Biosis Research, 2006a);
- *Flora and Fauna Assessment of Appin Colliery Longwall 219* (Biosis Research, 2006b);
- *Appin Area 3 Effects of Mine Subsidence on Aquatic Habitat and Biota* (TEL, 2005a);
- *Ecological effects of mine water discharge from Douglas Colliery: autumn and spring surveys, 2004* (TEL, 2005b);
- *Dendrobium Coal Mine Area 1 Baseline Study Aquatic Ecology Baseline Report* (TEL, 2005c);
- *West Cliff Area 5 Effects of Mine Subsidence on Aquatic Habitat and Biota* (TEL, 2005d);

- *Ecological Effects of Mine Water Discharge from Douglas Project* (TEL, 2006a);
- *Ecological Effects of Mine Water Discharge from Appin Colliery into the Georges River* (TEL, 2006b);
- *Ecological Effects of Mine Water Discharge from West Cliff Colliery into Brennans Creek* (TEL, 2006c);
- *Douglas Area 7 (Longwalls 701-704) - Effects of Mine Subsidence on Aquatic Habitat and Biota* (TEL, 2006d);
- *Dendrobium Area 3 Assessment of Mine Subsidence Impacts on Aquatic Habitat and Biota* (TEL, 2007a);
- *West Cliff Colliery Longwall 31a End of Panel Report Aquatic Habitat and Biota* (TEL, 2007b);
- *Appin Colliery Longwall 301 End of Panel Report Aquatic Habitat and Biota* (TEL, 2007c);
- *Appin Colliery Longwall 302 End of Panel Report Aquatic Habitat and Biota* (TEL, 2007d);
- *Fish Communities in the Nepean River in the Vicinity of Pheasants Nest Weir* (DPI, 2007);
- *Appin Longwalls 705-710 Effects of Mine Subsidence on Aquatic Habitat and Biota* (TEL, 2008a);
- *West Cliff Colliery Area 5 Longwalls 34-36 Assessment of Mine Subsidence Impacts on Aquatic Habitat and Biota* (TEL, 2008b);
- *Dendrobium Coal Mine Area 1 Assessment of Impacts on Aquatic Ecology* (TEL, 2008c);
- *West Cliff Colliery Longwall 32 End of Panel Report Aquatic Habitat and Biota* (TEL, 2008d);
- *Dendrobium Area 2 Longwall 3 End of Panel Report Aquatic Habitat and Biota* (TEL, 2008e);
- *Dendrobium Area 2 Longwall 4 End of Panel Report Aquatic Habitat and Biota* (TEL, 2008f);
- *Fish Distribution and Abundance within the Dharawal State Conservation Area* (DPI, 2008);
- *Appin West Longwalls 701-710: Aquatic Ecology Monitoring Spring 2008* (TEL, 2009a);
- *NRE No. 1 Mine – V Mains Aquatic Ecology Baseline Monitoring Program Baseline Report* (TEL, 2009b);
- *Metropolitan Coal Project Aquatic Ecology Assessment* (Bio-Analysis, 2008); and
- *Cataract River Fish Survey* (Winstanley, 2000).

A summary of the main findings of field investigations for aquatic ecology undertaken in the Project area within the upper Nepean River, Cataract River, Georges River and Woronora River catchments is presented in Sections 3.1 to 3.4 below.

3.1 Nepean River Catchment

The results of a number of recent studies undertaken in the upper reaches of the Nepean River are summarised below.

Water Quality

The presence of weirs at Pheasants Nest, Maldon, Menangle, Douglas Park and Broughton's Pass on the Cataract River has significantly reduced flow in the upper Nepean River (Williams, 1994). These weirs have transformed the Nepean River from a free-flowing watercourse into a series of long, slow flowing pools. The river also receives environmental flows from Sydney water supply reservoirs, mine water discharge as well as native bushland, rural and urban runoff. As such, the section of the Nepean River within the Project area is highly modified in terms of flow characteristics and water quality and conditions are largely determined by the quality and quantity of the various water inputs. A number of smaller watercourses, including Navigation Creek, Harris Creek, Carriage Creek, Byrnes Creek, Mallaty Creek, Simpsons Creek, Elladale Creek, Menangle Creek and several smaller 1st/2nd order streams have interrupted flow due to farm dams in their upper reaches. These streams are considered highly disturbed due to stock access and drainage from rural and urban areas.

A review of water quality data from the Nepean River between Douglas Park Weir and Menangle Weir collected by ICHPL since 2002 found:

- Average pH, salinity, phosphorous and nitrogen levels exceeded Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) guidelines for the protection of aquatic ecosystems in south-eastern Australia (Geoterra, 2006).
- Thermal and oxygen stratification between surface and deeper waters of the Nepean River, showing low to very low dissolved oxygen (DO) levels, particularly during summer months and low flow periods (Geoterra, 2006).
- Concentrations of zinc and aluminium were elevated in some reaches of the Nepean River between Douglas Park Weir and Menangle Weir (Geoterra, 2006).
- Strata gas emission into the Nepean River may influence levels of DO near the surface of the water column under low flow conditions (Ecoenginners, 2008).

BHP Billiton Illawarra Coal (BHPBIC) extracted coal from Longwall 701 between October 2007 and May 2008 and is currently mining Longwall 702 at Appin West Colliery (TEL, 2009a). Monitoring in the Nepean River to date indicates:

- Comparison of water quality variables sampled in the Nepean River before and after extraction of Longwall 701 found no change (TEL, 2008a).
- There has been no detectable impact on flow within the watercourses in the Appin Longwalls 701-719 Area (BHPBIC, 2008).
- Strata gas releases have occurred in four areas within the Nepean River and a single small release occurred in the lower reaches of Elladale Creek (TEL, 2009a). Strata gas emissions had ceased by the time the spring 2008 survey was undertaken (i.e. 22 October 2008) (TEL, 2009a).

- Two minor zones affected by iron staining were observed in the lower reaches of Elladale Creek and along the northern bank of the Nepean River adjacent to the strata gas release zones (TEL 2009a).
- There is no evidence that mining, including the release of strata gases that have occurred, have had a significant effect upon aquatic habitat or fish within the Nepean River (TEL 2009a).
- Despite some changes in patterns of distribution of aquatic macrophytes and macroinvertebrates within the Nepean River, compared to sampling done pre-mining, TEL (2009a) concluded that these changes are most likely not associated with mining.
- BHPBIC has commissioned further studies on the potential effects of subsidence on aquatic habitats and biota in overlying watercourses within the Appin Longwalls 701-719 Area.

A number of studies have been undertaken to assess potential effects on water quality associated with discharge of mine water from the Appin West pit top into Sandy Gully (TEL, 2004c; 2005b; 2006a) from where it flows into the Nepean River, via Clements Creek and Allens Creek. A summary of the main findings of these studies (TEL, 2004c; 2005b; 2006a) is presented in Section 6.4.

Aquatic Macroinvertebrates

The main findings of reviewed literature regarding aquatic macroinvertebrates include:

- No threatened species of invertebrates have been found during the course of several studies carried out within the Nepean River or several of its tributaries (TEL, 2003a; Ecowise Environmental, 2005a; TEL, 2006d; 2008a; 2008b).
- Fewer families of macroinvertebrates than expected were collected from sites sampled on the Nepean River (Band B; TEL, 2006d), Foot Onslow Creek (Band B; TEL, 2008a) and Navigation Creek (Band B; TEL, 2008a) using the AUSRIVAS technique, compared to reference sites selected by the AUSRIVAS model. No threatened species of macroinvertebrates were found.
- Twenty macroinvertebrate taxa were collected at a site in Mallaty Creek by TEL (2008b) who sampled this area to examine potential effects of mine subsidence associated with Longwalls 34 to 36. The site in Mallaty Creek was rated as similar to AUSRIVAS reference condition (TEL, 2008b). The Signal score indicated that the site was subject to moderate to severe pollution (TEL, 2008b).
- Regulated flow from upstream storages has had a profound impact on assemblages of macroinvertebrates (Growns and Growns, 2001).
- After sampling twenty-seven sites on the Hawkesbury-Nepean River (including at Douglas Park) and some of its tributaries, Williams (1994) found that:
  - The Nepean River was ‘widely impaired’. Disturbances associated with disposal of sewage, destruction of habitat, river regulation and poor management practices were thought to be the main factors causing a decline in the ‘health’ of the river.
  - Construction of water storages and weirs are thought to have resulted in displacement of taxa that favour high energy environments by taxa that prefer lower velocities.
  - Low flows have encouraged growth of algae on the riverbed and proliferation of organisms that graze on the attached algae.

- A summary of the main findings of studies that have examined the effects on assemblages of macroinvertebrates of discharge of mine water from the Douglas Project into Sandy Gully (TEL, 2004c; 2005b; 2006a) from where it flows into the Nepean River, via Clements Creek and Allens Creek is presented in Section 6.4.

Fish

In recent times, the Hawkesbury-Nepean system has shown signs of a decline in assemblages of fish (Gehrke and Harris, 1996; DPI, 2007). Species such as common galaxias, bully mullet, freshwater mullet and freshwater herring are reduced in abundance and grayling are now rarely recorded (Gehrke and Harris, 1996). Numerous factors are thought to have contributed to these declines, including flow regulation and the proliferation of dams and weirs. Starting at Penrith and moving upstream, there are 13 barriers to passage of fish along the main channel of the Nepean River (DPI, 2007). In addition, three headwater storages (Avon, Nepean and Cordeaux Dams) are operated to regulate flow within the system (DPI, 2007). As a result, catadromous species of fish (i.e. species that migrate to the estuary/sea to spawn) are unable to make recolonising migrations from estuarine areas (Gehrke *et al*., 2000). Regulated flow from upland storages has also had a profound impact on assemblages of macroinvertebrates (Growns and Growns, 2001), which are an important source of food for many species of fish.

The Australian grayling has been recorded within the Hawkesbury-Nepan River catchment in the Grose River, however, no records exist within the upper Nepean River Catchment or within any other watercourses within the Project area. Australian grayling need to migrate to and from the sea to complete their life cycle (McDowall, 1996) and as such would not be expected to occur within the upper Nepean River above barriers such as the Menangle Weir, which has no provision for fish passage. Given that it is highly unlikely that the Australian grayling occurs within watercourses within catchments of the Nepean River, Cataract River, Georges River or Woronora River, further investigation of this species is not considered necessary.

A search of the NSW government records of fish records in the Nepean River and its tributaries within the Project area using the BioNet database (Bionet, 2009) identified a total of 14 species (including 11 native species and three introduced species) (Table 2). A small number of Macquarie Perch have been collected approximately 12 km downstream of the Avon dam (upstream of the Project area).

Results from recent studies of fish assemblages within the Nepean River and a number of its smaller tributaries are summarised below:

- TEL (2004e; 2006d; 2008a; 2009a) sampled fish assemblages to examine the effects of mine subsidence in the Nepean River between Douglas Park and Menangle, Foot Onslow and Navigation Creeks and their unnamed tributaries, Harris Creek and small unnamed tributaries that flow into the Nepean River from the west, Ousedale Creek and Leafs Gully. Five species of native fish were recorded in the Nepean River including: Fire tail gudgeon (*Hypseleotris galii*), Flathead gudgeon (*Philypnodon grandiceps*), Dwarf flathead gudgeon (*Philypnodon* sp.), Australian smelt (*Retropinna semoni*) and Empire gudgeon (*Hypseleotris compressa*). No threatened species of fish were recorded.
- Flathead gudgeon (*Philypnodon grandiceps*) were recorded in Mallaty Creek, but no fish were recorded in Leafs Gully (TEL, 2003b).

Table 2 Species of Fish Listed within the Campbelltown Local Government Area of the Nepean River

Family Name	Species Name	Common Name
Anguillidae	*Anguilla reinhardtii*	Long finned eel
Clupeidae	*Potamalosa richmondia*	Freshwater herring
Cyprinidae	**Cyprinus carpio*	Carp
Cyprinidae	**Carassius auratus*	Goldfish
Eleotridae	*Gobiomorphus australis*	Striped gudgeon
Eleotridae	*Gobiomorphus coxii*	Cox's gudgeon
Eleotridae	*Hypseleotris galii*	Firetail gudgeon
Eleotridae	*Philypnodon grandiceps*	Flathead gudgeon
Mugilidae	*Mugil cephalus*	Flathead mullet
Percichthyidae	*#Macquaria australasica*	Macquarie perch
Percichthyidae	*Macquaria novemaculeata*	Australian bass
Plotosidae	*Tandanus tandanus*	Freshwater catfish
Poeciliidae	**Gambusia holbrooki*	Mosquito fish
Retropinnidae	*Retropinna semoni*	Australian smelt

Source: Bionet (2009).

* Denotes an alien species of fish; # Indicates a species listed as threatened under the FM Act.

3.2 Cataract River Catchment

Water Quality

Patterns of flow within the Cataract River between the Cataract Dam and Broughtons Pass Weir are highly modified due to the use of this section of the river for transfer of water by the SCA. Bulk water transfers are commonly approximately 150 ML per day but can be as high as 550 ML per day (Woodlots and Wetlands, 2003; from SCA data). During bulk water transfers, this section of the river can be characterised as continuous large pools connected by sections of rapid flow (TEL, 2005a). During periods of low flow (i.e. approximately 1.5 ML per day) the river could be expected to be reduced to a series of large pools connected by sections of shallow flow across sandstone rock bars and through boulder fields (TEL, 2005a).

Preece (2004) assessed cold water pollution below dams in NSW and concluded that the upper Cataract River is likely to be subject to cold water pollution because the outlets of the dam draw from 9 m and 20 m depths, which are below the dam's thermocline for much of the year. Results from studies to assess water quality at sites in the Cataract River between the Cataract Dam and Broughtons Pass Weir showed that pH and concentrations of DO are commonly below ANZECC and ARMCANZ (2000) guidelines for the protection of aquatic ecosystems (TEL, 2003c; 2005a).

Limited information is available from previous studies on tributaries of the Cataract River, with the exception of those sampled recently by TEL (2009b). In general, water quality sampling in the upper reaches of Wallandoola Creek and Lizard Creek found water quality to be relatively acidic, which is typical of Hawkesbury sandstone environments (TEL, 2009b). DO and turbidity were commonly below recommended ANZECC and ARMCANZ (2000) guideline values (TEL, 2009b).

Aquatic Macrophytes

Macrophytes were assessed at three locations in the Cataract River (upstream of Broughtons Pass, upstream of Jordans Pass and upstream of Appin Falls) in July 2005 as part of a study done by TEL (2005a). Aquatic macrophytes (i.e. *Myriophyllum* sp. and *Vallisneria* sp.) were recorded in deep pools upstream of Jordans Pass (TEL, 2005a). *Vallisneria* sp. was also recorded in pools upstream of Appin Falls (TEL, 2005a), the upper reaches of Wallandoola Creek and Lizard Creek (TEL, 2009b). It should be noted that Project field surveys undertaken in autumn 2008 did not find *Vallisneria* sp. It is likely that the leaves of the macrophyte Water Ribbons (*Triglochin procerum*), which is relatively common in the Cataract River and a number of other systems within the area, have previously been misidentified as leaves of *Vallisneria* sp. (Geoff Sainty, pers. comm., 2009).

Aquatic Macroinvertebrates

A summary of recent studies of aquatic macroinvertebrates in the Cataract River and a number of its tributaries is presented below:

- NSW Department of Land and Water Conservation (DLWC) sampled macroinvertebrates in the Cataract River as part of a study investigating the loss of water from pools downstream of Broughtons Pass Weir (Cataract Task Force, 1998). The study found families of macroinvertebrates that are sensitive to pollution of water were present although in low numbers (Cataract Task Force, 1998).
- AWT (1998) sampled three sites downstream of Broughtons Pass Weir and in control streams (i.e. O'Hares Creek and Avon River) to examine the effects of controlled releases of water on assemblages of macroinvertebrates. Taxa collected as part of this study were typical of taxa recorded in rivers and streams in coastal areas in NSW (AWT, 1998).
- Macroinvertebrates were sampled in the Cataract River by TEL (2003c) to determine the effects of bulk water transfers using the AUSRIVAS sampling technique. Fewer families of macroinvertebrates than expected were collected from the sites sampled compared to reference sites selected by the AUSRIVAS model (TEL, 2003c).
- No threatened species of macroinvertebrate were collected during several studies carried out within the Cataract River (AWT, 1998; TEL, 2003c; Ecowise Environmental, 2005a; TEL, 2005a; 2009b).

Fish

Notably, sampling undertaken as part of this study, and in previous studies (Gehrke and Harris, 1996; TEL, 2003c; 2005a) have shown that a viable population of Macquarie Perch, is present throughout the reach of the Cataract River between the Cataract Dam and Broughtons Pass Weir (which includes the Project area). A summary of results from recent studies of fish undertaken within the Cataract River and its smaller tributaries is presented below:

- Gehrke and Harris (1996) recorded six species of fish, including Macquarie Perch, immediately above or below Broughton Pass Weir.

- Seven sites were sampled downstream of Broughton's Pass Weir in the Cataract River by Winstanley (2000), as part of a study examining flow requirements to maintain a 'healthy' system. Three native fish (Firetailed gudgeon, Cox's gudgeon and Australian smelt) and one alien species (Mosquito fish) were collected. No threatened species were found.
- Fish were sampled using a backpack electrofisher and bait traps at sites in the Cataract River below the Cataract Dam and upstream of Broughtons Pass Weir by TEL (2003c; 2005a). Four species of fish, including Macquarie perch, Mosquito fish, Australian smelt and Flathead gudgeon were collected (TEL, 2003c; 2005a). *Euastacus* sp. was also collected at Jordans Pass in July 2005 (TEL, 2005a).
- Sampling of fish undertaken in the upper reaches of Wallandoola Creek and Lizard Creek failed to capture any individuals (TEL, 2009b). *Euastacus* sp. was, however, found to be present (TEL, 2009b).

3.3 Georges River Catchment

Substantial information is available on aquatic habitats, quality of water, macroinvertebrate and fish fauna in the upper reaches of the Georges River, at sites adjacent to the West Cliff Longwalls 30 to 36 Area. Initial studies were undertaken before commencement of longwall mining (Campbelltown City Council and Jarvis, 1997; MPR, 2001). Recent studies have focused on the general effects of mine subsidence (TEL, 2002a; 2002b; 2003b; 2005d; 2008b), effects of remediation at Marhnyes Hole (TEL, 2004d) and effects of the discharge of mine water from Appin East and West Cliff pit tops (TEL, 2004a; 2004b; 2006b; 2006c). The major findings of an examination of the effects of discharge of mine water, from Appin East pit top into the Georges River (TEL, 2004b; 2006b) and West Cliff pit top from where it flows into the Georges River via Brennans Creek (TEL, 2004a; 2006c) are presented in Section 6.4. The results of studies examining the effects of mine subsidence are summarised below.

Water Quality

The quality of water within the reach of the upper Georges River is determined by the relative contribution of rainfall inputs from the catchment, rural and urban runoff and licensed discharges of mine water from Appin East and West Cliff pit tops. Inputs range from 0.2-7.2 ML/day, but are typically between 0.5 and 3.0 ML/day and average 1.6 ML/day (Mine Subsidence Engineering Consultants [MSEC], 2007). Dry weather flows upstream of the licensed discharge points are low, averaging 0.3 ML/day and varying from 0 to 4.2 ML/day (MSEC, 2007). Discharges, particularly from the West Cliff pit top, contain elevated levels of pH, and conductivity and concentrations of dissolved iron, manganese and nickel, which have a considerable effect on the quality of water in the downstream reaches of the Georges River during prolonged dry periods (Ecoengineers, 2005). Water quality within the reach of the Georges River between its confluence with Brennans Creek to near Lysaghts Road has been characterised by elevated pH and conductivity, most likely related to mine water discharges and other anthropogenic effects (TEL, 2008d). Notably, a number of water quality variables measured in the river by Campbelltown City Council and Jarvis (1997), between its confluence with Brennans Creek and Marhynes Hole, did not comply with ANZECC (1992) guidelines prior to commencement of mining activities (MPR, 1999).

Aquatic Macrophytes

TEL (2002a; 2005d; 2008d) noted the presence of aquatic macrophytes in assessments undertaken to examine effects of mine subsidence on aquatic habitat and biota in West Cliff Area 5. *Typha* spp. were found to dominate instream vegetation in both riffle and pool habitats found in this reach of the Georges River (i.e. between its confluence with Brennans Creek and Marhynes Hole) (TEL, 2002a; 2005d; 2008d). Other aquatic plants included *Potamogeton tricarinatus* (synonym *sulcatus*), *Juncus usitatus*, *Isolepis prolifera* and various emergent grasses (TEL, 2002a; 2005d; 2008d).

Macroinvertebrates

Despite targeted searches (including searches for the threatened macroinvertebrate species), no threatened macroinvertebrate species have been collected during numerous studies carried out within reaches of the Georges River or its tributaries that lie within the Project area (Campbelltown City Council and Jarvis, 1997; MPR, 1999; TEL, 2002a; 2004d; 2005d; 2008d).

Campbelltown City Council and Jarvis (1997) investigated the structure and distribution of assemblages of macroinvertebrates in the Upper Georges River in relation to urban, agricultural and industrial impacts. Replicate samples of macroinvertebrates were collected from edge and riffle habitats at nine sites in the river on five occasions between 1995 and 1996 (Campbelltown City Council and Jarvis 1997). The main findings of these studies are summarised below:

- A total of 122 taxa from 79 macroinvertebrate families, the majority being insects, were identified.
- Dytiscid beetles, a pollution tolerant taxon, dominated the fauna at six of the study sites and accounted for 40% of the animals sampled.
- The structure of assemblages at upstream sites differed from assemblages downstream, but it was not clear whether this was due to a change in altitude or water quality.

Recent studies undertaken by TEL (2002a; 2005d; 2008d), investigating the effects of mine subsidence in relation to underground mining activities at the West Cliff Colliery found that:

- The macroinvertebrate fauna in the upper reaches of the Georges River is relatively diverse and dominated numerically by dytiscid beetles and water scavengers (hydrophilids).
- SIGNAL score for sites in the vicinity of Longwalls 31 to 33 suggest that the sites were probably moderately to severely polluted due to upstream activities.
- Taxa at sites located upstream of the study area in the Georges River was less diverse than at sites within the study area.
- Taxa at most of the sites within the study area and at all upstream sites were rated as slightly impoverished relative to the AUSRIVAS reference condition. Taxa at one site in the Georges River within the study area, however, were rated as similar to the reference condition. The Signal scores indicated that taxa were subject to moderate to severe pollution.

Similar techniques were used to survey macroinvertebrates from habitats in the Georges River, within and upstream of Marhynes Hole, before and after remediation of fracturing caused by subsidence (TEL, 2004d). In summary:

- A total of 58 taxa were collected from pool edge habitat across six sites and four survey periods, with Dytiscidae (beetles) and Hydrophilidae (water scavengers) generally being the most common taxa. AUSRIVAS analyses suggested that the fauna at the remediation sites were in a similar condition to those at upstream sites before and after remediation, which implied that remediation work had no significant effect on the macroinvertebrate fauna.
- Macroinvertebrate samples were also collected from rocks in pools. These samples contained 53 taxa in total and were dominated by Chironomidae (midge larvae), followed by Caenidae (mayflies) and Hydrophilidae. TEL (2004d) found significant differences in these assemblages between locations, sites and times, but no obvious differences due to remediation. It should be noted, however, that fewer Hydrophilidae were found at the remediation location than elsewhere in the first survey after remediation, but not during subsequent surveys. This decline may have been due to the effects of mine subsidence or as a result of physical disturbance.

The major findings of studies examining the effects of discharge of mine water from Appin East pit top into the Georges River (TEL, 2004b; 2006b) and West Cliff pit top from where it flows into the Georges River via Brennans Creek (TEL, 2004a; 2006c) are presented in Section 6.4.

Fish

There have been a number of surveys of fish in the upper reaches of the Georges River. Studies by the Australian Museum and NSW Fisheries have focused on areas downstream of areas with mining concessions (i.e. downstream of Dwyers Crossing/ Marhynes Hole), whereas those by MPR (2001) and TEL (2002b; 2003b; 2004d; 2005d) were carried out in the vicinity of areas with mining concessions (i.e. from near Kings Fall Bridge to Dwyers Crossing/ Marhynes Hole). The Australian Museum records show that eight species of fish have been found in the upper Georges River between 1889 and 1980. Three of these species, Golden perch (*Macquaria ambigua*), Silver perch (*Bidyanus bidyanus*) and Trout cod (*Maccullochella macquariensis*), were caught in the vicinity of Appin although not in the Georges River or its tributaries. Golden perch, Silver perch (listed as Vulnerable in NSW) and Trout cod (listed as Endangered) are native to the Murray-Darling River system. Given that the Golden perch, Silver perch and Trout cod are not native to systems within the Project area and that the records are from stockpiled water supply dams (including the Cataract Dam), it was not considered necessary to undertake a Species Evaluation for these species.

The Macquarie perch was recently recorded by DPI-Fisheries in the Georges River, near its confluence with Punchbowl Creek. Previously, this species had only been recorded from the Georges River catchment once, near Campbelltown, in 1984 (DPI, 2008)

The DPI-Fisheries (c. 2000) records of fish species collected at four locations (Holsworthy, Macquarie Fields, Liverpool and Kentlyn) in the Georges River (i.e. upstream of tidal influences, but downstream of the Project area) indicate that 12 species are present, including two species of introduced fish (i.e. Mosquito fish, *Gambusia holbrooki* and Goldfish *Carassius auratus*).

MPR (2001) recorded Mosquito fish upstream and downstream of Marhynes Hole while two native species, Firetailed gudgeon and Dwarf flathead gudgeon were found downstream of Marhynes Hole. Subsequent studies undertaken by TEL (2002b; 2004d) indicate that Long- and Short-finned eel, Striped gudgeon, Midgley's carp gudgeon and an unidentified Gudgeon species also occur in the vicinity of Marhynes Hole. Long-finned eels, Mosquito fish and Fire-tailed gudgeons have been recorded at sites to the north-east of Appin (TEL, 2003b) and in the vicinity of the Longwalls 31 to 33 mining area (TEL, 2005d). Western carp gudgeon have also been caught in the latter area (TEL, 2005d).

The DPI sampled six sites in O'Hares Creek and Stokes Creek using backpack electrofishing and trapping techniques between 20 May and 18 June 2008 (DPI, 2008). The main findings included:

- Four native species of fish (i.e. Longfinned eel, Cox's gudgeon, Climbing galaxias, Australian smelt), one native crayfish (*Euastacus* spp.) and one exotic species of fish (Mosquito fish) (DPI, 2008).
- The Mosquito fish was the most abundant species sampled (DPI, 2008).
- Macquarie perch were not found despite historical records and recent reports of the species from the Georges River catchment.

3.4 Woronora River Catchment

Water Quality

A number of surveys of water quality have been recently carried out at locations on the Woronora River, on behalf of Metropolitan Colliery (Cummins *et al*., 2007a; 2007b; Bio-Analysis, 2008; Roberts *et al*., 2008; Cummins *et al*., 2008; 2009). A review of the water quality data in relation to the ANZECC AND ARMCANZ (2000) guidelines for upland rivers (i.e. systems at > 150 m altitude) indicates that:

- Mean pH is commonly lower than the lower limit recommended by the ANZECC and ARMCANZ (2000) guidelines (i.e. pH 6.5-8.0).
- Mean DO (range = 50.5 – 94.0% Saturation) is occasionally lower than the lower limit recommended by ANZECC and ARMCANZ (2000).
- Mean electrical conductivity was above the upper ANZECC and ARMCANZ (2000) value in autumn 2007.
- Mean concentrations of total phosphorous and total nitrogen were above the upper ANZEC and ARMCANZ (2000) guideline values in spring 2006 (Cummins *et al*., 2007a).

Aquatic Macrophytes

Bio-Analysis (2008) sampled aquatic macrophytes at two locations on the upper reaches of the Woronora River and at locations within several other tributaries of the Woronora Reservoir. In general, few aquatic macrophytes were recorded, probably due to watercourses within the area being mostly steep and narrow with a predominantly bedrock substratum (Bio-Analysis, 2008). At locations sampled in the upper reaches of the Woronora River, emergent macrophytes included *Drosera binata*, *Juncus prismatocarpus*, *Lepidospermum polygalifolium*, *Lomandra longifolia*, *Typha domingensis* and *Viminaria juncea* (Bio-Analysis, 2008). The floating-attached species *Triglochin procerum* (Water ribbons) was relatively abundant at both sampling locations, in areas where pockets of sand had accumulated (Bio-Analysis, 2008). The submerged species, *Myriophyllum pedunculatum*, was also relatively common at the most downstream sampling locations (Bio-Analysis, 2008).

Macroinvertebrates

Fewer families of macroinvertebrates than expected were collected from two sites sampled on the Woronora River as part of surveys undertaken in 2007 and 2008 (Cummins *et al*., 2007a; 2007b; Roberts *et al*., 2008; Cummins *et al*., 2008; 2009). Taxa recorded in the Woronora River and a number of smaller tributaries within the area were typical of taxa recorded in streams and rivers in NSW. No listed threatened species have been recorded (Cummins *et al*., 2007a; 2007b; Bio-Analysis, 2008; Roberts *et al*., 2008; Cummins *et al*., 2008; 2009).

Fish

The Woronora River System was sampled at 20 sites in 2001 by the DPI-Fisheries to determine whether the Macquarie perch existed within the catchment (Bruce *et al*., 2001). No Macquarie Perch were located upstream or downstream of Woronora Reservoir (Bruce *et al*., 2001). Bruce *et al*. (2001) indicate that while some uncertainty remains about the status of the Macquarie perch, when the results are combined with other fish surveys carried out in the Woronora catchment (since 1994 together with historical information), there is no evidence that Macquarie Perch ever existed in the Woronora River system.

A recent study in the upper reaches of the Woronora River and a number of other tributaries of the Woronora Reservoir found low richness and abundance of assemblages of fish in this area (Bio-Analysis, 2008). The only native species of fish recorded were the Long-finned eel and Australian Smelt (Bio-Analysis, 2008). The dam wall of the Woronora Reservoir is likely to be a major barrier to migration of fish.

4.0 FIELD SAMPLING SITES AND METHODS

4.1 Survey Locations and Timing

Following a review of existing baseline information, a preliminary inspection of the Project extent of longwall mining area and surrounds was undertaken in March 2008 to identify additional suitable aquatic ecology sampling sites. Twenty-one additional locations were selected to be sampled in autumn 2008 in order to provide additional baseline information for the Project. An additional seven locations were also selected to be sampled in spring 2008 to better characterise the baseline aquatic environment. A total of 28 locations (56 sites) were sampled as part of this study (Table 3, Figure 6).

During the autumn 2008 survey, approximately 2 millimetres (mm) of rain was recorded at the Darkes Forest and Douglas Park Bureau of Meteorology (BoM) stations (BoM, 2009). Approximately 50 mm and 74 mm of rainfall respectively was recorded in the preceding month at the Douglas Park and Darkes Forest stations. During the spring 2008 survey, no rainfall was recorded at Darkes Forest and Douglas Park (BoM, 2009). Approximately 93 mm and 129 mm of rainfall respectively was recorded in the preceding month at the Douglas Park and Darkes Forest stations.

Table 3 Summary of Locations and Sites Sampled in Autumn and Spring 2008.

Sampling Location[1]	Sampling Sites	Mining Area	Relation to Past and Proposed Underground Mining	Timing (2008)
Nepean River Catchment				
Nepean River 1 (NP1)	NP1-1 and NP1-2	West and North Domain	Immediately west of proposed mining	Autumn
Nepean River 2 (NP2)	NP2-1 and NP2-2	West and North Domain	In vicinity of proposed mining	Autumn
Nepean River 3 (NP3)	NP3-1 and NP3-2	West and North Domain	In vicinity of proposed mining	Autumn
Carriage Creek (CaC)	CaC-1 and CaC-2	West Domain	Proposed mining	Spring
Racecourse Creek (RC)	RC-1 and RC-2	West Domain	West of proposed mining	Autumn
Clements Creek (ClC1)	ClC-1 and ClC-2	South Domain	Proposed mining	Autumn
Foot Onslow Creek (FC)	FC-1 and FC-2	North Domain	Proposed mining	Autumn
Simpsons Creek (SIMP)	SIMP-1 and SIMP-2	North and South Domains	Mining completed	Autumn
Cataract River Catchment				
Cataract River 1 (CR1)	CR1-1 and CR1-2	South Domain	In vicinity of proposed mining	Autumn
Cataract River 2(CR2)	CR2-1 and CR2-2	South Domain	South of completed mining	Autumn
Lizard Creek (LC)	LC-1 and LC-2	South Domain	In vicinity of proposed mining	Autumn
Wallandoola Creek 1 (WC1)	WC1-1 and WC1-2	South Domain	Proposed mining	Autumn
Wallandoola Creek 2 (WC2)	WC2-1 and WC2-2	South Domain	Proposed mining	Spring
Cascade Creek 1 (CC1)	CC1-1 and CC1-2	South Domain	Proposed mining	Autumn
Cascade Creek 2 (CC2)	CC2-1 and CC2-2	South Domain	Proposed mining	Autumn
Rocky Ponds Creek (RPC)	RPC-1 and RPC-2	South Domain	Mining completed	Autumn
Cataract Reservoir Tributary 2 (CRT2)	CRT2-1 and CRT2-2	South Domain	Proposed mining	Spring
Tributary of Cataract Reservoir Tributary 2 (TCRT)	TCRT-1 and TCRT-2	South Domain	Proposed mining	Spring

Table 3 (Continued) Summary of Locations and Sites Sampled in Autumn and Spring 2008.

Sampling Location[1]	Sampling Sites	Mining Area	Relation to Past and Proposed Underground Mining	Timing (2008)
Georges River Catchment				
Georges River 1 (GR1)	GR1-1 and GR1-2	North Domain	Mining completed	Autumn
Georges River 2 (GR2)	GR2-1 and GR2-2	North Domain	In vicinity of proposed mining	Spring
O'Hares Creek 1 (OC1)	OC1-1 and OC1-2	North Domain	In vicinity of proposed mining	Autumn
O'Hares Creek 2 (OC2)	OC2-1 and OC2-2	North Domain	In vicinity of proposed mining	Autumn
Brennans Creek (BC)	BR-1 and BR-2	Stage 4 Emplacement Area	Mining completed Proposed emplacement	Autumn
Dahlia Creek (DC)	DC-1 and DC-2	North Domain	Proposed mining	Spring
Stokes Creek 1 (SC1)	SC1-1 and SC1-2	North Domain	Proposed mining	Autumn
Stokes Creek 2 (SC2)	SC2-1 and SC2-2	North Domain	In vicinity of proposed mining	Autumn
Brennans Creek Tributary (BCT)	BCT-1 and BCT-2	Stage 4 Emplacement Area	Mining completed Proposed emplacement	Autumn
Tributary of O'Hares Creek (TOC)	TOC-1 and TOC-2	North Domain	Proposed mining	Spring

[1] Refer to Figure 6 for sampling locations and sites.

4.2 Survey Location Characteristics

4.2.1 Nepean River Catchment

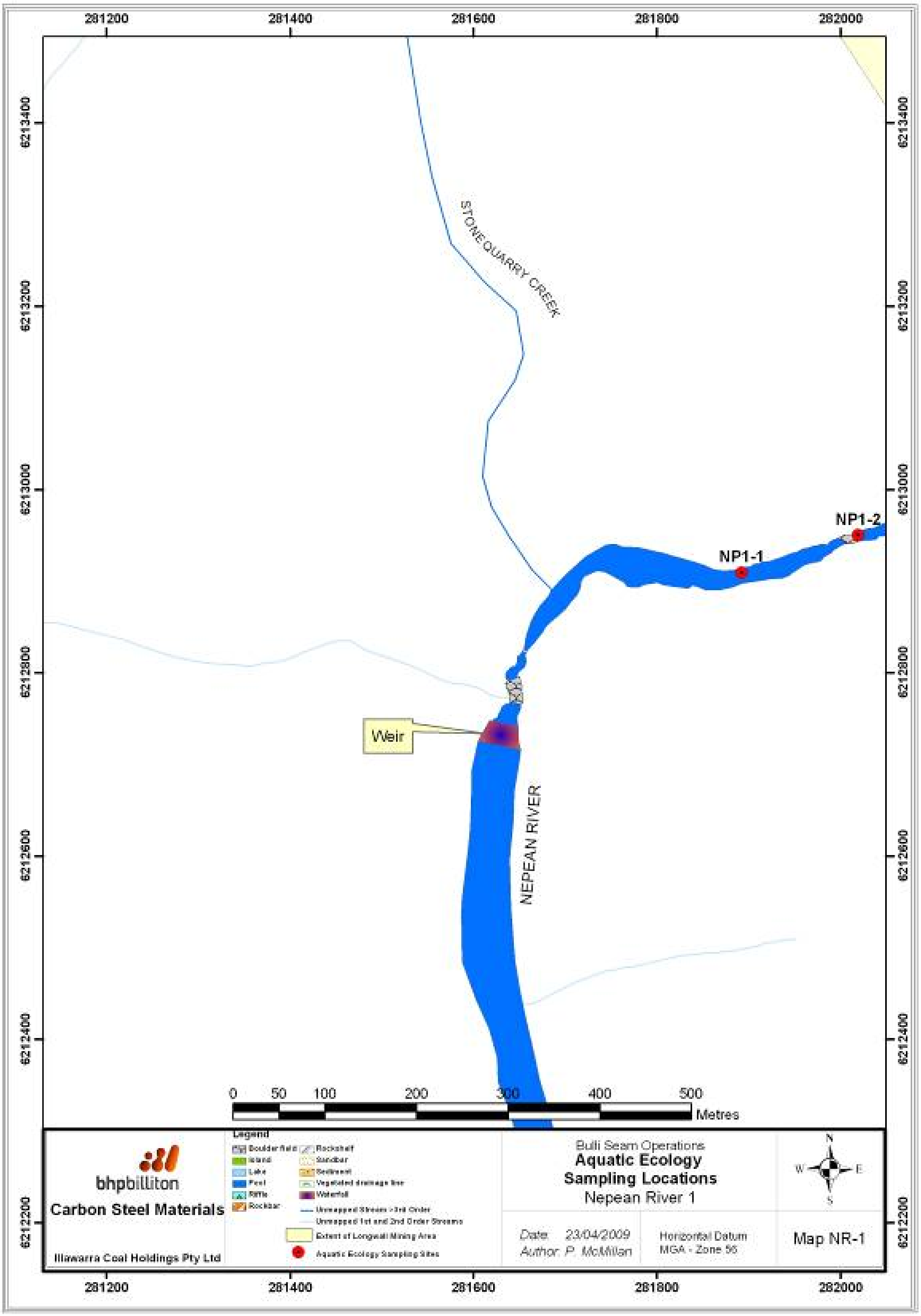
Nepean River

The Nepean River is classified as a 7th order stream. Three locations and six sites were sampled on the Nepean River in autumn 2008 (Figure 6). Location NP1 was sampled approximately 900 m upstream of the proposed future mining area in Appin Area 8 (Figure 3). Location NP2 was located within Appin West (Area 9) while location NP3 was in Appin Area 7 (Figures 2 and 3).

The upper reach of location NP1 was situated approximately 400 m downstream of the Maldon Weir (Figure 3). This section of the Nepean River is set in a deep sandstone gorge. The immediate catchment of the gorge is pasture, some residential buildings and native bushland. This location is situated upstream of the proposed future mining area (Figure 3, Plates 1 and 2 and Map 1).

Plate 1: Nepean River (NP1-1)

Plate 2: Nepean River (NP1-2)



Map 1 – Nepean River 1

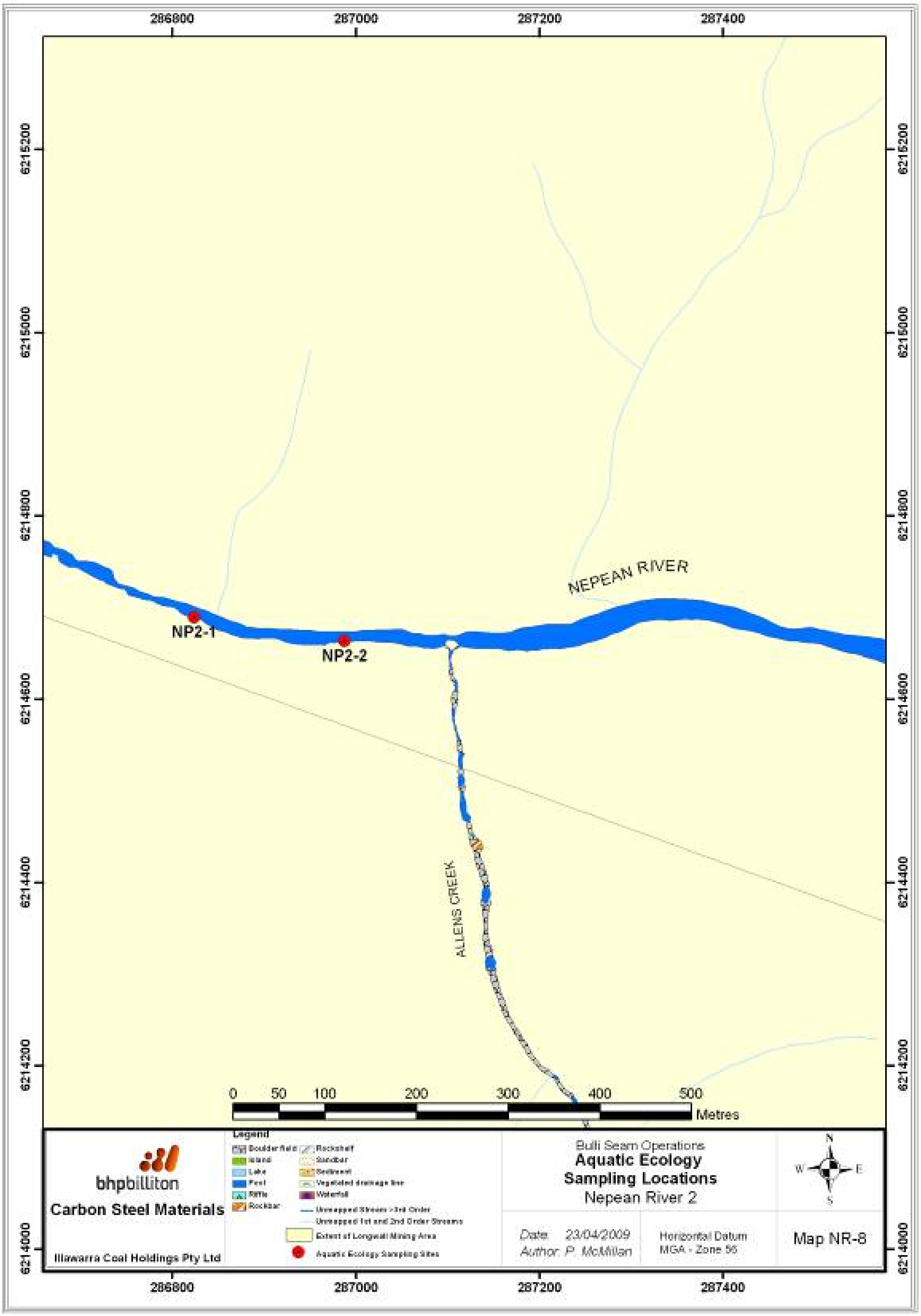
Movement of fish upstream, aquatic habitats and flow of water in this reach of the river are likely to be affected by the weir (~ 15 m high). At this sampling location (NP1) the river was characterised by a series of pools between 15 to 75 m wide to a depth of approximately 5 m, punctuated by chokes of large boulders. The substratum of the pools was predominantly bedrock, boulders and sand. The edge of the channel was comprised of boulder habitat and sandbars supporting riparian vegetation. There was evidence of disturbance to the river banks (i.e. bank degradation and weeds) from recreational activities (i.e. bank degradation and weeds) such as picnicking and swimming. Dominant riparian macrophytes included small patches of *Juncus subsecundus*, *Paspalum distichum*, *Persicaria decipiens* and the introduced species *Aster squamatus* (Attachment A). Extensive beds (approximately 90% of the edge habitat) of submerged macrophytes were present, comprised mainly of the *Elodea canadensis* (an introduced species) and *Hydrilla verticillata* (Attachment A). A few plants of the floating attached species, *Triglochin procerum*, were also present (Attachment A). Eighty-six individual Mosquito fish were collected at this location (Attachments B, E and F). Stream water was relatively clear and free of sediment.

At sampling location NP2, the river formed a continuous pool from 3 to 10 m wide to a depth of approximately 3 m. This location is situated within the proposed future mining area and is immediately upstream of a completed underground mining area (Figures 3 and 6, Plates 3 and 4 and Map 2).

Plate 3: Nepean River (NP2-1)

Plate 4: Nepean River (NP2-2)

There was no evidence of disturbance to the stream bank at sampling location NP2. The substratum of the pool was mostly bedrock and boulders with pockets of coarse sediment among the boulders on the floor of the stream channel. Dominant riparian macrophytes included scattered plants of the species, *Lomandra fluviatilis*, which is listed as being of national significance according to Rare or Threatened Australian Plants (ROTAP) classification (Briggs and Leigh, 1992). Also present were *Gleichenia dicarpa*, *Gahnia* sp., *Lomandra longifolia*, *Potamogeton sulcatus*, *Hemarthria uncinata*, *Isolepis cernua*, *Juncus prismatocarpus* and *Viola* sp. (Attachment A). Weed species included Common couch (*Cynodon dactylon*), *Ageratina riparia* and *Nasturtium officinale* (Attachment A). The submerged macrophyte, *E. canadensis*, was common and there were a few plants of *Triglochin microtuberosum* present (Attachment A). One individual of *G. holbrooki* was collected at this location (Attachments B, E and F). Visibility of the water was clear.



Map 2 – Nepean River 2

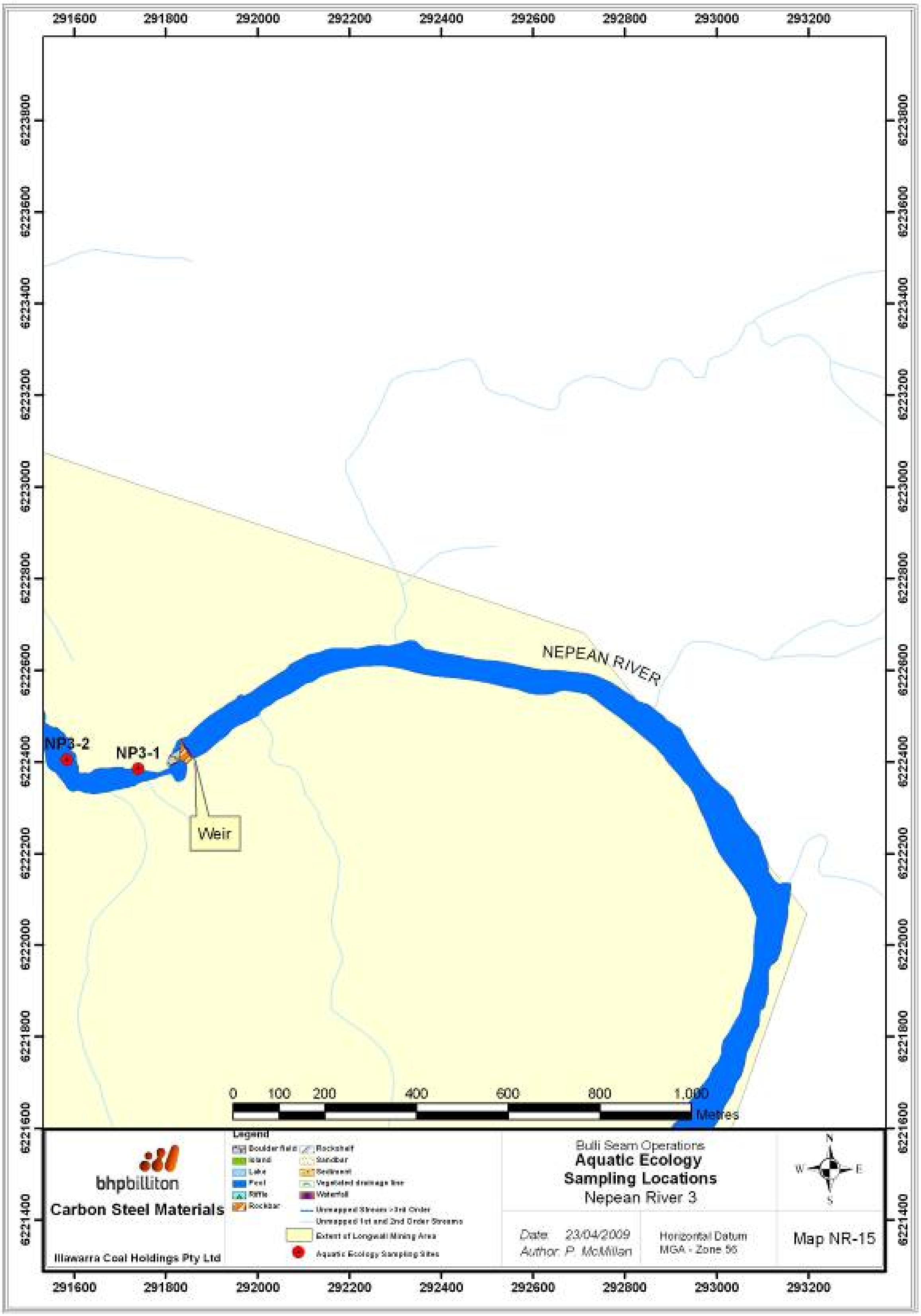
A reach of approximately 5 km of the Nepean River lies within the north-western region of the proposed future mining area, from the junction of Ousedale Creek (4th order) to downstream of the town of Menangle. This section of the river runs through completed and current underground mining areas (Figure 6). The upper reaches of this section of the river are set in a deep gorge with steep banks and discontinuous sandstone cliffs up to 25 m high. Further downstream, the gorge opens up and the river becomes wider and deeper. Notably, the Menangle Weir pool extends upstream towards the Douglas Park Weir (approximately 6 km in length) and can, therefore, be considered a single long, deep, slow flowing pool. There are a number of tributaries of the Nepean River within this area, including Mallaty Creek (3rd order), Navigation Creek (4th order), Harris Creek (3rd order), Foot Onslow Creek (3rd order), and many small 1st and 2nd order tributaries.

At sampling location NP3, the river formed a continuous pool from 4 to 35 m wide to a depth of approximately 3 m. The substratum of the pool was mostly bedrock and boulders with large (up to 40% of the edge habitat) pockets of sand. This location is situated north of current and completed mining and within the proposed future mining area (Figures 2 and 6, Plates 5 and 6 and Map 3). Recreational fishers, canoeists and other members of the public access the river from this location. This location is also heavily used for recreational activities including picnicking and swimming.

Plate 5: Nepean River (NP3-1)

Plate 6: Nepean River (NP3-2)

Dominant riparian macrophytes included *P. distichum*, *Juncus usitatus*, *J. prismatoscarpus*, *Persicaria hydropiper* and *Schenoplectus validus* and many species of weeds (including *Alternanthera denticulata*, *A. squamatus*, *Cynodon dactylon*, *Paspalum dilatatum* and *Rumex crispus*) (Attachment A). Expansive beds (up to 60% cover of the stream channel at the study sites) of the submerged macrophyte species *Vallisneria americana*, *E. canadensis* and *H. verticillata* grew along the shallower (< 2 m) sections of the stream channel (Attachment A). Forty-nine individuals of *G. holbrooki* were collected at this location (Attachments B, E and F). Visibility of the water was reasonably clear and free of sediment.



Map 3 – Nepean River 3

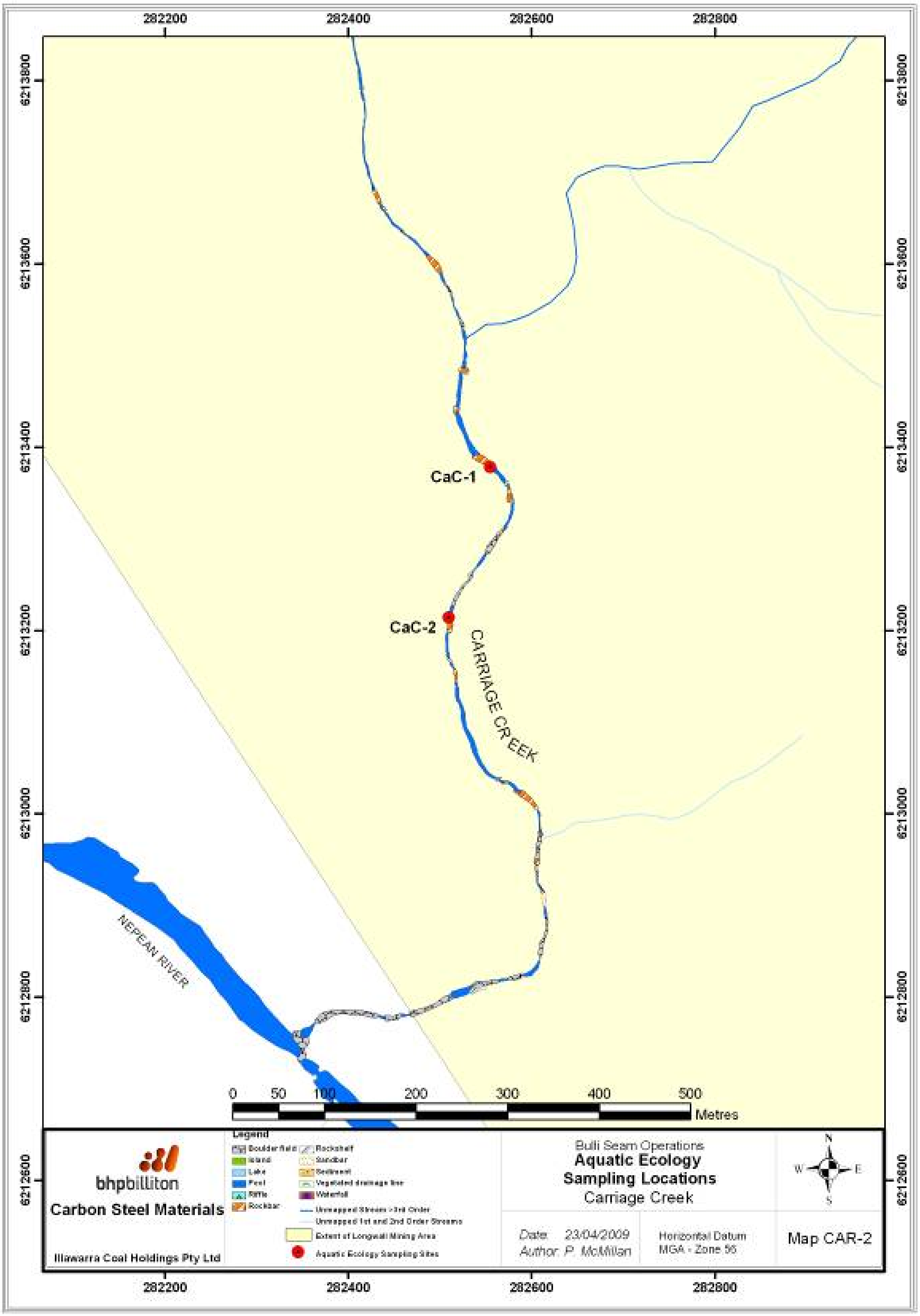
Carriage Creek

Carriage Creek is a small stream (approximately 4 km in length) that runs through a steep valley into the Nepean River downstream (~ 900 m) of the Maldon Weir. A large proportion of the stream lies within the proposed future mining area, where it is classified as a 4th order stream (Figure 3). Like most streams in the Picton and Appin area, the catchment of Carriage Creek is mostly devoted to grazing with some industrial and residential buildings and native bushland. There was evidence of stream-bank degradation, most likely related to cattle being able to access the stream at the sampling location. The sediment/shale based substratum further up in the streams catchment probably contributes to conductivity levels of > 1000 microSiemens per centimetre (µS/cm) measured at the sampling sites and the presence of plants such as *Phragmites australis*, *Typha domingensis* and *Triglochin striatum,* which are known to be tolerant of saline conditions.

Photographs of sampling location CaC are provided in Plates 7 and 8 and stream mapping on Map 4. Stream width at sampling sites (CaC-1 and CaC-2) was 0.3 to 8 m wide. Pools at the sites sampled were up to 0.75 m deep. The substratum was predominantly bedrock. In addition to *P. australis* and *Lomandra longifolia,* dominant riparian vegetation included *P. distichum*, *Lepidosperma laterale* and the weed, *Cyperus eragrostis* (Attachment A). A few small patches of *E. canadensis* were present at site 2 (Attachment A). *G. holbrooki* was relatively abundant (i.e. 55 individuals were collected) at the sampling location (Attachments B, E and F). Visibility of the water was reasonably clear and free of sediment.

Plate 7: Carriage Creek (CaC-1)

Plate 8: Carriage Creek (CaC-2)



Map 4 – Carriage Creek

Racecourse Creek

Racecourse Creek runs in a south-west direction through the town of Picton, south of Sydney. The stream flows into Stonequarry Creek, which flows into the Nepean River, downstream of the Maldon Weir. The immediate catchment of the stream is mostly pasture, residential buildings and some native bushland. Cattle have access to the stream at a number of places along the upper reaches and at the sampling location.

Photographs of sampling location RC are provided in Plates 9 and 10. Sampling location RC was located downstream of the proposed mining area (Figure 6), approximately 2 km downstream of a golf course. Stream width at the sampling sites (RC-1 and RC-2) was between 1 to 4 m wide to a depth of approximately 1.5 m deep. The substratum was predominantly soft silt and clay sediments. Water couch (*P. distichum*) dominated the riparian vegetation and the weeds, *Nasturtium officinale*, *Ranunculus repens, A. squamatus*, *Rumex crispus* and *Veronica anagallis-aquatica* were present (Attachment A). Patches of the submerged macrophyte, *Potamogeton sulcatus*, were scattered throughout the pools sampled (Attachment A). Seventy-nine individuals of *G. holbrooki* were collected at this location (Attachments B, E and F). Visibility of the water was poor.

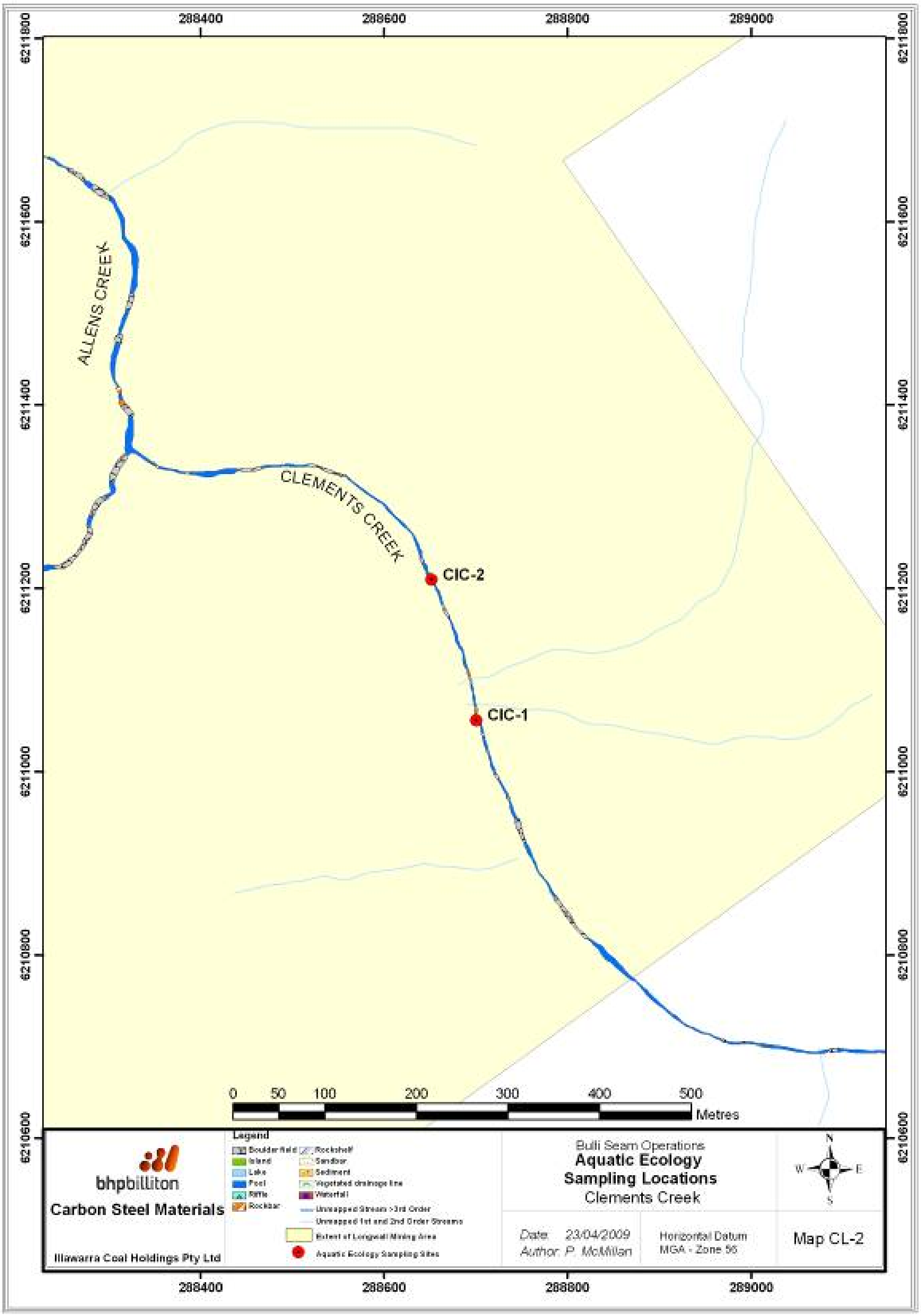
Plate 9: Racecourse Creek (RC-1)

Plate 10: Racecourse Creek (RC-2)

Clements Creek

Clements Creek flows in a north-west direction through the town of Wilton, south of Sydney. The section of Clements Creek that overlies the proposed future mining area is a 3rd order stream and flows into Allens Creek (Figure 3). Clements Creek is one of the small tributaries that feeds into Allens Creek, before it flows into the Nepean River approximately 2 km upstream of the Douglas Park Weir. The streams channel cuts through a steep, well-vegetated gorge. Beyond the gorge, the middle and lower reaches of the stream are gently sloping forming shallow pools separated by rock bars and vegetated chokes (TEL, 2004c). Land-use is mixed rural, residential and industrial, including the Appin West pit top located in the upper reaches of the catchment, near Sandy Gully. Mine water from the Appin West pit top discharges directly into Sandy Gully, which flows to Clements Creek, Allens Creek and then the Nepean River, where it has been shown to dilute rapidly with the base river flow (TEL, 2005b).

Stream mapping of sampling location ClC is provided on Map 5. Stream width at the sites sampled ranged between 0.4 to 12 m and the substratum of the shallow (up to 1 m deep) pools was predominantly bedrock with sand deposited amongst boulders in the stream channel. There were many fallen trees and branches lying across the stream. Dominant riparian vegetation included *Lomandra longifolia* and the ferns *Gleichenia dicarpa* and *Sticherus flabellatus* (Attachment A). A few plants of the emergent macrophyte species, *Typha orientalis*, were also present (Attachment A). No fish, including *G. holbrooki*, were collected at this location (Attachments B, E and F). Water quality appeared poor and extensive cover of green filamentous algae (up to 30% cover of the substratum at Site 2) was suggestive of high nutrient loads.



Map 5 – Clements Creek

Foot Onslow Creek

Foot Onslow Creek flows in a north-east direction past the town of Menangle, south of Sydney. This relatively small stream (i.e. 6.5 km in length) meanders through agricultural pasture before flowing into the Nepean River, approximately 200 m downstream of the Menangle Bridge (Figure 6). In many places, banks of the stream channel were heavily eroded, most likely associated with access by stock, and the stream channel was choked by grasses and the emergent macrophyte, *Typha orientalis*. Foot Onslow Creek (a 3rd order stream) is located north of current and completed mining and within the proposed future underground mining areas (Figure 6). There are a number of small, unnamed tributaries of Foot Onslow Creek within the mining area.

Photographs of sampling location FC are provided in Plates 11 and 12. Stream width at the sampling location FC was 0.5 to 4 m wide. Pools at the sites sampled were up to 0.6 m deep. The substratum was predominantly soft silt and clay sediments. Water couch (*P. distichum*) and many species of weeds, including *Paspalum dilatatum*, *C. dactylon* and *Ligustrum lucidum*, dominated the riparian vegetation (Attachment A). No fish, were collected at this location (Attachments B, E and F). Stream water was reasonably clear and free of sediment.

Plate 11: Foot Onslow Creek (FC-1)

Plate 12: Foot Onslow Creek (FC-2)

Simpsons Creek

Simpsons Creek flows into Elladale Creek, approximately 500 m from its confluence with the Nepean River (Figure 2).

Photographs of sampling location SIMP are provided in Plates 13 and 14. At the sampling location (SIMP), the channel (0.2 to 2 m wide and up to 0.3 m deep) of the stream-bed was predominantly cobble, boulders and bedrock with small deposits of silt and sand. Riparian vegetation included *Lomandra longifolia* (Attachment A). Weeds, including *Juncus usitatus*, *Bidens pilosa*, *Conyza bonariensis*, *C. dactylon*, *Hordeim leporinum* and *Parietaria judaica* were abundant along the stream channel and bank, indicating that flow in this reach of the stream was ephemeral (Attachment A). No individuals of *G. holbrooki* were collected at this location (Attachments B, E and F). Visibility of the water was fair.

