APPENDIX F

Aquatic Ecology Impact Assessment

Tahmoor South Project

Aquatic Ecology Impact Assessment of the Amended Project

Prepared for Tahmoor Coal Pty Ltd

2020

Document control

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Cover photograph: Eliza Creek in Project Area (Niche Environment and Heritage)

Executive summary

Context

Tahmoor Coal Pty Ltd (Tahmoor Coal) owns and operates the Tahmoor Mine, an underground coal mine approximately 80 km south-west of Sydney in the Southern Coalfields of NSW. Tahmoor Coal is seeking approval for the Tahmoor South Project (the Project). The Project involves the extension of underground coal mining at Tahmoor Mine, to the south and east of the existing Tahmoor Mine surface facilities area.

Niche Environment and Heritage (Niche) was commissioned by Tahmoor Coal to undertake an aquatic ecology impact assessment for the Project as part of the Environmental Impact Statement (EIS), specifically to assess whether the proposed development is likely to have a significant impact on aquatic ecological communities and specific threatened species listed on the NSW*, Fisheries Management Act 1994* (FM Act) and the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

In accordance with the requirements of the *Environmental Planning and Assessment Act 1979* (EP&A Act), the EIS was prepared to assess the potential environmental, economic and social impacts of the Project. The EIS for the Project was placed on public exhibition by the Department of Planning, Industry and Environment (DPIE) (formerly the Department of Planning and Environment (DPE)) from 23 January 2019 to 5 March 2019.

Key issues raised in submissions received during public exhibition included concerns relating to the proposed extent of longwall mining, the magnitude of subsidence impacts and the extent of vegetation clearing required for the expansion of the reject emplacement area (REA). In response to these and other issues raised in Government agency, local Council, stakeholder and community submissions, and as a result of ongoing mine planning, several amendments have been made to the proposed development, so as to also further reduce the predicted environmental impacts of the Tahmoor South Project.

The key amendments to the Project since public exhibition of the EIS are:

- A revised mine plan, including:
  - an amended longwall panel layout and the removal of LW109;
  - a reduction in the height of extraction within the longwall panels from up to 2.85 metres(m) to up to 2.6 m; and
  - a reduction in the proposed longwall width, from up to 305 m to approximately 285 m.
- A reduction in the total amount of Run-of-Mine (ROM) coal to be extracted over the Project life, from approximately 48 million tonnes (Mt) to approximately 43 Mt of ROM coal, comprising;
  - 30 Mt of coking coal product (reduced from 35 Mt);
  - 2 Mt of thermal coal product (reduced from 3.5 Mt)
- A revised extended REA; including:
  - a reduction in the additional capacity required to accommodate the Project;
  - a reduction in the REA extension footprint, from 43 ha to 11.06 ha;
  - an increase in the final height of the REA (from RL 305 m to RL 310 m).
- Confirmation of the location and footprint of ancillary infrastructure associated with the ventilation shaft sites (e.g. the power connection easement for ventilation shaft site TSC1); and
- A continuation of the use of the existing upcast shaft (T2); although, operation will reduce from two fans during Tahmoor North operations to one fan once the new ventilation shafts and fans (TSC1 and TSC2) are in operation in Tahmoor South.

This aquatic ecology impact assessment has been prepared to assess the impacts of the amended project. The assessment considers and outlines the differences in impacts compared to the original project as presented in the EIS. In this way, it serves as an update to the aquatic ecology impact assessment (Appendix K of the Tahmoor South Project EIS).

Key results – baseline monitoring

AUSRIVAS water quality sampling results indicated that reaches of some of the ephemeral/lower order streams such as Dry Creek, Carters Creek and Eliza Creek have electrical conductivity (EC) levels above ANZECC guidelines (ANZECC 2000). High salinity in intermittent or more permanently flowing lower order streams may indicate low surface flow and groundwater influence. High salinities in Tea Tree Hollow are influenced by mine water discharge from Licensed Discharge Point LDP1. All streams within the Project Area recorded low dissolved oxygen during monitoring, indicating poor connectivity or stream flow and aquatic ecological health at the time of sampling which is typical of intermittent low order streams in the area. The pH of Cow Creek and many of the control sites was low, indicating a slightly acidic environment typical of the surrounding sandstone geology. At Carters Creek and Tea Tree Hollow (below the mine water discharge point), pH was high, indicating a more alkaline environment associated with the outgassing of carbon dioxide and presence of carbonate minerals in the mine discharge water.

AUSRIVAS macroinvertebrate bands showed variable results between sampling times and seasons, however in general, macroinvertebrate fauna recorded at the majority of monitoring sites within the Project Area were generally comparable to reference condition. SIGNAL scores indicated that most sites within the Project Area were subject to moderate to severe pollution. These scores however are based upon the pollution tolerance of macroinvertebrate fauna that inhabit these semi-permanent/ephemeral streams and do not necessarily indicate anthropogenic pollution.

Quantitative sampling showed that most streams, including ephemeral streams/semi-permanent lower order streams and the Bargo River, have macroinvertebrate assemblages dominated by pollution sensitive Leptophlebiidae (may fly) and pollution tolerant Chironomidae (non-biting midges) larvae. This appeared to be the case for all sites in the Project Area. Bargo River sites were differentiated from lower order streams by greater abundance of Elmidae, Leptoceridae, Calamaceridae, and Ecnomidae. Mine water discharge control and impact sites were differentiated by reductions in Leptophlebiidae, Oligochaeta, Elmidae and increases in Chironominae and Caenidae in sites downstream of the discharge point. However, changes in these fauna could not be directly related to the impact of mine water discharge.

Bait fish trapping results showed that exotic Mosquito Fish were recorded from all waterways surveyed within the Project Area with the exception of Cow Creek. Native fish recorded include Firetail Gudgeons *Hypseleotris galii* caught in Dry Creek, Common Jollytail *Galaxias maculatus* in Bargo River and Eliza Creek, Australian Smelt *Retropinna semoni* in Bargo River, Mountain Galaxias *Galaxias olidus* in Hornes Creek and Empire Gudgeon *Hypseleotris compressa* caught at Stonequarry Creek. Freshwater yabbies *Cherax destructor* and common freshwater shrimp *Paratya australiensis* were caught in abundance from all creeks within the Project Area. Freshwater crayfish *Euastacus spinifer* were observed at sites on Hornes Creek and three were captured in bait traps at control sites on Moore Creek.

No threatened macroinvertebrates were identified from the baseline monitoring program or targeted surveys. No threatened fish (i.e. Macquarie Perch) have been identified in two years of baseline monitoring and the habitat assessment determined that the Project Area does not contain suitable habitat for this species.

Impact assessment

Subsidence related impacts

The ground movements induced by longwall mining can potentially have indirect impacts on aquatic biota through the diversion of surface water flows to the dilated substrata, increased levels of ponding and changes in water quality. Based on mine subsidence predictions (MSEC 2020), there will be little to no impact on aquatic habitat and biota in the Nepean and Bargo Rivers, however streams within the Project Area that occur directly over the proposed longwalls will experience fracturing, resulting in surface water flow diversion and potential changes in water chemistry.

In times of heavy rainfall, the majority of the runoff would flow over the beds of the streams and would not be diverted into the dilated strata below the stream beds. In times of low flow however, some or all of the surface flow could be diverted into the strata below the stream beds. Where loose materials occur in the substrate upstream of fracturing, it is possible that fracturing in the bedrock would not be seen at the surface as the fractures may be filled with soil during subsequent flow events (MSEC 2020). Strata cracking may also cause a degradation of water quality, typically a lower pH, elevated EC, increase in dissolved metals and precipitation of iron flocs.

Fracturing and the partial or total loss of water could result in loss of aquatic habitat in sections of Dog Trap Creek and Tea Tree Hollow, and subsequently loss of aquatic biota inhabiting pools. Native fish recorded in these waterways may be subject to desiccation and a range of macroinvertebrates will also suffer mortalities in areas where pools are drained while hardier species such as freshwater yabbies *Cherax destructor* and freshwater crayfish *Euastacus spinifer* may be able to relocate to other areas of aquatic habitat or retreat into their burrows.

All creeks discussed above have substrate consisting of sand, mud and cobbles upstream of the areas of impact and as such, there may be some natural infilling during subsequent flow events that will return some aquatic habitat over time. Considering the ability of aquatic fauna to recolonise intermittent waterways, there is expected to be some recovery of stream fauna once pool holding capacity and habitat is re-established.

Mine water discharge

Tahmoor Coal Pty Ltd is licensed to release treated water from their water management system in accordance with Environment Protection Licence No 1389 (EPL 1389) release limits. Under the current licence there is also a requirement to enhance treatment of water prior to release via a Pollution Reduction Program (PRP) 22, through the commissioning of a Waste Water Treatment Plant (WWTP). This involves the development and commissioning of a WWTP to reduce the concentrations of arsenic, nickel and zinc in mine water released from the consolidated Licensed Discharge Point 1 (LDP1). A barium precipitate was observed in Tea Tree Hollow (TTH12a), which is thought to be impacting benthic macroinvertebrates by smothering the substrate. The lack of interstitial spaces and covering of organic matter are thought to be limiting macroinvertebrate habitat and food supply.

PRP 22 was completed with the installation of a WWTP, with limited success in achieving the required discharge water quality. Tahmoor Coal is currently in the process of implementing Stage 3 of the PRP, comprising the commissioning of an upgraded WWTP (as discussed in Section 2.4.2 of this report). Completion of Stage 3 would see enhanced water quality through reduced heavy metals, electrical conductivity (EC) and barium precipitate in Tea Tree Hollow and downstream Bargo River. Salinity levels were investigated under PRP 23 as required by EPL 1389 and reported in Cardno 2016. This study (Cardno 2016) concluded that the desalination of discharge water was not a suitable measure to mitigate against elevated EC and recommended that EC discharge limits for LDP1 currently listed in the EPL 1389 remain unchanged. It was recommended that an aquatic ecology monitoring program aimed at identifying any future changes in aquatic health due to improvements in the discharge quality from LDP1 be established (PRP 26).

The results of predictive modelling of the water management system over the remaining mine life indicate that release to LDP1 is unlikely to increase above the EPL 1389 volume limits. On the basis of the above, it is expected that the Amended Project would not result in adverse water quality impacts due to releases and overflows from the site water management system (HEC 2020).

Mining impacts – baseflow reduction

Reduction in baseflow as a result of groundwater drawdown will mostly impact Dog Trap Creek and upstream Tea Tree Hollow. This may reduce the habitat available in low flows for periods of time, as pools will dry out more often. This is not expected to change the overall ecology of the waterways as the fauna are already the result of highly variable flows and complete drying out. However, there will likely be a reduction in abundance of fauna that use pool habitat at certain periods of time as they will dry more rapidly in low flows. In other creeks in the project area, namely Carters Creek, Eliza Creek, Bargo River, and Cow Creek, the small changes in baseflow will have negligible effect on aquatic ecology.

Recommendations

Subsidence

- It is recommended that subsidence monitoring of macroinvertebrates be conducted for a baseline period of two years prior to longwall extraction. The monitoring program may require the addition or relocation of sites according to the final mine plan, and should use the same sampling methods employed in the aquatic monitoring conducted to date.
- It is recommended that a BACI (Before After Control Impact) designed monitoring program be implemented to complement the baseline information collected and to assess monitoring impacts in an adaptive management framework.

Mine water discharge

- It is recommended that the requirements of PRP22 Stage 3 are implemented and the WWTP upgrades discussed in section 2.4 be implemented to improve the water quality of the mine water discharge.
- It is recommended that an investigation of Tea Tree Hollow downstream of LDP1 be undertaken to determine potential remediation methods to remove the impacts of the barium precipitate on the aquatic habitat.
- It is recommended that an aquatic ecology monitoring program aimed at identifying any future changes in aquatic health due to improvements in the discharge quality from LDP1 be established. Benthic macroinvertebrates, periphyton and the precipitate itself should be monitored.

Glossary

Term	Definition
Annual Recurrence Interval (ARI)	Used to describe the frequency or probability of floods occurring (e.g. a 100 year ARI flood is a flood that occurs or is exceeded on average once every 100 years).
ANZECC	Australian and New Zealand Environment and Conservation Council National water quality management strategy and assessment guidelines: Australian guidelines for fresh and marine water quality
Aquifer	Geologic formation, group of formations, or part of a formation capable of transmitting and yielding quantities of water.
Arterial roads	The main or trunk roads of the State road network.
Bed	Stratum of coal or other sedimentary deposit.
Bore	A cylindrical drill hole sunk into the ground from which water is pumped for use or monitoring.
Borehole	A hole produced in the ground by drilling for the investigation and assessment of soil and rock profiles.
Bulli seam	Shallowest coal horizon in the Illawarra Coal Measures in the Southern Coalfield. The Bulli coal seam is a primary source of coking coal, located in the Illawarra and Southern Coalfields of New South Wales.
Catchment	The area from which a surface watercourse or a groundwater system derives its water.
CEMP	Construction Environmental Management Plan. A site specific plan developed for the construction phase of a project to ensure that all contractors and sub-contractors comply with the environmental conditions of approval for the project and that environmental risks are properly managed.
Clearing	The removal of vegetation or other obstacles at or above ground level.
Coal handling and preparation plant (CHPP)	Treatment by screening to give coal of various sizes to meet a purchasers requirements and treatment by one or more processes to reduce the amount of waste (ash) present in the coal.
Compressive strain	Compressive strains decrease in the distance between two points and may cause shear cracking, steps, or concave curvatures at the ground surface.
Cover	The overburden above the coal resource.
Critical habitat	A critical habitat as defined under the *Biodiversity Conservation Act 2016* (BC Act) includes, the whole or any part or parts of the area or areas of land comprising the habitat of an endangered species, population or ecological community or critically endangered species or ecological community that is critical to the survival of the species, population or ecological community.
Cumulative impacts	Combination of individual effects of the same kind due to multiple actions from various sources over time.
Development	The operations involved in preparing a mine for extraction, including cutting roadways and headings. Also includes tunnelling, sinking, crosscutting, drifting, and raising.
Discharge	A release of water from a particular source.
Drainage	Natural or artificial means for the interception and removal of surface or subsurface water.
Ecology	The study of the relationship between living things and the environment.
Ecologically sustainable development (ESD)	As defined by the *Protection of the Environment Administration Act 1991*, requires the effective integration of economic and environmental considerations in decision making processes including: The precautionary principle. Inter-generational equity. Conservation of biological diversity and ecological integrity. Improved valuation, pricing and incentive mechanisms (includes polluter pays, full life cycle costs, cost effective pursuit of environmental goals).
Ecosystem	As defined in the *Environment Protection and Biodiversity Conservation Act 1999*, an ecosystem is a 'dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.'
Endangered Ecological Community (EEC)	An ecological community identified by the *Biodiversity Conservation Act 1995* that is facing a very high risk of extinction in New South Wales in the near future, as determined in accordance with criteria prescribed by the regulations, and is not eligible to be listed as a critically endangered ecological community.

Term	Definition
Edge effects	A change in species composition, physical conditions or other ecological factors at the boundary between two ecosystems or the ecological changes that occur at the boundaries of ecosystems (including changes in species composition, gradients of moisture, sunlight, soil and air temperature, wind speed and other factors).
Environmental Management Plan (EMP)	A plan used to manage environmental impacts during each phase of project development. It is a synthesis of proposed mitigation, management and monitoring actions, set to a timeline with defined responsibilities and follow up actions.
Environmental management system (EMS)	A quality system that enables an organisation to identify, monitor and control its environmental aspects. An EMS is part of an overall management system, which includes organisational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy.
Environment	As defined within the *Environmental Protection & Assessment Act, 1979*, all aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings.
Ephemeral	Existing for a short duration of time.
EPL	Environment Protection Licence. EPLs are issued by EPA under the *Protection of the Environment Operations Act 1997.* EPLs with respect to scheduled development work or scheduled activities or non-scheduled activities may regulate all forms of pollution (including water pollution) resulting from that work or those activities. EPLs authorising or controlling an activity carried on at any premises may also regulate pollution resulting from any other activity carried on at the premises to which the licence applies. .
Existing Tahmoor Approved Mining Area	Shown on Figure 1. Encompasses all existing approved mining areas associated with the Tahmoor Mine, including the Surface Facilities Area.
Fault	Break in the continuity of a coal seam or rock strata.
Greenhouse gases	Gases with the potential to cause climate change (e.g. methane, carbon dioxide and others listed in the *National Greenhouse and Energy Reporting Act 2007*). Expressed in terms of carbon dioxide equivalent.
Groundwater	Water located within an aquifer that is, held in the rocks and soil beneath the earth's surface.
Habitat	The place where a species, population or ecological community lives (whether permanently, periodically or occasionally).
Hydrogeology	The study of subsurface water in its geological context.
Hydrology	The study of rainfall and surface water runoff processes.
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment.
Key threatening process	As defined under the *Threatened Species Conservation Act 1994*, a key threatening process is any listed process under the Act that adversely affects threatened species, populations or ecological communities, or that could cause species, populations or ecological communities that are not threatened to become threatened.
Longwall	A system of coal mining, where the coal seam is extracted from on a broad front or long face.
Overburden	The geological units and material above the coal seam proposed or being mined.
Perched Water	Unconfined groundwater held above the water table by a layer of impermeable rock or sediment.
Pollutant	Any matter that is not naturally present in the environment.
Project Area	Shown on Figure 2. Encompasses 4,743 ha. It is determined as a 600 m buffer around the proposed mine plan and includes a section of Bargo River to incorporate the receiving waters of mine water discharge
Proposed development	Extension of underground coal mining and associated activities at Tahmoor Mine within the Project Area. Referred to as The Tahmoor South Project, as described in Section 4 of this EIS.
Riparian	Relating to the banks of a natural waterway.
Run-off	The portion of water that drains away as surface flow.
Seam	Layer or bed of coal.
Strain	The change in horizontal distance between two points at the surface after mining, divided by the pre-mining distance between the points and usually expressed in mm/m.
Subsidence	The vertical lowering, sinking or collapse of the ground surface.
Surface Facilities Area	Comprises surface land containing mining and non-mining infrastructure.
Surface water	Water flowing or held in streams, rivers and other wetlands in the landscape.
Tensile strain	The relative increase in the distance between two points on the surface.

Term	Definition
Tributary	A river or stream flowing into a larger river or lake.
Upsidence	A surface phenomenon associated with mining and subsidence and occurs where workings pass beneath a gorge or similar surface feature causing a concentration of horizontal stress in the strata between the bottom of the feature and the top of any goaf cavity. This increased stress may cause strata beds close to the surface to bend upwards and possibly fracture
Vulnerable	As defined under the *Biodiversity Conservation Act 1995*, a species that is facing a high risk of extinction in New South Wales in the medium-term future.
Water table	The surface of saturation in an unconfined aquifer at which the pressure of the water is equal to that of the atmosphere.
Waterway	Any flowing stream of water, whether natural or artificially regulated (not necessarily permanent).

Acronyms

Acronym	Term/Definition
AHD	Australian Height Datum
AEIA	Aquatic Ecology Impact Assessment
ANZECC	Australian and New Zealand Environment and Conservation Council
AUSRIVAS	Australian River Assessment System
BC Act	*Biodiversity Conservation Act 2016*
CCL	Consolidated Coal Lease
CHPP	Coal Handling & Preparation Plant
DGRs	Director-General's requirements
DP&I	Department of Planning and Infrastructure (now DPIE)
DTIRIS	NSW Department of Trade and Investment, Regional Infrastructure and Services
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EPA	NSW Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EPBC Act	*Environment Protection and Biodiversity Act 1999* (Cth)
EPL	Environment Protection Licence
Ha	Hectare/s
GHG	Greenhouse gas
LGA	Local Government Area
LoS	Level of service
mg/L	Milligrams per litre
micron	One millionth of a metre (abbreviation µ)
Mining SEPP	*State Environment Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*
mL	Millilitre
ML	Mining Lease
MNES	Matters of National Environmental Significance).
PEA	Preliminary Environmental Assessment
pH	A measure of acidity or alkalinity of a solution. The potential of hydrogen.
PRP	Pollution Reduction Program
REA	Rejects Emplacement Area. Can also be called refuse emplacement area.
RMZ	Risk Management Zone
SEPP	State Environmental Planning Policy
SEPP 44	*State Environmental Planning Policy 44 – Koala Habitat Protection*
SEWPaC	Former Commonwealth Department of Sustainability, Environment, Water, Population and Communities
SIMPER	Similarity percentages
TSC Act	*Threatened Species Conservation Act 1995* (NSW)
Wingecarribee LEP 2010	*Wingecarribee Local Environmental Plan 2010*
WinSC	Wingecarribee Shire Council
Wollondilly LEP 2011	*Wollondilly Local Environmental Plan 2011*
WSC	Wollondilly Shire Council

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1. Introduction

1.1 Tahmoor South Project

1.1.1 Overview

Tahmoor Coal Pty Ltd (Tahmoor Coal) owns and operates the Tahmoor Mine, an underground coal mine approximately 80 km south-west of Sydney in the Southern Coalfields of NSW (Figure 1). Tahmoor Coal produces up to two million tonnes per annum of product coal from its existing operations at the Tahmoor Mine, and undertakes underground mining under existing development consents, licences and the conditions of relevant mining leases.

Tahmoor Coal is seeking development consent for the continuation of mining at Tahmoor Mine, extending underground operations and associated infrastructure south, within the Bargo area. The development seeks to extend the life of underground mining at Tahmoor Mine for an additional 13 years until approximately 2035. The extended underground coal mining area will continue to be accessed via the existing surface facilities at Tahmoor Mine, located between the towns of Tahmoor and Bargo. The extension of these mining facilities encompasses the Tahmoor South Project (Project)

In accordance with the requirements of the *Environmental Planning and Assessment Act 1979* (EP&A Act), the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation) an Environmental Impact Statement (EIS) was prepared to assess the potential environmental impacts of the Project. The EIS for the Project was placed on public exhibition by the Department of Planning, Industry and Environment (DPIE) (formerly the Department of Planning and Environment (DPE)) from 23 January 2019 to 5 March 2019.

Key issues raised in submissions included concerns in relation to the proposed extent of longwall mining (mine plan), the magnitude of subsidence impacts and extent of vegetation clearing required for the expansion of the reject emplacement area (REA). In response to the issues raised, further refinements have been made to the mine plan to reduce the longwall extent and REA footprint so as to further reduce the predicted environmental impacts of the Tahmoor South Project.

Since exhibition of the EIS, several amendments have been made to the proposed development in response to issues raised in agency, local Council, stakeholder and community submissions, and as a result of ongoing mine planning. The key amendments are:

- A revised mine plan, including:
  - an amended longwall panel layout and the removal of LW109;
  - a reduction in the height of extraction within the longwall panels from up to 2.85 metres(m) to up to 2.6 m; and
  - a reduction in the proposed longwall width, from up to 305 m to approximately 285 m.
- A reduction in the total amount of Run-of-Mine (ROM) coal to be extracted over the Project life, from approximately 48 million tonnes (Mt) to approximately 43 Mt of ROM coal, comprising;
  - 30 Mt of coking coal product (reduced from 35 Mt);
  - 2 Mt of thermal coal product (reduced from 3.5 Mt)
- A revised extended REA; including:
  - a reduction in the additional capacity required to accommodate the Project;
  - a reduction in the REA extension footprint, from 43 ha to 11.06 ha;
  - an increase in the final height of the REA (from RL 305 m to RL 310 m).

- Confirmation of the location and footprint of ancillary infrastructure associated with the ventilation shaft sites (e.g. the power connection easement for ventilation shaft site TSC1); and
- A continuation of the use of the existing upcast shaft (T2); although, operation will reduce from two fans during Tahmoor North operations to one fan once the new ventilation shafts and fans (TSC1 and TSC2) are in operation in Tahmoor South.
- Revised mine water management.

The Project Area is shown in Figure 2 and comprises an area adjacent to, and to the south of, the existing Tahmoor approved mining area. It also overlaps a small area of the existing Tahmoor approved mining area comprising the surface facilities area, historical workings and other existing mine infrastructure.

1.1.2 Project timeframes

The Project seeks to extend the life of underground mining at Tahmoor Mine beyond the forecast completion of mining at Tahmoor North in approximately 2022, which is dependent upon geological and mining conditions. Longwall mining is proposed to commence in the Central Domain once mining is completed at Tahmoor North, and is expected to be completed in the Central Domain by approximately 2035, depending upon geological and mining conditions. Surface works, rehabilitation and mine closure would occur after this time.

1.1.3 Legislative framework

Legislation, policies, guidelines and criteria relevant to this assessment are described in Table 1 below.

Table 1 Legislation, policy and guidelines relevant to the assessment

Relevant legislation/policy/ guideline	Relationship to this assessment
Legislation	
Commonwealth	
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	The Commonwealth EPBC Act requires the proposed development to be assessed in terms of potential impact upon Matters of National Environmental Significance (MNES). MNES currently listed under the EPBC Act are: • World Heritage properties • Natural heritage places • wetlands of international importance • Threatened species and ecological communities • Migratory species • Commonwealth marine areas • Nuclear actions (including uranium mining). • A water resource, in relation to coal seam gas development and large coal mining development. The EPBC Act applies to the Project for commonwealth threatened species and ecological communities. All commonwealth threatened species and ecological communities recorded or predicted to occur within the Project Area require an assessment to be undertaken to determine if a referral is required to the Department of Environment (DoEE) who will in turn determine if the proposal is a Controlled Action under the EPBC Act. The decision on the referral was determined as a controlled action on 12 January 2018.
NSW	
*NSW Environmental Planning & Assessment Act 1979 (*EP&A Act*)*	Note: The Project is to be assessed under the transitional legislative arrangements of the NSW biodiversity legislation reforms, i.e. the new assessment methodologies now required under the *Biodiversity Conservation Act 2016* (BC Act) do not apply to the Project. The main law regulating land use in NSW is the Environmental *Planning and Assessment Act 1979* (EP&A Act). The assessment of the proposed development has been carried out for approval under the provisions for State Significant Development (SSD) within Part 4, Division 4.7 of the EP&A Act. Under the provisions of Part 4 of the EP&A Act, SSD applications require an Environmental Impact Statement to be prepared in accordance with Secretary's Environment Assessment Requirements (SEARs) (DPI 2011). The SEARs require biodiversity issues to be assessed by applicants (DPI 2011).