Plate 13: Simpsons Creek (SIMP-1)

Plate 14: Simpsons Creek (SIMP-2)

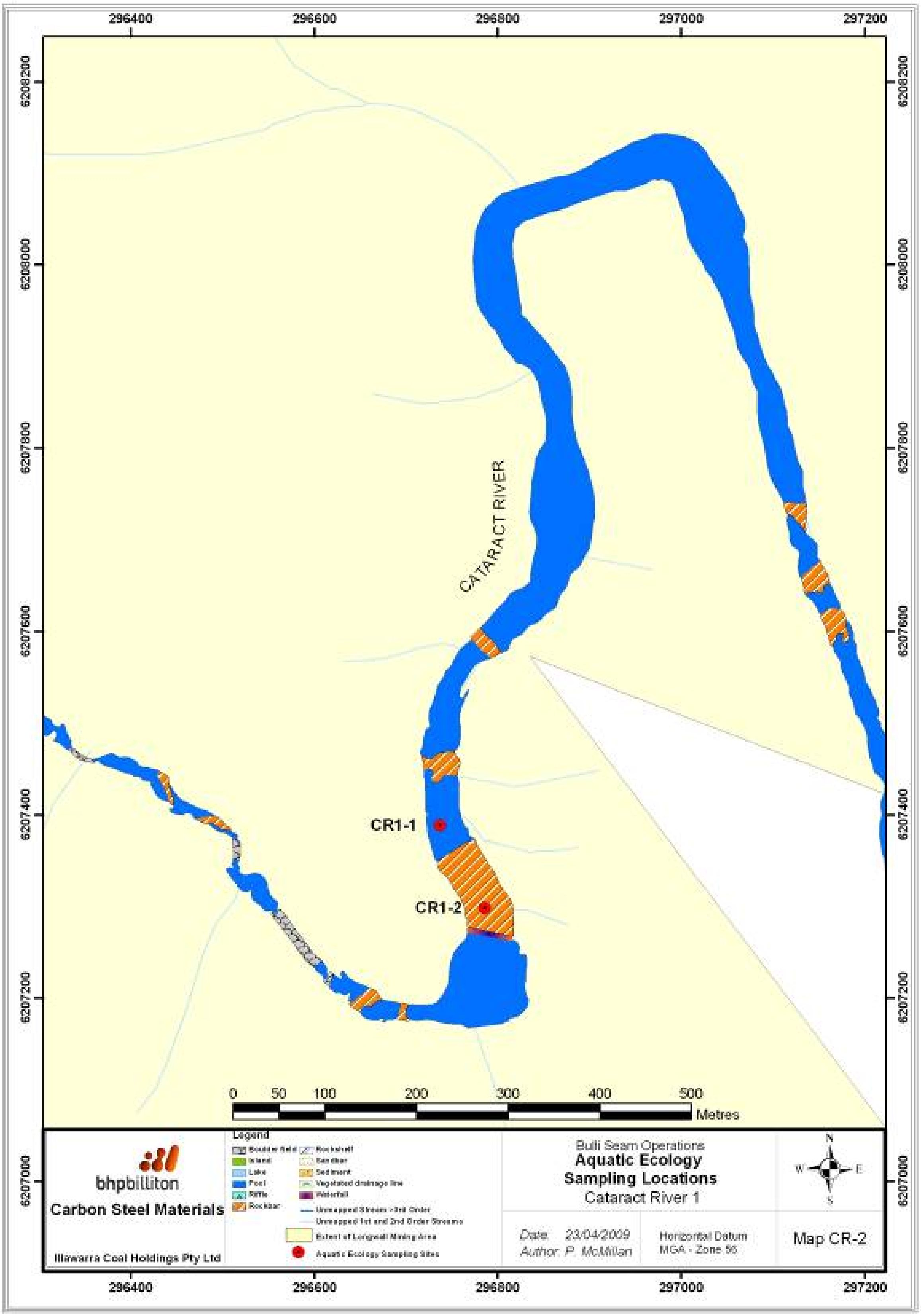
4.2.2 Cataract River Catchment

Cataract River

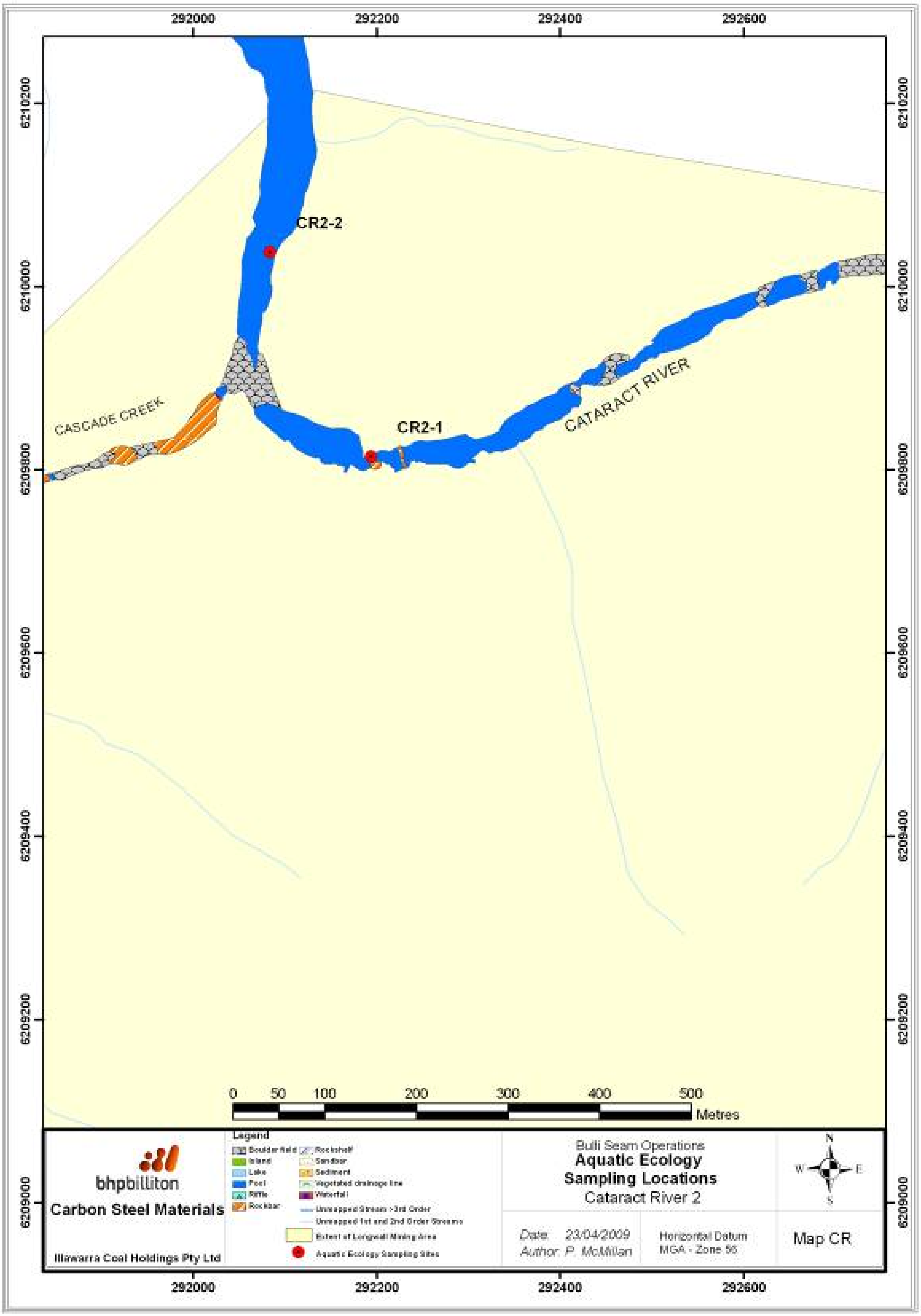
A section of approximately 7 km of the Cataract River (from Cataract Reservoir to below Broughtons Pass), which is classified as a 6th order stream, lies within the southern region of the proposed future mine area (Figures 2 and 4). This section of river is set in a deep gorge, which is naturally very rocky with steep sandstone cliffs. Land-use within the catchment consists of relatively undisturbed native bushland with some pasture in the vicinity of Wilton. A large proportion of the catchment is inaccessible to the public as it contributes to Sydney's water supply. As such, from the Cataract Dam to Broughtons Pass Weir, this section of the Cataract River is subject to highly variable flows associated with water supply releases.

Two locations (CR1 and CR2) and four sites (CR1-1, CR1-2, CR2-1, CR2-2) were sampled on the Cataract River in autumn 2008 (Figure 6). Sampling location CR1 was sampled immediately upstream of Appin Falls (approximately 3 km downstream of Cataract Dam) (Figures 4 and 6, Map 6). Location CR2 was located approximately 300 m upstream of the Broughtons Pass Weir. At the most upstream sampling location (CR1), the river banks consisted of sandy soil amongst sandstone bedrock and boulders. The river had a maximum width of approximately 50 m and consisted of a series of large sandstone rock bars over which rapid, shallow (~ 0.5 m) flow occurred forming numerous riffles and cascades. There were several holes of varying size and depth throughout the rock bars. The rock bars were separated by pools up to a depth of approximately 2 m and length of 40 m. The substratum of the pools was predominantly bedrock. Dominant riparian vegetation included scattered patches of *Juncus prismatocarpus, L. longifolia* and a few patches of the ferns, *Nephrolepis cordifolia*, *G. dicarpa* and *Sticherus flabellatus* (Attachment A). The weed, Whiskey grass (*Andropogen virginicus*), was also present (Attachment A). No submerged species of macrophyte were recorded at the time of the survey (Attachment A). Thirty-four individuals of *G. holbrooki* were recorded at this location (Attachments B, E and F). Deep pools, snags, overhanging vegetation and rocky crevices provide a number of suitable habitats for fish although the presence of Appin Falls (~ 30 m high) would constitute a major barrier to migration of most fish (possibly excluding Freshwater eels and Climbing galaxids) upstream. Stream water was relatively clear and free of sediment.

At sampling location CR2, the stream channel consisted of a series of pools (up to 40 m wide and 50 m long) connected by sections of rapid flow through sandstone boulders and over bedrock bars (Map 7). The substratum of the pools, which were up to approximately 2 m deep, was predominantly bedrock and boulders with pockets of sand and silt in areas of low flow. Disturbances noted in the vicinity of this location included a small weir upstream of CR2-1 (the most upstream site), which is used for monitoring flow. The presence of the weir creates an artificial pool and there is evidence of stream-bank degradation associated with clearing of riparian vegetation to access the flow station. Downstream of sampling location CR2, the Broughtons Pass Weir and associated infrastructure (including the pumping station, the Nepean tunnel outflow, the water supply inlet and roads) have considerably modified the aquatic and riparian habitats. Dominant riparian vegetation included *G. dicarpa*, *L. fluviatilis*, *Philydrum lanuginosum* and *Lepidosperma laterale* (Attachment A). The submerged/floating attached species of macrophyte, *P. sulcatus* and *Triglochin procerum* were present (Attachment A). A variety of fish habitats were present at this location, including deep holes, snags, overhanging vegetation, rocky crevices and riffles. Only one individual of *G. holbrooki* was collected at this location (Attachments B, E and F). Visibility of the water was clear.



Map 6 – Cataract River 1



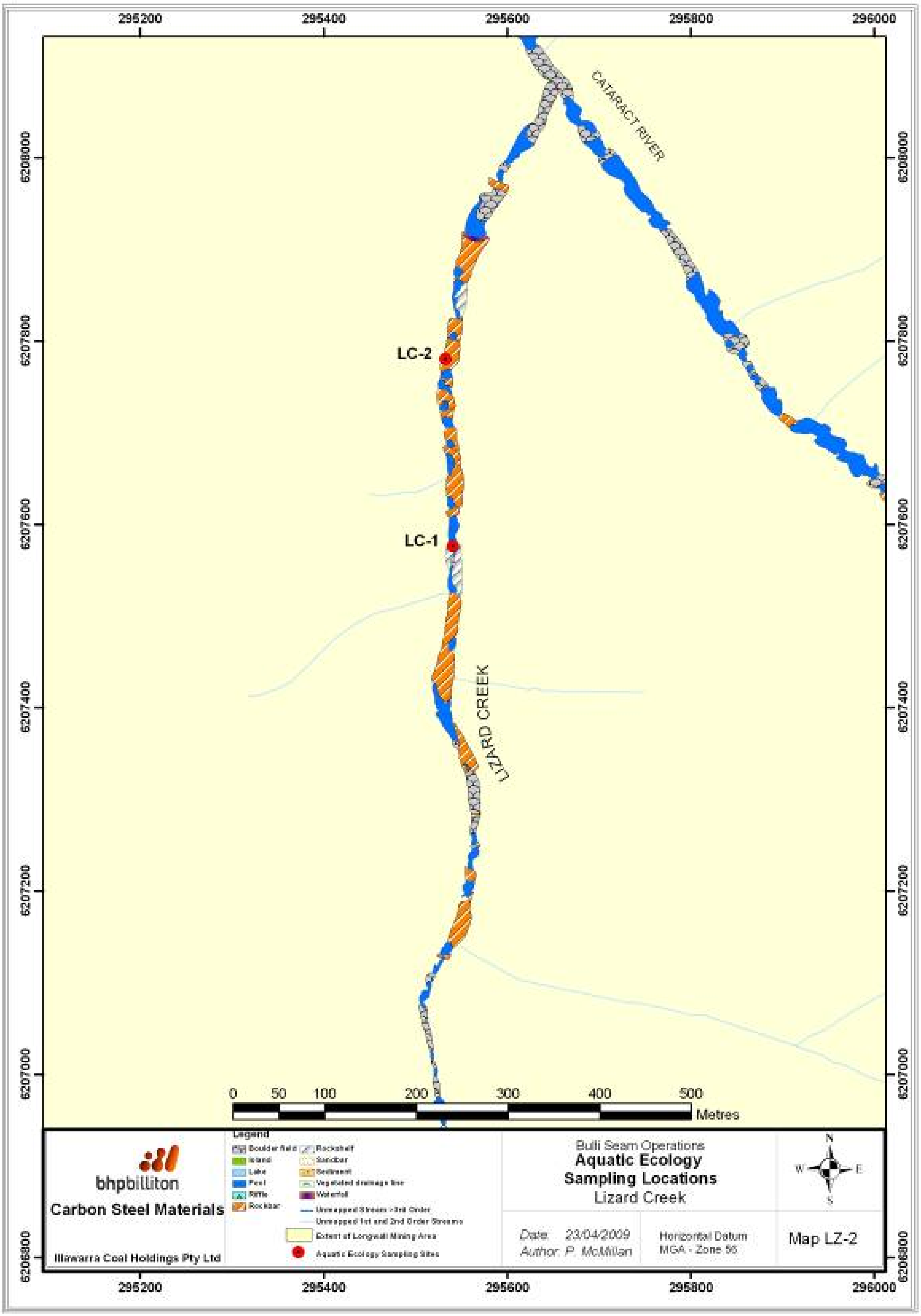
Map 7 – Cataract River 2

Lizard Creek

Lizard Creek is a small stream (approximately 5.4 km in length) which originates in an upland swamp, before flowing in a northerly direction through a steep valley into the Cataract River (Figure 4). The lower reaches of the stream (approximately 800 m), which is classified as a 5th order stream, lie within the proposed future mining area (Figure 4). Stream width at the sites sampled was 4 to 15 m wide and up to approximately 1 m deep. The substratum was predominantly bedrock with some boulders and deposits of sand. Representative photographs and stream mapping of sample location LC are provided in Plates 15 and 16 and Map 8. There was no evidence of disturbance at this sampling location. Aquatic macrophytes were not abundant at the sites sampled (Section 5.2), most likely related to the steep sandstone rock shelves on either side of the stream channel (Attachment A). The riparian vegetation consisted mostly of a few plants of *Baliskion* sp., *Isolepis cernua*, *G. dicarpa*, *L. filiforme*, *L. longifolia*, *Lomandra fluviatilis* and *Lepidosperma laterale* (Attachment A). No individuals of *G. holbrooki* were recorded at this location (Attachments B, E and F). Water visibility was clear.

Plate 15: Lizard Creek (LC-1)

Plate 16: Lizard Creek (LC-2)



Map 8 – Lizard Creek

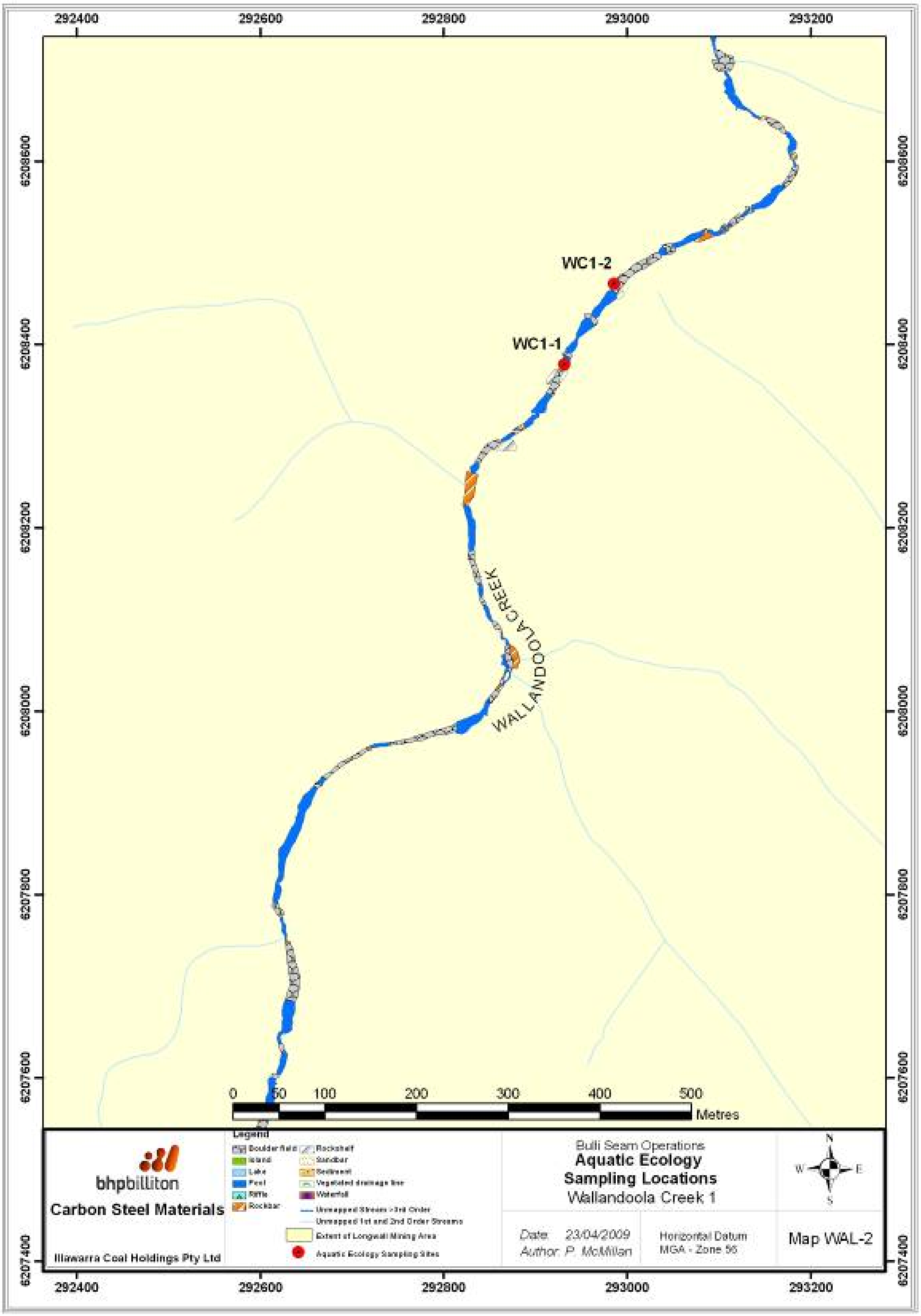
Wallandoola Creek

The headwaters of Wallandoola Creek (a 4th order stream) originate in a large upland swamp, north of Picton Road and the stream runs through a steep valley into the Cataract River (Figure 4). Two locations and four sites were sampled on Wallandoola Creek, within the proposed future mining area (Figure 4).

The most upstream sampling location (WC1) was sampled in autumn 2008 (Plates 17 and 18 and Map 9). The study reach was characterised by mostly small (2 to 15 m wide) interconnected pools up to approximately 1.5 m deep. The substratum was predominantly bedrock with boulders and small pockets of sand. There was no evidence of disturbance at this sampling location. Dominant riparian vegetation included *Baliskion* sp., *L. fluviatilis*, *L. longifolia* and *T. laurina* (Attachment A). Scattered patches of Water ribbons (*T. procerum*) were present in the pools (Attachment A). No *G. holbrooki* were collected at this location (Attachments B, E and F). Water visibility was good.

Plate 17: Wallandoola Creek (WC1-1)

Plate 18: Wallandoola Creek (WC1-2)

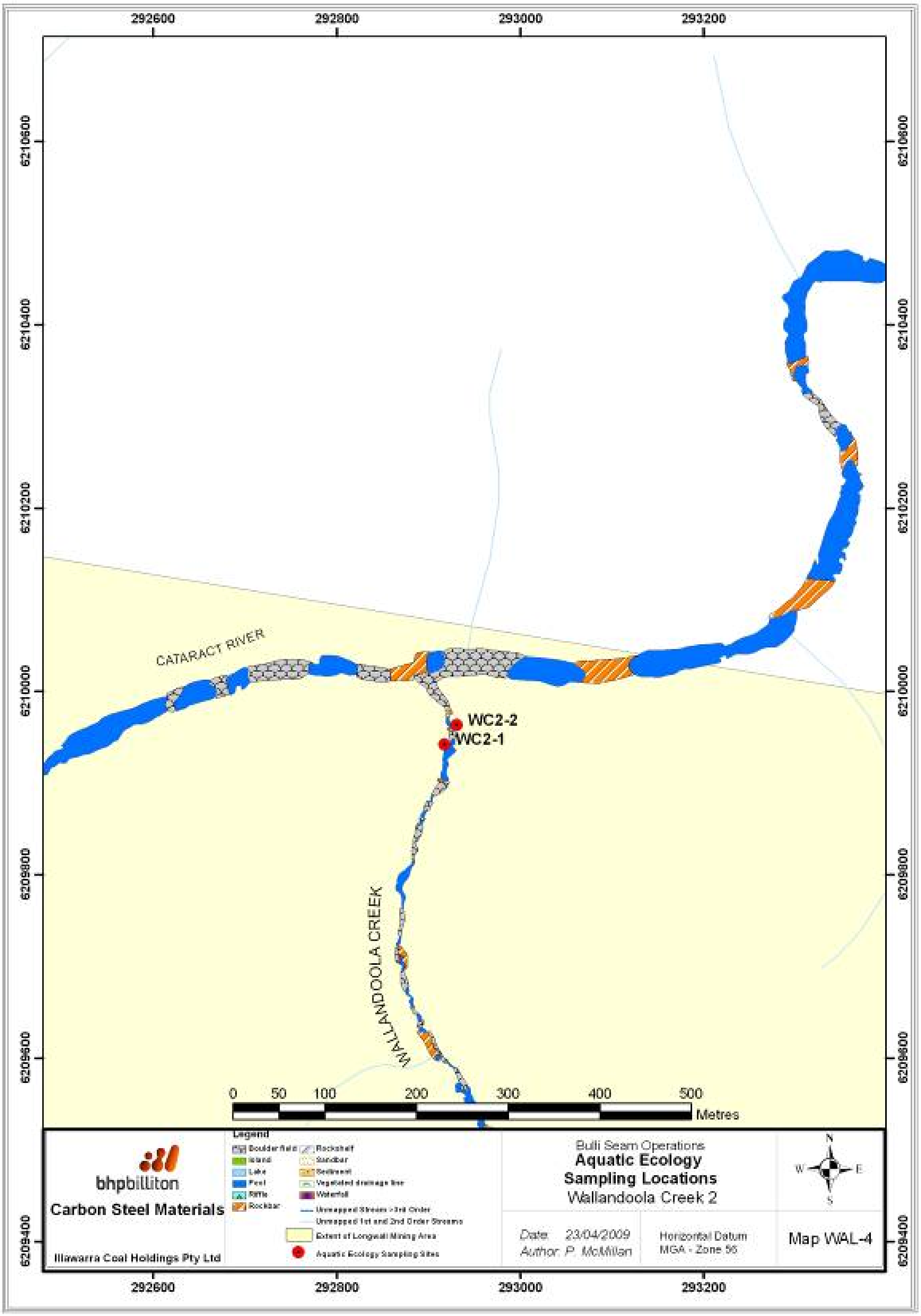


Map 9 – Wallandoola Creek 1

The most downstream location (WC2) sampled on Wallandoola Creek was situated near the streams confluence with the Cataract River (i.e. approximately 750 m downstream of Jordans Crossing), in spring 2008 (Figure 4, Plates 19 and 20 and Map 10). Pools, which were punctuated by chokes of large boulders, were up to 20 m wide and approximately 2 m deep. There was a relatively steep cascade (approximately 2 m) into the pool at the top of the study reach. The in-stream habitat was predominantly boulders, bedrock and deposits of sand in areas of low flow. There was no evidence of disturbance at this sampling location. Aquatic macrophytes were not abundant at the sites sampled (Attachment A), probably due to the streams steep and relatively shallow nature, which does not favour colonisation by aquatic plants (Moss, 1988).The dominant bank and riparian vegetation included *L. filiforme* and *T. laurina* (Attachment A). No individuals of *G. holbrooki* were recorded at this location (Attachments B, E and F). Water visibility was clear.

Plate 19: Wallandoola Creek (WC2-1)

Plate 20: Wallandoola Creek (WC2-2)



Map 10 – Wallandoola Creek 2

Cascade Creek

Cascade Creek is a tributary of the Cataract River, which lies mostly within the SCA area. The stream, which is classified as a 3rd order stream, originates in native bushland approximately 8.5 km south of the Cataract River and joins the river about 350 m upstream of Broughtons Pass Weir. The lower reaches of the stream (approximately 3.5 km) lie within the proposed future mining area (Figure 4). Two locations and four sites were sampled on Cascade Creek in autumn 2008 (Figure 6).

At the most upstream sampling location (CC1), the stream consisted of a series of relatively shallow (to a depth of approximately 1 m deep) pools that were approximately 0.5 to 8 m wide (Plates 21 and 22 and Map 11). The substratum was predominantly bedrock (~ 80%) with boulders (~ 10%) and sand (10%) in areas of low flow. There was no evidence of disturbance at this location. Dominant riparian macrophytes included *L. longifolia*, *Schoenus breviculmis*, *Hypolepis muelleri*, *Juncus prismatocarpus* and *Juncus subsecundas* (Attachment A). No submerged macrophytes or individuals of *G. holbrooki* were recorded at this location (Attachments B, E and F). There were no deep pools for refuge of fish but other suitable habitat included snags and overhanging vegetation. Visibility of the water was clear.

Plate 21: Cascade Creek (CC1-1)

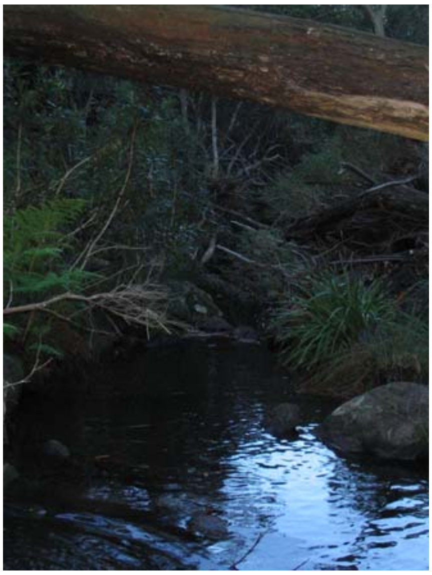
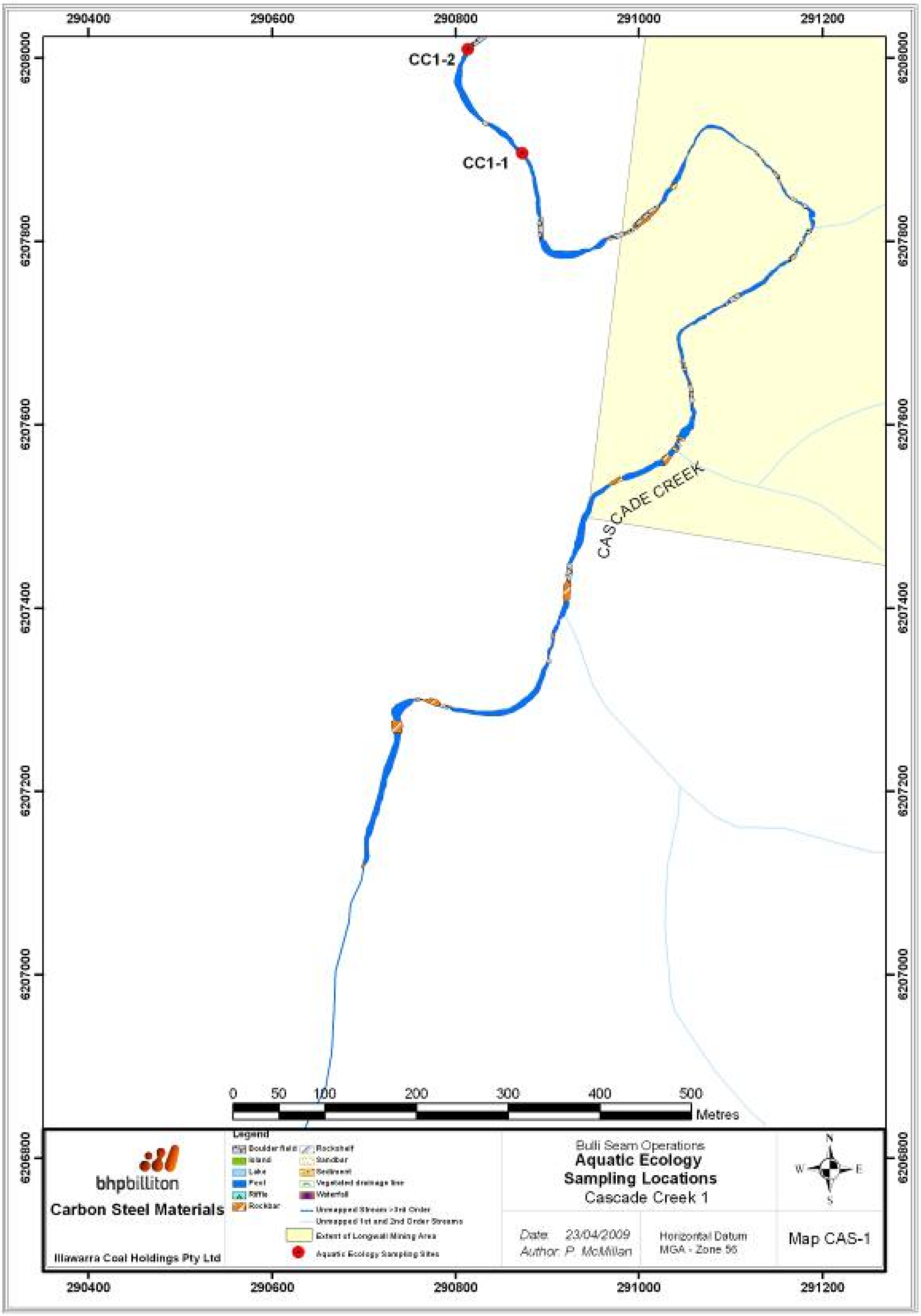


Plate 22: Cascade Creek (CC1-2)



Map 11 – Cascade Creek 1

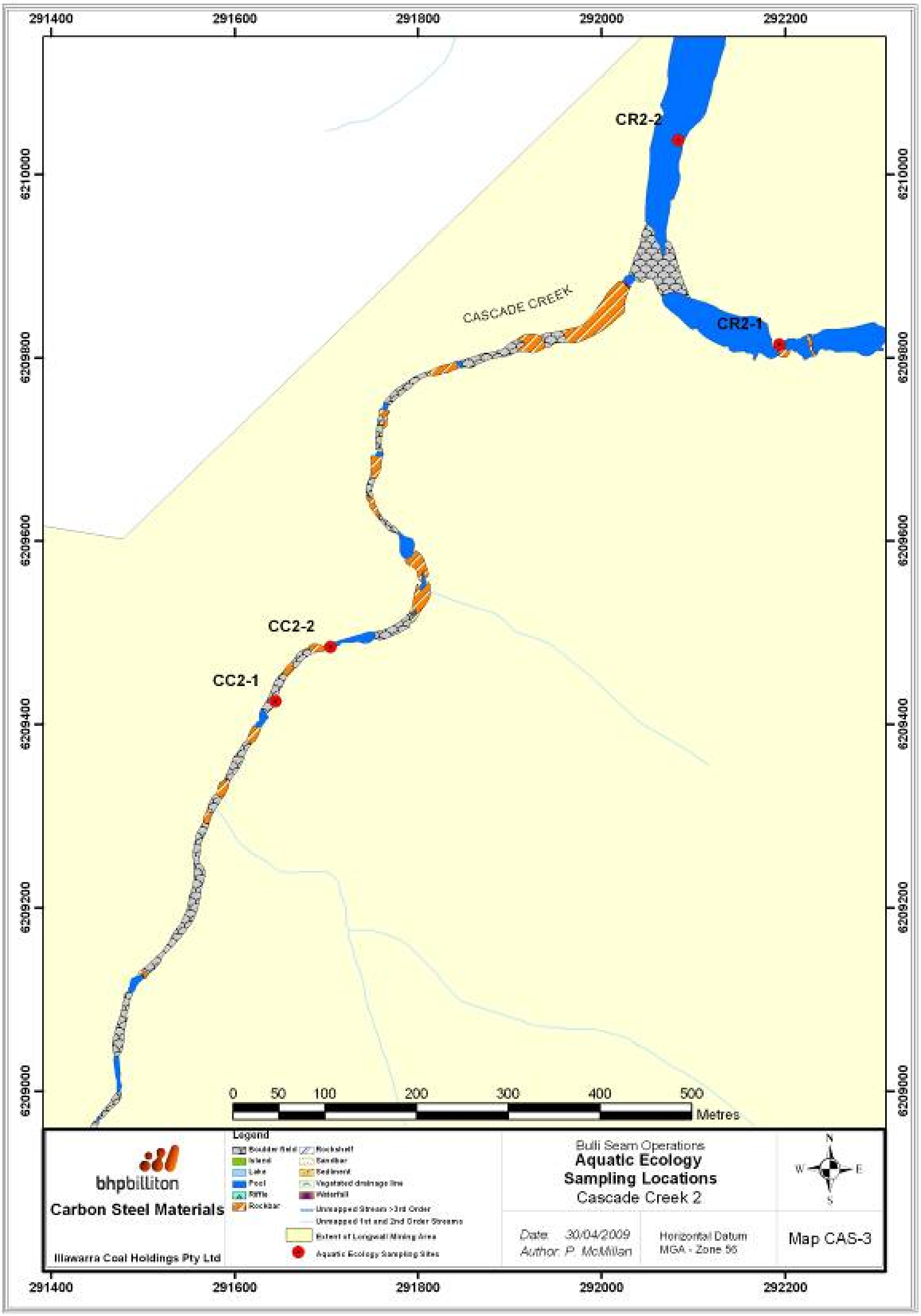
At sampling location CC2, the stream was a series of much broader (up to 55 m wide), deeper (up to approximately 1.5 m deep) pools than at the upstream location, punctuated by chokes of large boulders and, in some places, exposed bedrock (Plates 23 and 24 and Map 12). The in-stream habitat was predominantly bedrock, boulder and deposits of sand in areas of low flow. There was no evidence of disturbance at this sampling location. The dominant bank and riparian vegetation included *L. longifolia*, *Callicoma serratifolia*, Water gum (*Tristaniopsis laurina*) and *Lepidosperma filiforme* (Attachment A). Aquatic macrophytes were not abundant at the sites sampled (Attachment A). No individuals of *G. holbrooki* or native species of fish were recorded at this location despite there being a variety of fish habitats, including a deep pool at Site 2, snags, overhanging vegetation and rocky crevices (Attachments B, E and F). Water visibility was relatively clear and free of sediment.

Plate 23: Cascade Creek (CC2-1)

Plate 24: Cascade Creek (CC2-2)

Rocky Ponds Creek

The Rocky Ponds Creek, which is classified as a 3rd order stream, flows westwards into the Cataract River, downstream of the Broughtons Pass Weir. In the upper and middle reaches of the stream, many sections of the stream bed were dry and cattle had access to the stream. In the lower reaches, near the confluence with the Cataract River, the slope of the stream bed and surrounding catchment steepened.



Map 12 – Cascade Creek 2

Photographs of sampling location RPC are provided in Plates 25 and 26. Sampling location RPC was located approximately 3.5 km upstream of the confluence with the river (Figure 6). Pools at the sampling location ranged from 0.3 to 8 m wide and were up to 1 m deep in places. Pools are likely to be isolated from adjoining pools upstream and downstream during dry periods. The substratum consisted of mostly bedrock, boulders and sand. Riparian vegetation was dominated by *L. longifolia* and a number of species of weeds, including *Callitriche stagnalis*, *C. dactylon*, *Cyperus eragrostis*, *P. dilatatum* and *Plantago lanceolata* (Attachment A). No individuals of *G. holbrooki* were collected at this location (Attachments B, E and F). Visibility of the water was fair.

Plate 25: Rocky Ponds Creek (RPC-1)

Plate 26: Rocky Ponds Creek (RPC-2)

Cataract Reservoir Tributary 2

The headwaters of this small (approximately 3 km), 3rd order stream originate in an upland swamp, south of Appin Road. The stream is located within the SCA's Metropolitan Catchment Area and flows through native bushland in a southerly direction into the Cataract Reservoir (Figure 4). The upper reaches of the stream lie within the proposed future mining area (Figure 4).

Photographs and stream mapping of sampling location CRT2 are provided in Plates 27 and 28 and Map 13. At the sampling location (CRT2), the stream was a series of pools interrupted by sandstone rock bars over which shallow flow occurred at the time of the survey (i.e. spring 2008). Stream width ranged from 0.20 to 20 m and pools were up to approximately 1.5 m deep. The substratum of the watercourse was predominantly bedrock with pockets of sediment in deeper areas. The channel was well defined by sandy banks, submerged rock shelves and a continuous band of riparian vegetation dominated by *Baumea rubiginosa*, *G. dicarpa* and a few plants of *Leptocarpus tenax* and *Schoenus melanostachys* (Attachment A). No weeds or alien species of fish were recorded at this sampling location (Attachments A, B, E and F). Water visibility was clear.

Plate 27: Cataract Reservoir Tributary 2 (CRT2-1)

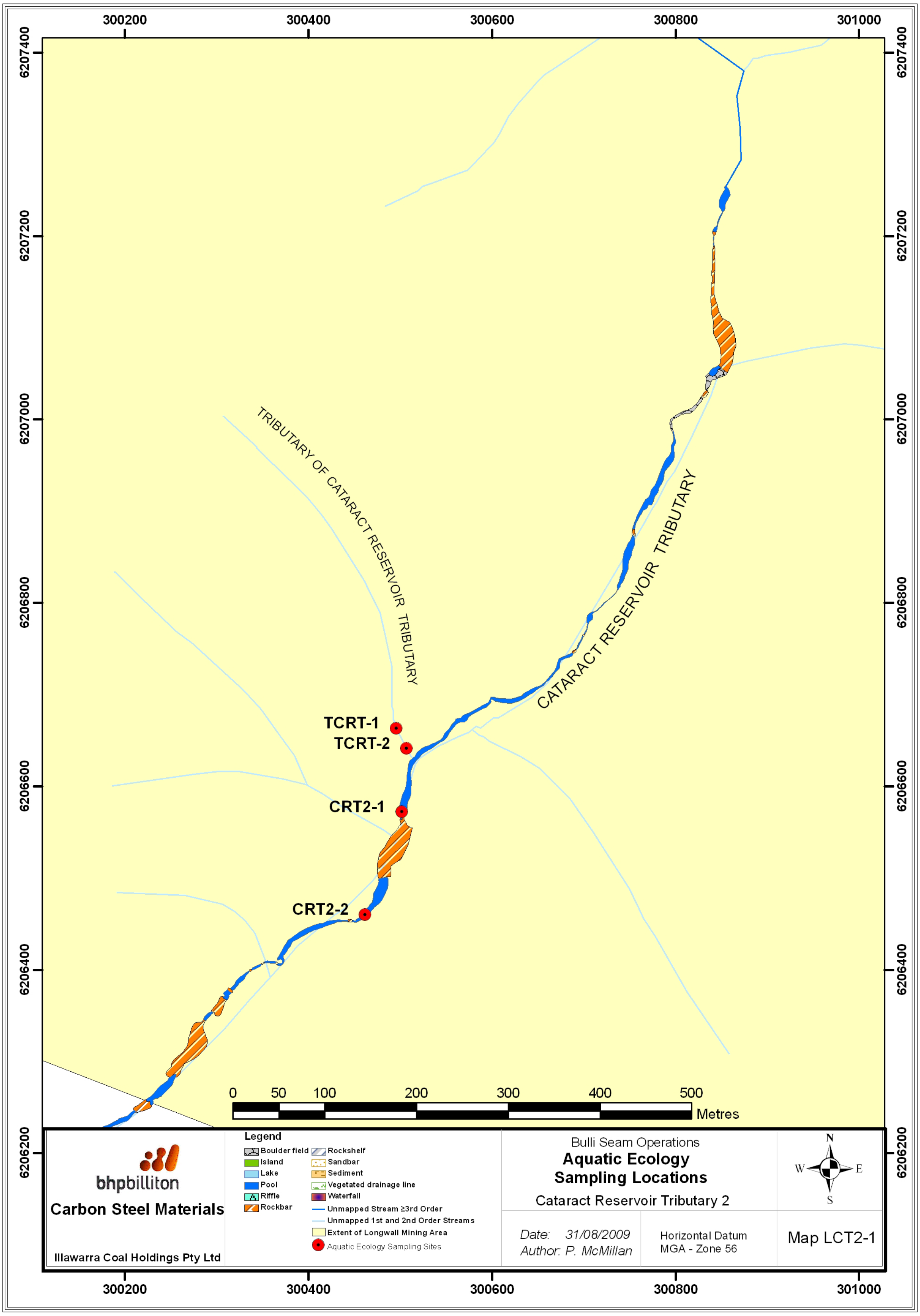
Plate 28: Cataract Reservoir Tributary 2 (CRT2-2)

Tributary of Cataract Reservoir Tributary 2

This small (approximately 400 m) tributary, which is classified as a 1st/2nd order stream, flows into the Cataract Reservoir Tributary 2 approximately 1,250 m upstream from its confluence with the Cataract Reservoir. The entire length of the stream, which consisted of some small, isolated, semi-permanent pools (up to 1.8 m wide and approximately 0.75 deep), lies within the proposed future mining area (Figure 4). There was no evidence of disturbance, including the absence of weeds and alien species of fish (Attachment A, B, E and F). Riparian vegetation consisted mostly of the sedge, *S. melanostachys* (Attachment A). Water visibility was fair. Photographs and stream mapping of sampling location TCRT are provided in Plates 29 and 30 and Map 13.

Plate 29: Tributary of Cataract Reservoir Tributary 2 (TCRT-1)

Plate 30: Tributary of Cataract Reservoir Tributary 2 (TCRT-2)



Map 13 – Cataract Reservoir Tributary 2 and Tributary of Cataract Reservoir Tributary 2

4.2.3 Georges River Catchment

Georges River

A reach of approximately 1.5 km of the headwaters of Georges River lies within the West Cliff area (Figure 2). The upper reaches of the Georges River are set in a sandstone gorge where landuse is largely undisturbed native bushland with some areas that are mixed rural and residential. West Cliff and Appin East pit tops are located within the Georges River catchment and discharge mine water into the Georges River in accordance with EPLs 2504 and 758 (Section 2.2). The river is classified as a 3rd order stream until the confluence with Brennans Creek, where it becomes a 4th order stream.

Sampling location GR1 was situated immediately upstream of the Appin East pit top discharge point into the Georges River (Plates 31 and 32). The river channel at this location is characterised by pools (up to 10 m wide and approximately 2 m deep) interspersed by rock bars. Substratum of the stream channel was predominantly bedrock with deposits of sand in deeper areas. The banks of the channel were mostly soft sediment and generally well vegetated by trees (including *Eucalypt* spp. and *Acacia* spp.) and other emergent macrophyte species including Tall spikerush (*Eleocharis sphacelata*) and *Typha orientalis* (Attachment A).

The submerged species of macrophyte, *P. sulcatus*, was relatively abundant in the pools sampled (Attachment A). One hundred and fourteen individuals of *G. holbrooki* were recorded at this location (Attachments B, E and F).

Plate 31: Georges River (GR1-1)

Plate 32: Georges River (GR1-2)

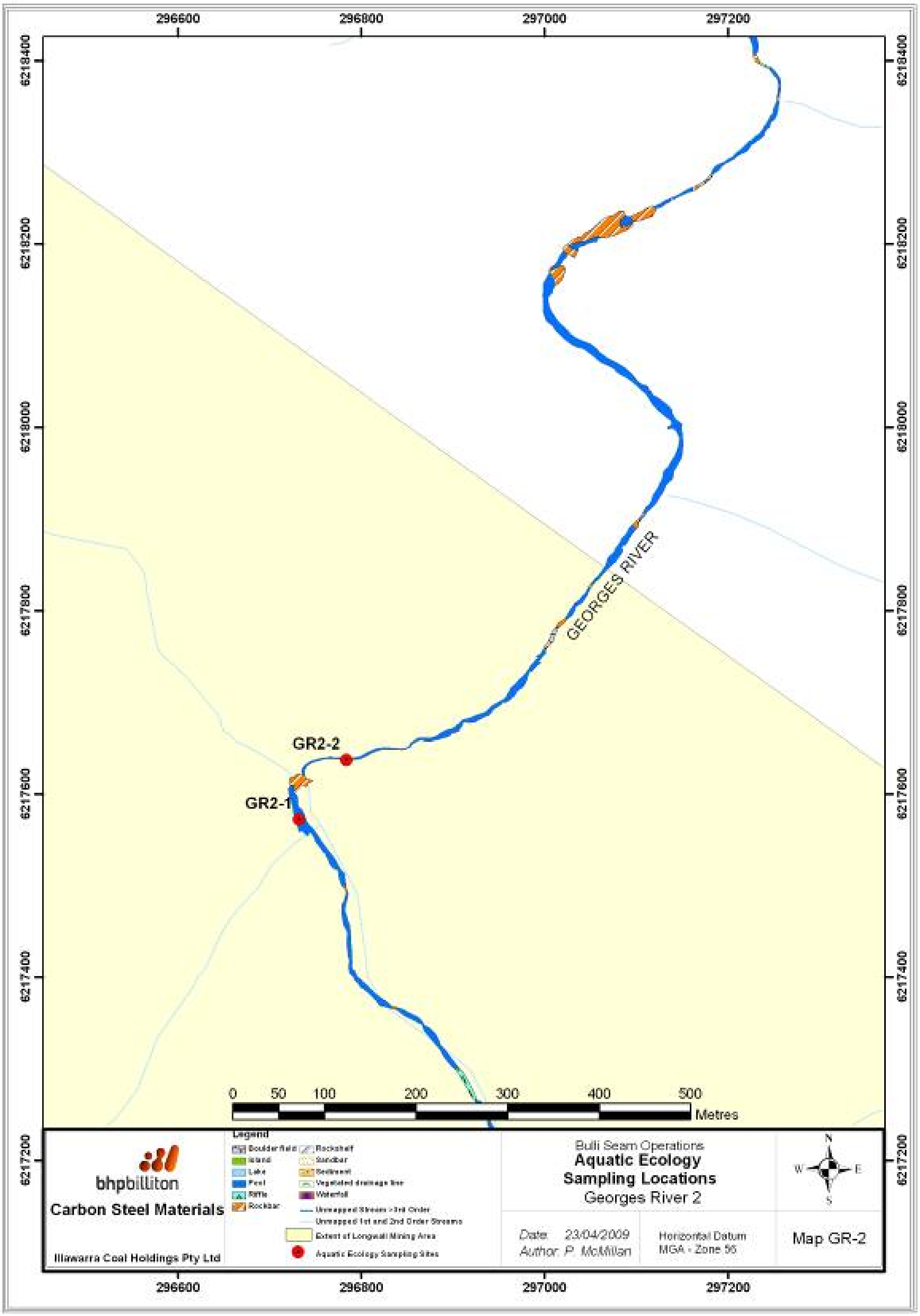
Very few species of native fish were recorded from this reach of the river, despite the presence of a number of habitats suitable for fish (e.g. snags, deep pools, over-hanging vegetation). One individual pupae of the dragonfly species, *Austrocordulia refracta* (Family, Austrocordulidae) was collected at the most upstream site sampled within location GR1 (GR1-1). This species (in its pupae form) is known to live under rocks where they sometimes co-exist with the threatened Sydney hawk dragonfly (*Austrocordulia leonardi*) (DPI – Fisheries, 2007) although no individuals of the Sydney hawk dragonfly were recorded by the Project surveys. At the time of the survey, visibility of the water was fair.

A section of approximately 4 km of the Georges River lies within the future proposed mining area in West Cliff Area 5 (Figure 2). Sampling location (GR2) was sampled on the river in this area in spring 2008 (Figure 6, Plates 33 and 34, Map 14). A number of small tributaries flow into this section of the river, which drain rural properties, urban development and native bushland. The river channel consisted of series of large pools separated by prominent rock bars. At sampling location GR2, pools ranged from 1 to 18 m wide to a depth of approximately 1 m. The substratum of the pools was predominantly soft-sediment (~ 95%) with some boulders. A large stand of *Typha domingensis*, which is tolerant of brackish water, grew in relatively shallow, sandy areas along the stream bank. Notably, mean electrical conductivity of water at this location was 1,572 (±2.7) µS/cm.

Plate 33: Georges River (GR2-1)

Plate 34: Georges River (GR2-2)

Other riparian vegetation at sampling location GR2 included *Fimbristylis* sp., *L. filiforme*, *S. melanostachys* and *T. laurina* (Attachments A and C). A few patches of *Isolepis inundata* were also present (Attachment A). Thirty individuals of *G. holbrooki* were collected at this location (Attachments B, E and F). Water visibility was relatively clear and free of sediment.



Map 14 – Georges River 2

O'Hares Creek

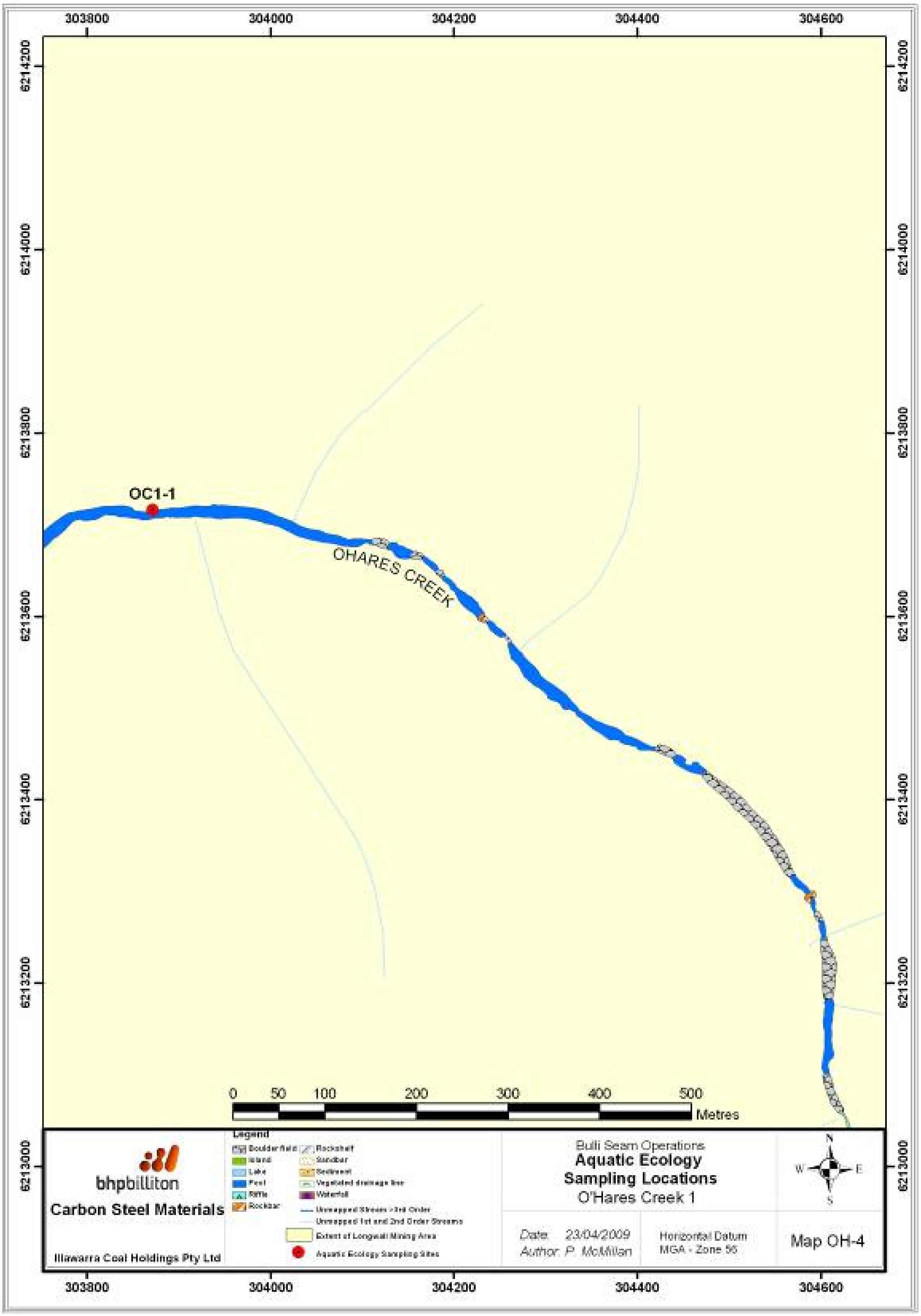
A reach of approximately 6.5 km of the upper and middle reaches of O'Hares Creek, a tributary of the Georges River, occurs within the North Cliff Area (Figure 5). This section of the stream (classified as a 4th order stream) is set in a sandstone gorge and natural rock bars and waterfalls are common along the watercourse. Two locations (four sites) were sampled on O'Hares Creek in autumn 2008 (Figure 6).

At the most upstream sampling location (OC1), the stream consisted of a series of relatively large (6 to 28 m wide), interconnected pools to a depth of approximately 0.75 m (Plates 35 and 36 and Maps 15a and 15b). The substratum was predominantly bedrock (approximately 80 %) with some boulders and deposits of sand in areas of low flow. The crossbedded sandstone substratum dips to the north approximately 20º. With the exception of where Fire Road 10C crosses O'Hares Creek, there was little evidence of disturbance. Dominant riparian vegetation included *Chorizandra cymbaria, Gleichenia dicarpa*, *Schoenus* sp. and *S. flabellatus* (Attachment A). Also present were scattered plants of *T. procerum* (Attachment A).

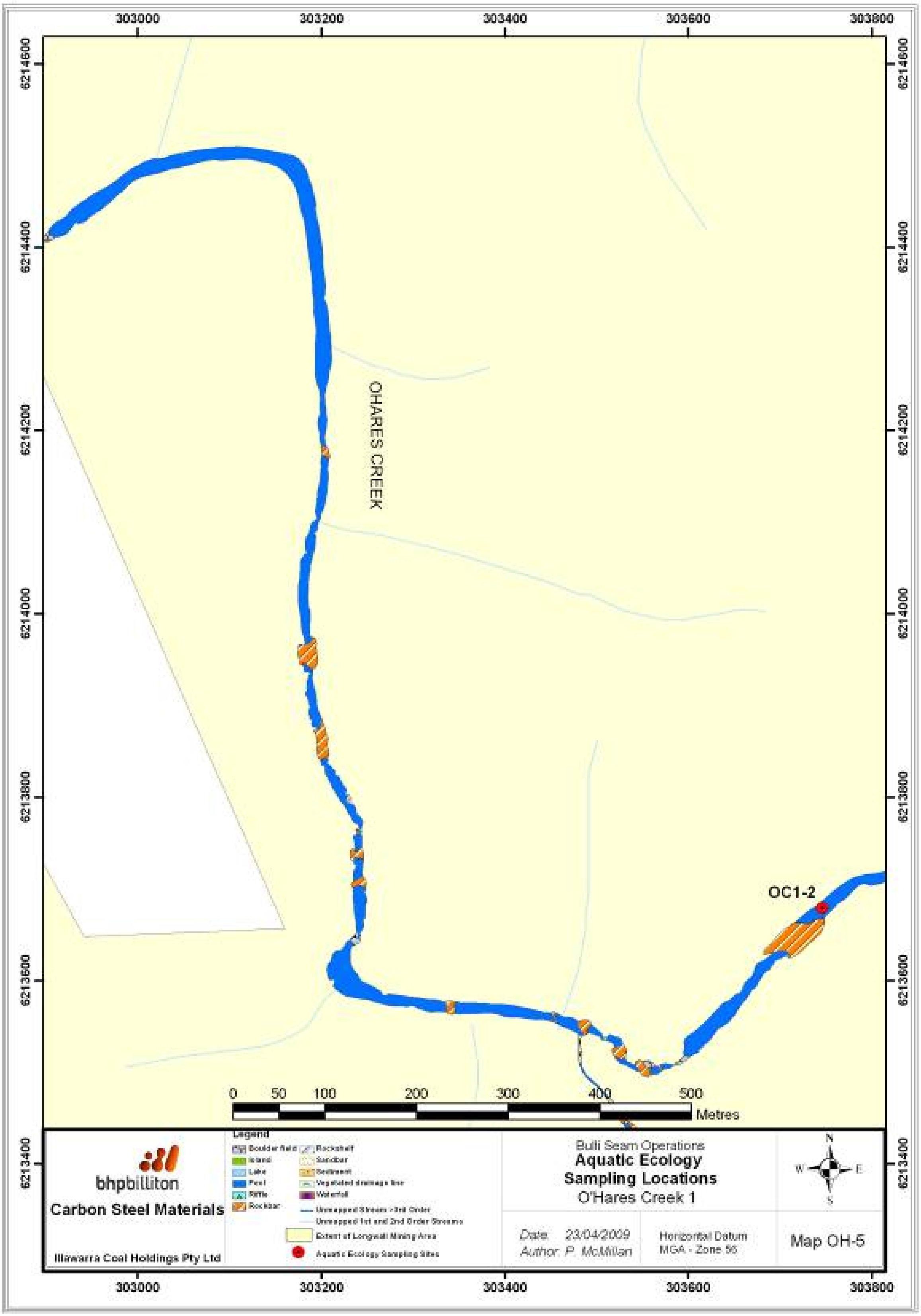
Plate 35: O'Hares Creek (OC1-1)

Plate 36: O'Hares Creek (OC1-2)

This section of the stream (at sampling location OC1) provided extensive and diverse habitat for fish. No individuals of *G. holbrooki* were recorded at this location (Attachments B, E and F). Stream water was relatively clear and free of sediment.



Map 15a – O'Hares Creek 1

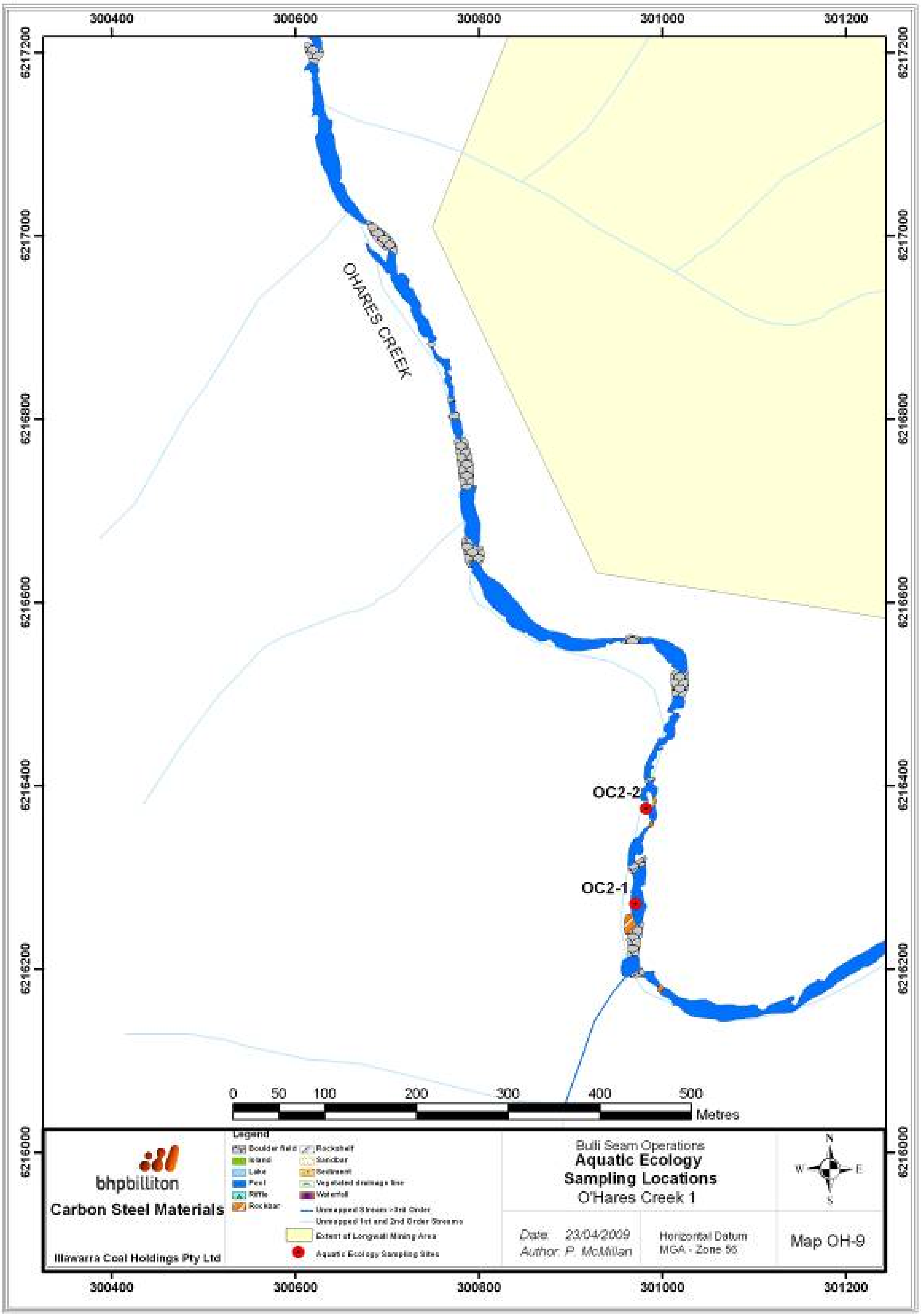


Map 15b – O'Hares Creek 1

Sampling location OC2 was sampled upstream of the weir (Plates 37 and 38 and Map 16). The width of the streambed was up to 35 m wide and the substratum was predominantly bedrock (~ 80%). There were several holes of varying size and depth throughout the rock shelves beside the stream channel. Dominant riparian vegetation included *C. cymbaria*, *Lepidosperma sp*. and *L. fluviatilis* (Attachment A). There was extensive and diverse habitat present for fish, including deep pools (up to approximately 2 m deep), snags, overhanging vegetation and in-stream vegetation. No individuals of *G. holbrooki* were recorded (Attachments B, E and F). Stream water was relatively clear and free of sediment.

Plate 37: O'Hares Creek (OC2-1)

Plate 38: O'Hares Creek (OC2-2)



Map 16 – O'Hares Creek 2

Brennans Creek

Brennans Creek is classified as a 3^{rd} order stream. The majority of Brennans Creek has been in-filled or highly modified by works associated with the approved coal wash emplacement (Section 2.1.3). Brennans Creek is dammed downstream of the existing coal wash emplacement to provide dilution of surface runoff for the approved coal wash emplacement and pit top and to also provide a reliable supply of water for use at the pit top (e.g. in the coal washing process).

Photographs of sampling location BC are provided in Plates 39 and 40. At the sampling location (BC), the stream consisted of a series of pools up to approximately 4 m wide and 1.5 m deep. The substratum was predominantly bedrock with some boulders and pockets of sand in areas of low flow. Noticeably, a large proportion of the substratum was covered in a thin (i.e. <0.5 cm) layer of coal fines and visibility of the water was poor. No fish, including *G. holbrooki*, were recorded at this location (Attachments B, E and F). Dominant riparian vegetation included *Juncus polyanthemus*, *Typha orientalis* and *Gahnia clarkei* and the weeds *C. dactylon* and *H. radicata* (Attachment A). The sampling locations are upstream of Brennans Creek Dam.

Plate 39: Brennans Creek (BC-1)

Plate 40: Brennans Creek (BC-2)

Dahlia Creek

Dahlia Creek is classified as a 3rd order stream and is located within the Dharawal State Conservation Area. The stream originates within an upland swamp and then flows through a steep sandstone gorge before joining with O'Hares Creek, approximately 5 km upstream of its confluence with Stokes Creek (Figure 5). Dahlia Creek is situated within the proposed future mining area. Photographs and stream mapping of sampling location DC are provided in Plates 41 and 42 and Map 17.

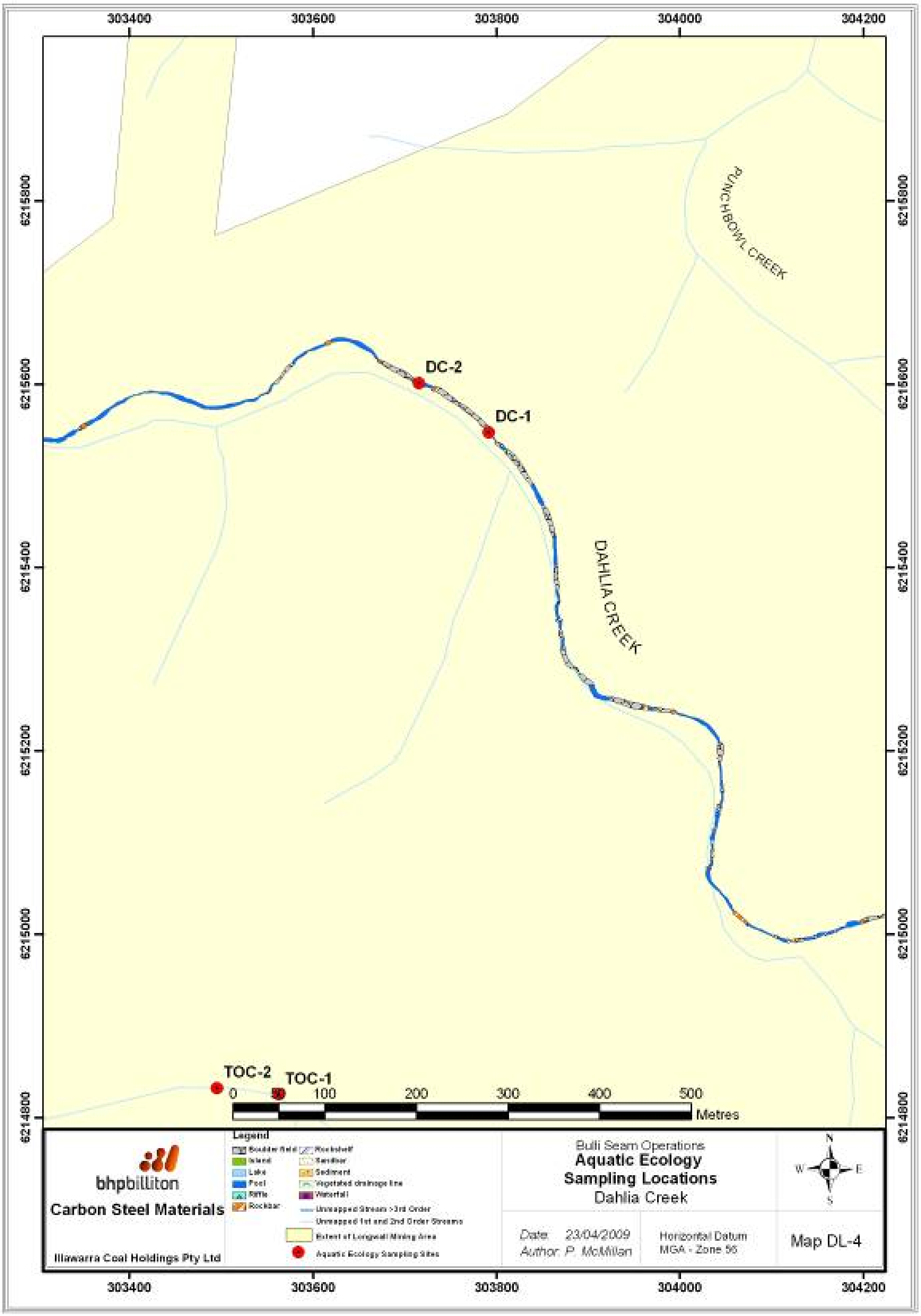
Plate 41: Dahlia Creek (DC-1)

Plate 42: Dahlia Creek (DC-2)

At the sampling location, the stream was a series of small (0.2 to 8 m wide), shallow (up to 0.75 m deep) pools interrupted by boulder chokes. The substratum was predominantly bedrock, boulders and deposits of sand in areas of low flow. The riparian vegetation was dominated by the fern, *S. flabellatus*, *Schoenus melanostachys* and Water gum (*T. laurina*) (Attachment A). No species of fish, including *G. holbrooki*, were collected at this location (Attachments B, E and F). Stream water was relatively clear and free of sediment.

Stokes Creek

Stokes Creek is predominately a 3rd order steam that flows in a northerly direction through the Dharawal State Conservation Area and then into O'Hares Creek near the township of Wedderburn. Approximately 2 km of the upper reaches of Stokes Creek, classified as a 2nd order stream, lie within the proposed future mining area (Figure 5).



Map 17 – Dahlia Creek

Two locations (4 sites) were sampled on Stokes Creek in autumn 2008 (Figure 6). Photographs of sampling locations SC1 and SC2 are provided in Plates 43 and 44. At the most upstream sampling location (SC1), the channel comprised pools (up to 6 m wide and 1 m deep) separated by rock bars (Plates 43 and 44 and Map 18). Cascades in the stream (up to 5 m) along this reach provide natural barriers to upstream migration of some species of fish. The substratum was predominantly bedrock at the most upstream site (SC1-1) but mostly sand at the downstream site (SC1-2). With the exception of a narrow walking track that crossed the stream near this location, there was little evidence of disturbance. Dominant riparian vegetation included *Baumea rubiginosa*, *Gahnia* sp., *Gleichenia dicarpa* and *L. fluviatilis* (Attachment A). No individuals of *G. holbrooki* were recorded at this location (Attachments B, E and F). Visibility of the water was fair and this was most likely related to the heavy rain that fell over the catchment in the days prior to sampling of this location.