*NSW Fisheries Management Act 1994 (*FM Act*)*	The main objectives of the NSW *Fisheries Management Act 1994* (FM Act) are to conserve, develop and share the fishery resources of NSW for the benefit of present and future generations, and in particular: • To conserve fish stocks and key fish habitats. • To conserve threatened species, populations and ecological communities of fish and marine vegetation. • To promote ecologically sustainable development, including the conservation of biological diversity, and, be consistent with these objectives. • To promote quality recreational fishing opportunities. • To appropriately share fisheries resources between the users of those resources. • To provide social and economic benefits for the wider community of NSW. • To recognise the spiritual, social and customary significance to Aboriginal persons of fisheries resources and to protect, and promote the continuation of, Aboriginal cultural fishing. The waterways within the Project Area fall within the definition of 'key fish habitats' based on DPI policy and guidelines (Fairfull 2013) and key fish habitat mapping (DPI 2017c). To meet the primary objectives, Part 7 of the FM Act deals with the protection of aquatic habitats and Part 7A deals with threatened species conservation. Part 7 commonly applies to "integrated development" proposals as defined by the EP&A Act. The FM Act applies within the Project Area for state listed threatened species, populations and ecological communities. Impacts of the proposed development on threatened species, populations and ecological communities known or considered to have suitable habitat in the Project Area are required to be assessed to determine if significant impacts are likely to occur. As stated above, a Species Impact Statement (SIS) is not required for SSD applications; however the SEARs require biodiversity issues to be assessed by applicants (DPI 2011).
Policy/Guidelines	
Policy and Guidelines for fish habitat, conservation and management (Fairfull 2013)	This document outlines policies and guidelines aimed at maintaining and enhancing fish habitat for the benefit of native fish species, including threatened species in marine, estuarine and freshwater environments. The document aims to help developers, their consultants and government and non-government organisations to ensure compliance with legislation, policies and guidelines as they relate to fish habitat conservation and management. Assessment of waterways within the Project Area (Section 3.5) was based on definitions described in this document.
National water quality management strategy and assessment guidelines: Australian and New Zealand guidelines for fresh and marine water quality (ANZECC/ARMCANZ)	The main objective of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality is to provide an authoritative guide for setting water quality objectives required to sustain current or likely future environmental values for natural and semi-natural water resources in Australia and New Zealand. These guidelines provide a framework for water resource management, state specific water quality guidelines for each environmental value and the context within which they should be applied, and guidelines for monitoring of aquatic ecosystems. The ecological monitoring design is consistent with these guidelines uses default trigger values to interpret water quality.
The Threatened Species Assessment Guideline – The Assessment of Significance (DPI, 2008)	Threatened species assessment is an integral part of environmental impact assessment. The Assessment of Significance Guidelines has been prepared to help applicants and/or proponents of a development or activity to interpret and apply the factors of assessment. These are the factors that need to be considered when assessing whether an action, development or activity is likely to significantly affect threatened species, populations or ecological communities, or their habitats. The guidelines clarify the specific terminology of the relevant legislation and provide clear interpretations of the factors of assessment. The Assessments of Significance undertaken as part of the impact assessment for the proposed development in this document have been undertaken in a manner consistent with these guidelines.

1.2 Aquatic ecology impact assessment relevance

1.2.1 The amended project

The amended development will use longwall mining to extract coal from the Bulli seam within the bounds of CCL716 and CCL747 (Figure 2). Coal extraction of up to four million tonnes of ROM coal per annum is proposed as part of the development with extraction of up to 43Mt of ROM coal over the life of the project. The project would produce approximately:

- 30Mt coking product
- 2Mt thermal product

- 12Mt rejects.

These approximate market mix volumes include moisture and are therefore an estimate only. Once the coal has been extracted and brought to the surface, it would be processed at Tahmoor Mine's existing CHPP and coal clearance facilities, and then transported via the existing rail loop, the Main Southern Railway and the Moss Vale to Unanderra Railway to Port Kembla and Newcastle (from time to time) for Australian and international markets. Up to 200,000 tonnes per annum of either product coal or reject material is proposed to be transported to customers via road.

The amended development would use the existing surface infrastructure at the Tahmoor Mine surface facilities area. Some upgrades are proposed to facilitate the extension.

The amended development also incorporates the planning for rehabilitation and mine closure once mining ceases.

The components of the amended development in summary comprise:

- Longwall mining in the Central Domain
- Mine development including underground redevelopment, vent shaft construction, pre-gas drainage and service connection
- Upgrades to the existing surface facilities area including:
  - Upgrades to the CHPP
  - Expansion of the existing REA
  - Additions to the existing bathhouses and associated access ways
  - Upgrades to onsite and offsite service infrastructure, including electrical
- Rail transport of product coal to Port Kembla and Newcastle (from time to time)
- Up to 200,000 tonnes per annum of either product coal or reject material is proposed to be transported to customers via road
- Mine closure and rehabilitation
- Environmental management

The components of the Project that relate to the amended project aquatic ecology impact assessment are detailed in Sections 1.2.2. and 1.2.3.

1.2.2 EIS submissions

The submissions received that relate to aquatic ecology have been addressed either directly in the response to submissions report (AECOM 2020) or, where applicable, were incorporated into this updated aquatic ecology assessment.

The main issue raised relating to the aquatic ecology section of the EIS was management of minewater discharge and the failure of the Waste Water Treatment Plant under PRP 22. A new management strategy has been proposed for minewater management; that is Stage 3 of PRP 22 to address water quality (refer to Section 2.4.2). This revised plan has been considered in the Amended Project Report (AECOM 2020).

Other issues raised were the adequacy/age of the aquatic monitoring data. While it is acknowledged that the data was collected five years ago, the data collected is considered appropriate for impact assessment for the following reasons:

- The sites selected were **representative** of the system that had available aquatic habitat in the areas potentially impacted by longwall mining or minewater discharge.

- Monitoring was conducted in multiple seasons (autumn and spring) over two years.
- Monitoring used a variety of techniques, notably AUSRIVAS and quantitative sampling.
- Monitoring was undertaken during wet and dry periods, which is a controlling factor in aquatic communities in intermittent streams.
- AUSRIVAS sampling was undertaken twice in each season in each year.
- The process affecting aquatic flora and fauna has remained unchanged over the five years.
- The predicted type of impact to invertebrate communities is unchanged despite any temporal variation in community composition.

However, it is recognised that more recent data will be required prior to longwall mining for ongoing monitoring. Further monitoring will be conducted in spring 2019 and autumn 2020 to update the baseline data for future monitoring purposes. This will involve sampling of potential impact sites and non-impacted/control locations at sites that are representative of the system present in the study area and will include additional sites in Tea Tree Hollow and Dog Trap Creek tributaries.

The survey for Sydney Hawk Dragonfly (SHD) was considered adequate considering its low likelihood of occurrence in the study area. However, while it is unlikely that the SHD occurs in the study area and will not be directly or indirectly impacted, Tahmoor Coal, as a conservative measure, will resurvey for adult and larval dragonflies in summer (2019/2020) in the Bargo River to address this concern.

Other issues raised in the submissions and addressed by Tahmoor Coal are provided in the Response to Submissions Report (AECOM 2020).

1.2.3 Amended aquatic ecology impact assessment

In addition to proposed changes in minewater discharge management, this updated aquatic ecology assessment takes into account the amended longwall layout. The main differences in terms of aquatic ecological impacts is the reduction in the 20 mm subsidence area particularly in the vicinity of Dog Trap Creek and Hornes Creek. While a substantial proportion of Dog Trap Creek is still likely to be impacted, Hornes Creek is unlikely to experience any measurable impacts (MSEC 2020). However, as a conservative measure, Hornes Creek is still considered as a potential impact site in this assessment. New information provided by the groundwater and surface water impacts assessments on subsidence impacts to pool habitat in Tea Tree Hollow and Dog Trap Creek as well as potential reduction in baseflows in Bargo river, Carters Creek, Eliza Creek and Cow Creek were also assessed to determine the potential impact to aquatic ecology.

1.2.4 Surface infrastructure development

Infrastructure upgrades

During construction, appropriate erosion and sediment controls will need to be in place to ensure run-off does not impact on receiving waters.

Increased mining rates

The Project will result in increased mining and processing rates, and an extension to the approved mine life. Extension of the REA will also be required to accommodate the reject material that would be produced over the mine life. These changes will entail the following potential impacts to water management:

- Water supply reliability and increased requirement for external supply.
- Changes and potential for increased risk of loss of containment of site contaminated water.
- Increased requirements for controlled releases of contaminated water and risk of non-compliance with licensed discharge conditions.

- Increased risk of release of disturbed area runoff from expanded Rejects Emplacement Area (HEC 2020a).

To maintain a safe and efficient underground mine environment, water entering the underground workings needs to be managed. Mine water would be collected in underground sumps and pumped from the mine to the existing water management system at the surface facilities area for treatment. Treated mine water will be either reused underground for non-potable uses or discharged at the surface via the existing Licensed Discharge Point (LDP1) into Tea Tree Hollow Creek.

Mine water contains elevated concentrations of dissolved salts and metals and can pose environmental risks to aquatic biota. In times of low rainfall however, mine water may be the only source of water for creeks, although at other times, the water may be diluted by other sources of runoff, in which case the potential effects of the discharge decrease with increasing distance from the source. Many factors, including the chemical composition of discharged water, conductivity, volume and periodicity of flow and habitat characteristics, combine to determine the abundance and composition of aquatic biota which, in turn, determines ecosystem viability (CEL 2011).

1.2.5 Underground mining (subsidence)

Underground mining operations have the potential to result in a number of subsidence related impacts on waterways within the Project Area, including geomorphic responses that would constitute an environmental impact with possible implications for ecological processes. The potential geomorphic responses to mining which need to be assessed and considered include:

- Irreversible changes in stream type.
- Change of alignment of the channel.
- Reduction of existing in-channel pool volume.
- Formation of new in-channel pools or a deepening of existing pools.
- Migration of soft knickpoint upstream at a faster than natural rate.
- Increased sediment supply to channel.
- Changes in water chemistry.
- Increased sediment accumulation in channel.
- Increased sediment scouring in channel.
- Increased cover (density) of vegetation on channel bed (baseflow shift from high depth of water to shallow depth).
- Decreased cover (density) of vegetation on channel bed (baseflow shift from shallow depth of water to dry, or from shallow to deep).
- Increased rockfall frequency above natural rate (Fluvial Systems 2013).

While there are established conceptual links between mining related causes and geomorphic responses, confident predictions cannot be made of geomorphic response for a given level of subsidence or change in stream flow. The likelihood of the risk occurring relative to the level of threat offered by the mining related change has been categorised in the geomorphology technical report (Fluvial Systems 2013).

The geomorphic responses listed above would potentially impact the aquatic habitat and biota in waterways within the Project Area. The level of impact would directly relate to the scale of the geomorphic responses. This is considered in the impact assessment section of this report.

In addition to the above geomorphic responses, subsidence movements have the potential to impact surface water quality through increased concentrations of metals and solutes liberated from subsidence induced cracking (HEC 2020a).

1.3 Purpose of this Report

This aquatic assessment has been prepared to assess the impacts of the amended project on aquatic ecology. The assessment considers the differences in impacts compared to the original project as presented in the EIS. In this way, it serves as an update to the Aquatic Ecology Impact Assessment (Niche 2018) (Appendix K of the Tahmoor South EIS).

1.3.1 Agency requirements

This report presents the Aquatic Ecology Impact Assessment (AEIA) undertaken for the amended Project (note references to the Project herein are referring to the amended project, unless otherwise stated). In preparing this aquatic ecology assessment, the Secretary's Environmental Assessment Requirements (SEARs) issued for the Tahmoor South Project (SSD 17_8445) on 20 June 2018 have been addressed as required. The key matters raised by the Secretary for consideration in the aquatic ecology impact assessment and where and how they are addressed in this report are outlined in Table 2.

Table 2: Secretary Environmental Assessment Requirements – Aquatic ecology

Key agency requirements		Section of report
NSW Department of Primary Industries		
Aquatic habitat assessment and Aquatic Fauna assessment	The AEIA uses aquatic baseline monitoring of 'key fish habitat' conducted in 2012/2013. The data includes: • Two years (autumn and spring) quantitative sampling of macroinvertebrates in BACI monitoring design. • Two years (autumn and spring) AUSRIVAS sampling of macroinvertebrates, water quality variables and habitat attributes. • Threatened dragonfly (macroinvertebrate) targeted sampling. • Macrophyte sampling as part of AUSRIVAS. • Physiochemical water quality sampling as part of AUSRIVAS. • Two years of seasonal fish sampling. • Aquatic habitat monitoring. • Photo point monitoring. Threatened dragonfly and Macquarie Perch potential habitat mapping and assessment were also conducted. Hydrological and monthly water quality data was conducted by surface water impact assessment.	Sections 3, 5 and 6.
NSW Environment Protection Authority		
The EIS should determine whether environmental value for the Bargo River are being met downstream of the discharges or will be met following full commission of the plant. *The EIS should integrate the results of the aquatic health study in the Bargo River (PRP23) as well as previous aquatic studies undertaken by the mine.*	The AEIA used the findings from PRP23 to determine whether the aquatic ecological values are being met downstream. The AEIA integrates the findings from the comprehensive baseline monitoring conducted in 2012/2013 as well as recent mine water discharge studies (PRP 23).	Section 4.4.2.
NSW Office of Environment and Heritage		

Effects of downstream fauna to water dependent flora and fauna. *Impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow aquatic connectivity and access to habitat for spawning and refuge (e.g. river benches)*	The AEIA assesses the impact to water dependent downstream flora and fauna, processes and functions, aquatic connectivity, spawning and refuge habitat. This is achieved through appraisal of baseline monitoring data which describes the existing environment and interpreting impacts from predicted water quality and hydrological changes due to mine water discharge and subsidence. Water quality results and hydrological impacts are provided by the surface water assessment (HEC 2020a).	Section 6.

1.3.2 Objectives

The aim of the AEIA is to assess the potential impacts of the proposed development on stream ecology and aquatic threatened species, populations, communities or their habitats. The assessment addresses the impacts of subsidence from underground coal mining as well as mine water discharge generated from surface facilities.

The assessment required two years of baseline monitoring to account for natural variation and provide the before component of a BACI (Before After Control Impact) study for the quantitative macroinvertebrate monitoring design. AUSRIVAS data was also collected at potential impact sites and compared to modelled reference sites to infer current stream health.

The specific objectives are to:

- Describe the natural/pre-mine development characteristics of stream ecology through quantitative and qualitative monitoring of macroinvertebrates as well as monitoring of fish, macrophytes, aquatic habitat and water quality in the Project Area.
- Identify or determine the likelihood of occurrence of threatened species, populations, habitat and/or communities with in the Project Area.
- Determine the subsidence and mine water discharge impacts that could affect stream ecology.
- Assess whether these impacts will cause significant adverse effects to stream ecology.
- Determine whether these impacts will significantly impair threatened species, populations, habitat or communities.
- Recommend mitigation measures to minimise potential impacts to stream ecology, in particular threatened aquatic species, populations and communities.

1.4 Report structure

This report is structured as follows:

- Section 1: Introduction – outlines the Project and presents the purpose of the report.
- Section 2: Proposed Development – provides a detailed description of the Project.
- Section 3: Methods – describes the methods employed for the aquatic ecology impact assessment.
- Section 4: Existing Environment – outlines the existing environment relevant to aquatic ecology.
- Section 5: Survey Results – describes the results of the aquatic ecology surveys.
- Section 6: Potential Impacts – describes the monitoring results, and the potential impacts of subsidence and mine water discharge on aquatic ecology and threatened species.
- Section 7: Safeguards and Management - provides a summary of environmental mitigation, management and monitoring responsibilities in relation to aquatic ecology management.
- Section 8: Conclusion.
- Section 9: Figures.

2. Tahmoor South Project

The Project Area is operationally divided into three different mining domains based on geological complexity and mining potential. The mining domains are the Central Domain, Eastern Domain and Southern Domain.

The Project seeks to undertake longwall mining of the Bulli seam within the Central Domain only, at a depth of between approximately 375 and 430 metres below ground level.

During the mine planning process, a constraints analysis, risk assessment and detailed fieldwork were undertaken to identify sensitive natural surface features (such as waterways, cliffs, and Aboriginal heritage sites) and to develop risk management zones (RMZs). Following the completion of the risk assessment process, the proposed longwall layout was modified to minimise significant subsidence impacts to natural features. Although the longwall layout will continue to be refined during the detailed design phase of the proposed development, the maximum extent of the proposed mine is shown in Figure 2.

2.1 Mine development

A number of pre-mining activities are required to be completed prior to commencement of longwall mining of the Central Domain, including:

- Recovery of existing underground development roadways.
- Redevelopment of the underground pit bottom.
- Pre-mining gas drainage.
- Longwall development including establishment of gate roads.
- Installation of electrical, water and gas management networks.
- The purchase and installation of equipment.

An additional 50 - 175 personnel would be required for the Tahmoor South Project development works, which may occur concurrently with the ongoing mining operations at Tahmoor North. Additional site amenities, including bathhouses and additional onsite car parks would be required to accommodate the increased workforce during the transition period from mining operations at Tahmoor North and the Tahmoor South Project's development works.

Other site infrastructure required for longwall mining at Tahmoor South includes construction of the new mine ventilation shafts. These and the pre-mining activities are detailed below.

2.1.1 Mine ventilation

The Project would use three existing vent shafts currently being used for the operations at Tahmoor North, being one upcast (T2) and two downcast shafts (T1 and T3).Two new ventilation shafts would be required to provide reliable and adequate supply of ventilation air to personnel in the mine, consisting of:

- TSC1: an upcast ventilation shaft located on Tahmoor Coal's Charlies Point Road property.
- TSC2: a downcast ventilation shaft located on Crown Land adjacent to Tahmoor Coal's Charlies Point Road property.

The construction of the ventilation shafts would entail a disturbance footprint of between four to six hectares at each location. Access to TSC1 and TSC2 will be from the existing road network. The construction of each of the proposed ventilation shafts would involve the following:

- Construction of internal roads for construction and operational maintenance vehicles access.

- Establishment of the construction site to allow sufficient space for stockpiling of shaft liners for TSC1 and TSC2, temporary spoil emplacement for TSC1 and TSC2 (spoil from TSC1 and TSC2 will be stockpiled at the REA), water management, storage and safe movement on-site during construction activities.
- Establishment of the ventilation shaft site involving:
  - Installation of environmental controls such as silt fences, fencing and a lockable gate, as well as display of appropriate signage relating to restricted entry.
  - Clearing of vegetation and stripping of topsoil. Topsoil will be temporarily stockpiled for rehabilitation post construction.
  - Excavation and construction of a temporary hardstand area for operation of drilling equipment.

The hardstand footprint would be determined by the size and number of liner pieces to be manufactured and excavated to a depth of approximately 0.2 metres. The temporary hardstand areas would include:

- Road base surrounding the site compound area and drill rig slab for site facilities.
- Laydown areas and a levelled hardstand area for storage of the ventilation shaft liners.
- A stable access way between the liner storage area and the shaft to facilitate transport of the cured liner segments on purpose built trailers.
- A 20 x 15 metre concrete pad constructed around the top of the shaft as a foundation for the drill rig and to provide a clean work area.
- Connection of 66 kV electrical power and establishment of electrical substations at ventilation shaft sites.
- Sinking of the shaft using blind boring methods, and lining of the shafts using a composite concrete and steel liner.
- Construction of fan buildings and installation of ventilation fans within fan buildings. The upcast shaft site's fan buildings will also incorporate a fan outlet stack, approximately 20 metres high, to control odour discharge from the mine.

The shaft construction sites would incorporate water treatment sedimentation controls, with the final water treatment from the ventilation shaft being pumped via overland pipeline to a final sedimentation pond at the surface facilities area for further treatment and discharge.

Following the construction phase, the footprint of the operational area of each ventilation shaft would be reduced to approximately two to four hectares, plus the internal vent shaft access road. The area immediately surrounding the ventilation shaft would be rehabilitated following the construction phase. The ventilation fans would operate for the life of the proposed development.

2.1.2 Gas drainage operations

The coal seams within the Southern Coalfields are generally known to be gassy, with methane and CO_2 released from the goaf and surrounding strata during mining. Gas in the underground mine would be managed by gas drainage operations including:

- Pre-mining gas drainage, whereby gas would be drawn from the coal seam and surrounding strata prior to longwall mining.
- Gas extraction via the mine ventilation system, which would occur throughout mining.
- Post-drainage of gas, whereby gas would be drawn from the goaf.

Gas management would continue to use the existing infrastructure, including the Tahmoor Mine Gas Plant, Gas Plant Vent and Flare Plant, as well as the WCMG Power Plant. Some components of the existing gas management infrastructure may need to be upgraded throughout the life of the Project.

2.1.3 Pre-mining gas drainage: underground and surface

The purpose of pre-mining gas drainage is to reduce gas volumes in the coal seams prior to mining, with the Bulli, Wongawilli and Balgownie seams targeted for pre-mining gas drainage at Tahmoor Mine. Pre-mining gas drainage of the gas levels in the seams is required to facilitate the timely commencement and progression of mining as well as to reduce the demands on the mine ventilation system for the purpose of gas dilution during operations.

Pre-mining gas drainage activities are undertaken underground, via drilling and drainage from the roadways developed for longwall panels. Underground pre-mining gas drainage works at Tahmoor Mine would drain gas following development of the mine roadways and prior to longwall development. Gas would be drawn from the coal seam by vacuum and piped to the Gas Plant at the surface facilities area via the underground pipe network. Underground gas drainage of the coal seam would continue ahead of longwall development for the duration of mining.

Gas from the coal seam would be drained using pumps, collected at the surface and piped to the existing Gas Plant at the Tahmoor Mine surface facilities area to be used in the WCMG Power Plant or Gas Fare Plant.

2.1.4 Post- mining gas-drainage

Post-mining gas drainage would be required as strata relaxation caused by the retreating underground longwall face will liberate volumes of gas into the mine workings from the underlying Wongawilli seam and from overlying strata, released due to fracturing of the goaf. To capture this gas during the proposed development, cross-measure boreholes are proposed to be drilled from the mine workings into the Wongawilli seam. These boreholes would be designed to collect the gas at its source or to intercept gas before it migrates into the mine workings. At the conclusion of mining from each panel, the panel would be sealed and gas drawn from the sealed areas as part of the post-mining gas drainage operations. The gas collected from the in-seam and cross-measure boreholes would be drawn by vacuum via the underground pipe network to the Gas Plant located at the surface facilities area. Post-mining gas drainage would not result in surface disturbance.

2.1.5 Mining method and equipment

Underground mining would be undertaken via conventional longwall development using continuous miners. Longwall development refers to the mining of a series of roadways (gate roads) and cut-through, to form pillars of coal that support the overlying strata during the extraction of coal. Longwalls would be up to 285 metres wide, measured as the distance between gate road centrelines. Coal would be cut from the coal face by the longwall shearer, loaded onto the armoured face conveyor and transported to the surface facilities area via a series of underground conveyors. The longwall retreats as coal is mined and the overlying rock strata collapses into the void left by the coal extraction, forming the goaf.

2.1.6 Mine access (underground)

The Project would use the existing infrastructure at Tahmoor Mine for employee and material access to the mine. Access to the Central Domain would be via the existing Tahmoor Mine surface facilities area, the existing drift, and men and materials travel lift installed within the T3 downcast shaft.

2.1.7 Coal logistics

The Project would use existing coal logistics to manage movement of coal from the site to market. No further surface development is required to facilitate coal logistics for the Project.

2.1.8 Mine dewatering

Mine water would be collected in underground sumps and pumped from the mine to the existing water management system at the surface facilities area for treatment. Treated mine water from the Waste Water Treatment Plant would be either reused underground for non-potable uses or discharged at the surface via the existing Licensed Discharge Point.

The inflow rates are predicted to increase over the first half of the operational life at Tahmoor South from about 2 ML/day to an average of 4.7 ML/d for the proposed life of Tahmoor South. The model predicts that peak rates will be on the order of 7.5-8 ML/d in 2028-29 and 2032-33.

A site water balance assessment undertaken for the Project (HEC 2020d) indicated that simulated releases of treated water to Tea Tree Hollow via LDP1 over the life of the Project were all compliant with the current EPL daily volumetric limits. An application would be made to vary the EPL in the instance that discharge volumes at the mine increase beyond this estimate.

Water quality impacts associated with the mine dewatering have been considered in Section 6.7.8 of this assessment.

2.2 Surface facilities area

The existing surface facilities and infrastructure at the Tahmoor Mine surface facilities area, operating within surface CCL 716 and Mining Lease 1642, would be used for the Project. Upgrades to some aspects of the surface facilities area would be required and are associated with the increase in annual coal production for the proposed development. Upgrades to existing surface infrastructure would be undertaken within the footprint of the existing Tahmoor Mine surface lease (Mining Lease 1642) and additional surface lease areas required for the Project.

2.2.1 Coal handling and preparation plant

The existing CHPP and existing ROM stockpile area would be used for the Project. During peak production ROM coal may be trucked from the ROM stockpile to the coal product stockpiles and re-trucked back to the ROM stockpile when required. Reject material generated from the coal washing process at the CHPP would be transported to the expanded REA via the existing reject conveyor to the reject bin for disposal, then transported by haul truck to the REA.

2.2.2 Rejects management

The existing REA would be expanded into adjacent areas to accommodate the reject material associated with the Project. The REA footprint is proposed to be expanded by 11.06 ha. This has been reduced from the 43 ha originally proposed in the EIS, primarily through increasing the height of the REA to accommodate the additional rejects from the Project.

The stormwater management system and infrastructure at the existing REA would be augmented with the construction of additional sedimentation dams, drains and a pumping station.

The expansion of the REA and associated infrastructure would result in vegetation disturbance, which has been considered in the terrestrial impact assessment.

2.3 Rehabilitation and mine closure

Rehabilitation of the proposed development would be undertaken using a staged approach, comprising:

- Progressive rehabilitation of the REA over the life of the Project. This process would involve capping the reject material with topsoil and revegetating. Annual monitoring would be undertaken to determine the success of revegetation and to inform ongoing management of the rehabilitated areas.
- Mine closure and rehabilitation of the surface facilities area and ventilation shafts.

2.4 Environmental management

Environmental management at Tahmoor Mine is currently governed by the Environmental Management System Strategy and Framework. The Project would be managed within this Framework and in line with existing procedures. Where required, the existing procedures and management plans would be updated to reflect the specific details of the Project.

In addition, a Mine Operations Plan (MOP) would be prepared to meet the requirements of the *Mining Act 1992* and *Mining Regulation 2016*. The Department of Planning Industry & Environment Division of Resources and Geosciences would be consulted to ensure that the MOP is prepared in accordance with the current guidelines at the time.

2.4.1 Subsidence monitoring and management

Tahmoor Mine currently manages and monitors subsidence as part of the existing operations at Tahmoor North. The systems and programmes currently in place to monitor and manage subsidence would continue during the proposed development and would be augmented to monitor the effects of mining within the Central Domain.

Specifically, subsidence would be managed through implementation of a series of Extraction Plans (EPs) in consultation with stakeholders. The management plans would describe measures to be undertaken to monitor surface subsidence and physical changes that are predicted to occur during mining. Measures detailed in the management plans would include:

- The requirements for inspection regimes for natural and built surface features.
- The layout of monitoring points and parameters to be measured.
- Monitoring methods and accuracy.
- The timing and frequency of surveys and inspections.
- Processes for recording and reporting of monitoring results.

2.4.2 Water management

Surface water runoff from operational areas and stockpiles would continue to be captured by the existing stormwater treatment dams at the surface facilities area. Following treatment, the water would continue to be discharged to Tea Tree Hollow at LDP1.

Potable water supply for use at the surface facilities area and underground would be drawn from the town water main, and non-potable supply sourced from the recycled water treatment plant at the surface facilities area. Mine water would be treated and recycled for non-potable underground use, or pass through the stormwater treatment dams and be discharged via LDPs.

Pollution Reduction Program 22 (PRP22)

Under PRP22, a Waste Water Treatment Plant (WWTP) was constructed at Tahmoor Underground Mine in June 2015. The treatment objectives were set by a Pollution Reduction Program (PRP) in the Environment Protection Licence No.1389 (EPL). The purpose of the plant is to treat up to 6 ML/day of mine water to reduce the concentrations of arsenic (As), nickel (Ni) and zinc (Zn) in the water discharged from the mine to below the following levels:

- As: 0.013 mg/L
- Ni: 0.011 mg/L
- Zn: 0.008 mg/L

PRP22 - Stage 2 commissioning has failed to deliver the water quality outcomes for Zn and Ni. Although Stage 2 WWTP process delivered the required water quality results for As, there is uncertainty regarding the long-term sustainability of ongoing performance due to biding and scaling of the GAC filter material (SIMEC 2019a). Tahmoor Coal have requested the Environment Protection Authority (EPA) to consider completion of PRP22 – Stage 2 to be replaced with proposed PRP22 – Stage 3. The proposed Stage 3 program is outlined in Table 3.

Table 3: PRP22 – Stage 3 Program

Scope of Works
Laboratory testing WWTP
Technical and Option Review
Engagement with EPA on proposed technology solution and PRP22 Stage 3
EPL 1389 variation to incorporate PRP22 Stage 3
SOW/Tenders/Contract
Plant construction & modifications WWTP
Plant commissioning & testing stage WWTP
PRP22 Stage 3 close-out report submitted to EPA

Licensed Discharge Point

The Tahmoor South Project would collect water underground in sumps and pump this water via underground pipes to the surface. As per the existing operations, the Project would continue to discharge a portion of the stormwater and treated mine water via Licensed Discharge Point LDP1 under EPL 1389.

Site water balance

The major components of the mine water balance for the proposed development would be:

- Inflows from surface runoff, direct rainfall onto dam surfaces, potable water draw and groundwater inflows to the underground operations.
- Outflows including discharges to the Bargo River catchment via LDPs to Tea Tree Hollow, evaporation from dam surfaces, and water loss to product coal and coarse rejects.

Site water management plan

Water management during operation of the proposed development would be governed by the water management plan currently in place at the Tahmoor Mine. The water management plan would be augmented to encompass the operations of the Project and would be implemented in line with the following objectives:

- Use available surface water runoff for use as process water.
- Minimise instances of licensed discharge.

- Minimise the magnitude of licensed discharge.
- The quality and quantity of water discharged is to be in accordance with relevant water quality criteria.

3. Methods

The aquatic ecology impact assessment methods were structured to specifically reflect relevant legislation, specific guidelines, and advice from local, state, and federal agency stakeholders, and to address the SEARs. The methods outline the monitoring design and impact assessment criteria.

3.1 Project Area

The Project Area includes all watercourses that occur within the extent of the longwall area. The New South Wales Department of Planning (NSW DoP 2008) defined "Risk Management Zones (RMZ's)" as streams within the mine subsidence area of 3rd order or above, under the Strahler (1952) stream classification scheme. The RMZ is defined from the outside extremity of the surface feature, either by a 40° angle from the vertical down to the coal seam that is proposed to be extracted, or by a surface lateral distance of 400 metres, whichever is the greater (NSW DoP 2008). However, closure and upsidence movements in the Southern Coalfields have been detected more than 500 metres from the edges of longwalls (Kay et al. 2006) and as such, the Project Area is defined as a buffer distance of 600 metres from the mine plan extent for the purpose of this assessment (Figure 2).

The Subsidence Study Area is a conservative region investigated for potential subsidence impacts, whereas the 20 millimetre subsidence contour taken from the subsidence assessment (MSEC 2020) defines the limit of actual subsidence impacts (Figure 2). The study area includes the Project Area and areas outside the project area including downstream water courses and control streams.

As mine water is discharged at the surface via the existing LDP1 into Tea Tree Hollow Creek, the Project Area also includes the receiving waters of Tea Tree Hollow Creek that occur outside of the 600 metre mine extent buffer and the Bargo River from its confluence with the Nepean River, for the assessment of mine water discharge. The Project Area covers an area of approximately 7,128 hectares.

3.2 Literature and data review

A number of resources were used to undertake the AEIA, a complete reference list is provided in Section 10. Primary resources include:

- AECOM (2012) Tahmoor South Project Preliminary Environmental Assessment, prepared for Tahmoor Coal August 2012.
- Niche (2012) Tahmoor South Pilot Study, Prepared for Tahmoor Coal.
- Niche (2013) Tahmoor South Aquatic Ecology Monitoring Project Year 2012-2013.
- DOP (2008) Impacts of Underground Coal Mining on Natural Features in the Southern Coalfields - Strategic Review. State of NSW through the Department of Planning, 2008 (commonly referred to as the Southern Coalfields Inquiry).
- PAC (2009) The Metropolitan Coal Project Review Report. State of NSW through the NSW Planning Assessment Commission, 2009.
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3.3 Threatened species

3.3.1 Threatened species search

Threatened native fish and aquatic invertebrate species, populations and ecological communities are protected by the NSW *Biodiversity Conservation Act 1995* (BC Act), FM Act and Commonwealth EPBC Act (note that the transitional arrangements tests of significance under the former *Threatened Species Conservation Act 1995* (TSC Act) apply to this assessment rather than the new assessment methodologies now required under the BC Act). A list of threatened aquatic species, populations and ecological communities (subject species) that occur or could potentially occur within the Project Area was identified by a database search from the following databases in June 2013, and updated in October 2017:

- The Office of Environment and Heritage BioNet Atlas of NSW Wildlife records for aquatic threatened species and/or endangered ecological communities listed under the BC Act which have been recorded within the locality (10 km area search co-ordinates: N: -34.1551; E: 150.7012; S: -34.3353; W: 150.4836).
- The Department of Environment and Energy (DoEE) Protected Matters Search Tool for Matters of National Environmental Significance (MNES) listed under the EPBC Act that may occur in the Project Area (10 km point search co-ordinates: -34.25069,150.57968).
- The Department of Primary Industries (DPI) list of threatened species under the FM Act that have been recorded within the Hawkesbury-Nepean CMA and/or recorded in the Wollondilly LGA using DPI Threatened Species Profile Viewer and DPI Spatial Data portal.

3.3.2 Determining affected species

In order to adequately determine the relevant level of assessment to apply to subject species, a further analysis of the likelihood of occurrence within the Project Area was undertaken. Diagram 1 provides a representation of the hierarchy of decision making employed to determine which species, populations, ecological communities or MNES were considered further for impact assessment.

Five categories for 'likelihood of occurrence' (Table 4) were attributed to species after consideration of criteria such as known records, presence or absence of important habitat features on the subject site, results of the field surveys and professional judgement. Species considered further in formal assessments of significance pursuant to relevant legislation were those in the 'Known' to 'Moderate' categories and where impacts for the species could reasonably occur from the development.

Diagram 1: Hierarchical process to determine species

Threatened Species

- The total pool of **threatened species, populations, ecological communities** or **MNES** which must be considered include all species, populations or ecological communities listed on the BC Act, FM Act and EPBC Act

Subject Species

- **Subject species** are defined as threatened species, populations or ecological communities that have been recorded or are considered to have important habitat features within 10 km of the Project Area as defined by the EPBC Act Protected Matters Search Tool or have been recorded in the catchment management area on the DPI records viewer

Affected Species

- **Affected species** are defined as subject species (including populations or ecological communities) that are known to occur or have a reasonable likelihood of occurence and which may be impacted by the project

Table 4: Likelihood of occurrence criteria.

Likelihood rating	Threatened macrophyte criteria	Threatened aquatic fauna criteria	Likelihood rating
Known	The species has been observed within the Project Area	The species has been observed within the Project Area	Known
High	It is likely that a species occurs within the Project Area	It is likely that a species inhabits or utilises habitat within the Project Area	High
Moderate	Potential habitat for a species occurs on the site. Adequate field survey would determine if there is a 'high' or 'low' likelihood of occurrence for the species within the Project Area	Potential habitat for a species occurs on the site and the species may occasionally utilise that habitat. Species unlikely to be wholly dependent on the habitat present within the Project Area	Moderate
Low	It is unlikely that the species inhabits the Project Area	It is unlikely that the species inhabits the Project Area.	Low
None	The habitat within the Project Area is unsuitable for the species.	The habitat within the Project Area is unsuitable for the species	None

3.4 Site selection for baseline monitoring

Scoping surveys were undertaken prior to monitoring using 1:25,000 Topographic Map Series, (Bargo 9029-3N and Picton 9029-4S sheets, Land and Property Information NSW Government) combined with field surveys to select monitoring sites that were representative of the creeks in terms of physical appearance and that were accessible. Where appropriate, access through private property to the creek lines was arranged by Tahmoor Coal.

Site locations were selected in an effort to capture the spatial variability of aquatic biota within streams (two sites per stream) and between streams (sampling of each stream in Project Area). Effort was also made to capture the variability of aquatic biota within sites through sample replication and following AUSRIVAS sampling methodology.

The baseline monitoring program was based on surveys of aquatic ecological indicators within the Tahmoor South Project Area. Within the Project Area, 1st order streams were observed to have relatively small catchments, lower energy (and sediment transport), few pools (if any) and fewer areas of exposed bedrock features. As such, they were of lower interest to the assessment of geomorphic risk compared with 2nd order streams and higher (Fluvial Systems 2013), and the risk to aquatic habitat and biota would also be lower. For the purpose of aquatic ecological assessment, monitoring points were therefore selected in streams of 2nd order or above.

3.4.1 Subsidence impact monitoring locations

Four potential impact watercourses were selected for monitoring within the Project Area and eight ecologically comparable creeks outside of the Project Area were selected as control watercourses, with two sampling sites at each location. These potential impact and control locations (creeks) are detailed in Table 5 and shown in Figure 3. It should be noted that despite mine layout changes as part of the amended Project, Hornes Creek is still considered as a potential impact site as a conservative measure. Bargo River is also unlikely to be impacted by subsidence; however, it similarly has been considered conservatively as a potential impact site. The amended Surface Water Impact Assessment (HEC 2020a) found that Carters Creek, Eliza Creek, and Cow Creek may experience some reduction in baseflow in low flow conditions; however, the impacts are considered negligible (Section 6) in the context of the natural variability in catchment conditions. In consideration of this and that these streams will not have subsidence impacts, they are treated as subsidence control sites in this assessment.

Table 5: Subsidence monitoring locations

Watercourse	Sampling site names	Strahler's (1952) Stream Order
Potential impact locations		
Dog Trap Creek	DTC9, DTC10	3
Tea Tree Hollow	TTH11, TTH12	3
Hornes Creek	HC13, HC14	4
Bargo River	BR15, BR16	5
Control locations		
Cow Creek	CWC1, CWC2	3
Carters Creek	CC3, CC4	3
Dry Creek	DC5, DC6	2
Eliza Creek	EC7, EC8	2
Bargo River tributary	CBR1, CBR2	2
Moore Creek	CMC3, CMC4	3
Cedar Creek	CCC5, CCC6	4
Stonequarry Creek	CSQ7, CSQ8	3

3.4.2 Mine water discharge impact monitoring locations

Mine water is currently discharged into Tea Tree Hollow Creek via mine discharge point LDP1, which flows into Bargo River. One^ impact monitoring site was selected downstream in Tea Tree Hollow Creek and two impact locations (two sampling sites at each location) downstream of the confluence point in Bargo River. One control monitoring site was selected upstream of mine discharge point LDP4 in Tea Tree Hollow Creek and two control locations (two sampling sites at each location) upstream of the confluence point in Bargo River. These potential impact and control locations are detailed in Table 6 and shown in Figure 4.

Subsidence monitoring sites TTH11, TTH12 and Sites BR15 and BR16 were used for this monitoring program. Additional Bargo River mine water discharge monitoring sites SBR3 to SBR8 were monitored for one year only. The monitoring was complimented by an aquatic health investigation (CEL 2016) which was incorporated as part of the impact assessment.

^At the commencement of the monitoring program (June 2012), the upstream (control) site on Tea Tree Hollow Creek (TTH11) was selected above the mine discharge point LDP4 and the downstream (impact) site (TTH12) was selected at a point below mine discharge point LDP4 and above discharge point LDP1. However, following 1.5 years of monitoring, discharge point LDP4 was converted to a high flow discharge only. As such, the downstream monitoring location on Tea Tree Hollow was relocated to downstream of the main discharge point at LDP1 (TTH12a).

Table 6: Discharge monitoring locations

Location	Sampling site names
Potential impact locations	
Tea Tree Hollow Creek - downstream	TTH12 (2012 – 2013), TTH12a (2013)
Bargo River – downstream	SBR5, SBR6, SBR7, SBR8
Control locations	
Tea Tree Hollow Creek - upstream	TTH11
Bargo River - upstream	SBR1 (BR15), SBR2 (BR16), SBR3, SBR4

3.5 Field surveys

The aquatic monitoring program is in accordance with the NSW Department of Planning's "Strategic Review of Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield" (NSW DoP 2008), hereafter referred to as the Strategic Review.

Specific recommendations within the Strategic Review that are relevant to aquatic ecological investigations include:

- Streams within the mine subsidence area of 3rd order or above, under the Strahler stream classification scheme are to be considered as Risk Management Zones (RMZs).
- A minimum of 2 years of baseline data, collected at appropriate frequency and scale should be provided for significant natural features.
- Monitoring of mine subsidence impacts should allow for back analysis and comparison of actual versus predicted effects and impacts, in order to review the accuracy and confidence levels of the prediction techniques used i.e. The use of Before, After, Control, Impact (BACI) design ecological studies (Underwood 1981).

Monitoring began in autumn 2012, prior to the commencement of longwall mining and upgrades of surface mine infrastructure. Sampling of sites occurred in autumn and spring for two years (see Appendix C for dates), survey effort for each component is provided in Table 7 with survey details for each component provided below. Survey timing and meteorology is provided in Appendix C.

Note that AUSRIVAS utilises modelled reference stream for comparison of macroinvertebrate fauna, and therefore control sites were not used as part of this component of the monitoring program.

Table 7: Aquatic survey effort.

Method	Sampling effort	Subsidence monitoring schedule	Mine water discharge monitoring schedule
Habitat monitoring	One sample at each site. Two sampling sites in each stream. At impact sites and control sites Eliza Creek, Dry Creek, Carters creek and Cow Creek.	Two sampling occasions in: autumn 2012, spring 2012, autumn 2013 and spring 2013.	One sampling occasion in spring 2012 and autumn 2013 combined with selected subsidence monitoring sites.
Photo point monitoring	One sample at each site. 2 sampling sites in each stream. At impact and control sites.	Two sampling occasions in: autumn 2012, spring 2012, autumn 2013 and spring 2013.	One sampling occasion in spring 2012 and spring 2013 combine with selected subsidence monitoring sites.
Water quality sampling	One sample at each site (average of 3 samples). Two sampling sites in each stream. At impact and control sites.	Two sampling occasions in: autumn 2012, spring 2012, autumn 2013 and spring 2013 for impact sites. Control sites were sampled on one occasion per season during quantitative macroinvertebrate sampling.	One sampling occasion in spring 2012 and spring 2013 combined with selected subsidence monitoring sites.
Fish sampling – bait traps	Four bait traps set at each site. Two sites in each stream at impact and control sites. Combined with fish caught in dip nets (AUSRIVAS sampling).	One sampling occasion in: autumn 2012, spring 2012, autumn 2013 and spring 2013.	One sampling occasion in spring 2012 and spring 2013 combined with selected subsidence monitoring sites.
Macrophyte sampling - AUSRIVAS	One sample at each site. Two sampling sites in each stream. At impact sites only and control sites Eliza Creek, Dry Creek, Carters creek and Cow Creek...	Two sampling occasions in: autumn 2012, spring 2012, autumn 2013 and spring 2013.	One sampling occasion in spring 2012 and spring 2013 combined with selected subsidence monitoring sites.
Macroinvertebrates - AUSRIVAS	One 10 metre dip net sweep at each site. Two sampling sites in each stream. At impact sites and control sites Eliza Creek, Dry Creek, Carters creek and Cow Creek.	Two sampling occasions in: autumn 2012, spring 2012, autumn 2013 and spring 2013.	One sampling occasion in spring 2012 and spring 2013 combined with selected subsidence monitoring sites.
Macroinvertebrates -Quantitative sampling	Three benthic samples at each site. Two sites in each stream at impact sites and controls.	Artificial collectors: autumn 2012. Benthic suction sampler: one sampling occasion in spring 2012, autumn 2013 and spring 2013.	One sampling occasion in spring 2012 and spring 2013 combined with selected subsidence monitoring sites.
Targeted survey			
Targeted surveys	Sydney Hawk dragonfly: 29 sites sampled using modified AUSRIVAS edge sampling technique.	One sampling occasion (5 days) in July/August 2013.	-

3.5.1 Aquatic habitat descriptions and monitoring

A qualitative description of the aquatic habitats at each site was made based on the following attributes:

- Topography.
- Extent and condition of riparian vegetation.
- Stream level and width.
- Instream features such as sequence of pools, runs and riffles.

- Presence and extent and type of aquatic vegetation.
- Stream substratum.
- Presence of fish habitat, including snags, bank undercuts and aquatic plants.

In addition to the above habitat descriptors, the Riparian, Channel and Environmental Inventory (RCE) assessment was undertaken at each site (Chessman et al. 1997; Appendix B). This assessment produces a score for each site based on a series of observations relating to the natural characteristics and degree of disturbance evident at each site and allows comparison between sites and over time.

A photo record point was also established at each site. Photographs were taken from the upstream point, the centre and the downstream point of the 100 m reach. At each photo point, an upstream and downstream photograph was taken (see Niche 2013).

3.5.2 Water quality

Surface water quality was measured *in situ* using a Yeo-kal 611 water quality probe, with three readings taken at subsidence monitoring sites and mine water discharge monitoring sites. The following variables were recorded:

- Temperature (°C)
- Salinity/conductivity (µS/cm)
- pH/alkalinity
- Oxidation – Reduction Potential (ORP) (mV)
- Dissolved Oxygen (% saturation and mg/L)
- Turbidity (ntu).

Water quality data were compared with the ANZECC (2000) default trigger values of physical and chemical stressors for the protection of slightly disturbed aquatic ecosystems in south-eastern Australia.

3.5.3 Fish sampling

Fish sampling was undertaken at subsidence and surface works monitoring sites (Appendix F and Appendix G). Fish surveys using bait traps were undertaken at each sample site once per season (Plate 1). Four bait traps were deployed in slow flowing pools at each site for two continuous hours. Additionally, fish at each site collected as part of the AUSRIVAS macroinvertebrate sampling were identified and counted. All captured fish and large crustaceans were immediately transferred to a bucket of water for identification and release. Fish were identified in the field using Field Guide to the Freshwater Fishes of Australia (Allen et al. 2002). Any individuals that could not be identified were preserved using 70% ethanol for later identification.

Fish sampling was done in accordance with an Animal Research Authority (Fauna Surveys: Terrestrial and Aquatic) and a Scientific Collection Permit (No. P10/0027-3.0) issued by the NSW Department of Primary Industries.

3.5.4 Macrophytes

The presence/absence of macrophytes within a 100 metre reach at each sample site was recorded. All macrophytes observed at surveys sites were identified to species.

3.5.5 Aquatic macroinvertebrate sampling

Aquatic macroinvertebrates were collected using both the AUSRIVAS protocol for NSW streams (Turak et al. 2004), and the quantitative sampling method for surveying macroinvertebrates.

AUSRIVAS sampling

The AUSRIVAS methods of sampling both pools and riffles were modified as no suitable in-stream riffle features were present. Samples were collected from pool edges for a distance of 10 metre either as a continuous line or in disconnected segments. Sampling in segments was often undertaken to ensure the sampling of sub-habitats such as macrophyte beds, bank overhangs, submerged branches and root mats. Segmented sampling was also employed where pool length was short and it was logistically difficult to sample in a continuous line (e.g. in-stream logs). A 250 µm dip net was drawn through the water with short sweeps towards the bank to dislodge benthic fauna while scraping submerged rocks and debris, sides of the stream bank and the bed substrate. Further sweeps in the water column targeted the suspended fauna. In many of the pools where it was difficult to scrape the substrate with the net (e.g. due to obstacles), the substrate was disturbed using a kicking motion and the net moved through the water column to collect specimens.

Each sample was rinsed from the net onto a white sorting tray from which animals were picked using forceps, pipettes and or paint brushes. Each tray was picked for a minimum period of forty minutes, after which they were picked at ten minute intervals for either a total of one hour or until no new specimens had been found. Care was taken to collect cryptic and fast moving animals in addition to those that were conspicuous or slow. Specimens were placed into a labelled jar containing 70% ethanol. In accordance with the AUSRIVAS protocol, samples were sorted under a binocular microscope (at 40 X magnification), identified to family or sub-order level.

The chemical and physical variables required for running the AUSRIVAS predictive model were also recorded. Alkalinity, modal depth and width of the river, percentage bedrock, boulder or cobble and latitude and longitude of each site were recorded in the field, whilst distance from source, altitude, land-slope and rainfall were determined in the laboratory.

Quantitative sampling

The Before monitoring component of a BACI (Before After Control Impact) monitoring design was implemented to assess the potential impacts of mining subsidence on aquatic ecology, provided that similar assessments are made during and/or after mining (Underwood 1991, 1992, 1993, 1994; Downes et al. 2002).

Artificial collectors

At the beginning of the autumn 2012 AUSRIVAS seasons, four replicate artificial collector units providing habitat structure for aquatic macroinvertebrates were deployed at each site. The collectors consisted of 24 centimetre long x 3 centimetre diameter bundles of nine wooden chopsticks held together with plastic cable ties (Plate 2). The four collectors were attached to nylon twine and submerged 1 metre apart at the edge of pools in approximately 0.5 metres of water. Collectors were anchored using concrete weights or tied to vegetation along the bank. The collectors were retrieved during the second survey, approximately six weeks after being deployed.

During retrieval the collectors were carefully cut away from their anchors, placed into plastic bags, labelled and preserved in 70% ethanol for subsequent laboratory identification and analysis. This method is based on a modified technique used by Cardno Ecology Lab (CEL 2010b). Artificial collecting sticks were rinsed using 70% ethanol onto a 250 µm mesh sieve and examined in the laboratory using a binocular microscope. Macroinvertebrates (adults, juveniles, larvae, pupae) were identified to family level except for Oligochaeta (to class), Polychaeta (to class), Ostracoda (to subclass), Nematoda (to phylum), Nemertea (to phylum), Acarina (to order) and Chironomidae (to subfamily).

The collectors were set in autumn 2012 and retrieved early June. Due to logistical constraints the artificial collectors were replaced with the suction sampler quantitative technique (Brooks 1994) for the remainder of the monitoring program. The data assessed in this report includes three seasons of benthic suction sampling and artificial collector data has been excluded from the analyses. Data collected with artificial collectors is provided in Tahmoor South Aquatic Monitoring Report (Niche 2012).

Benthic suction sampler

Macroinvertebrates were sampled from three random pool edges at each site. Pool-edge samples were collected from depths of 0.2 - 0.5 metre within 2 metres of the bank. A suction sampler described by Brooks (1994) (Plate 2) was placed over the substrate and operated for one minute at each sampling location. The sample was washed thoroughly over a 500 µm mesh sieve. All material retained on the 500 µm mesh sieve was preserved in 70% ethanol for laboratory sorting. Samples were subsampled in a 100 cell Marchant box (Marchant 1989) and 35% (35 cells) of the sample were randomly extracted. Samples that contained few invertebrates were not subsampled. All macroinvertebrates (except for segmented and unsegmented worms, Acarina and Chironomidae) were identified to family level. The segmented worms were identified to class (Oligochaeta) and unsegmented worms to phylum, except for flatworms which were identified to order (Tricladida). Acarina were identified to order and Chironomidae to subfamily. Small crustaceans Ostrocoda, Copapoda and Cladocera were not identified.

3.5.6 Targeted surveys

Targeted surveys were undertaken for the threatened Sydney Hawk Dragonfly (*Austrocordulia leonardi*) on 24 - 26 July and 31st July - 2 August, 2013. A conservative approach was adopted in implementing the targeted surveys to ensure that threatened fauna are not present in areas affected by subsidence within the Project Area. The survey primarily targeted the tributaries to the Bargo River and Nepean River, particularly since Austrocorduliidae (the Sydney Hawk dragonfly family) were observed in Eliza Creek in baseline monitoring samples. Bargo River sites within the Project Area were adequately sampled (eight sites) within the baseline monitoring program. Potential habitat for these dragonflies was based on geomorphology mapping prepared by Fluvial Systems (2013) and modelled using ArcGIS mapping software.

Sydney Hawk Dragonfly

All pools with a predominantly boulder and/or cobble substrate were defined as containing potential habitat. Within the Project Area, a total of 30 sites were identified (Figure 6) and subsequently surveyed for Sydney Hawk Dragonfly using a modified AUSRIVAS technique, whereby cobbles and boulders were actively lifted and the substrate stirred followed by sampling the water column using a 250 µm dip net in a continuous sweeping motion.

Sample processing and picking for the species followed AUSRIVAS protocol. Dragonflies were identified to family *in situ*. If they were not from *Austrocorduliidae* they were returned to the habitat from where they were collected. Dragonfly from the family *Austrocorduliidae* were kept for further identification.

3.6 Data analysis

3.6.1 AUSRIVAS samples

Samples collected using the AUSRIVAS protocol were analysed using the predictive spring and autumn models for NSW pool edge habitats. The AUSRIVAS model predicts the aquatic macroinvertebrate fauna expected to occur at a site in the absence of environmental stress, such as pollution or habitat degradation, and generates a number of indices, which are detailed below.

The Observed to Expected ratio (OE50)

OE50 is the ratio of the number of invertebrate families observed (NTC50) at a site to the number of families expected (NTE50) at that site. Only macroinvertebrate families with a greater than 50% predicted probability of occurrences are used by the model. OE50 provides a measure of biological impairment at the test site. The OE50 ratios are divided into bands representing the following different levels of impairment:

- Band X represents a more biologically diverse community than reference.
- Band A is considered similar to reference.
- Band B represents sites significantly impaired.
- Band C represents sites in a severely impaired condition.
- Band D represents sites that are extremely impaired.

Stream Invertebrate Grade Number Average Level (SIGNAL)

SIGNAL is a simple biotic index for river macroinvertebrates, developed initially for application to eastern Australia (Chessman 1995). The SIGNAL method uses ecological patterns to measure water quality using waterbugs. The SIGNAL score of a site can be calculated to form an objective opinion about river health. Table 8 provides a broad guide for interpreting the health of the site according to the SIGNAL score of the site.

Table 8: Guide to interpreting SIGNAL scores

SIGNAL Score	Habitat quality
Greater than 6	Healthy habitat
Between 5 and 6	Mild pollution
Between 4 and 5	Moderate pollution
Less than 4	Severe pollution

(Source: Gooderham J and Tsyrlin E 2002)

3.6.2 General sample analyses

Other analyses performed on the data to indicate stream health and aquatic macro-invertebrate diversity include taxa richness, EPT richness and EPT ratio, also detailed below.

Taxa richness

The richness of macroinvertebrate families (or class/orders if not identified to family level) was calculated as an indicator of stream health. The higher the number, the healthier the aquatic ecosystem.

EPT richness and EPT ratio

The EPT (Ephemeroptera, Plecoptera and Tricoptera) index is based on the insect orders that contain a majority of pollution sensitive taxa (Lenat 1988). All genera of Ephemeroptera, Plecoptera and Tricoptera were identified and the number of distinct taxa were counted as an indicator of ecosystem health. The higher the number, the healthier the aquatic ecosystem. The ratio of EPT to the number of taxa was also calculated as another measure of ecosystem health.

3.6.3 Quantitative macroinvertebrate data analysis

To estimate the original family densities per $0.21m^2$ (i.e. area of benthic suction sampler) any samples subsampled (35% subsampled) in the laboratory were multiplied by 100/35. Analysis of benthic invertebrate data was done using Primer v6.

Univariate mean family richness and density univariate data was graphed. Multivariate data was 4th root-transformed for the calculation of Bray-Curtis Similarity measure to reduce difference in scale among variables, but still retain information regarding relative abundances.

Non-metric multidimensional scaling nMDS (Clarke 1993) was undertaken to visualise patterns among the macroinvertebrate assemblage. In addition a nMDS plot was also performed on averaged sites to reduce the stress value and provide a better representation of the collected data. The Similarity Percentages Procedure (SIMPER) was performed to identify the main taxa contributing to differences in similarity of the assemblages observed in the nMDS.