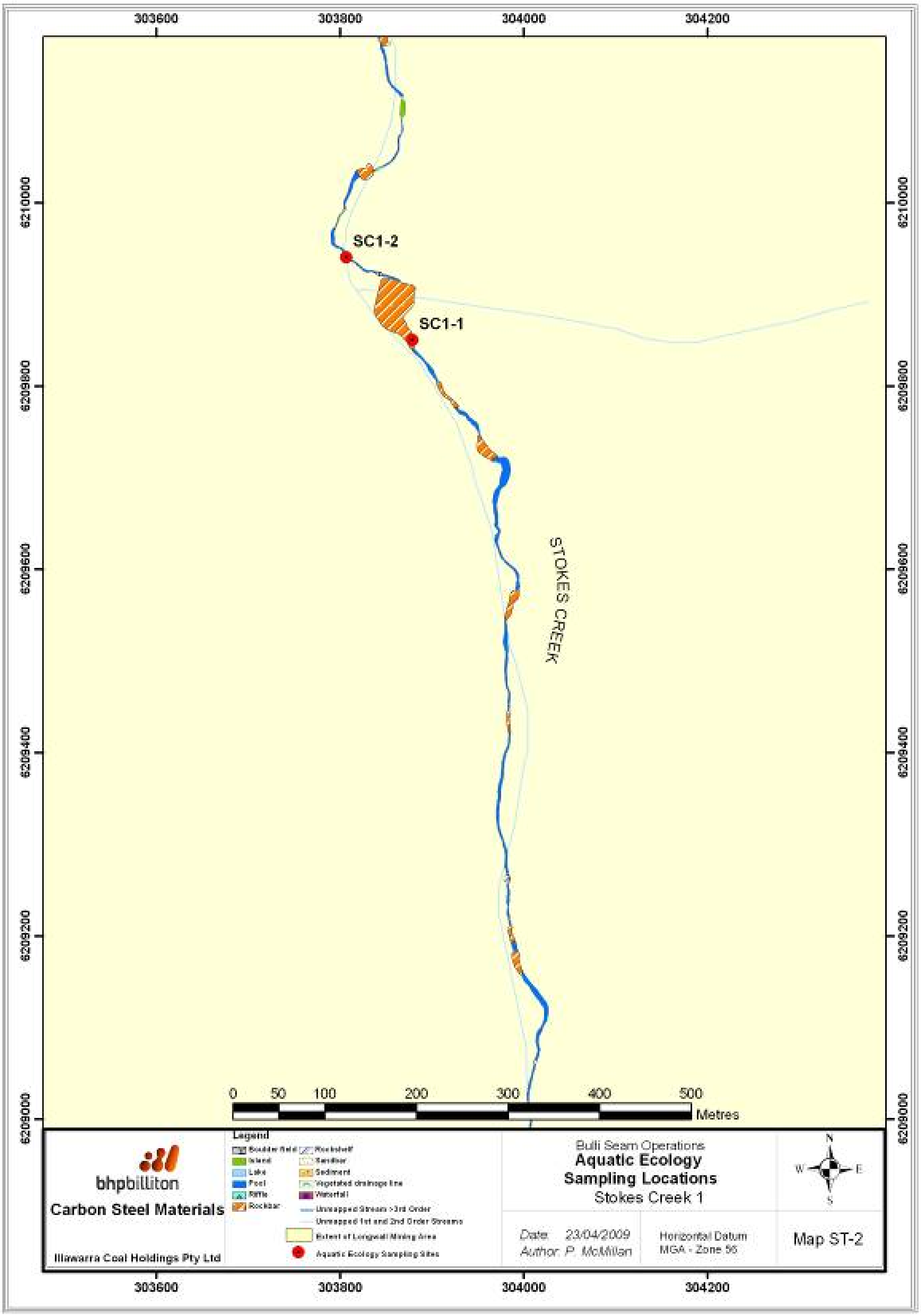
Plate 43: Stokes Creek (SC1-1)

Plate 44: Stokes Creek (SC1-2)

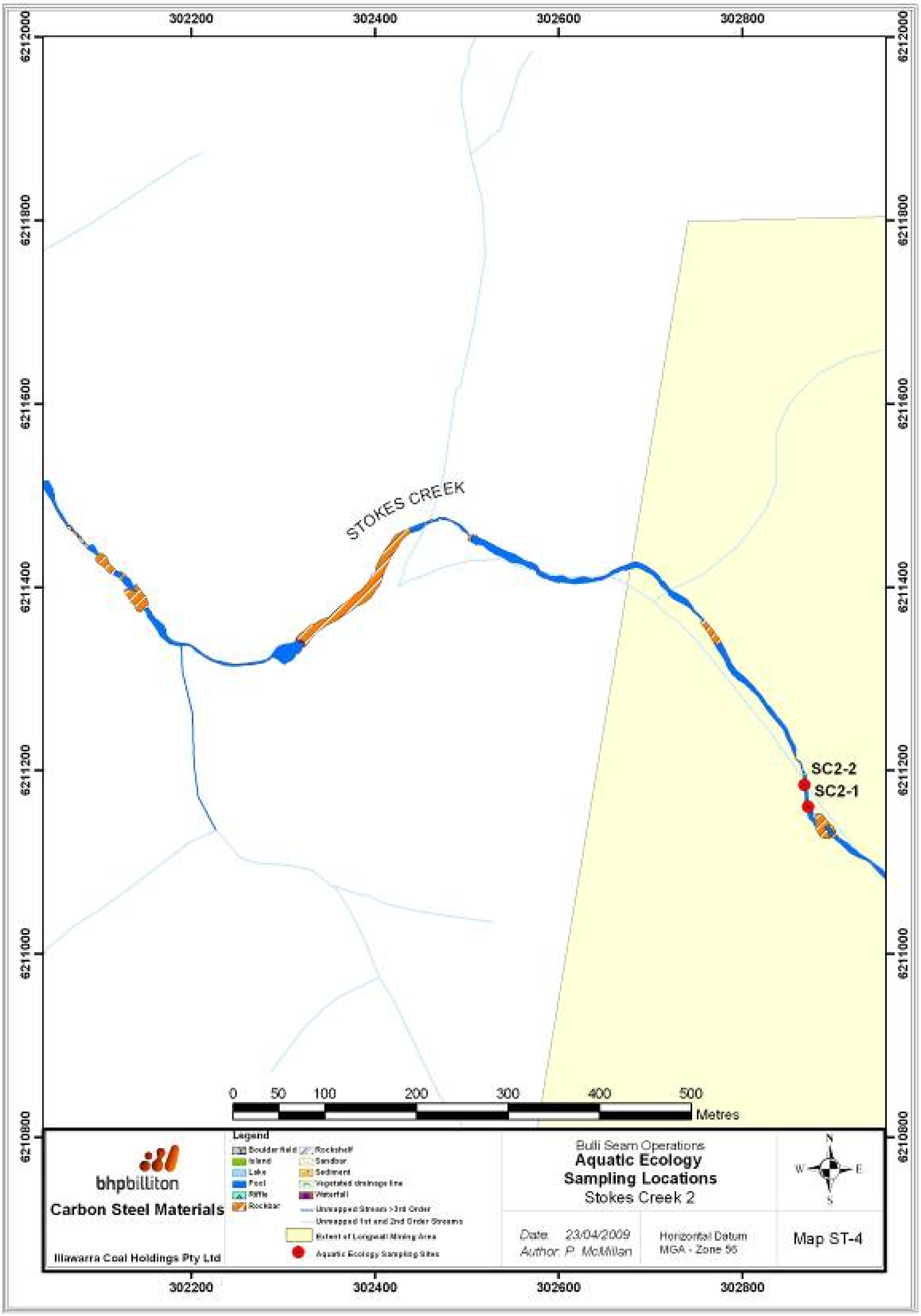
Sampling location SC2 was similar to the upstream location (SC1) (Plates 45 and 46 and Map 19). The stream was characterised by pools ranging between 0.5 to 10 m wide and up to approximately 1.5 m deep. The substratum was predominantly bedrock (approximately 80%). Riparian vegetation included sedges (*B. rubiginosa*, *C. cymbaria* and *Lepidosperma* sp., *Schoenus* sp.) ferns (*Gleichenia dicarpa*. and *Sticherus flabellatus*) and scattered patches of *L. fluviatilis* (Attachment A). No individuals of *G. holbrooki* were recorded at this location (Attachments B, E and F). Visibility of the water was fair.

Plate 45: Stokes Creek (SC2-1)

Plate 46: Stokes Creek (SC2-2)



Map 18 – Stokes Creek 1



Map 19 – Stokes Creek 2

Brennans Creek Tributary

The sampling location on the tributary of Brennans Creek within the proposed West Cliff Stage 4 Coal Wash Emplacement (BCT) was characterised by small semi-permanent pools up to 2 m wide and approximately 25 cm deep (Plates 47 and 48). The substratum of the study reach was dominated by soft sand with some areas of bedrock and boulders. There was evidence of coal fines deposited on the bottom of the stream channel, presumably from the coal stockpile located at the headwater of this tributary. No fish, including *G. holbrooki*, were recorded at this location (Attachments B, E and F). Dominant riparian vegetation included *L. filiforme*, *L. longifolia* and *Gahnia clarkei* (Attachment A). Water visibility was fair.


Plate 47: Brennans Creek Tributary (BCT-1)


Plate 48: Brennans Creek Tributary (BCT-2)

Tributary of O'Hares Creek

At sampling location TOC, the channel was characterised by small (up to 10 m wide) pools up to 1.5 m deep that would be isolated during periods when there was little rainfall in the catchment (Plates 49 and 50). The banks of the pools were mostly sandy with some boulders and the substratum was bedrock with pockets of sand deposited in areas of low flow. Riparian vegetation included *S. melanostachys*, *Lomandra fluviatilis* and *S. flabellatus* (Attachment A). One individual of *G. holbrooki* was recorded at this location (Attachments B, E and F). Visibility of the water was clear.


Plate 49: Tributary of O'Hares Creek (TOC-1)


Plate 50: Tributary of O'Hares Creek (TOC-2)

4.3 Water Quality

A number of water quality variables were measured at each sampling site prior to undertaking the biological sampling. Three replicate measurements of physico-chemical water quality were determined using a YEOKAL 611 submersible data logger. Variables included conductivity (µS/cm), DO (milligrams per litre [mg/L] and/or percentage saturation [%S]), pH (pH units), temperature (degrees Celsius [ºC]), oxygen-reduction potential (milliVolts [mV]) and turbidity (Neophelometric Turbidity Units [NTU]). Alkalinity was determined in the field using a CHEMetrics' total alkalinity field kit. Any results for alkalinity that were recorded less than the detection limit (i.e.10 mg/L) were assigned a concentration value of half the detection limit except in instances of zero alkalinity.

4.4 Assemblages of Macrophytes

The distribution of in-stream macrophytes (i.e. submerged and emergent aquatic plants) and riparian plants (i.e. emergent macrophytes and other plants found in the riparian zone) was also estimated along each sampling location by assigning a cover class to each species. The cover classes were: (1) one plant or small patch (i.e. few), (2) not common, growing in a few places (i.e. scattered), and (3) widespread (i.e. common). Cover class information was used to help provide a qualitative assessment of the structure of assemblages of macrophytes found at each location (see Section 5.2).

Within each site, an assessment of the in-stream aquatic vegetation was undertaken by estimating the relative abundance (i.e. percentage cover) of aquatic macrophytes within five randomly placed 0.25m^2 quadrats, using a stratified sampling technique. This information provided a quantitative measure of in-stream macrophytes within each site at each location (see Section 5.2).

4.5 Assemblages of Macroinvertebrates

Two methods were used to sample the distribution of aquatic macroinvertebrates at each site, *viz.* the AUSRIVAS protocol and quantitative sampling.

AUSRIVAS Protocol

To sample assemblages of macroinvertebrates in accordance with the Rapid Assessment Method (RAM), which is based on the AUSRIVAS protocol (Turak *et al.*, 2004), samples of stream edge habitats were collected using a 250 micrometre (µm) dip net. Edge habitat was defined as areas along stream banks with little or no flow, including alcoves and backwaters, with abundant leaf litter, fine sediment deposits, beds of macrophytes, overhanging banks and areas with trailing vegetation (Turak *et al.*, 2004).

At each site (approximately 100 m long), samples were collected over a total length of 10 m, usually in 1-2 m sections, ensuring all significant edge sub-habitats within a site were included in the sample (Turak *et al.*, 2004). The contents of each net sample were placed into a white sorting tray and animals were collected for a minimum period of 30 minutes. Thereafter, removals were done in 10 minute periods, up to a total of one hour (Turak *et al.*, 2004). If no new taxa were found within a 10 minute period, removals would cease (Turak *et al.*, 2004). The animals were placed inside a labelled container, preserved with 70% alcohol and taken to the laboratory.

In the laboratory, samples were identified using an ISSCO M400 stereomicroscope. Taxa were identified to family level with the exception of Acarina (to order), Chironomidae (to sub-family), Nematoda (to phylum), Nemertea (to phylum), Oligochaeta (to class), Ostracoda (to subclass) and Polychaeta (to class). Some families of Anisoptera (dragonfly larvae) were identified to species, as they could potentially include threatened aquatic species. The following taxonomic guides were used: Lawrence (1992), Cranston (1995), Dean *et al*. (1995), Horwitz *et al*. (1995), Dean and Suter (1996), Hawking and Smith (1997), Hawking and Theischinger (1999) and Lansbury and Lake (2002).

Quantitative Sampling

Within each site, three replicate samples of macroinvertebrates were collected in 1 minute sweeps of all habitats (edge, macrophytes, riffle, pools, beneath rocks, etc.) over a total length of 2 to 3 m, using a 250 µm dip net. The dip net was first used to disturb animals by agitating bottom sediments and rocks to suspend invertebrates into the water column. The net was then used to sweep through suspended material to collect invertebrates, including surface dwellers. For each replicate sample, the contents of the net were placed into white plastic trays filled with fresh water and then placed into pre-labelled plastic sample containers filled with 70% alcohol. In the laboratory, animals were identified to family level using an ISSCO M400 stereomicroscope, with the exception of some families of Anisoptera, which were identified to species level, because they could potentially include the threatened dragonfly species Adams emerald dragonfly (*Archaeophya adamsi*) and Sydney hawk dragonfly (*Austrocordulia leonardi*). The following taxonomic guides were used: Lawrence (1992), Cranston (1995), Dean *et al*. (1995), Horwitz *et al*. (1995), Dean and Suter (1996), Hawking and Smith (1997), Hawking and Theischinger (1999) and Lansbury and Lake (2002).

4.6 Assemblages of Fish

Within each site, three replicate samples of the assemblages of fish were collected using a Smith-Root 15C Electrofisher backpack unit. The Electrofisher was used to stun the fish in shallow water habitats (e.g. pools, submerged snags, soft substrata, macrophytes and under overhanging banks and vegetation). Three minutes of electrofishing effort per replicate was used. All stunned fish were collected using a dip net and placed into plastic trays filled with water.

In addition, bait traps (250 mm wide with an entrance that tapered to 60 mm wide, 450 mm long and 4 mm mesh size through-out) were used to sample assemblages of fish at locations where the electrofisher could not be operated safely and/or effectively (i.e. Nepean River Locations 1 and 2, Cataract River Location 2 and Georges River Location 1). Traps were baited with a mixture of bran and bread soaked in tuna oil, chicken pellets and strips of mullet and left in place for approximately 1.5 hours. All fish caught were placed into plastic trays filled with water.

Fish were identified and counted in the trays and then released back into the water once sampling at a site was completed. All collections of fish were undertaken in accordance with section 37 of the NSW *Fisheries Management Act, 1994* (FM Act) using the current Scientific Collection Permit Number P03/0032, and NSW Agriculture, Animal Research Authority Care and Ethics Certificate of Approval Number 03/2445.

4.7 Threatened Species

Searches of literature and various databases including those provided by the Atlas of NSW Wildlife, Department of the Environment, Water, Heritage and the Arts, DPI-Fisheries and the NSW Government BioNet system were carried out for threatened aquatic species, populations, ecological communities or their habitats that have the potential to occur in the study area. Data collected from previous field surveys were also used as part of this assessment. This review was undertaken prior to the field surveys to ensure that appropriate field methods were selected to target threatened aquatic biota that could potentially use the study area.

4.8 Data Analyses

Univariate and multivariate statistical procedures were used to examine spatial patterns in macroinvertebrates within the Project area, using a nested sampling design (i.e. sites nested in locations). Given that some locations were sampled in Autumn and some in Spring, the potential influence of temporal factors (e.g. season) must be taken into consideration when interpreting observed patterns between locations. Temporal variation within locations is not required for the EA and was not investigated during this study.

The univariate data were analysed using the General Linear Model Analysis of Variance (GMAV) analysis of variance (ANOVA) statistical package. ANOVA was used to determine spatial differences in the richness and abundance of macroinvertebrates. Student Newman Kuels (SNK) tests were used to determine where differences were found in the ANOVA (Underwood, 1981). Prior to ANOVA, the data sets were examined for homogeneity of variances using Cochran's test (Winer *et al*., 1991) and if necessary, transformations were carried out to stabilise the variances (Underwood, 1981).

Multivariate statistical techniques were used to examine patterns in assemblages of benthic fauna using the PRIMER software package (Plymouth Marine Laboratories, UK). Multivariate methods such as PRIMER allow comparisons of two (or more) samples based on the degree to which these samples share particular characteristics (e.g. taxa) (Clarke, 1993). A non-metric multidimensional scaling (nMDS) ordination is used to graphically illustrate relationships between samples. The significance of any apparent differences among the spatial scales examined (i.e. locations and sites) was determined using analysis of similarities (ANOSIM) (Clark, 1993). The similarity of percentages (SIMPER) procedure was used to examine the contribution of taxa to patterns of similarity between locations (Clarke and Warwick, 1994). SIMPER identifies which taxa are good discriminators between the scales of interest. Taxa were listed in decreasing order of importance, up to where 90% of the average similarity is accounted for (Clarke and Warwick, 1994).

Data collected using the AUSRIVAS sampling protocol was analysed using the NSW/Spring/Edge model (see Turak *et al.*, 2004). This predictive model was developed from sampling edge habitat at a number of sites across NSW, which had been determined to be unaffected by human disturbances, between 1994 and 1999 (Turak *et al.*, 2004). Physical and chemical data (see Ransom *et al*., 2004) are used by the model to determine the predicted (i.e. Expected) composition of macroinvertebrate fauna if the site is undisturbed (Turak *et al*., 2004). Thus, an AUSRIVAS assessment represents a comparison of the macroinvertebrates collected at a site (i.e. Observed) to those predicted to occur (i.e. Expected) if the site is in an undisturbed or 'reference' condition. The principal outputs of the AUSRIVAS model included:

- Observed to Expected ratio (OE50): the ratio of the number of macroinvertebrate families collected at a site which had a predicted probability of occurrence of greater than 50% (i.e. Observed) to the sum of the probabilities of all of the families predicted with greater than a 50% chance of occurrence (i.e. Expected) (Ransom *et al*., 2004).
- BAND: for each model, the OE50 taxa ratios are divided into bands representing different levels of impairment. Band X represents a more diverse assemblage of macroinvertebrates than reference sites; Band A is considered equivalent to reference condition; Band B represents sites below reference condition (i.e. significantly impaired); Band C represents sites well below reference condition (i.e. severely impaired); and Band D represents impoverished sites (i.e. extremely impaired) (Ransom *et al*., 2004).

5.0 RESULTS

5.1 Water Quality

Autumn 2008

Raw water quality data are provided in Attachment D. In autumn 2008, mean water temperature at each location ranged from 10.7 to 22.9°C (Tables 4 and 5), which is typical for that time of year. Mean pH at some sites was lower than the recommended ANZECC and ARMCANZ (2000) guideline (i.e. pH 6.5 – 8.0) for the protection of aquatic ecosystems in upland rivers, including sites sampled at Foot Onslow Creek (FC-1 and FC-2), Rocky Ponds Creek (RPC-1 and RPC-2), Simpsons Creek (SIMP-1 and SIMP-2), Brennans Creek Tributary (BCT-2), Stokes Creek Location 1 (SC1-1 and SC1-2), Stokes Creek Location 2 (SC2-1 and SC2-2) and Cascade Creek Location 1 (CC1-2) (Tables 4 and 5). Notably, locations sampled on Clements Creek (ClC) recorded mean conductivity levels of > 2,200 µS/cm (Table 4) and Brennans Creek (BC), Racecourse Creek (RC) and Brennan's Creek Tributary recorded mean conductivity levels of > 350 µS/cm (Table 5), while conductivity at Cataract River Location 2 (CR2-1 and CR2-2) was lower than the recommended ANZECC and ARMCANZ (2000) guidelines (Table 4). With the exception of sites sampled in Foot Onslow Creek (FC-1), Rocky Ponds Creek (RPC-1), Cascade Creek Locations 1 and 2 (CC1-2, CC2-1 and CC2-2), Georges River Location 1 (GR1-1 and GR1-2), Brennans Creek Location 1 (BC-1), O'Hares Creek Location 2 (OC2-1 and OC2-2), Brennans Creek Tributary (BCT-1 and BCT-2) and Clements Creek (ClC-1 and ClC-2), concentrations of DO were within the guideline trigger values (ANZECC and ARMCANZ, 2000) (Tables 4 and 5). Generally, turbidity levels were within the guideline values except at Nepean River Location 2 (NP2-1 and NP2-2), Nepean River Location 3 (NP3-1), Rocky Ponds Creek (RPC-1), Simpsons Creek (SIMP-1), Cataract River Location 2 (CR2-1 and CR2-2), Racecourse Creek (RC-1 and RC-2), Georges River Location 1 (GR1-1), Brennans Creek (BC-1 and BC-2), Brennans Creek Tributary (BCT-1) and Stokes Creek Location 1 (SC1-2) (Tables 4 and 5). Particularly high levels of turbidity in Racecourse Creek may be related to access to the stream by cattle in the vicinity of the sampling location (see Section 4.2). The mean oxidation reduction potential (ORP) of the sites sampled in autumn 2008 ranged from 307 to 660 mV in autumn 2008 while alkalinity ranged from 0 to 18 mg/L calcium carbonate ($CaCO_3$), with the exception of Clements Creek (i.e. 180 mg/L $CaCO_3$) (Tables 4 and 5).

Spring 2008

For the sites sampled in spring 2008, mean water temperature ranged from 17.4 to 25.1°C (Table 6). Comparisons with ANZECC AND ARMCANZ (2000) guidelines showed pH to be outside the guideline values at Carriage Creek (CaC-2), Wallandoola Creek (Location 2), Cataract Reservoir Tributary 2, Tributary of Cataract Reservoir Tributary 2, Dahlia Creek (DC-1) and Tributary of O'Hares Creek (Table 6). Mean conductivity was within the recommended guideline values at all sites sampled with the exception of Georges River (Location 2) (Table 6). Mean DO levels were outside ANZECC AND ARMCANZ (2000) guidelines at all locations except Carriage Creek (CaC1) and Wallandoola Creek (Location 2) (Table 6). Turbidity values were at the lower end of the range at sites sampled in Wallandoola Creek (WC2-2), Cataract Reservoir Tributary 2 (CRT2-1 and CRT2-2) and Dahlia Creek (DC-2) and higher than the range at Tributary of Cataract Reservoir Tributary 2 (Table 6). This was most likely related to low flows through their well vegetated catchments at the time of the survey. Mean ORP ranged from 191 to 374 mV while alkalinity ranged from 0 – 12 mg/L CaCO3 at the sites sampled in spring 2008 (Table 6).

Table 4. Mean (± SE) Measurements of Water Quality Variables Recorded at each Site within Each Location Sampled in Autumn 2008

Location	**Nepean River – Location 1**		**Nepean River – Location 2**		**Nepean River – Location 3**		**Clements Creek**	
Site	**NP1-1**	**NP1-2**	**NP2-1**	**NP2-2**	**NP3-1**	**NP3-2**	**ClC-1**	**ClC-2**
Temperature (°C) (*n* =3)	13.5 (0.06)	13.4 (0.01)	12.3 (0.01)	12.1 (0.00)	14.5 (0.00)	14.4 (0.00)	12.3 (0.05)	12.3 (0.02)
pH (*n* =3)	7.5 (0.02)	7.4 (0.00)	7.2 (0.00)	7.3 (0.00)	7.0 (0.00)	7.0 (0.00)	7.8 (0.00)	7.7 (0.01)
Conductivity (µS/cm) (*n* =3)	344 (0.33)	345 (0.33)	324 (0.00)	320 (0.00)	368 (1.67)	366 (0.00)	**4695** (2.73)	**4620** (4.48)
DO (% Saturation) (*n* =3)	109 (1.6)	108(0.20)	102 (0.03)	94 (0.06)	89 (0.07)	86 (0.03)	**129** (0.32)	**130** (1.03)
Turbidity (NTU) (*n* =3)	10.8 (1.14)	14.3 (9.55)	**2.3** (0.07)	**2.3** (0.07)	**2.5** (0.33)	7.2 (0.07)	17.8 (1.01)	34.5 (24.17)
ORP (mV) (*n* = 3)	583 (0.9)	585(0.33)	644 (0.00)	643 (0.00)	649 (0.00)	644 (0.00)	583 (0.58)	604 (0.00)
Alkalinity (mg/L $CaCO_3$) (*n* = 2)	14	13	18	16	15	14	180	180
Location	**Foot Onslow Creek**		**Rocky Ponds Creek**		**Simpsons Creek**		**Cataract River – Location 2**	
Site	**FC-1**	**FC-2**	**RPC-1**	**RPC-2**	**SIMP-1**	**SIMP-2**	**CR2-1**	**CR2-2**
Temperature (°C) (*n* =3)	17.7 (0.14)	21.3 (0.01)	14.4 (0.0)	16.4 (0.03)	18.1 (0.01)	17.4 (0.29)	15.4 (0.00)	15.2 (0.00)
pH (*n* =3)	**6.1** (0.02)	**6.1** (0.01)	**5.5** (0.00)	**6.0** (0.0)	**6.0** (0.0)	**6.2** (0.03)	6.8 (0.01)	7.0 (0.03)
Conductivity (µS/cm) (*n* =3)	188 (0.67)	192 (0.0)	154 (1.67)	150 (0.0)	182 (0.0)	191 (0.33)	**80** (0.00)	**78** (1.67)
DO (% Saturation) (*n* =3)	**71** (1.76)	100 (1.74)	**61** (0.03)	91 (0.26)	90 (0.0)	94 (1.02)	104 (0.24)	104 (0.99)
Turbidity (NTU) (*n* =3)	25.9 (1.68)	8.0 (0.38)	**1.8** (0.41)	13.6 (0.41)	**2.6** (0.1)	28.8 (4.35)	**2.7** (0.00)	**2.8** (0.50)
ORP (mV) (*n* = 3)	539 (1.5)	543 (0.33)	504 (0.33)	439 (0.0)	435(0.33)	490 (0.58)	624 (0.00)	548 (0.88)
Alkalinity (mg/L $CaCO_3$) (*n* = 2)	13	13	16	16	11	13	0	0

Note:

1. Guideline values recommended by the ANZECC and ARMCANZ (2000) guidelines for lowland rivers: pH (6.5 – 8.5); Conductivity (125 – 2200 µS/cm); DO (85-110% Saturation); Turbidity (6 – 50 NTU). There are no ANZECC and ARMCANZ (2000) guideline values for Temperature, ORP or Alkalinity. N/R = not recorded.
2. Values in bold are outside the guideline values recommended by ANZECC and ARMCANZ (2000) for Lowland Rivers (i.e. defined as those systems at <150 m altitude).

Table 5. Mean (± SE) Measurements of Water Quality Variables Recorded at Each Site within Each Location Sampled in Autumn 2008

Location	**Racecourse Creek**		**Cascade Creek – Location 1**		**Cascade Creek – Location 2**		**Wallandoola – Location 1**	
Site	**RC-1**	**RC-2**	**CC1-1**	**CC1-2**	**CC2-1**	**CC2-2**	**WC1-1**	**WC1-2**
Temperature (°C) (*n* =3)	12.0(0.02)	12.5 (0.03)	22.9 (0.03)	21.5 (0.0)	11.6 (0.03)	10.7 (0.00)	16.7 (0.0)	16.4 (0.0)
pH (*n* =3)	7.2 (0.00)	7.2 (0.01)	6.6 (0.1)	**6.4** (0.0)	6.6 (0.03)	6.8 (0.01)	6.7 (0.01)	6.6 (0.0)
Conductivity (µS/cm) (*n* =3)	**1686** (2.73)	**1675** (1.33)	203 (0.0)	200 (0.0)	231 (0.00)	241 (0.00)	73 (0.0)	73 (0.0)
DO (% Saturation) (*n* =3)	95 (1.35)	90 (1.42)	92 (2.58)	**88** (0.03)	**51**(1.26)	**65** (0.20)	103 (0.06)	98 (0.15)
Turbidity (NTU) (*n* =3)	**77.8** (24.01)	**227.9** (89.68)	2.1 (0.59)	2.1 (0.07)	13.3 (9.26)	5.4 (0.73)	4.7 (0.38)	2.5 (0.10)
ORP (mV) (*n* = 3)	650 (0.58)	647(1.20)	625(0.88)	622 (0.0)	576 (6.35)	552 (0.33)	649 (0.33)	660 (0.33)
Alkalinity (mg/L $CaCO_3$) (*n* = 2)	12	12	5	5	0	5	0	0
Location	**Lizard Creek**		**Cataract River – Location 1**		**Georges River - Location 1**		**Brennans Creek - Location 1**	
Site	**LC-1**	**LC-2**	**CR1-1**	**CR1-2**	**GR1-1**	**GR1-2**	**BC-1**	**BC-2**
Temperature (°C) (*n* =3)	15.2 (0.0)	15.4 (0.0)	16.4 (0.00)	16.7 (0.00)	12.1 (0.03)	11.7 (0.01)	18.6 (0.00)	18.4 (0.00)
pH (*n* =3)	7.0 (0.03)	6.8 (0.01)	6.6 (0.00)	6.7 (0.01)	6.6 (0.02)	6.8 (0.00)	7.8 (0.00)	7.8 (0.00)
Conductivity (µS/cm) (*n* = 3)	78 (1.67)	80 (0.0)	73 (0.00)	73 (0.00)	142 (0.00)	138 (0.00)	**2856** (66.9)	**3047** (1.3)
DO (% Saturation) (*n* = 3)	104 (0.99)	104 (0.24)	98(0.15)	103 (0.06)	**83** (0.18)	**78** (0.07)	**89** (0.33)	90 (0.03)
Turbidity (NTU) (*n* = 3)	2.8 (0.5)	2.7 (0.0)	2.5 (0.10)	4.7 (0.38)	**34.8** (7.77)	23.1 (0.27)	**28.2** (0.32)	**45.1** (0.33)
ORP (mV) (*n* = 3)	548 (0.88)	624 (0.0)	660 (0.33)	649 (0.33)	437 (0.33)	451 (0.00)	447 (0.00)	463 (0.33)
Alkalinity (mg/L $CaCO_3$) (*n* = 2)	5	5	0	0	5	5	12	12

Note:

1. Guideline values recommended by the ANZECC and ARMCANZ (2000) guidelines for upland rivers: pH (6.5 – 8.0); Conductivity (30 – 350 µS/cm); DO (90–110 % Saturation); Turbidity (2 – 25 NTU). There are no ANZECC and ARMCANZ (2000) guideline values for Temperature, ORP or Alkalinity. N/R = not recorded.
2. Values in bold are outside the guideline values recommended by ANZECC and ARMCANZ (2000) for Upland Rivers (i.e. defined as those systems at >150 m altitude).

Table 5 (Continued). Mean (± SE) Measurements of Water Quality Variables Recorded at Each Site within Each Location Sampled in Autumn 2008

Location	**Brennans Creek Tributary**		**O'Hares Creek - Location 1**		**O'Hares Creek - Location 2**		**Stokes Creek - Location 1**	
Site	**BCT-1**	**BCT-2**	**OC1-1**	**OC1-2**	**OC2-1**	**OC2-2**	**SC1-1**	**SC1-2**
Temperature (°C) (*n* =3)	11.8 (0.01)	14.4 (0.03)	15.7 (0.01)	15.7 (0.00)	16.3 (0.01)	16.4 (0.01)	14.1 (0.00)	14.2 (0.00)
pH (*n* =3)	7.1 (0.00)	**6.3** (0.00)	6.6 (0.01)	6.5 (0.01)	6.6 (0.00)	6.6 (0.00)	**6.3** (0.00)	**6.3** (0.01)
Conductivity (µS/cm) (*n* =3)	**506** (0.33)	**358** (1.53)	74 (0.00)	74 (0.00)	73 (0.00)	70 (1.33)	82 (0.00)	80 (1.67)
DO (% Saturation) (*n* =3)	**54** (0.29)	**18** (0.18)	109 (0.92)	103 (0.32)	**111** (0.24)	**111** (0.67)	95 (0.07)	107 (0.18)
Turbidity (NTU) (*n* =3)	**55.5** (0.59)	3.2 (0.10)	11.0 (0.41)	7.5 (1.29)	17.4 (0.17)	6.1 (0.07)	20.2 (0.47)	**35.0** (1.91)
ORP (mV) (*n* = 3)	371 (0.33)	307 (1.20)	606 (2.33)	599 (6.56)	603 (0.00)	625 (0.58)	483 (0.58)	481 (0.88)
Alkalinity (mg/L $CaCO_3$) (*n* = 2)	0	13	0	0	5	5	0	0
Location	**Stokes Creek - Location 2**							
Site	**SC2-1**	**SC2-2**						
Temperature (°C) (*n* =3)	15.0 (0.00)	15.0 (0.00)						
pH (*n* =3)	**6.4** (0.02)	**6.4** (0.00)						
Conductivity (µS/cm) (*n* =3)	82 (1.67)	80 (0.00)						
DO (% Saturation) (*n* =3)	106 (0.71)	110 (0.35)						
Turbidity (NTU) (*n* =3)	18.6 (0.63)	19.3 (0.32)						
ORP (mV) (*n* = 3)	520 (0.67)	529 (1.73)						
Alkalinity (mg/L $CaCO_3$) (*n* = 2)	0	0						

Note:

1. Guideline values recommended by the ANZECC and ARMCANZ (2000) guidelines for upland rivers: pH (6.5 – 8.0); Conductivity (30 – 350 µS/cm); DO (90–110 % Saturation); Turbidity (2 – 25 NTU). There are no ANZECC and ARMCANZ (2000) guideline values for Temperature, ORP or Alkalinity. N/R = not recorded.
2. Values in bold are outside the guideline values recommended by ANZECC and ARMCANZ (2000) for Upland Rivers (i.e. defined as those systems at >150 m altitude).

Table 6. Mean (± SE) Measurements of Water Quality Variables Recorded at Each Site within Each Location Sampled in Spring 2008

Location	**Carriage Creek**		**Wallandoola Creek – Location 2**		**Cataract Reservoir Tributary 2**		**Tributary of Cataract Reservoir Tributary 2**	
Site	**CaC-1**	**CaC-2**	**WC2-1**	**WC2-2**	**CRT2-1**	**CRT2-2**	**TCRT-1**	**TCRT-2**
Temperature (°C) (*n* =3)	25.1 (0.00)	24.2 (0.02)	21.9 (0.03)	21.2 (0.00)	23.2 (0.02)	22.8 (0.01)	18.4 (0.00)	19.0 (0.05)
pH (*n* =3)	6.5 (0.00)	**6.2** (0.00)	**6.3** (0.05)	**5.8** (0.00)	**5.4** (0.05)	**5.6** (0.04)	**5.3** (0.01)	**4.9** (0.03)
Conductivity (µS/cm) (*n* = 3)	1032 (0.00)	1042 (0.33)	168 (0.00)	166 (0.00)	123 (1.33)	123 (0.00)	172 (0.00)	178 (0.33)
DO (% Saturation) (*n* = 3)	105 (0.07)	**115** (0.20)	97(0.55)	86 (0.12)	**67** (1.37)	**74** (0.46)	**59** (0.12)	**49** (3.12)
Turbidity (NTU) (*n* = 3)	15.0 (0.85)	11.9 (0.60)	14.7 (0.20)	< **2** (0.0)	< **2** (0.0)	<**2** (0.))	**41.9** (0.59)	**33.3** (0.41)
ORP (mV) (*n* = 3)	307 (0.00)	352 (0.00)	215 (3.28)	248 (0.00)	255 (0.00)	246(0.67)	295 (0.00)	266 (0.58)
Alkalinity (mg/L $CaCO_3$) (*n* = 2)	12	12	5	5	0	0	10	10
Location	**Georges River – Location 2**		**Dahlia Creek**		**Tributary of O'Hares Creek**			
Site	**GR2-1**	**GR2-2**	**DC-1**	**DC-2**	**TOC-1**	**TOC-2**		
Temperature (°C) (*n* =3)	20.8 (0.00)	20.5 (0.00)	17.4 (0.00)	17.7 (0.00)	19.8 (0.00)	20.0 (0.00)		
pH (*n* =3)	7.1 (0.00)	7.2 (0.00)	**6.4** (0.00)	7.1 (0.00)	**6.0** (0.01)	**5.8** (0.01)		
Conductivity (µS/cm) (*n* =3)	**1578** (1.67)	**1566** (0.00)	140 (1.67)	141 (0.00)	150 (1.33)	153 (0.00)		
DO (% Saturation) (*n* =3)	**75** (0.87)	**64** (0.00)	**76** (0.68)	**83** (0.12)	**61** (0.23)	**52** (0.09)		
Turbidity (NTU) (*n* =3)	2.3 (0.10)	6.2 (0.79)	13.1 (0.00)	<**2.0** (0.))	2.2 (0.32)	2.2 (0.15)		
ORP (mV) (*n* = 3)	374 (0.33)	337 (0.00)	252 (0.00)	222 (0.00)	217 (0.00)	191 (0.00)		
Alkalinity (mg/L $CaCO_3$) (*n* = 2)	10	10	0	0	0	5		

Note:

1. Guideline values recommended by the ANZECC and ARMCANZ (2000) guidelines for lowland rivers: pH (6.5 – 8.5); Conductivity (125 – 2200 µS/cm); DO (85-110% Saturation); Turbidity (6 – 50 NTU); and Upland rivers: pH (6.5 – 8.0); Conductivity (30 – 350 µS/cm); DO (90–110 % Saturation); Turbidity (2 – 25 NTU). There are no ANZECC and ARMCANZ (2000) guideline values for Temperature, ORP or Alkalinity. N/R = not recorded.
2. Values in bold are outside the guideline values recommended by ANZECC and ARMCANZ (2000) for lowland rivers (i.e. Carriage Creek and Wallandoola Creek Location 2) or Upland Rivers (i.e. Cataract Reservoir Tributary 2, Tributary of Cataract Reservoir Tributary 2, Georges River Location 2, Dahlia Creek and Tributary of O'Hares Creek).

5.2 Assemblages of Macrophytes

A total of 122 species of plant were recorded from in-stream and riparian habitats sampled in autumn and spring 2008. Diversity of in-stream macrophytes ranged from 1 to 4 at the locations sampled. Submerged and floating attached species were recorded at sampling locations in the Nepean River, Georges River Location 1, Cataract River Location 2, O'Hares Creek, Carriage Creek and Racecourse Creek, where stream channels were wider and pockets of sediment were available for plants to colonise. Weeds were most common at locations situated in streams in the western domains of the Project area (i.e. Foot Onslow Creek, Rocky Ponds Creek, Simpsons Creek and at the most downstream location on the Nepean River), reflecting land-use activities within their catchments (i.e. mostly pasture for grazing) and public access. With the exception of the most upstream sampling location on the Cataract River near Appin Falls (i.e. CR1), no weeds were recorded at locations situated in Sydney Water Catchment Areas or the Dharawal State Conservation Area. Weeds recorded in the Cataract River near Appin Falls are most likely associated with public access to the falls via a walking track.

Autumn 2008

At sites sampled during the autumn 2008 survey, the tuft perennial herb, *Lomandra longifolia*, was the most widely distributed species (Attachment A). It was present at 11 of the 21 locations and common at Cascade Creek Location 1 and 2, Rocky Ponds Creek, Simpsons Creek, Brennans Creek, Brennans Creek Tributary and Allens Creek (Attachment A). The related species, *Lomandra fluviatilis*, was also relatively common with scattered patches recorded at Wallandoola Creek Location 1, Stokes Creek Locations 1 and 2, O'Hares Creek Location 2 and Cataract River Location 2 (Attachment A). The grasses *Paspalum dilatatum* and *Paspalum distichum* were common at Foot Onslow Creek and the latter at Racecourse Creek and scattered patches were recorded at Nepean River Location 3 and Rocky Ponds Creek (Attachment A). The perennial grass *Lepidosperma filiforme* was recorded with large percentage covers at Brennans Creek Tributary (Attachment A).

Other relatively abundant species included Couch Grass (*Cynodon dactylon*) which was present as scattered patches at Rocky Ponds Creek, Foot Onslow Creek, Simpsons Creek, Brennans Creek and Nepean River Locations 2 and 3 and the Coral Fern (*Gleichenia dicarpa*) which was common at Stokes Creek Locations 1 and 2 and O'Hares Creek Location 1 (Attachment A).

Submerged species of macrophytes were observed at all locations sampled on the Nepean River, particularly at Location 3 where the river channel becomes wider (Location 1: two species, Location 2: one species, Location 3: three species), Georges River (one species), Racecourse Creek and Cataract River Location 2 (one species) (Attachment A). The floating attached species, *Triglochin procerum*, was recorded at Nepean River Location 1, Wallandoola Creek Location 1, Cataract River Location 2 (Attachment A).

A total of twenty-nine introduced species of plant were recorded from locations sampled in autumn 2008 (Attachment A). Weeds were recorded at Nepean River Locations 1, 2 and 3 (three, four and six species, respectively), Racecourse Creek (five species), Foot Onslow Creek Location 1 (eight species), Rocky Ponds Creek Location 1 (eight species), Simpsons Creek (eight species), Cataract River Location 1 (two species) and Brennans Creek (two species), (Attachment A).

Overall, macrophytes were most abundant at sampling site SC2-2 followed by SC2-1 and SC1-2 (Figure 7a). Fewer individuals were recorded at Location AC1 than at any other location (Figure 7a).

Spring 2008

At sites sampled during spring 2008, the Black Bog Rush (*Schoenus melenostachys*) was the most widely distributed species (Attachment A). It was common at sites sampled at Dahlia Creek and at the Tributary of Cataract Reservoir Tributary 2 and scattered patches were recorded at the Tributary of O'Hares Creek, Cataract Reservoir Tributary 2 and Georges River (Location 2) (Attachment A). The Pouched Coral Fern (*Gleichenia dicarpa*) was also relatively abundant (Attachment A). It was common at Cataract Reservoir Tributary 2 and Tributary of Cataract Reservoir Tributary 2, and scattered patches were found at Wallandoola Creek (Location 2) and Tributary of O'Hares Creek (Attachment A).

Other common species included the perennial grass *Lepidosperma filiforme* and the Water Gum (*Tristaniopsis laurina*) (Attachment A). Large percentage covers of both species were recorded at Wallandoola Creek Location 2 and scattered patches were found at Georges River Location 2 and Dahlia Creek (Attachment A). A total of five species of weed, including the submerged species *Elodea Canadensis*, were recorded at the Carriage Creek sampling location in spring 2008 (Attachment A).

Submerged species of macrophytes were observed at all locations sampled on the Nepean River, particularly at Location 3 where the river channel becomes wider (Location 1: two species, Location 2: one species, Location 3: three species), Georges River (one species), Racecourse Creek and Cataract River Location 2 (one species) (Attachment A). The floating attached species, *Triglochin procerum*, was recorded at Nepean River Location 1, Wallandoola Creek Location 1, Cataract River Location 2 and O'Hares Creek Location 2 (Attachment A).

Overall macrophytes were most abundant at sampling site CaC-2 and WC2-1 in spring (Figure 7b).

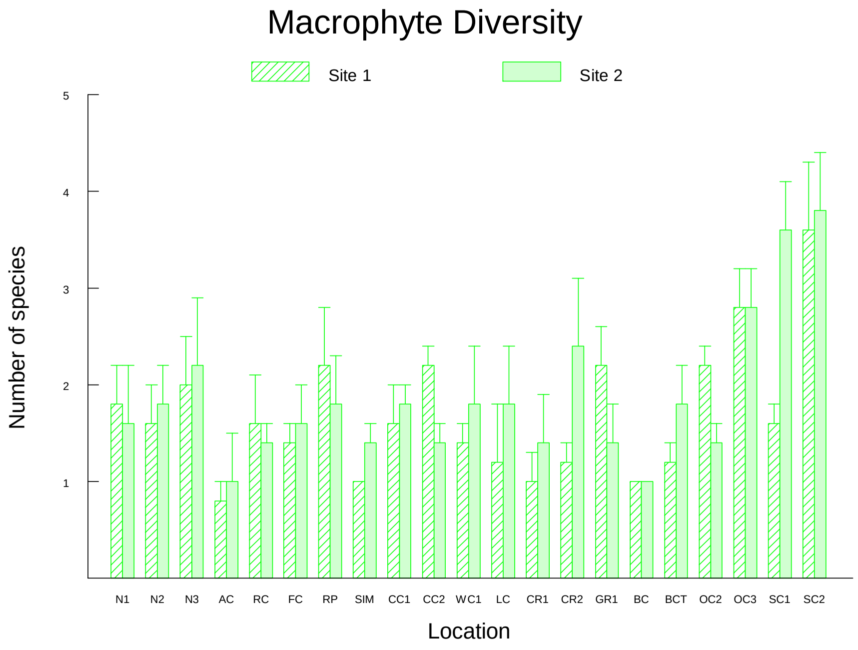


Figure 7a. Mean (+SE) Diversity (number of species) of In-stream Macrophytes at each Location sampled in Autumn 2008

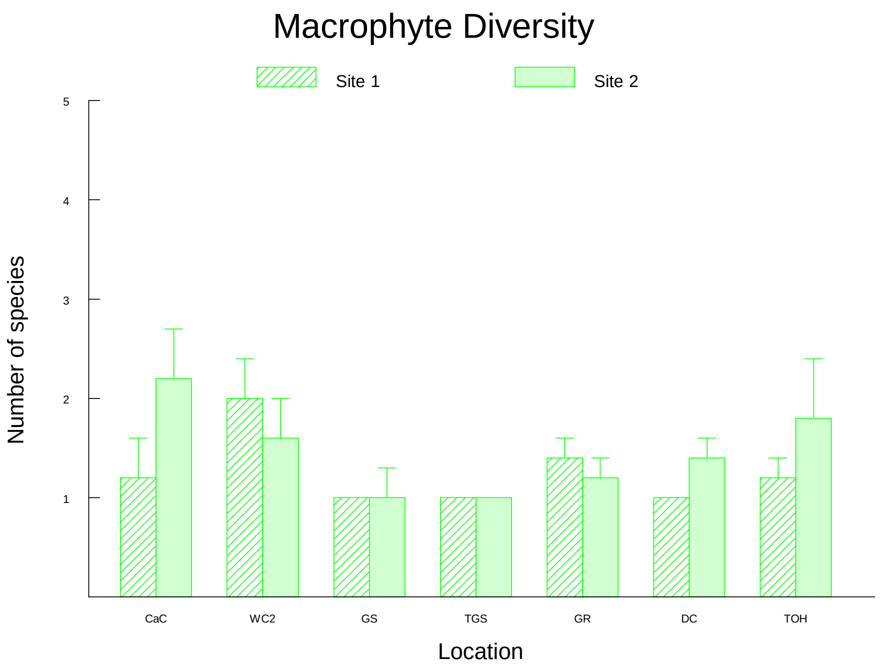


Figure 7b. Mean (+SE) Diversity (number of species) of In-stream Macrophytes at each Location sampled in Spring 2008

5.3 Assemblages of Macroinvertebrates

AUSRIVAS Protocol

A total of 2,070 individual macroinvertebrates from 71 taxa (1,543 individuals from 60 taxa at sites sampled during the autumn 2008 survey and 527 individuals from 42 taxa at sites sampled during the spring 2008 survey) were recorded from sites sampled using the AUSRIVAS protocol (Attachment E).

For sites sampled during the autumn 2008 survey, the OE50 scores ranged between 0.09 (BCT-2) and 0.76 (NP1-1) (Table 7). The OE50 scores ranged between 0.17 (WC2-1) and 0.69 (GR2-2) for sites sampled during the spring 2008 survey (Table 8). Of the fifty-five sites sampled, fourteen were grouped within Band B (i.e. significantly impaired), thirty-eight were grouped in Band C (i.e. severely impaired) and three were grouped in Band D (i.e. impoverished) (Tables 7 and 8). No sites were in Band A. Fewer families of macroinvertebrates than expected were recorded at all sites sampled compared to reference sites selected by the AUSRIVAS model (Tables 7 and 8).

Table 7 AUSRIVAS Results (Autumn 2008)

System	Mining Domain	Location	Site Code	OE50	Band
Nepean River Catchment					
Nepean River	West and North Domain	1	NP1-1	0.76	B
		1	NP1-2	0.48	B
		2	NP2-1	0.22	C
		2	NP2-2	0.36	C
		3	NP3-1	0.36	C
		3	NP3-2	0.36	C
Racecourse Creek	West Domain	1	RC-1	0.62	C
		1	RC-2	0.67	C
Clements Creek	South Domain	1	ClC-1	0.44	C
		1	ClC-2	0.35	C
Foot Onslow Creek	North Domain	1	FC-1	0.51	B
		1	FC-2	0.20	C
Simpsons Creek	North and South Domains	1	SIMP-1	0.18	C
		1	SIMP-2	0.40	C
Cataract River Catchment					
Cataract River	South Domain	1	CR1-1	0.14	C
		1	CR1-2	0.42	C
		2	CR2-1	0.42	C
		2	CR2-2	0.34	C
Lizard Creek	South Domain	1	LC-1	0.53	B
		1	LC-2	0.37	C
Wallandoola Creek	South Domain	1	WC1-1	0.45	C
		1	WC1-2	0.27	C
Cascade Creek	South Domain	1	CC1-1	0.55	B
		1	CC1-2	0.55	B
		2	CC2-1	0.55	B
		2	CC2-2	0.46	C
Rocky Ponds Creek	South Domain	1	RPC-1	0.18	C
		1	RPC-2	0.37	C
Georges River Catchment					
Georges River	North Domain	1	GR1-1	0.26	C
		1	GR1-2	0.46	C
O’Hares Creek	North Domain	1	OC1-1	0.55	B
		1	OC1-2	0.74	B
		2	OC2-1	0.35	C
		2	OC2-2	0.64	B
Brennans Creek	Stage 4 Emplacement Area	1	BC-1	0.18	C
		1	BC-2	0.09	D
Stokes Creek	North Domain	1	SC1-1	0.37	C
		1	SC1-2	0.18	C
		2	SC2-1	0.65	B
		2	SC2-2	0.18	C
Brennans Creek Tributary	Stage 4 Emplacement Area	1	BCT-1	0.28	C
		1	BCT-2	0.09	D

Table 8 AUSRIVAS Results (Spring 2008)

System	Mining Domain	Location	Site Code	OE50	Band
Nepean River Catchment					
Carriage Creek	West Domain	1	CaC-1	0.46	C
		1	CaC-2	0.57	B
Wallandoola Creek	South Domain	2	WC2-1	0.17	D
		2	WC2-2	0.52	B
Cataract Reservoir Tributary 2	South Domain	1	CRT2-1	0.44	C
		1	CRT2-2	0.46	C
Tributary of Cataract Reservoir Tributary 2[1]	South Domain	1	TCRT-1	0.48	C
Georges River Catchment					
Georges River	North Domain	2	GR2-1	0.46	C
		2	GR2-2	0.69	B
Dahlia Creek	North Domain	1	DC-1	0.33	C
		1	DC-2	0.33	C
O'Hares Creek Tributary	North Domain	1	TOC-1	0.29	C
		1	TOC-2	0.25	C

[1] Only one site was sampled due to limited availability of suitable habitat.

Quantitative Sampling

A total of 5,444 individuals from 76 macroinvertebrate taxa (4,612 individuals from 69 taxa at sites sampled in autumn 2008 and 832 individuals from 49 taxa at sites sampled in spring 2008) were collected from sites using the quantitative sampling technique. For sites sampled during the autumn 2008 survey, the most abundant macroinvertebrate taxon was the Leptoceridae (404 individuals) followed by the Atyidae (356 individuals), Leptophlebiidae (290 individuals), Corixidae (261 individuals) and the Dytiscidae (253 individuals) (Attachment F). For locations sampled in spring 2008, the most abundant taxon was the Ceinidae (127 individuals), followed by the Hydrophilidae (123 individuals), Atyidae (64 individuals), Leptophlebiidae (63 individuals) and the Chironomidae (62 individuals) (Attachment F).

Autumn 2008

For sites sampled during the autumn 2008 survey, the analyses of variance found mean total abundance (i.e. numbers of individuals) of macroinvertebrates varied significantly between sites nested within locations (Table 9; Figure 8a). Overall, macroinvertebrates were most abundant at sampling site RP-2 followed by site ClC-2 (Figure 8a). Fewer individuals were collected at Locations SC1 and BCT than at all other locations (Figure 8a). Mean diversity (number of taxa) of macroinvertebrates varied significantly between sites nested within locations and across locations, however SNK tests were unable to distinguish among locations (Table 9; Figure 8b). In general, greater numbers of macroinvertebrate taxa were found at sites RC-2 and OC1-1 whilst the lowest diversity of taxa was recorded at sampling locations on Brennans Creek Tributary and Stokes Creek (Location 1) (Figure 8b).

Table 9 Summary of Analyses of Variance Comparing the Total Number of Individuals (abundance) and Taxa (richness) of Macroinvertebrates Sampled in the Project Area in Autumn 2008

		Abundance		**Richness**	
Source of variation	**df**	**MS**	**F**	**MS**	**F**
Location	20	15.60	1.95 ns	45.57	5.11 **
Site (Location)	21	8.01	3.82 **	8.92	1.71 *
Residual	84	2.10		5.21	
Total	125				
Cochran's Test		*C* = 0.1303 ns		*C* = 0.0959 ns	
Transformation		Sqrt (x + 1)		None	

Note: Data were examined for heterogeneity of variances using Cochran's (C) test. *F*-ratios in bold were calculated after post-hoc pooling was carried out at *P* > 0.25 (Winer *et al*. 1991). ns = not significant (*P* > 0.05); * = significant (*P* < 0.05); ** = significant (*P* < 0.01).

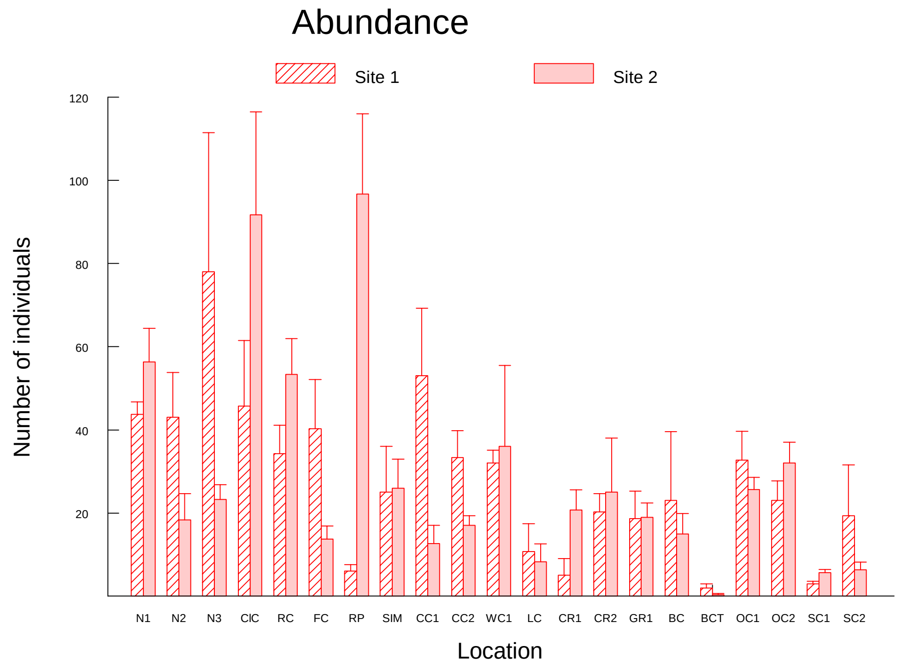


Figure 8a. Mean (+SE) Abundance (numbers of individuals) of Macroinvertebrates at each Location sampled in Autumn 2008

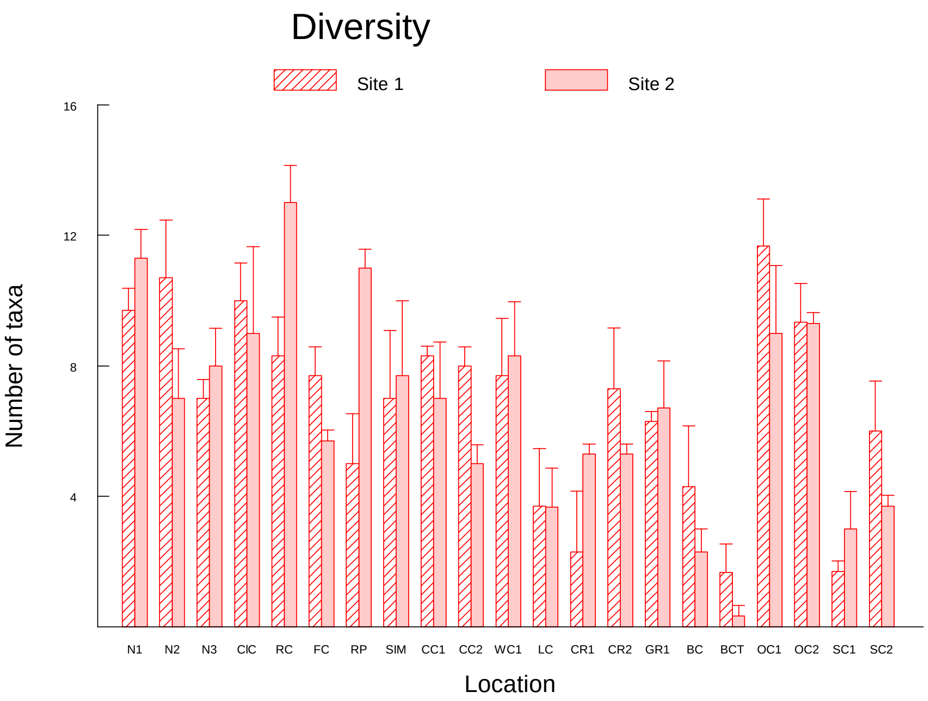


Figure 8b. Mean (+SE) Diversity (numbers of taxa) of Macroinvertebrates at each Location sampled in Autumn 2008

The ANOSIM test indicated that there was a significant difference (Global *R*: 0.65) in the structure of assemblages of macroinvertebrates among locations (*P* < 0.01). Pairwise comparisons found significant differences between all of the locations sampled, with the exception of those listed in Table 9. Due to the considerable number of locations sampled during the autumn 2008 survey, nMDS ordinations for the river locations and the stream locations are presented separately (Figures 9 and 10). It should be noted that for samples that contain no individuals, the Bray-Curtis coefficient is undefined and attempts to generate an nMDS display collapse (Clarke *et al*., 2006). Consequently, a constant with value of 1 had to be added to the original abundance matrix for all samples before generating the nMDS plot to illustrate sample patterns, because three of the samples in the Brennans Creek Tributary replicates contained no individuals.

For the river locations, pairwise comparisons found no difference between Locations 1 and 3 on the Nepean River, which was evident in the nMDS ordination as the replicates tended to group together (Figure 9). A similar lack of difference was evident between Locations 1 and 2 on the Cataract River (Figure 9). The nMDS ordination for stream locations demonstrated considerable variation between most of the locations sampled. Notably, assemblages of macroinvertebrates sampled on Stokes Creek and O’Hares Creek were not distinctly different from each other (Figure 10). There appeared to be considerable variation between sites sampled in Rocky Ponds Creek and Location 1 on Cascade Creek (Figure 10). The stress value (rivers: 0.20; streams: 0.24) associated with the ordinations indicated that they provided a potentially useful 2-dimensional picture (Clarke and Warwick, 1994).

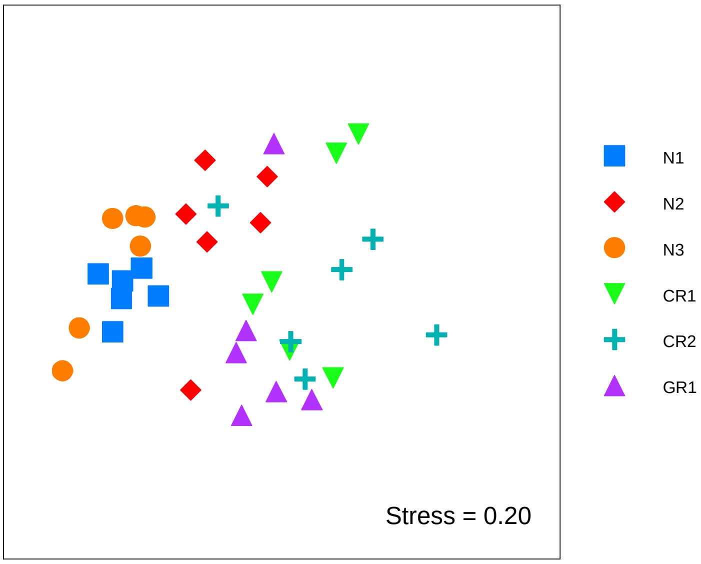


Figure 9. Plot of nMDS Ordination for Macroinvertebrates Sampled at each River Location in Autumn 2008. Ordinations are based on non-transformed abundances and Bray-Curtis similarities (*n* = 6 replicates).

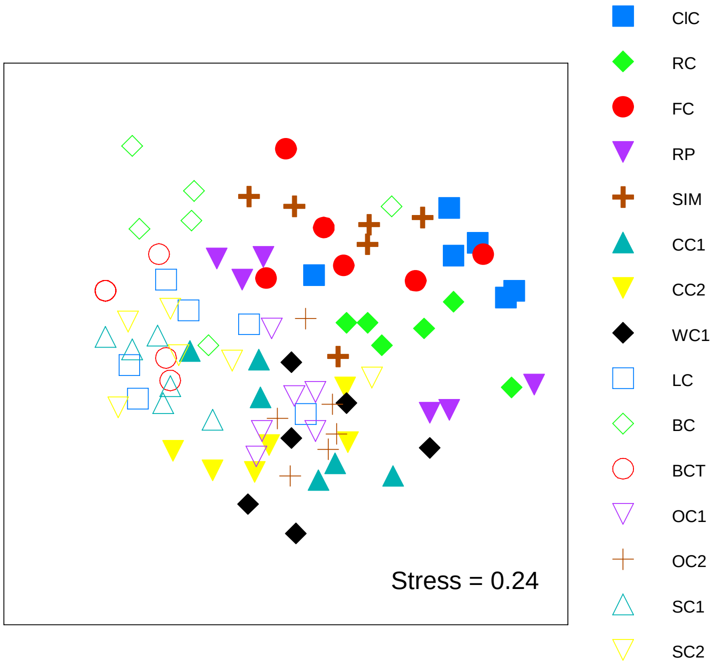


Figure 10. Plot of nMDS Ordination for Macroinvertebrates Sampled at each Creek Location in Autumn 2008. Ordinations are based on non-transformed abundances and Bray-Curtis similarities (*n* = 6 replicates).

The SIMPER procedure found that the most important taxon to contribute to the structure of assemblages of macroinvertebrates varied among locations (Table 10). For instance, in the Nepean River, freshwater shrimps (Atyidae) were ranked the highest at locations NP1 and NP3 whilst scavenger beetles (Hydrophilidae) were ranked highest at NP2 (Table 10). Mayflies (Leptophlebiidae) were ranked highly at several locations (i.e. CC2, CR1, CR2, GR1, OC1, CC1, WC2 and LC) (Table 10). Atyidae were ranked highest at locations sampled in Stokes Creek, followed by caddis flies (Leptoceridae) (Table 10). Hydrophilidae were ranked highest in Clements Creek while non-biting midges (Chironomidae) were ranked as most important in Racecourse Creek (Table 10). Predacious beetles (Dytiscidae), amphipods (Ceinidae), small water striders (Veliidae), Leptoceridae (Caddis flies) and Mayflies (Leptophlebiidae) were ranked highest in Foot Onslow Creek, Rocky Ponds Creek, Cascade Creek, Simpsons Creek, Wallandoola Creek and O'Hares Creek (Location 1), respectively (Table 10). No taxon was ranked as important at the Brennans Creek Tributary (Table 10).

Spring 2008

For the sites surveyed during the spring 2008 survey, analyses of variance found that the mean total abundance of macroinvertebrates varied between sites nestled within locations however SNK tests were unable to distinguish among locations (Table 11 and Figure 11a). Overall, macroinvertebrates were most abundant at locations on Carriage Creek followed by locations on the Tributary of Cataract Reservoir Tributary 2 (Figure 11a). Fewer individuals were collected at Wallandoola Creek (Location 2) than at all other locations (Figure 11a). Mean diversity of macroinvertebrates did not vary significantly at either site or location scale (Table 11 and Figure 11b). In general, greater numbers of macroinvertebrate taxon were found at locations on Carriage Creek and Georges River (Location 1) whilst the lowest diversity was recorded at sampling location Wallandoola Creek (Location 2) (Figure 11b).

Table 10 Taxa Ranked in Order of Importance that Contributed to the Average Similarity within Locations Sampled in Autumn 2008 as Determined using the SIMPER Analysis (1-4 presented).

Common Name	Taxa	Locations														
		NP1	NP2	NP3	ClC	RC	FC	RPC	SIMP	CC1	CC2	WC2	LC	CR1	CR2	GR1
Shrimps	Atyidae	1		1										3		
Mayflies	Baetidae											3				
Mayflies	Caenidae		3													
Amphipods	Ceinidae							1		1						
Non-biting Midges	Chironomidae		4	3		1										
Damselflies	Coenagrionidae	4				3										
Water boatmen	Corixidae	3	2	2	2	4										
Mosquitoes	Culicidae						4									
Dixid Midges	Dixidae															3
Predacious Beetles	Dytiscidae				3		1	4								4
Water Striders	Gerridae														2	
Whirligig Beetles	Gyrinidae												1			
Scavenger Beetles	Hydrophilidae		1		1			3	3							
Caddis Flies	Leptoceridae	2				2				4	3	1	2			2
Mayflies	Leptophlebiidae									2	1	2	3	1	1	1
Dragonflies	Libellulidae													2		
Damselflies	Megapodagrionidae										4					
Water Treaders	Mesoveliidae								4							
Round Worms	Nematode			4												
Back Swimmers	Notonectidae									3	2					
Gastropods	Physidae								2							
Marsh Beetles	Scirtidae						3	2								
Small Water Striders	Veliidae						2		1			4			3	

Table 10 (Continued). Taxa Ranked in Order of Importance that Contributed to the Average Similarity within Locations Sampled in Autumn 2008 as Determined using the SIMPER Analysis (1-4 presented).

Common Name	Taxa	Locations														
		BC	BCT	OC1	OC2	SC1	SC2									
Shrimps	Atyidae					1	1									
Mayflies	Baetidae			4	4											
Water Striders	Gerridae						3									
Whirligig Beetles	Gyrinidae	1					4									
Caddis Flies	Leptoceridae			2	1	2	2									
Mayflies	Leptophlebiidae			1												
Back Swimmers	Notonectidae			3	3											
Small Water Striders	Veliidae				2											

Table 11 Summary of Analyses of Variance Comparing the Total Number of Individuals (abundance) and Taxa (richness) of Macroinvertebrates Sampled in the Project Area in Spring 2008.

		Abundance		Richness	
Source of variation	**df**	**MS**	**F**	**MS**	**F**
Location	6	920.54	**5.04 ****	1.56	3.27 ns
Site (Location)	7	123.02		0.48	2.03 ns
Residual	28	197.71		0.23	
Total	41				
Cochran's Test		*C* = 0.6945 **		*C* = 0.2950 ns	
Transformation		None		Sqrt (x + 1)	

Note: Data were examined for heterogeneity of variances using Cochran's (C) test. *F*-ratios in bold were calculated after post-hoc pooling was carried out at *P* > 0.25 (Winer *et al*., 1991). ns = not significant (*P* > 0.05); * = significant (*P* < 0.05); ** = significant (*P* < 0.01).