3.7 Assumptions and limitations

This report combines two years of baseline aquatic monitoring data (2012 – 2013) with previous research carried out by MSEC (subsidence), HEC (surface water) and Fluvial Systems (geomorphology). The following assumptions have been made and limitations encountered during this assessment:

- While efforts were made to ensure macroinvertebrate sites are representative of the streams ecosystem, temporally and spatially, it is not possible to encompass the full extent of stream diversity in the Project Area.
- Suitable habitat for Sydney Hawk Dragonfly was identified using GIS mapping based on geomorphological mapping (Fluvial Systems 2013). Targeted field surveys of these areas were limited for a number of reasons:
    - Access was unavailable through private property.
    - All small streams were not surveyed as some streams may have been characterised as similar based on aerial photography and terrain data.
    - Parts of Bargo River and the Nepean River were too deep to safely navigate and cross on foot.
- The weather in 2012 was cool and wet at the start of the year, and warm and dry in the latter half of the year, with rainfall and temperature close to the historical average. The year 2013 was the warmest year on record for NSW maximum temperatures, and the third-warmest for mean temperatures. Rainfall was above average along the coast, with several heavy rainfall events, but below average in inland NSW and across the Murray Darling Basin (BOM 2013). While weather can influence the abundance and diversity of aquatic biota recorded during surveys, it is considered that the weather experienced during the monitoring period was fairly typical for the area, and that low flows and the drying out of some pools (i.e. sample sites on Dog Trap Creek), is consistent with the ephemeral nature of the creeks within the Project Area. As such, it is assumed that the weather experienced during monitoring did not alter the diversity and abundance of species recorded from what would typically occur.

4. Existing environment

4.1 Project Area summary

The Project Area is located approximately 80 kilometres south-west of Sydney, in the vicinity of the townships of Tahmoor and Bargo, in the Southern Coalfield and is encompassed by CCL 747 and CCL 716 (Figure 2), on the south western edge of the Sydney Basin, situated on the western extent of the Woronora Plateau. The Project Area occurs within the boundaries of Wollondilly and Wingecarribee Local Government Areas (LGA), with the western and southern areas located in Wingecarribee LGA and northern and eastern areas in Wollondilly LGA.

Most of the area to the east of the Project Area consists of rural residential development, whilst the western portion consists primarily of vegetated land privately held but mainly undeveloped and a large tract of Crown Land. Topography varies within the Project Area with the eastern portion situated on gently undulating flats, the south east with moderately inclined side slopes and the western portion comprising steep incised gullies with exposed Hawkesbury Sandstone.

The Bargo River is the main natural feature within the Project Area, located on the western side of CCL 747. A number of unnamed 1st and 2nd order tributaries flow into Bargo River. Other significant creeks within the Project Area include: Hornes Creek, Dog Trap Creek, Eliza Creek, Tea Tree Hollow Creek, Dry Creek, Carters Creek and Cow Creek. Sections of these creeks (3^{rd} order and above) are mapped as Key Fish Habitat (DPI 2017c). The Project has 3rd Order Streams and above that contain both highly sensitive Key Fish Habitat (Type1) "*Freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 metres in length, or native aquatic plants" and minimal Key Fish Habitat (Type 3) "Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation*" (DPI 2013).

4.2 Key characteristics of the area

The following landscape information is summarised from NSW DoP (2008) and is a generalised description of the land encompassed by the Southern Coalfields.

4.2.1 Topography

The essential landscape feature which has determined the valley forms and cliff lines of the Southern Coalfields is the Hawkesbury Sandstone, which is highly resistant to weathering. The weathering and erosion caused by the concentration of moving water along the networks of faults and joints, which occur naturally in this rock as the result of stresses imposed during geologic time, has led to the development of a system of deeply incised river gorges that drain the plateaus. The river valleys, particularly the downstream sections as they approach the Hawkesbury River Valley, are often narrow with steep sides and stream beds largely composed of the sandstone bedrock, with rock bars and boulder-strewn channels. These steep-sided valleys, may take the form of a gorge, with imposing sandstone cliffs on one or both sides of the river. An example is the Bargo River Gorge, located between Pheasants Nest and Tahmoor (NSW DoP 2008), which is within the boundary of CCL 747.

Further upstream in most catchments, the rivers are less incised and their valleys are broader and more open in form although the sandstone bedrock still remains the key geomorphological determinant. Stream beds are still generally composed of exposed sandstone bedrock, with rock bars and channels strewn with smaller boulders and cobbles. The sandstone bedrock becomes a drainage surface (either at the base of swampy vegetation draping the landscape or below the regolith), which sheds groundwater towards the streams. The groundwater provides base flow for the streams and supports the generally perennial character of the larger streams and rivers (NSW DoP 2008).

4.2.2 Geomorphology

The following geomorphic characterisation is taken from the geomorphology technical report prepared for the Tahmoor South Project (Fluvial Systems 2013).

In terms of landscape scale characteristics, the majority of the proposed development is underlain by Hawkesbury Sandstone, with a smaller portion underlain by Wianamatta Group. The soils in this region are characterised by generally weakly developed soils on sandstone and shale. Some of the soils are highly susceptible to erosion by concentrated water flow, which is expected of weakly developed soils in steep environments. The susceptibility of the soils to water erosion is part of the natural process of delivery of sediment to streams. Some of the soils are high in iron content and can be responsible for release of dissolved iron to stream water.

The streams comprise small headwater streams on relatively low gradient plateau landscapes and streams eroded into rocky gorges. The gorges are rimmed by cliffs of various lengths and heights, with densely vegetated talus slopes below the cliffs. These cliffs, and the talus slopes below them, are relatively stable.

A wide range of channel bed materials was observed over the Project Area. Mud was more prevalent in small streams on the plateau, but it was also occasionally present in the lower reaches of tributary streams. Sand, gravel, cobble and bedrock were commonly found throughout the Project Area. Exposed bedrock was commonly observed in streams throughout the Project Area. Streams with particularly frequent bedrock features in their beds were Lower Eliza Creek and [two tributaries to the Bargo River]. The frequency of bedrock features was also high in Dog Trap Creek, Cow Creek and Dry Creek, but less so in Carters Creek, Hornes Creek and Tea Tree Hollow. The observed frequency of bedrock features in the bed of Bargo River was an underestimate because at the time of sampling, for most of its length the water was too deep to permit observation of the bed.

In-channel pools are common in streams within the Project Area, particularly in Dog Trap Creek, Dry Creek and Cow Creek. Tea Tree Hollow has a lower frequency of pools compared to other creeks. Boulders are the most common type of hydraulic control on pools, with 47% being boulders, 33% rock bars, 12% high points of cohesive material, 8% gravel, cobble or sand bars, and 1% artificial material. As the channels are bedrock controlled, they are naturally resilient to geomorphic change.

The continuity of riparian vegetation and level of tree cover was within the natural range of undisturbed sites and as such, provides geomorphic stability of streams in the Project Area. Grass cover on the low flow channel was found on all of the small headwater streams of the creeks in the Project Area, but it was uncommon in 2nd order streams and higher. Dry Creek was an exception, but with a small catchment area it is a relatively low energy stream.

Knickpoints were common in streams within the Project Area and soft knickpoints were found mainly on small, plateau streams running through both cleared and uncleared land. Hard knickpoints were found in steeper streams.

Ferruginous seeps in rocks close to stream channels were uncommon in the Project Area. One seep was observed on Dog Trap Creek, and one on Carters Creek. The seep on Dog Trap Creek covered a very small area of a few square centimetres, while the seep on Carters Creek was more substantial. The seep on Carters Creek was clearly related to emergence of water to the creek that had seeped through the wall of a farm dam located immediately upstream. The creek water downstream of this ferruginous seep was not discoloured.

The majority of streams are defined as being in a stable, close to natural geomorphic condition. Some streams were impacted by factors that marginally reduced their condition. These factors included clearance of riparian trees, licensed discharges, incision, mobile knick-points, and filamentous algae. Some streams were affected by loss of water to the subsurface over short reaches, and others were impacted by ferruginous seeps and suspended colloids. These factors do not have strong implications for geomorphic condition, but they could have relevance for ecological condition. A few isolated major culverts were judged to be in poor condition, as these were an unnatural stream type.

4.2.3 Catchments

The Project Area is part of Bargo River/Nepean catchment and consists of a number of smaller sub-catchments including Hornes Creek, Tea Tree Hollow, Dog Trap Creek, Dry Creek, Cow Creek, Carters Creek and Eliza Creek.

The upland areas, including the Bargo Township, are drained by headwater streams of Hornes Creek, Tea Tree Hollow, Dog Trap Creek and Eliza Creek. The central domain of the Project Area is drained predominantly by Tea Tree Hollow and Dog Trap Creek which flow generally north and eastward toward the Bargo River. A small area on the south western side of the central domain is drained by headwater tributaries of Hornes Creek which flows into the Bargo River at Picton Weir (HEC 2018a).

The eastern Project Area is predominantly drained by Eliza Creek which flows generally northward to the Nepean River. A small part of the eastern Project Area is also drained by Cow Creek and Carters Creek, which flows north-eastward to the Nepean River (HEC 2020a).

Thirlmere Lakes

The Thirlmere Lakes lie to the west of the existing Tahmoor Mine (approximately 3 kilometres from the subsidence area) (Figure 3), in the upper reaches of Blue Gum Creek, which ultimately flows to Lake Burragorang (Warragamba Dam). Thirlmere Lakes lie within the Thirlmere Lakes National Park which is part of the Greater Blue Mountains World Heritage Area and is mapped as 'Key Fish Habitat' (DPI 2017c). The Lakes are a series of five interconnected Lakes (in order from most upstream to downstream): Gandangarra, Werri Berri, Couridjah, Baraba and Nerrigorang. The nearest Tahmoor Mine longwall panels to the Thirlmere Lakes were mined between 1996 and 2002 and were located approximately 600 metres from Lake Couridjah.

4.2.4 Hydrology

Catchment modelling was undertaken in the Surface Water Baseline Study (HEC 2020a) using deterministic models, which are configured to simulate catchment characteristics important to the environmental assessment. The modelling results suggest that there may be a transmission loss in the Dog Trap Creek catchment and perhaps in Eliza Creek. The base flow makes a substantial less contribution to flow in Dog Trap Creek the Bargo River Upstream. The rate that groundwater drains out of storage and into the Bargo River upstream is substantially slower than in Dog Trap or Eliza Creek. Stream flow characteristics of each creek have been described in the Surface Water Baseline Study (HEC 2020a).

4.2.5 Watercourses

The type of topography described above usually provides a series of pools and riffle sections in 1st and 2nd order creeks, which provide important macro-invertebrate habitat and fish refuge. The higher order streams are typically broader and provide habitat for larger fish species (NSW DoP 2008). Within the

Project Area there are eight named creeks ranging from1st order to 4th order creeks (using Strahlers' 1952 stream order system).

Bargo River is the main watercourse within the Project Area and is located on the western side of the Project Area. Bargo River is a tributary of the Nepean River and falls within the Bargo River sub-catchment, which is the smallest sub-catchment (130.70 km^2) of the Hawkesbury Nepean catchment. It contains two reaches separated by the Bargo reservoir. Reach one, Bargo R1, is considered to be in near natural condition, while Bargo R2 is experiencing some degradation from mining activity impacts and exhibits poor riparian zone condition. In addition, Picton Weir upstream is also having a negative effect on this reach (HNCMA 2006) as it affects the natural flow of the river downstream.

Following its confluence with Bargo River, the Nepean River continues to flow north, through the Nepean River sub-catchment, eventually flowing into the Hawkesbury River which enters the Pacific Ocean. Both the Bargo River and Upper Nepean River sub-catchments form part of the Western Sydney Region of the Hawkesbury-Nepean Catchment Management Authority (CMA).

4.2.6 Vegetation

The riparian vegetation around Bargo River is dominated by Hinterland Sandstone Gully Forest. This vegetation community also occurs around Hornes Creek, Dog Trap Creek and Cow Creek. Cumberland Shale Sandstone Transition Forest is mapped along parts of Eliza Creek, Dry Creek and Carters Creek, while areas of Sydney Hinterland Transition Woodland occur predominantly along Eliza Creek and Dog Trap Creek (Tozer 2010). Spiny-head Mat-rush *Lomandra longifolia* is very common along creeks, and has extensively colonised the low-level areas of all potential impact streams within the Project Area.

4.3 Water quality

4.3.1 Baseline watercourse monitoring

Water quality monitoring was conducted by Tahmoor Coal at all baseline stream flow monitoring sites in the Project Area from early 2012 to June 2015 and reported by Hydro and Engineering Consulting (HEC 2020a). Water quality parameters tested include aluminium, arsenic, barium, cadmium, chromium, copper, iron, lead, mercury, selenium, magnesium, sodium, potassium, arsenic, sulphate, zinc, pH, electrical conductivity, turbidity, chloride and calcium carbonate hardness. The baseline water quality data was assessed against ANZECC guideline (ANZECC 2000) trigger levels for the protection of Aquatic Ecosystems and Recreational Uses in accordance with the perceived principal beneficial uses of the surface water resources in the area. A summary of the major findings of the baseline water quality monitoring program for each watercourse presented in HEC 2020a are provided below.

Cow Creek

At the Cow Creek monitoring site there have been twenty exceedances of the aquatic ecosystem guideline trigger value for zinc and three for copper. There have also been exceedances of both the aquatic ecosystem and recreational use guideline trigger values for aluminium, cadmium and pH. The median concentrations of aluminium and zinc have exceeded the guideline trigger values for protection of aquatic ecosystems. All other parameters were below guideline trigger values.

Carters Creek

At the Carters Creek monitoring site there have been twenty nine exceedances of the aquatic ecosystem trigger for zinc and nine for copper. There have also been exceedances of both the aquatic ecosystem and recreational use triggers for aluminium, pH, turbidity and cadmium. The median concentrations of aluminium and zinc exceeded the trigger values for protection of aquatic ecosystems. All other parameters were below guideline trigger values.

Dry Creek

At the Dry Creek monitoring site, there have been twenty seven exceedances of the aquatic ecosystem guideline trigger value for zinc, two for lead and nine for copper. There have also been exceedances of both the aquatic ecosystem and recreational use guideline trigger values for aluminium. The median concentrations of aluminium and zinc both exceeded the guideline trigger values for protection of aquatic ecosystems. All other parameters were below guideline trigger values.

Eliza Creek

At the Eliza Creek monitoring site, there have been thirty four exceedances of the aquatic ecosystem guideline trigger value for zinc, four for lead and seventeen for copper. There have been exceedances of the recreational guideline value for chloride and iron. There have also been exceedances of both the aquatic ecosystem and recreational use guideline trigger values for aluminium. The median concentrations of copper and zinc have exceeded the guideline trigger values for protection of aquatic ecosystems. All other parameters' median values were below the guideline trigger values. Compared to the other monitoring sites, the concentrations of sodium and chloride in Eliza Creek have been elevated.

Dog Trap Creek

At the Dog Trap Creek Downstream there have been twenty two exceedances of the aquatic ecosystem guideline trigger for zinc and six for copper. There have been seven exceedances of the iron guideline trigger value for recreational use. There have also been exceedances of both the aquatic ecosystem and recreational use guideline trigger values for aluminium. The median concentrations of aluminium and zinc have exceeded the guideline trigger values for both protection of aquatic ecosystems and recreational use. All other parameters were within guideline trigger values.

Water quality at the Dog Trap Creek upstream site was generally similar to the downstream site. There have been thirty one exceedances of the aquatic ecosystem trigger value for zinc and seven for copper. There have been nine exceedances of the iron guideline trigger value for recreational use. There have also been exceedances of both the aquatic ecosystem and recreational use trigger guideline values for aluminium. The median concentrations of aluminium and zinc have both exceeded the guideline trigger values for protection of aquatic ecosystems. All other parameters were below guideline trigger values.

Tea Tree Hollow

At the Tea Tree Hollow monitoring site, which is downstream of the Tahmoor Mine licenced discharge point LDP 1, there have been twenty six exceedances of the aquatic ecosystem guideline trigger value for zinc, twenty six for selenium, eight for lead, twenty six for arsenic and twenty for copper. There have also been exceedances of both the aquatic ecosystem and recreational use guideline trigger values for aluminium, arsenic and selenium. The median concentrations of aluminium, arsenic, copper, selenium, pH and zinc exceeded the guideline trigger values or ranges for protection of aquatic ecosystems. Compared to the other monitoring sites the concentrations of sodium and bicarbonate have been elevated.

Hornes Creek

All but two of the samples collected from Hornes Creek exceeded the guideline trigger value for protection of aquatic ecosystems for zinc. There were five exceedances of the guideline trigger value for protection of aquatic ecosystems for cadmium and eight for copper. There were sixteen exceedances of the iron guideline trigger value for recreational use. There were sixteen exceedances of the aquatic ecosystem guideline trigger range for pH and five exceedances of the turbidity guideline trigger value. There have also been exceedances of both the aquatic ecosystem and recreational use guideline triggers for aluminium and selenium. The median concentration of aluminium and zinc exceeded the guideline trigger values for protection of aquatic ecosystems.

Bargo River

All but two of the samples collected at the Bargo River Upstream exceeded the zinc guideline trigger for protection of aquatic ecosystems. There were fifteen exceedances of the iron guideline trigger for recreational use and one for barium. There have also been exceedances of both the aquatic ecosystem and recreational use guideline trigger values for aluminium, arsenic and cadmium. The median concentrations of aluminium and zinc exceeded the guideline trigger values for protection of aquatic ecosystems.

The concentrations of bicarbonate and sodium at the Bargo River at Rockford Bridge, were noticeably higher than at the upstream sites on the Bargo River. It is presumed that this reflects the effects of licensed releases from LDP1 at the Tahmoor pit top via Tea Tree Hollow. All but one of the samples collected exceeded the guideline trigger for protection of aquatic ecosystems for zinc. There were twelve exceedances of the guideline trigger for protection of aquatic ecosystems for arsenic, six for copper and four for lead.

There were eighteen exceedances of the guideline trigger for recreational use for bicarbonate, seventeen for sodium, and twenty three for barium. There have also been exceedances of both the aquatic ecosystem and recreational use guideline trigger values for aluminium, arsenic and selenium. The median concentrations of aluminium, arsenic, selenium, zinc and pH have exceeded the guideline trigger values for protection of aquatic ecosystems.

Temporal water quality monitoring

A history of key water quality indicators were recorded by Hydro and Engineering Consulting (HEC 2020a) at Tea Tree Hollow, Dog Trap Creek (downstream) and Eliza Creek monitoring sites. The following specific observations were presented in HEC 2020a:

- Electrical conductivity (an indication of salinity) has been significantly higher and more variable at the Eliza Creek monitoring site than at other sites.
- pH values have been within or close to the ANZECC guideline range (6.5 to 8.5) - at all three monitoring sites. Relatively higher values have been recorded at Tea Tree Hollow and relatively lower values have been recorded at the Eliza Creek monitoring site.
- Turbidity has been consistently relatively low at the Dog Trap Creek monitoring site. Relatively elevated levels have been recorded at the Eliza Creek monitoring site.
- Sulphate has been consistently low at Tea Tree Hollow and higher and more variable at the Dog Trap and Eliza Creek monitoring sites.
- Aluminium concentrations have been highly variable at all three monitoring sites.
- Arsenic concentrations have been low at the Dog Trap and Eliza Creek monitoring sites but occasionally elevated and highly variable at the Tea Tree Hollow monitoring site.
- Iron concentrations have been low at the Tea Tree Hollow and Eliza Creek monitoring sites and occasionally elevated at the Dog Trap Creek monitoring site.
- Manganese concentrations have been highly variable but uncorrelated between monitoring sites. More persistent elevated concentrations have been recorded at the Eliza Creek monitoring site.

Results of water quality monitoring data collected as part of the baseline aquatic assessment for this report is discussed in Section 5.3.

4.4 Mine water discharge – water quality and aquatic ecology

4.4.1 PRP22 – Mine water treatment plant

PRP22 states: *"The treatment process must reduce concentrations of arsenic, nickel and zinc to levels below the default 95%ile trigger values for protection of aquatic ecosystems specified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000) in the Bargo River downstream of the confluence with Tea Tree Hollow."*

The completion of construction of the Waste Water Treatment Plant was achieved during July 2015, however as outlined in Section 2.4.2, improvements are required for the plant to operate efficiently. The upgrades are expected to be implemented under the proposed PRP22 - Stage 3 and the program outlined in Waste Water Treatment Plant – PRP22 Detailed Plan (SIMEC 2019a), and are expected to reduce concentrations of arsenic, nickel and zinc to acceptable limits.

The water quality target values for the WWTP are shown in Table 9.

Table 9: Treated water quality

Analyte	Treated Water Quality
pH – pH units	6.5-9
Conductivity – uS/cm	500
Suspended Solids mg/L	30
Turbidity NTU	150
O&g mg/L	10
Iron mg/L	0.7
Manganese mg/L	1.9
Nickel mg/L	0.011
Zinc mg/L	0.008
As (V) ug/L	13
As (III) ug/L	24

4.4.2 PRP 23 - Aquatic ecology investigation

PRP23 in EPL 1389 states: "*The Licensee must conduct an aquatic health monitoring investigation in Tea Tree Hollow and the Bargo River. The main objective of the investigation will be to define site specific trigger values for electrical conductivity in the Bargo River, and recommend suitable discharge concentration limits for electrical conductivity at Licensed Discharge Point.*"

The results from the PRP23 investigation (Cardno 2016) found that there is an apparent effect of the discharge on aquatic ecology in Tea Tree Hollow and Bargo River with a reduction in pollution sensitive invertebrates and an increase in pollution tolerant invertebrates downstream of the Discharge Point. However, the report found that the impairment was not excessive, in the context of a system modified by other anthropogenic land uses. The results of the field study suggest that the effect of the discharge on aquatic ecology appears localised to within a few kilometres downstream of the Discharge Point that includes Tea Tree Hollow and the Bargo River.

Based on conclusions for CEL (2016), there is no strong justification for the need to improve ecological health by further reductions in EC levels. While there was evidence of an effect of the discharge on the aquatic ecology of Tea Tree Hollow and at locations on the Bargo River, these effects appear to be localised to areas immediately downstream of the Discharge Point in the Bargo River and elevated levels are not likely in the Nepean River. The study found that:

- *"While EC experienced at LDP1 is elevated, levels are not considered to be excessive. Current EC levels in the Bargo are also not considered to be excessively high with respect to the reported tolerances of many aquatic biota present in Tea Tree Hollow and the Bargo River. Previous studies have indicated that the Bargo River and Tea Tree Hollow support functioning aquatic ecosystems as indicated by the presence of aquatic macroinvertebrates that are relatively sensitive to elevated EC. Furthermore, once water from the Bargo River enters the Nepean River a few kilometres downstream from Tea Tree Hollow, EC values would further reduce following dilution. The effect of the mine water discharge (due to elevated EC at least), if any, would likely be limited to the lower reaches of the Bargo River only, and would be very unlikely to affect the wider catchment.*
- *Measures to reduce EC at LDP1 would likely result in reduced flow in Tea Tree Hollow and the Bargo, as discharge water would likely be re-used on site. Discharge from LDP1 constitutes a substantial proportion of flow in the Bargo, and any reduction in flow would likely have consequences on aquatic ecology, such as reductions in habitat area and connectivity. Thus, there may be no net benefit of reducing EC to aquatic ecology given if it resulted in reduced flow (and habitat connectivity) in Tea Tree Hollow and the Bargo River.*
- *The results of the modelling indicate that EC at LDP1 has less influence on EC levels on the Bargo River than flow at LDP1 and background levels of EC and flow in the Bargo. The amount of variation present in these predictors, and thus the relatively large range of EC levels required at LDP1 to achieve the PC80 on the Bargo, could make implementing a suitable EC limit at LDP1 problematic, unless a very conservative level of EC at LDP1 was implemented."*

However, despite these findings that there is limited impact to aquatic ecology from the current discharge regime, the proposed water treatment measures outlined in PRP22 - Stage 3 will effectively reduce EC concentrations to 500 µS/cm (Table 9), which is more tolerable to aquatic flora and fauna and well below the current EPL limit of 2600 µS/cm. This will increase stream health in areas immediately downstream of the discharge.

5. Results

5.1 Threatened species searches

A search of Fisheries NSW Spatial Data Portal (DPI 2017b) showed one species, the Macquarie Perch, having indicative distribution in the Hawkesbury/Nepean Catchment. The EPBC protected matters search tool also reported the Macquarie Perch within a 10 kilometre radius of the Project Area. Species listed under the FM Act with potential habitat within the Project Area that were not shown on the DPI database portal were also considered. NSW NPWS Wildlife database showed one threatened insect, the Giant Dragonfly with an aquatic larval stage, recorded within a 10 kilometre radius of the Project Area. As a result of the database searches, the following four species were included as Subject Species:

- Macquarie Perch,
- Giant Dragonfly,
- Sydney Hawk dragonfly, and
- Adam's Emerald dragonfly.

The likelihood of occurrence of these Subject Species within the Project Area based on habitat assessment and the known habitat requirements of each species is considered in Appendix A. Table 10 summarises the Subject Species and their likelihood of occurrence in the Project Area. Only the Sydney Hawk Dragonfly, is considered to have potential habitat within the Project Area.

Results of targeted surveys for this species are provided in Section 5.8 and the assessment of significance for this species is provided in Appendix I. It is considered unlikely that the Project will have a significant impact on the Sydney Hawk Dragonfly.

Table 10: Threatened aquatic species recorded within the locality and likelihood of occurrence

Scientific Name	Common Name	Status	Likelihood of occurrence rating
Austrocordulia leonardi	Sydney Hawk Dragonfly	Endangered FM Act	Moderate. Potential habitat occurs in the Bargo/Nepean River. No historical records in the study area.
Archaeophya adamsi	Adam's Emerald Dragonfly	Endangered FM Act	Low. Only one potential riffle habitat located which will not be impacted by the proposal.
Petalura gigantea	Giant Dragonfly	Endangered BC Act	Low. No suitable swamp habitat.
Macquaria australasica	Macquarie perch	Endangered EPBC Act, FM Act	Low. Potential habitat occurs in the Nepean River outside of the Project Area. No historical records in the Bargo River or in Nepean River downstream of Bargo River. Records and potential habitat occur in the Nepean River upstream of Bargo River confluence.

5.2 Habitat monitoring

Subsidence monitoring sites are shown in Figure 3 and mine water discharge monitoring sites in Figure 4

5.2.1 Subsidence monitoring sites

Table 11 details the habitat at each monitoring site.

Potential impact sites

The majority of the creeks within the Project Area had a lower stratum riparian zone dominated by Spiny-headed Mat-rush (*Lomandra longifolia*) and had a high percentage of bedrock and boulders instream. Habitat attributes within these creeks included pools with bank overhang and trailing bank vegetation, rock bars, small waterfalls and sections of dry bed dominated by Spiny-headed Mat-rush and boulders. Hornes Creek and Tea Tree Hollow had an obvious orange discolouration of the water, iron flocs and algae present... Macrophytes were uncommon (Table 11). Many of the creeks contained freshwater yabbies *Cherax destructor*, freshwater shrimp *Paratya australiensis* and the Mosquito Fish *Gambusia holbrooki*.

Control sites

Filamentous algae and orange discolouration was typical of some sections of Bargo River, Cedar Creek, Stonequarry Creek, Carters Creek and Eliza Creek. Alkalinity of the water was low at the majority of the control sites and appeared to be a natural condition. Moore Creek, Eliza Creek, Dry Creek, Carters Creek and Cow Creek control sites, had similar vegetation and bed characteristics to many of the potential impact sites. Both Cedar Creek and Stonequarry Creek control sites did have some similarities in bed structure, however the riparian zones were comprised of different vegetation communities and had greater exotic species coverage.