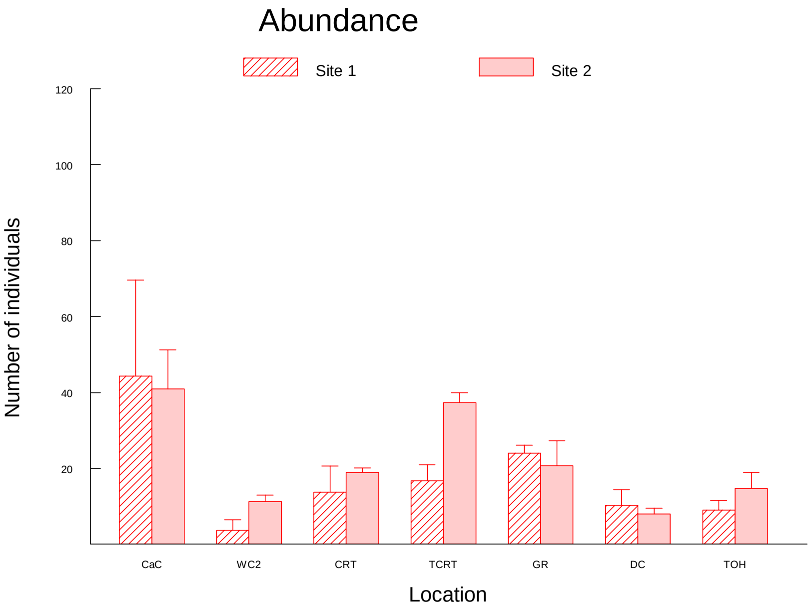


Figure 11a. Mean (+SE) Abundance (numbers of individuals) of Macroinvertebrates at each Location sampled in Spring 2008

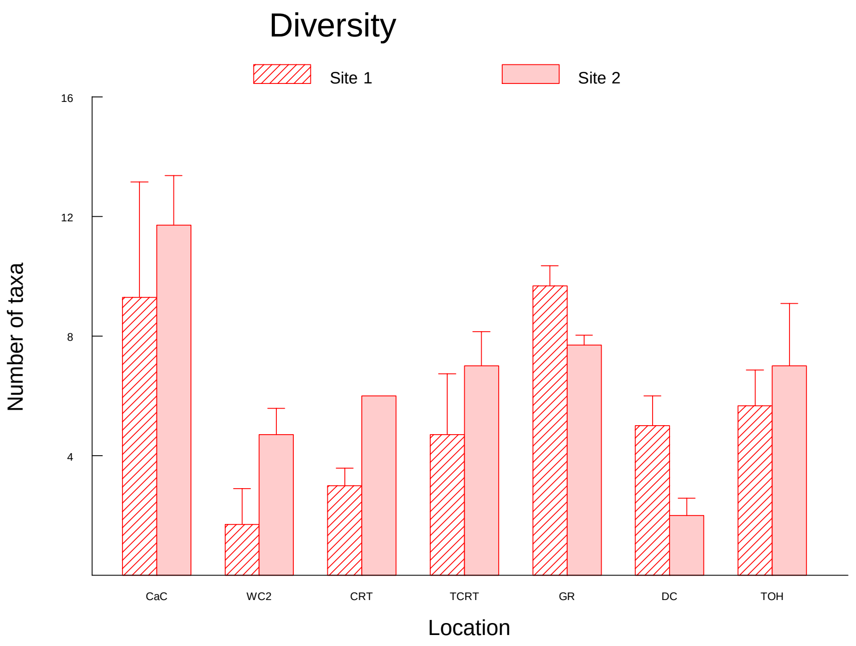


Figure 11b. Mean (+SE) Diversity (numbers of taxa) of Macroinvertebrates at each Location sampled in Spring 2008

The ANOSIM test indicated that there was a significant difference (Global *R*: 0.64) in the structure of assemblages of macroinvertebrates among locations ($P < 0.01$). Pairwise comparisons found significant differences between all of the locations sampled, with the exception of Dahlia Creek (DC) and the Tributary of O'Hares Creek (TOC). The nMDS ordination grouped assemblages in samples from Dahlia Creek and the Tributary of O'Hares Creek separate from all other locations (Figure 12). The ordination also indicated considerable differences between the structure of assemblages at Tributary of Cataract Reservoir Tributary 2 (TCRT) and Carriage Creek (CaC) and all other locations (Figure 12). It should be noted that before generating the nMDS plot to illustrate sample patterns, a constant with value of 1 had to be added to the original abundance matrix for all samples, as one replicate from the Wallandoola Creek (WC-2) (Location 2) contained no individuals.

The SIMPER procedure found that the most important taxon to contribute to the structure of assemblages of macroinvertebrates varied among the locations (Table 12). For instance, mayflies (Leptophlebiidae) were ranked highly at Wallandoola Creek (Location 2). At Georges River (Location 2), mayflies (Caenidae) were ranked highly whilst amphipods (Ceinidae) and shrimp (Atyidae) were ranked highest at Carriage Creek and Cataract Reservoir Tributary 2, respectively (Table 12). Whirligig beetles (Gyrinidae) were ranked highest at locations sampled in Dahlia Creek and the Tributary to O'Hares Creek (Table 12). Scavenger beetles (Hydrophilidae) were the only taxon ranked as important at the Tributary to Cataract Reservoir Tributary 2 (Table 12).

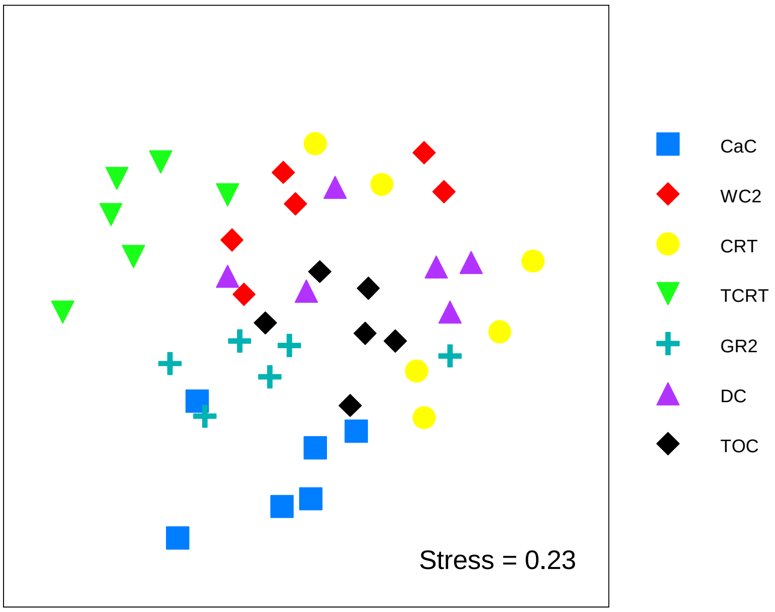


Figure 12. Plot of nMDS Ordination for Macroinvertebrates Sampled at each Location in Spring 2008. Ordinations are based on non-transformed abundances and Bray-Curtis similarities (*n* = 6 replicates).

Table 12 Taxa Ranked in Order of Importance that Contributed to the Average Similarity within a Location in Spring 2008 as Determined using the SIMPER Analysis (1-4 presented).

Common Name	Taxa	Location						
		CaC	WC2	CRT2	TCRT2	GR2	DC	TOC
Shrimps	Atyidae			1				
Mayflies	Caenidae	2				1		
Amphipods	Ceinidae	1						
Non-biting Midges	Chironomidae	3				2		4
Predacious Beetles	Dytiscidae						2	
Water Striders	Gerridae			3				
Whirligig Beetles	Gyrinidae					3	1	1
Scavenger Beetles	Hydrophilidae		2		1			
Caddis Flies	Leptoceridae		3			4		
Mayflies	Leptophlebiidae		1				3	2
True Bugs	Notonectidae	4		2				3

Conclusion

A total of 6,399 individuals from 82 taxa were collected using the AUSRIVAS and quantitative sampling techniques. Fewer families of macroinvertebrates than expected were recorded at all sites sampled, particularly in Brennans Creek and the Tributary of Brannans Creek, compared to reference sites selected by the AUSRIVAS model. The most abundant taxon collected at sites surveyed in autumn 2008 were Leptoceridae followed by Atyidae, Leptophlebiidae, Corixidae and the Dytiscidae. For locations sampled in spring 2008, the most abundant taxon was the Ceinidae followed by the Hydrophilidae, Atyidae, Leptophlebiidae and the Chironomidae. Mean diversity varied significantly across locations sampled in autumn 2008. The most important taxon to contribute to the structure of assemblages varied amongst locations.

5.4 Assemblages of Fish

Thirteen species of fish (including two introduced species and one threatened species listed under the FM Act and the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* [EPBC Act]) were recorded in the study area by electro fishing and/or baited traps (Tables 13 to 15 and Attachment B).

For sites sampled during the autumn 2008 electrofish survey, diversity was greater at the river locations, particularly Nepean River 1(NR1), where six species were recorded. At other river locations, between one and five species were collected (Attachment B). In contrast, diversity was much lower within stream locations. At ten of the 15 stream locations no catch was recorded and the largest number of species captured was three at Racecourse Creek (Attachment B). The introduced Mosquito fish (*Gambusia holbrooki*) was recorded at four of the six river locations (Nepean River [Locations 1, 2 and 3], Cataract River [Locations 1 and 2] and Georges River) and one stream location (Racecourse Creek). The introduced Common carp (*Cyprinus carpio*) was captured at Cataract River Location 1 (CR1; two individuals) and Racecourse Creek (1 individual). Three individuals of the threatened species, Macquarie perch (*Macquaria australasica*) were also collected at Cataract River 1 (CR1). Other relatively common species included the Long-finned Eel (*Anguilla reinhardtii*), the Climbing Galaxias (*Galaxias brevipinnis*) and the Flat head Gudgeon (*Philypnodon grandiceps*).

At the sites sampled during spring 2008, the diversity of fish recorded was relatively low at all locations (between one and three species). The introduced Mosquito fish (*Gambusia holbrooki*) was recorded at locations; Carriage Creek, Tributary of O'Hares Creek and Georges River (Location 2). Other species recorded at more than one location included the Long-finned Eel (*Anguilla reinhardtii*) and the Striped Gudgeon (*Gobiomorphus australis*) (Attachment B).

In the autumn survey, four species of fish were also collected using baited traps at four of the six river locations. The Australian Smelt (*Retropinna semoni*) was recorded at three locations (i.e. Nepean River [NR1 and NR2] and the Cataract River [CR2]). Other species captured included the Climbing Galaxias (*Galaxias brevipinnis*) and the Flat head Gudgeon (*Philypnodon grandiceps*) (Attachment B).

Table 13 Species of Fish Recorded at River Locations in Autumn 2008 Using Electro Fishing (E) and Baited Traps (B)

Common name	**Species**	**Location**											
		NP1		**NP2**		**NP3**		**CR1**		**CR2**		**GR**	
		E	**B**	**E**	**B**	**E**	**B**	**E**	**B**	**E**	**B**	**E**	**B**
Short-finned eel	*Anguilla australis*											✓	
Long-finned eel	*Anguilla reinhardtii*					✓		✓		✓			
Climbing galaxias	*Galaxias brevipinnis*										✓		
Striped gudgeon	*Gobiomorphus australis*	✓											
Gambusia	*Gambusia holbrooki**	✓				✓		✓				✓	
Australian smelt	*Retropinna semoni*	✓	✓		✓						✓		
Flat head gudgeon	*Philypnodon grandiceps*	✓	✓	✓		✓							
Australian bass	*Macquaria novemaculeata*	✓											
Dwarf flathead gudgeon	*Philypnodon sp.*	✓		✓		✓							
Macquarie perch	*Macquaria australasica*$^+$							✓					
Common carp	*Cyprinus carpio**							✓					
Freshwater catfish	*Tandanus tandanus*					✓							

✓ = species recorded; * = introduced species; $^+$ = threatened species

Table 14 Species of Fish Recorded at Creek Locations in Autumn 2008

Common name	Species	Locations														
		ClC	RC	FC	RPC	SIMP	CC1	CC2	WC2	LC	BC	BCT	OC1	OC2	SC1	SC2
Short-finned eel	*Anguilla australis*				✓											
Long-finned eel	*Anguilla reinhardtii*												✓	✓		
Climbing galaxias	*Galaxias brevipinnis*								✓	✓			✓			
Striped gudgeon	*Gobiomorphus australis*		✓													
Gambusia	*Gambusia holbrooki**		✓													
Australian smelt	*Retropinna semoni*															
Flat head gudgeon	*Philypnodon grandiceps*															
Australian bass	*Macquaria novemaculeata*															
Dwarf flathead gudgeon	*Philypnodon sp.*															
Macquarie perch	*Macquaria australasica*$^+$															
Common carp	*Cyprinus carpio**		✓													
Freshwater catfish	*Tandanus tandanus*															

✓ = species recorded; * = introduced species; $^+$ = threatened species

Table 15 Species of Fish Recorded at Locations in Spring 2008

Common name	Species	Location						
		Ca	WC2	CRT	TCRT	GR2	DC	TOC
Short finned eel	*Anguilla australis*	✓						
Long finned eel	*Anguilla reinhardtii*					✓		✓
Climbing galaxias	*Galaxias brevipinnis*		✓					
Common jollytail	*Galaxias maculatus*			✓				
Striped gudgeon	*Gobiomorphus australis*	✓	✓			✓		
Gambusia	*Gambusia holbrooki**	✓				✓		
Australian smelt	*Retropinna semoni*		✓					

✓ = species recorded; * = introduced species

Fish fauna were also recorded opportunistically during macroinvertebrate sampling. A total of 139 individuals of the introduced fish, *Gambusia holbrooki*, were recorded in the Georges River (GR1: 18 individuals, GR2: eight individuals), Nepean River (NP1: 40 individuals, (NP2: one individual, NP3: 16 individuals), Racecourse Creek (44 individuals), Cataract River (CR1: six individuals; CR2: two individuals), O'Hares Creek Tributary (one individual) and Carriage Creek (three individuals) (Attachments E and F).

Conclusion

In summary, eleven native species of fish were recorded, including the threatened species Macquarie Perch (*Macquaria australasica*), which was recorded in the Cataract River upstream of Appin Falls (CR1). Two introduced species of fish, *Gambusia holbrooki* (Mosquito fish) and *Cypinus carpio* (Common carp), were recorded in large numbers across the study area. Mosquito fish is a major pest species in the freshwaters of eastern NSW. At total of 450 individuals of Mosquito fish were collected from seven of the 28 locations sampled as part of this study.

5.5 Threatened Species

A review of relevant literature and databases identified four threatened aquatic species or their habitats that are either known or have the potential to occur in the Project area. One of these (Macquarie perch) was recorded by the Project surveys. The species are as follows:

- Adams emerald dragonfly (*Archaeophya adamsi*) – listed as Vulnerable under the FM Act;
- Sydney hawk dragonfly (*Austrocordulia leonardi*) – listed as Endangered under the FM Act;
- Giant Dragonfly (*Petalura gigantea*) – listed as Endangered under Schedule 1 of the NSW *Threatened Species Conservation Act, 1995* (TSC Act); and
- Macquarie perch (*Macquaria australasica*) – listed as Vulnerable under the FM Act and listed as Endangered under the EPBC Act.

Potential impacts of the Project on these threatened species are assessed in Section 6.

6.0 ASSESSMENT OF POTENTIAL IMPACTS

Due to the spatial extent of the Project and the number and variation of aquatic habitats present, the following section describes the potential impacts of the Project on aquatic ecology in various sub-sections, as follows:

- Section 6.1 provides an overview of activities proposed to be undertaken as part of the Project and outlines the Project stream impact minimisation criteria (Section 6.1.1).
- Section 6.2 describes the potential effects of Project-related subsidence on aquatic habitats separately for each of the seven mining domains (i.e. Section 6.2.1 West Cliff Area 5, Section 6.2.2 Appin Area 7, Section 6.2.3 Appin West [Area 9], Section 6.2.4 Appin Area 8, Section 6.2.5 Appin Area 2 Extended, Section 6.2.6 Appin Area 3 Extended and Section 6.2.7 North Cliff).
- In the same manner as for impacts to aquatic habitats, Section 6.3 describes the subsequent potential impacts to aquatic biota and riparian vegetation (individually discussing aquatic macrophytes, macroinvertebrates, fish and riparian vegetation) separately for each of the seven mining domains (i.e. Section 6.3.1 West Cliff Area 5, Section 6.3.2 Appin Area 7, Section 6.3.3 Appin West [Area 9], Section 6.3.4 Appin Area 8, Section 6.3.5 Appin Area 2 Extended, Section 6.3.6 Appin Area 3 Extended and Section 6.3.7 North Cliff).

6.1 Overview of Project Activities

The main activities associated with the development of the Project would include:

- continued development of underground mining operations within existing coal leases and new mining leases to facilitate a total ROM coal production rate of up to 10.5 Mtpa;
- ongoing exploration activities within existing exploration tenements;
- upgrade of the existing West Cliff Colliery Washery to support the increased ROM coal production;
- continued mine gas drainage and capture for beneficial utilisation at the WestVAMP and Appin-Tower Power Project;
- continued use of electricity generated by the existing Appin-Tower Power Project (owned and operated by EDL power stations) utilising coal bed methane drained from the Bulli Seam;
- upgrade of existing surface facilities and supporting infrastructure at the Bulli Seam Operations (e.g. service boreholes, gas drainage equipment, waste water treatment and waste water disposal);
- continued and expanded placement of coal wash at the West Cliff Colliery Coal Wash Emplacement;
- continued road transport of ROM coal between the Bulli Seam Operations (i.e. from the Appin Colliery pit top to the West Cliff Colliery Washery) and the Dendrobium Washery at Port Kembla;
- continued road transport of product coal from the West Cliff Colliery Washery via the public road network to BlueScope Steelworks and Port Kembla Coal Terminal;

- ongoing surface rehabilitation (including rehabilitation of mine related infrastructure areas that are no longer required) and remediation works; and
- other associated minor infrastructure, plant, equipment and activities.

The main activities associated with the development of the Project are described in detail in Sections 1 and 2 in the Main Report of the EA.

6.1.1 Project Stream Impact Minimisation Criteria

The Project stream impact minimisation criteria includes avoidance of impacts such as significant fracturing of rock bars that would result in surface flow diversion and draining of pools along the Cataract River, Georges River (in West Cliff Area 5), Lizard Creek, Nepean River, O'Hares Creek and Stokes Creek (downstream of Longwall 5a – refer to Appendix A of the EA). In addition, the Project avoids directly mining beneath the headwater reaches of the Georges and Woronora Rivers, labelled as "perennial" on 1:25,000 topographic mappings (Lands Department, 2000), therefore reduces potential impacts to these streams. Further detail regarding the stream impact minimisation criteria is provided in Section 2 in the Main Report of the EA and in Appendix A of the EA.

The assessment of potential impacts of the Project on aquatic ecology is based on the potential subsidence impacts as described in the Subsidence Assessment (Appendix A of the EA), potential groundwater impacts as described in the Groundwater Assessment (Appendix B of the EA) and the potential surface water impacts as described in the Surface Water Assessment (Appendix C of the EA).

6.2 Subsidence Impacts on Aquatic Habitats

Potential impacts on aquatic habitats and ecology are described below. The following section is substantially based on the Surface Water Assessment (Appendix C of the EA). Aquatic habitats include more persistent or perennial sources of water (e.g. Cataract River, Nepean River, O'Hares Creek, Georges River, Stokes Creek), intermittent sources of water (e.g. Ousedale Creek, Harris Creek and Byrnes Creek and flood lagoons and ox-bows such as those in the lower sections of the Nepean River near Menangle) and non-persistent sources of water (e.g the headwaters of ephemeral streams).

The effects of subsidence on flow and water quality in streams will depend on its geomorphic nature and its hydrological characteristics. The character of streams in the Project Application area varies significantly in terms of (Appendix C of the EA):

- scale (i.e. ranging from the Nepean River which commands a catchment of 1,233 square kilometres [km2] [at the downstream end of the Project area] compared to the tributary of Carriage Creek which has a catchment area of approximately 0.5 km2);
- geology and geomorphic character (i.e. ranging between catchments dominated by Hawkesbury Sandstone which are typically deeply incised gullies that follow a strata controlled alignment dominated by rock bars, pools and boulders with sparse fine sediment deposits; and those formed in Wianamatta Shales which typically follow an alignment and have a cross sectional form determined by alluvial processes); and

- level of development (i.e. ranging from the highly regulated and modified watercourses such as the Nepean River to streams in largely undisturbed catchments such as Stokes Creek in the Dharawal State Conservation Area).

The potential effects of subsidence on streams within the Project area can be usefully generalised into two types (*ibid.*):

1. Incised, strata controlled watercourses which have formed in the erosion resistant Hawkesbury Sandstone terrain.
2. Alluvial watercourses which are controlled by fluvial morphological processes and which have formed in weathered and erodible Wianamatta Shale terrains.

Incised Valleys in Hawkesbury Sandstone

Where subsidence and in particular valley closure in streams formed in the Hawkesbury Sandstone is sufficient to result in fracturing of rock bars and development of significant fracturing and dilation (generally limited to 15 to 20 m in depth), the following effects are expected (*ibid.*):

- diversion of a portion of streamflow along the stream length via the created fracture network;
- re-emergence of surface flow downstream of the affected area;
- reduced frequency of pools overflowing and lower pool water levels during dry weather;
- reduced and periodic loss of interconnection between pools during dry weather;
- small changes in bed gradients and limited potential for scouring at locations where tilts considerably increase the natural pre-mining stream gradients;
- localised and transient increases in iron concentrations and other minerals due to flushing from freshly exposed fractures in the sandstone rocks;
- creation and/or enhancement of existing iron rich springs; and
- drainage of strata gas[1].

Alluvial Valleys in Wianamatta Shale

The streams in alluvial valleys in Wianamatta Group shale areas are typically formed in relatively shallow open valleys. The nature of the substrates in these areas generally allow the sediments to be subject to subsidence movements without creating the interconnected dilation type of fracturing that occurs in the Hawkesbury Sandstone terrains (Appendix A of the EA). Past experience indicates that subsidence impacts on streams formed in the Wianamatta Group shale terrain typically include: localised and relatively isolated fracturing of bed sediments; creation of transient and permanent pools in subsidence depressions; and/or alteration to existing pools and small scale bed and bank scour due to local increases in bed and bank slope.

---

[1] Release of methane-rich strata gases from overburden sequences above the coal seam.

The predominance of clay rich (cohesive) bed sediments in these watercourses means that subsidence induced fractures are more likely to self-seal over time when compared to streams bedded in the Hawkesbury Sandstone. There is unlikely to be any significant diversion of flow, with any localised diversion being of a temporary nature (Appendix C of the EA).

The predominance of cohesive bed sediments also means that bed and bank erosion is expected to be slow relative to that which may occur in more sandy soil profiles. The rate of morphological change (due to subsidence effects) toward a new equilibrium is also likely to be relatively slow and may be masked by earlier disturbances associated with clearing in these catchments (Appendix C of the EA).

There is also the possibility of transient strata gas emissions from the subsided landscape including within these streams. Emissions within streams are evident from bubbling in existing pools or slow moving water bodies. (Appendix C of the EA.).

Subsidence Impacts on In-stream Ponds

The effects of subsidence on the hydrological behaviour of in-stream pools will depend on the nature of the pools in the catchments that they occur in (*ibid*.). The nature and distribution of pools in the Project area varies significantly. In-stream pools tend to occur in the mid and lower sections of streams and comprise either local depressions in the bed rock or ponds formed behind prominent rock bars. Pools mapped in the Project area vary in size from a few metres to over 300m in length and from 0.1m to over 2m in depth (*ibid*.).

While mine subsidence has the potential to increase the rate of leakage and consequently increase the rate of water level recession in pools, it is likely that a portion of the pools subject to mine subsidence effects would hold some water during prolonged dry periods (*ibid*.). The rate of water level decline in affected pools and the frequency with which these pools are likely to be dry or experience low water levels would vary depending on: i) the size and depth of pools; ii) the frequency and persistence of low and no flows entering the pool from the upstream catchment; iii) the particular geological conditions of the pool bed rock and the rock bars which control water levels in most pools; and iv) the size of valley closure and upsidence movements experienced in the affected reach of the watercourse (*ibid*.).

The water balance of in-stream pools is dominated by upstream runoff inflow and overflow (*ibid*.). Evaporation from the surface is typically a small component of the water balance as is seepage and incident rainfall. A number of rock bar controlled pools in un-mined areas have also been observed to have significant underflow through their controlling downstream rock bar (*ibid*.). Subsidence associated with longwall mining has affected a number of pools in the Southern Coalfields most notably by reducing water level persistence during low flow periods. The mechanism for this is believed to be the creation of a fracture network beneath the bed of the stream as a result of the dilation effects of upsidence and shearing/compressive effects of valley closure (*ibid*.). The resulting dilation fracturing is usually nearly horizontal (i.e. parallel to the bed) and is interconnected with predominantly sub-vertical compressive/shear fractures which intercept the bed. This pattern of fractures provides a pathway for subsurface diversion (underflow) of low flows downstream (*ibid*.). The diverted flows return to the surface near the downstream end of the fracture network which does not extend beyond the extent of subsidence movements (*ibid*.).

Observation of past subsidence effects on in-stream pools indicates a variable response with some pools experiencing relatively much smaller effects than others (*ibid*.). The key variables which can be expected to affect subsidence impacts on pools are (*ibid*.):

- The hydraulic capacity of the fracture network and its interconnectivity with the stream bed upstream of the pool, the bed of the pool and its downstream rock bar; the hydraulic capacity of the subsidence fracturing would in turn be dependent on the amount of valley closure and upsidence and on the strength of the bedrock and the orientation characteristics of any pre-exiting jointing and bedding planes.
- The depth, length and volume of the pool.
- The nature of bed sediment present or moving through the pool reach.
- The frequency, regularity and magnitude of flows entering the pool from the upslope catchment.

A series of theoretical water balance analyses have been undertaken by Gilbert and Associates in Appendix C of the EA to illustrate the range of potential and expected responses to subsidence induced dilation fracturing and underflow over the range of different catchment and pool 'types' that occur within the Project area. These analyses are indicative in nature and are based on different indicative pool geometries taken from stream mapping, indicative pool underflow rates based on values reported elsewhere in the Illawarra Region (HCPL, 2008) and simulated inflows based on recorded flows from the gauging station at O'Hares Creek at Wedderburn. Recorded flows were adjusted to account for different catchment areas, different catchment rainfall and different low flow persistence characteristics.

The following generic pool scenarios have been simulated by Gilbert and Associates in Appendix C of the EA:

1. Small, shallow pool formed in a depression in a large catchment subject to relatively small subsidence effects i.e. low rates of flow diversion. This scenario is intended to represent a small pool of the type commonly observed in many Project area streams formed in the Hawkesbury Sandstone catchments (pools of this nature have been mapped on the Cataract Reservoir Tributaries, Cascade Creek and Stokes Creek).
2. Large, long, deep pool in a small catchment subject to large subsidence effects i.e. high rates of flow diversion. This scenario is intended to represent larger pools in smaller catchments (a pool of this nature has been mapped on Dahlia Creek). This situation is likely to be relatively rare in the Project area and the effects simulated here correspond to larger subsidence effects and is therefore reflective of upper bound effects.
3. Moderate sized pool in a moderately sized catchment with small low flow persistence - subject to moderate subsidence effects i.e. moderate rates of flow diversion. This scenario is intended to represent a moderate sized pool on a stream flowing through a cleared rural catchment in the lower rainfall areas of the Project area (pools of this nature have been mapped on Navigation Creek).
4. Medium sized pool a moderately sized catchment with high low flow persistence, subject to moderate subsidence effects i.e. moderate rates of flow diversion. This scenario is intended to represent a medium sized pool on a stream flowing though a partially cleared catchment in the higher rainfall areas of the Project area (pools of this nature have been mapped on the upper reaches of Georges River).
5. A small pool in a moderately sized ephemeral catchment, subject to small subsidence effects, i.e. small flow diversion. This scenario is intended to represent a typical pool in a stream flowing though a cleared rural catchment in the Wianamatta Group shale areas of the Project area (pools of this nature have been mapped on Carriage Creek and Foot Onslow Creek).

Results of the pool modelling presented above indicate that the frequency that pools would be full or near full might decrease by a few percent in some cases and up to 50% in rare situations (i.e. Scenario 2 above) (*ibid*.). Small, shallow pools in small catchments which become well connected to extensive subsidence induced fracture networks are likely to be the most likely to experience periodic drying (*ibid*.). Small, deeper pools in large catchments with strong low flow persistence are less likely to be affected by subsidence induced bed fracturing (*ibid*.). Streams formed in the Hawkesbury Sandstone terrains of the Project area typically contain a wide range of different pool sizes and types and experience has shown a range of different effects occur in response to subsidence induced dilation fracturing with some pools retaining water through dry periods (*ibid*.).

6.2.1 Aquatic Habitats in West Cliff Area 5

Streams within this domain include the Georges River, Stokes Creek and several small tributaries of the Nepean River, notably Nepean Creek and Mallaty Creek, all of which are classed as incised valleys in Hawkesbury Sandstone[2] (*ibid*.).

Within this domain, the Project stream impact minimisation criteria includes avoidance of impacts such as significant fracturing of rock bars that would result in surface flow diversion and draining of pools along the Georges River and Stokes Creek. Whilst fracturing leading to localised surface flow loss via underflow is unlikely to occur in these streams, it is likely that there would be isolated instances of fracturing and iron staining, transient spikes in water quality parameters such as iron and temporary strata gas releases in some pools (Appendix C of the EA.).

Potential impacts of the Project on smaller streams in this domain, notably Nepean Creek and Mallaty Creek include reduced pool water levels and persistence of inter-pool flow, isolated iron staining and spikes in water quality parameters such as iron and likely transient strata gas emissions (Appendix C of the EA.).

6.2.2 Aquatic Habitats in Appin Area 7

Named streams within this domain include the Nepean River, Foot Onslow Creek, Navigation Creek and Ousedale Creek. The Nepean River and Ousedale Creek are classified as incised valleys in Hawkesbury Sandstone while Foot Onslow and Navigation Creeks are classified as alluvial valleys in Wianamatta Shale that may also contain isolated rocky outcrops (Appendix C of the EA.).

Within this domain, the Project stream impact minimisation criteria include avoidance of impacts such as cliff falls along the Nepean River. As outlined in Appendix C of the EA it is highly unlikely that there would be any observable effects on stream flow or water levels in the Nepean River within this domain. Some shallow in-stream fracturing is expected, along with iron staining, transient spikes in water quality parameters such as iron and transient strata gas releases causing bubbling in the Menangle Weir pool (Appendix C of the EA.).

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[2] Although classified as incised valleys in Hawkesbury Sandstone, significant fluvial/alluvial processes occur in the less incised upper reaches of Nepean Creek and Mallaty Creek (Appendix C of the EA).

In regard to Foot Onslow and Navigation Creeks, Gilbert and Associates (2009) indicate in Appendix C of the EA that impacts on these streams are expected to be limited to: localised areas of iron staining; possibly fracturing and enhanced leakage from farm dams and pools (where present); and possible low flow diversion in areas of rock outcrop or where bedrock is covered by a thin mantle of alluvium. These effects are unlikely to be pervasive.

The expected impacts of the Project on Ousedale Creek within Appin Area 7 would be similar to those observed in the previously undermined section of the streams namely reduced low flow persistence due to underflow diversion, minor iron staining and transient spikes in water quality parameters such as iron and transient releases of strata gas (Gilbert & Associates, 2009).

6.2.3 Aquatic Habitats in Appin West (Area 9)

Streams within this domain include the Nepean River, the upper reaches of Racecourse Creek, the upper reaches of Navigation Creek, the upper reaches of Matahill Creek, Harris Creek and a small un-named tributary of the Nepean River. The Nepean River, Harris Creek and the un-named tributary of the Nepean River are classified as incised valleys in Hawkesbury Sandstone while Racecourse Creek and the upper reaches of Matahill Creek are classified as an alluvial valley in Wianamatta Shale (*ibid.*)

Within this domain, the Project stream impact minimisation criteria includes avoidance of impacts such as cliff falls along the Nepean River. Gilbert and Associates (2009) indicates in Appendix C of the EA that due to the protection afforded to the Douglas Park Weir, there are no expected impacts to flow or pool depth in the long pool created by the Douglas Park Weir. Some iron staining, fracturing and liberation of iron and other minerals is expected, as is the transient strata gas releases causing bubbling in the weir pool.

Impacts on the headwaters of Racecourse Creek are expected to include localised areas of iron staining, transient spikes in water quality parameters such as iron and areas of surface flow diversion.

In regard to Matahill and Navigation Creeks, Gilbert and Associates (2009) indicates in Appendix C of the EA that the potential impacts are expected to include isolated instances of iron staining and spikes in water quality parameters such as iron, transient strata gas emission and induced leakage in pools and farm dams. It is considered unlikely that any of these types of impact would be pervasive but rather there may be some isolated incidents (*ibid.*). MSEC (2009) indicate that mining induced tilts the downstream sections of Foot Onslow and Navigation Creeks at the base of the Razorback Range may cause localised reversal of the existing bed slope and subsequent additional ponding. These changes are expected to be localised in nature (e.g. within a 130 m section for Navigation Creek and two short sections of Foot Onslow Creek [both less than 90 m]), minor (e.g. pond depths of less than 500 mm), and are not expected to significantly alter the hydrology and subsequent habitat availability along these streams (Appendix C of the EA).

The potential impacts of subsidence on Harris Creek and the un-named tributary of the Nepean River include iron staining, transient spikes in water quality parameters such as iron, likely strata gas emissions, reduced pool levels in dry weather and localised underflow and a reduction in the frequency and persistence of inter-pool flow. These effects are likely to be isolated (*ibid.*).

6.2.4 Aquatic Habitats in Appin Area 8

Named streams within this domain include the Nepean River and Allens, Carriage, Byrnes and Racecourse Creeks. The Nepean River, Allens Creek, Carriage Creek, Byrnes Creek and the upper reaches of racecourse Creek are classified as incised valleys in Hawkesbury Sandstone while the lower reaches of Racecourse Creek is classified as an alluvial valley in Wianamatta Shale (*ibid.*).
Within this domain, the Project stream impact minimisation criteria include avoidance of impacts such as cliff falls along the Nepean River. The predicted valley closure movements along the Nepean River within this domain are considered insufficient to cause any significant fracturing of controlling rockbars and subsequent flow loss. Transient releases of strata gas are likely to occur and be visible as gas bubbling in ponded sections of the Nepean River. There is some risk that dilation fracturing could occur in the vicinity of two rockbars in a section of the Nepean River where closure movement in excess of 200 mm is predicted, leading to local lowering of water level in the upstream pools during low flows. Iron staining and the formation of iron springs through enhanced groundwater inflows could also occur.

In regard to Allens Creek, the confluence with the Nepean River is within the weir pondage of the Douglas Park Weir which is unlikely to be affected by mining. The first 500 m of Allens Creek upstream of the confluence with the Nepean River, which is mostly a boulder field, is not expected to have any noticeable flow and/or water level impacts. Potential impacts in the upstream sections of Allens Creek include lowering of pool water level (in the few locations where pool water levels are controlled by rock bars) or loss of surface flow over rock bars during dry weather flow conditions. Iron staining, transient spikes in water quality parameters such as iron and strata gas emissions are also expected (*ibid.*).

In regard to Carriage Creek, the predicted subsidence effects are sufficient to cause fracturing of at least some of the rock bars, which would lead to low flow diversion and lowering of pool water levels and reduced interconnectivity between pools during dry weather. There is expected to be some localised and transient increases in iron concentrations and transient strata gas releases (*ibid.*).

Potential impacts on Byrnes Creek include iron staining and transient increases in iron concentrations in runoff waters and possibly a lowering of water level and more frequent drying of the pool mapped in the upper reaches (*ibid.*).

In regard to Racecourse Creek, the predicted impacts are expected to be limited to localised areas of iron staining, possibly fracturing and surface flow diversion in the headwaters and induced leakage in pools and farm dams in the lower reaches. As outlined in Appendix C of the EA, it is considered unlikely that any of these types of impact would be pervasive but rather isolated incidents.

6.2.5 Aquatic Habitats in Appin Area 2 Extended

Streams within this domain include the headwater reach of the Georges River, unnamed tributaries of the Cataract Reservoir and a section of the Cataract River downstream from the Cataract Dam, all of which are classed as incised valleys in Hawkesbury Sandstone (*ibid.*).

Within this domain, the Project stream impact minimisation criteria includes avoidance of impacts such as significant fracturing of rock bars that would result in surface flow diversion and draining of pools along the Cataract River. In addition, the Project avoids directly mining beneath the headwater reaches of the Georges River and therefore reduces potential impacts to this stream.

In regard to potential impacts of the Project on the Cataract River, Gilbert and Associates (2009) indicates in Appendix C of the EA that small localised impacts including increased iron staining and transient spikes in water quality parameters such as iron are expected. Emissions of strata gas which would be seen as bubbling for a period of time in some pools would also be expected.

In regard to the headwater reach of the Georges River and unnamed tributaries of the Cataract Reservoir, Gilbert and Associates (2009) indicates in Appendix C of the EA that potential impacts are expected to include localised fracturing of rock bars and shelves, diversion of a portion of low flows during dry periods, along with continued iron staining, and periodic pulses of water quality parameters such as iron.

6.2.6 Aquatic Habitats in Appin Area 3 Extended

Streams within this domain include the Cataract River, three named tributaries of the Cataract River (i.e. Lizard, Wallandoola and Cascade Creeks), one un-named tributary of the Cataract River (located between Lizard and Wallandoola Creeks), a section of Clements Creek and Third Point Creek, all of which are classed as incised valleys in Hawkesbury Sandstone (*ibid.*).

Within this domain, the Project stream impact minimisation criteria includes avoidance of impacts such as significant fracturing of rock bars that would result in surface flow diversion and draining of pools along the Cataract River and Lizard Creek. Potential impacts of the Project on the Cataract River and Lizard Creek are expected to include localised fractures along with increased iron staining and transient spikes in water quality parameters such as iron. Emissions of strata gas which would be seen as bubbling for a period of time in some pools would also be expected.

Potential impacts of the Project on Wallandoola Creek, Cascade Creeks, the un-named tributary of the Cataract River, Clements Creek and Third Point Creek include fracturing and localised flow diversion (including reduced water level and drying during dry weather at some pools), iron staining and transient spikes in water quality parameters such as iron in areas where flows emerge from subsidence induced fractures fractures and strata gas emissions for a period of time (*ibid.*).

6.2.7 Aquatic Habitats in North Cliff

Streams within this domain include Woronora River and O’Hares, Stokes, Dahlia, Cobbong and Punchbowl Creeks, all of which are classified as incised valleys in Hawkesbury Sandstone (*ibid.*).

Within this domain, the Project stream impact minimisation criteria includes avoidance of impacts such as significant fracturing of rock bars that would result in surface flow diversion and draining of pools along O’Hares Creek and Stokes Creek (downstream of Longwall 5a – refer to Appendix A of the EA). In addition, the Project avoids directly mining beneath the headwater reaches of Woronora River (Section 6.1.1) and therefore reduces potential impacts to this stream.

In the Woronora River, there is expected to be minor (i.e. localised and small scale) impacts including fractures forming in rock bars and rock shelves, increases in iron staining and the potential for minor transient strata gas emission in some pools (although this has not been observed at the adjacent Metropolitan Colliery). These effects, if they do occur, are expected to be isolated. The risk of subsidence effects leading to flow loss within the Woronora River catchment being anything other than a localised loss of surface water and increase in underflow where natural underflow has already been observed is considered to be very low (*ibid.*).

Gilbert and Associates (2009) indicate in Appendix C of the EA that the potential impacts on surface water hydrology of O'Hares Creek are expected to be small and from a practical perspective negligible. There is however a risk of minor impacts including isolated fracturing and iron staining and increases in iron concentrations. Transient strata gas emissions seen as bubbling in pools is considered unlikely given that none have been observed at the adjacent Metropolitan Colliery.

In regard to Stokes Creek, there is some potential for fracturing leading to localised underflow to occur over a relatively short stretch of stream where the predicted valley closure is in excess of 200 mm (i.e. upstream of Longwall 5a – refer to Appendix A of the EA). This could lead to reduced pool water levels during dry weather and possibly pools drying up during dry weather. It is also likely that increased iron staining and transient spikes in water quality parameters such as iron could occur in the area and some strata gas release (*ibid.*).

Potential impacts of the Project on Dahlia, Cobbong, and Punchbowl Creeks include fracturing and localised surface flow diversion (including reduced water level and drying of pools during dry weather), transient increases in iron concentrations and iron staining in areas where flows emerge from subsidence induced fractures (*ibid.*). Transient strata gas emissions seen as bubbling in pools is considered unlikely given that none have been observed at the adjacent Metropolitan Colliery.

6.2.8 Subsidence Impacts on Aquatic Habitats – Summary

The alteration of natural flow regimes of rivers and streams is recognised as a key threatening process under the TSC Act and FM Act. The Project stream impact minimisation criteria includes avoidance of impacts such as significant fracturing of rock bars that would result in surface flow diversion and draining of pools along the Cataract River, Georges River (in West Cliff Area 5), Lizard Creek, Nepean River, O'Hares Creek and Stokes Creek (downstream of Longwall 5a – refer to Appendix A of the EA). In addition, the Project avoids directly mining beneath the headwater reaches of the Georges and Woronora Rivers (Section 6.1.1), and therefore reducing potential impacts to these streams. Further detail regarding the stream impact minimisation criteria is provided in Section 2 in the Main Report of the EA and in Appendix A of the EA.

Mine subsidence would result in fracturing of the rock strata in other streams (e.g. Allens Creek, Carriage Creek, Dahlia Creek, Punchbowl Creek, Tributary of Cataract Reservoir and Wallandoola Creek) which is expected to result in reaches of streams where the conveyance of a portion of low flows via the fracture network occurs, and a reduction in water level in pools as they become hydraulically connected with the fracture network. There is also expected to be reduced continuity of flow between affected pools during dry weather. Gilbert and Associates (2009) indicates in Appendix C of the EA that mine subsidence associated with the Project would have a negligible effect on moderate and larger flow conditions.

Pool water levels would fluctuate in response to stream flow variability (i.e. increasing during periods of increasing flow and reducing with flow recession). Gilbert and Associates (2009) indicates in Appendix C of the EA that during periods of significant rainfall and runoff, the water level in subsidence impacted pools would be similar to pools unaffected by subsidence. Under these flow conditions pools and their downstream rock bars would become “drowned out”. During dry periods when flows are in a low, recessionary regime the water level in pools affected by subsidence would recede much faster than is the case in unaffected pools (*ibid*.). Experience has shown however that a range of different effects can occur in response to subsidence induced fracturing with some pools retaining water through dry periods (Appendix C of the EA).

Mine subsidence is also expected to result in localised changes in stream water quality. The effects of subsidence on water quality have been most noticeable as localised and transient changes (spikes or pulses) in iron, manganese and to a lesser extent aluminium, zinc and nickel and minor associated increases in electrical conductivity (Appendix C of the EA). The most likely mechanism for this appears to be flushing of minerals from freshly exposed fractures created by upsidence and valley closure (*ibid*.). These pulses are generally isolated and non-persistent (Appendix C of the EA).

With regards to non-persistent sources of water (e.g. the headwaters of ephemeral streams) the magnitude of surface fracturing predicted by MSEC (Appendix A of the EA) is considered unlikely to significantly influence the hydrological processes in these areas (Appendix C of the EA) and therefore significant changes to the availability of these aquatic habitats is not expected.

6.3 Potential Effects of Subsidence on Aquatic Biota and Riparian Vegetation

Specific evidenced -based assessments of the impacts of subsidence on aquatic biota and riparian vegetation have been undertaken by ICHPL on all recent (i.e. post 2005) longwall mining operations managed by them. These assessments have included the monitoring of four groups of biota, namely, aquatic macrophytes, macroinvertebrates, fish and riparian vegetation. The important contribution to healthy ecosystem function made by these groups and some of the factors that affect their abundance and distribution, including the potential effects of subsidence, are introduced below.

While all available evidence has been considered, significant weight has been given to the findings of the Southern Coalfields Inquiry (Department of Planning [DoP], 2008) and specific contemporary on-site studies. Hence the following assessment draws on the potential subsidence impacts described in Appendix A of the EA, potential groundwater impacts described in Appendix B of the EA, the potential surface water impacts as described in Appendix C of the EA and the potential flora impacts described in Appendix E of the EA. Consequently, this assessment relies on the coverage, rigour and predictive capacity of these studies and the models therein. Therefore the predictions presented below are contingent on the actual surface water and subsidence effects being equal to or less than those predicted. Although Appendix A of the EA considers the subsidence predictions (on which this assessment is based) to be conservative, contingent management would be employed where the effects are greater than those predicted (Appendices O and P). In the event that impacts are greater than those predicted by the subsidence, flora and/or water assessments, the implementation of these contingent measures would ensure that the predictions described above remain relevant.

Aquatic Macrophytes

Aquatic macrophytes are important dynamic biological components of streams. For example, they can modify physicochemical conditions, form structural habitats for epiphytes and fauna, trap detritus, provide shelter, compete with algae and provide detritus to food chains (Carpenter and Lodge, 1986). Studies of macrophytes and the association between macrophytes, macroinvertebrates and fish have emphasised the role of structural complexity in determining the composition of these assemblages (Pusey and Arthington, 2003).

A loss of macrophytes resulting from disturbance can be a major impact to streams, especially if this has resulted from permanent loss of water habitat. Potential fracturing of the stream bed due to mine subsidence can result in a reduction in pool water levels. This type of impact has been observed previously where reduced pool water levels associated with longwall mining activities resulted in the exposure and desiccation of an aquatic macrophyte (Water Ribbons: *Triglochin procerum*) (TEL, 2005 to 2006; Gingra Ecological Surveys, 2007). These impacts were, however, short-term and once pool water levels returned, so too did the plants (Gingra Ecological Surveys, 2007). Obligate water plants such as submerged and floating species generally require permanent water however they can, in time, recolonise dry areas if and when water levels return. These aquatic plants have evolved reproductive strategies to cope with the variable nature of flow in streams and wetlands within Australia.

Macroinvertebrates

The composition and abundance of macroinvertebrates within coastal streams is controlled by flow regime, food supply, water quality, biotic interactions and habitat structure (Cummins *et al*., 1997; Growns and Growns, 1997). River regulation (i.e. the alteration of the natural flow regime) has been found to have significant effects on in-stream river ecology (Gehrke and Harris, 1996; Gehrke, 1997). The distribution and abundance of macroinvertebrates can be affected by changes in the flow intensity and pattern (Growns and Growns, 1997), pollution (Wright *et al*., 1995), and differences in habitat and structure (Kay *et al*., 1999). Significant differences have been detected between assemblages of macroinvertebrates found in riffle zones and those found along the edges of streams as well as between assemblages found in aquatic macrophytes compared to overhanging riparian vegetation (Cummins *et al*., 1997). Furthermore, changes in the structure of assemblages of plants and animals are commonly observed as the geomorphology of streams naturally change as they progress from their upper to lower reaches (Williams, 1980; Moss, 1988). Upstream and downstream differences can also occur because of obstructions (both human-made and natural). Natural variability in the richness and abundance of assemblages of macroinvertebrates can be related to their species-specific reproductive strategies as well as type of habitat including prevailing flow regimes.

Increased concentrations of iron and iron staining associated with subsidence can lead to the concentration of iron reducing bacterial flocs. The ecological impacts of these flocs on aquatic macroinvertebrate species are largely unknown, but may include smothering of benthic habitats and/or organisms. Emission of strata gas associated with subsidence into a river or stream may cause a reduction in DO in the water-column, due to microbiological consumption of dissolved methane, particularly during low flow conditions (EcoEngineers, 2008). Low concentrations of DO can result in adverse effects on many aquatic organisms, which depend upon oxygen for their functioning (ANZECC and ARMCANZ, 2000).

DO is a primary indicator when assessing the suitability of surface waters to support aquatic macroinvertebrate life. The ANZECC and ARMCANZ (2000) guidelines recommend DO levels of between 85 to 110% for the protection of lowland rivers. TEL (2008a) reviewed studies that examined the effects of low DO on aquatic macroinvertebrates and found that DO levels of between 60 to 85% caused slight reductions in metabolism in highly sensitive taxa, including mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera).

Reduced metabolism is likely to compromise fitness in the long term by reducing feeding, growth, emergence, and fecundity (TEL, 2008a). Indeed, distinct changes in the composition of assemblages of macroinvertebrates have been found in lowland streams where levels of DO had declined towards 30% saturation (Jacobsen, 2007). Mayflies, stoneflies and caddisflies commonly begin to exhibit significant mortality in these ranges (Nebeker, 1972; Chambers *et al*., 2000). Many organisms adapted to lentic environments (e.g. Diptera, Oligochaeta, Coleoptera) would still perform well and their populations may thrive in the absence of some of these other competitors (TEL, 2005a). It is important to note though, that the acute toxicity of most contaminants is elevated under conditions of low levels of DO (Sprague, 1985). Therefore, any negative effects on assemblages of macroinvertebrates observed at low levels of DO may be compounded by changes in toxicity. Many species of macroinvertebrates that become stressed by environmental factors have the ability to drift downstream in search of better conditions.

Macroinvertebrates dependent upon aquatic habitat that are unable to relocate to other areas of aquatic habitat are likely to perish as a result of dessication and/or predation as the pools drain. Nonetheless, if adverse impacts on macroinvertebrates were to occur at specific locations (e.g. particular pools), the remaining unaffected pools (which would be acting concurrently as refugia pools), would more than likely rapidly seed macroinvertebrate re-establishment within the impacted pool, when water levels return.

It is likely that some rock fractures caused by subsidence would fill with alluvial deposits during subsequent flow events (depending on the nature of the stream and upstream fluvial process [Appendix C of the EA]). This process of fracturing, drying and water habitat recovery has been documented in the Waratah Rivulet as well as in streams affected by subsidence in central Utah, USA (Sidle *et al*., 2000). Flow monitoring in the Georges River after mining of Longwall Panels 25 to 28 (between May 1999 and July 2004) indicated that underflow rates declined following flood events, probably due to sediment becoming trapped in the fractures, causing partial blocking of some fracture flow pathways (*ibid*.). The Wainamatta Shale that overlie significant areas in the western domains provide a significant source of fine sediment. This source is also supplemented by material eroded from the Hawkesbury Sandstone areas (Appendix C of the EA).

Successful recovery following fractures induced by subsidence does not always occur. For example, in West Virginia, United States of America (USA), longwall-mined headwater streams were found to often re-emerge downstream but streams were particularly impacted near the source of impact (Stout, 2004). Abundance of macroinvertebrates in streams investigated by Stout (2004) recovered to reference conditions in the lower reaches but neither diversity nor longevity of the assemblages of macroinvertebrates recovered along the stream gradients. In contrast to this, a recent study of the assemblages of macroinvertebrates in the upper reaches of Wallandoola Creek and Lizard Creek (i.e. tributaries of the Cataract River), overlying areas undermined approximately 10 years ago, found no difference in the structure of assemblages compared to locations sampled in nearby streams that had never been exposed to mining activities (TEL, 2009b).

Fish

The composition and abundance of fish within coastal streams is controlled by flow regime, food supply, water quality, biotic interactions and habitat structure (Harris, 1995). Snags consisting of trees, limbs and root masses that are partly or wholly submerged are one of the most important habitat components for fish within a stream. Snags not only provide fish with shelter and a substratum for food but are also used as breeding sites by some species. Many fish would remain near the bank for shade, shelter and to avoid currents. Deep pools provide important fish habitat and may be used as refuge areas during drier times when flow in a stream decreases or stops. Even after prolonged droughts, fish are expected to rapidly recolonise drought-affected areas provided refuge areas such as deep pools are available to use during the drought. Other channel habitats such as undercut banks, rock ledges, boulders, macrophyte beds and backwaters all offer key habitat sites for fish. Different fish species prefer different substratum types for breeding. In general, however, a stream with a sand or silt substratum is much less productive than a stream with a gravel substratum. The small spaces between rocks and gravel provide shelter for small fish and their food.

Mine subsidence can affect fish if water habitat becomes less available (e.g. pools drain and dry up), physical barriers to fish movement are created (e.g. sections of stream are drained for prolonged periods), chemical barriers are created, water quality is reduced (e.g. low DO concentrations), or fish eggs are smothered (e.g. iron precipitates form over eggs and rock surfaces in breeding areas).

In some cases, declines in water volume in pools can cause an increase in water temperature which could, in turn, cause a decrease in levels of DO. This is more likely in deeper pools (~2 to 3 m) where stratification of the water-column can develop. Increased temperatures and solar radiation can cause blooms of algae which in turn could lead to large daily changes in levels of DO and proliferation of organisms that graze on the attached algae. Reduced freshwater inflows also have the potential to exacerbate problems such as pollution associated with runoff from agricultural, industrial and residential areas (Pierson *et al*., 2002).

The conveyance of surface water flows to sub-surface fractures in areas affected by subsidence can also reduce connectivity among sections of a stream channel and may impede fish passage. The installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams is listed as a key threatening process under the FM Act. Alteration of natural flow regimes can occur by altering surface and subsurface water levels, reducing or increasing flows, changing the frequency, duration, magnitude, timing, predictability and variability of flow events and changing the rate of rise or fall of water levels. Many species of fishes are adversely impacted by changes to natural flows (DPI, 2006).

Alien species, particularly Mosquito Fish (*Gambusia holbrooki*), commonly thrive in disturbed habitats and still waters (McDowall, 1996), especially when pre-existing assemblages are depauperate (Ross, 1991; Stanford *et al*., 1996). Recent studies have found assemblages of fish in highly-regulated rivers (e.g. the Cataract and Nepean Rivers) have a greater proportional abundance of alien to native fish compared to un-regulated rivers (Gehrke *et al*., 1995; Gehrke and Harris, 2001). For example, in the Murray-Darling system, Gehrke *et al*. (1995) found a highly significant reduction in diversity of fish with increasing flow regulation.

The emission of strata gas caused by subsidence can cause a decline in levels of DO within a water column due to microbiological consumption of dissolved methane by natural aerobic bacteria, particularly during low flow conditions (EcoEngineers, 2008). Low concentrations of DO can result in adverse effects on many aquatic organisms, including fish, which depend upon oxygen for their functioning (ANZECC and ARMCANZ, 2000). The 1992 ANZECC Guidelines recommended that DO should not normally be permitted to drop below 6 mg/L or 80-90 % saturation, determined over at least one diurnal cycle. These data, however, were based almost exclusinvely on data from overseas, due to there being very little data available on oxygen tolerance of Australian and New Zealand aquatic organisms. Data for freshwater species of Australian fish indicate that concentrations of DO below 5 mg/L or 60-70 % saturation are stressful to many species (Koehn and O'Conner, 1990).

Riparian Vegetation

Riparian vegetation has several primary physical and biological functions, which are important in maintaining the health of aquatic systems (Turak and Bickel, 1994; Pusey and Arthington, 2003). Riparian vegetation increases habitat structural complexity and provides organic matter for many aquatic organisms (Cummins *et al*., 1997). For example, the roots of trees bind and stabilise the soil, minimise siltation, provide shelter and help to retain the general channel shape, including key habitat features such as pools, riffles and backwaters. Fallen leaf material provides food for macroinvertebrates, which then in turn provides food for fish or larger macroinvertebrates. More than half of the diet of predatory fish may come from invertebrate animals falling into the stream from the bank. Overhanging trees also provide shade and lowers water temperatures. This is beneficial because higher water temperatures can be detrimental to fish and can also increase the rate of algal growth.

The following sections provide an assessment of the potential impacts of the Project on assemblages of aquatic macrophytes, macroinvertebrates, fish and riparian vegetation for each domain in the Project area (Sections 6.3.1 to 6.3.7).

6.3.1 West Cliff Area 5

Streams present within this domain include the Georges River, Stokes Creek and several smaller tributaries of the Nepean River, the most notable being Nepean and Mallaty Creeks (Figure 2). All are classed as incised valleys in Hawkesbury Sandstone although the upper reaches of Nepean and Mallaty Creeks have significant flurial processes. The potential impacts of mining on biota (i.e. aquatic macrophytes, macroinvertebrates, fish and riparian vegetation) within and/or beside the watercourses that flow through this domain are discussed in Sections 6.3.1.1 to 6.3.1.4.

6.3.1.1 Aquatic Macrophytes

Submerged and floating attached species of macrophyte were relatively common at locations in the Georges River and Stokes Creek where stream channels were wider, sedimentary habitat was available for plants to colonise and there was generally permanent water available. The Project stream impact minimisation criteria includes avoidance of significant fracturing of rock bars resulting in surface flow diversion and draining of pools in the Georges River and in Stokes Creek.

Potential impacts on smaller streams in this domain (notably Nepean and Mallaty Creeks) are described in Section 6.2.1. Aquatic macrophytes, however, are not naturally abundant in these smaller watercourses because of their ephemeral nature. Furthermore, tributaries, including Mallaty Creek, are generally highly disturbed with degraded riparian vegetation due to extensive stock access, high levels of erosion and extensive interruption of flow from farm dams. Most pools on Mallaty Creek were observed to be highly turbid (Gilbert & Associates, 2009).

Given that Gilbert & Associates (2009) state that significant fracturing leading to localised surface flow loss is unlikely to occur within the Georges River and Stokes Creek and the low abundance of macrophytes in smaller tributaries within the domain, it is considered unlikely that the Project would have a significant impact on the composition or distribution of macrophytes within the West Cliff Area 5 domain.

6.3.1.2 Macroinvertebrates

The Project stream impact minimisation criteria includes avoidance of significant fracturing of rock bars resulting in surface flow diversion and draining of pools in the Georges River and in Stokes Creek. However, some isolated instances of iron staining and associated increases in concentrations of iron as well as temporary emissions of strata gas may occur in these watercourses (Appendix C of the EA). Reduced levels of DO could have a measurable impact on macroinvertebrates although only if they coincide with low flow conditions (i.e. coincide with a period of lower re-aeration co-efficient). As the water in the Georges River and this section of Stokes Creek would typically be re-aerated over a very short distance, the decrease in DO levels is not expected to have any significant impact on water quality (Gilbert & Associates, 2009). As impacts on water quality are expected to be minor, short-lived and localised (Appendix C of the EA), it is considered unlikely that populations of macroinvertebrates in the Georges River and Stokes Creek would be significantly affected. Notwithstanding, it is recommended that the spatial extent and duration of any incidence of reduced levels of DO associated with emissions of methane gas be monitored.

If disturbance to the smaller tributaries in this domain did include diversion of surface water, the potential resultant draining of pools may cause a temporary loss of small areas of aquatic habitat. Aquatic macroinvertebrates dependent upon this habitat that are unable to relocate to other areas of aquatic habitat are likely to perish as a result of dessication and/or predation as the pools drain. The drainage of a pool following river bed or rock bar fracturing could also prevent downstream drift of invertebrates. More mobile species, such as freshwater crayfish and yabbies, may be able to relocate to other areas of aquatic habitat. These species can also withstand prolonged periods of drought by retreating into their burrows (DPI, 2006). If adverse impacts on macroinvertebrates were to occur at pool specific locations, the significant remaining intact pools (acting concurrently as refugia pools), would likely rapidly seed macroinvertebrate re-establishment within the impacted pool, as and when water levels return.

Given that changes in water quality are predicted to be localised and transient (Gilbert & Associates, 2009), the aquatic habitat within the Project area is fairly extensive, and therefore assemblages of macroinvertebrates would be expected to recover quickly once water levels return, it is considered unlikely that populations would be significantly adversely affected by the small areas of habitat that may potentially be affected. Moreover, any potential impacts affecting the areas on the western side of the Georges River would be hard to discern, should they occur, because of the degraded nature of the existing aquatic habitat in this area.

No threatened aquatic macroinvertebrate species have been identified within the watercourses present within this domain. An assessment of potential impacts of the Project on threatened macroinvertebrates has been undertaken and is presented in Section 6.7.

6.3.1.3 Fish

As discussed previously in Section 6.2.1 to 6.2.8, Project related subsidence is not expected to be of sufficient magnitude to have a significant impact on the overall aquatic habitat within the Georges River or Stokes Creek. Given that impacts on water quality are expected to be minor, temporary and localised (Appendix C of the EA) and that fish are highly mobile, it is considered unlikely that populations of fish in the Gorges River and Stokes Creek would be significantly adversely affected by the small areas of habitat potentially affected by the Project.

Macquarie perch have recently been recorded in the Georges River near Punchbowl Creek approximately 15 km downstream of the Project (Scott Carter pers. comm.). Previously, this species has only been reported from the Georges River catchment once, in 1894 (DPI, 2008). Recent, intensive sampling in Stokes Creek did not detect any Macquarie perch despite the presence of suitable rocky pool habitat typically used by this species (Knight and Bruce, 2008). An assessment of potential impacts of the Project on Macquarie perch has been undertaken and is presented in Section 6.7.

Recent studies (Section 3) have found that the diversity and abundance of fish within the upper reaches of the smaller, ephemeral tributaries is generally very low. Fish living within these ephemeral systems are adapted to periods of no flow and reduced water levels. Notwithstanding, potential fish habitat and assemblages of fish within smaller, ephemeral tributaries within this domain, including Nepean and Mallaty Creeks, may be impacted in areas where fracturing and loss of water is predicted. Some species of fish, such as Freshwater eels, may be able to relocate to nearby pools, however, most species would likely perish as a result of desiccation and/or predation. Draining of pools in areas affected by subsidence also has the potential to result in a temporary barrier to fish passage. Although localised loss of fish are possible (e.g. in some pools), it is considered unlikely that such losses would have a significant impact on the size of populations within the Project area.

6.3.1.4 Riparian Vegetation

The degradation of native riparian vegetation along NSW watercourses is listed as a key threatening process under the FM Act. Riparian vegetation can potentially be impacted by subsidence primarily as a result of changes in the level of the stream water. Vegetation growing close to the stream bank can also be adversely affected by strata gas emissions. An example of this occurred near the Project area where oxidation of gas was attributed to causing the death of riparian vegetation along the Cataract River, above Tower Colliery longwalls (Everett *et al.*, 1998). In this case, the impacts appear to have been temporary as affected riparian vegetation recovered to resemble pre-mining conditions. Hence, it is considered unlikely that stream water level changes or strata gas emissions that may occur as a result of mine subsidence within this domain would disturb riparian vegetation to the extent that its ecological role would be adversely impacted.

6.3.2 Appin Area 7

Streams present within this domain include the Nepean River as well as Foot Onslow, Navigation and Ousedale Creeks. The Nepean River and Ousedale Creek are classified as incised valleys in Hawkesbury Sandstone while Foot Onslow and Navigation Creeks are classified as alluvial valleys in Wainamatta Shale. The potential impacts of mining on biota (i.e. aquatic macrophytes, macroinvertebrates, fish and riparian vegetation) within and/or beside the watercourses that flow through this domain are discussed in Sections 6.3.2.1 to 6.3.2.4.

6.3.2.1 Aquatic Macrophytes

Extensive assemblages of submerged macrophytes occur within the reaches of the Nepean River that occur within this domain. Appendix C of the EA predicts it highly unlikely that there would be any observable effects on stream flow or water levels within this reach of the Nepean River as a result of the Project. Therefore, it can be concluded that detectable impacts to assemblages of macrophytes here would be unlikely. This conclusion is supported by comparisons of macrophytes in reaches of the Nepean River that have undergone a net vertical uplift of 90-295 mm after extraction of Longwalls 701-704 as these comparisons have found no detectable changes in composition or distribution (TEL, 2009a).

The catchment areas of the upper reaches of Foot Onslow Creek, Navigation Creek and the smaller tributaries to the east of the Nepean River have been substantially cleared for agricultural development. Presently, few aquatic macrophytes occur within these tributaries due to the nature of available aquatic habitat (i.e. small, remnant pools), the degraded riparian vegetation, extensive stock access, high levels of erosion and extensive interruption of flow from farm dams.

The upper reaches of Ousedale Creek are also subject to modified flow due to construction of farm dams. In the lower reaches, reduced pool water levels could result in the exposure and desiccation of any beds of aquatic macrophytes. Such an event has been observed in the nearby Waratah Rivulet (see TEL, 2005-2006; Gingra Ecological Surveys, 2007). These impacts were shown to be short term and once pool water levels returned so too did the plants (Gingra Ecological Surveys, 2007).

Given the minor nature of predicted impacts and, in some areas, the low abundance of macrophytes, it is considered unlikely that the Project would have a significant impact on the composition or distribution of macrophytes within Appin Area 7.

6.3.2.2 Macroinvertebrates

EcoEngineers (2008) identified that, under low flow conditions, adverse impacts on levels of DO within the Nepean River may result from microbiological consumption of dissolved methane (a product of strata gas emissions). The Nepean River between Maldon Weir and Menangle Weir is particularly susceptible to depressed DO because this section of the flooded river has no cascades or rapids and therefore has a low re-aeration co-efficient (EcoEngineers, 2008). Depleted levels of DO in this section of the Nepean River would be likely to be slow to recover down river, particularly under low flow conditions (EcoEngineers, 2008). Widespread, prolonged, very low levels of DO in the Nepean River could have potential impacts on aquatic biota including aquatic macroinvertebrates.

To date, monitoring of levels of DO within the Nepean River has found no evidence of widespread, prolonged very low levels of DO related to mining activities (Ecoengineers, 2008). Moreover, monitoring of aquatic ecology at a number of sites within the Nepean River before, during and following extraction of Longwall 701 found no evidence of effect on macroinvertebrate fauna at sites adjacent to the longwall despite minor iron staining and gas release (TEL, 2009a). Notwithstanding, it is recommended that the spatial extent and duration of any incidence of reduced levels of DO associated with emissions of methane gas be monitored.

If disturbance to sections of the smaller tributaries, including Foot Onslow Creek, Navigation Creek and Ousedale Creek, which occur within this Domain, did include diversion of surface water, the potential resultant draining of pools may cause a temporary loss of small areas of aquatic habitat and/or prevent downstream drift of macroinvertebrates. Aquatic macroinvertebrates dependent upon this habitat that are unable to relocate to other areas of aquatic habitat are likely to perish as a result of dessication and/or predation as the pools drain. If adverse impacts on macroinvertebrates were to occur at pool specific locations, the significant remaining intact pools (acting concurrently as refugia pools), would likely rapidly seed macroinvertebrate re-establishment within the impacted pool, as and when water levels return.

Given that changes in water quality in smaller tributaries within this domain is predicted to be localised and transient (Appendix C of the EA) and that assemblages of macroinvertebrates should recover quickly once water levels return, it is considered unlikely that populations would be significantly adversely affected. Moreover, any potential impacts affecting these areas would be hard to discern, should they occur, because of the degraded nature of the existing aquatic habitat in this area.

No threatened aquatic macroinvertebrate species have been collected within the watercourses within this domain. An assessment of potential impacts of the Project on threatened macroinvertebrates has been undertaken and is presented in Section 6.7.

6.3.2.3 Fish

Regulation of the Nepean River through numerous weirs has transformed this river from a natural series of riffle and pool habitats to a series of very long, deep, slow flowing pools, separated by weirs. As discussed previously the Project stream impact minimisation criteria avoids draining of the Nepean River. Given that any reductions in DO associated with strata gas emissions are likely to be temporary and localised (Appendix C of the EA) and that fish are highly mobile, it is considered unlikely that strata gas emissions from mining induced subsidence resulting in reduced DO in the Nepean River would have a significant effect on any population of fish. Notably, monitoring of aquatic ecology at a number of sites within the Nepean River has found no evidence as yet that mining of longwalls has had any adverse effects on populations of fish despite minor iron staining and gas release (TEL, 2009a). Notwithstanding, it is recommended that the spatial extent and duration of any incidence of reduced levels of DO associated with emissions of methane gas be monitored.

Recent studies (Section 3) have found that the diversity and abundance of fish within the upper reaches of the smaller tributaries within this domain is generally very low. Notwithstanding, potential fish habitat may be impacted in areas where fracturing and loss of water is predicted. Some species of fish, such as Freshwater eels, may be able to relocate to nearby pools, however, most species would be likely to perish as a result of desiccation and/or predation. Although localised loss of fish are possible (e.g. in some pools), it is considered unlikely that the assemblages of fish present within the Project area would be altered significantly as only small areas of habitat would be potentially affected.