Table 11: Subsidence monitoring sites: habitat

Watercourse	Site names	Habitat description
Potential impact locations		
Dog Trap Creek	DTC9, DTC10	Dog Trap Creek is a 3rd order stream with a catchment area of 13.6 km^2 at its confluence with the Bargo River. It drains the eastern part of the Central Domain. The catchment consists of rural residential areas with mixed farming. Dog Trap Creek flows into Bargo River approximately 1 km upstream of Mermaids Pool and is characterised by areas of very steep sided valleys. The creek is dominated by bedrock and ranges in width from 1 - 7 metres with a modal width of approximately 4 metres. Habitat features include pools, small waterfalls, undercut banks, trailing vegetation, snags and boulder dominated rapid sections. The riparian vegetation has been mapped as Sydney Hinterland Transition Woodland (Tozer 2010). The canopy was observed to consist mostly of Grey Gum (*Eucalyptus punctata*) and Sydney Peppermint (*E. piperita)*, with the middle stratum dominated by *Melaleuca* sp*., Leptospermum* sp*., Acacia* sp., and Black Wattle *Callicoma serratifolia*. The lower stratum was dominated by Spiny-headed Mat-rush. At both survey sites, the banks are characterised by native forest however there are rural properties upstream. The upstream survey site (DTC9) is located in a valley to the east of Charlies Point Road off a fire trail. During monitoring, a visual assessment of the water quality indicated some minor disturbance with slightly turbid waters and the instream habitat indicated some disturbance through the presence of Mosquito fish. The riparian zone showed evidence of flood damage, with large deposits of debris along the bank. The downstream survey site (DTC10) is located off a fire trail on Charlies Point Road and has similar attributes to the upstream location, however the sides of the creek are steeper with some escarpment sections. During monitoring, a visual assessment of disturbance related to human activities indicated there was minor disturbance to water quality, with a light film on the surface of the water. Instream disturbance included flood debris and there was little evidence of weed invasion. Dog Trap Creek was unable to be sampled during spring 2012 surveys as the creek was dry at sample sites and for much of the creek.
Tea Tree Hollow	TTH11, TTH12	Tea Tree Hollow is a 3rd order stream with a catchment area of 6.8 km^2 which drains the western part of the Central Domain. Tea Tree Hollow flows into Bargo River approximately 4 kilometres upstream of Mermaids Pool and the catchment contains Tahmoor Mine. The Tahmoor Mine discharges water from mine discharge point LDP1, along Tea Tree Hollow Creek. It is considered that without this discharge the creek would likely be a dry gully (CEL 2009). The riparian vegetation community at both sites along Tea Tree Hollow has been mapped as Sydney Hinterland Transition Woodland (Tozer 2010). The dominant canopy species recorded were Sydney Peppermint and Scribbly Gum *E. sclerophylla*, while the middle stratum was dominated by Black Wattle, *Melaleuca* sp., *Leptospermum* sp., *A. longifolia*, *Hakea* sp*., Pomaderris* sp., and *Lambertia formosa*. Spiny-headed Mat-rush dominated the lower stratum, with some ferns, exotic grasses and exotic herbs also present. The bed of the creek was highly influenced by the mine operations, with unnatural sediment deposits (barium precipitate) present. Habitat attributes include pools with undercut banks and trailing vegetation, riffle sections, snags and small drop offs. The upstream survey site (TTH11) is located downstream of a cleared track that crosses the creek. The site is upstream of mine discharge point LDP4 and access along this track is through the mine site. During monitoring, a visual assessment of disturbance related to human activities indicated some influence from the mine water discharge entering downstream, with slightly turbid waters observed. Water flow at this site was minimal. Instream evidence of disturbance included the presence of Mosquito fish, filamentous algae, gravel and dirty coloured sediments. There was also evidence of moderate weed invasion from Crofton Weed in the riparian vegetation. The original downstream survey site (TTH12) is located downstream of LDP4. During monitoring, the creek was observed to be flowing on all monitoring occasions (from mine water discharge) and the waters appeared turbid and some foam was present on the surface of the water. Instream evidence of disturbance included the presence of Mosquito fish, filamentous algae, gravel and dirty coloured sediments. There was also evidence of disturbance of the riparian vegetation, with some walking tracks in the vegetation and exotic grasses. As discussed in Section 3.4.2, the modification of mine discharge site LDP4 to a high flow discharge point only in mid-2013 necessitated a change in the downstream monitoring site to below the main mine water discharge LDP1 (TTH12a).

		The downstream site on Tea Tree Hollow Creek (TTH12a) is located downstream of LDP1. During monitoring, a visual assessment of disturbance related to human activities reported clear water however the instream environment had been highly compromised, with extensive development of a dark-coloured crystalline precipitate over the substrate (Plate 3). Samples of the deposit were collected for Tahmoor Coal. The subsequent laboratory analysis by ALS indicated that the deposit was high in barium, iron, aluminium and manganese. The high level of heavy metals is due to the precipitation from the discharged mine water over the extended 30 years of operation of the Tahmoor Mine, with the heavy metals in the mine water most likely derived from the leaching of coal (Singh et al. 1998).
Hornes Creek	HC13, HC14	Hornes Creek is a 4th order stream with a total catchment of 19.5 km^2. Approximately 3% (0.585km^2) of its catchment lies within the Project Area. The catchment consists of native bushland (owned by the mine) and a portion of the township of Bargo. Hornes Creek flows into Bargo River approximately 100 metres upstream of the Picton Weir. The bed is dominated by bedrock and habitat features include bank overhang, trailing bank vegetation, snags and small waterfalls. The upstream monitoring site on Hornes Creek (HC13) is a 3rd order stream and is located upstream of the Ashby Close road crossing. The riparian vegetation has been mapped as Sydney Hinterland Transition Woodland (Tozer 2010). The dominant canopy species consisted of large smooth barked eucalypt species with a middle stratum dominated by Black Wattle, *Melaleuca* sp., *Leptospermum* sp., *A. longifolia*, *Hakea* sp., *Pomaderris* sp. and *Banksia* sp. The lower stratum was dominated by Spiny-headed Mat-rush, *Banksia spinosa* and native sedges *S. melanostachys* with some ferns. During monitoring, a visual assessment of disturbance related to human activities indicated moderate disturbance in water quality, with orange discolouration. Instream disturbance was also observed with filamentous algae and Mosquito Fish present. Only minor disturbance to the riparian zone was observed. The downstream monitoring site (HC14) is located in a remote section of Hornes Creek and is accessible via a fire trail PC2. The riparian vegetation at this site has been mapped as Hinterland Sandstone Gully Forest (Tozer 2010) and the canopy is dominated by Sydney Peppermint and Scribbly Gum, while the middle stratum is dominated by Black Wattle, *Melaleuca* sp., *Leptospermum* sp., *A. longifolia* and *Hakea* sp. Spiny-headed Mat-rush dominated the lower stratum, with some ferns, exotic grasses and herbs and *Lambertia formosa* also present. During monitoring, a visual assessment of disturbance related to human activities indicated slight disturbance through the presence of orange discoloration in the water column, Mosquito Fish, and some plastic bottles in the stream, along with some evidence of flood damage to the riparian zone.
Bargo River	BR15, BR16	Bargo River is a tributary of the Nepean River; however it and its watercourses fall within the Bargo River sub-catchment, which is the smallest sub-catchment (130.70 km^2) of the Hawkesbury Nepean catchment. It contains two reaches separated by the Picton Weir. Reach one (Bargo R1) is considered to be in near intact condition, while the second reach downstream (Bargo R2) is experiencing some degradation from mining activity impacts and damage from local access to the riparian zone. Picton Weir itself is also having a negative effect on this reach (HNCMA 2006). The Bargo River is a 5th order perennial stream. The river commences near the townships of Hill Top and Yerrinbool, flows to the west of the proposed longwalls, to where it drains into the Nepean River approximately 1.1 kilometres north-west of the proposed LW202. Approximately 450 metres of the Bargo River is located just inside the Project Area. The surface water flows in this section of the Bargo River are controlled by the Picton Weir (also called the Bargo Weir) and licensed discharge from Tahmoor Mine, which enters the river via Tea Tree Hollow. Reports by Fluvial Systems (2013) and Hydro and Engineering Consulting (HEC 2020a) further describe this river. The Bargo River valley within the Project Area is typically between 20 and 40 metres high, comprising cliffs, rock outcrops and talus slopes in a number of locations. The river bed consists of a series of pools, rock bars, riffles and boulder fields. The average natural gradient of this section of the river is around 20 millimetres/metre (i.e. 2 %, or 1 in 50). The riparian vegetation in this section of the Bargo River has been mapped as Hinterland Sandstone Gully Forest (Tozer 2010) and is characterised by rainforest species. Habitat features include bedrock bars and pools, boulders, overhanging bank, trailing vegetation, snags and riffle sections. Water was flowing from the Weir at the time of all monitoring occasions. The upstream monitoring location on Bargo River (BR15) is located in a steep valley approximately 1 kilometre downstream of Picton Weir, where it is a 4th order stream. The width of this section of river is from 7 - 15 metres with a modal width of approximately 7 metres. During surveys, a visual assessment of disturbance related to human activities indicated only little disturbance to the water quality and instream habitat, with moderate disturbance of the riparian zone through the proximity of a fire trail and the presence of the Weir itself altering natural flows and depths. The downstream monitoring location (BR16) is located approximately 1.7 kilometres downstream of the Picton Weir, again in a steep-sided valley. The width at this point is 2 - 12 metres with a modal width of 5 metres. During surveys, a visual assessment of disturbance related to human activities indicated a more moderate level of disturbance to the water quality with foam observed on the surface of the water. Presence of Mosquito Fish indicated some instream disturbance and the riparian zone has been considerably modified through the construction of a fire trail and changes to the water flows following construction of the Weir.
Control locations		
Bargo River tributary	CBR1, CBR2	The control sites on Bargo River are located downstream of the Picton Weir, upstream of the Project Area and within a steep-sided gorge. Both locations are mapped as Hinterland Sandstone Gully Forest (Tozer 2010). The upstream control site (CBR1) is located approximately 400 metres downstream of the Weir. At this point, the river is wide, ranging from 4 - 14 metres with a modal width of 10 metres within the 100 metre reach. The middle stratum species were dominated by *Cyperus* sp. and *Melaleuca* sp., while the lower stratum contained sedges *S. melanostachys* and *L. laterale*, with some Bracken Fern (*P. esculentum*) and Coral Fern (*Gleichenia microphylla*). Emergent macrophytes contributed 30% of the surface water area at this site. The water was deep and the substrate consisted of silt and clay. During monitoring, a visual assessment of disturbance related to human activities indicated a moderate level of disturbance to the water quality with turbidity observed. Instream environment contained some rubbish and the riparian zone was impacted by changes to the natural hydrology (Picton Weir), the proximity of the fire trail and the presence of rubbish.

		The second control site (CBR2) is located on a 3rd order tributary that joins with Bargo River approximately 600 metres downstream of Picton Weir. The creek is characterised by bedrock and boulders, with a smaller percentage of cobbles and smaller substrate. The riparian vegetation at this site consists of tall eucalypts and she-oaks with some rainforest species. The width of the stream ranged from 1 - 4 metres with a mode of 3 metres. Both sides of the creek at this location are characterised by native forest. A visual assessment of the water quality and riparian zone indicated slight disturbance to the water quality, with an oily film present. The instream environment had been impacted by the constructed fire trail crossing at the creek and there was evidence of weed invasion in the riparian zone.
Moore Creek	CMC3, CMC4	Moore Creek is located outside the Project Area, to the west of the railway line and within Bargo State Recreation Area. It flows into Little River which flows north into Lake Burragorang which merges with the Nepean River. The first control site on Moore Creek (CMC3) is located in a steep valley to the south west of the town of Balmoral. Access to the site is via Bolan Road fire trail. As with many of the potential impact sites, the canopy vegetation is dominated by Sydney Peppermint and Grey Gum, however the middle and lower stratum vegetation differed at this site as Spiny-headed Mat-rush was not dominant. Present were Hop Bush (*Dodonea triquetra*) and Tea Tree (*Leptospermum* sp.) and Devils Twine (*Cassytha* sp.), along with sedges *S.melanostachys* and Bracken Fern. The creek bed comprises large amounts of detritus, with some boulders. Habitat attributes include pools with trailing bank vegetation and some rock bars and associated drops and a lot of snags. During monitoring, a visual assessment of disturbance related to human activities indicated no disturbance to water quality, however there were large amounts of detritus and some exotics species present in the riparian zone near the fire trail. Alkalinity test kits were unable to provide a measure at this site and further testing is required. This site was dry during spring 2012 surveys and, as a result, a site 200 m upstream of CMC4 was selected for future sampling spring surveys. The vegetation type and site characteristics resembled CMC4. The second control site on Moore Creek (CMC4) is located approximately 500 metres upstream of its confluence with Little River where it is a 3rd order stream. Access into Bargo State Recreation Area is via foot through a locked gate. The site is a steep valley and is characterised primarily by bedrock. The riparian vegetation consists of a canopy of Sydney Peppermint and Scribbly Gum with middle stratum species such as Tea Tree., *Acacia* sp., *Callistemon* sp. and *Hakea* sp. The lower stratum was dominated by sedges *S. melanostachys*, Cone Sticks (*Petrophile* sp.) and Coral Fern. Some macrophytes were present and the width of the stream ranged from 0.5 - 6 metres with a mode of 3 metres. Both sides of the bank are characterised by native forest. A visual assessment of the water quality and riparian zone indicated no evidence of disturbance however there was some filamentous algae present. Moore Creek has similar habitat attributes to many of the potential impact locations as it is dominated by bedrock, with low shrub riparian vegetation.
Cedar Creek	CCC5, CCC6	Cedar Creek is located approximately 7 kilometres north of the northern boundary of the Project Area. It flows into Stonequarry Creek which eventually flows into the Nepean River at a point approximately 4 kilometres downstream of the Bargo River and Nepean River confluence. Both control sites on Cedar Creek (CCC5 and CC6) are located downstream of the Cedar Creek Road bridge. The sites are in a broad valley with a catchment area dominated by rural residential properties and orchards. The width of the stream ranged from 1 - 12 metres with a mode of 7 metres. The riparian vegetation has a canopy of Grey Gum and Stringybark species with a middle stratum of Hop Bush, *Melaleuca* sp., Cherry Ballarat (*Exocarpus cupressiformis*), *A. longifolia*, *Ozothamnus diosmifolium* and a lower stratum consisting of *Juncus kraussi*i along with exotic grasses and herbs. A visual assessment of the water quality and instream habitat indicated a moderate level of disturbance, with turbid looking water, orange discolouration, filamentous algae, *Typha* sp. and Mosquito fish present along with rubbish and weeds in the riparian zone.
Stonequarry Creek	CSQ7, CSQ8	Stonequarry Creek flows into the Nepean River at a point approximately 4 kilometres downstream of the Bargo River and Nepean River confluence. Its catchment area consists of rural residential areas and farmland. The upstream control site (CSQC7) is located in a newly developed rural estate, the stream exhibiting steep banks. The riparian vegetation has a canopy of *Allocasuarina* sp. and *E. grandis*, while the middle stratum was dominated by Cheese Tree (*Glochidion ferdinandi var ferdinandi*), Hop Bush, *Melaleuca* sp. and *Acacia* sp. The lower stratum consists of ferns and a large percentage of exotic species. The bed consists of boulder and bedrock with habitat attributes such as pools and riffles and some emergent macrophytes (*Persicaria decipiens*). The water was flowing at the time of survey despite a long period of dry weather. A visual assessment of the water quality and instream habitat indicated a high level of disturbance, with turbid, orange water with oily films, foam and iron flocks. The instream disturbance consisted of considerable amounts of filamentous algae and the riparian vegetation contained exotic grasses and Lantana *camara*. The downstream control site on Stonequarry Creek (CSQC8) is located under the Mulhollands Road Bridge. The riparian vegetation at this site was very different to other sites, and consisted primarily of Mahoganys in the canopy and exotics such as Privet (*Ligustrum lucidum*) in the middle stratum. The lower stratum contained some Spiny-headed Mat-rush and maiden hair ferns. The bed consisted primarily of bedrock, with some bank overhang and trailing bank vegetation. The water was flowing at the time of surveys despite a long period of dry weather. A visual assessment of the water quality and instream habitat indicated a high level of disturbance, with turbid, orange water and a considerable amount of filamentous algae in the instream environment. The riparian vegetation contained exotic weeds such as Privet and Wandering Jew (*Tradescantia fluminensis*).
Cow Creek	CWC1, CWC2	Cow Creek is a 3rd order stream at the Project Area boundary and has a catchment area of 10.1 km^2 at its confluence with the Nepean River, some 18% of which is within the Project Area. The upper reaches of Cow Creek drain a small area (Figure 3) on the south-eastern side of the Project Area at the southern end of the Central Domain. The majority of the Cow Creek catchment falls within the Sydney Water Catchment Area (SCA). Cow Creek feeds into the Nepean River approximately 5.5 kilometres upstream of the Nepean River's confluence with the Cordeaux. Cow Creek has a high frequency of exposed bedrock features in its bed and in-channel pools were common compared to other creeks within the Project Area. Habitat features such as pools, small waterfalls, undercut banks, trailing vegetation, snags and boulder-dominated rapid sections were characteristic of this creek. The bed substrate primarily consisted of a thin sediment layer over bedrock. As it flows through undisturbed forested land, it also had a relatively high frequency of in-stream wood and plant detritus/debris. Surface flow loss was observed in Cow Creek during geomorphology field surveys and was presumed to be a natural situation (Fluvial Systems 2013).

		At monitoring sites within Cow Creek, the riparian vegetation has been mapped as Hinterland Sandstone Gully Forest (Tozer 2010). The dominant trees observed included Stringybark species and Sydney Peppermint. The middle stratum consisted of *Melaleuca* sp., *Leptospermum* sp., *Banksia* sp. and *Persoonia* sp., while the lower stratum was dominated by Bracken Fern and *Blechum* sp. The width of the creek varied from 0.5 to 8 metres, with the modal width being ~ 3 metres. The upstream site CWC1 is at a junction where the creek becomes a 3rd order stream. During monitoring, visual assessments of disturbance related to human activities indicated some turbidity in the water column, and the creek bed contained fallen debris from previous floodwaters, however there was no evidence of in-stream disturbance or disturbance to the riparian zone either through weed invasion or clearing. The second site CWC2 is located outside of the Project Area and further downstream where other first order tributaries (that are sourced within the Project Area) have entered the creek. At this point, the catchment area is approximately 325 hectares, of which is within the Project Area. During monitoring, there was no evidence of disturbance to the water quality, instream habitat or riparian zone.
Carters Creek	CC3, CC4	Carters Creek is a 3rd order stream at the Project Area boundary. It drains a total area of 6.4 km^2 at its confluence with the Nepean River, some 35% of which is within the Project Area. The upper reaches of Carters Creek drain a small area (Figure 3) on the south-eastern side of the Project Area, near the southern end of the Eastern Domain. The catchment of this creek consists mostly of rural residential properties and mixed rural agricultural properties. Along much of Carters Creek in the rural areas the riparian zone remained intact. Carters Creek feeds into the Nepean River approximately 2.5 kilometres downstream of the Nepean/Cordeaux River confluence. The width of the creek varied from 0.5 to 8 metres, with the modal width being ~ 3 metres. Habitat features such as pools, small waterfalls, undercut banks, trailing vegetation, snags and boulder-dominated rapid sections were characteristic of this creek. The bed substrate primarily consisted of bedrock. A substantial ferruginous seep was observed on Carters Creek and was thought to be associated with water that had seeped through the wall of a farm dam located immediately upstream (Fluvial Systems 2013). At monitoring sites within Carters Creek, the vegetation was unmapped (Tozer 2010). The dominant canopy species observed at both survey sites included Grey Gum and Sydney Peppermint, while middle stratum was dominated by *Allocasuarina littoralis* at CC3 and *Melaleuca* sp., *Acacia longifolia* at CC4. The lower stratum was dominated by Spiny-headed Mat-rush at both sites, with some ferns (Bracken Fern and *Adiantum aethiopicum*) present. The upstream monitoring site (CC3) is located just below the junction where the creek becomes a 3rd order stream. The catchment area at this site is approximately 244 hectares, which is wholly within the Project Area. During monitoring, a visual assessment of disturbance related to human activities indicated there was moderate disturbance of water quality, with an oily film observed on the surface and orange discolouration and some iron flocs observed in the water. Filamentous algae and the introduced Mosquito Fish were also observed instream indicating moderate disturbance. The riparian vegetation showed no evidence of clearing, bank destabilisation or serious weed infestation, however, Crofton Weed (*Ageratina adenophora*), which is a Class 4 noxious weed under the *NSW Noxious weeds Act 1993*, was present. The second survey site (CC4) is downstream of the Mockingbird Road bridge overpass, outside of the Project Area. This site encompasses the northern arm of Carters Creek, which is also within the Project Area. Some sections of the creek appeared to have little to no water, with the drainage line defined only by a high density of Spiny-headed Mat-rush. Disturbance to water quality at this site was evident by minor orange colouration of the water. There was some rubbish instream along with Mosquito Fish, and walking tracks occurred throughout the riparian vegetation. Smaller amounts of Crofton Weed was observed along with some exotic grasses.
Dry Creek	DC5, DC6	Dry Creek is a 2nd order stream at the Project boundary and is located in the eastern portion of the Project Area with all of its catchment within the Project Area (Figure 3). The proposed longwall runs under a length of nearly 2 kilometres of the creek bed. The catchment of this creek consists mostly of rural residential properties with some mixed farming e.g. poultry and hobby farms. Dry Creek feeds into the Nepean River approximately 1.7 kilometres upstream of its confluence with the Bargo River. Habitat features such as pools, small waterfalls, undercut banks, trailing vegetation, snags and boulder dominated rapid sections were characteristic of this creek. The bed substrate primarily consisted of bedrock. The creek was dominated by little to no water flow, where the creek bed was defined only by a high density of Spiny-headed Mat-rush. At the upstream monitoring site on Dry Creek (DC5), the riparian vegetation was mapped as Cumberland Shale Sandstone Transition Forest while the downstream site (DC6) was unmapped (Tozer 2010). The canopy at both survey sites was dominated by Grey Gum, Sydney Peppermint and Stringybark species. DC6 also had some Ironbark species present. The middle stratum was dominated by *Melaleuca* sp., *Leptospermum* sp. and *A. littoralis*. The lower stratum was dominated by Spiny-headed Mat-rush, with only a small percentage cover of ferns, vines and native sedges (*Schoenus melanostachys*). The width of the creek varied from 0.5 to 8 metres, with the modal width being ~ 1 metre. The upstream survey site (DC5) is located on a section of creek that is a 2nd order stream, upstream of the Pheasants Nest Road Bridge. At this point, the catchment area is approximately 184 hectares. During monitoring, a visual assessment of disturbance related to human activities indicated there was evidence of disturbance to water quality, with orange colouration resulting in very turbid looking water. The instream habitat was also disturbed, with some rubbish evident and Mosquito Fish present along with influence from the Pheasants Nest Road Bridge in the form of structural changes to the creek in this area (rubble and revetment). The downstream site (DC6) is located close to its confluence with the Nepean River and as such, the catchment at this site encompasses nearly the entire Dry Creek catchment area. Disturbance at this site was less evident; however there was still some orange coloration and iron flocs present along with some instream rubbish. There was some evidence of walking tracks or exotic weeds within the riparian zone.
Eliza Creek	EC7, EC8	Eliza Creek is a 2nd order stream with a catchment area of 4.9 km^2 at its confluence with the Bargo River. It drains the bulk of the Eastern Domain. The longwalls are proposed both under and to run roughly parallel to Eliza Creek for a portion of its length (Figure 3). Eliza Creek feeds into the Nepean River approximately 1.4 kilometres upstream of the Nepean/Bargo River confluence. The lower reach of Eliza Creek had a high amount of exposed bedrock in the form of rock bars and rock slabs. Habitat features such as pools, small

		waterfalls, undercut banks, trailing vegetation, snags and boulder dominated rapid sections were observed along the creek. In some areas, the riparian vegetation along this creek had a high percentage of exotic species. A failed dam was observed on Eliza Creek during geomorphology surveys and directly upstream a deposit of fine sediment of unknown origin which appeared to contain ferruginous material was observed. Below this deposit, the creek had an orange discolouration (Fluvial Systems 2013). The ferruginous colloids suspended in the water and filamentous algae were observed downstream of the deposit. The deposit and failed dam occur between EC7 and EC8. At the upstream monitoring site (EC7), the riparian vegetation has been mapped as Sydney Hinterland Transition Woodland (Tozer, 2010). The upper canopy at this site was dominated by Grey Gum, Sydney Peppermint, and Blue Gum (*E. saligna*), while the middle stratum contained *A. littoralis*, *Acacia* sp., *M. nodosa*, *P. linearis* and *Leptospermum* sp. The lower stratum was the dominant layer and was dominated almost entirely by Spiny-headed Mat-rush, with occasional sedges (*S. melanostachys*) and ferns (Bracken Fern *and A. aethiopicum*). The width of the creek ranged from 1 – 5 metres, with a modal width of approximately 2 metres. The EC7 site has a catchment area of approximately 234 hectares which consists of farmland with grazing cattle and sheep. During monitoring, a visual assessment of disturbance related to human activities indicated that there was little evidence of disturbance at this site, with some turbidity in the water column, Mosquito Fish were present and there was minor presence of weeds and disturbance in the riparian zone. The creek bed was dominated by boulders, with areas of dry creek bed marked only by Spiny-headed Mat-rush. The downstream site (EC8) is located off Lyrebird Road, approximately 1 kilometres upstream of its confluence with the Nepean River. The riparian vegetation at this site has been mapped as Hinterland Sandstone Gully Forest (Tozer 2010). The upper stratum was dominated by Grey Gum and Sydney Peppermint, while the middle stratum consisted *of A. littoralis* and *Leptospermum* sp. Spiny-headed Mat-rush was the dominant species along the creek, with some *S. melanostachys*. The creek bed at this site was dominated by bedrock. During monitoring, a visual assessment of disturbance related to human activities indicated that the water quality at this site was highly disturbed, with a strong orange colouration, an oily film and foam on the surface. Instream habitat was also highly disturbed, with filamentous algae present and *Typha* sp. Some exotic species were also observed in the riparian zone.

5.2.2 Mine water discharge monitoring sites

Table 12 details the habitat at each monitoring site.