The Macquarie perch has previously been recorded in the Project area and surrounds, including in the Nepean River, downstream of Pheasants Nest Weir. An assessment of the potential impacts of the Project on the Macquarie perch has been undertaken and is presented in Section 6.7.

6.3.2.4 Riparian Vegetation

It is considered unlikely that changes in the level of water in streams or the emission of strata gas caused by mine subsidence within this domain would disturb riparian vegetation to the extent that its ecological role would be significantly adversely impacted. The potential impacts of changes in the water level of streams and emission of strata gas caused by subsidence is discussed further in Section 6.3.1.4.

6.3.3 Appin West (Area 9)

Streams present within this domain include the Nepean River, the upper reaches of Racecourse, Matahill and Harris Creeks as well as a small un-named 3rd order tributary of the Nepean River. The Nepean River, Harris Creek and the un-named tributary of the Nepean River are classified as incised valleys in Hawkesbury Sandstone while Racecourse Creek and the upper reaches of Matahill Creek are classified as alluvial valleys in Wianamatta Shale (Appendix C of the EA). The potential impacts of mining on biota (i.e. aquatic macrophytes, macroinvertebrates, fish and riparian vegetation) within and/or beside the watercourses that flow through this domain are discussed in Sections 6.3.3.1 to 6.3.3.4.

6.3.3.1 Aquatic Macrophytes

The section of the Nepean River that flows through this domain comprises a near continuous weir pool that has been created by the Douglas Park Weir. Given the avoidance of impacts to the Douglas Park Weir, (Appendix C of the EA), potential impacts to assemblages of macrophytes here should be similar in scale to those observed further downstream during the mining already undertaken in Appin Area 7 (i.e. no detectable change) (see Section 6.3.2.1).

Stream mapping and field investigations indicate that Harris Creek is typical of 3rd order streams formed in Hawkesbury Sandstone terrain. Little habitat for aquatic macrophytes is available in the upper reaches due to extensive erosion of the banks and channel probably caused by stock access. Significant lengths of the middle reaches of Harris Creek were mapped as comprising boulder fields with isolated rock bars and vegetated beds (Appendix C of the EA). Valley closure movements in areas near the middle reaches are predicted to be below 200 mm and subsequently fracturing resulting in diversion of flow is unlikely.

Reduced pool water levels in downstream reaches could result in the exposure and desiccation of some aquatic macrophytes. Such an event has been observed in the nearby Waratah Rivulet (TEL, 2005 to 2006; Gingra Ecological Surveys, 2007). These impacts were shown to be short term and once pool water levels returned so too did the plants (Gingra Ecological Surveys, 2007).

Based on predictions by Gilbert and Associates (2009), potential impacts to the upper reaches of Racecourse Creek and Matahill Creek and reaches of Navigation Creek should be similar in scale to those observed for smaller tributaries set in Wianamatta Shale (e.g. Foot Onslow Creek) within Appin Area 7.

Given that predictions about the impact of subsidence on aquatic habitat outlined in Section 6.2.3 indicate that impacts of these types are likely to be localised and would not persist once flow is restored, it is considered that the potential impacts of the Project on assemblages of macrophytes within the Appin Area 9 domain would be limited.

6.3.3.2 Macroinvertebrates

Given the avoidance of impacts to the Douglas Park Weir (Appendix C of the EA), potential impacts to assemblages of macroinvertebrates present in the reach of the Nepean River included in this domain should be similar in scale to those observed further downstream during mining of Appin Area 7 (see Section 6.3.2.2).

Based on predictions in Appendix C of the EA, potential impacts to assemblages of macroinvertebrates in the upper reaches of Racecourse Creek and Matahill Creek and reaches of Navigation Creek should be similar in scale to those observed for smaller tributaries set in Wianamatta Shale (e.g. Foot Onslow Creek) within Appin Area 7 (Section 6.3.2.2).

If disturbance to some reaches of Harris Creek did include diversion of surface water, the potential resultant draining of pools may cause a temporary loss of small areas of aquatic habitat. Aquatic macroinvertebrates dependent upon this habitat that are unable to relocate to other areas of aquatic habitat are likely to perish as a result of dessication and/or predation as the pools drain. The drainage of a pool following river bed or rock bar fracturing could also prevent downstream drift of macroinvertebrates. More mobile species, such as freshwater crayfish and yabbies, may be able to relocate to other areas of aquatic habitat. If adverse impacts on macroinvertebrates were to occur at pool specific locations, the significant remaining intact pools (acting concurrently as refugia pools), would likely rapidly seed macroinvertebrate re-establishment within the impacted pool, as and when water levels return.

Given that changes in water quality are predicted to be localised and transient (Appendix C of the EA), the aquatic habitat within the Project area is fairly extensive and that assemblages of macroinvertebrates should recover quickly once water levels return, it is considered unlikely that populations in Harris Creek or smaller tributaries within this domain would be significantly adversely affected. Moreover, any potential impacts affecting the areas on the western side of the Nepean River would be hard to discern, should they occur, because of the degraded nature of the existing aquatic habitat in this area.

No threatened aquatic macroinvertebrate species have been collected within watercourses within this domain. An assessment of potential impacts of the Project on threatened macroinvertebrates has been undertaken and is presented in Section 6.7.

6.3.3.3 Fish

Given the avoidance of impacts to the Douglas Park Weir (Appendix C of the EA), potential impacts to assemblages of fish in reaches of the Nepean River that occur within Appin Area 9 are expected to be similar in scale to those observed further downstream during mining of Appin Area 7 (see Section 6.3.2.3).

Recent studies (refer to Section 3) have found that the diversity and abundance of fish within the smaller tributaries within this domain is generally very low. Notwithstanding, potential fish habitat and assemblages of fish within Harris Creek, the upper reaches of Racecourse Creek and Matahill Creek, some reaches of Navigation Creek and other smaller, ephemeral tributaries within the domain may be impacted in areas where fracturing and loss of water is predicted. Some species of fish, such as Freshwater eels, may be able to relocate to nearby pools, however, most species would be likely to perish as a result of desiccation and/or predation. Although localised loss of fish are possible (e.g. in some pools), it is considered unlikely that the size of populations of fish present within the Project area would be altered significantly as Gilbert and Associates (2009) (Appendix C of the EA) predict only small areas of habitat would be potentially affected.

Known records of Macquarie perch occur within the Project area and surrounds, including in the Nepean River, downstream of Pheasants Nest Weir. An assessment of the potential impacts of the Project on the Macquarie perch has been undertaken and is presented in Section 6.7.

6.3.3.4 Riparian Vegetation

It is considered unlikely that changes in the level of water in streams or the emission of strata gas caused by mine subsidence within this domain would disturb riparian vegetation to the extent that its ecological role would be significantly adversely impacted. The potential impacts of changes in the water level of streams and emission of strata gas caused by subsidence is discussed further in Section 6.3.1.4.

6.3.4 Appin Area 8

Streams present within this domain include the Nepean River as well as Allens, Carriage, Byrnes and Racecourse Creeks. The Nepean River and Allens, Carriage and Byrnes Creeks and the upper reaches of Racecourse Creek are all classified as incised valleys in Hawkesbury Sandstone while the lower reaches of Racecourse Creek is classified as an alluvial valley in Wianamatta Shale. The potential impacts of mining on biota (i.e. aquatic macrophytes, macroinvertebrates, fish and riparian vegetation) within and/or beside the watercourses that flow through this domain are discussed in Sections 6.3.4.1 to 6.3.4.4.

6.3.4.1 Aquatic Macrophytes

Based on the stream design criteria for the Nepean River in this domain (Section 6.2.4), potential impacts to assemblages of macrophytes should be similar in scale to those observed further downstream during the mining already undertaken in Appin Area 7 (i.e. no detectable change) (see Section 6.3.2.1).

Based on predictions in Appendix C of the EA, it is considered that potential impacts of the Project on assemblages of macrophytes in Racecourse Creek would be similar in scale to those observed for Foot Onslow Creek and Navigation Creek within Appin Area 7 (Section 6.3.2.1) (i.e. minor).

The Project could potentially impact Carriage Creek, Byrnes Creek, Clements Creek, Stringybark Creek and Allens Creek by causing lowering of water levels in some pools during dry weather and this could result in the exposure and desiccation of macrophytes. These impacts are expected to be short-term because, as discussed in Section 6.3, obligate water plants can, in time, recolonise dry areas once water levels return. Moreover, any impacts from mining on macrophytes are expected to be difficult to discern because of the highly disturbed nature of the systems due to extensive stock access, high levels of erosion and extensive interruption of flow from the farm dams.

Given the temporary and limited nature of predicted impacts and, in some areas, low abundance of macrophytes, it is considered that the potential impacts of the Project on the composition or distribution of macrophytes within the Appin Area 8 domain would be very limited.

6.3.4.2 Macroinvertebrates

Based on predictions in Appendix C of the EA, potential impacts to assemblages of macroinvertebrates in this domain should be similar in scale to those observed further downstream in the Nepean River during the mining of Appin Area 7 (i.e. no detectable change) (see Sections 6.3.2.2 and 6.3.3.2).

Potential impacts to assemblages of macroinvertebrates in Racecourse Creek are expected to be minor because Gilbert and Associates (2009) (Appendix C of the EA) predict any fracturing of bedrock is unlikely to cause significant change to flow in areas with deep alluvial cover over bedrock.

If disturbance to some reaches of Carriage, Byrnes, Clements, Stringybark and Allens Creeks did include diversion of surface water, the potential resultant draining of pools may cause a temporary loss of small areas of aquatic habitat. Aquatic macroinvertebrates dependent upon this habitat that are unable to relocate to other areas of aquatic habitat are likely to perish as a result of dessication and/or predation as the pools drain. The drainage of a pool following river bed or rock bar fracturing could also prevent downstream drift of macroinvertebrates. More mobile species, such as freshwater crayfish and yabbies, may be able to relocate to other areas of aquatic habitat. If adverse impacts on macroinvertebrates were to occur at pool specific locations, the significant remaining intact pools (acting concurrently as refugia pools), would likely rapidly seed macroinvertebrate re-establishment within the impacted pool, as and when water levels return.

Given that changes in water quality are predicted to be localised and transient (Appendix C of the EA), the aquatic habitat within the Project area is fairly extensive and that assemblages of macroinvertebrates should recover quickly once water levels return, it is considered unlikely that populations in Carriage, Byrnes, Clements, Stringybark and Allens Creeks or smaller tributaries within this domain would be subject to significant adverse affects by the small areas of habitat that may potentially be affected. Moreover, any potential impacts affecting these streams would be difficult to discern, should they occur, because of the degraded nature of the existing aquatic habitat in this area.

No threatened aquatic macroinvertebrate species have been collected within watercourses within this domain. An assessment of potential impacts of the Project on threatened macroinvertebrates has been undertaken and is presented in Section 6.7.

6.3.4.3 Fish

Given the stream design criteria for the Nepean River, potential impacts to assemblages of fish in the Nepean River are expected to be minor.

Based on predictions in Appendix C of the EA, potential impacts to assemblages of fish in Racecourse Creek are expected to be minor. Recent studies (Section 3) have found diversity and abundance of fish within Carriage Creek, Clements Creek and Allens Creek to be very low. Although localised loss of individual fish are possible (e.g. in some pools), it is considered unlikely that the size of populations of fish present within the Project area would be altered significantly due to the Project.

The Macquarie perch has previously been recorded within the Project area and surrounds, including in the Nepean River, downstream of Pheasants Nest Weir. An assessment of the potential impacts of the Project on the Macquarie perch has been undertaken and is presented in Section 6.7.

6.3.4.4 Riparian Vegetation

It is considered unlikely that changes in the level of water in streams or the emission of strata gas caused by mine subsidence within this domain would disturb riparian vegetation to the extent that its ecological role would be significantly, adversely impacted. The potential impacts of changes in the water level of streams and emission of strata gas caused by subsidence is discussed further in Section 6.3.1.4.

6.3.5 Appin Area 2 Extended

Streams present within this domain include the uppermost headwaters of the Georges River, several low order unnamed tributaries of the Cataract Reservoir and a section of the Cataract River downstream of the Cataract Dam. All are classed as incised valleys in Hawkesbury Sandstone. The potential impacts of mining on biota (i.e. aquatic macrophytes, macroinvertebrates, fish and riparian vegetation) within and/or beside the watercourses that flow through this domain are discussed in Sections 6.3.5.1 to 6.3.5.4.

6.3.5.1 Aquatic Macrophytes

The Project stream impact minimisation criteria includes avoidance of significant fracturing of rock bars that would result in surface flow diversion and draining of pools in the Cataract River (Appendix C of the EA). Based on this, it is considered unlikely that the Project would have a significant impact on the composition or distribution of macrophytes within reaches of the Cataract River present within the Appin Area 2 Extended domain.

Potential impacts to assemblages of macrophytes in other smaller tributaries within this domain, including the uppermost headwaters of the Georges River, are expected to be minor due to the level of expected impacts. It is therefore considered unlikely that the Project would have a significant impact on the composition or distribution of macrophytes in the Appin Area 2 Extended domain.

6.3.5.2 Macroinvertebrates

Due to the potential impacts of the Project on the Cataract River, habitat loss for aquatic biota in the Cataract River is not expected. However, minor bubbling from emission of strata gas, iron staining and transient spikes in water quality parameters (including iron) are expected to occur in the Cataract River during low (environmental) flows (Appendix C of the EA). The presence of iron floc on the surface of aquatic plants, boulders, snags and the substratum could potentially reduce habitat available to macroinvertebrates and cause local changes in aquatic ecology. Emission of strata gas into the river could occur for a period of time and this could in turn potentially cause a reduction in DO in the water-column during low flow conditions (Appendix C of the EA). Low concentrations of DO can result in adverse effects on aquatic biota, which depend upon oxygen for their functioning (ANZECC and ARMCANZ, 2000), including macroinvertebrates.

The section of the Cataract River within the Project area is subjected to bulk water transfer of flows typically of the order of 50 to 150 ML/day (or sometimes as high as 550 ML/day) from the Cataract Dam (TEL, 2007c). As such, low flows within this section of the river are relatively infrequent (MSEC, 2005). It is expected that regular transfers of water from the Cataract Dam to Broughtons Pass Weir would flush and disperse any accumulated iron staining and flocs downstream. If water quality deteriorates through increased acidity, low DO or increased concentrations of metals, this is likely to occur in a relatively small area and for a short period of time (i.e. until water transfers and increased flows return). Therefore, impacts on macroinvertebrates are likely to be restricted to a very small area and for a relatively short period. This would be unlikely to have a significant overall effect on assemblages of macroinvertebrates within the Cataract River.

Gilbert and Associates (2009) predicts in Appendix C of the EA a range of impacts on the headwaters of the Georges River and low order, unnamed tributaries of the Cataract Reservoir (Section 6.2.5). Localised fracturing of rock bars and shelves, minor loss of flows during dry periods, continued iron staining, and periodic spikes of water quality parameters (including iron) in the unnamed tributaries of the Cataract Reservoir are expected (Appendix C of the EA). Macroinvertebrates dependent upon habitat in these areas that are unable to relocate to other areas of aquatic habitat are likely to perish as a result of increased desiccation and/or predation. The presence of iron floc on the surface of aquatic plants, boulders, snags and the substratum could reduce available habitat and cause local changes in aquatic ecology.

Emission of strata gas into the stream could occur at differing rates and volumes, which has the potential to cause a reduction in DO in the water-column, although this is unlikely to be measurable due to the high re-aeration co-efficient in these streams during flow. Nonetheless, if adverse impacts on macroinvertebrates were to occur at specific locations (e.g. particular pools), unaffected pools (which would be acting concurrently as refugia pools), would more than likely rapidly seed macroinvertebrate re-establishment within the impacted pool, during the next flow event. It is, therefore, considered unlikely that the Project would have any significant long-term impacts on the size of populations of macroinvertebrates in the upper Georges River, unnamed tributaries of the Cataract Reservoir or the reach of the Cataract River present within this domain.

No threatened aquatic macroinvertebrate species have been collected within watercourses within this domain. An assessment of potential impacts of the Project on threatened macroinvertebrates has been undertaken and is presented in Section 6.7.

6.3.5.3 Fish

Due to the potential impacts of the Project on the Cataract River, significant habitat loss for fish is not expected (Appendix C of the EA). Regular transfers of water from the Cataract Dam to Broughtons Pass Weir are expected to flush and disperse any accumulated iron staining and flocs downstream. In the unlikely event that water quality deteriorates through increased acidity, low DO or increased concentrations of metals, this is likely to occur in a relatively small area and for a short period of time (i.e. until water transfers and increased flows return). Therefore, impacts on assemblages of fish are likely to be restricted to a very small area and are not predicted to have a significant overall affect on fish within the Cataract River.

Based on predictions in Appendix C of the EA, it is expected that potential impacts to assemblages of fish in the upper reaches of the Georges River and low order tributaries of the Cataract Reservoir would be minor.

Viable populations of Macquarie perch occur within the Project area and surrounds, including a reach of the Cataract River, between the Cataract Dam and Broughtons Pass Weir. An assessment of the potential impacts of the Project on the Macquarie perch has been undertaken and is presented in Section 6.7.

6.3.5.4 Riparian Vegetation

It is considered unlikely that changes in the level of water in streams or the emission of strata gas caused by mine subsidence within this domain would disturb riparian vegetation to the extent that its ecological role would be significantly, adversely impacted. The potential impacts of changes in the water level of streams and emission of strata gas caused by subsidence is discussed further in Section 6.3.1.4.

6.3.6 Appin Area 3 Extended

Streams present within this domain include the Cataract River, three named tributaries of the Cataract River (i.e. Lizard, Wallandoola and Cascade Creeks), one un-named tributary of the Cataract River located between Lizard and Wallandoola Creeks and a section each of Clements and Third Point Creeks. All are classed as incised valleys in Hawkesbury Sandstone. The potential impacts of mining on biota (i.e. aquatic macrophytes, macroinvertebrates, fish and riparian vegetation) within and/or beside the watercourses that flow through this domain are discussed in Sections 6.3.6.1 to 6.3.6.4.

6.3.6.1 Aquatic Macrophytes

The Project stream impact minimisation criteria includes avoidance of significant fracturing of rock bars that would result in surface flow diversion and draining of pools in the Cataract River and Lizard Creek. Based on this, it is considered unlikely that the Project would have a significant effect on structure and distribution of assemblages of macrophytes within the reaches of these watercourses within the Area 3 Extended domain.

Stream mapping, field investigations and examination of past studies indicate that Wallandoola Creek, Cascade Creek and the un-named 3rd order tributary are all typical of 4th order and small 3rd order streams draining Hawkesbury Sandstone catchments in the area.

Macrophytes are not naturally abundant in the reaches of the named streams that occur within this domain or in the minor tributaries. Given the low abundance of aquatic macrophytes and nature of the predicted impacts (including in regard to Clements and Third Point Creeks), it is considered unlikely that the Project would have a significant impact on the composition or distribution of macrophytes in the Appin Area 3 Extended domain.

6.3.6.2 Macroinvertebrates

Based on predictions in Appendix C of the EA, potential impacts to assemblages of macroinvertebrates in the Appin Area 3 Extended reach of the Cataract River and Lizard Creek are expected to be similar in scale to those described for the upstream reaches of the Cataract River in Appin Area 2 Extended (Section 6.3.5.2). Potential impacts of the Project on Wallandoola and Cascade Creeks and the un-named 3rd order tributary are expected. For example, macroinvertebrates dependent upon this habitat that are unable to relocate to other areas of aquatic habitat are likely to perish as a result of increased desiccation and/or predation as the pools drain. The presence of iron floc on the surface of aquatic plants, boulders, snags and the substratum could reduce available habitat and cause local changes in aquatic ecology.

Emission of strata gas into the stream at varying rates and volumes could occur, which has the potential to cause a reduction in DO in the water-column, although this is unlikely to be measurable due to the high re-aeration co-efficient in these streams during flow. Nonetheless, if adverse impacts on macroinvertebrates were to occur at specific locations (e.g. particular pools), unaffected pools (which would be acting concurrently as refugia pools), would more than likely rapidly seed macroinvertebrate re-establishment within the impacted pool, during the next flow.

Notably, a recent study of assemblages of macroinvertebrates in the upper reaches of Wallandoola Creek and Lizard Creek that overly areas undermined approximately ten years ago, found no difference in the structure of assemblages compared to locations sampled in nearby streams that had never been exposed to mining activities (TEL, 2009b).

Given that changes in water quality are predicted to be localised and transient in watercourses within this domain and that assemblages of macroinvertebrates should recover, it is considered unlikely that the Project would have any significant long-term impacts on the size of populations of macroinvertebrates in watercourses within this domain.

No threatened aquatic macroinvertebrate species have been collected within watercourses within this domain. An assessment of potential impacts of the Project on threatened macroinvertebrates has been undertaken and is presented in Section 6.7.

6.3.6.3 Fish

The Project design criteria avoids flow diversion and pool loss in the Cataract River and Lizard Creek so, consequently, mine subsidence induced impacts are not predicted to cause significant habitat loss for fish (Appendix C of the EA).

Based on predictions in Appendix C of the EA, potential impacts to assemblages of fish are expected to be similar in nature to those described for other Project domains (section 6.3.1 to 6.3.5) (i.e. minor).

Viable populations of Macquarie perch occur within the Project area and surrounds, including a reach of the Cataract River, between the Cataract Dam and Broughtons Pass Weir. An assessment of the potential impacts of the Project on the Macquarie perch has been undertaken and is presented in Section 6.7.

6.3.6.4 Riparian Vegetation

It is considered unlikely that changes in the level of water in streams or the emission of strata gas caused by mine subsidence within this domain would disturb riparian vegetation to the extent that its ecological role would be significantly, adversely impacted. The potential impacts of changes in the water level of streams and emission of strata gas caused by subsidence is discussed further in Section 6.3.1.4.

6.3.7 North Cliff

Streams within this domain include the Woronora River as well as O'Hares, Stokes, Dahlia, Cobbong, and Punchbowl Creeks, all of which are classified as incised valleys in Hawkesbury Sandstone. The potential impacts of mining on biota (i.e. aquatic macrophytes, macroinvertebrates, fish and riparian vegetation) within and/or beside the watercourses that flow through this domain are discussed in Sections 6.3.7.1 to 6.3.7.4.

6.3.7.1 Aquatic Macrophytes

Based on the Project stream design criteria and the predicted impacts to O'Hares Creek, Stokes Creek and the Woronora River, it is considered unlikely that the Project would have a significant effect on the structure and distribution of assemblages of macrophytes within these watercourses.

Short-term impacts to some macrophytes are expected to occur in Stokes Creek, Dahlia Creek, Cobbong Creek and Punchbowl Creek, as well as minor tributaries due to the predicted impacts to these streams (Section 6.2.7). Stream mapping and field investigations indicate that macrophytes are not naturally abundant in the reaches of the named streams or minor tributaries that occur within this domain. Given the low abundance of aquatic macrophytes and nature of the predicted impacts, it is considered unlikely that the Project would have a significant impact on the composition or distribution of macrophytes in the North Cliff domain.

6.3.7.2 Macroinvertebrates

Stream mapping and field observations indicate that watercourses within this domain are typical of similar 3rd and 4th order streams in other Project domains (i.e. West Cliff Area 5 and Appin Areas 2 and 3 Extended). Based on predictions in Appendix C of the EA, potential impacts to assemblages of macroinvertebrates are expected to be similar in nature to those predicted in other domains. No threatened aquatic macroinvertebrate species have been collected within the watercourses present in this domain. An assessment of potential impacts of the Project on threatened macroinvertebrates has been undertaken and is presented in Section 6.7.

6.3.7.3 Fish

The Project design criteria avoids significant fracturing leading to flow diversion and pool loss in O'Hares Creek and Stokes Creek and impacts to the upper reaches of the Woronora River are reduced by not mining under the river. Assemblages of fish in the upper reaches of the Woronora River have been found to be depauperate and this is most likely associated with the presence of the Woronora Reservoir (Bio-Analysis, 2008).

Some reaches of O'Hares and Stokes Creek provide the rocky pool habitat typically used by Macquarie perch however, recent intensive sampling in these streams did not detect any individuals (Knight and Bruce, 2008). The Macquarie perch was not recorded in these streams during the Project surveys conducted in autumn 2008. Whilst it is considered unlikely that the Project would significantly impact on fish fauna within O'Hares Creek, Stokes Creek and the Woronora River, an assessment of potential impacts of the Project on Macquarie perch has been undertaken and is presented in Section 6.7.

The observations of previously undermined streams indicate that although mining is likely to increase the rate of leakage (and consequently pool level recession) of pools, it is likely that a portion of the pools subject to mine subsidence effects would hold some water during prolonged dry periods (Appendix C of the EA). These latter pools may remain full during most typical wetting and drying cycles providing refugia habitat for aquatic ecology (Appendix C of the EA).

Stream mapping indicates that the 2nd and 3rd order reaches of Punchbowl Creek that occur within the Project area are typical of similarly sized drainages in the Hawkesbury sandstone terrain. The stream falls from the ridgelines at the top of the catchment into the more incised flatter valley areas where it flows over a series of rock bars, small pools and small waterfalls and rapids. During the stream mapping, surface flow was frequently observed to disappear under rock bars and boulder fields and then reappear further downstream. Most pools observed were less than 50 m long and relatively shallow. The longest pool was mapped at about 200m long and some 1m deep. Riffle habitat typically used by fish such as the Macquarie perch to spawn was not present.

In summary, based on predictions made in Appendix C of the EA, potential impacts associated with the Project are expected to be similar in scale to 3rd and 4th order streams (e.g. Cascade Creek and Wallandoola Creek) and minor tributaries in Area 3 Extended.

6.3.7.4 Riparian Vegetation

It is considered unlikely that changes in the level of water in streams or the emission of strata gas caused by mine subsidence within this domain would disturb riparian vegetation to the extent that its ecological role would be significantly, adversely impacted. The potential impacts of changes in the water level of streams and emission of strata gas caused by subsidence is discussed further in Section 6.3.1.4.

6.4 Potential Impacts of Mine Water Discharge

At the Appin East pit top, mine water is released to the Georges River, upstream of its confluence with Brennans Creek. Mine water discharge is regulated by EPL 758. Mine water at the West Cliff pit top is released into Brennans Creek which flows into the Georges River. Mine water discharge from West Cliff pit top is regulated by EPL 2504. At the Appin West pit top, mine water is released into Sandy Gully and flows to the Nepean River via Clements Creek and Allens Creek. Mine water discharge at Appin West pit top is regulated by EPL 398.

TEL conducted a number of surveys between 2004 and 2005 to investigate the ecological effects of mine water discharge from the West Cliff pit top (2004a; 2006c), Appin East pit top (2004b; 2006b) and Appin West pit top (2004c; 2005b; 2006a). The surveys found that many water quality variables downstream of mine water discharge points exceeded the ANZECC and ARMCANZ (2000) guidelines (e.g. conductivity at Allens Creek [TEL, 2005b; 2006b] and Georges River [TEL, 2004a; 2004b; 2006b], pH at the Georges River [TEL, 2004a; 2004b; 2006b], DO at Georges River [TEL, 2004a] and salinity at Allens Creek [TEL, 2004c]). There was also some evidence of stratification of the water column near the confluence of Brennans Creek and Georges River (TEL, 2006c).

Surveys were also undertaken at three sites adjacent to each of the discharge points at West Cliff and Appin East pit tops and at three sites on each of two reference streams (i.e. Punchbowl Creek and O’Hares Creek) (TEL, 2006c). The surveys included investigations of water quality (i.e. alkalinity, conductivity, DO, oxygen redox potential, pH, temperature and turbidity) and macroinvertebrate distribution (using dip netting and a RAM based on the AUSRIVAS protocol).

An interim report on the surveys undertaken at Appin East pit top indicated that, according to the AUSRIVAS output, the mean O/E number of taxa from sites in the Georges River was less than in the two reference streams (TEL, 2004c). Comparison of the O/E numbers of taxa across sites along the Georges River suggests that the condition of sites ‘improves’ with distance downstream from the discharge point (TEL, 2004c). TEL (2004c) concluded that any impacts of mine discharge from Appin East pit top appeared to be confined to within a few hundred metres from the discharge point.

The final reports (i.e. following completion of the full monitoring program), however, found no evidence that the assemblages of macroinvertebrates in the vicinity of the West Cliff or Appin East pit tops were impoverished or that taxon richness and abundances were very low relative to those at control locations (TEL, 2006b, 2006c). The temporal variability in macroinvertebrates was not directly related to the variability in water quality indicators and could, instead, reflect temporal differences in the quality of the edge habitat available to macroinvertebrates at individual sites, possibly influenced by changes in the volume and frequency of discharge (TEL, 2006b; 2006c).

Importantly, the surveys were done at a time when the discharges from the two pit tops were the major sources of flow in this section of the Georges River, and these conditions had persisted for at least the past five years due to lower than average rainfall (TEL, 2006c). For this reason, TEL (2006c) concluded that the effects of mine water discharges on aquatic ecology were therefore likely to have been maximised relative to effects that would occur under normal or high flow. This implies that the impacts deemed to be small would be even smaller under natural or high flow regimes (TEL, 2006c).

Surveys were also done by TEL (2004a) to investigate the ecological effects of mine water discharged from Appin West pit top on Allens Creek and the Nepean River. The survey recorded no detectable impact of mine water discharge on macroinvertebrates within the edge habitat of the Nepean River in terms of O/E numbers of taxa (TEL, 2004a). The AUSRIVAS RAM rated most of the sites on Allens Creek and on the external control streams (i.e. Stonequarry Creek and the Bargo River) as being significantly impaired with substantial impacts on water/habitat quality. However, sites in the Nepean River near the confluence with Allens Creek showed little impairment, suggesting that the impacts of mine discharge in shallow edge habitats were relatively confined (TEL, 2004a).

Subsequent investigations into the effects of mine water discharge from the Appin West pit top found no evidence that the mine water discharge from Appin West pit top had adverse effects on aquatic macroinvertebrate fauna in Allens Creek or at its confluence with the Nepean River (TEL, 2006a). The macroinvertebrate assemblage at Allens Creek did not have significantly fewer taxa or total individuals or lower abundances of specific taxa than those at the control locations (TEL, 2006a).

Discharges from the three pit tops are licensed and regulated by the DECC via EPLs. IHCPL would continue to operate in accordance with these EPLs as part of the Project. Further, the West Cliff pit top discharge EPL 2504 requires the undertaking of a PRP. The PRP requires ICHPL to derive a scientifically justifiable salinity limit that would apply to the dry weather discharges from Brennans Creek Dam that flows to the Georges River catchment. In accordance with EPL 2504, the PRP will consider:

- the in-stream ecological effects in the Georges River of water discharges from West Cliff Colliery;
- the ecotoxicity, chemical composition, salt concentration and load of the discharge from West Cliff Colliery;
- relevant scientific literature on the impact of comparable salinity on ecosystem health; and
- the NSW Water Quality and River Flow Objectives for the Georges River.

As described in Section 2 in the Main Report of the EA, the existing water management system would be progressively augmented as water management requirements change over the life of the Project.

ICHPL intends to complete the PRP assessments and trials by the end of 2009 in accordance with the PRP.

The methods needed to achieve compliance with these limits would be the subject of another PRP following determination of the dry weather salinity limit. A plan to implement the preferred option would then follow for completion prior to July 2013 in accordance with the PRP under EPL No. 2504.

6.5 Other Direct or Indirect Potential Impacts

Project activities (e.g. ongoing surface exploration activities, the upgrade and extension of surface infrastructure, access tracks, environmental monitoring and management activities, stream restoration activities and other minor Project-related surface activities) have the potential to increase soil erosion/sedimentation or result in water contamination (e.g. fuel leakages from equipment or uncontrolled spills).

Project activities may also require the diversion/pumping of stream flow around surface activities (e.g. during stream restoration activities) that have the potential to obstruct fish movement. However, the diversion/pumping of stream flow around surface activities would be temporary in nature.

Human-caused Climate Change is listed as a key threatening process under the TSC Act and Loss of Climatic Habitat Caused by Anthropogenic Emissions of Greenhouse Gases is listed as a key threatening process under the EPBC Act.

The potential influence of climate change on the nature and extent of the Project potential impacts has been considered, including those relating to groundwater (Appendix B of the EA) and surface water (Appendix C of the EA). Heritage Computing (2009) concluded in Appendix B of the EA that the Project is likely to have a negligible incremental effect on baseflow and that the anticipated effects of climate change on baseflow in the project catchments are far greater than any changes in baseflow induced by mining (i.e. by more than two orders of magnitude). Climate change would produce more pronounced seasonal patterns of runoff, with increasing amounts of runoff occurring in summer and less in the autumn, winter and spring (Appendix C of the EA). Relative to the current streamflows, which are more winter dominated, the above effects have the potential to lead to a more uniform pattern of flows through the year (Appendix C of the EA.). There would be an increase in larger flow events in summer, however there would also be a tendency for reduced streamflow overall (*ibid*.). The effects described above would occur irrespective of any effects of longwall mining (Appendix C of the EA).

The predicted (slight) increase in summer rain and rainfall intensity has the potential to increase low flow persistence in summer which is, currently, likely to be the dominant time for low pool water levels and loss of inter-pool connection (Appendix C of the EA). The predicted large reductions in winter and spring rainfall would be expected to result in a significant change to the flow regime irrespective of any mining impacts (*ibid*.). The potential impacts of the Project on riparian vegetation (which are likely to be minor and limited in extent) are unlikely to significantly exacerbate the predicted effects of climate change (Appendix E of the EA).

The potential impacts of the Project may possibly slightly increase the vulnerability of the aquatic ecosystem to climate change. However, such impacts are likely to be relatively small and unlikely to significantly adversely affect aquatic biota and their habitats within the Project area.

6.6 Cumulative Impacts on Aquatic Ecology

Cumulative impacts can be defined as the total impact on the environment that results from the incremental impacts of the action (in this case, the Project) added to other past, present, and reasonably foreseeable future actions in a defined area. Cumulative impacts include direct and indirect impacts on the environment. An assessment of the cumulative impacts of the Project on aquatic ecology is provided in this section.

In regard to past and present actions, there are a number of historic (e.g. Tower Colliery, Appin Areas 1, 2, 3 and 4 workings) and present (e.g. Appin Longwalls 701 to 704 and West Cliff Longwalls 31 to 33) mining operations that are located in the vicinity of the Project (Figures 2 to 5). The locations of the Appin East and West Cliff pit tops are shown on Figure 4. A large proportion of the Project underground mining area and surrounds occur within the Woronora, Metropolitan and O'Hares Creek Special Areas, which are largely undeveloped and covered predominantly by native vegetation. A limited trail system exists for fire management and access for a range of catchment matters in this area.

A number of other land uses exist in the vicinity of mining operations including parks and reserves (e.g. Dharawal State Conservation Area and Dharawal Nature Reserve), residential areas (e.g. Douglas Park, Appin, Wilton, Maldon, Menangle Park and Wedderburn), infrastructure (e.g. the Hume Highway, Main Southern Railway, electricity transmission lines, bridges, communication towers and cables, and gas and water pipelines) and rural holdings (Figures 2 to 5). These past and present actions have been considered in the assessment of cumulative impacts. In regard to future actions, the likely extent and nature of impacts of any future mining in the vicinity of the Project is unknown at this stage. Future mining would be subject to separate assessment (including the assessment of cumulative impacts) and approvals and therefore the extent and nature of the impacts is yet to be determined.

This assessment of cumulative impacts on aquatic ecology has considered the species present (e.g. in terms of species diversity, abundance and dynamics), patterns of species distribution (the communities and ecosystem present that encompass all species), broad habitat types (the ecological niches for the range of species present), and ecosystem processes (how species interact through their involvement in key cycles, e.g. carbon, water and nutrient cycles, and the interception and flow of solar energy).

Based on the studies undertaken for the Project, other studies and available literature, the aquatic ecosystem and associated riparian community in the eastern and southern domains of Project area appear to be in reasonably good condition at all scales, and key ecosystem processes appear to be functionally intact. System resilience (the capacity of the aquatic ecosystem to self repair in response to perturbations such as drought and fire) appears to be very high. Areas in the western domains of the Project however have been subject to historic and current agricultural and rural disturbances which have resulted in the aquatic ecosystem appearing to be in a greatly reduced condition. The aquatic diversity and abundance present in the Project area appears typical of upland sandstone and shale rivers and tributaries.

The following aspects have also been considered in assessing cumulative impacts:

- The likely nature of the cumulative impacts.
- Whether the cumulative impacts, including those associated with the Project, are likely to be linear or exponential in nature or reflect some other relationship.
- Whether or not some or all impacts might interact synergistically to produce an overall impact greater than the sum of individual impacts.
- Whether the Project is likely to cause an ecological threshold to be exceeded and thereby lead to a change in ecological state as a result of any impacts.
- Whether or not the Project is likely to lead to a significant decline in the resilience of aquatic ecosystems.

- Whether or not key ecosystem cycles are likely to remain intact (e.g. carbon, water and nutrients) and whether or not solar energy interception is compromised as a result of cumulative impacts.
- Whether or not impact outcomes stabilise relatively quickly (e.g. in one to two years), take many year to fully express themselves (e.g. 10 year or more), or continue to develop over much longer periods of time.

Several predictions can be made regarding the cumulative impacts of the past, present and future actions described above (including potential impacts of the Project). These predictions are based on a future point in time when cumulative impacts have likely peaked within the footprint area under consideration. These predictions are based on the Surface Water Assessment (Appendix C of the EA) and Subsidence Assessment (Appendix A of the EA) and consequently rely on the precision, rigour and predictive capacity of these studies and the models therein. Specifically, the predictions presented below are contingent on the actual surface water and subsidence effects being equal to or less than those predicted. The predicted outcomes are:

- The impacts on aquatic ecology are likely to increase linearly and proportionally with the longwall area mined.
- No ecological threshold(s) would be exceeded at landscape scale.
- Ecological resilience across the footprint landscape would not be changed by the Project.
- Key ecosystem cycles would remain intact at landscape scale.
- Energy interception across the footprint landscape would not be compromised.
- The impacts described are likely to be fully expressed within a few years of the completion of site-specific mining and similarly at landscape scale when all mining ceases.

Although MSEC (2009) (Appendix A of the EA) consider the subsidence predictions (on which this assessment is based) to be conservative, contingent management would be employed where the effects are greater than those predicted (Appendices O and P of the EA), such that the predictions described above remain relevant.

6.7 Species Evaluations

This aquatic ecology impact assessment has been prepared in accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005), which identify important factors that must be considered when assessing potential impacts on threatened species, populations, or ecological communities, or their habitats for development applications assessed under Part 3A of the NSW *Environmental Planning and Assessment Act, 1979* (DEC and DPI, 2005). Threatened species evaluations have been conducted and include consideration of the following items:

- How is the Project likely to affect the lifecycle of a threatened species and/or population?
- How is the Project likely to affect the habitat of a threatened species, population or ecological community?
- Does the Project affect any threatened species or populations that are at the limit of its known distribution?
- How is the Project likely to affect current disturbance regimes?

- How is the Project likely to affect habitat connectivity?
- How is the Project likely to affect critical habitat?

Four threatened aquatic biota listed in the schedules of the TSC Act, FM Act or EPBC Act are known or considered to potentially occur in streams within the Project area or immediate surrounds, namely, Macquarie perch (*Macquaria australasica*), Sydney hawk dragonfly (*Austrocordulia leonardi*), Adams Emerald Dragonfly (*Archaeophya adamsi*) and Giant Dragonfly (*Petalura gigantea*). Only one of these species, namely the Macquarie perch, was recorded during the Project surveys.

The potential impact of the Project on each of these four threatened species is considered in this section. Species evaluations have been prepared using specific mine subsidence predictions for the Project area and an understanding of the likely mine subsidence impacts in relation to watercourses and water chemistry as described in the Subsidence Assessment (Appendix A of the EA), the Groundwater Assessment (Appendix B of the EA) and the Surface Water Assessment (Appendix C of the EA).

Macquarie Perch

The Macquarie perch inhabits the cool, clear water of rivers, lakes and reservoirs and prefers slow-flowing, deep rocky pools (Allen *et. al*., 2002). Macquarie perch generally occur as solitary fish, swimming near the bottom or in mid-water (Allen *et. al*., 2002). However, individuals form small shoals during the spawning season which occurs between October and December (*ibid*.). Macquarie perch move to areas just upstream of shallow riffles over gravel or rocky bottoms to spawn (*ibid*.). Macquarie perch in reservoirs move into flowing feeder streams to spawn (*ibid*.). Females release eggs, which settle among stones and gravel of the riverbed (DPI, 2005) or otherwise sink into fractures in the substrate (Allen *et. al*., 2002). Sexual maturity occurs after two years for males and three years for females (Allen *et. al*., 2002). A field study by Appleford *et. al*. (1998) has shown that both male and female Macquarie perch inhabiting rivers tend to mature at a much smaller size than conspecifics residing in lakes.

The diet of the Macquarie perch consists of aquatic insects, crustaceans and molluscs (DPI, 2005). This species mainly forages on the bottom and only takes a small proportion of its food at the water surface (Cadwallader and Eden, 1979 in Commonwealth Department of the Environment, Water, Heritage and the Arts [DEWHA], 2009). Migration associated with spawning is known to occur in lake dwelling Macquarie perch, however, migration may not be necessary in stream dwelling fish (DEWHA, 2009).

Threats to this species include river siltation, river regulation and degradation, degradation caused by inappropriate fire regimes, drought, recreational fishing and introduced fish (DEWHA, 2009). A viral disease carried by the Redfin perch (*Perca fluviatilis*), an introduced species, has also caused a decline in numbers of the Macquarie perch (Allen *et. al*., 2002).

Observations made in this study, and in previous studies (Gehrke and Harris, 1996; TEL, 2003c; 2005a), have shown that a viable population of the Macquarie perch is present in the Project area. This population occurs throughout the reach of the Cataract River between the Cataract Dam and the Broughtons Pass Weir. Individuals of this species have also been found in the Nepean River, downstream of Pheasants Nest Weir (Gerhke and Harris, 1996) and recently in the Georges River, near its confluence with Punchbowl Creek (S. Carter pers. com) approximately 15 km downstream of the Project extent of longwall mining area.

Previously, the Macquarie perch has only been reported from the Georges River catchment once, in 1894 (DPI, 2008). Intensive sampling in O'Hares Creek and Stokes Creek (tributaries of the Georges River) failed to detect any Macquarie perch despite the presence of rocky pool habitat typically used by this species in these areas (Knight and Bruce, 2008).

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Potential impacts of the Project on fish are summarised in Section 6. The lifecycle of the Macquarie perch has the potential to be adversely affected if activities associated with the Project cause loss of habitat (associated with rock bar fracturing and subsequent draining of pools), physical barriers (drainage of sections of stream resulting in extensive barriers to fish movement), chemical barriers, reduction in water quality (e.g. increased acidity or sediments loads, low DO levels and increased concentrations of metals such as iron, zinc, manganese and nickel) and smothering of eggs in breeding areas (e.g. iron precipitates forming over eggs and rock surfaces).

A viable population of Macquarie perch is present throughout the reach of the Cataract River, between the Cataract Dam and Broughtons Pass Weir. The Project stream design criteria avoids impacts such as significant fracturing resulting in flow diversion or draining of pools in the Cataract River, consequently, mine subsidence induced impacts are not predicted to lead to significant habitat loss for this species but minor bubbling and iron staining are expected to occur (Appendix C of the EA). Formation of iron oxide is not expected to cause detectable changes in water quality although minor aesthetic impacts may occur (EcoEngineers, 2008). Emission of strata gas into a river or stream can cause a reduction in DO in the water-column due to microbiological consumption of dissolved methane by natural aerobic bacteria, particularly during low flow conditions (EcoEngineers, 2008). Low concentrations of DO can result in adverse effects on many aquatic organisms, including fish, which depend upon oxygen for their functioning (ANZECC and ARMCANZ, 2000).

The section of the Cataract River within the Project area is subjected to bulk water transfer of flows typically of the order of 50 to 150 ML/day but can be as high as 550 ML per day from Cataract Dam (TEL, 2007c). As such, low flows within this section of the river are relatively infrequent (MSEC, 2005). If water quality deteriorates through increased acidity, low DO or increased concentrations of metals, impacts on Macquarie perch are likely to be restricted to a very small area and are not predicted to have an adverse affect on their lifecycle. It is expected that regular transfers of water from the Cataract Dam to Broughtons Pass Weir would flush and disperse any accumulated iron staining and flocs downstream.

Mining subsidence impacts to reaches of the Nepean River that occur within the Project area are not predicted to create new barriers to fish passage but deterioration of water quality following subsidence induced fracturing of the river bed and gas emissions are possible. It is expected that regular moderate to high flows would flush and disperse any accumulated iron staining and flocs downstream. The Nepean River is, however, particularly susceptible to impacts associated with gas emissions because it is a flooded river with no cascades or rapids between Maldon Weir and Menangle Weir, so it has a low re-aeration co-efficient (EcoEngineers, 2008). To date, monitoring of levels of DO within the Nepean River has found no evidence of widespread, prolonged very low levels of DO related to mining activities (Ecoengineers, 2008). Notably, monitoring of aquatic ecology at a number of sites within the Nepean River has found no evidence as yet that mining of longwalls has had any adverse effects on populations of fish despite minor iron staining and gas release (TEL, 2009a). It is considered highly unlikely that a viable population of the Macquarie perch is present in this section of the Nepean River, because of lack of suitable habitat (including natural riffle habitat required for Macquarie perch to spawn) and numerous barriers to fish passage from downstream. Nevertheless, it is recommended that the spatial extent and duration of reduced levels of DO associated with emissions of methane gas in some areas (associated with the induction of ferruginous springs) be monitored.

Riffle habitat and permanent pools within the Georges River and its larger tributaries (including O'Hares Creek, Stokes Creek and Punchbowl Creek) may provide important habitat for Macquarie perch within various stages of its life cycle. ICHPL would avoid directly undermining the Georges River and Stokes Creek in the West Cliff Area 5 domain and O'Hares Creek in the North Cliff domain, so loss of habitat due to fracturing of rock bars and subsequent draining of pools is not predicted to occur in these systems (Appendix C of the EA). Changes in water quality are predicted to be localised, transient and unlikely to cause adverse effects based on monitoring (Appendix C of the EA).

There is some potential for dilation fracturing to occur in a small section of Stokes Creek (~ 760 m in length) and in some sections of the upper reaches of Punchbowl Creek (i.e. ~15 km upstream of the confluence with the Georges River) (Appendix C of the EA). In Stokes Creek, Gilbert and Associates (2009) (Appendix C of the EA) predict that dilation fracturing could lead to reduced pool water levels during dry weather and possibly shallow pools drying up during prolonged dry weather. It is also possible that increased iron staining could occur in the area and possibly some methane gas release (Appendix C of the EA), the potential effects of which are discussed further in Question 2. The largest pool mapped in this section of the creek was about 10 m long (Appendix C of the EA). The pool had formed upstream of a prominent rock bars which was dry at the time that stream mapping was done (Appendix C of the EA).

Stream mapping indicates that the second and third order reaches of Punchbowl Creek that occur within the Project area are typical of similar sized drainages in the Hawkesbury sandstone terrain. The creek falls from the ridgelines at the top of the catchment into the more incised flatter valley areas where it flows over a series of rockbars, small pools and small waterfalls and rapids (Appendix C of the EA). Surface flow was frequently observed to disappear under rock bars and boulder fields and then reappear further downstream (Appendix C of the EA), presenting many natural barriers to upstream movement of fish within the upper reaches of the creek. Riffle habitat typically used by fish such as the Macquarie perch to spawn was not present.

Mine subsidence induced impacts resulting from the proposal are not predicted to lead to loss of riffle habitat or large permanent pools within watercourses that provide suitable habitat for this species within the Project area (i.e. Cataract River, Nepean River, Georges River, O'Hares Creek or the lower reaches of Stoes Creek and Punchbowl Creek) (Appendix C of the EA). Changes in water quality are predicted to be localised, transient and unlikely to cause adverse effects based on monitoring (Appendix C of the EA). It is therefore considered unlikely that the Project would have a significant adverse effect on the lifecycle of this species.

2. *How is the proposal likely to affect the habitat of a threatened species, population or ecological community?*

The Macquarie perch inhabits the cool, clear water of rivers, lakes and reservoirs and prefers slow-flowing, deep rocky pools (Allen et. al., 2002), especially with cover (DEWHA, 2009). The upper reaches of rivers and their tributaries are favoured, although individuals often occur in very low numbers (Bruce *et al*., 2007).

The Project stream design criteria would avoid the loss of riffle habitat or large permanent pools within watercourses that provide suitable habitat for the Macquarie perch (e.g. Cataract River, Nepean River, Georges River, Stokes Creek and O'Hares Creek). However, minor strata gas bubbling and iron staining are expected to occur (Appendix C of the EA). Some short-term, minor siltation and erosion may also occur as a result of mine subsidence-induced mobilisation of sediments, however, these impacts are likely to be relatively minor compared with those typically occurring during storm events.

Minor iron precipitates are not expected to cause detectable changes in water quality (EcoEngineers, 2008) but mats of iron reducing bacteria (flocs) could temporarily form in areas where diverted subsurface flows return to a waterway. Natural iron staining is commonly noted in streams in

Hawkesbury Sandstone. Large amounts of deposited floc material could potentially smother benthic habitat in breeding areas although these flocs are expected to be dispersed by high flows.

It is considered unlikely that potential impacts of Project-related subsidence would have a significant effect on quality or availability of habitat for the Macquarie perch.

3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Macquarie perch are generally found in the Murray-Darling Basin and parts of south-eastern coastal NSW, including the Hawkesbury and Shoalhaven catchments (DPI, 2005). The Macquarie perch occurs in the middle to upper reaches of the Murray River and its tributaries in NSW and Victoria as well as the Yarra system in Victoria (Allen *et. al*., 2002).

The Project is located within the known distribution of Macquarie perch and does not represent a distributional limit for this species.

4. How is the proposal likely to affect current disturbance regimes?

The frequency and magnitude of disturbance or environmental variability are key factors in determining both habitat diversity and species diversity (Connell, 1978; Ward and Stanford, 1983; Puckridge *et al*., 1998). The current disturbance regimes (i.e. processes that periodically affect a habitat) within the Project area include fire, natural flooding and bulk cold water releases from the Cataract Dam to Broughtons Pass Weir on the Cataract River, changed environmental flow patterns and a reduction in stream connectivity.

The disturbance regime most critical to the lifecycle and survival of Macquarie perch in the Project area is likely to be the flow regimes of rivers and streams. Modification of natural river flows can lead to reduced opportunities for dispersal (e.g. migration to other areas is possible when floodwaters rise) as well as degraded habitat quality. Habitat quality for the Macquarie perch can be degraded, for instance, when coarse substrata used for habitat and/or breeding (e.g. gravel) is smothered with fine sediments and/or iron flocs during prolonged periods of low flow. Scouring during high flows (e.g. floods) could remove or redistribute fine sediment. Habitat for this species may also be affected when declining water volume in pools causes an increase in water temperature which, in turn, causes a decrease in levels of DO and/or proliferation of algal blooms and the organisms that graze on the attached algae. Reduced freshwater inflows also have the potential to exacerbate problems such as pollution associated with runoff from agricultural, industrial and residential areas (Pierson *et al*., 2002). In addition, alien species, particularly *Gambusua holbrooki*, commonly thrive in disturbed habitats and still waters (McDowall, 1996) (Section 6).

It is considered unlikely that the Project would lead to a significant change in existing disturbance regimes (including flooding) and, therefore, would not increase adverse effects on the Macquarie perch. Furthermore, activities associated with bulk-water transfers from the Cataract Dam by the SCA would continue and be unaffected by the Project.

5. *How is the proposal likely to affect habitat connectivity?*

Loss of habitat connectivity for the Macquarie perch within the Project area would be possible if draining of pools due to subsidence resulted in complete exposure of any sections of the river bed. The Project stream design criteria avoids impacts such as significant fracturing leading to flow diversion or draining of pools in the Cataract River, Nepean River, Georges River, O'Hares Creek and Stokes Creek. There is likely to be reduced continuity of flow between affected pools in a small section of the upper reaches of Stokes Creek and in the upper reaches of Punchbowl Creek, however, the hydraulic capacity of the network in these areas is naturally not constant (Appendix C of the EA).

In the very unlikely event that strata gas emissions into the Nepean River cause prolonged, very low levels of DO in some sections of the river, and render habitat unsuitable to fish, it is expected that individual Macquarie perch would be able to take refuge in other similar deep water habitats present upstream and downstream of the affected area. As the water in the Cataract River, Georges River, O'Hares Creek and Stokes Creek would typically be re-aerated over a very short distance, any decrease in levels of DO levels are expected to be temporary and localized. It is therefore unlikely that the Project would have a significant adverse affect on habitat connectivity for the Macquarie perch.

6. *How is the proposal likely to affect critical habitat?*

There are no critical habitats for the Macquarie perch as listed under the FM Act. No areas of critical habitat as listed on the NSW National Parks and Wildlife Service (NPWS) Critical Habitat Register (NPWS, 2008) or DEWHA Register of Critical Habitat (2008) occur within the Project area or surrounds.

Sydney Hawk Dragonfly

The Sydney hawk dragonfly (*Austrocordulia refracta*) was first collected in 1968 from the Woronora River (downstream of the Woronora Dam, near Engadine) and subsequently at Kangaroo Creek (near Audley) (Theischinger, 1973), and later from the Nepean River (near Maldon Bridge) (Theischinger, 1997; Hawking and Theischinger, 1999). All specimens collected were found in deep riverine pools with cooler water (DPI- Fisheries, 2004). The Sydney hawk dragonfly has specific habitat requirements and has only previously been collected from deep, shady riverine pools with cooler water (DPI, 2005). Most of the lifecycle of this species is spent as aquatic larvae as, after metamorphosing, adults are only present for a few weeks (DPI-Fisheries, 2004). The larvae of the Sydney hawk dragonfly are found under rocks, where it may co-exist with the southern form of *Austrocordulia refracta* (Theischinger, 1997; Hawking and Theischinger, 1999). As is common to all dragonflies, this species is predatory (DPI, 2005). The larvae hunt or ambush aquatic prey whereas adults capture prey on the wing (*ibid*.).

Threats to the Sydney hawk dragonfly include the loss of natural deep pools through the regulation of rivers and alteration of flows, habitat degradation resulting from the removal of riparian vegetation as well as water pollution and siltation due to land clearing, waste disposal and stormwater runoff (DPI, 2005).

Despite widespread and consistent efforts, the Sydney hawk dragonfly has not been recorded in locations other than those detailed above (DPI-Fisheries, 2004). Moreover, intensive surveys in recent years have failed to detect the presence of any life stages of the Sydney hawk dragonfly along the Kangaroo Creek or in the Woronora River after the removal of the weir at Heathcote (Hawking and Theischinger, 2004). The species has not been located in the Project area.

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Potential impacts of the Project on macroinvertebrates are summarised in Section 6. The lifecycle of the Sydney hawk dragonfly has the potential to be adversely affected by the Project if subsidence causes a loss of habitat (e.g. associated with rock bar fracturing and subsequent draining of pools) or changes in water quality (including increased acidity, low DO levels and increased concentrations of metals such as iron, zinc, manganese or nickel).

The Sydney hawk dragonfly has specific habitat requirements, including slow-flowing water in rocky rivers with steep sides that provide shady resting areas. Large permanent pools within the Nepean and Georges Rivers within and downstream of the Project area appear to provide suitable habitat for the larvae of the Sydney hawk dragonfly. Rapid variation in water level and flow rate are thought to have a negative affect on the suitability of habitat for this species, consequently, this species is considered unlikely to be present in the reach of the Cataract River subjected to bulk cold water transfer from the Cataract Dam.

The Project stream design criteria avoids significant fracturing resulting in stream flow diversion and draining of pools in several streams that provide suitable habitat for Sydney hawk dragonfly (e.g. Nepean and Georges Rivers). Consequently, mine subsidence-induced impacts resulting from the Project are not predicted to lead to habitat loss through pool draining, however, minor strata gas bubbling and iron staining are expected to occur (Appendix C of the EA). Potential effects on the quality of water and formation of mats of iron reducing bacteria are predicted to be localised, transient and, based on monitoring, are unlikely to cause significant adverse affects (Appendix C of the EA).

Emission of strata gas into a river or stream can result in a reduction in DO in the water-column due to microbiological consumption of dissolved strata by natural aerobic bacteria, particularly during low flow conditions (EcoEngineers, 2008). In some watercourses (e.g. reaches of the Nepean River that occur within the Project area), deterioration of water quality following subsidence-induced fracturing of the river bed and subsequent strata gas emissions are possible. The Nepean River is particularly susceptible to low DO levels due to increased nutrient levels and a lack of turbulent flow and hence, strata gas emissions have the potential to increase these effects (EcoEngineers, 2008).

Although dragonflies, which are stressed by environmental factors, have the capability to drift downstream in search of better conditions, widespread, prolonged, very low levels of DO in the Nepean River are likely to be detrimental to the lifecycle of the Sydney hawk dragonfly. Such an occurrence however is considered extremely unlikely and more related to catchement effects other than the Project. Notwithstanding, it is recommended that the spatial extent and duration of any incidence of reduced levels of dissolved oxygen associated with emissions of strata as be monitored.

Generally, potential effects on water quality in large permanent pools within the Georges River are predicted to be localised, transient and unlikely to cause adverse effects (Appendix C of the EA).

It is considered unlikely that the Project would result in significant adverse effects on the lifecycle of the Sydney hawk dragonfly.

2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The Sydney hawk dragonfly has specific habitat requirements, including slow-flowing water in rocky rivers with steep sides that provide shady resting areas. Large permanent pools within the Nepean and Georges Rivers within and downstream of the Project area appear to provide suitable habitat for the larvae of the Sydney hawk dragonfly. Rapid variation in water level and flow rate are thought to have a negative affect on the suitability of habitat for this species, consequently, this species is considered unlikely to be present in the reach of the Cataract River subjected to bulk cold water transfer from Cataract Dam.

As described above, mine subsidence induced impacts resulting from the Project are not predicted to lead to loss of large permanent pools within watercourses that contain potential habitat for this species, however, minor strata gas bubbling and iron staining are predicted (Appendix C of the EA). Based on the findings of monitoring, potential effects on the quality of water and formation of mats of iron reducing bacteria due to the Project are predicted to be localised, transient and unlikely to cause significant adverse effects (Appendix C of the EA). Widespread, prolonged very low flows coinciding with high strata gas emissions leading to extensive reduced levels of DO in the Nepean River could potentially occur, and if it does, may reduce the quality of habitat for the Sydney hawk dragonfly. This however is considered very unlikely to occur. Notwithstanding, it is recommended that the spatial extent and duration of any incidence of reduced levels of DO associated with emissions of strata gas be monitored.

A range of management protocols are proposed to manage the activities of people using the Project area. These protocols would help to prevent further disturbances to habitat and, in particular, would help to minimise the potential for an increase in the frequency of fires (which can cause loss of shade in riparian areas as well as temporary changes in water quality).

The potential impacts of Project-related subsidence are not expected to have a significant effect on quality or availability of habitat for the Sydney hawk dragonfly such that it would be likely to place the species at risk of extinction.

3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The known distribution of the Sydney hawk dragonfly is extremely limited as it has been found at only three locations, all in a small area south of Sydney from Audley to Picton (DPI-Fisheries, 2004). The Sydney hawk dragonfly is known from the Hawkesbury-Nepean, Georges, Port Hacking and Karuah drainages (DPI, 2005). The Project area is located within the known distribution of the Sydney hawk dragonfly and does not represent a distributional limit for this species.

4. How is the proposal likely to affect current disturbance regimes?

The current disturbance regimes (i.e. processes that periodically affect a habitat) within the Project area include fire, natural flooding and bulk cold water releases from the Cataract Dam to Broughtons Pass Weir on the Cataract River, changed environmental flow patterns, and loss of in stream connectivity.

The disturbance regime most critical to the lifecycle and survival of the Sydney hawk dragonfly operating in the Project area is likely to be the flooding regimes of rivers and streams. Modification of natural river flows can lead to reduced opportunities for dispersal (e.g. migration of larvae between pools may be possible when floodwaters rise) as well as degraded habitat quality. For example, the quality of habitat of the Sydney hawk dragonfly can be degraded by siltation (DPI, 2005). Scouring during high flows (e.g. floods) could remove or redistribute fine sediment.

Habitat for this species may also be affected when declining water volume in pools causes an increase in water temperature as this species has only been found in deep, shady riverine pools with cooler water (DPI, 2005). Reduced freshwater inflows (e.g. from flooding) also have the potential to exacerbate problems such as pollution associated with runoff from agricultural, industrial and residential areas (Pierson *et al*., 2002). In addition, alien species, particularly *Gambusua holbrooki*, commonly thrive in disturbed habitats and still waters (McDowall, 1996) (Section 6).

An additional disturbance regime operating in the Project area that is likely to be important to the survival of the Sydney hawk dragonfly is fire. As a range of management protocols are proposed to be in place to manage activities of people in the Project area, the frequency of fires should not change as a result of the Project.

It is considered unlikely that the Project would lead to a significant change in existing disturbance regimes (including flooding and fire) in potential Sydney hawk dragonfly habitat and, therefore, would not increase adverse effects on the Sydney hawk dragonfly. Furthermore, activities associated with bulk-water transfers from the Cataract Dam by the SCA would continue and be unaffected by the Project.

5. How is the proposal likely to affect habitat connectivity?

Loss of habitat connectivity for the larval stage of the Sydney hawk dragonfly within the Project area would be possible if draining of pools occurred or the Project resulted in complete exposure of any sections of the river bed. The Project stream design criteria would avoid significant fracturing resulting in the diversion or the draining of pools in streams most likely to provide potential habitat for the Sydney hawk dragonfly (e.g. large permanent pools within the Nepean and Georges Rivers within and downstream of the Project area) (Appendix C of the EA). It is therefore unlikely that the Project would result in significant adverse effects on habitat connectivity for the Sydney hawk dragonfly.

6. How is the proposal likely to affect critical habitat?

No areas of critical habitat have been listed on the Threatened Species Schedules of the *FM Act* for the Sydney hawk dragonfly. No areas of critical habitat as listed on the NPWS Critical Habitat Register (NPWS, 2008) or DEWHA Register of Critical Habitat (2008) occur within the Project area or surrounds.

Adams Emerald Dragonfly

The Adams emerald dragonfly is one of Australia's rarest dragonflies with only five adults ever collected, all in the greater Sydney region (DPI-Fisheries, 2002). Adams emerald dragonfly are known to inhabit small streams with gravel or sandy bottoms, in narrow, shaded riffle zones with moss and rich riparian vegetation (DPI-Fisheries, 2002). Adams emerald dragonfly larvae live for approximately seven years and undergo various moults before metamorphosing into adults (DPI-Fisheries, 2002). Adults live for only a few months and, during this time, they generally fly away from the water to mature before returning to breed (DPI, 2005). Adult males congregate at breeding sites where they typically guard a territory and females are thought to lay their eggs into the water (*ibid*.). As is common to all dragonflies, this species is predatory (DPI, 2005). The larvae hunt or ambush aquatic prey whereas adults capture prey on the wing (*ibid*.).

Threats to this species include habitat degradation resulting from the removal of riparian vegetation as well as water pollution and siltation due to land clearing, waste disposal and stormwater runoff (DPI, 2005). Natural disasters may also threaten this species given that local extinctions could affect the survival of the species as a whole (*ibid*.).

The Adams emerald dragonfly was not located in the Project area during the current studies.

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Potential impacts of the Project on macroinvertebrates are summarised in Section 6. The Adams emerald dragonfly appears to have limited dispersal abilities and a low natural rate of recruitment (DPI, 2005). The lifecycle of the Adams emerald dragonfly has the potential to be adversely impacted by the Project if subsidence causes a loss of habitat (e.g. by changing the levels of ponding, flooding and scouring of banks along streams, by changing the alignment, altering the cross-bed gradient or by altering surface water flows associated with fracturing of stream beds) or changes in water quality (including increased acidity and salinity, low DO levels and increased concentrations of metals such as iron, zinc, manganese and nickel) (Section 6).

Mine subsidence in areas containing suitable habitat for this species (i.e. small to moderate sized streams including O'Hares and Stokes Creeks, the upper reaches of the Georges River, and in some reaches of some of the small to moderate sized tributaries) has the potential to adversely impact on stream water quality as well as other habitat for the Adams emerald dragonfly. The Project stream minimisation criteria avoids significant fracturing resulting in stream flow diversion and draining of pools in O'Hares Creek, the majority of Stokes Creek. The ephemeral headwater of the Georges River would not be directly undermined, thereby reducing potential hydrological effects (Appendix C of the EA). For streams such as Dahlia Creek, a tributary of the Cataract Reservoir and Punchbowl Creek, fracturing of bedrock and the consequent diversion of a portion of flow could occur. Fracturing of rock strata in watercourses can also result in a reduction in water level in pools and reduced continuity of flows between affected pools in dry weather (Appendix C of the EA).

This potential draining of pools may cause a temporary loss of small areas of aquatic habitat. The larvae of the Adams emerald dragonfly, if dependent upon areas of aquatic habitat that is drained are likely to perish as a result of desiccation and/or predation as the pools drain (if they are unable to relocate to other suitable areas of aquatic habitat). It is important to note that aquatic biota living within these ephemeral systems are adapted to periods of no flow and reduced water levels and that significant remaining intact pools (acting concurrently as refugia pools), commonly rapidly seed re-establishment as and when water levels return. In addition, the Adams emerald dragonfly has an adult stage that is capable of flying. Moreover, this loss of aquatic habitat would be likely to be temporary as it is only expected to be discernible during periods of low flow (Section 6).

Iron staining; transient spikes in water quality parameters such as iron associated with fracturing of bed rock and transient strata gas emissions are also predicted to occur (Appendix C of the EA). Mats of iron reducing bacteria (flocs) could temporarily form in areas where diverted subsurface flows discharge back into a waterway. Natural iron staining is commonly noted in streams in Hawkesbury Sandstone areas but large amounts of deposited floc material could potentially smother benthic habitat in breeding areas. These flocs can be dispersed by high flows.

In summary, based on existing information for the Sydney area it is unlikely that waterways within the Project area support an established population of the Adams emerald dragonfly. If a population of this species were to exist within the Project area, it is unlikely that the Project would disrupt the lifecycle of this species such that it would be likely to place this species at the risk of extinction. This conclusion is based on the prediction that any impacts such as water loss due to flow diversion into fractures, increased levels of ponding, flooding or scouring, sedimentation in riffles or degradation of water quality are predicted to be temporary, minor and localised in nature (Appendix C of the EA) and would be unlikely to have a significant impact in the context of the available habitat within the Project area.

2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The Adams emerald dragonfly favours small to moderate sized streams with gravel or sandy bottoms, in narrow, shaded riffle zones (DPI-Fisheries, 2002). Aquatic larvae of the Adams emerald dragonfly appear to have specific habitat requirements (i.e. small streams with gravel or sandy bottoms, in narrow, shaded riffle zones with moss and rich riparian vegetation). Suitable habitat for the Adams emerald dragonfly occurs in the Project area as riffle habitat in some small to moderate sized streams (e.g. O'Hares and Stokes Creek, the upper reaches of the Georges River and in some reaches of the small to moderate sized tributaries [such as Dahlia Creek, the tributary of the Cataract Reservoir and Punchbowl Creek]).

Mine subsidence in areas containing suitable habitat for this species has the potential to adversely impact on stream water quality as well as other habitat for the Adams emerald dragonfly. Any impacts such as water loss due to flow diversion into fractures, increased levels of ponding, flooding or scouring, sedimentation in riffles or degradation of water quality are predicted to be temporary, minor and localised in nature (Appendix C of the EA) and would be unlikely to have a significant impact in the context of the available habitat within the Project area.

A range of management protocols are proposed to manage the activities of people using the Project area. These protocols would help to prevent further disturbances to habitat and, in particular, would help to ensure that the frequency of fires (which can cause loss of shade in riparian areas) does not increase.

The potential impacts of Project-related subsidence are not expected to have a significant effect on quality or availability of habitat for the Adams emerald dragonfly such that it would be likely to place this species at the risk of extinction.

3. *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The Adams emerald dragonfly is known only from four localities, all in the greater Sydney region: Somersby Falls and Floods Creek in Brisbane Waters National Park near Gosford; Tunks Creek and Berowra Creek near Berowra and Hornsby; Bedford Creek in the Lower Blue Mountains; and Hungry Way Creek in Wollemi National Park (DPI- Fisheries, 2002). There are no records for the Adams emerald dragonfly south of Sydney despite widespread and consistent efforts to collect individuals since the 1960s (DPI-Fisheries, undated).

The Project area is located to the south of the known distribution of the Adams emerald dragonfly and, if discovered in the Project area, would represent a distributional limit for this species.

4. *How is the proposal likely to affect current disturbance regimes?*

The current disturbance regimes (i.e. processes that periodically affect a habitat) within the Project area include fire, natural flooding and bulk cold water releases from the Cataract Dam to Broughtons Pass Weir on the Cataract River, changed environmental flow patters, and loss of in stream connectivity.

The disturbance regime most critical to the lifecycle and survival of the Adams emerald dragonfly in the Project area is likely to be the flooding regimes of rivers and streams. Modification of natural river flows can lead to reduced opportunities for dispersal (e.g. migration of larvae between pools may be possible when floodwaters rise) as well as degraded habitat quality. For example, the quality of habitat of the Adams emerald dragonfly can be degraded by siltation (DPI, 2005). Scouring during high flows (e.g. floods) could remove or redistribute fine sediment. Reduced freshwater inflows (e.g. from flooding) also have the potential to exacerbate problems such as pollution associated with runoff from agricultural, industrial and residential areas (Pierson *et al*., 2002). In addition, alien species, particularly *Gambusia holbrooki*, commonly thrive in disturbed habitats and still waters (McDowall, 1996) (Section 6).

An additional disturbance regime operating in the Project area that is likely to be important to the survival of the Adams emerald dragonfly is fire. As a range of management protocols are proposed to be in place to manage activities of people in the Project area, the frequency of fires should not change.

It is considered unlikely that the Project would lead to a significant change in existing disturbance regimes (including flooding and fire) and, therefore, would not increase adverse effects on the Adams emerald dragonfly.

5. *How is the proposal likely to affect habitat connectivity?*

Loss of habitat connectivity for the larval stage of the Adams emerald dragonfly within the Project area would be possible if draining of pools following river bed or rock bar fracturing prevented downstream drift of invertebrates. The Adams emerald dragonfly has an adult stage that is capable of flying, although adults only live for a few months. Any impacts such as water loss due to flow diversion into fractures are predicted to be temporary, minor and localised in nature (Appendix C of the EA). For these reasons, it is considered unlikely that the Project would significantly adversely affect habitat connectivity for the Adams emerald dragonfly, such that it would be likely to place this species at the risk of extinction.

6. How is the proposal likely to affect critical habitat?

No areas of critical habitat have been listed on the Threatened Species Schedules of the FM Act for the Adams emerald dragonfly. No areas of critical habitat as listed on the NPWS Critical Habitat Register (NPWS, 2008) or DEWHA Register of Critical Habitat (2008) occur within the Project area or surrounds.

Giant Dragonfly

The Giant Dragonfly is the second largest dragonfly in Australia and one of the largest dragonflies in the world. Potential habitats of the Giant Dragonfly include permanent swamps and bogs containing some free water and open vegetation (NSW Scientific Committee, 2004). Females deposit eggs in moss or other soft vegetation (DEC, 2005). The larval stage is unusually long, being from at least ten to 30 years but adults are short-lived, surviving for only one summer after emerging in late spring (NSW Scientific Committee, 2004). Larvae inhabit permanent, long-chambered burrows with terrestrial entrances, from which they emerge at night, and in wet weather, in search of insects and other arthropods to eat (NSW Scientific Committee, 2004). Interestingly, larvae are not known to swim and avoid open water (NSW Scientific Committee, 2004). Adult Giant Dragonfly, which are also obligate carnivores, are thought to be poor flyers and do not readily disperse (NSW Scientific Committee, 2004).

Threats to the Giant Dragonfly include loss or modification of swamps, use of pesticides on or adjacent to swamps decreasing water quality of swamps caused by pollution and siltation and changes to natural water flows (DEC, 2005).

The largest and most viable population of this species is believed to occur in sphagnum swamp areas within Wingecarribee Swamp, near Moss Vale (NSW Scientific Committee, 2004). This species is difficult to detect as the adult stage is short-lived and the larvae are highly cryptic. The species was not located in the Project area during the current studies.

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The potential impacts of the Project on macroinvertebrates is summarised in Section 6. In addition, the potential impacts of the Project on upland swamps is provided in Appendix O of the EA. The lifecycle of the Giant Dragonfly could be adversely affected if activities associated with the Project cause the surface hydrological conditions in swamps to change. Subsidence-related fracturing can potentially influence the drainage flow regimes of upland swamps. Lower levels of moisture in the soil can cause swamps to be more vulnerable to fire and flood and can cause extensive erosion (Young, 1982; Krogh, 2004; 2007).

As outlined in Appendix O of the EA, the Project may result in significant negative consequences in eight of the 226 (3.5%) swamps within the Project area. However, ICHPL would develop and implement measures to mitigate and manage negative consequences in these eight swamps as part of the Project. It is therefore considered unlikely to have any biologically significant effect on the soil moisture regime that sustains vegetation/habitats in all swamps. For these reasons, it is unlikely that there would be an increase in fire frequency or erosion that could significantly adversely impact habitat for the Giant Dragonfly. It is considered unlikely that the Project would result in a reduction in the availability of habitat and resources such that the lifecycle of the Giant Dragonfly would be significantly adversely affected.

2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The Giant Dragonfly inhabits both coastal and upland permanent wetlands (NSW Scientific Committee, 2004). Direct loss of habitat for this species can occur as a result of vegetation clearance. However, vegetation clearance would not take place in upland swamps, except for very minimal clearance to enable monitoring (e.g. for equipment and access). Loss of habitat for the Giant Dragonfly within the Project area could also occur if changes in hydrology result in swamps partially or fully drying out. Subsidence-related fracturing can potentially influence the drainage flow regimes of upland swamps. Lower levels of moisture in the swamp soil can cause swamps to be more vulnerable to fire and flood and can cause extensive erosion (Young, 1982; Krogh, 2004; 2007). A significant increase in the frequency of fires could lead to habitat loss for the Giant Dragonfly.

The magnitude of the predicted effects of the Project on swamps is considered too small to influence the hydrological processes in all areas of suitable habitat for the Giant Dragonfly (Appendix O of the EA). A range of management protocols are proposed to manage the activities of people using the Project area. These protocols would help to prevent further disturbances to habitat and, in particular, would help to ensure that the frequency of fires is not increased. It is, therefore, unlikely that the Project would result in significant adverse affects on the quality or availability of habitat for the Giant Dragonfly.

3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Giant Dragonfly is found along the east coast of NSW, from the Victorian border to northern NSW, however, this species has not been recorded in most areas for many years (DEC, 2005; NSW Scientific Committee, 2004). The Giant Dragonfly is not found west of the Great Dividing Range (DEC, 2005). The Project area is located within the known distribution of the Giant Dragonfly and does not represent a distributional limit for this species.

4. How is the proposal likely to affect current disturbance regimes?

The current disturbance regimes (i.e. processes that periodically affect a habitat) within the Project area include fire and natural flooding. The disturbance regime most critical to the lifecycle and survival of the Giant Dragonfly in the Project area is likely to be fire. As a range of management protocols are proposed to be in place to manage activities of people in the Project area, the frequency of occurrence of fires is unlikely to change.

It is considered unlikely that the Project would lead to a significant change in existing disturbance regimes (including fire) and, therefore, would be unlikely to significantly adversely affect the Giant Dragonfly.

5. How is the proposal likely to affect habitat connectivity?

Loss of habitat connectivity for the Giant Dragonfly within the Project area could occur following the clearing of corridors that connect areas of habitat, a significant increase in the frequency of fires, or if changes in hydrology alter water levels and result in a swamp partially or fully drying out.

Vegetation clearance would not take place in upland swamps (the preferred habitat of this species), except for very minimal clearance to enable monitoring (e.g. for equipment and access). Given that a range of management protocols are proposed to be in place to manage the activities of people in the Project area and the predicted impacts on upland swamps described in Appendix O of the EA, it is unlikely that the Project would result in an increase in the frequency of fires. It is therefore unlikely that the Project would result in significant adverse affects on habitat connectivity for the Giant Dragonfly.

6. How is the proposal likely to affect critical habitat?

No areas of critical habitat, as defined by the TSC Act, have been declared for the Giant Dragonfly. No areas of critical habitat as listed on the NPWS Critical Habitat Register (NPWS, 2008) or DEWHA Register of Critical Habitat (2008) occur within the Project area or surrounds.

7.0 MITIGATION AND MANAGEMENT MEASURES

A Biodiversity Management Plan would be developed for the Project and would include measures to minimise impacts on aquatic biota and their habitats. These measures would be dependant on the nature and extent of the observed/predicted subsidence effects. Potential measures would include:

- vegetation clearance management measures;
- erosion and sediment control measures;
- management of fuels, oils and other hydrocarbons;
- control of weeds and exotic pests; and
- remediation of subsidence-effected rock bars and streams.

An aquatic ecology monitoring programme would be developed to monitor subsidence-induced impacts on aquatic ecology and to monitor the response of aquatic ecosystems to the implementation of mitigation/management measures. The aquatic ecology monitoring programme would be described in detail in the Biodiversity Management Plan, and would include representative monitoring streams and their tributaries. Further detail regarding the proposed mitigation and management measures is provided in Section 5 in the Main Report of the EA.

In regard to discharges from pit tops, Illawarra Coal would continue to operate in accordance with the relevant EPLs in consultation with the DECC and the outcomes of the current PRPs.

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Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at each Stream Replicate Using Random Quadrats

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Wallandoola Creek - 14/06/2008**										**Lizard Creek - 14/06/2008**									
Site	**WC1-1**					**WC1-2**					**LC1-1**					**LC1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Adiantum aethiopicum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ageratina riparia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Alternanthera denticulata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Andropgon virginicus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Aster squamatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baliskion sp.	0	50	0	0	0	40	10	0	0	0	0	0	0	0	10	0	0	0	20	0
Baumea rubiginosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baumea teretifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Bidens pilosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Callitriche stagnalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex fascicularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chorizandra cymbaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cirsium vulgaris*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Conyza bonariensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cladium procerum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cynodon dactylon*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cyperus eragrostis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperus polystachyos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drosera binata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eleocharis sphacelata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Elodea canadensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Entolasia stricta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Eragrostis curvula*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia clarkei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Gahnia sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gleichenia dicarpa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	20	0	10	0	30
Glossostigma elatinoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Gnaphalium* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gonocarpus micranthus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemarthria uncinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Hordeum leporinum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrilla verticillata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Hypochaeris radicata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hypolepis muelleri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isolepis cernua	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	20	0	0

Attachment A
Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Wallandoola Creek - 14/06/2008**										**Lizard Creek - 14/06/2008**									
Site	**WC1-1**					**WC1-2**					**LC1-1**					**LC1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Isolepis inundata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus fockeii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus microcephalus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus polyanthemus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus prismatocarpus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus sarophorus	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	5	0	0	0	0
Juncus subsecundus	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus usitatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma filiforme	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0
Lepidosperma gunnii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma laterale	0	0	0	0	10	0	0	0	0	0	50	0	0	20	0	0	0	0	10	0
Lepyrodia sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia scariosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ligustrum lucidum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra fluviatilis	0	0	0	0	40	0	0	40	0	20	0	0	0	10	0	50	0	0	0	0
Lomandra longifolia	0	0	0	0	0	0	0	20	0	10	0	0	20	0	0	0	0	0	0	20
**Nasturtium officinale*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Nephrolepis cordifolia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ottelia ovalifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Parietaria judaica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Paspalum dilatatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paspalum distichum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria decipiens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria hydropiper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Phalaris aquatica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Philydrum lanuginosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Plantargo lanceolata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potamogeton sulcatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pteridium esculentum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ranunculus repens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Rosa rubiginosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Rumex crispus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Setaria* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schenoplectus validus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus breviculmis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Wallandoola Creek - 14/06/2008**										**Lizard Creek - 14/06/2008**									
Site	**WC1-1**					**WC1-2**					**LC1-1**					**LC-1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Sida rhomba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spirodela sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Stenotaphrum secundatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sticherus flabellatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin microtuberosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin procerum	40	0	20	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin striatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristania neriifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristaniopsis laurina	0	0	0	80	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0
Typha orientalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Urtica incisa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vallisneria americana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Veronica anagallis-aquatica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Foot Onslow Creek - 13/06/2008**										**Rocky Ponds Creek - 13/06/2008**									
Site	**FC1-1**					**FC1-2**					**RPC1-1**					**RPC1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Adiantum aethiopicum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0
**Ageratina riparia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Alternanthera denticulata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Andropgon virginicus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Aster squamatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0
Baliskion sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baumea rubiginosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baumea teretifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Bidens pilosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Callitriche stagnalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0
Carex fascicularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chorizandra cymbaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cirsium vulgaris*	0	0	0	0	0	20	0	20	0	0	0	0	0	0	0	0	0	0	0	0
**Conyza bonariensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cladium procerum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cynodon dactylon*	0	0	0	0	20	10	10	30	10	0	0	0	10	0	0	0	0	10	0	0
**Cyperus eragrostis*	0	0	0	0	0	0	0	0	0	10	20	30	0	0	0	0	0	0	0	0
Cyperus polystachyos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drosera binata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eleocharis sphacelata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Elodea canadensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Entolasia stricta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Eragrostis curvula*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia clarkei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gleichenia dicarpa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glossostigma elatinoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Gnaphalium* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0
Gonocarpus micranthus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemarthria uncinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Hordeum leporinum*	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0
Hydrilla verticillata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Hypochaeris radicata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hypolepis muelleri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isolepis cernua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Foot Onslow Creek - 13/06/2008**										**Rocky Ponds Creek - 13/06/2008**									
Site	**FC1-1**					**FC1-2**					**RPC1-1**					**RPC1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Isolepis inundata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0
Juncus australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus fockeii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus microcephalus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus polyanthemus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus prismatocarpus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus sarophorus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus subsecundus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus usitatus	0	0	0	0	0	0	0	0	0	0	0	30	0	0	35	0	0	0	5	0
Lepidosperma sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma filiforme	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma gunnii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma laterale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia scariosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ligustrum lucidum*	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra fluviatilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra longifolia	0	0	0	0	0	0	0	0	0	0	30	0	20	60	0	70	0	0	20	90
**Nasturtium officinale*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Nephrolepis cordifolia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ottelia ovalifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Parietaria judaica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Paspalum dilatatum*	0	30	0	70	30	60	50	20	50	80	30	0	0	0	0	0	0	5	0	0
Paspalum distichum	100	60	90	20	0	0	0	0	40	5	20	20	0	0	0	0	0	0	0	0
Persicaria decipiens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria hydropiper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Phalaris aquatica*	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
Philydrum lanuginosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Plantago lanceolata*	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0
Potamogeton sulcatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pteridium esculentum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ranunculus repens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Rosa rubiginosa*	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Rumex crispus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Setaria* sp.	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0
Schenoplectus validus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus breviculmis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

< TOC Home >

Attachment A
Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Foot Onslow Creek - 13/06/2008**										**Rocky Ponds Creek - 13/06/2008**									
Site	**FC1-1**					**FC1-2**					**RPC1-1**					**RPC1-2**				
Replicate																				
Sida rhomba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spirodela sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
**Stenotaphrum secundatum*	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0
Sticherus flabellatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin microtuberosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin procerum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin striatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristania neriifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristaniopsis laurina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Typha orientalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Urtica incisa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vallisneria americana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Veronica anagallis-aquatica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Simpsons Creek - 13/06/2008**										**Cascade Creek - 13/06/2008**									
Site	**SIMP1-1**					**SIMP1-2**					**CC1-1**					**CC1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Adiantum aethiopicum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ageratina riparia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Alternanthera denticulata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Andropgon virginicus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Aster squamatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baliskion sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baumea rubiginosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baumea teretifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Bidens pilosa*	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Callitriche stagnalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex fascicularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chorizandra cymbaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cirsium vulgaris*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Conyza bonariensis*	0	0	20	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cladium procerum	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cynodon dactylon*	0	0	0	0	10	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cyperus eragrostis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperus polystachyos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drosera binata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eleocharis sphacelata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Elodea canadensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Entolasia stricta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Eragrostis curvula*	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia clarkei	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0
Gahnia sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gleichenia dicarpa	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
Glossostigma elatinoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Gnaphalium* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gonocarpus micranthus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	5	0
Hemarthria uncinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Hordeum leporinum*	0	0	50	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
Hydrilla verticillata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Hypochaeris radicata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hypolepis muelleri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	20	30	40	0	0
Isolepis cernua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Simpsons Creek - 13/06/2008**										**Cascade Creek - 13/06/2008**									
Site	**SIMP1-1**					**SIMP1-2**					**CC1-1**					**CC1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Isolepis inundata	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0
Juncus australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus fockeii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus microcephalus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus polyanthemus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus prismatocarpus	0	0	0	0	0	0	0	0	0	0	30	0	0	20	0	0	0	0	0	0
Juncus sarophorus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus subsecundus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	30
Juncus usitatus	0	0	0	0	0	0	0	10	0	20	0	0	0	0	0	0	0	0	0	0
Lepidosperma sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma filiforme	0	80	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0
Lepidosperma gunnii	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0
Lepidosperma laterale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia scariosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Ligustrum lucidum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra fluviatilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra longifolia	50	0	0	50	70	60	0	70	50	50	0	0	0	20	0	0	40	30	80	50
*Nasturtium officinale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Nephrolepis cordifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ottelia ovalifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Parietaria judaica	0	0	0	20	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
*Paspalum dilatatum	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paspalum distichum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria decipiens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria hydropiper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Phalaris aquatica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Philydrum lanuginosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Plantargo lanceolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potamogeton sulcatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pteridium esculentum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Ranunculus repens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Rosa rubiginosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Rumex crispus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Setaria sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schenoplectus validus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus breviculmis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	10	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Simpsons Creek - 13/06/2008**										**Cascade Creek - 13/06/2008**									
Site	**SIMP1-1**					**SIMP1-2**					**CC1-1**					**CC1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Sida rhomba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spirodela sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Stenotaphrum secundatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sticherus flabellatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin microtuberosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin procerum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin striatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristania neriifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristaniopsis laurina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Typha orientalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Urtica incisa*	0	0	0	0	0	0	0	10	20	0	0	0	0	0	0	0	0	0	0	0
Vallisneria americana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Veronica anagallis-aquatica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Georges River - 30/05/2008**										**Brennans Creek - 30/05/2008**									
Site	**GR1-1**					**GR1-2**					**BC1-1**					**BC1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Adiantum aethiopicum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Ageratina riparia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Alternanthera denticulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Andropgon virginicus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Aster squamatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baliskion sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baumea rubiginosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baumea teretifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Bidens pilosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Callitriche stagnalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex fascicularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chorizandra cymbaria	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0
*Cirsium vulgaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Conyza bonariensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cladium procerum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Cynodon dactylon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0
*Cyperus eragrostis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperus polystachyos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drosera binata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eleocharis sphacelata	0	15	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Elodea canadensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Entolasia stricta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Eragrostis curvula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia clarkei	0	0	0	0	0	0	0	0	0	25	0	0	15	15	40	0	0	0	0	0
Gahnia sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gleichenia dicarpa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glossostigma elatinoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Gnaphalium sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gonocarpus micranthus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemarthria uncinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Hordeum leporinum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrilla verticillata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Hypochaeris radicata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
Hypolepis muelleri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isolepis cernua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Georges River - 30/05/2008**										**Brennans Creek - 30/05/2008**									
Site	**GR1-1**					**GR1-2**					**BC1-1**					**BC1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Isolepis inundata	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus fockeii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus microcephalus	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus polyanthemus	0	0	0	0	0	0	0	5	0	0	80	40	0	0	0	0	0	50	20	20
Juncus prismatocarpus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus sarophorus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus subsecundus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus usitatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma filiforme	0	0	0	0	0	0	0	20	15	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma gunnii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma laterale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia scariosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ligustrum lucidum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra fluviatilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra longifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Nasturtium officinale*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Nephrolepis cordifolia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ottelia ovalifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Parietaria judaica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Paspalum dilatatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paspalum distichum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria decipiens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria hydropiper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Phalaris aquatica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Philydrum lanuginosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Plantargo lanceolata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potamogeton sulcatus	20	0	0	10	20	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0
Pteridium esculentum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ranunculus repens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Rosa rubiginosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Rumex crispus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Setaria* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schenoplectus validus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus breviculmis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Georges River - 30/05/2008**										**Brennans Creek - 30/05/2008**									
Site	**GR1-1**					**GR1-2**					**BC1-1**					**BC1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Sida rhomba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spirodela sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Stenotaphrum secundatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sticherus flabellatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin microtuberosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin procerum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin striatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristania neriifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristaniopsis laurina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Typha orientalis	25	0	80	10	60	0	0	0	0	0	0	0	0	0	0	80	60	0	0	0
**Urtica incisa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vallisneria americana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Veronica anagallis-aquatica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Brennans Creek Tributary - 30/05/2008**										**Nepean River - 28/05/2008**									
Site	**BCT1-1**					**BCT1-2**					**NP1-1**					**NP1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Adiantum aethiopicum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ageratina riparia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Alternanthera denticulata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Andropgon virginicus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Aster squamatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Baliskion sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baumea rubiginosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baumea teretifolia	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0
**Bidens pilosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Callitriche stagnalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex fascicularis	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0
Chorizandra cymbaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cirsium vulgaris*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Conyza bonariensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cladium procerum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cynodon dactylon*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cyperus eragrostis*	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0
Cyperus polystachyos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drosera binata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eleocharis sphacelata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Elodea canadensis*	0	0	0	0	0	0	0	0	0	0	90	0	90	0	20	90	90	0	0	0
Entolasia stricta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Eragrostis curvula*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia clarkei	0	0	0	0	80	0	40	0	0	30	0	0	0	0	0	0	0	0	0	0
Gahnia sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gleichenia dicarpa	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0
Glossostigma elatinoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Gnaphalium* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gonocarpus micranthus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemarthria uncinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Hordeum leporinum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrilla verticillata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70	0	0
**Hypochaeris radicata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hypolepis muelleri	0	20	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0
Isolepis cernua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Brennans Creek Tributary - 30/05/2008**										**Nepean River - 28/05/2008**									
Site	**BCT1-1**					**BCT1-2**					**NP1-1**					**NP1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Isolepis inundata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus fockeii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus microcephalus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus polyanthemus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus prismatocarpus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus sarophorus	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
Juncus subsecundus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
Juncus usitatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma filiforme	0	0	60	50	0	60	0	0	0	30	0	0	0	0	0	0	0	0	0	0
Lepidosperma gunnii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma laterale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia scariosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ligustrum lucidum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra fluviatilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra longifolia	50	20	5	0	0	0	0	0	30	0	0	10	0	0	0	0	0	0	0	0
**Nasturtium officinale*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Nephrolepis cordifolia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ottelia ovalifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Parietaria judaica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Paspalum dilatatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paspalum distichum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
Persicaria decipiens	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	30
Persicaria hydropiper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Phalaris aquatica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Philydrum lanuginosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Plantargo lanceolata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potamogeton sulcatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pteridium esculentum	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0
**Ranunculus repens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Rosa rubiginosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Rumex crispus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Setaria* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schenoplectus validus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus breviculmis	0	0	0	0	0	0	0	50	20	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Brennans Creek Tributary - 30/05/2008**										**Nepean River - 28/05/2008**									
Site	**BCT1-1**					**BCT1-2**					**NP1-1**					**NP1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Sida rhomba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spirodela sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Stenotaphrum secundatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sticherus flabellatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin microtuberosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin procerum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	5	0
Triglochin striatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristania neriifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristaniopsis laurina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Typha orientalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Urtica incisa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vallisneria americana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Veronica anagallis-aquatica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Clements Creek - 28/05/2008**										**Cascade Creek - 28/05/2008**									
Site	**CIC-1**					**CIC-2**					**CC2-1**					**CC2-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Adiantum aethiopicum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ageratina riparia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Alternanthera denticulata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Andropgon virginicus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Aster squamatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baliskion sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baumea rubiginosa	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0
Baumea teretifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Bidens pilosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	10	0	30
**Callitriche stagnalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex fascicularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chorizandra cymbaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0
**Cirsium vulgaris*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Conyza bonariensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cladium procerum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cynodon dactylon*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cyperus eragrostis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperus polystachyos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drosera binata	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
Eleocharis sphacelata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Elodea canadensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Entolasia stricta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Eragrostis curvula*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia clarkei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gleichenia dicarpa	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0
Glossostigma elatinoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Gnaphalium* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gonocarpus micranthus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemarthria uncinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Hordeum leporinum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrilla verticillata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Hypochaeris radicata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hypolepis muelleri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isolepis cernua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Clements Creek - 28/05/2008**										**Cascade Creek - 28/05/2008**									
Site	**CIC-1**					**CIC-2**					**CC2-1**					**CC2-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Isolepis inundata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus fockeii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus microcephalus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus polyanthemus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus prismatocarpus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus sarophorus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus subsecundus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus usitatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma filiforme	0	0	0	0	0	0	0	0	0	0	0	20	50	0	50	0	0	0	0	30
Lepidosperma gunnii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma laterale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia scariosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ligustrum lucidum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra fluviatilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0
Lomandra longifolia	0	50	0	100	40	0	100	100	0	30	0	60	20	10	0	0	20	50	0	20
**Nasturtium officinale*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Nephrolepis cordifolia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ottelia ovalifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0
**Parietaria judaica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Paspalum dilatatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paspalum distichum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria decipiens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria hydropiper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Phalaris aquatica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Philydrum lanuginosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0
**Plantargo lanceolata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potamogeton sulcatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pteridium esculentum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ranunculus repens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Rosa rubiginosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Rumex crispus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Setaria* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schenoplectus validus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus breviculmis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

< TOC Home >

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Clements Creek - 28/05/2008**										**Cascade Creek - 28/05/2008**									
Site	**CIC-1**					**CIC-2**					**CC2-1**					**CC2-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Sida rhomba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spirodela sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Stenotaphrum secundatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sticherus flabellatus	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0
Triglochin microtuberosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin procerum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin striatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristania neriifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristaniopsis laurina	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	50	0
Typha orientalis	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Urtica incisa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vallisneria americana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Veronica anagallis-aquatica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Nepean River - 20/05/2008**										**Nepean River - 20/05/2008**									
Site	**NP2-1**					**NP2-2**					**NP3-1**					**NP3-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Adiantum aethiopicum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ageratina riparia*	0	20	0	0	20	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
**Alternanthera denticulata*	0	0	0	0	0	0	0	0	0	0	0	30	10	60	0	20	0	0	0	0
**Andropgon virginicus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Aster squamatus*	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	40	20	0	0	10
Baliskion sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baumea rubiginosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baumea teretifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Bidens pilosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Callitriche stagnalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex fascicularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chorizandra cymbaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cirsium vulgaris*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Conyza bonariensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cladium procerum	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0
**Cynodon dactylon*	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	30
**Cyperus eragrostis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperus polystachyos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drosera binata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eleocharis sphacelata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Elodea canadensis*	0	30	0	0	0	20	0	0	0	0	0	0	0	0	40	0	0	0	30	0
Entolasia stricta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Eragrostis curvula*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia clarkei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia sp.#	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0
Gleichenia dicarpa	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glossostigma elatinoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Gnaphalium* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gonocarpus micranthus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemarthria uncinata	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Hordeum leporinum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrilla verticillata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0
**Hypochaeris radicata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hypolepis muelleri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isolepis cernua	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Nepean River - 20/05/2008**										**Nepean River - 20/05/2008**									
Site	**NP2-1**					**NP2-2**					**NP3-1**					**NP3-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Isolepis inundata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus fockeii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus microcephalus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus polyanthemus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus prismatocarpus	0	0	10	0	0	0	0	0	0	0	0	0	10	0	0	0	20	0	0	0
Juncus sarophorus	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0
Juncus subsecundus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus usitatus	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	10
Lepidosperma sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma filiforme	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma gunnii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma laterale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia scariosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*_Ligustrum lucidum_	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra fluviatilis	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra longifolia	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0
*_Nasturtium officinale_	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
*_Nephrolepis cordifolia_	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ottelia ovalifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*_Parietaria judaica_	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*_Paspalum dilatatum_	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
Paspalum distichum	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	5	0	0	0
Persicaria decipiens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria hydropiper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	10
*_Phalaris aquatica_	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Philydrum lanuginosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*_Plantargo lanceolata_	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potamogeton sulcatus	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0
Pteridium esculentum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*_Ranunculus repens_	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*_Rosa rubiginosa_	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*_Rumex crispus_	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0
*_Setaria_ sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schenoplectus validus	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0
Schoenus sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus breviculmis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Nepean River - 20/05/2008**										**Nepean River - 20/05/2008**									
Site	**NP2-1**					**NP2-2**					**NP3-1**					**NP3-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Sida rhomba	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	10	0	0	0
Spirodela sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Stenotaphrum secundatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sticherus flabellatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin microtuberosum	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin procerum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin striatum	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
Tristania neriifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristaniopsis laurina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Typha orientalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Urtica incisa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vallisneria americana	0	0	0	0	0	0	0	0	0	0	30	20	0	0	0	0	0	0	60	0
**Veronica anagallis-aquatica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola sp.	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	Racecourse Creek - 20/05/2008										O'Hares Creek - 26/04/2008									
Site	RC1-1					RC1-2					OC1-1					OC1-2				
Replicate	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Adiantum aethiopicum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ageratina riparia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Alternanthera denticulata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Andropgon virginicus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Aster squamatus*	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0
Baliskion sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baumea rubiginosa	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0
Baumea teretifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Bidens pilosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Callitriche stagnalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex fascicularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chorizandra cymbaria	0	0	0	0	0	0	0	0	0	0	0	80	0	0	0	0	0	0	50	0
**Cirsium vulgaris*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Conyza bonariensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cladium procerum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cynodon dactylon*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cyperus eragrostis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperus polystachyos	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drosera binata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eleocharis sphacelata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Elodea canadensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Entolasia stricta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Eragrostis curvula*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia clarkei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0
Gleichenia dicarpa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	10	0	0	0	0
Glossostigma elatinoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50
**Gnaphalium* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gonocarpus micranthus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemarthria uncinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Hordeum leporinum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrilla verticillata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Hypochaeris radicata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hypolepis muelleri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isolepis cernua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	Racecourse Creek - 20/05/2008										O'Hares Creek - 26/04/2008									
Site	RC1-1					RC1-2					OC1-1					OC1-2				
Replicate	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Isolepis inundata	0	0	10	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
Juncus australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus fockeii	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
Juncus microcephalus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus polyanthemus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus prismatocarpus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus sarophorus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus subsecundus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus usitatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma sp.#	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0
Lepidosperma filiforme	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma gunnii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma laterale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia scariosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Ligustrum lucidum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra fluviatilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra longifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	10	0	0
*Nasturtium officinale	0	0	20	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
*Nephrolepis cordifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ottelia ovalifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Parietaria judaica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Paspalum dilatatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paspalum distichum	0	0	0	0	60	0	0	0	0	70	0	0	0	0	0	0	0	0	0	0
Persicaria decipiens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria hydropiper	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
*Phalaris aquatica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Philydrum lanuginosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Plantargo lanceolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potamogeton sulcatus	0	0	50	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0
Pteridium esculentum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Ranunculus repens	0	0	0	30	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0
*Rosa rubiginosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Rumex crispus	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
*Setaria sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schenoplectus validus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus sp.#	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	40	0	0	0
Schoenus breviculmis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A
Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Racecourse Creek - 20/05/2008**										**O'Hares Creek - 26/04/2008**									
Site	**RC1-1**					**RC1-2**					**OC1-1**					**OC1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Sida rhomba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spirodela sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Stenotaphrum secundatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sticherus flabellatus	0	0	0	0	0	0	0	0	0	0	30	0	0	0	30	50	0	0	0	0
Triglochin microtuberosum	0	20	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin procerum	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0
Triglochin striatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristania neriifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristaniopsis laurina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Typha orientalis	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Urtica incisa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vallisneria americana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Veronica anagallis-aquatica*	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**O'Hares Creek - 26/04/2008**										**Stokes Creek - 26/04/2008**									
Site	**OC2-1**					**OC2-2**					**SC1-1**					**SC1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Adiantum aethiopicum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ageratina riparia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Alternanthera denticulata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Andropgon virginicus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Aster squamatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baliskion sp.	0	0	0	0	0	0	2	0	20	0	0	0	0	0	0	50	0	20	10	0
Baumea rubiginosa	0	0	0	0	0	0	0	0	0	0	0	5	0	0	10	0	0	0	5	0
Baumea teretifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0
**Bidens pilosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Callitriche stagnalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex fascicularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chorizandra cymbaria	2	0	2	0	5	10	0	0	10	0	0	0	0	0	0	0	0	0	0	0
**Cirsium vulgaris*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Conyza bonariensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cladium procerum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cynodon dactylon*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cyperus eragrostis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperus polystachyos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drosera binata	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
Eleocharis sphacelata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Elodea canadensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Entolasia stricta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Eragrostis curvula*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia clarkei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia sp.#	0	0	0	0	0	3	0	5	0	0	0	0	20	0	0	10	0	0	0	10
Gleichenia dicarpa	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	30	20	50	10	0
Glossostigma elatinoides	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
**Gnaphalium* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gonocarpus micranthus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemarthria uncinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Hordeum leporinum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrilla verticillata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Hypochaeris radicata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hypolepis muelleri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isolepis cernua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**O'Hares Creek - 26/04/2008**										**Stokes Creek - 26/04/2008**									
Site	**OC2-1**					**OC2-2**					**SC1-1**					**SC1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Isolepis inundata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus fockeii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus microcephalus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus polyanthemus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus prismatocarpus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus sarophorus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus subsecundus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus usitatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	20	0
Lepidosperma sp.#	5	20	0	5	0	10	0	0	0	10	0	0	0	0	0	0	5	0	0	0
Lepidosperma filiforme	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma gunnii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma laterale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia sp.#	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
Lepyrodia scariosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ligustrum lucidum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra fluviatilis	2	20	10	40	20	0	20	0	0	0	0	0	5	0	0	10	10	0	0	5
Lomandra longifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Nasturtium officinale*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Nephrolepis cordifolia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ottelia ovalifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Parietaria judaica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Paspalum dilatatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paspalum distichum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria decipiens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria hydropiper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Phalaris aquatica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Philydrum lanuginosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Plantargo lanceolata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potamogeton sulcatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pteridium esculentum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ranunculus repens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Rosa rubiginosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Rumex crispus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Setaria* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schenoplectus validus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus sp.#	0	0	0	0	0	0	10	0	0	5	0	0	0	0	0	0	0	0	0	0
Schoenus breviculmis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**O'Hares Creek - 26/04/2008**										**Stokes Creek - 26/04/2008**									
Site	**OC2-1**					**OC2-2**					**SC1-1**					**SC1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Sida rhomba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spirodela sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Stenotaphrum secundatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sticherus flabellatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin microtuberosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin procerum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin striatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristania neriifolia	5	0	5	30	0	5	0	10	0	5	0	0	0	0	0	0	0	0	0	0
Tristaniopsis laurina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Typha orientalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Urtica incisa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vallisneria americana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Veronica anagallis-aquatica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Stokes Creek - 26/04/2008**										**Cataract River - 13/04/2008**									
Site	**SC2-1**					**SC2-2**					**CR1-1**					**CR1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Adiantum aethiopicum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ageratina riparia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Alternanthera denticulata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Andropgon virginicus*	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0
**Aster squamatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baliskion sp.	1	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
Baumea rubiginosa	0	5	0	0	1	2	2	5	0	0	0	0	0	0	0	0	0	0	0	0
Baumea teretifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Bidens pilosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Callitriche stagnalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex fascicularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chorizandra cymbaria	0	0	0	0	0	2	0	20	2	0	30	0	0	0	0	0	0	0	0	0
**Cirsium vulgaris*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Conyza bonariensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cladium procerum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cynodon dactylon*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cyperus eragrostis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperus polystachyos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drosera binata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	10
Eleocharis sphacelata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Elodea canadensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Entolasia stricta	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Eragrostis curvula*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia clarkei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia sp.#	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
Gleichenia dicarpa	5	40	0	20	5	30	0	20	40	30	0	0	0	0	0	0	0	0	0	20
Glossostigma elatinoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Gnaphalium* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gonocarpus micranthus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemarthria uncinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Hordeum leporinum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrilla verticillata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Hypochaeris radicata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hypolepis muelleri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isolepis cernua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Stokes Creek - 26/04/2008**										**Cataract River - 13/04/2008**									
Site	**SC2-1**					**SC2-2**					**CR1-1**					**CR1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Isolepis inundata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0
Juncus fockeii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus microcephalus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus polyanthemus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus prismatocarpus	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	30	0	0
Juncus sarophorus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus subsecundus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus usitatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma sp.#	0	0	2	0	5	0	0	0	20	50	0	0	0	0	0	0	0	0	0	0
Lepidosperma filiforme	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Lepidosperma gunnii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma laterale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0
Lepyrodia sp.#	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia scariosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ligustrum lucidum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra fluviatilis	20	40	10	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra longifolia	0	0	5	0	0	0	0	0	0	0	0	0	50	0	0	0	20	0	0	0
**Nasturtium officinale*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Nephrolepis cordifolia*	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	30	0	0
Ottelia ovalifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Parietaria judaica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Paspalum dilatatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paspalum distichum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria decipiens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria hydropiper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Phalaris aquatica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Philydrum lanuginosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Plantargo lanceolata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potamogeton sulcatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pteridium esculentum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Ranunculus repens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Rosa rubiginosa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Rumex crispus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Setaria* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schenoplectus validus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus sp.#	0	0	0	0	0	5	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus breviculmis	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Stokes Creek - 26/04/2008**										**Cataract River - 13/04/2008**									
Site	**SC2-1**					**SC2-2**					**CR1-1**					**CR1-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Sida rhomba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spirodela sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Stenotaphrum secundatum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sticherus flabellatus	0	0	0	0	0	5	0	0	10	10	0	0	0	0	0	0	0	0	10	0
Triglochin microtuberosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin procerum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin striatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristania neriifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristaniopsis laurina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Typha orientalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Urtica incisa*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vallisneria americana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Veronica anagallis-aquatica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Cataract River - 13/04/2008**									
Site	**CR2-1**					**CR2-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Adiantum aethiopicum	0	0	0	0	0	0	0	0	0	0
**Ageratina riparia*	0	0	0	0	0	0	0	0	0	0
**Alternanthera denticulata*	0	0	0	0	0	0	0	0	0	0
**Andropgon virginicus*	0	0	0	0	0	0	0	0	0	0
**Aster squamatus*	0	0	0	0	0	0	0	0	0	0
Baliskion sp.	0	0	0	0	0	0	0	0	0	0
Baumea rubiginosa	0	0	0	0	0	0	0	0	0	0
Baumea teretifolia	0	0	0	0	0	0	0	0	0	0
**Bidens pilosa*	0	0	0	0	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	0	0	0	0	0	0	0
**Callitriche stagnalis*	0	0	0	0	0	0	0	0	0	0
Carex fascicularis	0	0	0	0	0	0	0	0	0	0
Chorizandra cymbaria	0	0	0	0	0	0	0	0	0	0
**Cirsium vulgaris*	0	0	0	0	0	0	0	0	0	0
**Conyza bonariensis*	0	0	0	0	0	0	0	0	0	0
Cladium procerum	0	0	0	0	0	0	0	0	0	0
**Cynodon dactylon*	0	0	0	0	0	0	0	0	0	0
**Cyperus eragrostis*	0	0	0	0	0	0	0	0	0	0
Cyperus polystachyos	0	0	0	0	0	0	0	0	0	0
Drosera binata	0	0	0	0	0	0	0	0	0	0
Eleocharis sphacelata	0	0	0	0	0	0	0	0	0	0
**Elodea canadensis*	0	0	0	0	0	0	0	0	0	0
Entolasia stricta	0	0	0	0	0	0	0	0	0	0
**Eragrostis curvula*	0	0	0	0	0	0	0	0	0	0
Gahnia clarkei	0	0	0	0	0	0	0	0	0	0
Gahnia sp.#	0	0	0	0	0	10	0	0	0	0
Gleichenia dicarpa	0	0	0	0	20	0	0	0	10	10
Glossostigma elatinoides	0	0	0	0	0	0	0	0	0	0
**Gnaphalium* sp.	0	0	0	0	0	0	0	0	0	0
Gonocarpus micranthus	0	0	0	0	0	0	0	0	0	0
Hemarthria uncinata	0	0	0	0	0	0	0	0	0	0
**Hordeum leporinum*	0	0	0	0	0	0	0	0	0	0
Hydrilla verticillata	0	0	0	0	0	0	0	0	0	0
**Hypochaeris radicata*	0	0	0	0	0	0	0	0	0	0
Hypolepis muelleri	0	0	0	0	0	0	0	0	0	0
Isolepis cernua	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Cataract River - 13/04/2008**									
Site	**CR2-1**					**CR2-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Isolepis inundata	0	0	5	0	0	0	20	0	0	0
Juncus australis	0	0	0	0	0	0	0	0	0	0
Juncus fockeii	0	0	0	0	0	0	0	0	0	0
Juncus microcephalus	0	0	0	0	0	0	0	0	0	0
Juncus polyanthemus	0	0	0	0	0	0	0	0	0	0
Juncus prismatocarpus	0	0	0	0	0	0	0	0	0	0
Juncus sarophorus	0	0	0	0	0	10	0	0	0	0
Juncus subsecundus	0	0	0	0	0	0	0	0	0	0
Juncus usitatus	0	0	0	0	0	0	0	0	0	0
Lepidosperma sp.#	0	0	0	0	0	0	0	0	0	0
Lepidosperma filiforme	0	0	0	0	0	0	0	0	0	0
Lepidosperma gunnii	0	0	0	0	0	0	0	0	0	0
Lepidosperma laterale	0	10	0	0	0	0	0	0	0	30
Lepyrodia sp.#	0	0	0	0	0	0	0	0	0	0
Lepyrodia scariosa	0	0	0	0	0	0	0	10	0	0
**Ligustrum lucidum*	0	0	0	0	0	0	0	0	0	0
Lomandra fluviatilis	30	0	0	0	0	30	0	30	0	0
Lomandra longifolia	0	0	0	0	0	0	0	0	0	0
**Nasturtium officinale*	0	0	0	0	0	0	0	0	0	0
**Nephrolepis cordifolia*	0	0	0	0	0	0	0	0	0	0
Ottelia ovalifolia	0	0	0	0	0	0	0	0	0	0
**Parietaria judaica*	0	0	0	0	0	0	0	0	0	0
**Paspalum dilatatum*	0	0	0	0	0	0	0	0	0	0
Paspalum distichum	0	0	0	0	0	0	0	0	0	0
Persicaria decipiens	0	0	0	0	0	0	0	0	0	0
Persicaria hydropiper	0	0	0	0	0	0	0	0	0	0
**Phalaris aquatica*	0	0	0	0	0	0	0	0	0	0
Philydrum lanuginosum	0	30	0	0	0	0	0	5	0	0
**Plantargo lanceolata*	0	0	0	0	0	0	0	0	0	0
Potamogeton sulcatus	0	0	0	60	0	0	0	0	0	0
Pteridium esculentum	0	0	0	0	0	0	0	0	0	0
**Ranunculus repens*	0	0	0	0	0	0	0	0	0	0
**Rosa rubiginosa*	0	0	0	0	0	0	0	0	0	0
**Rumex crispus*	0	0	0	0	0	0	0	0	0	0
**Setaria* sp.	0	0	0	0	0	0	0	0	0	0
Schenoplectus validus	0	0	0	0	0	0	0	0	0	0
Schoenus sp.#	0	0	0	0	0	0	0	0	0	0
Schoenus breviculmis	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Autumn 2008

Location - Date	**Cataract River - 13/04/2008**									
Site	**CR2-1**					**CR2-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Sida rhomba	0	0	0	0	0	0	0	0	0	0
Spirodela sp.	0	0	0	0	0	0	0	0	0	0
**Stenotaphrum secundatum*	0	0	0	0	0	0	0	0	0	0
Sticherus flabellatus	0	0	0	0	20	0	0	0	0	0
Triglochin microtuberosum	0	0	0	0	0	0	0	0	0	0
Triglochin procerum	0	0	0	0	0	0	20	0	0	0
Triglochin striatum	0	0	0	0	0	0	0	0	0	0
Tristania neriifolia	0	0	0	0	0	0	0	0	0	0
Tristaniopsis laurina	0	0	0	0	0	20	0	50	0	0
Typha orientalis	0	0	0	0	0	0	0	0	0	0
**Urtica incisa*	0	0	0	0	0	0	0	0	0	0
Vallisneria americana	0	0	0	0	0	0	0	0	0	0
**Veronica anagallis-aquatica*	0	0	0	0	0	0	0	0	0	0
Viola sp.	0	0	0	0	0	0	0	0	0	0

\# Not included in the sum of the 'Total Number of Taxa' for the survey period.

* Denotes an introduced species.

Denotes species not considered to be aquatic macrophytes (i.e. species that do not survive for long-periods of time when inundated with water, Geoff Sainty pers. comm. 2008). It should be noted that the species, *Tristaniopsis laurina* (Water gum), will survive in water for extended periods but has not been included as a macrophyte because it is a tree.

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Spring 2008

Location - Date	**Carriage Creek - 18/12/2008**										**Cataract Reservoir Tributary 2 - 18/12/2008**									
Site	**CaC-1**					**CaC-2**					**CRT2-1**					**CRT2-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
**Aster squamatus*	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
Baumea rubiginosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	80	0	30	0	0
Baumea teretifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex appressa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centrolepis fascicularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cyperus eragrostis*	0	10	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0
Dicksonia antarctica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eleocharis sp.	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Elodea canadensis*	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
Euchordia complanatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fimbristylis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia clarkei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gleichenia dicarpa	0	0	0	0	0	0	0	0	0	0	10	0	50	0	0	0	0	0	80	0
Glossostigma sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemarthria uncinata	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrocotyle sp.	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isolepis inundata	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
**Juncus articulatis*	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0
Juncus fockei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma filiforme	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma laterale	0	0	0	80	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0
Leotocarpus tenax	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	10
Lepyrodia scariosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra fluviatilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra longifolia	0	0	0	0	0	80	0	0	80	0	0	0	0	0	0	0	0	0	0	0
Paspalum distichum	0	0	50	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phragmites australis	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0
**Rumex conglomeratus*	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus melanostachys	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	20	0	0
Schoenoplectus mucronatus	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sticherus flabellatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristaniopsis laurina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Typha orientalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Spring 2008

Location - Date	**Tributary of Cataract Reservoir Tributary 2 - 18/12/2008**										**Georges River - Location 2 - 18/12/2008**									
Site	**TCRT-1**					**TCRT-2**					**GR2-1**					**GR2-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Baumea rubiginosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baumea teretifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex appressa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centrolepis fascicularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cyperus eragrostis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dicksonia antarctica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eleocharis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Elodea canadensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euchordia complanatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fimbristylis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	30
Gahnia clarkei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gleichenia dicarpa	0	20	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
Hemarthria uncinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0
Hydrocotyle sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isolepis inundata	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	10	0	0	0	0
**Juncus articulatis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus fockei	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0
Lepidosperma filiforme	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	10	0
Lepidosperma laterale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leotocarpus tenax	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia scariosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra fluviatilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra longifolia	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paspalum distichum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phragmites australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Rumex conglomeratus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus melanostachys	50	0	50	0	50	10	10	0	20	70	0	10	0	0	0	0	0	10	0	0
Schoenoplectus mucronatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sticherus flabellatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tristaniopsis laurina	0	0	0	0	0	0	0	0	0	0	0	0	0	80	0	0	0	40	0	0
Typha orientalis	0	0	0	0	0	0	0	0	0	0	0	0	80	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Spring 2008

Location - Date	**Wallandoola Creek - Location 2 - 17/12/2008**										**Dahlia Creek - 17/12/2008**									
Site	**WC2-1**					**WC2-2**					**DC-1**					**DC-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
**Aster squamatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baumea rubiginosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baumea teretifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	0	0	0	0	0	0	0	0	80	0	0	0	0	0	0	0	0
Carex appressa	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
Centrolepis fascicularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Cyperus eragrostis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dicksonia antarctica	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	10	0
Eleocharis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Elodea canadensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euchordia complanatus	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
Fimbristylis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia clarkei	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gleichenia dicarpa	5	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemarthria uncinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrocotyle sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isolepis inundata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Juncus articulatis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus fockei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma filiforme	35	5	70	5	0	0	20	60	0	0	0	10	0	0	0	0	0	0	10	0
Lepidosperma laterale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leotocarpus tenax	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia scariosa	0	0	0	0	40	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0
Lomandra fluviatilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra longifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paspalum distichum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phragmites australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
**Rumex conglomeratus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus melanostachys	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	70	70	0	0	80
Schoenoplectus mucronatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sticherus flabellatus	0	30	0	0	0	0	0	0	0	0	80	0	80	0	0	0	10	0	0	0
Tristaniopsis laurina	5	0	0	0	0	20	5	0	5	0	0	0	0	0	80	0	0	50	0	0
Typha orientalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment A

Percentage Cover of Aquatic Macrophyte Species Recorded at Each Stream Replicate Using Random Quadrats - Spring 2008

Location - Date	**Tributary of O'Hares Creek - 17/12/2008**									
Site	**TOC-1**					**TOC-2**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
**Aster squamatus* (marked *)	0	0	0	0	0	0	0	0	0	0
Baumea rubiginosa	0	0	0	0	5	0	0	10	0	0
Baumea teretifolia	0	0	0	0	0	0	0	10	0	0
Callicoma serratifolia	0	0	0	0	0	0	0	0	0	0
Carex appressa	0	0	0	0	0	0	0	0	0	0
Centrolepis fascicularis	0	0	0	0	0	0	0	0	10	0
**Cyperus eragrostis*	0	0	0	0	0	0	0	0	0	0
Dicksonia antarctica	0	0	0	0	0	0	0	0	5	0
Eleocharis sp.	0	0	0	0	0	0	0	0	0	0
**Elodea canadensis*	0	0	0	0	0	0	0	0	0	0
Euchordia complanatus	0	0	0	0	0	0	0	0	0	0
Fimbristylis sp.	0	0	0	0	0	0	0	0	0	0
Gahnia clarkei	0	0	0	0	0	80	0	0	0	0
Gleichenia dicarpa	0	0	0	0	30	0	0	0	20	0
Hemarthria uncinata	0	0	0	0	0	0	0	0	0	0
Hydrocotyle sp.	0	0	0	0	0	0	0	0	0	0
Isolepis inundata	0	0	0	0	0	0	0	0	0	0
**Juncus articulatis*	0	0	0	0	0	0	0	0	0	0
Juncus fockei	0	0	0	0	0	0	0	0	0	0
Lepidosperma filiforme	0	0	0	0	0	0	0	0	0	0
Lepidosperma laterale	0	0	0	0	0	0	0	0	0	0
Leotocarpus tenax	0	0	0	0	0	0	0	0	0	0
Lepyrodia scariosa	0	0	0	0	0	0	0	0	0	0
Lomandra fluviatilis	0	30	0	60	0	0	0	0	0	0
Lomandra longifolia	0	0	0	0	0	0	0	0	0	0
Paspalum distichum	0	0	0	0	0	0	0	0	0	0
Phragmites australis	0	0	0	0	0	0	0	0	0	0
**Rumex conglomeratus*	0	0	0	0	0	0	0	0	0	0
Schoenus melanostachys	20	0	0	0	0	0	0	0	30	0
Schoenoplectus mucronatus	0	0	0	0	0	0	0	0	0	0
Sticherus flabellatus	0	0	30	0	0	0	80	0	0	80
Tristaniopsis laurina	0	0	0	0	0	0	0	0	0	0
Typha orientalis	0	0	0	0	0	0	0	0	0	0

* denotes an introduced species

Note: Data = % cover measured in each quadrat (0.25 m^2)

Denotes species not considered to be aquatic macrophytes (i.e. species that do not survive for long-periods of time when inundated with water, Geoff Sainty pers. comm. 2008). It should be noted that the species, *Tristaniopsis laurina* (Water gum), will survive in water for extended periods but has not been included as a macrophyte because it is a tree.

Attachment B

Electrofish Survey and Fish Baiting Results

Attachment B
Electrofish Survey- Autumn 2008

	Location - Date	Wallandoola Creek - 14/06/2008						Lizard Creek - 14/06/2008						Rocky Ponds Creek - 13/06/2008		
	Site	**WC1-1**			**WC1-2**			**LC1-1**			**LC1-2**			**RPC1-2**		
	Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Anguilla australis	Short-finned eel	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Anguilla reinhardtii	Long-finned eel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Galaxias brevipinnis	Climbing galaxias	1	0	1	1	0	1	2	0	1	0	1	0	0	0	0
Gobiomorphus australis	Striped gudgeon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Gambusia holbrooki**	Gambusia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Retropinna semoni	Australian smelt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Philypnodon grandiceps	Flat head gudgeon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Macquaria novemaculeata	Australian bass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Philypnodon sp.	Dwarf flathead gudgeon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Macquaria australasica	Macquarie perch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Cyprinus carpio**	Common carp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tandanus tandanus	Freshwater catfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Location - Date	Cascade Creek - 13/06/2008						Georges River - 30/05/2008						Nepean River - 28/05/2008					
	Site	**CC1-1**			**CC1-2**			**GR1-1**			**GR1-2**			**NP1-1**			**NP1-2**		
	Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Anguilla australis	Short-finned eel	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Anguilla reinhardtii	Long-finned eel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Galaxias brevipinnis	Climbing galaxias	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiomorphus australis	Striped gudgeon	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
*Gambusia holbrooki**	Gambusia	0	0	0	0	0	0	3	5	4	32	13	23	3	5	4	0	0	0
Retropinna semoni	Australian smelt	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Philypnodon grandiceps	Flat head gudgeon	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	2	3	1
Macquaria novemaculeata	Australian bass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Philypnodon sp.	Dwarf flathead gudgeon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Macquaria australasica	Macquarie perch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Cyprinus carpio**	Common carp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tandanus tandanus	Freshwater catfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment B
Electrofish Survey- Autumn 2008

	Location - Date	**Cascade Creek - 28/05/2008**						**Nepean River - 20/05/2008**					
	Site	**CC2-1**			**CC2-2**			**NP2-1**			**NP2-2**		
	Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Anguilla australis	Short-finned eel	0	0	0	0	0	0	0	0	0	0	0	0
Anguilla reinhardtii	Long-finned eel	0	0	0	0	0	0	0	0	0	0	0	0
Galaxias brevipinnis	Climbing galaxias	0	0	0	0	0	0	0	0	0	0	0	0
Gobiomorphus australis	Striped gudgeon	0	0	0	0	0	0	0	0	0	0	0	0
*Gambusia holbrooki**	Gambusia	0	0	0	0	0	0	0	0	0	0	0	0
Retropinna semoni	Australian smelt	0	0	0	0	0	0	0	0	0	0	0	0
Philypnodon grandiceps	Flat head gudgeon	0	0	0	0	0	0	3	1	2	2	1	1
Macquaria novemaculeata	Australian bass	0	0	0	0	0	0	0	0	0	0	0	0
Philypnodon sp.	Dwarf flathead gudgeon	0	0	0	0	0	0	2	1	4	1	1	2
Macquaria australasica	Macquarie perch	0	0	0	0	0	0	0	0	0	0	0	0
*Cyprinus carpio**	Common carp	0	0	0	0	0	0	0	0	0	0	0	0
Tandanus tandanus	Freshwater catfish	0	0	0	0	0	0	0	0	0	0	0	0

	Location - Date	**Nepean River - 20/05/2008**						**Racecourse Creek - 20/05/2008**					
	Site	**NP3-1**			**NP3-2**			**RC1-1**			**RC1-2**		
	Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Anguilla australis	Short-finned eel	0	0	0	0	0	0	0	0	0	0	0	0
Anguilla reinhardtii	Long-finned eel	0	0	1	0	1	0	0	0	0	0	0	0
Galaxias brevipinnis	Climbing galaxias	0	0	0	0	0	0	0	0	0	0	0	0
Gobiomorphus australis	Striped gudgeon	0	0	0	0	0	0	0	0	0	0	0	1
*Gambusia holbrooki**	Gambusia	8	12	13	0	0	0	0	0	2	1	3	1
Retropinna semoni	Australian smelt	0	0	0	0	0	0	0	0	0	0	0	0
Philypnodon grandiceps	Flat head gudgeon	0	0	0	0	0	1	0	0	0	0	0	0
Macquaria novemaculeata	Australian bass	0	0	0	0	0	0	0	0	0	0	0	0
Philypnodon sp.	Dwarf flathead gudgeon	0	0	0	1	0	0	0	0	0	0	0	0
Macquaria australasica	Macquarie perch	0	0	0	0	0	0	0	0	0	0	0	0
*Cyprinus carpio**	Common carp	0	0	0	0	0	0	0	0	1	0	0	0
Tandanus tandanus	Freshwater catfish	0	1	1	0	0	0	0	0	0	0	0	0

Attachment B
Electrofish Survey- Autumn 2008

Location - Date		**O'Hares Creek - 26/04/2008**						**O'Hares Creek - 26/04/2008**					
Site		**OC1-1**			**OC1-2**			**OC2-1**			**OC2-2**		
	Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Anguilla australis	Short-finned eel	0	0	0	0	0	0	0	0	0	0	0	0
Anguilla reinhardtii	Long-finned eel	0	0	0	1	1	0	0	2	0	0	0	0
Galaxias brevipinnis	Climbing galaxias	0	0	0	0	1	2	0	0	0	0	0	0
Gobiomorphus australis	Striped gudgeon	0	0	0	0	0	0	0	0	0	0	0	0
*Gambusia holbrooki**	Gambusia	0	0	0	0	0	0	0	0	0	0	0	0
Retropinna semoni	Australian smelt	0	0	0	0	0	0	0	0	0	0	0	0
Philypnodon grandiceps	Flat head gudgeon	0	0	0	0	0	0	0	0	0	0	0	0
Macquaria novemaculeata	Australian bass	0	0	0	0	0	0	0	0	0	0	0	0
Philypnodon sp.	Dwarf flathead gudgeon	0	0	0	0	0	0	0	0	0	0	0	0
Macquaria australasica	Macquarie perch	0	0	0	0	0	0	0	0	0	0	0	0
*Cyprinus carpio**	Common carp	0	0	0	0	0	0	0	0	0	0	0	0
Tandanus tandanus	Freshwater catfish	0	0	0	0	0	0	0	0	0	0	0	0

Location - Date		**Stokes Creek - 26/04/2008**						**Stokes Creek - 26/04/2008**					
Site		**SC1-1**			**SC1-2**			**SC2-1**			**SC2-2**		
	Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Anguilla australis	Short-finned eel	0	0	0	0	0	0	0	0	0	0	0	0
Anguilla reinhardtii	Long-finned eel	0	0	0	0	0	0	0	0	0	0	0	0
Galaxias brevipinnis	Climbing galaxias	0	0	0	0	0	0	0	0	0	0	0	0
Gobiomorphus australis	Striped gudgeon	0	0	0	0	0	0	0	0	0	0	0	0
*Gambusia holbrooki**	Gambusia	0	0	0	0	0	0	0	0	0	0	0	0
Retropinna semoni	Australian smelt	0	0	0	0	0	0	0	0	0	0	0	0
Philypnodon grandiceps	Flat head gudgeon	0	0	0	0	0	0	0	0	0	0	0	0
Macquaria novemaculeata	Australian bass	0	0	0	0	0	0	0	0	0	0	0	0
Philypnodon sp.	Dwarf flathead gudgeon	0	0	0	0	0	0	0	0	0	0	0	0
Macquaria australasica	Macquarie perch	0	0	0	0	0	0	0	0	0	0	0	0
*Cyprinus carpio**	Common carp	0	0	0	0	0	0	0	0	0	0	0	0
Tandanus tandanus	Freshwater catfish	0	0	0	0	0	0	0	0	0	0	0	0

Attachment B
Electrofish Survey- Autumn 2008

	Location - Date	**Cataract River - 13/04/2008**						**Cataract River - 13/04/2008**					
	Site	**CR1-1**			**CR1-2**			**CR2-1**			**CR2-2**		
	Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Anguilla australis	Short-finned eel	0	0	0	0	0	0	0	0	0	0	0	0
Anguilla reinhardtii	Long-finned eel	0	0	0	0	0	1	0	0	0	0	0	1
Galaxias brevipinnis	Climbing galaxias	0	0	0	0	0	0	0	0	0	0	0	0
Gobiomorphus australis	Striped gudgeon	0	0	0	0	0	0	0	0	0	0	0	0
*Gambusia holbrooki**	Gambusia	4	9	11	0	0	0	0	0	0	0	0	0
Retropinna semoni	Australian smelt	0	0	0	0	0	0	0	0	0	0	0	0
Philypnodon grandiceps	Flat head gudgeon	0	0	0	0	0	0	0	0	0	0	0	0
Macquaria novemaculeata	Australian bass	0	0	0	0	0	0	0	0	0	0	0	0
Philypnodon sp.	Dwarf flathead gudgeon	0	0	0	0	0	0	0	0	0	0	0	0
Macquaria australasica	Macquarie perch	1	1	1	0	0	0	0	0	0	0	0	0
*Cyprinus carpio**	Common carp	0	0	0	0	0	2	0	0	0	0	0	0
Tandanus tandanus	Freshwater catfish	0	0	0	0	0	0	0	0	0	0	0	0

* Denotes an introduced species.

Note: No fish were caught at the following sites:

- Foot Onslow Creek; Sites FC1-1 and FC1-2; Replicates 1, 2 and 3 (13/06/2008).
- Rocky Ponds Creek; Site RPC1-1; Replicates 1, 2 and 3 (13/06/2008).
- Simpsons Creek; Sites SIMP1-1 and SIMP1-2; Replicates 1, 2 and 3 (13/06/2008).
- Brennans Creek; Sites BC1-1 and BC1-2; Replicates 1, 2 and 3 (30/05/2008).
- Brennans Creek Tributary; Sites BCT1-1 and BCT1-2; Replicates 1, 2 and 3 (30/05/2008).
- Clements Creek; Sites CIC-1 and CIC-2; Replicates 1, 2 and 3 (28/05/2008).

Attachment B
Bait Survey Results - Autumn 2008

Location - Date		**Georges River - 30/05/2008**						**Nepean River - 28/05/2008**					
Site		**GR1-1**			**GR1-2**			**NP1-1**			**NP1-2**		
	Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Species Name	**Common Name**												
Galaxias brevipinnis	Climbing galaxias	0	0	0	0	0	0	0	0	0	0	0	0
Philypnodon grandiceps	Flat head gudgeon	0	0	0	0	0	0	0	0	0	1	0	0
Retropinna semoni	Australian smelt	0	0	0	0	0	0	0	0	0	5	1	0
	Freshwater shrimp	0	0	0	3	0	0	0	0	0	0	0	0

Location and Date of Sampling		**Nepean River - 20/05/2008**						**Cataract River - 13/04/2008**					
Site		**NP2-1**			**NP2-2**			**CR2-1**			**CR2-2**		
	Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Species Name	**Common Name**												
Galaxias brevipinnis	Climbing galaxias	0	0	0	0	0	0	1	0	0	0	0	0
Philypnodon grandiceps	Flat head gudgeon	0	0	0	0	0	0	0	0	0	0	0	0
Retropinna semoni	Australian smelt	0	11	47	3	1	42	0	0	0	4	8	1
	Freshwater shrimp	0	0	0	0	0	0	0	0	0	0	2	0

Note:

Location was not suitable for baiting at the following sites:

- Wallandoola Creek; Sites WC1-1 and WC 1-2; Replicates 1, 2 and 3.
- Lizard Creek; Sites LC1-1 and LC1-2; Replicates 1, 2 and 3.
- Cascade Creek; Sites CC1-1, CC1-2, CC2-1 and CC2-2; Replicates 1, 2 and 3 .
- Rocky Ponds Creek; Sites RPC1-1 and RPC1-2; Replicates 1, 2 and 3.
- Foot Onslow Creek; Sites FC1-1 and FC1-2; Replicates 1, 2 and 3.
- Simpsons Creek; Sites SIMP1-1 and SIMP1-2; Replicates 1, 2 and 3.
- Brennans Creek; Sites BC1-1 and BC1-2; Replicates 1, 2 and 3.
- Brennans Creek Tributary; Sites BCT1-1 and BCT1-2; Replicates 1, 2 and 3.
- Clements Creek; Sites CIC-1 and CIC-2; Replicates 1, 2 and 3.
- Nepean River u/s Menangle Bridge; Sites N3-1 and N3-2; Replicates 1, 2 and 3.
- Racecourse Creek; Sites RC1-1 and RC1-2; Replicates 1, 2 and 3.
- Stokes Creek; Sites SC1-1, SC1-2, SC2-1and SC2-2; Replicates 1, 2 and 3.
- O'Hares Creek; Sites OC1-1, OC1-2, OC2-1 and OC2-2; Replicates 1, 2 and 3.
- Cataract River at Appin Falls; Sites CR1-1 and CR1-2; Replicates 1, 2 and 3.

Attachment B
Electrofish Survey - Spring 2008

Location - Date		**Carriage Creek - 18/12/2008**						**Cataract Reservoir Tributary 2 - 18/12/2008**					
Site		**CaC1**			**CaC2**			**CRT2-1**			**CRT2-2**		
Replicate		**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Anguilla australis	Short-finned eel	1	0	1	0	0	0	0	0	0	0	0	0
Anguilla reinhardtii	Long-finned eel	0	0	0	0	0	0	0	0	0	0	0	0
Galaxias brevipinnis	Climbing galaxias	0	0	0	0	0	0	0	0	0	0	0	0
Galaxias maculatus	Common jollytail	0	0	0	0	0	0	0	0	0	3	2	2
Gobiomorphus australis	Striped gudgeon	0	1	0	0	0	0	0	0	0	0	0	0
*Gambusia holbrooki**	Gambusia	12	10	11	6	4	8	0	0	0	0	0	0
Retropinna semoni	Australian smelt	0	0	0	0	0	0	0	0	0	0	0	0

Location - Date		**Georges River - Location 2 - 18/12/2008**						**Wallandoola Creek - Location 2 - 17/12/2008**					
Site		**GR2-1**			**GR2-2**			**WC2-1**			**WC2-2**		
Replicate		**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Anguilla australis	Short-finned eel	0	0	0	0	0	0	0	0	0	0	0	0
Anguilla reinhardtii	Long-finned eel	1	0	1	0	0	0	0	0	0	0	0	0
Galaxias brevipinnis	Climbing galaxias	0	0	0	0	0	0	0	0	0	3	0	0
Galaxias maculatus	Common jollytail	0	0	0	0	0	0	0	0	0	0	0	0
Gobiomorphus australis	Striped gudgeon	0	0	0	1	0	0	0	0	0	2	0	0
*Gambusia holbrooki**	Gambusia	0	0	0	6	5	7	0	0	0	0	0	0
Retropinna semoni	Australian smelt	0	0	0	0	0	0	0	0	0	5	0	0

Location - Date		**Dahlia Creek - 17/12/2008**						**Tributary of O'Hares Creek - 17/12/2008**					
Site		**DC1**			**DC2**			**TOC1**			**TOC2**		
Replicate		**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Anguilla australis	Short-finned eel	0	0	0	0	0	0	0	0	0	0	0	0
Anguilla reinhardtii	Long-finned eel	0	0	0	0	0	0	1	0	0	0	0	0
Galaxias brevipinnis	Climbing galaxias	0	0	0	0	0	0	0	0	0	0	0	0
Galaxias maculatus	Common jollytail	0	0	0	0	0	0	0	0	0	0	0	0
Gobiomorphus australis	Striped gudgeon	0	0	0	0	0	0	0	0	0	0	0	0
*Gambusia holbrooki**	Gambusia	0	0	0	0	0	0	0	0	0	0	0	0
Retropinna semoni	Australian smelt	0	0	0	0	0	0	0	0	0	0	0	0

Note: No fish were caught at the Tributary of Cataract Reservoir Tributary 2 Sites TGS2-1 and TGS2-2; Replicates 1, 2 and 3 (18/12/2008).