Table 12: Mine water discharge monitoring sites: habitat

Location	Site names	Habitat description
Potential impact locations		
Tea Tree Hollow Creek - downstream	TTH12 (2012 – 2013), TTH12a (2013)	The mine discharge monitoring sites in Tea Tree Hollow Creek are the same as those used for subsidence monitoring (TTH11, TTH12 and TTH12a) and have been described in Table 11. Tea Tree Hollow Creek is an ephemeral tributary which flows naturally only after significant localised rainfall. Mine water discharged into the creek therefore constitutes most of the flow and also contributes a large proportion of flow to the Bargo River downstream of the confluence with Tea Tree Hollow. In the absence of mine discharge, Tea Tree Hollow and the Bargo River would become a series of isolated pools during drought periods (CEL 2011).
Bargo River – downstream	SBR5, SBR6, SBR7, SBR8	Survey site SBR5 is located approximately 350 metres downstream of the Tea Tree HollowCreek confluence and SBR6 is located a further 500 metres downstream. At both sites, the river width ranges from 4 - 12 metres with a modal width of 6 metres. The substrate is mainly bedrock with some boulder riffle sections between pools. The valley is steep with moderate shading of the river from riparian vegetation. A visual assessment of disturbance related to human activities taken during surveys indicates little disturbance to the quality of the water and instream habitat. The riparian zone was mostly intact. Survey sites SBR7 and SBR8 are near Rockford Bridge, approximately 2.5 kilometres downstream of the Tea Tree Hollow confluence. At this point along the Bargo River, the width ranges from 5 - 20 metres with a modal width of 10 metres. The valley is steep sided, with low-moderate shading along the river from riparian vegetation and the substrate was mostly bedrock. A visual assessment of disturbance related to human activities taken during surveys indicated little disturbance to the quality of the water and instream habitat. The riparian zone was mostly intact. There was moderate instream disturbance in the form of bridge piers and artificial substrate at Rockford Bridge.
Control locations		
Tea Tree Hollow Creek - upstream	TTH11	The mine discharge monitoring sites in Tea Tree Hollow are the same as those used for subsidence monitoring (TTH11, TTH12 and TTH12a) and have been described in Table 11.
Bargo River - upstream	SBR1, SBR2, SBR3, SBR4	Survey sites SBR1 and SBR2 are located downstream of Picton Weir and are described in Table 11 as Bargo River (sites BR15 and BR16). This location was within the Project Area boundary and as such considered as a potential impact site for subsidence analysis, however as there will be likely no subsidence impacts on this location, it is considered suitable as a control location for the analysis of potential surface works impacts. Survey sites SBR3 and SBR4 are located immediately upstream of Remembrance Driveway. Here the river is located in a broad valley with a lower level of shading from riparian vegetation. The width at this point ranges from 10 – 20 metres with a modal width of 12 metres. The substrate was mainly bedrock. A visual assessment of disturbance related to human activities taken during surveys indicates little disturbance to the quality of the water, with some orange discolouration present, moderate instream disturbance based on the presence of filamentous algae, exotic Mosquito Fish and some instream rock construction at SBR4. The

		riparian zone was moderately to highly disturbed, with a cleared grassy reserve on the left bank and a 60 metre wide riparian strip separating the river from Remembrance Driveway on the right bank.

5.3 Water quality monitoring (AUSRIVAS)

Default trigger values for physical and chemical stressors for south-east Australia for slightly disturbed ecosystems (upland rivers) are available for pH, DO%, salinity (conductivity (µS/cm)) and turbidity (NTU) (ANZECC 2000).

5.3.1 Subsidence monitoring sites

Water quality field data for subsidence monitoring sites is provided in Appendix D. Table 13 shows monitoring events where water quality parameters were triggered for each site.

pH and Alkalinity

No distinct patterns were observed for pH with most sites experiencing fluctuations below, within and above ANZECC trigger values. However site TTH12 (downstream of the mine water discharge) was consistently elevated above ANZECC trigger values. Alkalinity levels varied throughout the sampling period. However were consistently low during sampling in autumn 2012, spring 2012 and autumn 2013 at the control locations: Bargo River, Moore Creek and Cedar Creek (Appendix D). Low alkalinity means that there is less buffering capacity against changes in pH.

Dissolved oxygen

Generally, dissolved oxygen was depressed among all streams falling below ANZECC trigger values with exception of sampling in June 2012 (Table 13, Appendix D). Low dissolved oxygen is expected in streams, particularly those of low order, in times of low or no visible flow.

Electrical Conductivity/Salinity

During two years of monitoring, EC exceeded the ANZECC trigger values consistently at a number of sites within the Project Area particularly at the Tea Tree Hollow downstream sites , which exceeded trigger values by four times and reached concentrations greater than 1000 µS/cm. Of the control sites, Stonequarry Creek and Eliza Creek consistently exceeded trigger levels. It is thought that groundwater is contributing to the higher concentration in Eliza and Stonequarry Creeks whereas Tea Tree Hollow is the result of mine water discharge.

Turbidity

Generally turbidity was quite low among all streams, however there were occasions, notably in November 2012, and October 2013, when trigger values were exceeded (Table 13, Appendix D). The turbidity results were expected for streams in the area and likely related rainfall and subsequent flow. There were no sites that had significantly high turbidity.

Table 13: Triggered water quality parameters per site – Subsidence sites

Site	Autumn May 2012				Autumn June 2012				Spring Oct 2012				Spring Nov 2012				Autumn March 2013				Autumn April 2013				Spring Sept 2013				Spring Oct 2013			
	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T
PIS																																
DTC9								✓	x	x	x	x	x	x	x	x										✓						✓
DTC10		✓						✓	x	x	x	x	x	x	x	x	✓	✓			✓	✓				✓				✓		✓
TTH11		✓							✓	✓	✓			✓	✓	✓		✓		✓	✓	✓				✓				✓	✓	✓

Site	Autumn May 2012				Autumn June 2012				Spring Oct 2012				Spring Nov 2012				Autumn March 2013				Autumn April 2013				Spring Sept 2013				Spring Oct 2013			
	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T
TTH12 (12a)	✓		✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓		✓	
HC13		✓						✓						✓		✓	✓	✓			✓	✓	✓			✓			✓	✓	✓	✓
HC14		✓	✓		✓			✓		✓				✓				✓				✓				✓			✓	✓	✓	
BR15		✓							✓	✓				✓				✓			✓	✓			✓	✓			✓	✓		✓
BR16		✓							✓	✓				✓				✓				✓				✓						
CS																																
CWC1	✓	✓				✓				✓			✓	✓		✓	✓	✓			✓	✓			✓	✓				✓		
CWC2		✓				✓				✓			✓	✓			✓	✓			✓	✓			✓	✓				✓		
CC3		✓			✓													✓			✓	✓				✓				✓	✓	
CC4	✓		✓		✓		✓			✓	✓	✓		✓	✓	✓	✓	✓			✓	✓				✓	✓			✓	✓	✓
DC5		✓	✓			✓	✓		✓	✓		✓		✓		✓	✓	✓			✓	✓			✓	✓				✓	✓	✓
DC6			✓			✓	✓		✓	✓	✓			✓		✓	✓	✓			✓	✓				✓	✓			✓	✓	✓
EC7		✓				✓	✓	✓		✓		✓		✓		✓	✓	✓		✓	✓	✓				✓		✓		✓		✓
EC8			✓				✓			✓	✓			✓	✓				✓	✓						✓	✓	✓			✓	✓
CBR1		✓								✓			x	x	x	x	✓	✓			x	x	x	x		✓			x	x	x	x
CBR2		✓							✓	✓			x	x	x	x	✓	✓			x	x	x	x		✓			x	x	x	x
CMC3	✓	✓			✓				✓	✓			x	x	x	x	✓	✓			x	x	x	x	✓	✓			x	x	x	x
CMC4	✓	✓			✓				x	x	x	x	x	x	x	x	✓	✓			x	x	x	x	✓	✓			x	x	x	x
CCC5	✓	✓	✓		✓					✓			x	x	x	x		✓			x	x	x	x					x	x	x	x
CCC6		✓	✓		✓					✓			x	x	x	x		✓			x	x	x	x		✓			x	x	x	x
CSQC7			✓		✓		✓		✓	✓	✓		x	x	x	x		✓			x	x	x	x	✓		✓		x	x	x	x
CSQC8		✓	✓		✓		✓		✓	✓	✓		x	x	x	x		✓			x	x	x	x		✓	✓	✓	x	x	x	x

PIS = Potential impact sites, CS = control sites, A = pH, D = percentage dissolved oxygen S = salinity/electrical conductivity, T = turbidity, ✓ = trigger value reached, x = no samples.

5.3.2 Mine water discharge monitoring sites

Water quality field data for subsidence monitoring sites is provided in Appendix E. Table 14 shows monitoring events where water quality parameters were triggered for each mine water discharge site

Salinity and pH were above ANZECC trigger values in 2012 at monitoring sites on the Bargo River that were located downstream of its confluence with Tea Tree Hollow (i.e. SRB5, SBR6, SBR7 & SBR8), however these same sites were below trigger values in 2013. The saline, alkaline water is a result of the existing coal wash discharge from Tea Tree Hollow Creek. The dissolved oxygen was below the guidelines at the majority of monitoring sites. Further studies (CEL 2016) have been conducted to assess stream health and determine appropriate EC trigger values of mine water discharge.

Table 14: Triggered water quality parameters per site – mine water discharge sites

Site	Autumn May 2012				Autumn June 2012				Spring Oct 2012				Spring Nov 2012				Autumn March 2013				Autumn April 2013				Spring Sept 2013				Spring Oct 2013			
	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T
PIS																																
TTH12 (12a)	✓		✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓		✓	

Site	Autumn May 2012				Autumn June 2012				Spring Oct 2012				Spring Nov 2012				Autumn March 2013				Autumn April 2013				Spring Sept 2013				Spring Oct 2013			
	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T	A	D	S	T
SBR5	x	x	x	x	x	x	x	x	✓	✓	✓		x	x	x	x					x	x	x	x	x	x	x	x	x	x	x	x
SBR6	x	x	x	x	x	x	x	x	✓		✓		x	x	x	x					x	x	x	x	x	x	x	x	x	x	x	x
SBR7	x	x	x	x	x	x	x	x	✓	✓	✓		x	x	x	x					x	x	x	x	x	x	x	x	x	x	x	x
SBR8	x	x	x	x	x	x	x	x	✓		✓		x	x	x	x					x	x	x	x	x	x	x	x	x	x	x	x
CS																																
TTH11		✓							✓	✓	✓			✓	✓	✓		✓		✓	✓	✓				✓				✓	✓	✓
SBR1		✓							✓	✓				✓				✓			✓	✓			✓	✓			✓	✓		✓
SBR2		✓							✓	✓				✓				✓				✓				✓						
SBR3	x	x	x	x	x	x	x	x		✓			x	x	x	x	✓				x	x	x	x	x	x	x	x	x	x	x	x
SBR4	x	x	x	x	x	x	x	x		✓			x	x	x	x		✓			x	x	x	x	x	x	x	x	x	x	x	x

PIS = Potential impact sites, CS = control sites, A = pH, D = percentage dissolved oxygen S = salinity, T = turbidity, ✓ = trigger value reached, x = no samples.

5.4 Fish monitoring

5.4.1 Subsidence monitoring sites

Field data for bait traps and dip nets are presented in Appendix F. Table 15 combines all monitoring data and summarises the species captured at each site. Bait traps were deployed once per season however there was an additional deployment in autumn 2012 and spring 2013. Fish caught using the dip net method used for AUSRIVAS sampling (two samples per season only at potential impact sites) were also identified and quantified.

Nine species were detected during bait trap and dip net surveys. The most commonly caught species included the yabby (*Cherax destructor*), common freshwater shrimp (*Paratya australiensis*) and the Mosquito Fish (*Gambusia holbrooki*). Mosquito Fish were recorded from all waterways surveyed within the Project Area with the exception of Cow Creek.

Freshwater yabbies were caught during all sampling occasions at all creeks within the Project Area with the exception of Bargo River.

Table 15: Fish monitoring summary: subsidence monitoring sites

	Yabby *Cherax destructor*	Common Freshwater Shrimp *Paratya australiensis*	Mosquito Fish *Gambusia holbrooki*	Australian Smelt *Retropinna semoni*	Firetail Gudgeon *Hypseleotris galii*	Common Jollytail *Galaxias maculatus*	Mountain Galaxias *Galaxias olidus*	Spiny Crayfish *Euastacus spinifer*	Empire Gudgeon *Hypseleotris compressa*
PIS									
DTC9	55	17	5						
DTC10	67	26	2						
TTH11	26	5	12						
TTH12 (12a)	22		20						
HC13	1		119						
HC14	1	26	11			2	1		
BR15		18	27	3					
BR16	1	26	9	8					

CS									
CWC1	41	40							
CWC2	60	63							
CC3	54	85	378						
CC4	2	98	31						
DC5	74	11	17		3				
DC6	48		5		1				
EC7	68	1	24						
EC8	3	4	9			4			
CBR1									
CBR2									
CMC3	2					5		4	
CMC4						9		6	
CCC5			1						
CCC6			2						
CSQC7									
CSQC8									1

5.4.2 Mine water discharge monitoring sites

Field data for bait traps and dip nets is presented in Appendix G. Table 16 combines all monitoring data and summarises the species captured at each site. The dip net method used for AUSRIVAS sampling was employed at both potential impact and control sites for mine water discharge monitoring sites.

Four species, yabby, common freshwater shrimp, Mosquito Fish and Australian Smelt (*Retropinna semoni*) were detected at the mine water discharge monitoring sites, with all four detected at the control sites and only three (Common Freshwater Shrimp absent) at the potential impact sites. Mosquito Fish were detected at all monitoring sites, and the Common Freshwater Shrimp only at control sites.

Table 16: Fish monitoring summary: mine water discharge monitoring sites

	Yabby *Cherax destructor*	Common Freshwater Shrimp *Paratya australiensis*	Mosquito Fish *Gambusia holbrooki*	Australian Smelt *Retropinna semoni*
PIS				
TTH12 (12a)	22		20	
SBR5	1		12	28
SBR6			13	19
SBR7			3	25
SBR8	1		7	12
CS				
TTH11	26	5	12	
SBR1		1	24	3
SBR2	1	4	8	2
SBR3		20	20	
SBR4		10	3	10

5.4.3 Threatened fish

Based on likelihood of occurrence (Appendix A) and historic records, the Project Area does not contain habitat for any threatened fish species listed on the FM Act, BC Act or EPBC Act. It is considered unlikely that Macquarie Perch inhabit the Bargo River and tributaries within the Project Area. This is based on lack of recorded occurrences of Macquarie Perch above Mermaid Falls, which acts as a barrier to fish passage and the lack of suitable habitat and numerous barriers to fish passage to creeks below Mermaid Falls within the Project Area, as mapped by Fluvial Systems (2013). Macquarie Perch are however known from the Nepean River, upstream of the Bargo River confluence (Figure 5). There would be no reduction in the quality of the water in Bargo River below Mermaid Falls (where there is potential Macquarie Perch habitat) as a result of the Project (HEC 2020a).

5.5 Macrophytes

Field data for macrophyte surveys are presented in Appendix H. The abundance, diversity and distribution of macrophytes recorded during aquatic monitoring surveys in the Project Area was low, with only some sites (CC4, EC8, TTH11, TTH12b, HC13 and HC14) consistently recording macrophytes. Submerged and floating macrophytes generally require permanent water however they can, in time, recolonise dry areas if and when water levels return.

At impact monitoring sites, sedges and rushes such as Spiny-headed Mat-rush, *S. melanostachys*, Saw Sedge (*G. clarkei*), *C. appressa* and *C. gracilis* were common and in some cases very dominant along creeks, however the abundance and diversity of aquatic macrophytes was low. Floating Pond Weed (*Potamogeton sulcatus*) was recorded at sample sites CC4, *Typha orientalis* at TTH12, EC7 and EC8, Slender Knotweed (*Persicaria decipiens*) at EC7 and EC8 and Tall Spikerush (*Eleocharis sphacelata*) at EC8, HC13 and HC14. Macrophytes recorded at BR15 (SBR1) included Tall Spikerush, Jointed Twig Rush (*Baumea articulate*) and *Typha domingensis* (Appendix H).

5.6 Macroinvertebrates (AUSRIVAS)

AUSRIVAS macroinvertebrates data is presented in Table 17 and Appendix J.

5.6.1 Subsidence AUSRIVAS monitoring

Table 17 presents the AUSRIVAS scores and other calculated health indicator data for each subsidence monitoring site.

Macroinvertebrate fauna recorded at subsidence monitoring sites within the Project Area were generally comparable to modelled reference sites (Band A). Throughout the baseline monitoring period sites such as Bargo River, Tea Tree Hollow, and Hornes Creek scores lowered to Band B, possibly indicating impairment to macroinvertebrate communities at this time. Some sites consistently recorded SIGNAL scores below 4 indicating that the sites were subject to severe pollution (Table 8). However it must be noted that low SIGNAL scores are reflective of the dominance of pollution tolerant species and can occur with the absence of pollution if the waterway is subject to natural environmental stressors (e.g. low rainfall/flow). Bargo River consistently recorded higher SIGNAL scores, indicating only moderate pollution. The EPT richness was generally low (ranging from 2-8) over the two years of sampling indicating a degree of impairment, however it must be noted that these indices are not rated and were also observed in control streams. As such, the low EPT richness index scored by these streams could be a reflection of natural macroinvertebrate assemblages.

Table 17: AUSRIVAS macroinvertebrate results at subsidence monitoring sites

Summary of Taxa and EPT richness and ratio, AUSRIVAS results and SIGNAL score for macroinvertebrate assemblages collected using AUSRIVAS techniques in autumn 2012, spring 2012, autumn 2013 and spring 2013 at subsidence monitoring sites.

Autumn 2012: May and June combined data																
LOCATION	**Cow Ck**		**Carters Ck**		**Dry Ck**		**Eliza Ck**		**Dog Trap Ck**		**Tea Tree Hollow**		**Hornes Ck**		**Bargo R.**	
SITE	CWC1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	DTC9	DTC10	TTH11	TTH12a	HC13	HC14	BR15	BR16
Taxon richness (Family level)	16	22	31	30	22	22	22	34	22	24	26	28	27	36	20	25
Abundance	181	275	227	310	147	213	282	370	318	287	263	321	266	253	287	186
EPT richness	4	3	4	3	3	4	4	7	5	5	3	4	3	5	2	4
EPT ratio	0.25	0.14	0.13	0.10	0.14	0.18	0.18	0.21	0.23	0.21	0.12	0.14	0.11	0.14	0.10	0.16
OE50	0.96	0.99	0.96	0.98	0.99	1	0.93	0.99	0.95	1	0.93	0.94	1.06	1	1.01	0.97
O0Signal	4.5	4.23	3.98	4.02	4.09	4.23	4.11	4.24	4.23	4.15	4.29	4.18	3.98	3.74	4.58	4.7
Band	A	A	A	X	A	A	A	B	A	A	A	A	A	A	B	B
SIGNAL	4.19	3.55	3.32	3.50	3.41	3.77	3.18	3.79	3.55	3.29	3.31	3.68	3.32	3.31	4.30	4.32

Spring 2012: October and November combined data																
LOCATION	**Cow Ck**		**Carters Ck**		**Dry Ck**		**Eliza Ck**		**Dog Trap Ck**		**Tea Tree Hollow**		**Hornes Ck**		**Bargo R.**	
SITE	CWC1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	DTC9	DTC10	TTH11	TTH12a	HC13	HC14	BR15	BR16
Taxon richness (Family level)	17	19	20	38	15	19	25	23	28	24	21	27	30	25	17	19
Abundance	190	233	122	298	80	182	190	183	316	114	191	184	259	230	190	233
EPT richness	3	2	3	5	2	2	2	4	3	4	2	3	6	7	3	2
EPT ratio	0.18	0.11	0.15	0.13	0.13	0.11	0.08	0.17	0.11	0.17	0.10	0.11	0.20	0.28	0.18	0.11
OE50	0.92	1.04	1.04	1.25	0.77	0.84	0.92	0.56	1.17	0.88	0.67	0.96	0.93	1	0.92	1.04
O0Signal	3.71	4	3.84	3.97	3.86	3.63	3.59	4.53	3.89	4.09	3.72	3.89	4.39	4.96	3.71	4
Band	A	A	A	X	B	A	A	B	X	A	B	A	A	A	A	A
SIGNAL	4.00	4.00	4.20	4.13	3.80	3.63	3.40	4.52	3.82	4.08	3.86	3.89	4.27	5.16	4.00	4.00

Autumn 2013: March and April combined data																
LOCATION	**Cow Ck**		**Carters Ck**		**Dry Ck**		**Eliza Ck**		**Dog Trap Ck**		**Tea Tree Hollow**		**Hornes Ck**		**Bargo R.**	
SITE	CWC1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	DTC9	DTC10	TTH11	TTH12a	HC13	HC14	BR15	BR16
Taxon richness (Family level)	14	18	30	21	15	20	30	25	18	16	16	26	31	20	31	14
Abundance	148	102	293	110	159	146	172	167	209	123	101	333	299	222	230	148
EPT richness	3	4	5	3	3	3	6	4	4	3	3	4	4	6	8	3
EPT ratio	0.21	0.22	0.17	0.14	0.20	0.15	0.20	0.16	0.22	0.19	0.19	0.15	0.13	0.30	0.26	0.21
OE50	0.87	1.11	1.05	1.01	0.92	0.83	0.96	0.99	1.11	0.83	0.74	0.85	0.92	1.2	0.65	1.07
O0Signal	4.27	3.82	4.05	3.81	3.89	4.38	3.83	4.37	3.96	4.37	3.5	3.72	3.36	3.84	4.41	4.66
Band	A	A	A	A	A	A	A	A	A	A	B	A	A	X	B	A
SIGNAL	4.27	3.59	4.05	3.56	3.41	3.76	3.33	4.68	3.96	4.37	3.50	3.72	3.44	3.88	4.64	4.67

Spring 2013: September and October combined data																
LOCATION	**Cow Ck**		**Carters Ck**		**Dry Ck**		**Eliza Ck**		**Dog Trap Ck**		**Tea Tree Hollow**		**Hornes Ck**		**Bargo R.**	
SITE	CWC1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	DTC9	DTC10	TTH11	TTH12a	HC13	HC14	BR15	BR16
Taxon richness (Family level)	16	21	24	28	22	20	22	32	26	25	26	29	24	32	27	29
Abundance	198	158	193	258	178	172	187	214	219	206	217	209	331	292	168	202
EPT richness	2	3	5	4	3	3	3	6	5	5	4	6	3	5	7	7
EPT ratio	0.13	0.14	0.21	0.14	0.14	0.15	0.14	0.19	0.19	0.20	0.15	0.21	0.13	0.16	0.26	0.24
OE50	0.84	0.88	0.88	1.17	0.86	1.01	1.01	0.98	1.04	1.1	1.01	0.88	0.82	1.11	0.97	1.06
O0Signal	4.19	4.19	4.04	3.71	3.82	3.8	4	4.13	4.04	3.92	3.8	4.11	3.75	3.9	4.35	4.61
Band	A	A	A	X	A	A	A	A	A	A	A	A	B	A	A	A
SIGNAL	4.19	4.19	4.04	3.71	3.82	3.80	4.00	4.28	4.08	3.92	3.65	4.14	3.96	3.78	4.19	4.62

5.6.2 Mine water discharge AUSRIVAS monitoring

Table 18 presents the AUSRIVAS scores and other calculated health indicator data for each mine water discharge monitoring site.

The macroinvertebrate fauna at the majority of sites along the Bargo River were defined as significantly impaired (Band B) with two sites defined as comparable to reference condition (Band A). SIGNAL scores ranged between 4.16 and 5.56, and, as all sites were above 4, were classed as being moderately polluted. One site (SBR2) recorded a SIGNAL score above 5 indicating only mild pollution at this monitoring site (Table 18).

During autumn 2013 monitoring surveys, taxon richness ranged between 12 and 26, abundance ranged between 72 and 159 and EPT richness between 2 and 6. The macroinvertebrate fauna at the majority of sites along the Bargo River were defined as significantly impaired (Band B) with one site defined as comparable to reference condition (Band A). SIGNAL scores ranged between 3.84 and 4.80. One site recorded a SIGNAL score below 4, indicating severe pollution, while the remaining seven monitoring sites recorded SIGNAL scores between 4 and 5 indicating moderate pollution (Table 18).

The quality of the water and the macroinvertebrate fauna present was lower in the autumn 2013 surveys compared to the spring 2012.

Table 18: AUSRIVAS macroinvertebrate results at mine water discharge monitoring sites

Summary of Taxa and EPT richness and ratio, AUSRIVAS results and SIGNAL score for macroinvertebrate assemblages collected using AUSRIVAS techniques in spring 2012 and autumn 2013 at mine water discharge monitoring sites.

Spring: October 2012								
LOCATION	**Bargo River Downstream of Picton Weir**		**Bargo River Remembrance Driveway**		**Bargo River Tea Tree Hollow Confluence**		**Bargo River Rockford Bridge**	
SITE	**SBR1**	**SBR2**	**SBR3**	**SBR4**	**SBR5**	**SBR6**	**SBR7**	**SBR8**
Taxon richness (Family level)	27	23	26	28	21	23	30	26
Abundance	151	129	128	132	114	55	128	102
EPT richness	6	5	6	7	4	4	6	5
EPT ratio	0.25	0.29	0.23	0.25	0.19	0.17	0.20	0.19
OE50	1.1	1.17	0.8	0.73	0.8	0.73	1.13	0.86
O0Signal	4.67	5.35	4.11	4.57	4.06	4.5	4.19	4.21
Band	A	B	B	B	B	B	A	A
SIGNAL	4.74	5.56	4.29	4.48	4.16	4.56	4.21	4.27

Autumn: March 2013								
LOCATION	**Bargo River Downstream of Picton Weir**		**Bargo River Remembrance Driveway**		**Bargo River Tea Tree Hollow Confluence**		**Bargo River Rockford Bridge**	
SITE	**SBR1**	**SBR2**	**SBR3**	**SBR4**	**SBR5**	**SBR6**	**SBR7**	**SBR8**
Taxon richness	22	31	13	26	15	16	12	15
Abundance	159	153	109	91	93	75	72	65

EPT richness	5	6	3	5	5	6	2	6
EPT ratio	0.23	0.19	0.23	0.19	0.33	0.38	0.17	0.40
OE50	0.58	1.01	0.64	0.81	0.77	0.71	0.56	0.59
O0Signal	4.42	4.44	4.38	4.07	4.47	4.25	4	4.8
Band	B	A	B	B	B	B	B	B
SIGNAL	4.09	3.84	4.38	4.15	4.47	4.25	4.00	4.80

5.7 Macroinvertebrates (quantitative sampling)

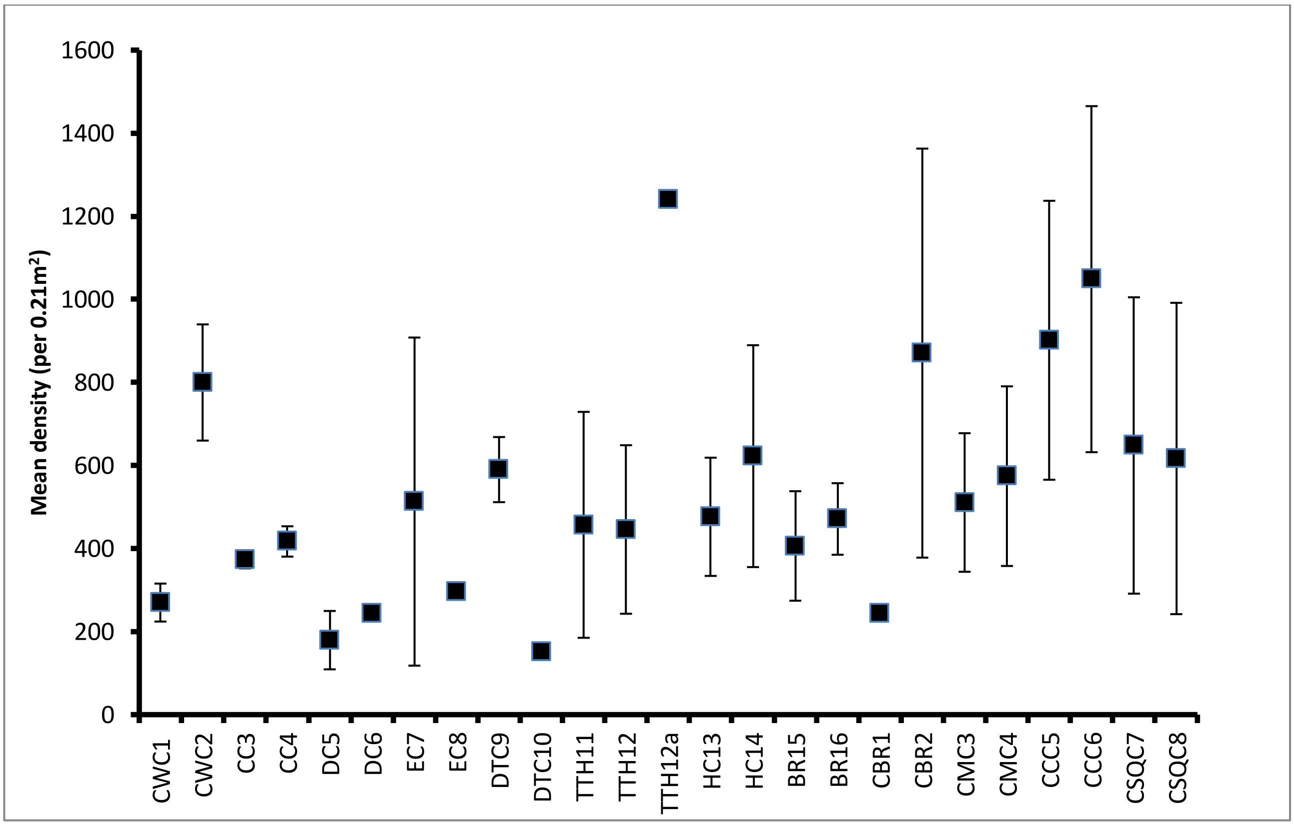
Average family densities at each site are presented in Appendix I. Subsidence monitoring site results include data from three sampling seasons, spring 2012, autumn 2013 and spring 2013. Autumn data 2012 was excluded from this analysis because of a necessary change in sampling method (discussed in Section 3.5.5). Analysis of autumn 2012 sampling season is provided in Tahmoor South Aquatic Monitoring Report, Niche 2013. Results are discussed in relation to the impact assessment in Section 6.