* Denotes an introduced species.

Attachment C

Estimated Cover of Plant Species Recorded along each Stream Survey Location

Attachment C
Estimated Cover of Plant Species Recorded along each Stream Survey Location - Autumn 2008

Survey Location	**Nepean River**						**Clements Creek - 28/05/2008**		**Racecourse Creek - 20/05/2008**		**Foot Onslow Creek - 13/06/2008**	
	28/05/2008		**20/05/2008**		**20/05/2008**							
	N1-1	**N1-2**	**N2-1**	**N2-2**	**N3-1**	**N3-2**	**CIC-1**	**CIC-2**	**RC1-1**	**RC1-2**	**FC1-1**	**FC1-2**
Acacia sp.	0	0	0	0	0	0	0	0	0	0	0	0
Adiantum aethiopicum	0	0	0	0	0	0	0	0	0	0	0	0
*Ageratina riparia	0	0	1	0	0	0	0	0	0	0	0	0
Allocasuarina sp.	0	0	0	0	0	0	0	0	0	0	0	0
Alternanthera denticulata	0	0	0	0	3	3	0	0	0	0	0	0
*Andropgon virginicus	0	0	0	0	0	0	0	0	0	0	0	0
*Asparagus sp.	0	0	0	0	0	0	0	0	0	0	0	0
*Aster squamatus	0	1	0	0	3	3	0	0	0	1	0	0
Baliskion sp.	0	0	0	0	0	0	0	0	0	0	0	0
Baumea rubiginosa	0	0	0	0	0	0	0	0	0	0	0	0
Baumea teretifolia	0	0	0	0	0	0	0	0	0	0	0	0
*Bidens pilosa	0	0	0	0	0	0	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	0	0	0	0	0	0	0	0	0
*Callitriche stagnalis	0	0	0	0	0	0	0	0	0	0	0	0
*Cardiospermum sp.	0	0	0	0	2	3	0	0	0	0	0	0
Carex fascicularis	1	0	0	0	0	0	0	0	0	0	0	0
Casuarina glauca	0	0	0	0	0	0	0	0	0	0	0	0
Chorizandra cymbaria	0	0	0	0	0	0	0	0	0	0	0	0
*Cirsium vulgaris	0	0	0	0	0	0	0	0	0	0	0	1
Cladium procerum	0	0	0	1	0	0	0	0	0	0	0	0
*Conyza bonariensis	0	0	0	0	0	0	0	0	0	0	0	0
*Cortadera jubata	0	0	0	0	0	0	0	0	0	0	0	0
*Cynodon dactylon	0	0	2	0	0	3	0	0	0	0	2	3
*Cyperus eragrostis	0	0	0	0	0	0	0	0	0	0	0	1
Cyperus polystachyos	0	0	0	0	0	0	0	0	1	0	0	0
Dicksonia antarctica	0	0	0	0	0	0	0	0	0	0	0	0
Drosera binata	0	0	0	0	0	0	0	0	0	0	0	0
Eleocharis sphacelata	0	0	0	0	0	0	0	0	0	0	0	0
*Elodea canadensis	0	3	3	2	3	2	0	0	0	0	0	0
Entolasia marginata	0	0	0	0	0	0	0	0	0	0	0	0
Entolasia stricta	0	0	0	0	0	0	0	0	0	0	0	0
*Eragostis curvula	0	0	0	0	3	0	0	0	0	0	0	0
*Ehrharta erecta	0	0	0	0	0	0	0	0	0	0	0	0

< TOC Home >

Attachment C
Estimated Cover of Plant Species Recorded along each Stream Survey Location - Autumn 2008

Survey Location	Nepean River						Clements Creek - 28/05/2008		Racecourse Creek - 20/05/2008		Foot Onslow Creek - 13/06/2008	
	28/05/2008		20/05/2008		20/05/2008							
	N1-1	N1-2	N2-1	N2-2	N3-1	N3-2	CIC-1	CIC-2	RC1-1	RC1-2	FC1-1	FC1-2
Eucalptus sp.	0	0	0	0	0	0	0	0	0	0	0	0
*Foeniculum vulgare	0	0	0	0	0	0	0	0	0	0	1	0
Gahnia clarkei	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia sp.	0	0	0	0	0	0	0	0	0	0	0	0
Gleditsia triacanthos	0	0	0	0	0	0	0	0	0	0	1	0
Gleichenia dicarpa	0	0	1	0	0	0	0	1	0	0	0	0
Glossostigma elatinoides	0	0	0	0	0	0	0	0	0	0	0	0
*Gnaphalium sp.	0	0	0	0	0	0	0	0	0	0	0	0
Gonocarpus micranthus	0	0	0	0	0	0	0	0	0	0	0	0
Hemarthria uncinata	0	0	1	0	0	0	0	0	0	0	0	0
*Hordeum leporinum	0	0	0	0	0	0	0	0	0	0	0	1
Hydrilla verticillata	0	2	0	0	2	2	0	0	0	0	0	0
*Hypochaeris radicata	0	0	0	0	0	0	0	0	0	0	0	0
Hypolepis muelleri	0	0	0	0	0	0	0	0	0	0	0	0
Isolepis cernua	0	0	1	0	0	0	0	0	0	0	0	0
Isolepis inundata	0	0	0	0	0	0	0	0	1	0	0	0
Juncus australis	0	0	0	0	0	0	0	0	0	0	0	0
Juncus fockeii	0	0	0	0	0	0	0	0	0	0	0	0
Juncus microcephalus	0	0	0	0	0	0	0	0	0	0	0	0
Juncus planifolius	0	0	0	0	0	0	0	0	0	0	0	0
Juncus polyanthemus	0	0	0	0	0	0	0	0	0	0	0	0
Juncus prismatocarpus	0	0	1	0	1	1	0	0	0	0	0	0
Juncus sarophorus	0	0	0	0	0	0	0	0	0	0	0	0
Juncus subsecundus	0	1	0	0	0	0	0	0	0	0	0	0
Juncus usitatus	0	0	0	0	2	2	0	0	0	0	0	0
Lepidosperma sp.	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma gunnii	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma filiforme	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma laterale	0	0	0	0	0	0	0	0	0	0	0	0
Leptospermum polygalifolium	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia sp.	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia scariosa	0	0	0	0	0	0	0	0	0	0	0	0
*Ligustrum lucidum	0	0	0	0	0	1	0	0	0	0	1	2

Attachment C
Estimated Cover of Plant Species Recorded along each Stream Survey Location - Autumn 2008

Survey Location	Nepean River						Clements Creek - 28/05/2008		Racecourse Creek - 20/05/2008		Foot Onslow Creek - 13/06/2008	
	28/05/2008		20/05/2008		20/05/2008							
	N1-1	N1-2	N2-1	N2-2	N3-1	N3-2	CIC-1	CIC-2	RC1-1	RC1-2	FC1-1	FC1-2
Lomandra fluviatilis	0	0	2	0	0	0	0	0	0	0	0	0
Lomandra longifolia	0	0	0	0	0	0	3	3	0	0	0	0
*Lolium perenne	0	0	0	0	0	0	0	0	0	0	0	0
*Nasturtium officinale	0	0	0	0	0	0	0	0	2	1	0	0
*Nephrolepis cordifolia	0	0	0	0	0	0	0	0	0	0	0	0
*Olea europa	0	0	0	0	0	1	0	0	0	0	1	0
Ottelia ovalifolia	0	0	0	0	0	0	0	0	0	0	0	0
*Parietaria judaica	0	0	0	0	0	0	0	0	0	0	0	0
*Paspalum dilatatum	0	0	0	0	0	2	0	0	0	0	3	3
Paspalum distichum	0	1	0	0	2	2	0	0	3	2	3	3
*Pennisetum clandestinum	0	0	0	0	0	0	0	0	0	0	1	0
Persicaria decipiens	0	1	0	0	2	0	0	0	0	0	0	0
Persicaria hydropiper	0	0	0	0	2	2	0	0	0	1	0	0
*Phalaris aquatica	0	0	0	0	0	0	0	0	0	0	1	1
Philydrum lanuginosum	0	0	0	0	0	0	0	0	0	0	0	0
Pittosporum undulatum	0	0	0	0	0	0	0	0	0	0	0	0
*Plantago lanceolata	0	0	0	0	0	0	0	0	0	0	0	0
Potamogeton sulcatus	0	0	0	0	0	0	0	0	2	2	0	0
Pteridium esculentum	0	0	0	0	0	0	0	0	0	0	0	0
*Ranunculus repens	0	0	0	0	0	0	0	0	2	2	0	0
*Rosa rubiginosa	0	0	0	0	0	0	0	0	0	0	1	0
*Rumex crispus	0	0	0	0	2	0	0	0	0	1	1	1
*Salix fragilis	0	0	0	0	1	2	0	0	0	0	0	0
*Setaria sp.	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus sp.	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus breviculmis	0	0	0	0	2	0	0	0	0	0	0	0
Schenoplectus validus	0	0	0	0	1	0	0	0	0	0	0	0
Sida rhombifolia	0	0	0	0	2	1	0	0	0	0	0	0
Spirodela sp.	0	0	0	0	0	0	0	0	0	0	0	0
*Stenotaphrum secundatum	0	0	0	0	0	0	0	0	0	0	0	0
Sticherus flabellatus	0	0	0	0	0	0	0	1	0	0	0	0
Triglochin microtuberosum	0	0	0	1	0	0	0	0	1	1	0	0
Triglochin procerum	0	1	0	0	0	0	0	0	0	0	0	0

Attachment C
Estimated Cover of Plant Species Recorded along each Stream Survey Location - Autumn 2008

Survey Location	**Nepean River**						**Clements Creek - 28/05/2008**		**Racecourse Creek - 20/05/2008**		**Foot Onslow Creek - 13/06/2008**	
	28/05/2008		**20/05/2008**		**20/05/2008**							
	N1-1	**N1-2**	**N2-1**	**N2-2**	**N3-1**	**N3-2**	**CIC-1**	**CIC-2**	**RC1-1**	**RC1-2**	**FC1-1**	**FC1-2**
Triglochin striatum	0	0	0	1	0	0	0	0	0	0	0	0
Tristania neriifolia	0	0	0	0	0	0	0	0	0	0	0	0
Tristaniopsis laurina	0	0	0	0	0	0	0	0	0	0	0	0
Typha orientalis	0	0	0	0	0	0	1	0	1	0	1	0
*Urtica incisa	0	0	0	0	0	0	0	0	0	0	0	0
Vallisneria gigantea	0	0	0	0	3	3	0	0	0	0	0	0
*Veronica anagallis-aquatica	0	0	0	0	0	0	0	0	1	0	0	0
Viminaria juncea	0	0	0	0	0	0	0	0	0	0	0	0
Viola sp.	0	0	1	0	0	0	0	0	0	0	0	0
*Xanthium occidentale	0	0	0	0	0	2	0	0	0	0	0	0
Filamentous algae	0	1	2	0	3	3	3	0	3	3	0	0
Diatoms	0	3	3	0	0	0	3	0	3	3	0	0
Sponge	0	0	0	0	0	0	0	0	0	0	0	0
Moss	0	0	1	0	0	0	0	0	0	0	0	0

Attachment C

Estimated Cover of Plant Species Recorded along each Stream Survey Location - Autumn 2008

Survey Location	Rocky Ponds Creek - 13/06/2008		Simpsons Creek - 13/06/2008		Cascade Creek				Wallandoola Creek - 14/06/2008		Lizard Creek - 14/06/2008	
					13/06/2008		28/05/2008					
	RP1-1	**RP1-2**	**SIMP1-1**	**SIMP1-2**	**CC1-1**	**CC1-2**	**CC2-1**	**CC2-2**	**WC1-1**	**WC1-2**	**LC1-1**	**LC1-2**
Acacia sp.	2	0	0	0	3	2	3	3	0	0	0	0
Adiantum aethiopicum	0	1	0	0	1	0	0	0	0	0	0	0
*Ageratina riparia	0	0	0	0	0	0	0	0	0	0	0	0
Allocasuarina sp.	0	0	0	0	1	2	0	0	0	0	0	0
Alternanthera denticulata	0	0	0	0	0	0	0	0	0	0	0	0
*Andropgon virginicus	0	0	0	0	0	0	0	0	0	0	0	0
*Asparagus sp.	0	0	1	0	0	0	0	0	0	0	0	0
*Aster squamatus	0	1	0	0	0	0	0	0	0	0	0	0
Baliskion sp.	0	0	0	0	0	0	0	0	1	2	1	1
Baumea rubiginosa	0	0	0	0	0	0	2	0	0	0	0	0
Baumea teretifolia	0	0	0	0	1	0	0	0	0	0	0	0
*Bidens pilosa	0	0	0	2	0	0	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	0	0	0	2	3	0	0	0	0
*Callitriche stagnalis	0	1	0	0	0	0	0	0	0	0	0	0
*Cardiospermum sp.	0	0	0	0	0	0	0	0	0	0	0	0
Carex fascicularis	0	0	0	0	0	0	0	0	0	0	0	0
Casuarina glauca	0	0	0	0	0	0	0	0	0	0	0	0
Chorizandra cymbaria	0	0	0	0	0	0	1	0	0	0	0	0
*Cirsium vulgaris	0	0	1	0	0	0	0	0	0	0	0	0
Cladium procerum	0	0	0	0	0	0	0	0	0	0	0	0
*Conyza bonariensis	0	0	2	0	0	0	0	0	0	0	0	0
*Cortadera jubata	0	0	1	0	0	0	0	0	0	0	0	0
*Cynodon dactylon	2	1	2	2	0	0	0	0	0	0	0	0
*Cyperus eragrostis	3	0	0	0	0	0	0	0	0	0	0	0
Cyperus polystachyos	0	0	0	0	0	0	0	0	0	0	0	0
Dicksonia antarctica	0	0	0	0	0	0	0	0	0	0	0	0
Drosera binata	0	0	0	0	0	0	1	1	0	0	0	0
Eleocharis sphacelata	0	0	0	0	0	0	0	0	0	0	0	0
*Elodea canadensis	0	0	0	0	0	0	0	0	0	0	0	0
Entolasia marginata	1	0	0	0	0	0	0	0	0	0	0	0
Entolasia stricta	0	0	0	0	0	0	0	0	0	0	0	0
*Eragostis curvula	0	0	2	1	0	0	0	0	0	0	0	0

Attachment C
Estimated Cover of Plant Species Recorded along each Stream Survey Location - Autumn 2008

Survey Location	Rocky Ponds Creek - 13/06/2008		Simpsons Creek - 13/06/2008		Cascade Creek				Wallandoola Creek - 14/06/2008		Lizard Creek - 14/06/2008	
					13/06/2008		28/05/2008					
	RP1-1	RP1-2	SIMP1-1	SIMP1-2	CC1-1	CC1-2	CC2-1	CC2-2	WC1-1	WC1-2	LC1-1	LC1-2
*Ehrharta erecta	0	0	0	0	0	0	0	0	0	0	0	0
Eucalptus sp.	0	0	0	0	1	1	0	0	0	0	0	0
*Foeniculum vulgare	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia clarkei	0	0	0	0	2	0	0	0	0	0	0	1
Gahnia sp.	0	0	0	0	0	0	0	0	0	0	0	0
Gleditsia triacanthos	0	0	0	0	0	0	0	0	0	0	0	0
Gleichenia dicarpa	0	0	0	2	0	0	0	0	0	0	1	1
Glossostigma elatinoides	0	0	0	0	0	0	0	0	0	0	0	0
*Gnaphalium sp.	0	1	0	0	0	0	0	0	0	0	0	0
Gonocarpus micranthus	0	0	0	0	0	2	0	0	0	0	0	0
Hemarthria uncinata	0	0	0	0	0	0	0	0	0	0	0	0
*Hordeum leporinum	0	0	2	1	0	0	0	0	0	0	0	0
Hydrilla verticillata	0	0	0	0	0	0	0	0	0	0	0	0
*Hypochaeris radicata	0	0	0	0	0	0	0	0	0	0	0	0
Hypolepis muelleri	0	0	0	0	0	3	0	0	0	0	0	0
Isolepis cernua	0	0	0	0	0	0	0	0	0	0	1	1
Isolepis inundata	0	1	0	0	0	1	0	0	0	0	0	0
Juncus australis	0	0	0	0	0	0	0	0	0	0	0	0
Juncus fockeii	0	0	0	0	0	0	0	0	0	0	0	0
Juncus microcephalus	0	0	0	0	0	0	0	0	0	0	0	0
Juncus planifolius	2	0	0	0	0	0	0	0	0	0	0	0
Juncus polyanthemus	0	0	0	0	0	0	0	0	0	0	0	0
Juncus prismatocarpus	0	0	0	0	2	0	0	0	0	0	0	0
Juncus sarophorus	0	0	0	0	0	0	0	0	0	1	0	1
Juncus subsecundus	0	0	0	0	0	2	0	0	1	0	0	0
Juncus usitatus	2	1	0	2	1	0	0	0	0	0	0	0
Lepidosperma sp.	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma gunnii	0	0	0	0	2	0	0	0	0	0	0	0
Lepidosperma filiforme	0	0	1	0	2	0	3	2	0	0	1	0
Lepidosperma laterale	0	0	0	0	0	0	0	0	1	0	1	1
Leptospermum polygalifolium	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia sp.	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia scariosa	0	0	0	0	0	0	0	0	0	0	0	0

Attachment C
Estimated Cover of Plant Species Recorded along each Stream Survey Location - Autumn 2008

Survey Location	Rocky Ponds Creek - 13/06/2008		Simpsons Creek - 13/06/2008		Cascade Creek				Wallandoola Creek - 14/06/2008		Lizard Creek - 14/06/2008	
					13/06/2008		28/05/2008					
	RP1-1	**RP1-2**	**SIMP1-1**	**SIMP1-2**	**CC1-1**	**CC1-2**	**CC2-1**	**CC2-2**	**WC1-1**	**WC1-2**	**LC1-1**	**LC1-2**
*Ligustrum lucidum	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra fluviatilis	0	0	0	0	1		2	1	2	2	1	1
Lomandra longifolia	2	3	3	3	2	3	3	3	0	2	1	1
*Lolium perenne	2	1	0	0	0	0	0	0	0	0	0	0
*Nasturtium officinale	0	0	0	0	0	0	0	0	0	0	0	0
*Nephrolepis cordifolia	0	0	0	0	0	0	0	0	0	0	0	0
*Olea europa	0	0	0	0	0	0	0	0	0	0	0	0
Ottelia ovalifolia	0	0	0	0	0	0	0	1	0	0	0	0
*Parietaria judaica	0	0	2	2	0	0	0	0	0	0	0	0
*Paspalum dilatatum	2	1	1	0	0	0	0	0	0	0	0	0
Paspalum distichum	2		1	0	0	0	0	0	0	0	0	0
*Pennisetum clandestinum	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria decipiens	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria hydropiper	0	0	0	0	0	0	0	0	0	0	0	0
*Phalaris aquatica	2	0	0	0	0	0	0	0	0	0	0	0
Philydrum lanuginosum	0	0	0	0	1	0	0	2	0	0	0	0
Pittosporum undulatum	0	0	2	2	0	0	0	0	0	0	0	0
*Plantago lanceolata	2	0	0	0	0	0	0	0	0	0	0	0
Potamogeton sulcatus	0	0	0	0	0	0	0	0	0	0	0	0
Pteridium esculentum	0	0	0	0	0	0	0	0	0	0	0	0
*Ranunculus repens	0	0	0	0	0	0	0	0	0	0	0	0
*Rosa rubiginosa	0	0	0	0	0	0	0	0	0	0	0	0
*Rumex crispus	0	0	0	0	0	0	0	0	0	0	0	0
*Salix fragilis	0	0	0	0	0	0	0	0	0	0	0	0
*Setaria sp.	3	0	0	0	0	0	0	0	0	0	0	0
Schoenus sp.	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus breviculmis	0	0	0	0	2	2	0	0	0	0	0	0
Schenoplectus validus	0	0	0	0	0	0	0	0	0	0	0	0
Sida rhombifolia	1	0	0	0	0	0	0	0	0	0	0	0
Spirodela sp.	0	1	0	0	0	0	0	0	0	0	0	0
*Stenotaphrum secundatum	1	0	0	0	0	0	0	0	0	0	0	0
Sticherus flabellatus	0	0	0	0	0	0	0	0	0	0	0	0
Triglochin microtuberosum	0	0	0	0	0	0	0	0	0	0	0	0

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Attachment C

Estimated Cover of Plant Species Recorded along each Stream Survey Location - Autumn 2008

Survey Location	Rocky Ponds Creek - 13/06/2008		Simpsons Creek - 13/06/2008		Cascade Creek				Wallandoola Creek - 14/06/2008		Lizard Creek - 14/06/2008	
					13/06/2008		28/05/2008					
	RP1-1	**RP1-2**	**SIMP1-1**	**SIMP1-2**	**CC1-1**	**CC1-2**	**CC2-1**	**CC2-2**	**WC1-1**	**WC1-2**	**LC1-1**	**LC1-2**
Triglochin procerum	0	0	0	0	0	0	0	0	2	1	0	0
Triglochin striatum	0	0	0	0	0	0	0	0	0	0	0	0
Tristania neriifolia	0	0	0	0	0	0	0	0	0	0	0	0
Tristaniopsis laurina	0	0	0	0	0	0	3	3	2	1	0	0
Typha orientalis	0	0	0	0	0	0	0	0	0	0	0	0
*Urtica incisa	0	0	0	0	0	0	0	0	0	0	0	0
Vallisneria gigantea	0	0	0	0	0	0	0	0	0	0	0	0
*Veronica anagallis-aquatica	0	0	0	0	0	0	0	0	0	0	0	0
Viminaria juncea	0	0	0	0	0	0	0	0	0	0	0	0
Viola sp.	0	0	0	0	0	0	0	0	0	0	0	0
*Xanthium occidentale	0	0	0	0	0	0	0	0	0	0	0	0
Filamentous algae	0	0	0	0	0	0	0	1	1	0	0	0
Diatoms	0	0	0	0	0	0	0	0	3	0	3	
Sponge	0	0	0	0	0	0	0	1	0	0	0	0
Moss	0	1	0	0	0	0	3	3	2	0	2	0

Attachment C
Estimated Cover of Plant Species Recorded along each Stream Survey Location - Autumn 2008

Survey Location	Cataract River - 13/04/2008				Georges River - 30/05/2008		Brennans Creek - 30/05/2008		Brennans Creek Tributary - 30/05/2008		O'Hares Creek - 26/04/2008	
	CR1-1	CR1-2	CR2-1	CR2-2	GR1-1	GR1-2	BC1-1	BC1-2	BCT1-1	BCT1-2	OC1-1	OC1-2
Acacia sp.	0	0	0	0	2	0	3	2	0	0	0	0
Adiantum aethiopicum	0	0	0	0	0	0	0	0	0	0	0	0
*Ageratina riparia	0	0	0	0	0	0	0	0	0	0	0	0
Allocasuarina sp.	0	0	0	0	0	0	0	0	0	0	0	0
Alternanthera denticulata	0	0	0	0	0	0	0	0	0	0	0	0
*Andropgon virginicus	1	0	0	0	0	0	0	0	0	0	0	0
*Asparagus sp.	0	0	0	0	0	0	0	0	0	0	0	0
*Aster squamatus	0	0	0	0	0	0	0	0	0	0	0	0
Baliskion sp.	0	0	0	0	0	0	0	0	0	0	0	0
Baumea rubiginosa	0	0	0	0	0	0	0	0	0	0	2	0
Baumea teretifolia	0	0	0	0	0	0	0	0	0	1	0	0
*Bidens pilosa	0	0	0	0	0	0	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	0	0	1	0	2	3	0	0	0
*Callitriche stagnalis	0	0	0	0	0	0	0	0	0	0	0	0
*Cardiospermum sp.	0	0	0	0	0	0	0	0	0	0	0	0
Carex fascicularis	0	0	0	0	0	0	0	0	0	0	0	0
Casuarina glauca	0	0	0	0	0	0	1	0	0	0	0	0
Chorizandra cymbaria	1	0	0	0	0	1	0	0	0	0	3	2
*Cirsium vulgaris	0	0	0	0	0	0	0	0	0	0	0	0
Cladium procerum	0	0	0	0	0	0	0	0	0	0	0	0
*Conyza bonariensis	0	0	0	0	0	0	0	0	0	0	0	0
*Cortadera jubata	0	0	0	0	0	0	0	0	0	0	0	0
*Cynodon dactylon	0	0	0	0	0	1	1	3	0	0	0	0
*Cyperus eragrostis	0	0	0	0	0	0	0	0	0	0	0	0
Cyperus polystachyos	0	0	0	0	0	0	0	0	0	0	0	0
Dicksonia antarctica	0	0	0	0	0	0	0	3	0	0	0	0
Drosera binata	1	1	0	0	0	0	0	0	0	0	0	0
Eleocharis sphacelata	0	0	0	0	3	0	0	0	0	0	0	0
*Elodea canadensis	0	0	0	0	0	0	0	0	0	0	0	0
Entolasia marginata	0	0	0	0	1	0	0	0	0	0	0	0
Entolasia stricta	0	0	0	0	0	0	0	0	0	0	0	0
*Eragostis curvula	0	0	0	0	0	0	0	0	0	0	0	0

Attachment C
Estimated Cover of Plant Species Recorded along each Stream Survey Location - Autumn 2008

Survey Location	**Cataract River - 13/04/2008**				**Georges River - 30/05/2008**		**Brennans Creek - 30/05/2008**		**Brennans Creek Tributary - 30/05/2008**		**O'Hares Creek - 26/04/2008**	
	CR1-1	**CR1-2**	**CR2-1**	**CR2-2**	**GR1-1**	**GR1-2**	**BC1-1**	**BC1-2**	**BCT1-1**	**BCT1-2**	**OC1-1**	**OC1-2**
*Ehrharta erecta	0	0	0	0	0	0	1	0	0	0	0	0
Eucalptus sp.	0	0	0	0	0	0	0	0	0	0	0	0
*Foeniculum vulgare	0	0	0	0	0	0	0	0	0	0	0	0
Gahnia clarkei	0	0	0	0	1	1	0	0	3	2	0	0
Gahnia sp.	0	0	0	1	0	0	3	0	0	0	0	2
Gleditsia triacanthos	0	0	0	0	0	0	0	0	0	0	0	0
Gleichenia dicarpa	1	1	2	1	0	0	0	0	0	2	0	0
Glossostigma elatinoides	0	0	0	0	0	0	0	0	0	0	0	2
*Gnaphalium sp.	0	0	0	0	0	0	0	0	0	0	0	0
Gonocarpus micranthus	0	0	0	0	0	0	0	0	0	0	0	0
Hemarthria uncinata	0	0	0	0	0	0	0	0	0	0	0	0
*Hordeum leporinum	0	0	0	0	0	0	0	0	0	0	0	0
Hydrilla verticillata	0	0	0	0	0	0	0	0	0	0	0	0
*Hypochaeris radicata	0	0	0	0	2	0	0	1	0	0	0	0
Hypolepis muelleri	0	0	0	0	0	0	1	3	2	2	0	0
Isolepis cernua	0	0	0	0	0	0	0	0	0	0	0	0
Isolepis inundata	0	0	1	1	2	0	1	0	0	0	1	0
Juncus australis	0	1	0	0	0	0	0	0	0	0	0	0
Juncus fockeii	0	0	0	0	0	0	0	0	0	0	1	0
Juncus microcephalus	0	0	0	0	2	0	0	0	0	0	0	0
Juncus planifolius	0	0	0	0	0	1	0	0	0	0	0	0
Juncus polyanthemus	0	0	0	0	1	2	2	2	0	0	0	0
Juncus prismatocarpus	1	1	0	0	0	1	0	0	0	0	0	0
Juncus sarophorus	0	0	0	1	0	0	0	0	0	0	0	0
Juncus subsecundus	0	0	0	0	0	0	1	0	0	0	0	0
Juncus usitatus	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma sp.	0	0	0	0	0	0	0	0	0	0	2	0
Lepidosperma gunnii	0	0	0	0	0	0	0	0	0	0	0	0
Lepidosperma filiforme	0	1	0	0	1	2	3	3	3	3		0
Lepidosperma laterale	0	1	1	2	0	0	0	0	0	0	0	0
Leptospermum polygalifolium	0	0	0	0	1	0	0	0	0	0	0	0
Lepyrodia sp.	0	0	0	0	0	0	0	0	0	0	0	0
Lepyrodia scariosa	0	0	0	1	0	0	0	0	0	0	0	0

Attachment C
Estimated Cover of Plant Species Recorded along each Stream Survey Location - Autumn 2008

Survey Location	Cataract River - 13/04/2008				Georges River - 30/05/2008		Brennans Creek - 30/05/2008		Brennans Creek Tributary - 30/05/2008		O'Hares Creek - 26/04/2008	
	CR1-1	CR1-2	CR2-1	CR2-2	GR1-1	GR1-2	BC1-1	BC1-2	BCT1-1	BCT1-2	OC1-1	OC1-2
*Ligustrum lucidum	0	0	0	0	0	0	0	0	0	0	0	0
Lomandra fluviatilis	0	0	2	2	0	0	0	0	0	0	0	0
Lomandra longifolia	2	1	0	0	1	2	1	2	3	2	2	0
*Lolium perenne	0	0	0	0	0	0	0	0	0	0	0	0
*Nasturtium officinale	0	0	0	0	0	0	0	0	0	0	0	0
*Nephrolepis cordifolia	1	1	0	0	0	0	0	0	0	0	0	0
*Olea europa	0	0	0	0	0	0	0	0	0	0	0	0
Ottelia ovalifolia	0	0	0	0	0	0	0	0	0	0	0	0
*Parietaria judaica	0	0	0	0	0	0	0	0	0	0	0	0
*Paspalum dilatatum	0	0	0	0	0	0	0	0	0	0	0	0
Paspalum distichum	0	0	0	0	0	0	1	0	0	0	0	0
*Pennisetum clandestinum	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria decipiens	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria hydropiper	0	0	0	0	0	0	0	0	0	0	0	0
*Phalaris aquatica	0	0	0	0	0	0	1	0	0	0	0	0
Philydrum lanuginosum	0	0	2	1	0	0	0	0	0	0	0	0
Pittosporum undulatum	0	0	0	0	0	0	0	0	0	0	0	0
*Plantago lanceolata	0	0	0	0	0	0	0	0	0	0	0	0
Potamogeton sulcatus	0	0	2	0	3	2	0	0	0	0	0	0
Pteridium esculentum	0	0	0	0	0	0	1	0	1	2	0	0
*Ranunculus repens	0	0	0	0	0	0	0	0	0	0	0	0
*Rosa rubiginosa	0	0	0	0	0	0	0	0	0	0	0	0
*Rumex crispus	0	0	0	0	0	0	0	0	0	0	0	0
*Salix fragilis	0	0	0	0	0	0	0	0	0	0	0	0
*Setaria sp.	0	0	0	0	0	0	0	0	0	0	0	0
Schoenus sp.	0	0	0	0	0	0	0	0	0	0	3	2
Schoenus breviculmis	0	0	0	0	0	0	0	0	0	2	0	0
Schenoplectus validus	0	0	0	0	0	0	0	0	0	0	0	0
Sida rhombifolia	0	0	0	0	0	0	0	0	0	0	0	0
Spirodela sp.	0	0	0	0	0	0	0	0	0	0	0	0
*Stenotaphrum secundatum	0	0	0	0	0	0	0	0	0	0	0	0
Sticherus flabellatus	0	1	2	0	0	2	0	0	0	1	3	3
Triglochin microtuberosum	0	0	0	0	0	0	0	0	0	0	0	0

Attachment C
Estimated Cover of Plant Species Recorded along each Stream Survey Location - Autumn 2008

Survey Location	**Cataract River - 13/04/2008**				**Georges River - 30/05/2008**		**Brennans Creek - 30/05/2008**		**Brennans Creek Tributary - 30/05/2008**		**O'Hares Creek - 26/04/2008**	
	CR1-1	**CR1-2**	**CR2-1**	**CR2-2**	**GR1-1**	**GR1-2**	**BC1-1**	**BC1-2**	**BCT1-1**	**BCT1-2**	**OC1-1**	**OC1-2**
Triglochin procerum	0	0	0	1	0	0	0	0	0	0	3	0
Triglochin striatum	0	0	0	0	0	0	0	0	0	0	0	0
Tristania neriifolia	0	0	0	0	0	0	0	0	0	0	0	0
Tristaniopsis laurina	0	0	0	2	0	0	0	0	3	0	0	0
Typha orientalis	0	0	0	0	3	0	0	2	0	0	0	0
*Urtica incisa	0	0	0	0	0	0	0	0	0	0	0	0
Vallisneria gigantea	0	0	0	0	0	0	0	0	0	0	0	0
*Veronica anagallis-aquatica	0	0	0	0	0	0	0	0	0	0	0	0
Viminaria juncea	0	0	0	0	1	0	2	0	0	0	0	0
Viola sp.	0	0	0	0	0	0	0	0	0	0	0	0
*Xanthium occidentale	0	0	0	0	0	0	0	0	0	0	0	0
Filamentous algae	1	0	0	1	0	0	0	0	0	0	0	0
Diatoms	3	0	3	2	0	0	0	0	0	0	0	0
Sponge	0	0	0	0	0	0	0	0	0	0	0	0
Moss	0	0	1	1	0	0	0	0	3	0	2	2

Attachment C
Estimated Cover of Plant Species Recorded along each Stream Survey Location - Autumn 2008

Survey Location	O'Hares Creek - 26/04/2008		Stokes Creek - 26/04/2008			
	OC2-1	OC2-2	SC1-1	SC1-2	SC2-1	SC2-2
Acacia sp.	0	0	0	0	0	0
Adiantum aethiopicum	0	0	0	0	0	0
*Ageratina riparia	0	0	0	0	0	0
Allocasuarina sp.	0	0	0	0	0	0
Alternanthera denticulata	0	0	0	0	0	0
*Andropgon virginicus	0	0	0	0	0	0
*Asparagus sp.	0	0	0	0	0	0
*Aster squamatus	0	0	0	0	0	0
Baliskion sp.	0	1	0	3	1	1
Baumea rubiginosa	0	0	2	1	2	2
Baumea teretifolia	0	0	0	2	0	0
*Bidens pilosa	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	0	0	0
*Callitriche stagnalis	0	0	0	0	0	0
*Cardiospermum sp.	0	0	0	0	0	0
Carex fascicularis	0	0	0	0	0	0
Casuarina glauca	0	0	0	0	0	0
Chorizandra cymbaria	2	3	0	0	0	2
*Cirsium vulgaris	0	0	0	0	0	0
Cladium procerum	0	0	0	0	0	0
*Conyza bonariensis	0	0	0	0	0	0
*Cortadera jubata	0	0	0	0	0	0
*Cynodon dactylon	0	0	0	0	0	0
*Cyperus eragrostis	0	0	0	0	0	0
Cyperus polystachyos	0	0	0	0	0	0
Dicksonia antarctica	0	0	0	0	0	0
Drosera binata	0	0	1	0	0	0
Eleocharis sphacelata	0	0	0	0	0	0
*Elodea canadensis	0	0	0	0	0	0
Entolasia marginata	0	0	0	0	0	0
Entolasia stricta	0	0	0	0	1	0
*Eragostis curvula	0	0	0	0	0	0

Attachment C
Estimated Cover of Plant Species Recorded along each Stream Survey Location - Autumn 2008

Survey Location	O'Hares Creek - 26/04/2008		Stokes Creek - 26/04/2008			
	OC2-1	OC2-2	SC1-1	SC1-2	SC2-1	SC2-2
*Ehrharta erecta	0	0	0	0	0	0
Eucalptus sp.	0	0	0	0	0	0
*Foeniculum vulgare	0	0	0	0	0	0
Gahnia clarkei	0	0	0	0	0	0
Gahnia sp.	0	2	2	2	0	1
Gleditsia triacanthos	0	0	0	0	0	0
Gleichenia dicarpa	0	0	0	0	0	0
Glossostigma elatinoides	0	0	1	0	0	0
*Gnaphalium sp.	0	0	0	0	0	0
Gonocarpus micranthus	0	0	0	0	0	0
Hemarthria uncinata	0	0	0	0	0	0
*Hordeum leporinum	0	0	0	0	0	0
Hydrilla verticillata	0	0	0	0	0	0
*Hypochaeris radicata	0	0	0	0	0	0
Hypolepis muelleri	0	0	0	0	0	0
Isolepis cernua	0	0	0	0	0	0
Isolepis inundata	0	0	0	0	0	0
Juncus australis	0	0	0	0	0	0
Juncus fockeii	0	0	0	0	0	0
Juncus microcephalus	0	0	0	0	0	0
Juncus planifolius	0	0	0	0	0	0
Juncus polyanthemus	0	0	0	0	0	0
Juncus prismatocarpus	0	0	0	0	0	0
Juncus sarophorus	0	0	0	0	0	0
Juncus subsecundus	0	0	0	0	0	0
Juncus usitatus	0	0	0	2	0	0
Lepidosperma sp.	3	2	1	1	2	3
Lepidosperma gunnii	0	0	0	0	0	0
Lepidosperma filiforme	0	0	0	0	0	0
Lepidosperma laterale	0	0	0	0	0	0
Leptospermum polygalifolium	0	0	0	0	0	0
Lepyrodia sp.	0	0	1	0	2	0
Lepyrodia scariosa	0	0	0	0	0	0

Attachment C
Estimated Cover of Plant Species Recorded along each Stream Survey Location - Autumn 2008

Survey Location	O'Hares Creek - 26/04/2008		Stokes Creek - 26/04/2008			
	OC2-1	OC2-2	SC1-1	SC1-2	SC2-1	SC2-2
*Ligustrum lucidum	0	0	0	0	0	0
Lomandra fluviatilis	3	2	1	2	3	0
Lomandra longifolia	0	0	0	0	1	0
*Lolium perenne	0	0	0	0	0	0
*Nasturtium officinale	0	0	0	0	0	0
*Nephrolepis cordifolia	0	0	0	0	0	0
*Olea europa	0	0	0	0	0	0
Ottelia ovalifolia	0	0	0	0	0	0
*Parietaria judaica	0	0	0	0	0	0
*Paspalum dilatatum	0	0	0	0	0	0
Paspalum distichum	0	0	0	0	0	0
*Pennisetum clandestinum	0	0	0	0	0	0
Persicaria decipiens	0	0	0	0	0	0
Persicaria hydropiper	0	0	0	0	0	0
*Phalaris aquatica	0	0	0	0	0	0
Philydrum lanuginosum	0	0	0	0	0	0
Pittosporum undulatum	0	0	0	0	0	0
*Plantago lanceolata	0	0	0	0	0	0
Potamogeton sulcatus	0	0	0	0	0	0
Pteridium esculentum	0	0	0	0	0	0
*Ranunculus repens	0	0	0	0	0	0
*Rosa rubiginosa	0	0	0	0	0	0
*Rumex crispus	0	0	0	0	0	0
*Salix fragilis	0	0	0	0	0	0
*Setaria sp.	0	0	0	0	0	0
Schoenus sp.	0	1	0	0	0	2
Schoenus breviculmis	0	0	0	0	1	0
Schenoplectus validus	0	0	0	0	0	0
Sida rhombifolia	0	0	0	0	0	0
Spirodela sp.	0	0	0	0	0	0
*Stenotaphrum secundatum	0	0	0	0	0	0
Sticherus flabellatus	0	0	0	0	0	2
Triglochin microtuberosum	0	0	0	0	0	0

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Attachment C
Estimated Cover of Plant Species Recorded along each Stream Survey Location - Autumn 2008

Survey Location	**O'Hares Creek - 26/04/2008**		**Stokes Creek - 26/04/2008**			
	OC2-1	**OC2-2**	**SC1-1**	**SC1-2**	**SC2-1**	**SC2-2**
Triglochin procerum	0	0	0	0	0	0
Triglochin striatum	0	0	0	0	0	0
Tristania neriifolia	3	0	0	0	0	0
Tristaniopsis laurina	0	2	0	0	0	0
Typha orientalis	0	0	0	0	0	0
*Urtica incisa	0	0	0	0	0	0
Vallisneria gigantea	0	0	0	0	0	0
*Veronica anagallis-aquatica	0	0	0	0	0	0
Viminaria juncea	0	0	0	0	0	0
Viola sp.	0	0	0	0	0	0
*Xanthium occidentale	0	0	0	0	0	0
Filamentous algae	0	0	0	0	0	0
Diatoms	0	0	0	0	0	0
Sponge	0	0	0	0	0	0
Moss	0	1	1	1	1	1

* denotes an introduced species

Denotes species not considered to be aquatic macrophytes (i.e. species that do not survive for long-periods of time when inundated with water, Geoff Sainty pers. comm. 2008). It should be noted that the species, *Tristaniopsis laurina* (Water gum), will surive in water for extended periods but has not been included as a macrophyte because it is a tree.

Cover Classes

1 = few

2 = scattered

3 = common

Attachment C

Estimated Cover of Plant Species Recorded along each Stream Survey Location - Spring 2008

Survey Location	**Carriage Creek - 18/12/2008**		**Wallandoola Creek - 17/12/2008**		**Cataract Reservoir Tributary 2 - 18/12/2008**	
	CaC1	**CaC2**	**WC2-1**	**WC2-2**	**CRT2-1**	**CRT2-2**
**Aster squamatus*	0	1	0	0	0	0
Baumea rubiginosa	0	0	0	0	1	3
Baumea teretifolia	0	0	0	0	0	0
Blechnum sp.	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	0	0	0
Carex appressa	0	0	0	1	0	0
Centrolepis fascicularis	0	0	0	0	0	0
Chorizandra cymbaria	0	0	0	0	0	0
**Cyperus eragrostis*	1	2	0	0	0	0
Dicksonia antarctica	0	0	0	1	0	0
Drosera binata	0	0	0	0	0	0
Drosera spatulata	0	0	0	0	0	0
Elatine gratioloides	0	0	0	0	0	0
Eleocharis sp.	0	1	0	0	0	0
**Elodea canadensis*	0	1	0	0	0	0
Euchordia complanatus	0	0	0	1	0	0
Fimbristylis sp	0	0	0	0	0	0
Gahnia sp.	0	0	0	0	0	0
Gahnia clarkei	0	0	2	0	0	0
Gleichenia dicarpa	0	0	2	0	2	3
Glossostigma sp.	0	0	0	0	0	0
Hemarthria uncinata	1	0	0	0	0	0
Hydrocotyle sp.	0	1	0	0	0	0
Isolepis inundata	0	1	0	0	0	0
**Isolepis prolifera*	0	0	0	0	0	0
Juncus australis	0	0	0	0	0	0
**Juncus articulatis*	0	1	0	0	0	0
Juncus fockei	0	0	0	0	0	0
Juncus planifolius	0	0	0	0	0	0
Juncus polyanthemus	0	0	0	2	0	0
Juncus prismatocarpus	0	0	0	0	0	0
Juncus sarophorus	0	0	0	0	0	0
Juncus subsecundus	0	0	0	0	0	0
Lepidosperma filiforme	0	0	3	3	0	0
Lepidosperma laterale	3	0	0	0	0	1
Leotocarpus tenax	0	0	0	0	1	1
Lepyrodia scariosa	0	0	1	1	0	0
Lomandra fluviatilis	0	0	0	0	0	0
Lomandra longifolia	0	3	0	0	0	0
Myriophyllum pedunculatum	0	0	0	0	0	0
Paspalum distichum	3	0	0	0	0	0
Phragmites australis	0	3	0	0	0	0
Restio sp. (Baliskion)	0	0	0	0	0	0
**Rumex conglomeratus*	1	0	0	0	0	0
Schoenus apogon	0	0	0	0	0	0
Schoenus melanostachys	0	0	0	0	1	1
Schoenoplectus mucronatus	1	0	0	0	0	0
Sticherus flabellatus	0	0	2	0	0	0
Triglochin striatum	0	1	0	0	0	0
Tristaniopsis laurina	0	0	3	3	0	0
Typha domingensis	0	2	0	0	0	0
Typha orientalis	0	0	0	0	0	0
Viminaria juncea	0	0	0	0	0	0
algae nitella chara	3	3	0	0	0	0
diatoms	3	3	0	0	3+	3
moss	0	0	0	0	1	1
filamentous	0	0	0	0	2	1

Attachment C

Estimated Cover of Plant Species Recorded along each Stream Survey Location - Spring 2008

Survey Location	**Tributary of Cataract Reservoir Tributary 2 - 18/12/2008**		**Georges River - 18/12/2008**		**Dahlia Creek - 17/12/2008**		**Tributary of O'Hares Creek - 17/12/2008**	
	TCRT2-1	**TCRT2-2**	**GR21**	**GR22**	**DC1**	**DC2**	**TOC1**	**TOC2**
*_Aster squamatus_	0	0	0	0	0	0	0	0
Baumea rubiginosa	0	0	0	0	0	0	1	1
Baumea teretifolia	0	0	0	0	0	0	0	1
Blechnum sp.	0	0	0	0	0	0	0	0
Callicoma serratifolia	0	0	0	0	3	0	0	0
Carex appressa	0	0	0	0	0	0	0	0
Centrolepis fascicularis	0	0	0	0	0	0	0	1
Chorizandra cymbaria	0	0	0	0	0	0	0	0
*_Cyperus eragrostis_	0	0	0	0	0	0	0	0
Dicksonia antarctica	0	0	0	0	0	1	0	1
Drosera binata	0	0	0	0	0	0	0	0
Drosera spatulata	0	0	0	0	0	0	0	0
Elatine gratioloides	0	0	0	0	0	0	0	0
Eleocharis sp.	0	0	0	0	0	0	0	0
*_Elodea canadensis_	0	0	0	0	0	0	0	0
Euchordia complanatus	0	0	0	0	0	0	0	0
Fimbristylis sp	0	0	1	1	0	0	0	0
Gahnia sp.	0	0	0	0	0	0	0	0
Gahnia clarkei	0	0	0	0	0	0	0	3
Gleichenia dicarpa	1	1	0	0	0	0	1	1
Glossostigma sp.	0	0	0	0	0	0	0	0
Hemarthria uncinata	0	0	0	1	0	0	0	0
Hydrocotyle sp.	0	0	0	0	0	0	0	0
Isolepis inundata	0	0	1	1	0	0	0	0
*_Isolepis prolifera_	0	0	0	0	0	0	0	0
Juncus australis	0	0	0	0	0	0	0	0
*_Juncus articulatis_	0	0	0	0	0	0	0	0
Juncus fockei	0	0	1	0	0	0	0	0
Juncus planifolius	0	0	0	0	0	0	0	0
Juncus polyanthemus	0	0	0	0	0	0	0	0
Juncus prismatocarpus	0	0	0	0	0	0	0	0
Juncus sarophorus	0	0	0	0	0	0	0	0
Juncus subsecundus	0	0	0	0	0	0	0	0
Lepidosperma filiforme	0	0	1	1	1	1	0	0
Lepidosperma laterale	0	0	0	0	0	0	0	0
Leotocarpus tenax	0	0	0	0	0	0	0	0
Lepyrodia scariosa	0	0	0	0	0	0	0	0
Lomandra fluviatilis	0	0	0	0	0	0	2	0
Lomandra longifolia	1	0	0	0	0	0	0	0
Myriophyllum pedunculatum	0	0	0	0	0	0	0	0
Paspalum distichum	0	0	0	0	0	0	0	0
Phragmites australis	0	0	0	0	0	0	0	0
Restio sp. (Baliskion)	0	0	0	0	0	0	0	0
*_Rumex conglomeratus_	0	0	0	0	0	0	0	0
Schoenus apogon	0	0	0	0	0	0	0	0
Schoenus melanostachys	3	2	1	1	1	3	1	2
Schoenoplectus mucronatus	0	0	0	0	0	0	0	0
Sticherus flabellatus	0	0	0	0	3	1	1	3
Triglochin striatum	0	0	0	0	0	0	0	0
Tristaniopsis laurina	0	0	2	2	3	2	0	0
Typha domingensis	0	0	2	0	0	0	0	0
Typha orientalis	0	0	0	0	0	0	0	0
Viminaria juncea	0	0	0	0	0	0	0	0
algae nitella chara	0	0	2	2	0	0	0	2
diatoms	0	1	3	3	1	1	1	1
moss	1	0	0	0	3	3	3	3
filamentous	1	0	1	1	0	0	3	0

* denotes an introduced species

Geoff Sainty pers. comm. 2008). It should be noted that the species, _Tristaniopsis laurina_ (Water gum), will surive in water for extended periods but

Cover Classes

1 = few

2 = scattered

3 = common

Attachment D

Water Quality Data

Attachment D
Water Quality Data - Autumn 2008

Parameter	Wallandoola Creek - 14/06/2008										Lizard Creek - 14/06/2008									
	WC1-1			Mean	SE	WC1-2			Mean	SE	LC1-1			Mean	SE	LC1-2			Mean	SE
	1	2	3			1	2	3			1	2	3			1	2	3		
Temperature (°C)	16.7	16.7	16.7	16.7	0.0	16.4	16.4	16.4	16.4	0.0	15.2	15.2	15.2	15.2	0.0	15.4	15.4	15.4	15.4	0.0
pH (pH units)	6.7	6.7	6.7	6.7	0.0	6.6	6.6	6.6	6.6	0.0	7.1	7.0	7.0	7.0	0.0	6.8	6.8	6.8	6.8	0.0
Conductivity (µS/cm)	73	73	73	73	0	73	73	73	73	0	75	80	80	78	2	80	80	80	80	0
Dissolved Oxygen (%S)	103.2	103.1	103.0	103.1	0.1	97.4	97.7	97.9	97.7	0.1	105.5	104.7	102.2	104.1	1.0	104.5	103.9	103.7	104.0	0.2
Dissolved Oxygen (mg/L)	10.0	10.0	10.0	10.0	0.0	9.5	9.6	9.6	9.6	0.0	10.6	10.5	10.3	10.5	0.1	10.4	10.4	10.4	10.4	0.0
Turbidity (NTU)	5.4	4.6	4.1	4.7	0.4	2.7	2.4	2.4	2.5	0.1	2.4	3.8	2.2	2.8	0.5	2.7	2.7	2.7	2.7	0.0
Oxidation Reduction Potential (mv)	649	648	649	649	0	659	660	660	660	0	546	549	548	548	1	624	624	624	624	0
Alkalinity (mg/L $CaCO_3$)	0	-	-	N/A	N/A	0	-	-	N/A	N/A	5	-	-	N/A	N/A	5	-	-	N/A	N/A

Parameter	Foot Onslow Creek - 13/06/2008										Rocky Ponds Creek - 13/06/2008									
	FC1-1			Mean	SE	FC1-2			Mean	SE	RPC1-1			Mean	SE	RPC1-2			Mean	SE
	1	2	3			1	2	3			1	2	3			1	2	3		
Temperature (°C)	17.5	17.7	18.0	17.7	0.1	21.3	21.3	21.3	21.3	0.0	14.4	14.4	14.4	14.4	0.0	16.4	16.3	16.4	16.4	0.0
pH (pH units)	6.1	6.1	6.0	6.1	0.0	6.1	6.1	6.1	6.1	0.0	5.5	5.5	5.5	5.5	0.0	5.9	5.9	5.9	5.9	0.0
Conductivity (µS/cm)	189	189	187	188	1	192	192	192	192	0	157	152	152	154	2	150	150	150	150	0
Dissolved Oxygen (%S)	74.7	70.7	68.7	71.4	1.8	103.0	99.4	97.0	99.8	1.7	60.8	60.8	60.7	60.8	0.0	91.0	90.1	90.4	90.5	0.3
Dissolved Oxygen (mg/L)	7.1	6.7	6.5	6.8	0.2	9.1	8.8	8.6	8.8	0.1	6.2	6.2	6.2	6.2	0.0	8.9	8.8	8.9	8.9	0.0
Turbidity (NTU)	28.7	26.2	22.9	25.9	1.7	7.3	8.6	8.1	8.0	0.4	2.0	2.5	1.1	1.9	0.4	14.2	13.7	12.8	13.6	0.4
Oxidation Reduction Potential (mv)	541	539	536	539	1	544	543	543	543	0	504	505	504	504	0	439	439	439	439	0
Alkalinity (mg/L $CaCO_3$)	13	-	-	N/A	N/A	13	-	-	N/A	N/A	16	-	-	N/A	N/A	16	-	-	N/A	N/A

Parameter	Simpsons Creek - 13/06/2008										Cascade Creek - 13/06/2008									
	SIMP1-1			Mean	SE	SIMP1-2			Mean	SE	CC1-1			Mean	SE	CC1-2			Mean	SE
	1	2	3			1	2	3			1	2	3			1	2	3		
Temperature (°C)	18.1	18.1	18.1	18.1	0.0	17.1	17.1	17.9	17.4	0.3	22.9	22.9	22.9	22.9	0.0	21.5	21.5	21.5	21.5	0.0
pH (pH units)	6.0	6.0	6.0	6.0	0.0	6.2	6.2	6.1	6.2	0.0	6.7	6.6	6.6	6.6	0.1	6.4	6.4	6.4	6.4	0.0
Conductivity (µS/cm)	182	182	182	182	0	191	191	192	191	0	203	203	203	203	0	200	200	200	200	0
Dissolved Oxygen (%S)	90.2	90.2	90.2	90.2	0.0	95.1	95.0	92.0	94.0	1.0	96.9	89.1	89.2	91.7	2.6	87.9	87.8	87.8	87.8	0.0
Dissolved Oxygen (mg/L)	8.5	8.5	8.5	8.5	0.0	9.2	9.2	8.7	9.0	0.2	8.3	7.7	7.7	7.9	0.2	7.8	7.7	7.7	7.7	0.0
Turbidity (NTU)	2.8	2.5	2.5	2.6	0.1	20.4	31.2	34.9	28.8	4.3	3.3	1.4	1.7	2.1	0.6	2.2	2.2	2.0	2.1	0.1
Oxidation Reduction Potential (mv)	435	435	434	435	0	491	490	489	490	1	623	625	626	625	1	622	622	622	622	0
Alkalinity (mg/L $CaCO_3$)	11	-	-	N/A	N/A	13	-	-	N/A	N/A	5	-	-	N/A	N/A	5	-	-	N/A	N/A

Attachment D
Water Quality Data - Autumn 2008

Parameter	Georges River - 30/05/2008										Brennans Creek - 30/05/2008									
	GR1-1			Mean	SE	GR1-2			Mean	SE	BC1-1			Mean	SE	BC1-2			Mean	SE
	1	2	3			1	2	3			1	2	3			1	2	3		
Temperature (°C)	12.0	12.1	12.1	12.1	0.0	11.7	11.7	11.7	11.7	0.0	18.6	18.6	18.6	18.6	0.0	18.4	18.4	18.4	18.4	0.0
pH (pH units)	6.6	6.6	6.6	6.6	0.0	6.8	6.8	6.8	6.8	0.0	7.8	7.8	7.8	7.8	0.0	7.8	7.8	7.8	7.8	0.0
Conductivity (µS/cm)	142	142	142	142	0	138	138	138	138	0	2,981	2,836	2,752	2,856	67	3,049	3,049	3,045	3,048	1
Dissolved Oxygen (%S)	82.7	83.3	83.1	83.0	0.2	78.0	78.2	78.2	78.1	0.1	89.8	89.0	88.7	89.2	0.3	90.1	90.1	90.0	90.1	0.0
Dissolved Oxygen (mg/L)	8.9	9.0	8.9	8.9	0.0	8.5	8.5	8.5	8.5	0.0	8.3	8.2	8.2	8.2	0.0	8.4	8.4	8.4	8.4	0.0
Turbidity (NTU)	19.3	42.6	42.6	34.8	7.8	23.6	22.8	22.8	23.1	0.3	28.8	28.2	27.7	28.2	0.3	45.6	45.3	44.5	45.1	0.3
Oxidation Reduction Potential (mv)	436	437	437	437	0	451	451	451	451	0	447	447	447	447	0	463	463	462	463	0
Alkalinity (mg/L $CaCO_3$)	5	-	-	N/A	N/A	5	-	-	N/A	N/A	12	-	-	N/A	N/A	12	-	-	N/A	N/A

Parameter	Brennans Creek Tributary - 30/05/2008										Nepean River - 28/05/2008									
	BCT1-1			Mean	SE	BCT1-2			Mean	SE	NP1-1			Mean	SE	NP1-2			Mean	SE
	1	2	3			1	2	3			1	2	3			1	2	3		
Temperature (°C)	11.8	11.8	11.8	11.8	0.0	14.5	14.4	14.4	14.4	0.0	13.5	13.5	13.3	13.5	0.1	13.4	13.4	13.4	13.4	0.0
pH (pH units)	7.1	7.1	7.1	7.1	0.0	6.3	6.3	6.3	6.3	0.0	7.5	7.4	7.5	7.5	0.0	7.4	7.4	7.4	7.4	0.0
Conductivity (µS/cm)	507	506	506	506	0	361	356	357	358	2	344	344	345	344	0	345	345	344	345	0
Dissolved Oxygen (%S)	54.8	54.3	53.8	54.3	0.3	18.0	17.8	17.4	17.7	0.2	107.8	111.6	106.4	108.6	1.6	108.0	107.4	108.0	107.8	0.2
Dissolved Oxygen (mg/L)	5.9	5.9	5.8	5.9	0.0	1.8	1.8	1.8	1.8	0.0	11.2	11.6	11.1	11.3	0.2	11.3	11.2	11.3	11.3	0.0
Turbidity (NTU)	54.3	55.9	56.2	55.5	0.6	3.3	3.3	3.0	3.2	0.1	10.9	126.5	8.7	48.7	38.9	4.6	4.9	33.4	14.3	9.6
Oxidation Reduction Potential (mv)	371	371	372	371	0	305	308	309	307	1	585	582	583	583	1	585	584	585	585	0
Alkalinity (mg/L $CaCO_3$)	0	-	-	N/A	N/A	13	-	-	N/A	N/A	14	-	-	N/A	N/A	13	-	-	N/A	N/A

Parameter	Clements Creek - 28/05/2008										Cascade Creek - 28/05/2008									
	ClC1			Mean	SE	ClC2			Mean	SE	CC2-1			Mean	SE	CC2-2			Mean	SE
	1	2	3			1	2	3			1	2	3			1	2	3		
Temperature (°C)	12.4	12.3	12.3	12.3	0.1	12.3	12.3	12.2	12.3	0.0	11.6	11.6	11.5	11.6	0.0	10.7	10.7	10.7	10.7	0.0
pH (pH units)	7.8	7.8	7.8	7.8	0.0	7.8	7.7	7.7	7.7	0.0	6.6	6.6	6.5	6.6	0.0	6.8	6.8	6.8	6.8	0.0
Conductivity (µS/cm)	4,697	4,699	4,690	4,695	3	4,622	4,611	4,626	4,620	4	231	231	231	231	0	241	241	241	241	0
Dissolved Oxygen (%S)	130.0	129.4	128.9	129.4	0.3	129.1	132.4	129.6	130.4	1.0	50.3	53.1	48.8	50.7	1.3	65.2	64.9	64.5	64.9	0.2
Dissolved Oxygen (mg/L)	13.7	13.6	13.6	13.6	0.0	13.6	14.0	13.7	13.8	0.1	5.5	5.8	5.3	5.5	0.1	7.2	7.2	7.2	7.2	0.0
Turbidity (NTU)	16.0	17.9	19.5	17.8	1.0	11.1	82.8	9.5	34.5	24.2	3.5	31.8	4.6	13.3	9.3	6.8	4.3	5.2	5.4	0.7
Oxidation Reduction Potential (mv)	584	583	582	583	1	604	604	604	604	0	587	576	565	576	6	552	552	553	552	0
Alkalinity (mg/L $CaCO_3$)	180	-	-	N/A	N/A	180	-	-	N/A	N/A	0	-	-	N/A	N/A	5	-	-	N/A	N/A

Attachment D
Water Quality Data - Autumn 2008

Parameter	Nepean River - 20/05/2008										Nepean River - 20/05/2008									
	NP2-1			Mean	SE	NP2-2			Mean	SE	NP3-1			Mean	SE	NP3-2			Mean	SE
	1	2	3			1	2	3			1	2	3			1	2	3		
Temperature (°C)	12.3	12.3	12.2	12.2	0.0	12.1	12.1	12.1	12.1	0.0	14.5	14.5	14.5	14.5	0.0	14.4	14.4	14.4	14.4	0.0
pH (pH units)	7.2	7.2	7.2	7.2	0.0	7.3	7.3	7.3	7.3	0.0	7.0	7.0	7.0	7.0	0.0	7.0	7.0	7.0	7.0	0.0
Conductivity (µS/cm)	324	324	324	324	0	320	320	320	320	0	370	365	370	368	2	366	366	366	366	0
Dissolved Oxygen (%S)	102.0	102.1	102.0	102.0	0.0	94.1	94.2	94.3	94.2	0.1	89.5	89.3	89.3	89.4	0.1	85.5	85.5	85.4	85.5	0.0
Dissolved Oxygen (mg/L)	10.9	10.9	10.9	10.9	0.0	10.1	10.1	10.2	10.1	0.0	9.1	9.1	9.1	9.1	0.0	8.7	8.7	8.7	8.7	0.0
Turbidity (NTU)	2.2	2.4	2.4	2.3	0.1	2.2	2.4	2.4	2.3	0.1	3.0	2.7	1.9	2.5	0.3	7.1	7.1	7.3	7.2	0.1
Oxidation Reduction Potential (mv)	644	644	644	644	0	643	643	643	643	0	649	649	649	649	0	644	644	644	644	0
Alkalinity (mg/L $CaCO_3$)	18	-	-	N/A	N/A	16	-	-	N/A	N/A	15	-	-	N/A	N/A	14	-	-	N/A	N/A

Parameter	Racecourse Creek - 20/05/2008										O'Hares Creek - 26/04/2008									
	RC1-1			Mean	SE	RC1-2			Mean	SE	OC1-1			Mean	SE	OC1-2			Mean	SE
	1	2	3			1	2	3			1	2	3			1	2	3		
Temperature (°C)	12.0	11.9	12.0	12.0	0.0	12.6	12.5	12.5	12.5	0.0	15.7	15.7	15.7	15.7	0.0	15.7	15.7	15.7	15.7	0.0
pH (pH units)	7.2	7.2	7.2	7.2	0.0	7.2	7.2	7.2	7.2	0.0	6.6	6.6	6.6	6.6	0.0	6.5	6.5	6.5	6.5	0.0
Conductivity (µS/cm)	1,691	1,684	1,682	1,686	3	1,674	1,678	1,674	1,675	1	74	74	74	74	0	74	74	74	74	0
Dissolved Oxygen (%S)	97.5	94.4	92.9	94.9	1.4	90.2	92.9	88.0	90.4	1.4	111.2	108.8	108.2	109.4	0.9	103.9	102.8	103.4	103.4	0.3
Dissolved Oxygen (mg/L)	10.5	10.1	10.0	10.2	0.2	9.6	9.9	9.3	9.6	0.2	11.1	10.8	10.8	10.9	0.1	10.3	10.2	10.3	10.3	0.0
Turbidity (NTU)	96.6	30.1	106.6	77.8	24.0	152.5	406.5	124.6	227.9	89.7	11.7	10.3	10.9	11.0	0.4	5.7	6.8	10.0	7.5	1.3
Oxidation Reduction Potential (mv)	651	650	649	650	1	649	646	645	647	1	610	605	602	606	2	607	604	586	599	7
Alkalinity (mg/L $CaCO_3$)	12	-	-	N/A	N/A	12	-	-	N/A	N/A	0	-	-	N/A	N/A	0	-	-	N/A	N/A

Parameter	O'Hares Creek - 26/04/2008										Stokes Creek - 26/04/2008									
	OC2-1			Mean	SE	OC2-2			Mean	SE	SC1-1			Mean	SE	SC1-2			Mean	SE
	1	2	3			1	2	3			1	2	3			1	2	3		
Temperature (°C)	16.3	16.3	16.3	16.3	0.0	16.4	16.4	16.3	16.4	0.0	14.1	14.1	14.1	14.1	0.0	14.2	14.2	14.2	14.2	0.0
pH (pH units)	6.6	6.6	6.6	6.6	0.0	6.6	6.6	6.6	6.6	0.0	6.3	6.3	6.3	6.3	0.0	6.3	6.3	6.3	6.3	0.0
Conductivity (µS/cm)	73	73	73	73	0	73	69	69	70	1	82	82	82	82	0	77	82	82	80	2
Dissolved Oxygen (%S)	111.3	111.1	110.5	111.0	0.2	112.1	111.2	109.8	111.0	0.7	95.1	95.1	94.9	95.0	0.1	107.5	106.9	107.3	107.2	0.2
Dissolved Oxygen (mg/L)	10.9	10.9	10.9	10.9	0.0	11.0	10.9	10.8	10.9	0.1	9.8	9.8	9.8	9.8	0.0	11.0	11.0	11.0	11.0	0.0
Turbidity (NTU)	17.6	17.6	17.1	17.4	0.2	6.2	6.2	6.0	6.1	0.1	20.9	19.3	20.4	20.2	0.5	31.2	36.6	37.2	35.0	1.9
Oxidation Reduction Potential (mv)	603	603	603	603	0	626	625	624	625	1	484	483	482	483	1	482	481	479	481	1
Alkalinity (mg/L $CaCO_3$)	5	-	5	N/A	N/A	0	-	-	N/A	N/A	0	-	-	N/A	N/A	0	-	-	N/A	N/A

Attachment D
Water Quality Data - Autumn 2008

Parameter	Stokes Creek - 26/04/2008										Cataract River - 13/04/2008									
	SC2-1			Mean	SE	SC2-2			Mean	SE	CR1-1			Mean	SE	CR1-2			Mean	SE
	1	2	3			1	2	3			1	2	3			1	2	3		
Temperature (°C)	15.0	15.0	15.0	15.0	0.0	15.0	15.0	15.0	15.0	0.0	16.4	16.4	16.4	16.4	0.0	16.7	16.7	16.7	16.7	0.0
pH (pH units)	6.4	6.3	6.3	6.4	0.0	6.4	6.4	6.4	6.4	0.0	6.6	6.6	6.6	6.6	0.0	6.7	6.7	6.7	6.7	0.0
Conductivity (µS/cm)	80	85	80	82	2	80	80	80	80	0	73	73	73	73	0	73	73	73	73	0
Dissolved Oxygen (%S)	107.3	104.9	105.7	106.0	0.7	111.0	110.4	109.8	110.4	0.3	97.4	97.7	97.9	97.7	0.1	103.2	103.1	103.0	103.1	0.1
Dissolved Oxygen (mg/L)	10.8	10.6	10.7	10.7	0.1	11.2	11.1	11.1	11.1	0.0	9.5	9.6	9.6	9.6	0.0	10.0	10.0	10.0	10.0	0.0
Turbidity (NTU)	19.5	19.0	17.4	18.6	0.6	19.8	18.7	19.3	19.3	0.3	2.7	2.4	2.4	2.5	0.1	5.4	4.6	4.1	4.7	0.4
Oxidation Reduction Potential (mv)	521	519	521	520	1	532	529	526	529	2	659	660	660	660	0	649	648	649	649	0
Alkalinity (mg/L $CaCO_3$)	0	-	-	N/A	N/A	0	-	-	N/A	N/A	0	-	-	N/A	N/A	0	-	-	N/A	N/A

Parameter	Cataract River - 13/04/2008									
	CR2-1			Mean	SE	CR2-2			Mean	SE
	1	2	3			1	2	3		
Temperature (°C)	15.4	15.4	15.4	15.4	0.0	15.2	15.2	15.2	15.2	0.0
pH (pH units)	6.8	6.8	6.8	6.8	0.0	7.1	7.0	7.0	7.0	0.0
Conductivity (µS/cm)	80	80	80	80	0	75	80	80	78	2
Dissolved Oxygen (%S)	104.5	103.9	103.7	104.0	0.2	105.5	104.7	102.2	104.1	1.0
Dissolved Oxygen (mg/L)	10.4	10.4	10.4	10.4	0.0	10.6	10.5	10.3	10.5	0.1
Turbidity (NTU)	2.7	2.7	2.7	2.7	0.0	2.4	3.8	2.2	2.8	0.5
Oxidation Reduction Potential (mv)	624	624	624	624	0	546	549	548	548	1
Alkalinity (mg/L $CaCO_3$)	0	-	-	N/A	N/A	0	-	-	N/A	N/A

N/A - not applicable

SE - standard error

Note: One alkalinity measurement was conducted at each site.