5.7.1 Subsidence monitoring sites

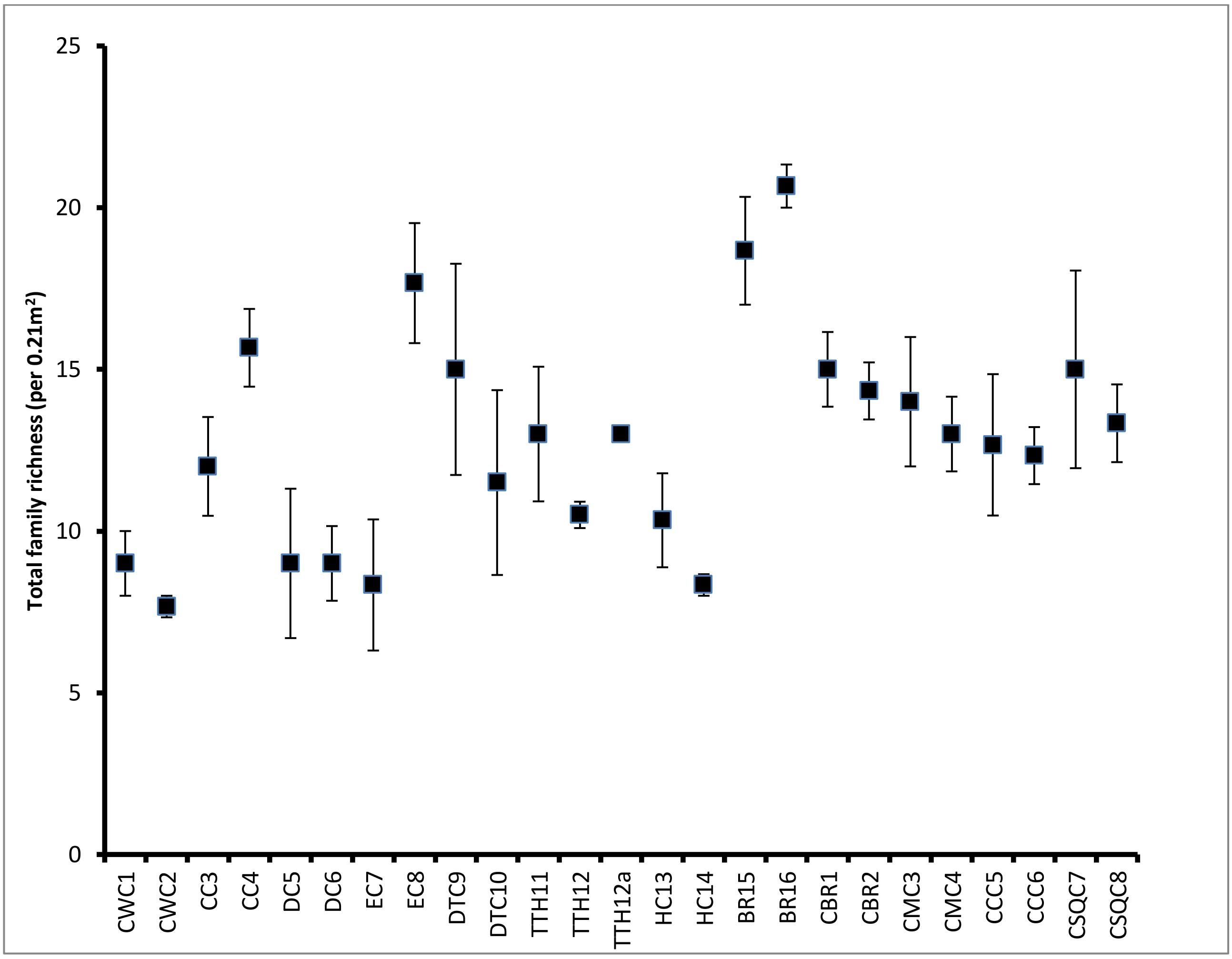
Univariate results

The average density over all sites and seasons sampled was 520.7 individuals per 0.21m^2.The highest mean density was recorded in Carters Creek (1048 individuals per 0.21m^2), although Tea Tree Hollow (TTH12a) recorded a total of 1240 individuals per 0.21m^2 (one sampling occasion only) (Graph 1)

There was an average of 12.8 (per 0.21m^2) families observed across all sites and seasons (Graph 2). The highest mean family richness was recorded in Bargo River (BR16) (20.7 families per 0.21m^2) and the lowest in Cow Creek (CWC2) (7.6 families per 0.21m^2).



Graph 1: Mean density of macroinvertebrates at subsidence monitoring sites (Error bars = +- S.E.).

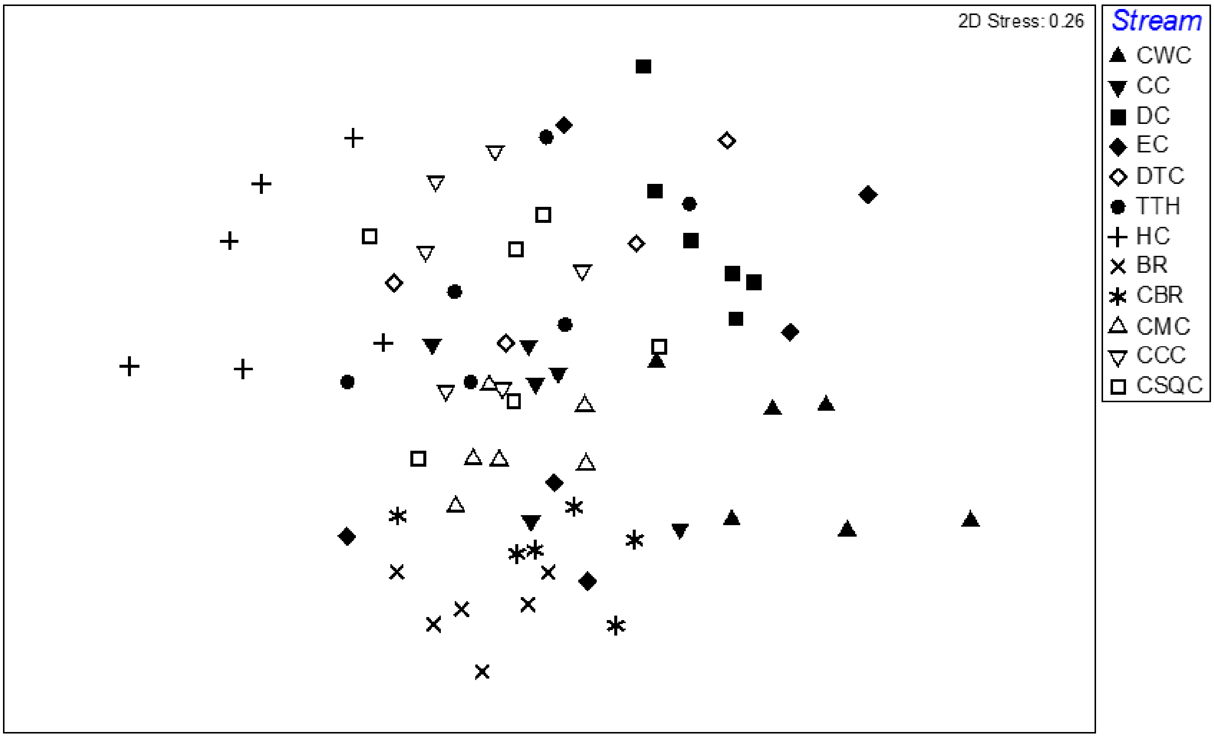


Graph 2: Mean family richness at subsidence monitoring sites (Error bars = +-S.E.)

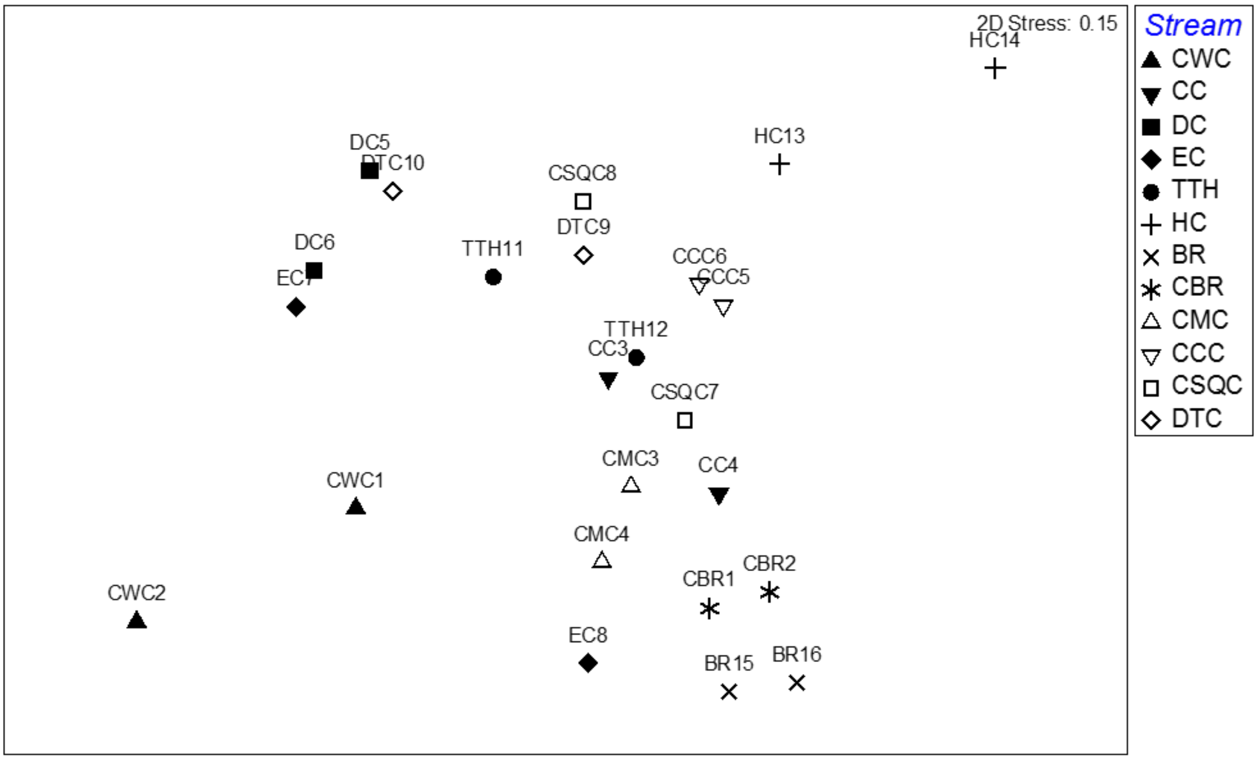
Multivariate results

There appears to be minor grouping of sites within streams (Graph 3 and Graph 4) e.g. Bargo River (BR15, BR16, CBR1, CBR2), however as with the case with Eliza Creek (EC7 and EC8) sites can be quite dispersed. The data in general is quite spread with no obvious groupings of different streams. Horne Creek and Cow Creek appear the most different from other sampling sites (Graph 3 and Graph 4).

SIMPER procedure (Appendix L) showed that sub-families, Chironominae, Orthocladinae and families Leptophlebiidae and Oligochaeta contributed most to the within stream similarity for all streams. This implies that these families occur at more consistent densities with in stream (that is at each site through time) than other taxa and that these families are common among streams. Differences between stream groups were variable. Differences in density of the most common taxa, previously listed, contributed to the dissimilarities between lower order semi-permanent streams. Bargo River sites (BR15, BR16, CBR1 and CBR2) were differentiated from the lower order streams consistently by the families Elmidae, Leptoceridae, Calamoceridae, and Ecnomidae.



Graph 3: MDS plot of subsidence monitoring sites showing each sampling occasion at each site



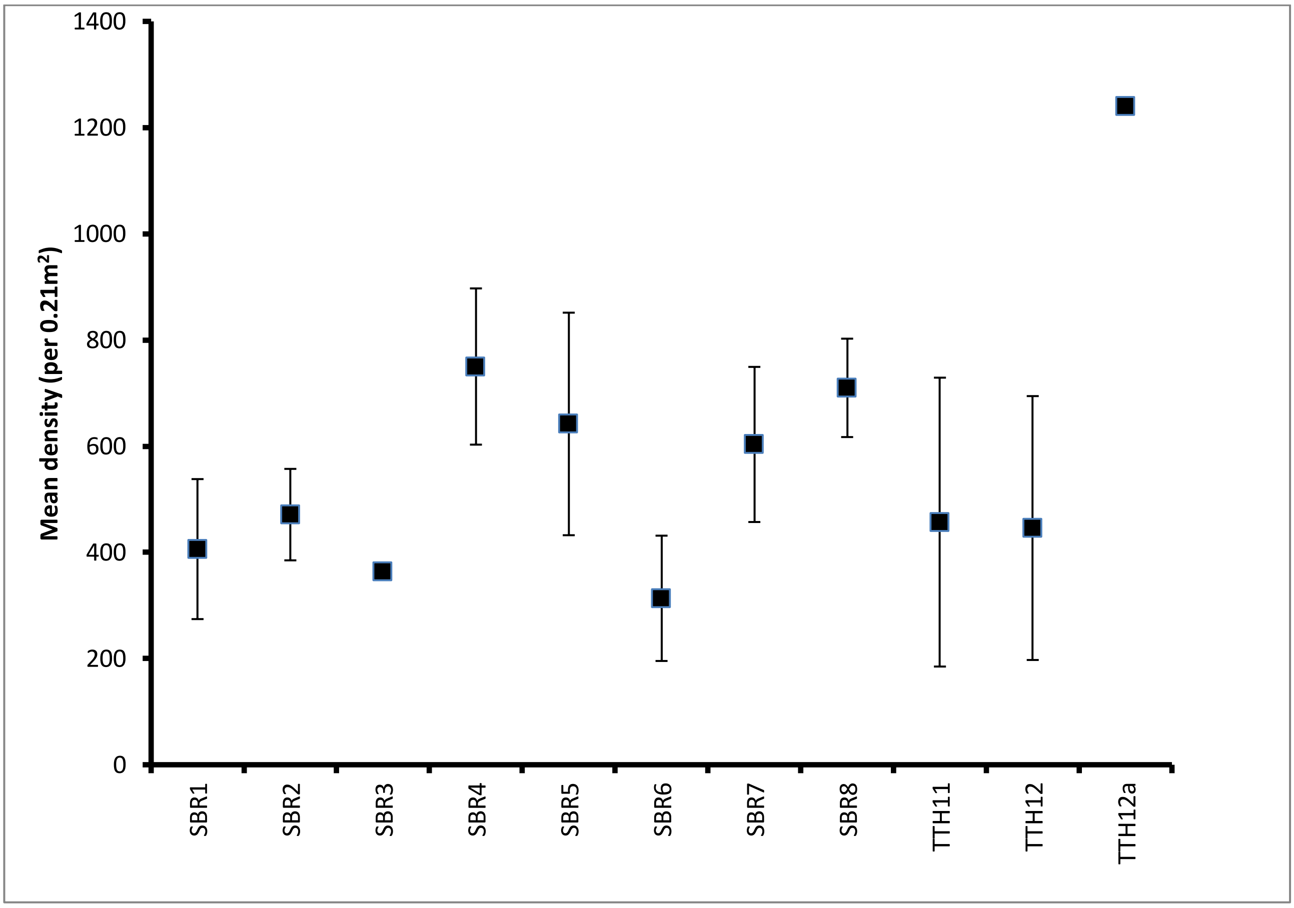
Graph 4: MDS plot of subsidence monitoring sites showing samples averaged across sites.

5.7.2 Mine water discharge monitoring

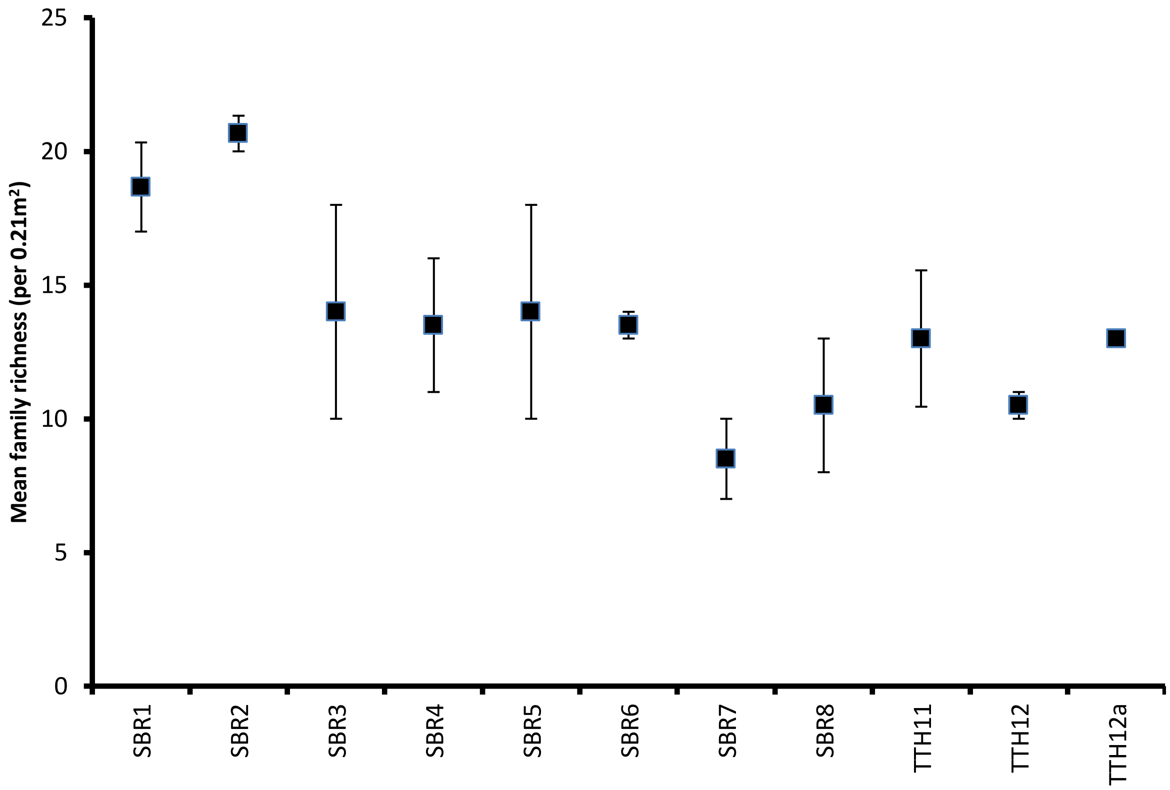
Univariate results

The average density over all sites and seasons sampled was 537.39 individuals per 0.21m^2.The highest mean density was recorded in Bargo River control site (SBR4) (750 individuals per 0.21m^2), although Tea Tree Hollow (TTH12a) recorded a total of 1240 individuals per 0.21m^2 (one sampling occasion only) (Graph 5). The lowest mean densities were recorded in Bargo River impact group (SBR6), (313.21 per 0.21m^2) (Graph 5).

There was on average 13.6 (per 0.21m^2) families observed across all sites and seasons. The highest mean family richness was recorded in Bargo River control sites (SBR1 and SBR2) (20.7 and 18.7 families per 0.21m^2 respectively) and the lowest in Bargo River impact group (SBR7) (8.5 families per 0.21m^2) (Graph 6).



Graph 5: Mean density of macroinvertebrates at mine water discharge monitoring sites (Error bar = +-S.E.)

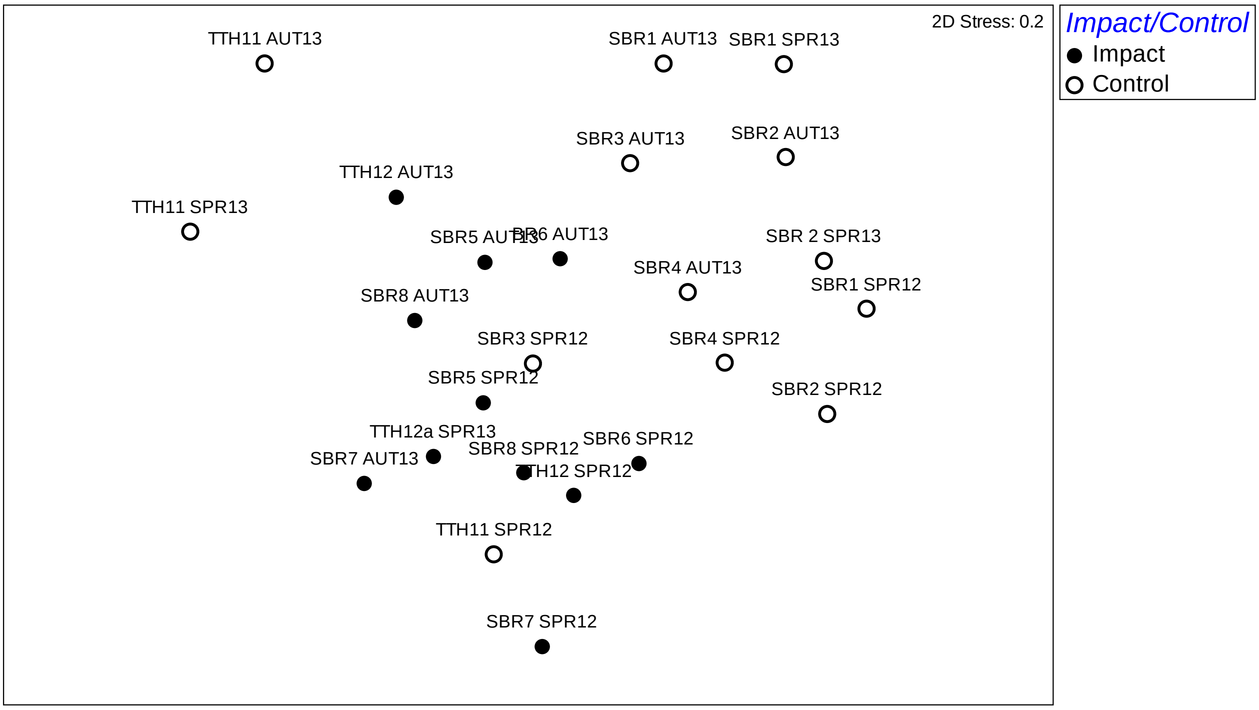


Graph 6: Mean family richness at mine water discharge monitoring sites (Error bars = ±S.E.)

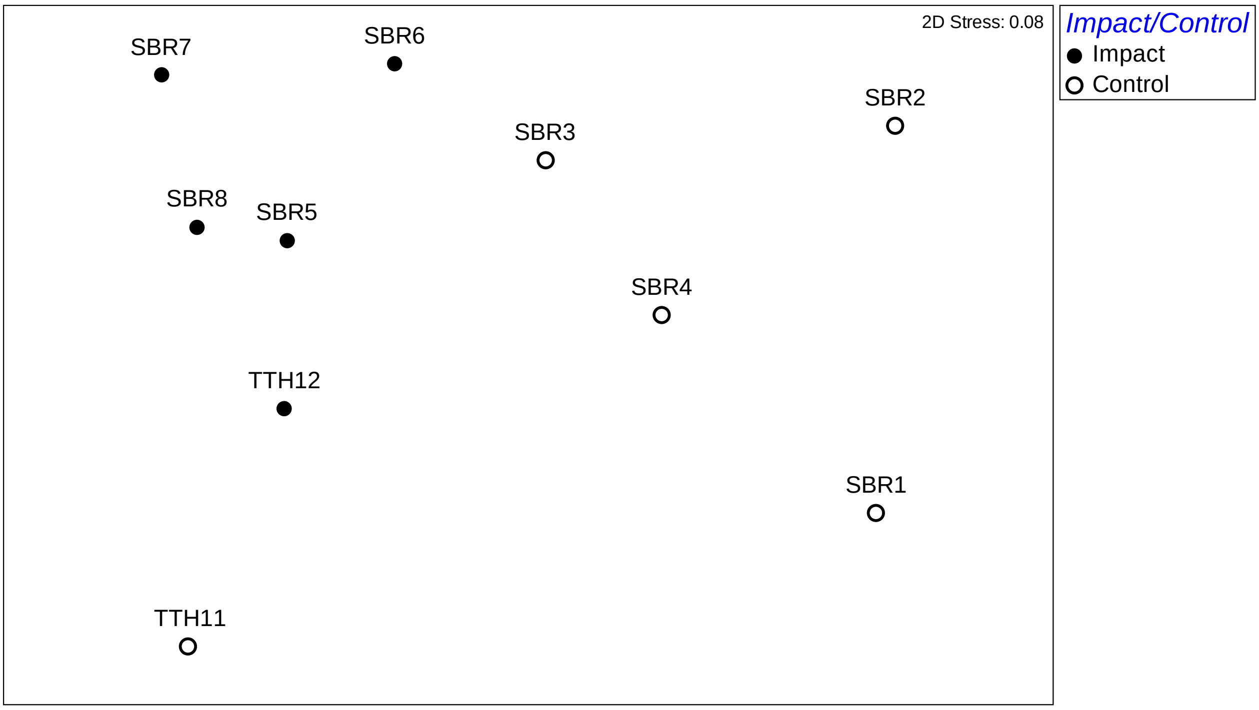
Multivariate results

There appears to be some grouping of impact and control sites particularly within Bargo River (SBR1, SBR2, SBR3, SBR4, SBR5, SBR6, SBR7, and SBR8) (Graph 7 and Graph 8).

SIMPER procedure (Appendix L) showed that within impact groups the sub-families, Chironominae, Tanypodinae, and family Caenidae contributed most to the within stream similarity. Chironominae, Tanypodinae, Leptophlebiidae and Oligochaeta contributed most to control group's similarity. Lower densities of Leptophlebiidae, Oligochaeta, Elmidae and increased densities of Chironominae and Caenidae in impact groups contributed most to the dissimilarity between impact and control groups. SIMPER performed on Tea Tree Hollow and Bargo River showed similar results however increased densities in Ecnomidae contributed to the difference between Tea Tree Hollow impact and control sites.



Graph 7: MDS plot mine water discharge monitoring sites showing each sampling occasion at each site.



Graph 8: MDS plot of mine water discharge sites averaged across site groups.