Attachment D
Water Quality Data - Spring 2008

Parameter	Carriage Creek - 18/12/2008										Cataract Reservoir Tributary 2- 18/12/2008									
	Ca-1			Mean	SE	Ca-2			Mean	SE	CRT2-1			Mean	SE	CRT2-2			Mean	SE
	1	2	3			1	2	3			1	2	3			1	2	3		
Temperature (°C)	25.1	25.1	25.1	25.1	0.0	24.2	24.2	24.2	24.2	0.0	23.1	23.2	23.2	23.2	0.0	22.8	22.8	22.8	22.8	0.0
pH (pH units)	6.5	6.5	6.4	6.4	0.0	6.2	6.2	6.2	6.2	0.0	5.5	5.4	5.3	5.4	0.1	5.7	5.6	5.5	5.6	0.0
Conductivity (µS/cm)	1,032	1,032	1,032	1,032	0	1,041	1,042	1,042	1,042	0	122	126	122	123	1	123	123	123	123	0
Dissolved Oxygen (%S)	105.1	105.1	105.3	105.2	0.1	114.4	115.0	115.0	114.8	0.2	69.6	67.8	64.9	67.4	1.4	74.5	73.6	72.9	73.7	0.5
Dissolved Oxygen (mg/L)	8.6	8.6	8.7	8.6	0.0	9.6	9.6	9.6	9.6	0.0	6.0	5.8	5.5	5.8	0.1	6.4	6.3	6.3	6.3	0.0
Turbidity (NTU)	16.7	13.9	14.5	15.0	0.9	11.2	13.1	11.4	11.9	0.6	-1.1	-1.4	-1.7	-1.4	0.2	-2.8	-2.5	-2.5	-2.6	0.1
Oxidation Reduction Potential (mv)	307	307	307	307	0	352	352	352	352	0	255	255	255	255	0	245	245	247	246	1
Alkalinity (mg/L $CaCO_3$)	12	-	-	N/A	N/A	12	-	-	N/A	N/A	0	-	-	N/A	N/A	0	-	-	N/A	N/A

Parameter	Tributary of Cataract Reservoir Tributary 2 - 18/12/2008										Georges River - Location 2 - 18/12/2008									
	TRT2-1			Mean	SE	TRT2-2			Mean	SE	GR2-1			Mean	SE	GR2-2			Mean	SE
	1	2	3			1	2	3			1	2	3			1	2	3		
Temperature (°C)	18.4	18.4	18.4	18.4	0.0	19.1	19.0	18.9	19.0	0.1	20.8	20.8	20.8	20.8	0.0	20.5	20.5	20.5	20.5	0.0
pH (pH units)	5.3	5.3	5.3	5.3	0.0	4.9	4.9	4.9	4.9	0.0	7.1	7.1	7.1	7.1	0.0	7.2	7.2	7.2	7.2	0.0
Conductivity (µS/cm)	172	172	172	172	0	178	179	179	179	0	1,576	1,576	1,581	1,578	2	1,566	1,566	1,566	1,566	0
Dissolved Oxygen (%S)	59.6	59.5	59.2	59.4	0.1	54.7	49.4	43.9	49.3	3.1	76.8	75.2	73.8	75.3	0.9	63.8	63.8	63.8	63.8	0.0
Dissolved Oxygen (mg/L)	5.6	5.6	5.6	5.6	0.0	5.1	4.6	4.1	4.6	0.3	6.8	6.7	6.6	6.7	0.1	5.7	5.7	5.7	5.7	0.0
Turbidity (NTU)	43.0	41.6	41.0	41.9	0.6	33.2	34.0	32.6	33.3	0.4	2.2	2.2	2.5	2.3	0.1	5.6	5.3	7.8	6.2	0.8
Oxidation Reduction Potential (mv)	295	295	295	295	0	267	266	265	266	1	375	374	374	374	0	337	337	337	337	0
Alkalinity (mg/L $CaCO_3$)	10	-	-	N/A	N/A	10	-	-	N/A	N/A	10	-	-	N/A	N/A	10	-	-	N/A	N/A

Parameter	Wallandoola Creek - Location 2 - 17/12/2008										Dahlia Creek - 17/12/2008									
	WC2-1			Mean	SE	WC2-2			Mean	SE	DC-1			Mean	SE	DC-2			Mean	SE
	1	2	3			1	2	3			1	2	3			1	2	3		
Temperature (°C)	21.9	22.0	21.9	21.9	0.0	21.2	21.2	21.2	21.2	0.0	17.4	17.4	17.4	17.4	0.0	17.7	17.7	17.7	17.7	0.0
pH (pH units)	6.4	6.3	6.2	6.3	0.0	5.8	5.8	5.8	5.8	0.0	6.4	6.4	6.4	6.4	0.0	7.1	7.1	7.1	7.1	0.0
Conductivity (µS/cm)	168	168	168	168	0	166	166	166	166	0	142	137	142	140	2	141	141	141	141	0
Dissolved Oxygen (%S)	96.9	97.8	95.9	96.9	0.5	85.4	85.8	85.7	85.6	0.1	74.8	76.8	76.9	76.2	0.7	83.1	82.9	82.7	82.9	0.1
Dissolved Oxygen (mg/L)	8.5	8.6	8.4	8.5	0.1	7.6	7.6	7.6	7.6	0.0	7.2	7.4	7.4	7.3	0.1	7.9	7.9	7.9	7.9	0.0
Turbidity (NTU)	14.5	14.5	15.1	14.7	0.2	<2.0	<2.0	<2.0	0.0	0.0	13.1	13.1	13.1	13.1	0.0	<2.0	<2.0	<2.0	0.0	0.0
Oxidation Reduction Potential (mv)	209	217	220	215	3	248	248	248	248	0	252	252	252	252	0	222	222	222	222	0
Alkalinity (mg/L $CaCO_3$)	5	-	-	N/A	N/A	5	-	-	N/A	N/A	0	-	-	N/A	N/A	0	-	-	N/A	N/A

Attachment D
Water Quality Data - Spring 2008

Parameter	Tributary of O'Hares Creek - 17/12/2008									
	TOC-1			Mean	SE	TOC-2			Mean	SE
	1	2	3			1	2	3		
Temperature (°C)	19.8	19.8	19.8	19.8	0.0	20.0	20.0	20.0	20.0	0.0
pH (pH units)	6.1	6.0	6.0	6.0	0.0	5.8	5.8	5.8	5.8	0.0
Conductivity (µS/cm)	149	149	153	150	1	153	153	153	153	0
Dissolved Oxygen (%S)	61.8	61.4	61.0	61.4	0.2	51.3	51.6	51.5	51.5	0.1
Dissolved Oxygen (mg/L)	5.6	5.6	5.6	5.6	0.0	4.7	4.7	4.7	4.7	0.0
Turbidity (NTU)	1.7	2.2	2.8	2.2	0.3	2.2	2.0	2.5	2.2	0.1
Oxidation Reduction Potential (mv)	217	217	217	217	0	191	191	191	191	0
Alkalinity (mg/L $CaCO_3$)	0	-	-	N/A	N/A	5	-	-	N/A	N/A

N/A - not applicable

SE - standard error

Note: One alkalinity measurement was conducted at each site.

Attachment E

AUSRIVAS Macroinvertebrate Data

< TOC Home >

Attachment E
AUSRIVAS Macroinvertebrate Data - Autumn 2008

Location - Date	Wallandoola Creek - 14/06/2008		Lizard Creek - 14/06/2008		Foot Onslow Creek - 13/06/2008		Rocky Ponds Creek - 13/06/2008	
Site	**WC1-1**	**WC1-2**	**LC1-1**	**LC1-2**	**FC1-1**	**FC1-2**	**RPC1-1**	**RPC1-2**
Acariformes	0	0	0	0	0	0	0	0
Aeshnidae	0	0	0	0	1	0	0	0
Araneae	0	0	2	0	1	0	2	0
Atyidae	0	1	0	0	0	1	0	0
Baetidae	1	0	0	0	0	0	0	0
Caenidae	0	0	0	0	0	0	0	0
Calamoceratidae	0	0	0	0	0	0	0	0
Ceinidae	0	0	0	0	0	0	4	9
Chironomidae - Chironominae	1	0	0	2	3	0	0	12
Chironomidae - Tanypodinae	0	0	0	0	0	0	0	0
Chrysomelidae	0	0	0	0	0	0	1	0
Coenagrionidae	0	0	0	0	1	0	0	0
Collembola	0	0	0	0	0	0	1	0
cf Corbiculidae (juvenile)	0	0	0	0	0	0	0	0
Cordulephyidae	0	1	0	0	0	0	0	0
Corydalidae	0	0	0	0	0	0	0	0
Culicidae	0	0	0	0	1	2	0	0
Corixidae	0	0	0	3	0	0	0	0
Cyclopoida	0	0	0	0	4	0	0	0
Daphniidae	0	0	0	0	2	0	0	0
Dixidae	0	0	0	0	0	0	0	0
Dytiscidae	0	0	1	7	18	2	1	0
Ecnomidae	0	0	0	1	0	0	0	0
Empididae	0	0	0	0	0	0	0	0
Gambusia#	0	0	0	0	0	0	0	0
Gerridae	0	0	0	0	0	0	0	0
Gyrinidae	1	0	2	0	0	0	0	0
Haliplidae	0	0	0	0	0	0	0	0
Helicopsychidae	0	0	0	0	0	0	0	0
Hirudinea	0	0	0	0	0	0	0	0
Hydridae	0	0	0	0	0	0	0	0
Hydraenidae	0	0	0	0	0	0	1	0
Hydrobiosidae	0	0	0	0	0	0	0	0
Hydrophilidae	1	0	0	1	3	0	1	1
Leptoceridae	5	30	19	0	3	0	0	7
Leptophlebiidae	0	1	1	2	0	0	0	0
Libellulidae	0	0	0	0	0	0	0	0
Lymnaeidae	0	0	0	0	0	0	0	0
Megapodagrionidae	0	0	0	0	0	0	0	0

Attachment E
AUSRIVAS Macroinvertebrate Data - Autumn 2008

Location - Date	**Wallandoola Creek - 14/06/2008**		**Lizard Creek - 14/06/2008**		**Foot Onslow Creek - 13/06/2008**		**Rocky Ponds Creek - 13/06/2008**	
Site	**WC1-1**	**WC1-2**	**LC1-1**	**LC1-2**	**FC1-1**	**FC1-2**	**RPC1-1**	**RPC1-2**
Mesoveliidae	0	0	0	0	0	0	0	0
Nematodae	0	0	0	0	0	0	0	0
Notonectidae	0	0	0	0	0	2	0	0
Oligochaeta	0	0	0	0	1	0	0	3
Oniscidae	0	0	0	0	1	0	0	0
Ostracoda	0	0	0	0	1	0	1	0
Planorbidae	0	0	0	0	0	1	1	0
Pleidae	0	0	0	0	0	0	2	0
Physidae	0	0	0	0	8	0	3	0
Protoneuridae	0	0	0	0	0	0	0	0
Pyralidae	0	0	0	0	0	0	0	0
Scirtidae	0	0	1	1	13	0	0	23
Sialidae	0	0	0	0	0	0	0	0
Staphylinidae	0	0	0	0	0	0	0	0
Stratiomyidae	0	0	0	0	4	1	0	0
Synlestidae	0	0	0	0	0	0	0	0
Synthemistidae	0	0	0	0	0	0	0	1
Telephlebiidae	0	0	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0	0	0
Tricladida	0	0	0	0	0	0	0	1
Veliidae	1	0	2	0	3	0	5	1
Total Individual Macroinvertebrates	**10**	**33**	**28**	**17**	**68**	**9**	**23**	**58**
No. Taxa	**6**	**4**	**7**	**7**	**17**	**6**	**12**	**9**

Attachment E
AUSRIVAS Macroinvertebrate Data - Autumn 2008

Location - Date	**Simpsons Creek - 13/06/2008**		**Cascade Creek - 13/06/2008**		**Georges River - 30/05/2008**		**Brennans Creek - 30/05/2008**	
Site	**SIMP1-1**	**SIMP1-2**	**CC1-1**	**CC1-2**	**GR1-1**	**GR1-2**	**BC1-1**	**BC1-2**
Acariformes	0	0	0	0	0	0	0	0
Aeshnidae	0	0	2	0	0	0	0	0
Araneae	0	0	0	0	0	0	0	0
Atyidae	0	0	0	0	2	0	0	0
Baetidae	0	0	0	0	0	0	0	0
Caenidae	0	0	0	0	0	0	0	0
Calamoceratidae	0	0	0	0	0	0	0	0
Ceinidae	0	0	12	10	0	0	0	0
Chironomidae - Chironominae	0	0	0	2	0	0	0	0
Chironomidae - Tanypodinae	0	1	0	1	0	0	0	0
Chrysomelidae	0	0	0	0	0	0	0	0
Coenagrionidae	0	0	0	1	1	0	0	0
Collembola	0	0	1	0	0	0	0	1
cf Corbiculidae (juvenile)	0	0	0	0	0	2	0	0
Cordulephyidae	0	0	0	0	0	0	0	0
Corydalidae	0	0	0	0	0	0	0	0
Culicidae	0	0	0	0	0	0	0	0
Corixidae	0	0	0	0	0	0	5	6
Cyclopoida	0	0	0	0	0	0	0	0
Daphniidae	0	0	0	0	0	0	0	0
Dixidae	0	0	1	0	0	0	0	0
Dytiscidae	1	0	0	1	0	2	10	0
Ecnomidae	0	0	0	0	0	1	0	0
Empididae	0	0	0	0	0	0	0	0
Gambusia#	0	0	0	0	3	3	0	0
Gerridae	0	0	0	0	0	0	0	0
Gyrinidae	0	0	3	0	0	0	5	48
Haliplidae	0	0	0	0	0	0	0	0
Helicopsychidae	0	0	0	0	0	0	0	0
Hirudinea	0	0	0	0	0	0	0	0
Hydridae	0	0	0	0	0	0	0	0
Hydraenidae	0	0	0	0	0	0	0	0
Hydrobiosidae	0	0	0	0	0	0	0	0
Hydrophilidae	1	0	0	1	2	0	3	0
Leptoceridae	1	1	4	0	9	3	0	0
Leptophlebiidae	0	1	5	10	13	14	0	0
Libellulidae	0	0	0	0	0	0	4	3
Lymnaeidae	0	0	0	0	0	0	0	0
Megapodagrionidae	0	0	0	2	0	0	0	0

Attachment E
AUSRIVAS Macroinvertebrate Data - Autumn 2008

Location - Date	Simpsons Creek - 13/06/2008		Cascade Creek - 13/06/2008		Georges River - 30/05/2008		Brennans Creek - 30/05/2008	
Site	SIMP1-1	SIMP1-2	CC1-1	CC1-2	GR1-1	GR1-2	BC1-1	BC1-2
Mesoveliidae	0	3	0	0	0	0	0	0
Nematodae	0	0	0	0	0	0	0	0
Notonectidae	0	1	1	2	0	1	0	0
Oligochaeta	0	0	0	0	0	0	0	0
Oniscidae	0	0	0	0	0	0	0	0
Ostracoda	0	0	1	1	0	0	0	0
Planorbidae	0	0	0	0	0	0	0	0
Pleidae	0	0	0	0	0	0	0	0
Physidae	28	1	0	0	0	0	0	0
Protoneuridae	0	0	0	0	0	0	0	0
Pyralidae	0	0	0	0	0	0	0	0
Scirtidae	0	0	1	0	0	1	0	0
Sialidae	0	0	0	0	0	0	0	0
Staphylinidae	0	0	0	0	0	1	0	0
Stratiomyidae	1	0	0	0	0	0	0	0
Synlestidae	0	0	0	0	0	0	0	0
Synthemistidae	0	0	0	0	0	0	1	0
Telephlebiidae	0	0	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	1	0	0
Tricladida	0	0	0	0	0	0	0	0
Veliidae	0	27	0	0	0	0	0	0
Total Individual Macroinvertebrates	**32**	**35**	**31**	**31**	**30**	**29**	**28**	**58**
No. Taxa	**5**	**7**	**10**	**10**	**5**	**9**	**6**	**4**

Attachment E
AUSRIVAS Macroinvertebrate Data - Autumn 2008

Location - Date	Brennans Creek Tributary - 30/05/2008		Nepean River - 28/05/2008		Clements Creek - 28/05/2008		Cascade Creek - 28/05/2008	
Site	BCT1-1	BCT1-2	NP1-1	NP1-2	CIC-1	CIC-2	CC2-1	CC2-2
Acariformes	0	0	0	0	0	0	0	0
Aeshnidae	0	0	0	0	0	0	0	2
Araneae	0	0	0	0	2	1	1	1
Atyidae	0	0	51	31	0	0	0	0
Baetidae	0	0	1	0	1	0	0	0
Caenidae	0	0	2	0	0	0	0	0
Calamoceratidae	0	0	1	2	0	0	0	0
Ceinidae	0	0	1	0	0	1	22	5
Chironomidae - Chironominae	0	0	10	2	4	2	0	0
Chironomidae - Tanypodinae	0	0	1	6	0	0	0	0
Chrysomelidae	0	0	2	0	0	0	0	0
Coenagrionidae	0	0	15	3	0	0	0	0
Collembola	0	0	0	0	0	0	0	0
cf Corbiculidae (juvenile)	0	0	0	0	0	0	0	0
Cordulephyidae	0	0	0	0	0	0	0	0
Corydalidae	1	0	0	0	0	0	0	0
Culicidae	0	0	0	0	0	0	0	0
Corixidae	0	0	41	1	4	12	1	0
Cyclopoida	0	0	1	0	0	0	0	0
Daphniidae	0	0	0	0	0	0	0	0
Dixidae	0	0	0	0	0	0	0	0
Dytiscidae	0	0	1	5	12	18	2	1
Ecnomidae	0	0	0	0	1	0	0	0
Empididae	0	0	0	0	0	0	0	0
Gambusia#	0	0	1	33	0	0	0	0
Gerridae	0	0	0	0	0	0	0	0
Gyrinidae	2	0	0	0	0	0	0	0
Haliplidae	0	0	0	0	0	0	0	0
Helicopsychidae	0	0	0	0	0	0	0	0
Hirudinea	0	0	0	1	0	0	0	0
Hydridae	0	0	0	0	0	0	0	0
Hydraenidae	0	0	0	1	0	0	1	0
Hydrobiosidae	0	0	0	0	0	0	0	0
Hydrophilidae	0	1	1	1	18	21	0	0
Leptoceridae	0	0	10	33	0	0	3	3
Leptophlebiidae	0	1	0	0	0	1	29	4
Libellulidae	0	0	2	0	0	0	0	0
Lymnaeidae	0	0	0	0	0	0	0	0

Attachment E
AUSRIVAS Macroinvertebrate Data - Autumn 2008

Location - Date	**Brennans Creek Tributary - 30/05/2008**		**Nepean River - 28/05/2008**		**Clements Creek - 28/05/2008**		**Cascade Creek - 28/05/2008**	
Site	**BCT1-1**	**BCT1-2**	**NP1-1**	**NP1-2**	**CIC-1**	**CIC-2**	**CC2-1**	**CC2-2**
Megapodagrionidae	3	0	0	0	1	0	3	0
Mesoveliidae	0	0	1	0	0	0	0	0
Nematodae	0	0	0	0	0	0	0	0
Notonectidae	1	0	0	0	1	8	2	9
Oligochaeta	0	0	0	0	0	0	0	0
Oniscidae	0	0	0	0	0	0	0	0
Ostracoda	0	0	0	0	1	8	0	0
Planorbidae	0	0	0	0	0	0	0	0
Pleidae	0	0	0	1	0	0	0	0
Physidae	0	0	0	0	0	0	0	0
Protoneuridae	0	0	2	6	0	0	0	1
Pyralidae	0	0	0	1	0	0	0	0
Scirtidae	0	0	6	0	0	0	0	0
Sialidae	0	0	0	0	0	0	0	0
Staphylinidae	0	0	0	0	0	0	0	0
Stratiomyidae	0	0	0	0	0	0	0	0
Synlestidae	0	0	0	0	0	0	0	0
Synthemistidae	0	0	0	0	0	0	1	0
Telephlebiidae	0	0	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0	0	0
Tricladida	0	0	1	0	0	0	0	0
Veliidae	0	0	3	0	2	0	6	0
Total Individual Macroinvertebrates	**7**	**2**	**154**	**127**	**47**	**72**	**71**	**26**
No. Taxa	**4**	**2**	**20**	**14**	**11**	**9**	**11**	**8**

Attachment E
AUSRIVAS Macroinvertebrate Data - Autumn 2008

Location - Date	Nepean River - 20/05/2008		Nepean River - 20/05/2008		Racecourse Creek - 20/05/2008		O'Hares Creek - 26/04/2008	
Site	**NP2-1**	**NP2-2**	**NP3-1**	**NP3-2**	**RC1-1**	**RC1-2**	**OC1-1**	**OC1-2**
Acariformes	0	0	0	0	0	0	0	0
Aeshnidae	0	0	0	0	0	0	0	0
Araneae	0	1	0	0	3	0	0	0
Atyidae	2	0	12	21	0	0	9	5
Baetidae	0	0	0	0	0	0	1	0
Caenidae	0	4	0	1	0	2	0	0
Calamoceratidae	0	0	0	0	0	0	0	0
Ceinidae	0	0	0	0	0	0	0	1
Chironomidae - Chironominae	3	3	7	3	4	14	0	0
Chironomidae - Tanypodinae	0	0	1	0	0	0	0	0
Chrysomelidae	0	0	0	1	0	0	0	0
Coenagrionidae	0	0	1	2	2	0	0	0
Collembola	1	1	0	0	0	1	0	0
cf Corbiculidae (juvenile)	0	0	0	0	0	0	0	0
Cordulephyidae	0	0	0	0	0	0	0	0
Corydalidae	0	0	0	0	0	0	0	0
Culicidae	0	0	0	0	0	0	0	0
Corixidae	2	1	0	6	1	3	2	2
Cyclopoida	0	0	2	1	0	0	0	0
Daphniidae	0	0	0	0	0	0	0	0
Dixidae	0	0	0	0	0	0	0	0
Dytiscidae	0	1	1	0	0	4	7	1
Ecnomidae	0	0	0	0	0	3	0	0
Empididae	0	0	0	0	1	0	0	0
Gambusia#	0	0	0	0	12	16	0	0
Gerridae	0	0	0	0	0	0	0	2
Gyrinidae	0	0	0	0	0	0	8	2
Haliplidae	0	0	0	0	0	1	0	0
Helicopsychidae	0	0	0	0	0	0	0	0
Hirudinea	0	0	0	0	0	0	0	0
Hydridae	0	0	0	0	3	3	0	0
Hydraenidae	0	0	0	0	0	0	0	0
Hydrobiosidae	0	0	0	0	0	0	0	0
Hydrophilidae	0	16	1	1	3	2	3	0
Leptoceridae	0	1	3	1	7	1	3	17
Leptophlebiidae	0	0	0	0	0	0	5	6
Libellulidae	0	1	0	0	3	1	0	0
Lymnaeidae	0	0	0	0	7	1	0	0

Attachment E
AUSRIVAS Macroinvertebrate Data - Autumn 2008

Location - Date	**Nepean River - 20/05/2008**		**Nepean River - 20/05/2008**		**Racecourse Creek - 20/05/2008**		**O'Hares Creek - 26/04/2008**	
Site	**NP2-1**	**NP2-2**	**NP3-1**	**NP3-2**	**RC1-1**	**RC1-2**	**OC1-1**	**OC1-2**
Megapodagrionidae	0	1	0	0	0	0	0	0
Mesoveliidae	0	1	0	0	0	0	0	0
Nematodae	0	1	0	0	0	0	0	0
Notonectidae	0	0	0	0	5	0	11	2
Oligochaeta	0	0	0	0	0	0	0	0
Oniscidae	0	0	0	0	0	0	0	0
Ostracoda	0	0	5	9	0	2	0	0
Planorbidae	0	0	0	0	0	0	0	0
Pleidae	0	0	0	0	0	0	0	0
Physidae	0	0	1	1	3	0	0	0
Protoneuridae	0	0	0	0	0	0	0	0
Pyralidae	0	0	0	0	0	0	0	0
Scirtidae	0	0	0	0	0	0	0	0
Sialidae	0	0	3	0	0	0	0	0
Staphylinidae	0	0	0	0	0	0	0	0
Stratiomyidae	0	0	0	0	0	0	0	0
Synlestidae	0	0	0	0	0	0	0	1
Synthemistidae	0	0	0	0	0	0	0	1
Telephlebiidae	0	0	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0	0	0
Tricladida	0	0	0	0	1	1	0	0
Veliidae	0	0	0	0	1	0	0	3
Total Individual Macroinvertebrates	**8**	**32**	**37**	**47**	**56**	**55**	**49**	**43**
No. Taxa	**4**	**12**	**11**	**11**	**14**	**14**	**9**	**12**

Attachment E
AUSRIVAS Macroinvertebrate Data - Autumn 2008

Location - Date	O'Hares Creek - 26/04/2008		Stokes Creek - 26/04/2008		Stokes Creek - 26/04/2008		Cataract River - 13/04/2008	
Site	**OC2-1**	**OC2-2**	**SC1-1**	**SC1-2**	**SC2-1**	**SC2-2**	**CR1-1**	**CR1-2**
Acariformes	0	1	0	0	0	0	0	0
Aeshnidae	0	0	0	0	0	0	0	0
Araneae	0	0	0	0	0	0	0	0
Atyidae	0	0	6	1	1	12	0	0
Baetidae	0	0	0	0	0	0	0	0
Caenidae	2	0	0	0	0	0	0	5
Calamoceratidae	0	0	0	0	0	0	0	0
Ceinidae	0	0	0	0	0	0	0	0
Chironomidae - Chironominae	13	0	0	0	0	0	1	3
Chironomidae - Tanypodinae	0	0	0	0	0	0	0	0
Chrysomelidae	0	0	0	0	0	0	0	0
Coenagrionidae	0	0	0	0	0	0	0	0
Collembola	0	0	0	0	0	0	0	0
cf Corbiculidae (juvenile)	0	0	0	0	0	0	0	0
Cordulephyidae	0	0	0	0	0	0	0	0
Corydalidae	0	0	0	0	0	0	0	0
Culicidae	0	0	0	0	0	0	0	0
Corixidae	0	0	0	0	1	0	0	0
Cyclopoida	0	0	0	0	0	0	0	0
Daphniidae	0	0	0	0	0	0	0	0
Dixidae	0	0	0	0	0	0	0	0
Dytiscidae	1	1	1	0	2	0	0	0
Ecnomidae	0	0	0	0	0	0	0	0
Empididae	0	0	0	0	0	0	0	0
Gambusia#	0	0	0	0	0	0	2	0
Gerridae	0	3	0	0	4	0	0	0
Gyrinidae	0	0	0	0	3	4	0	0
Haliplidae	0	0	0	0	0	0	0	0
Helicopsychidae	0	0	0	0	1	0	0	0
Hirudinea	0	0	0	0	0	0	0	0
Hydridae	0	0	0	0	0	0	0	0
Hydraenidae	0	0	0	0	0	0	0	0
Hydrobiosidae	0	0	0	0	0	0	0	1
Hydrophilidae	0	0	0	0	0	0	1	0
Leptoceridae	0	1	0	0	2	0	0	1
Leptophlebiidae	0	0	1	0	1	0	3	39
Libellulidae	0	0	0	0	0	0	0	1
Lymnaeidae	0	0	0	0	0	0	0	0

Attachment E
AUSRIVAS Macroinvertebrate Data - Autumn 2008

Location - Date	O'Hares Creek - 26/04/2008		Stokes Creek - 26/04/2008		Stokes Creek - 26/04/2008		Cataract River - 13/04/2008	
Site	**OC2-1**	**OC2-2**	**SC1-1**	**SC1-2**	**SC2-1**	**SC2-2**	**CR1-1**	**CR1-2**
Megapodagrionidae	0	0	0	0	0	0	0	0
Mesoveliidae	0	1	0	0	0	0	0	0
Nematodae	0	0	0	0	0	0	1	0
Notonectidae	3	5	2	1	2	0	0	0
Oligochaeta	0	0	0	0	0	0	0	0
Oniscidae	0	0	0	0	0	0	0	0
Ostracoda	0	0	0	0	0	0	0	0
Planorbidae	0	0	0	0	0	0	0	1
Pleidae	0	0	0	0	0	0	0	0
Physidae	0	0	0	0	0	0	0	0
Protoneuridae	0	0	0	0	0	0	0	0
Pyralidae	0	0	0	0	0	0	0	0
Scirtidae	0	1	0	0	0	0	0	2
Sialidae	0	0	0	0	0	0	0	0
Staphylinidae	0	0	0	0	0	0	0	0
Stratiomyidae	0	0	0	0	0	0	0	0
Synlestidae	0	1	0	0	0	0	0	0
Synthemistidae	0	0	0	0	0	0	0	0
Telephlebiidae	0	0	0	0	0	0	0	1
Tipulidae	0	0	0	0	0	0	0	0
Tricladida	0	0	0	0	0	0	0	0
Veliidae	3	8	0	0	0	0	0	1
Total Individual Macroinvertebrates	**22**	**22**	**10**	**2**	**17**	**16**	**8**	**55**
No. Taxa	**5**	**9**	**4**	**2**	**9**	**2**	**4**	**10**

Attachment E
AUSRIVAS Macroinvertebrate Data - Autumn 2008

Location - Date	Cataract River - 13/04/2008	
Site	CR2-1	CR2-2
Acariformes	0	0
Aeshnidae	0	0
Araneae	0	0
Atyidae	5	0
Baetidae	0	0
Caenidae	2	0
Calamoceratidae	0	0
Ceinidae	0	0
Chironomidae - Chironominae	0	0
Chironomidae - Tanypodinae	0	0
Chrysomelidae	0	0
Coenagrionidae	0	0
Collembola	0	0
cf Corbiculidae (juvenile)	0	0
Cordulephyidae	0	0
Corydalidae	0	0
Culicidae	0	0
Corixidae	0	1
Cyclopoida	0	0
Daphniidae	0	0
Dixidae	0	0
Dytiscidae	1	1
Ecnomidae	0	0
Empididae	0	0
Gambusia#	1	0
Gerridae	0	0
Gyrinidae	0	0
Haliplidae	1	0
Helicopsychidae	0	0
Hirudinea	0	0
Hydridae	0	0
Hydraenidae	0	0
Hydrobiosidae	0	0
Hydrophilidae	1	3
Leptoceridae	1	0
Leptophlebiidae	1	2
Libellulidae	0	5
Lymnaeidae	0	0

Attachment E
AUSRIVAS Macroinvertebrate Data - Autumn 2008

Location - Date	Cataract River - 13/04/2008	
Site	**CR2-1**	**CR2-2**
Megapodagrionidae	1	0
Mesoveliidae	0	0
Nematodae	0	0
Notonectidae	0	0
Oligochaeta	0	1
Oniscidae	0	0
Ostracoda	0	0
Planorbidae	0	0
Pleidae	0	0
Physidae	0	0
Protoneuridae	0	0
Pyralidae	1	0
Scirtidae	1	1
Sialidae	0	0
Staphylinidae	0	0
Stratiomyidae	0	0
Synlestidae	0	0
Synthemistidae	0	0
Telephlebiidae	0	0
Tipulidae	0	0
Tricladida	0	0
Veliidae	0	8
Total Individual Macroinvertebrates	**16**	**22**
No. Taxa	**10**	**8**

Gambusia not included in the sum of 'Total Individual Macroinvertebrates' or 'Total No. Taxa' for the survey period.

Attachment E
AUSRIVAS Macroinvertebrate Data - Spring 2008

Location - Date	**Carriage Creek - 18/12/2008**		**Cataract Reservoir Tributary 2 - 18/12/2008**		**Tributary of Cataract Reservoir Tributary 2 - 18/12/2008**	**Georges River - Location 2 - 18/12/2008**	
Site	**Ca-1**	**Ca-2**	**CRT2-1**	**CRT2-2**	**TCRT2**	**GR2-1**	**GR2-2**
Acariformes (cf Hydrachnidae)	0	0	0	0	1	0	0
Aeshnidae	0	3	0	0	0	0	0
Araneae	0	0	0	1	0	0	1
Atyidae	2	12	3	1	0	0	2
Caenidae	8	7	0	0	0	7	10
Calamoceratidae	0	0	0	0	0	0	10
Ceinidae	42	20	0	0	0	0	4
Chironomidae - Chironominae	12	9	0	0	0	5	25
Chironomidae - Tanypodinae	0	4	0	0	0	3	4
Coenagrionidae	0	0	0	0	0	1	0
Cordulephyidae	2	1	0	0	0	2	1
Corixidae	0	0	0	0	0	1	0
Cyclopoida	0	0	0	0	0	0	0
Diptera pupae	0	0	0	1	0	0	0
Dytiscidae	6	2	0	1	7	1	6
Gambusia#	1	0	0	0	0	1	3
Gerridae	2	0	0	6	0	0	0
Gomphidae	0	0	0	0	0	1	1
Gripopterygidae	0	0	0	11	0	0	0
Gyrinidae	0	1	0	0	0	36	2
Heteroceridae	1	0	0	0	0	0	0
Hydraenidae	0	0	0	0	1	0	0
Hydrophilidae	1	2	2	0	16	9	16
Leptoceridae	0	0	5	0	1	1	3
Leptophlebiidae	0	0	4	0	8	0	1
Lestidae	0	0	0	0	0	0	0
Libellulidae	0	0	0	0	0	0	1
Lymnaeidae	1	4	0	0	0	0	0
Megapodagrionidae	0	1	0	0	0	2	2
Nepidae	0	0	0	1	0	0	0
Notonectidae	5	3	1	0	2	0	0
Oligochaeta	0	0	0	0	0	0	1
Ostracoda	0	11	0	0	0	0	0
Parastacidae - *Cherax* sp.	0	0	0	0	5	0	0
Physidae	0	1	0	0	0	0	8
Scirtidae	0	0	0	1	0	0	1
Synthemistidae	0	0	0	0	1	0	0
Tipulidae	0	0	0	0	0	0	1
Tubificidae	0	0	0	0	0	0	1
Unidentifed zygoptera (no head)	0	0	0	0	0	0	0
Unidentifed gastropod (no shell)	1	0	0	0	0	0	0
Veliidae	0	0	1	2	5	0	0
Total Individual Macroinvertebrates	**84**	**81**	**16**	**25**	**47**	**70**	**104**
No. Taxa	**12**	**15**	**6**	**9**	**10**	**12**	**21**

Attachment E
AUSRIVAS Macroinvertebrate Data - Spring 2008

Location - Date	**Wallandoola Creek - Location 2 - 17/12/2008**		**Dahlia Creek - 17/12/2008**		**Tributary of O'Hares Creek - 17/12/2008**	
Site	**WC2-1**	**WC2-2**	**DC-1**	**DC-2**	**TOC-1**	**TOC-2**
Acariformes (cf Hydrachnidae)	0	0	0	0	0	0
Aeshnidae	0	0	0	0	0	0
Araneae	0	0	0	0	1	0
Atyidae	3	3	0	2	8	11
Caenidae	0	0	0	0	0	0
Calamoceratidae	0	3	0	0	0	0
Ceinidae	0	0	0	0	0	0
Chironomidae - Chironominae	0	4	0	0	1	9
Chironomidae - Tanypodinae	0	0	0	0	0	0
Coenagrionidae	0	0	0	0	0	1
Cordulephyidae	0	0	0	0	0	0
Corixidae	0	0	0	0	0	0
Cyclopoida	0	0	0	0	0	5
Diptera pupae	0	0	0	0	0	0
Dytiscidae	0	1	0	1	0	0
Gambusia#	0	0	0	0	0	1
Gerridae	4	4	0	0	0	0
Gomphidae	0	0	0	0	0	0
Gripopterygidae	0	0	0	0	0	0
Gyrinidae	0	0	1	4	4	0
Heteroceridae	0	0	0	0	0	0
Hydraenidae	0	0	0	0	0	1
Hydrophilidae	0	0	0	0	0	0
Leptoceridae	0	6	1	2	0	1
Leptophlebiidae	0	1	0	0	0	0
Lestidae	0	0	0	0	0	2
Libellulidae	0	0	0	0	0	4
Lymnaeidae	0	0	0	0	0	0
Megapodagrionidae	0	0	0	0	0	0
Nepidae	0	0	0	0	0	0
Notonectidae	0	0	1	0	2	0
Oligochaeta	0	1	0	0	0	0
Ostracoda	0	0	0	0	0	0
Parastacidae - *Cherax* sp.	0	0	0	0	0	0
Physidae	0	0	0	0	0	5
Scirtidae	0	0	1	0	0	0
Synthemistidae	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0
Tubificidae	0	0	0	0	0	0
Unidentifed zygoptera (no head)	0	0	0	0	1	0
Unidentifed gastropod (no shell)	0	0	0	0	0	0
Veliidae	0	0	0	0	0	0
Total Individual Macroinvertebrates	**7**	**23**	**4**	**9**	**17**	**40**
No. Taxa	**2**	**8**	**4**	**4**	**6**	**9**

Gambusia not included in the sum of 'Total Individual Macroinvertebrates' or 'Total Number of Taxa' for the survey period.

Attachment F

Quantitative Macroinvertebrate Sampling Taxa and Abundance

Attachment F
Quantitative Macroinvertebrate Sampling Taxa and Abundance -Autumn 2008

Location - Date	**Wallandoola Creek - 14/06/2008**						**Lizard Creek - 14/06/2008**						**Foot Onslow Creek - 13/06/2008**						**Rocky Ponds Creek - 13/06/2008**					
Site	**WC1-1**			**WC1-2**			**LC1-1**			**LC1-2**			**FC1-1**			**FC1-2**			**RPC1-1**			**RPC1-2**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Taxa																								
Acariformes	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aeshnidae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Araneae	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0
Atyidae	1	0	0	0	0	1	0	0	0	0	0	5	0	0	0	0	0	1	0	0	0	0	0	1
Austrocorduliidae - *Austrocordulia refracta*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetidae	0	1	2	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenidae	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calamoceratidae	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carabidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ceinidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	1	23	19	14
Ceratopogonidae	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironomidae	0	0	0	0	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	2	3
Chrysomelidae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coenagrionidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1
Collembola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cordulephyidae	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Culicidae	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	6	4	1	0	0	0	0	0	0
Corixidae	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Cyclopoida	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Daphniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera - pupae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera - adult	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Dixidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dugesiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Dytiscidae	0	2	0	1	0	0	0	0	2	0	0	4	4	2	11	1	3	1	0	1	2	0	0	1
Ecnomidae	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Elmidae	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gambusia#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gelastocoridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Gerridae	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gomphidae	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gripopterygidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gyrinidae	0	0	0	0	0	1	0	4	1	0	2	4	0	0	0	0	0	0	0	0	0	0	0	0
Haliplidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helicopsychidae	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemicorduliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hirudinea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydraenidae	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Hydridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment F
Quantitative Macroinvertebrate Sampling Taxa and Abundance -Autumn 2008

Location - Date	**Wallandoola Creek - 14/06/2008**						**Lizard Creek - 14/06/2008**						**Foot Onslow Creek - 13/06/2008**						**Rocky Ponds Creek - 13/06/2008**					
Site	**WC1-1**			**WC1-2**			**LC1-1**			**LC1-2**			**FC1-1**			**FC1-2**			**RPC1-1**			**RPC1-2**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Taxa																								
Hydrophilidae	0	0	0	0	0	6	0	0	0	0	0	0	25	1	3	0	0	0	1	1	0	3	14	3
Hydroptilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isostictidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leptoceridae	23	9	2	2	7	59	0	1	3	0	2	1	0	1	2	0	0	0	1	0	0	2	5	9
Leptophlebiidae	2	4	27	1	0	0	0	0	13	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Libellulidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lymnaeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Megapodagrionidae	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mesoveliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
Nematode	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nemertea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Notonectidae	0	0	0	5	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1
Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	2	0	0	1	0	0	4	0
Ostracoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Planorbidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	1	0	0	0	0	0
Pleidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1
Physidae	0	0	0	0	0	0	0	0	0	0	0	0	0	5	11	2	0	0	1	0	0	0	0	0
Protoneuridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Psephenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyralidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scirtidae	0	1	0	2	0	1	0	0	0	0	0	0	19	6	7	0	1	0	1	0	0	32	87	38
Sialidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Simuliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sphaeriidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stratiomyidae	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	1	0	0	0	0	1	0	0
Synlestidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Synthemistidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Telephlebiidae	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tipulidae	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Veliidae	0	6	0	2	0	1	0	0	0	0	0	0	9	2	0	0	3	3	0	0	0	9	1	1
Total Individual Macroinvertebrates	**30**	**28**	**38**	**17**	**16**	**75**	**2**	**6**	**24**	**4**	**4**	**17**	**61**	**20**	**40**	**19**	**14**	**8**	**8**	**7**	**3**	**81**	**135**	**74**
Total No. Taxa	**5**	**11**	**7**	**10**	**6**	**11**	**1**	**3**	**7**	**3**	**2**	**6**	**6**	**9**	**8**	**5**	**6**	**6**	**7**	**6**	**2**	**12**	**10**	**12**

Attachment F
Quantitative Macroinvertebrate Sampling Taxa and Abundance -Autumn 2008

Location - Date	Simpsons Creek - 13/06/2008						Cascade Creek - 13/06/2008						Georges River - 30/05/2008						Brennans Creek - 30/05/2008					
Site	SIMP1-1			SIMP1-2			CC1-1			CC1-2			GR1-1			GR1-2			BC1-1			BC1-2		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Taxa																								
Acariformes	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aeshnidae	0	0	0	0	0	0	1	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Araneae	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Atyidae	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	2	1	0	0	0	0	0	0	0
Austrocorduliidae - *Austrocordulia refracta*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Baetidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calamoceratidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carabidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ceinidae	0	1	1	2	0	0	24	34	11	2	1	6	0	0	0	0	0	1	0	0	0	0	0	0
Ceratopogonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironomidae	0	0	0	2	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0
Chrysomelidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coenagrionidae	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	1	0	0	1	0	0	0	0
Collembola	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cordulephyidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Culicidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Corixidae	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	4	0	0
Cyclopoida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Daphniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera - pupae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera - adult	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dixidae	0	0	0	0	0	0	0	0	1	0	0	0	2	0	1	1	1	0	0	0	0	0	0	0
Dugesiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dytiscidae	0	2	1	0	3	0	0	16	4	0	0	0	0	0	1	2	10	0	0	8	0	0	0	0
Ecnomidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Elmidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gambusia#	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	1	11	0	0	0	0	0	0	0
Gelastocoridae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Gerridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Gomphidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gripopterygidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gyrinidae	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	1	0	1	7	30	0	9	2	24
Haliplidae	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helicopsychidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemicorduliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hirudinea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydraenidae	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment F

Quantitative Macroinvertebrate Sampling Taxa and Abundance -Autumn 2008

Location - Date	**Simpsons Creek - 13/06/2008**						**Cascade Creek - 13/06/2008**						**Georges River - 30/05/2008**						**Brennans Creek - 30/05/2008**					
Site	**SIMP1-1**			**SIMP1-2**			**CC1-1**			**CC1-2**			**GR1-1**			**GR1-2**			**BC1-1**			**BC1-2**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Taxa																								
Hydrophilidae	2	6	5	1	1	0	0	0	0	0	0	0	0	1	1	1	0	0	0	7	0	0	1	0
Hydroptilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isostictidae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Leptoceridae	0	0	0	2	1	0	5	6	0	1	1	1	12	4	1	2	5	0	0	0	2	0	0	0
Leptophlebiidae	0	0	0	2	0	0	4	19	7	7	0	1	10	11	0	7	6	10	0	1	0	0	0	0
Libellulidae	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	6	0	0	4	0
Lymnaeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Megapodagrionidae	0	0	0	1	0	0	2	1	0	1	1	1	0	3	0	0	0	0	2	0	1	0	0	0
Mesoveliidae	0	0	0	10	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nematode	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nemertea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Notonectidae	0	0	0	1	0	0	4	4	6	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Oligochaeta	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Ostracoda	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Planorbidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pleidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physidae	3	11	13	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Protoneuridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Psephenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyralidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scirtidae	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0
Sialidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Simuliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sphaeriidae	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stratiomyidae	0	1	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Synlestidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Synthemistidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Telephlebiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Veliidae	0	2	14	8	24	7	0	0	0	4	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Total Individual Macroinvertebrates	**7**	**23**	**45**	**33**	**33**	**12**	**42**	**85**	**32**	**17**	**4**	**17**	**30**	**24**	**8**	**20**	**36**	**13**	**9**	**56**	**4**	**14**	**7**	**24**
Total No. Taxa	**4**	**6**	**11**	**12**	**7**	**4**	**8**	**9**	**8**	**7**	**4**	**10**	**7**	**8**	**7**	**10**	**8**	**4**	**2**	**8**	**3**	**3**	**3**	**1**

Attachment F
Quantitative Macroinvertebrate Sampling Taxa and Abundance -Autumn 2008

Location and Date of Sampling	**Brennans Creek Tributary - 30/05/2008**						**Nepean River - 28/05/2008**						**Clements Creek - 28/05/2008**						**Cascade Creek - 28/05/2008**					
Site	**BCT1-1**			**BCT1-2**			**NP1-1**			**NP1-2**			**CIC-1**			**CIC-2**			**CC2-1**			**CC2-2**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Taxa																								
Acariformes	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Aeshnidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Araneae	0	0	0	0	0	0	0	0	1	0	0	1	1	2	2	0	0	0	0	0	0	0	0	0
Atyidae	0	0	0	0	0	0	22	20	9	31	13	8	0	0	0	0	0	0	0	0	0	1	0	0
Austrocorduliidae - *Austrocordulia refracta*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0
Caenidae	0	0	0	0	0	0	0	1	0	0	0	2	6	0	1	2	0	3	0	0	0	0	0	0
Calamoceratidae	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0
Carabidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ceinidae	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	2	0
Ceratopogonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironomidae	1	1	0	0	0	0	1	5	2	0	1	3	0	2	4	0	0	4	0	2	0	0	0	0
Chrysomelidae	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coenagrionidae	0	0	0	0	0	0	4	3	1	2	4	3	1	0	0	0	0	0	0	0	0	0	0	0
Collembola	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Cordulephyidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Culicidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Corixidae	0	0	0	0	0	0	6	4	12	8	1	3	10	3	5	34	16	30	0	0	0	0	0	0
Cyclopoida	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	1	0	0	0	0	0	0	0	0
Daphniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera - pupae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera - adult	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dixidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dugesiidae	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Dytiscidae	0	0	0	0	0	0	0	0	0	9	3	2	12	3	6	14	6	49	2	4	0	0	0	2
Ecnomidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Elmidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gambusia#	0	0	0	0	0	0	0	1	0	5	26	8	0	0	0	0	0	0	0	0	0	0	0	0
Gelastocoridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gerridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0
Gomphidae	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
Gripopterygidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gyrinidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Haliplidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helicopsychidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemicorduliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Hirudinea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydraenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment F
Quantitative Macroinvertebrate Sampling Taxa and Abundance -Autumn 2008

Location - Date	**Brennans Creek Tributary - 30/05/2008**						**Nepean River - 28/05/2008**						**Clements Creek - 28/05/2008**						**Cascade Creek - 28/05/2008**					
Site	**BCT1-1**			**BCT1-2**			**NP1-1**			**NP1-2**			**CIC-1**			**CIC-2**			**CC2-1**			**CC2-2**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Taxa																								
Hydrophilidae	0	0	0	1	0	0	0	0	0	0	0	0	14	1	34	24	17	11	0	0	0	0	0	0
Hydroptilidae	0	0	0	0	0	0	0	3	0	8	0	2	0	0	0	0	0	0	1	0	0	0	0	0
Isostictidae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0
Leptoceridae	0	0	0	0	0	0	3	7	4	2	27	13	0	0	0	1	0	2	9	6	3	0	0	0
Leptophlebiidae	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	5	8	1	5	12
Libellulidae	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	1	0	0	0	0	0	0
Lymnaeidae	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Megapodagrionidae	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	3	1
Mesoveliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nematode	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nemertea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Notonectidae	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	10	0	0	5	3	4	9	3	6
Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ostracoda	0	0	0	0	0	0	1	0	0	0	0	0	14	1	3	19	4	15	0	0	0	0	0	0
Planorbidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pleidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Protoneuridae	0	0	0	0	0	0	1	1	0	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Psephenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Pyralidae	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Scirtidae	0	0	0	0	0	0	3	4	6	0	0	0	0	0	1	0	0	3	1	2	0	0	0	0
Sialidae	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Simuliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sphaeriidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stratiomyidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0
Synlestidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Synthemistidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Telephlebiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Veliidae	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	8	1	0	0	0
Total Individual Macroinvertebrates	**3**	**3**	**0**	**1**	**0**	**0**	**45**	**49**	**38**	**75**	**83**	**50**	**61**	**14**	**62**	**108**	**43**	**124**	**43**	**36**	**21**	**13**	**17**	**21**
Total No. Taxa	**3**	**2**	**0**	**1**	**0**	**0**	**11**	**10**	**9**	**11**	**12**	**14**	**10**	**8**	**12**	**10**	**4**	**13**	**8**	**9**	**7**	**5**	**6**	**4**

Attachment F
Quantitative Macroinvertebrate Sampling Taxa and Abundance -Autumn 2008

Location - Date	**Nepean River - 20/05/2008**						**Nepean River - 20/05/2008**						**Racecourse Creek - 20/05/2008**						**O'Hares Creek - 26/04/2008**					
Site	**NP2-1**			**NP2-2**			**NP3-1**			**NP3-2**			**RC1-1**			**RC1-2**			**OC1-1**			**OC1-2**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Taxa																								
Acariformes	2	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0
Aeshnidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Araneae	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	2
Atyidae	1	1	1	0	1	0	57	11	79	8	7	12	2	0	0	1	0	0	5	1	0	3	0	9
Austrocorduliidae - *Austrocordulia refracta*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetidae	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	4	2	1	7	0
Caenidae	5	1	3	9	1	0	0	0	5	0	0	0	0	0	0	1	1	0	4	0	0	5	1	0
Calamoceratidae	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carabidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ceinidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	2	0	0
Ceratopogonidae	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironomidae	5	0	13	2	0	3	0	2	12	1	0	2	10	12	43	15	6	21	1	1	1	3	0	0
Chrysomelidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coenagrionidae	0	0	0	1	0	0	2	4	0	0	1	0	2	4	0	2	3	2	0	0	0	0	0	0
Collembola	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
Cordulephyidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Culicidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corixidae	0	11	18	7	0	1	1	6	0	6	3	0	4	1	0	0	35	3	0	2	4	1	1	1
Cyclopoida	0	0	0	0	0	0	0	0	0	2	0	4	0	1	0	0	1	0	1	0	0	0	0	0
Daphniidae	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera - pupae	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Diptera - adult	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dixidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dugesiidae	0	0	0	0	0	0	1	0	0	1	2	0	1	0	0	2	2	0	0	0	0	0	0	0
Dytiscidae	2	12	2	0	2	0	1	0	1	1	0	0	0	2	1	2	0	1	3	1	0	1	0	0
Ecnomidae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	2	0	0	0	0	0	0
Elmidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gambusia#	0	0	0	1	0	0	0	0	9	3	3	1	7	10	5	16	0	6	0	0	0	0	0	0
Gelastocoridae	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gerridae	0	10	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0
Gomphidae	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Gripopterygidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gyrinidae	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	3	3	1	0	1	0
Haliplidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helicopsychidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Hemicorduliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hirudinea	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydraenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydridae	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	7	0	0	0	0	0	0

Attachment F

Quantitative Macroinvertebrate Sampling Taxa and Abundance -Autumn 2008

Location - Date	**Nepean River - 20/05/2008**						**Nepean River - 20/05/2008**						**Racecourse Creek - 20/05/2008**						**O'Hares Creek - 26/04/2008**					
Site	**NP2-1**			**NP2-2**			**NP3-1**			**NP3-2**			**RC1-1**			**RC1-2**			**OC1-1**			**OC1-2**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Taxa																								
Hydrophilidae	3	10	2	1	3	0	0	1	0	0	1	1	0	0	0	1	5	4	1	1	0	0	0	0
Hydroptilidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Isostictidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leptoceridae	0	2	4	3	0	3	6	0	37	0	0	0	4	3	0	4	2	4	3	0	16	2	5	4
Leptophlebiidae	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	1	4	6	2	10
Libellulidae	1	1	3	2	1	0	0	0	0	0	0	0	0	0	0	5	2	0	0	0	0	0	0	0
Lymnaeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Megapodagrionidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Mesoveliidae	2	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nematode	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Nemertea	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Notonectidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	2	1	1	2	3
Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Ostracoda	0	0	0	0	0	0	0	0	0	2	0	9	0	0	0	1	0	0	0	0	0	0	0	0
Planorbidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pleidae	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physidae	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	1	0	0	0	0	0	0
Protoneuridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Psephenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyralidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scirtidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	2	0	0	0	1	0	0	0
Sialidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Simuliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sphaeriidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stratiomyidae	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Synlestidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Synthemistidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Telephlebiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Veliidae	0	6	0	2	0	8	0	0	0	0	0	0	0	0	1	3	4	3	0	0	0	0	0	0
Total Individual Macroinvertebrates	**23**	**60**	**46**	**31**	**8**	**17**	**69**	**25**	**149**	**27**	**20**	**30**	**35**	**37**	**53**	**57**	**70**	**55**	**45**	**21**	**32**	**28**	**20**	**29**
Total No. Taxa	**10**	**14**	**8**	**12**	**5**	**6**	**7**	**6**	**9**	**11**	**9**	**7**	**11**	**11**	**7**	**15**	**15**	**12**	**14**	**12**	**9**	**13**	**8**	**6**

Attachment F
Quantitative Macroinvertebrate Sampling Taxa and Abundance -Autumn 2008

Location - Date	**O'Hares Creek - 26/04/2008**						**Stokes Creek - 26/04/2008**						**Stokes Creek - 26/04/2008**						**Cataract River - 13/04/2008**					
Site	**OC2-1**			**OC2-2**			**SC1-1**			**SC1-2**			**SC2-1**			**SC2-2**			**OC1-1**			**OC1-2**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Taxa																								
Acariformes	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Aeshnidae	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Araneae	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Atyidae	0	0	0	0	1	2	2	1	4	1	2	0	0	5	3	1	1	5	0	3	0	0	1	5
Austrocorduliidae - *Austrocordulia refracta*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetidae	7	7	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	1
Calamoceratidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carabidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ceinidae	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ceratopogonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironomidae	0	2	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0
Chrysomelidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coenagrionidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Collembola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cordulephyidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Culicidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corixidae	0	0	3	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Cyclopoida	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Daphniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera - pupae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera - adult	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dixidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dugesiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dytiscidae	0	0	1	0	1	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0
Ecnomidae	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Elmidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gambusia#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0	3	0
Gelastocoridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gerridae	4	2	1	0	0	1	0	0	0	0	0	0	0	4	0	2	0	2	0	0	0	3	0	0
Gomphidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gripopterygidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Gyrinidae	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0
Haliplidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helicopsychidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemicorduliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hirudinea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydraenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydridae	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Attachment F
Quantitative Macroinvertebrate Sampling Taxa and Abundance -Autumn 2008

Location - Date	**O'Hares Creek - 26/04/2008**						**Stokes Creek - 26/04/2008**						**Stokes Creek - 26/04/2008**						**Cataract River - 13/04/2008**					
Site	**OC2-1**			**OC2-2**			**SC1-1**			**SC1-2**			**SC2-1**			**SC2-2**			**CR1-1**			**CR1-2**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Taxa																								
Hydrophilidae	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Hydroptilidae	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Isostictidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leptoceridae	0	5	0	5	12	10	1	0	0	1	0	7	3	4	1	0	1	0	0	0	0	0	0	1
Leptophlebiidae	2	4	0	1	2	0	0	0	0	1	1	0	1	0	1	0	0	0	0	3	0	17	6	5
Libellulidae	0	2	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3	2	1	0	13
Lymnaeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Megapodagrionidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mesoveliidae	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nematode	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Nemertea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Notonectidae	3	0	5	11	0	2	0	1	0	0	2	0	0	5	0	0	0	1	0	0	0	0	0	0
Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ostracoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Planorbidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pleidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Protoneuridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Psephenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyralidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scirtidae	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sialidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Simuliidae	1	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sphaeriidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stratiomyidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Synlestidae	1	1	0	1	12	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Synthemistidae	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Telephlebiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Veliidae	3	3	0	14	1	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Total Individual Macroinvertebrates	**25**	**30**	**14**	**37**	**37**	**22**	**3**	**2**	**4**	**5**	**5**	**7**	**7**	**44**	**7**	**4**	**5**	**10**	**0**	**16**	**4**	**25**	**14**	**26**
Total No. Taxa	**10**	**11**	**7**	**9**	**10**	**9**	**2**	**2**	**1**	**5**	**3**	**1**	**5**	**9**	**4**	**3**	**4**	**4**	**0**	**7**	**2**	**5**	**6**	**6**

Attachment F
Quantitative Macroinvertebrate Sampling Taxa and Abundance -Autumn 2008

Location - Date	**Cataract River - 13/04/2008**					
Site	**CR2-1**			**CR2-2**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**
Taxa						
Acariformes	0	0	0	0	0	1
Aeshnidae	0	0	0	0	0	0
Araneae	0	0	0	1	0	0
Atyidae	2	0	0	0	0	0
Austrocorduliidae - *Austrocordulia refracta*	0	0	0	0	0	0
Baetidae	0	0	0	0	0	0
Caenidae	0	0	3	0	0	0
Calamoceratidae	0	0	1	0	0	0
Carabidae	0	0	0	1	0	0
Ceinidae	0	0	0	0	0	0
Ceratopogonidae	0	0	0	0	0	0
Chironomidae	0	1	0	0	0	0
Chrysomelidae	0	0	0	0	0	0
Coenagrionidae	0	0	0	0	0	0
Collembola	0	0	0	0	0	0
Cordulephyidae	0	1	0	0	0	0
Culicidae	0	0	0	0	1	0
Corixidae	0	6	1	0	0	0
Cyclopoida	0	0	0	0	0	0
Daphniidae	0	0	0	0	0	0
Diptera - pupae	0	0	0	0	0	0
Diptera - adult	0	0	0	0	0	0
Dixidae	0	0	0	0	0	0
Dugesiidae	0	0	0	0	0	0
Dytiscidae	1	4	0	0	0	0
Ecnomidae	0	0	0	0	0	0
Elmidae	0	0	0	0	0	0
Gambusia#	0	0	0	0	0	0
Gelastocoridae	0	0	0	0	0	0
Gerridae	0	5	2	44	4	0
Gomphidae	0	0	0	0	0	1
Gripopterygidae	0	0	0	0	0	0
Gyrinidae	0	0	0	0	0	0
Haliplidae	0	0	0	0	0	0
Helicopsychidae	0	0	0	0	0	0
Hemicorduliidae	0	0	0	0	0	0
Hirudinea	0	0	0	0	0	0
Hydraenidae	0	2	0	0	0	0
Hydridae	0	0	0	0	0	0

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Attachment F
Quantitative Macroinvertebrate Sampling Taxa and Abundance -Autumn 2008

Location - Date	**Cataract River - 13/04/2008**					
Site	**CR2-1**			**CR2-2**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**
Taxa						
Hydrophilidae	0	2	0	0	1	0
Hydroptilidae	0	0	0	0	0	0
Isostictidae	0	0	0	0	0	0
Leptoceridae	0	2	0	0	0	0
Leptophlebiidae	7	0	9	1	2	1
Libellulidae	0	3	0	0	7	0
Lymnaeidae	0	0	0	0	0	0
Megapodagrionidae	0	1	1	0	0	0
Mesoveliidae	0	0	0	0	0	0
Nematode	0	0	0	0	0	0
Nemertea	0	0	0	0	0	0
Notonectidae	2	0	0	0	0	0
Oligochaeta	0	0	0	0	0	2
Ostracoda	0	0	0	0	0	0
Planorbidae	0	0	0	0	0	0
Pleidae	0	0	0	0	0	0
Physidae	0	0	0	0	0	0
Protoneuridae	0	0	0	0	0	0
Psephenidae	0	0	0	0	0	0
Pyralidae	0	0	0	0	0	0
Scirtidae	0	2	0	0	0	0
Sialidae	0	0	0	0	0	0
Simuliidae	0	0	0	0	0	0
Sphaeriidae	0	0	0	0	0	0
Stratiomyidae	0	0	0	0	0	0
Synlestidae	0	0	0	0	0	0
Synthemistidae	0	0	0	0	0	0
Telephlebiidae	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0
Veliidae	3	0	0	3	4	1
Total Individual Macroinvertebrates	**15**	**29**	**17**	**50**	**19**	**6**
Total No. Taxa	**5**	**11**	**6**	**5**	**6**	**5**

Gambusia not included in the sum of T'otal Individual Macroinvertebrates' or 'Total No. Taxa' for the survey period.

Attachment F
Quantitative Macroinvertebrate Sampling Taxa and Abundance - Spring 2008

Location - Date	**Carriage Creek - 18/12/2008**						**Cataract Reservoir Tributary 2 - 18/12/2008**						**Tributary of Cataract Reservoir Tributary 2 - 18/12/2008**						**Georges River - Location 2 - 18/12/2008**					
Site	**CaC1**			**CaC2**			**CRT2-1**			**CRT2-2**			**TCRT2-1**			**TCRT2-2**			**GR2-1**			**GR2-2**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Taxa																								
Acariformes (cf Hydrachnidae)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Anisoptera (juvenile)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Araneae	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0
Atyidae	0	1	0	11	0	1	11	1	10	1	7	14	0	0	0	0	0	0	0	0	0	0	0	0
Caenidae	3	1	0	2	6	2	0	0	0	0	0	0	0	0	0	0	0	0	3	16	10	1	4	2
Calamoceratidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	3
Ceinidae	4	23	62	6	5	22	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
Ceratopogonidae (L.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Chironomidae	0	1	9	2	1	7	0	0	0	0	0	0	1	0	0	0	0	0	1	3	2	0	2	21
Coenagrionidae	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0
Collembola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cordulephyidae	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	1	0	1
Corydalidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Cyclopoida	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dugesiidae	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dytiscidae	0	1	1	3	3	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	8	0
Ecnomidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Elmidae (L.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gambusia#	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1	3
Gelastocoridae	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gerridae	0	0	0	0	1	0	0	0	0	3	3	0	1	0	0	2	6	0	0	0	0	0	0	0
Glossosomatidae	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
Gripopterygidae	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Gyrinidae	1	0	0	0	0	1	0	0	0	10	0	3	0	0	0	0	0	0	2	0	2	2	1	0
Hydraenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0
Hydrophilidae	0	0	1	0	2	0	0	0	0	0	0	0	18	14	3	17	29	22	2	1	1	0	0	1
Isostictidae	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Leptoceridae	0	0	0	0	0	1	1	0	0	1	1	0	1	0	0	0	0	0	3	3	1	0	0	1
Leptophlebiidae	0	0	0	0	0	0	13	1	0	0	0	0	0	0	4	1	0	9	0	0	1	0	3	2
Libellulidae	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Lumbriculidae	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lymnaeidae	0	0	1	0	1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Megapodagrionidae	0	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	1	2	0	1	0	0	0	1
Notonectidae	2	0	2	7	0	4	0	0	0	3	4	1	0	0	0	0	0	0	0	0	0	0	0	0
Odontoceridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

< TOC Home >

Attachment F
Quantitative Macroinvertebrate Sampling Taxa and Abundance - Spring 2008

Location - Date	**Carriage Creek - 18/12/2008**						**Cataract Reservoir Tributary 2 - 18/12/2008**						**Tributary of Cataract Reservoir Tributary 2 - 18/12/2008**						**Georges River - Location 2 - 18/12/2008**					
Site	**CaC1**			**CaC2**			**CRT2-1**			**CRT2-2**			**TCRT2-1**			**TCRT2-2**			**GR2-1**			**GR2-2**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Taxa																								
Ostracoda	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0
Parastacidae - *Cherax* sp.	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Physidae	0	1	2	1	0	4	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Pleidae	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polycentropodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scirtidae	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	0	2	0	0	0
Sialidae	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Sphaeriidae or Corbiculidae (juvenile)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stratiomyidae	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Synlestidae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
Synthemistidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
Telephlebiidae	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	1	0	1	1	0	0	0	0
Veliidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	8	1	0	2	0	0	0	0	0
Zygoptera (juvenile)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Individual Macroinvertebrates	**11**	**28**	**95**	**35**	**28**	**62**	**26**	**2**	**13**	**19**	**17**	**21**	**25**	**14**	**11**	**33**	**42**	**37**	**23**	**28**	**22**	**12**	**22**	**35**
Total No. Taxa	**5**	**6**	**17**	**10**	**10**	**15**	**4**	**2**	**3**	**6**	**6**	**6**	**8**	**1**	**5**	**7**	**9**	**5**	**11**	**9**	**9**	**7**	**8**	**8**

Attachment F
Quantitative Macroinvertebrate Sampling Taxa and Abundance - Spring 2008

Location - Date	**Wallandoola Creek - Location 2 - 17/12/2008**						**Dahlia Creek - 17/12/2008**						**Tributary of O'Hares Creek - 17/12/2008**					
Site	**WC2-1**			**WC2-2**			**DC1**			**DC2**			**TOC1**			**TOC2**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Taxa																		
Acariformes (cf Hydrachnidae)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Anisoptera (juvenile)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Araneae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atyidae	4	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Caenidae	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Calamoceratidae	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Ceinidae	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0
Ceratopogonidae (L.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironomidae	0	0	0	1	1	0	1	0	3	0	1	0	1	0	0	2	1	1
Coenagrionidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Collembola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Cordulephyidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Corydalidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyclopoida	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Dugesiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dytiscidae	0	0	0	0	0	0	4	1	4	1	0	0	2	0	0	1	0	0
Ecnomidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Elmidae (L.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Gambusia#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gelastocoridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gerridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glossosomatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gripopterygidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gyrinidae	0	0	0	0	0	0	0	0	0	5	9	7	1	3	0	1	4	5
Hydraenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrophilidae	3	0	0	3	2	0	0	0	1	0	0	0	0	1	0	1	1	0
Isostictidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leptoceridae	0	0	0	2	6	2	1	0	0	0	0	0	0	0	4	7	3	1
Leptophlebiidae	1	0	0	6	1	5	1	2	8	0	0	0	0	0	0	3	2	0
Libellulidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment F
Quantitative Macroinvertebrate Sampling Taxa and Abundance - Spring 2008

Location and Date of Sampling	**Wallandoola Creek - Location 2 - 17/12/2008**						**Dahlia Creek - 17/12/2008**						**Tributary of O'Hares Creek - 17/12/2008**					
Site	**WC2-1**			**WC2-2**			**DC1**			**DC2**			**TOC1**			**TOC2**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Taxa																		
Lumbriculidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lymnaeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Megapodagrionidae	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	3	0	0
Notonectidae	0	0	0	0	0	0	1	0	1	0	0	0	0	1	3	2	0	2
Odontoceridae	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ostracoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parastacidae - *Cherax* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pleidae	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polycentropodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Scirtidae	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0
Sialidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sphaeriidae or Corbiculidae (juvenile)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stratiomyidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Synlestidae	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
Synthemistidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Telephlebiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Veliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zygoptera (juvenile)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Individual Macroinvertebrates	**9**	**2**	**0**	**13**	**13**	**8**	**9**	**4**	**18**	**6**	**11**	**7**	**6**	**7**	**14**	**23**	**12**	**9**
Total No. Taxa	**4**	**1**	**0**	**5**	**6**	**3**	**6**	**3**	**6**	**2**	**3**	**1**	**5**	**4**	**8**	**11**	**6**	**4**

Gambusia not included in the sum of 'Total Individual Macroinvertebrates' or 'Total No. Taxa' for the survey period.

Note: Juvenile Zygoptera and Juvenille Anisoptera not included the sum of 'Total No. Taxa' for the survey period.