5.8 Targeted surveys

The Sydney Hawk Dragonfly is listed as endangered under the FM Act. Targeted surveys for this species and were conducted in July/August 2013 at sites within the Project Area. Areas of potential habitat were identified using geomorphology mapping (Fluvial Systems 2013) and habitat preferences for each species. For Sydney Hawk Dragonfly, all pools with a predominantly boulder and/or cobble substrate were defined as containing potential habitat. Within the Project Area, a total of 29 sites were identified and subsequently surveyed for this species. Of the 29 sites, 27 were sampled (two were dry), and seven sites recorded dragonflies from various families (Table 19).

The Sydney Hawk Dragonfly belongs to the family *Austrocorduliidae*. This family was observed at Eliza Creek on two sampling occasions and during targeted surveys. The specimens were sent to Sydney Water for identification to species level. Identification included consultation with dragonfly expert Gunther Theischinger (OEH). The specimens were confirmed as the non-threatened *Austrocorduliidae refracta*. This species is often found in similar habitats of deep and shady riverine pools with cooler water (DPI 2007) and rocky substrate. *A. refracta* can inhabit smaller streams whereas the Sydney Hawk Dragonfly is thought to be restricted to larger streams in coastal areas (Theischinger 2013). Therefore the presence of *A. refracta* does not necessarily imply suitable habitat for the Sydney Hawk Dragonfly. The Sydney Hawk Dragonfly has a moderate likelihood of occurrence as potential habitat may occur in the Bargo River or in the Nepean River; areas unlikely to be impacted by the subsidence.

Table 19: Dragonfly targeted surveys

Site	Dragonfly Family	Count
SHD CWC4	Sythemistidae	1
EC8	Austrocorduliidae, (*Austrocordulia refracta*)	1
SHD DTC5	Aeshnidae	1
SHD TTH4	Gomphidae	1
SHD HC1	Libellulidae, Hemicordulidae	1, 2
SHD HC3	Libellulidae, Cordulephyidae	2, 1
SHD BR3	Telephlebiidae, Gomphidae	1, 1

6. Impact Assessment

6.1 Amended aquatic ecology impact assessment

The main differences in terms of aquatic ecological impacts of the amended project when compared to the EIS is the reduction in the 20 mm subsidence area, particularly in Dog Trap Creek and Hornes Creek. While a substantial proportion of Dog Trap Creek is still likely to be impacted, Hornes Creek is unlikely to experience any measurable impacts (MSEC 2020). Similar types of aquatic impacts are likely to be experienced as was documented in the original assessment, however as discussed, the spatial extent of subsidence impacts to streams are considerably reduced. Additionally, the introduction of new minewater discharge management measures such as the WWTP PRP22 Stage 3 as discussed later in the section 6.5.3 will likely improve stream health in impacted areas downstream of the discharge point.

HEC (2020a) assessed baseflow reductions to surface flow as a result of the amended project on Eliza Creek, Carters Creek and Cow Creek in addition to Bargo River, Dog Trap Creek and Tea Tree Hollow. While impacts to Dog Trap and Tea Tree Hollow were similar to the previous assessment, there were negligible impacts to Carters Creek and Eliza Creek and Bargo River. HEC (2020a) identified a greater potential for Cow Creek to be impacted by reduction in baseflows; however further modelling (discussed in section 6.5.3) suggest that this will likely have negligible impact on typical pool aquatic habitat.

6.2 Commonwealth

The EPBC protected matters search tool reported the Macquarie Perch within a 10 kilometre radius of the Project Area. The creeks within the Project Area were determined to contain a “None” to “Low Likelihood” of containing Macquarie Perch habitat. This is based on the highly fragmented habitat, with rock bars and other barriers to fish movement, along with the ephemeral nature of the 1st and 2nd order streams within the Project Area. The creeks also lack suitable spawning habitat. Whilst there are some sections on the Bargo River within the Project Area that contain suitable habitat for Macquarie Perch, they occur above Mermaid Falls and below Picton Weir. It is considered unlikely that a viable population of Macquarie Perch exists in this limited range and there are no recorded occurrences of this species within this section of the Bargo River despite surveys being conducted as part of this assessment and surveys by NSW DPI.

Figure 6 shows the quality of Macquarie Perch habitat in the broader area based on the likelihood of occurrence criteria described in Diagram 1. None of the creeks within the Project Area are defined as moderate or above and as such, this species is unlikely to occur within the Project Area.

6.3 State

The assessment of the Project has been carried out for approval under the provision for State Significant Development within Part 4, Division 4.1 of the EP&A Act. Threatened aquatic biodiversity as listed on the NSW BC Act and FM Act have been considered in this assessment. The Project is to be assessed under the transitional legislative arrangements of the NSW biodiversity legislation reforms, i.e. the new assessment methodologies now required under the *Biodiversity Conservation Act 2016* do not apply to the Project.

6.3.1 NSW BC Act and FM Act

Threatened species

Of those Subject Species identified within the Project Area, only the Sydney Hawk Dragonfly was considered to have potential habitat within the Project Area. The assessment of significance for this species is provided in Appendix I. It is considered unlikely that the Project will have a significant impact on the Sydney Hawk Dragonfly.

Key fish habitat

The Project may affect key fish habitat at a number of locations, particularly in areas along Dog Trap Creek and Tea Tree Hollow Creek (see section 6.4-6.6), and therefore some remediation measures may be required. If monitoring indicates this is the case, DPI Fisheries will be required to be consulted to determine the appropriate habitat rehabilitation measures or if environmental compensation is required. Any conditions will be incorporated into the monitoring and management of the waterways and key fish habitat. Further, as part of the development of the required Extraction Plan and associated management plans for the Project, a Trigger Action Response Plan (TARP) will be prepared, which will incorporate appropriate triggers, monitoring regimes and appropriate actions for key fish habitat in the Project Area.

All creeks within the Project Area have been mapped as 'key fish habitat' based on DPI key fish habitat mapping for Wollondilly LGA (DPI 2013c) or classified as 'key fish habitat' based on stream order (3rd order and above). Under this definition, significant environmental impacts (direct and indirect) on 'key fish habitat' are to have habitat rehabilitated or offset by environmental compensation. Compensation to offset fisheries resource or habitat losses will be considered only after it is demonstrated that the proposed loss is unavoidable, in the best interests of the community in general and is in accordance with the FM Act, Regulations and DPI (2013). Habitat replacement (as a compensation measure) will need to account for indirect as well as direct impacts of development to ensure that there is "no net loss" of key fish habitats.

Key threatening processes

A list of Key Threatening Processes (KTP) is maintained under the FM Act and is provided for by Part 7A, Division 2 of the FM Act. One KTP is considered relevant to the proposed development: human-caused climate change. The information regarding this KTP has been taken from the Final Determinations of the KTP and references therein. Key Threatening Processes listed under the BC Act are considered in the Terrestrial Ecology Report (Niche 2018).

Anthropogenic climate change

Climate change has occurred throughout geological history and has been a major force for evolution. It is now evident that in recent times (the so-called "Anthropocene"), 63% of greenhouse gases responsible for climate change originate from human-induced carbon dioxide and human-caused climate change is substantially affecting species, populations and communities of aquatic animals and vegetation throughout the world.

There is physical evidence that human-induced climate change is affecting biodiversity globally, in terrestrial, freshwater and marine systems. The International Panel on Climate Change (IPCC 2007) stated that "*observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature changes*".

Climate change is also predicted to have an impact on freshwater communities via changes in the seasonality of rainfall (increases and decreases) and the frequency and severity of storm events. Annually, the numbers of extreme warm events is likely to increase. The regional scenario for NSW freshwater aquatic systems is drying of aquatic areas, increased drought occurrence, higher water temperatures with diminished water flows, which will produce low oxygen levels and increased conductivity (salinity). Freshwater communities of fish and invertebrates in rivers, swamps and floodplains are likely to experience additional impacts as most species have specialised habitat and dietary requirements.

Compared to the open estuaries and ocean waters, freshwater rivers are geographically constrained and limit the migratory options for aquatic plants, invertebrates and fish. Freshwater flows are a stimulus for breeding in many Australian freshwater fish species and thus the changes in volume and timing of spring floods are predicted to significantly impact fish recruitment. With low or reduced flow, freshwater river systems will shift towards lotic rather than lentic environments with a corresponding shift in the biological communities. In shallow freshwater rivers and lakes there is a balance between the phytoplankton communities (heterotrophy) and the bacterial biofilm (mostly autotrophs) on the substrate as the primary producers. Under some climate change scenarios a metabolic shift from heterotrophic communities to autotrophic communities is predicted.

Human-induced climate change is predicted to impact negatively on the survival and demography of aquatic ecosystems in NSW. Fisheries Scientific Committee is of the opinion that Human-induced Climate Change adversely affects threatened species and could cause species, populations or ecological communities that are not threatened to become threatened.

Coal extraction of up to 4 million tonnes of ROM coal per annum is proposed as part of the development. The Project's main sources of Green House Gas (GHG) emissions include fugitive methane from mine ventilation, pre- and post-drainage and flaring. Other emissions include diesel, unleaded petrol consumption, post-mining activities, electricity use and use of SF6 (sulphur hexafluoride gas) (Pacific Environment 2018). The GHG Assessment prepared for Tahmoor Coal found that the Project's contribution to the projected climate change and the associated impacts would be in proportion with its contribution to minimal global GHG emissions. While the majority of the product coal will be combusted in other countries, the burning of coal is the largest contributor to CO_2 emissions and will contribute to climate change regardless of where it is burned. As further discussed in Section 7.10.3 of the Project Amendment Report, Tahmoor's current end customer base is located in countries that are signatories to the Paris Agreement within the United Nations Framework convention on Climate Change.

Tahmoor Coal will employ a number of mitigation measures at the Project site to minimise the generation of GHG emissions. Such measures will include fugitive methane abatement such as the use of flares and recycling through a co-generation plant and Continuous Emissions Monitoring of fugitive emissions (Pacific Environment 2018). Tahmoor Coal will employ a number of mitigation measures to minimise the generation of GHG emissions. These are detailed in Section 7.10.3 of the Project Amendment Report.

6.4 Construction impacts

Direct impacts on the aquatic environment during construction would be minimal as there would be no direct works within waterways. There is potential for indirect impacts via run-off effects. The implementation of appropriate erosion and sediment control measures during construction would minimise the likelihood of these impacts.

6.5 Operational impacts

Potential operational impacts of the proposed development include the following:

- Changes in stream gradients.
- Increased levels of ponding, scouring and/or desiccation due to mining tilt.
- Fracturing and surface water flow diversion in the streams.
- Loss of surface flows to groundwater (baseflow reduction)
- Changes to water quality.

These operational impacts and how they relate to the ecology of the Project Area are discussed in more detail in the sections below.

6.5.1 Changes in stream gradients and increased levels of ponding, scouring or desiccation

Mining can potentially result in increased levels of ponding in locations where the mining induced tilts oppose and are greater than the natural stream gradients that exist before mining. Mining can also potentially result in an increased likelihood of scouring of the stream beds in the locations where the mining induced tilts considerably increase the natural stream gradients that exist before mining (MSEC 2020).

There is a predicted reversal of grade along a naturally flat section of Dog Trap Creek, upstream of the tailgate of LW103B. There is increased potential for ponding upstream of this location, which is estimated to be up to 0.2 m deep and 150 m long (MSEC 2020).

Elsewhere, there are no other predicted reversals of grade due to the proposed mining. It is possible that there could be some localised areas along the streams which could experience small increases in the levels of ponding, where the predicted maximum tilts occur in the locations where the natural gradients are low. As the predicted changes in grade are typically less than 1 %, however, any localised changes in ponding are expected to be minor and not result in adverse impacts on these streams (MSEC 2020).

Stream gradients will increase where they flow into the predicted subsidence trough near the edges of the proposed longwalls. The streams flow predominantly over Hawkesbury Sandstone, which has a high resilience to scouring. As discussed in the report by Fluvial Systems (2013), mud was commonly found in the channel bed with soft knickpoints in small streams on the plateau. The predicted maximum increases in grade are typically less than 1 %, which are relatively small compared to the natural gradients and, therefore, the potential for increased scouring is not expected to be significant (MSEC 2020).

Further discussions on the potential changes in ponding and flooding along the streams are provided in the surface water impact assessment (HEC 2020a).

6.5.2 Fracturing and surface water flow diversion in the streams

Where the longwalls mine directly beneath the streams it is considered likely that fracturing resulting in surface water flow diversion would occur. Compressive strains due to closure are expected to be of sufficient magnitude to cause the underlying strata to buckle and induce cracking at the surface at some locations. This is likely to lead to the diversion of water from the stream beds into the dilated strata beneath it (MSEC 2020).

It is unlikely however that there would be any net loss of water from the catchment since any redirected flow would not intercept any flow path that would allow the water to be diverted into deeper strata or the mine (MSEC 2020).

If significant fracturing was to occur, partial or complete diversion of surface water and drainage of pools would occur at locations and times where the rate of flow diversion is greater than the rate of incoming surface water. The majority of the streams are ephemeral and so water typically flows during and for a period of time after each rain event. In times of heavy rainfall, the majority of the runoff would flow over the beds of the streams and would not be diverted into the dilated strata below the stream beds. In times of low flow, however, some or all of the water could be diverted into the strata below the stream beds (MSEC 2020).

The impacts of localised diversion of surface flow in upsidence induced subsurface fracture networks, include loss of water holding capacity of pools, reduced frequency of pools overflowing and periodic loss of interconnection between pools during dry weather within the affected reach. Potentially these sorts of impacts could occur in Tea Tree Hollow and Dog Trap Creek, (HEC 2020a).

While much of the channel beds are exposed bedrock, Fluvial Systems (2013) report that sand, gravel, cobble and mud were also commonly found in the channel beds throughout the Project Area. Where such loose materials occur, it is possible that fracturing in the bedrock would not be seen at the surface. In the event that fracturing of the bedrock occurs in these locations within the alignments of the streams, the fractures may be filled with soil during subsequent flow events (MSEC 2020). Where little sediment is present, the impacts are likely to remain for longer periods of time and remediation may be required after the completion of mining (MSEC 2020).

Based on the previous experience of mining beneath streams at Tahmoor Mine, it is likely that fracturing and surface flow diversions will occur in the sandstone bedrock along the streams, particularly for streams that are located directly above the proposed longwalls. In some of these locations, the fracturing could impact the holding capacity of the standing pools, particularly those located directly above the proposed longwalls. It is unlikely, however, that there would be any net loss of water from the catchment (MSEC 2020).

With respect to streams or sections of streams located away from the proposed longwalls, the likelihood of fracturing and surface flow diversions reduces substantially compared to stream sections located directly above the proposed longwalls. Minor and isolated fracturing could however occur outside the extent of the proposed longwalls (MSEC 2020).

Based on predicted closure values there are areas along Tea Tree Hollow and Dog Trap Creek that at risk of Type 3 impacts defined as: fracturing in a rock bar or upstream pool resulting in reduction in standing water level based on current rainfall and surface water flow (HEC 2020a).

The following qualitative descriptors have been derived from the rock bar impact model and applied to the impact assessment for pools for the Project:

- For predicted total closure of less than 210 mm, less than 10% of rock bars or upstream pools are expected to be impacted.
- For predicted total closure between 210 mm and 290 mm, less than 20% of rock bars or upstream pools are expected to be impacted.
- For predicted total closure between 290 mm and 420 mm, less than 30% of rock bars or upstream pools are expected to be impacted.
- For predicted total closure between 420 mm and 475 mm, less than 40% of rock bars or upstream pools are expected to be impacted.

Of the 14 pools mapped in Tea Tree Hollow one pool on the tributary of Tea Tree Hollow is predicted to have a total closure of less than 290 mm (MSEC 2020a), (less than 20% of pools are expected to be impacted). Two pools on the tributary of Tea Tree Hollow have a predicted total closure of 300 and 325 mm respectively (MSEC 2020). At this total closure prediction, less than 30% of pools are expected to be impacted (Barbato et al. 2014; HEC 2020a).

The largest number of pools (in excess to 70), were mapped on Dog Trap Creek. For 40 of these pools, less than 20% of pools are expected to be impacted. For 18 pools, less than 30% are expected to be impacted and for 14 pools, less than 50% are expected to be impacted (HEC 2020a).

Further discussions on the potential impacts of surface cracking and changes in surface water flows are provided in the reports by Hydro and Engineering Consulting (HEC 2020a, b, c).

6.5.3 Loss of surface flows to groundwater (baseflow reduction)

HydroSimulations (2020) have made predictions of baseflow reductions for local and regional streams.

The maximum predicted reduction in flow is relatively small in terms of mean daily flow but represents a significant percentage (51.9%) of the average estimated baseflow at Dog Trap Creek, a small percentage at Cow Creek, Bargo River and Carters Creek (1.1% to 3.45%) and a low percentage at Tea Tree Hollow and Eliza Creek (less than 1%). The reduction in flow in Tea Tree Hollow would be offset by on-going licensed discharge from LDP1 (HEC 2020a).

It is expected that reduction in baseflow would be most noticeable during periods of low flow which would normally be dominated by baseflow. Changes in flow in Dog Trap Creek and Tea Tree Hollow upstream are likely to be distinguishable in low flow conditions. The potential impacts to aquatic habitat and ecology in these waterways are discussed in section 6.7.6. However, impacts to Carters Creek, Eliza Creek and Bargo River are likely to be imperceptible.

In relation to Cow Creek, HEC (2020a) found that there would be no apparent effect for flows greater than about 0.5 ML/day in the creek. The largest effect would be seen on flows less than approximately 0.1 ML/day. The probability that flow would be greater than 0.01 ML/day would reduce from 83% to 79% of days based on the maximum predicted baseflow reduction. This level of change may be detectable during normal periods of low flow and distinguishable from natural variability in catchment conditions. To further understand the impact this change may have on pool water levels and pool habitat in Cow Creek, additional modelling was conducted. HEC modelled three pools (small, medium and large) using existing catchment runoff and baseflow, and predicted baseflow reduction.

- For CO1-1 (the smallest pond):
  - The level of the pond is predicted to be greater than 0.265 m for 99% of days, reducing to 0.257 m due to the predicted maximum baseflow reduction.
  - The pool is predicted to be at full capacity 85% of days currently, reducing to 81% of days due to the predicted maximum baseflow reduction.
  - The maximum predicted difference in level due to baseflow reduction is 0.018 m.
- For CO2-1 (representative of median size pools in Cow Creek):
  - The level of the pond is predicted to be greater than 0.706 m for 99% of days, reducing to 0.701 m due to the predicted maximum baseflow reduction.
  - The pool is predicted to be at full capacity 85% of days currently, reducing to 81% of days due to the predicted maximum baseflow reduction.
  - The maximum predicted difference in level due to baseflow reduction is 0.021 m.
- For CO3-1 (the largest pond):
  - The level of the pond is predicted to be greater than 0.616 m for 99% of days, reducing to 0.612 m due to the predicted maximum baseflow reduction.
  - The pool is predicted to be at full capacity 83% of days currently, reducing to 79% of days due to the predicted maximum baseflow reduction.
  - The maximum predicted difference in level due to baseflow reduction is 0.021 m.

Based on the results presented above, HEC (2020a) concluded that the estimated reduction in water level would likely be imperceptible in the pools in Cow Creek, and very small compared to natural variability in catchment conditions and is therefore considered to be negligible.

6.5.4 Water quality

Subsidence impacts

Predicted subsidence impacts on waterways in the Project Area are based on specialists' reports (Fluvial Systems 2013; MSEC 2020 and HEC 2020a) and are discussed in Section 6.5 which considers the impact of the proposal on aquatic habitats. The following potential impacts of subsidence on water quality in overlying waterways is summarised from Hydro and Engineering Consulting (HEC 2020a).

Liberation of contaminants can occur from subsidence induced fracturing in watercourses, causing localised and transient increases in iron concentrations and other constituents due to flushing of freshly exposed fractures in the sandstone rocks which contain iron and other mineralisation. This sort of impact has the potential to affect Tea Tree Hollow and Dog Trap Creek and downstream watercourses. Fracturing of bedrock is predicted to occur and upsidence related buckling of stream beds is predicted along some sections of these creeks. Based on past experience in the Southern Coalfields, including experience at Tahmoor North, it is expected that upsidence induced fracturing may lead to releases of aluminium, iron, manganese and zinc. It is likely these will be seen as transient spikes in the concentration of these and possibly other metals which would be relatively localised. The extent of these impacts is expected to be similar to impacts observed in similar streams in the Southern Coalfield i.e. iron staining and flocs in pools and localised and transient spikes in iron, manganese and aluminium in waterways previously undermined.

Changes to chemical characteristics of surface flows

Changes to chemical characteristics of surface flows can also occur as a result of changes in base flow. One of the effects of longwall subsidence on watercourses commonly reported is the emergence of ferruginous springs. These concentrated (point) inflows have a distinctive orange to red/brown colouration caused by enhanced groundwater inflows and oxidation of iron commonly present in shallow groundwater in the area. This is often accompanied by iron flocs, staining of the bed, increased turbidity and the build-up of iron rich slimes. Changes can also occur to the chemical composition of surface flows due to either increased or decreased groundwater fed base flow contribution to watercourses (HEC 2020a).

These sorts of impacts have the potential to affect Tea Tree Hollow, Dog Trap Creek and downstream watercourses (HEC 2020a).

Contamination of surface waters by gas drainage

Drainage of strata gas and expression to the surface through surface water has occurred to varying degrees in the Southern Coalfields. It is most readily detectable in permanent slow moving pools. Studies of the phenomena have shown that the gas flow does not affect the quality of surface waters that it drains through, due to the very low solubility of methane and the short residence time in the water column, however there have been rare instances of vegetation die back reported.

It has not been reported as an issue at Tahmoor North, most likely due to the relative absence of perennial water bodies. It is considered likely there will be strata gas emissions generated as a result of the Tahmoor South Project and that some of these may be visible as bubbling in more persistent pools in overlying watercourses (HEC 2020a).

Mine water discharge

Tahmoor Coal is licensed to release treated water from their water management system in accordance with EPL 1389 release limits. Under the current licence there is also a requirement to enhance treatment of water prior to release via a PRP22, which involves the development and commissioning of a water treatment plant to reduce the concentrations of arsenic, nickel and zinc in mine water released from the consolidated Licensed Discharge Point 1. Tahmoor Coal propose that implementation of PRP 22 - Stage 3 outlined in the Waste Water Treatment Plant – PRP22 Detailed Plan (SIMEC 2019a) will achieve the desired water quality discharge concentrations.

The results of predictive modelling of the water management system over the remaining mine life indicate that total discharge and spill from the pit top of the combined existing Tahmoor North operation and the proposed Tahmoor South Project are unlikely to increase significantly from current levels.

Whilst not anticipated, accidental spills could also occur which could result in transient impacts to water quality. The risk of these occurring is not likely to increase as a result of the Project and would be managed as part of the site environmental management system (HEC 2020a).

6.6 Aquatic habitat

Habitat features are shown in Figure 7. Streams within the Project Area are base flow Groundwater Dependent Ecosystems (GDE's) and contain both surface and hyporheos habitats (Niche 2017b), and are supported (through the provision of base flow) by springs and seeps and associated wetland GDE habitat (this does not refer to threatened wetlands) (Niche 2017b). The habitats of these GDEs, particularly riverine aquatic habitats, are expected to exhibit some form of impact from subsidence. The ground movements associated with longwall mining can impact on the availability of aquatic habitats by changing the levels of ponding, flooding and scouring of banks along watercourses and altering surface water flows through the fracturing of river and stream beds. Changes to water quality would also impact the quality of the aquatic habitat available.

6.6.1 Nepean River

The maximum predicted subsidence along the Nepean River resulting from the extraction of the proposed longwalls is less than 20 mm. While the river could experience some very low levels of vertical subsidence, it is not expected to experience any significant conventional tilts, curvatures and strains. It is not expected, therefore, that the Nepean River would experience any adverse impacts resulting from the conventional subsidence movements (MSEC 2020).

As such, the quality and quantity of available aquatic habitat in the Nepean River is unlikely to be impacted by the proposal.

6.6.2 Bargo River

The maximum predicted subsidence, upsidence and closure for the Bargo River, resulting from the extraction of the proposed longwalls, is less than 20 mm (MSEC 2020).

The Bargo River is located at a distance of 690 m from the closest proposed longwall panel. At this distance MSEC (2020) considered that the Bargo River would not experience measurable subsidence or upsidence movements. MSEC's (2020) findings indicate that it is unlikely flow rates or water quality in the Bargo River would be affected by subsidence associated with the Project.

There has been a long history of over 30 years of mining directly beneath or near the Bargo River at Tahmoor Mine. While impacts have occurred when longwalls were mined directly beneath the river, no impacts have been observed when mining has been undertaken more than 500 m from the river. Based on this, it is extremely unlikely that the extraction of the proposed longwalls would result in any adverse impacts on the river. Even if the predictions and impact assessments were exceeded, the likelihood of pool drainage is considered extremely low given the water flows in the river.

Mermaid Pool is located on the Bargo River and no impacts were observed from previous extractions within 750 m of the pool, and as such, the likelihood of any impacts on the pool is extremely low given the large distance away from the proposed longwalls.

As such, the quality and quantity of available aquatic habitat in the Bargo River is unlikely to be impacted by the proposal.

6.6.3 Thirlmere Lakes

Modelling by HEC (2020a) predict that:

- The magnitude of change in recharge/discharge would be very small compared to natural variability in downstream catchment conditions, and in the context of the potential impacts on inflow to downstream Lake Burragorang (Warragamba Dam), it would be imperceptible.
- Average Lake water levels would decrease by between 0.01 m and 0.06 m.
- The magnitude of change water levels would be imperceptible and very small compared to natural variability and are therefore considered negligible.
- Hydro Simulations (2020) have indicated a gradual recovery in groundwater impacts following completion of mining. Therefore the above changes would decrease with time following the end of mining.

Given the impacts stated above are likely to be small in terms of quantity and relative to natural variability, it is unlikely that these change in water availability in likely to affect aquatic habitat and flora and fauna or key fish habitat.

6.6.4 Streams

Table 20 describes the main streams within the Project Area in relation to their proximity to the proposed longwalls and discusses the possible impacts.

The level of impact of the Project on streams that occur within the Project Area relates to the proximity of the longwalls to the streams. Where the longwalls mine directly beneath the streams it is considered likely that fracturing resulting in surface water flow diversion will occur. Compressive strains due to closure are expected to be of sufficient magnitude to cause the underlying strata to buckle and induce cracking at the surface at some locations. This is likely to lead to the diversion of water from the stream beds into the dilated strata beneath it. In some of these locations, MSEC (2020) expects that the fracturing could impact the holding capacity of the standing pools, particularly those located directly above the proposed longwalls. MSEC considers it unlikely that there would be any net loss of water from the catchment.

Where loose materials occur, it is possible that fracturing in the bedrock would not be seen at the surface. In the event that fracturing of the bedrock occurs in these locations within the alignments of the streams, the fractures may be filled with soil during subsequent flow events (MSEC 2020). Aquatic habitat features present in all of the streams within the Project Area include pools, small waterfalls, undercut banks, trailing vegetation, snags and boulder dominated rapids.

Table 20: Stream impacts

Location	Strahler Stream Order	Description	Discussion of impact
Dog Trap Creek	3rd Order	Located directly above the proposed LW101B, and 103B to LW108B, with a total length of 2.8 kilometres directly mined beneath LW12 and LW3	The substrate overlying the proposed longwall along these sections of Dog Trap Creek consists of mud, cobble, boulder and bedrock with numerous wet pools and rock knickpoints. During monitoring, a visual assessment of the water quality and instream habitat indicated only minor disturbance with slightly turbid waters and the presence of Mosquito fish. The largest number of pools (in excess to 70), were mapped on Dog Trap Creek.

		have been previously mined beneath a 1.0 km section downstream of LW109.	Of these, 14 are located in areas of risk to fracturing and altered surface flow (HEC 2020a). For 40 of these pools, less than 20% of pools are expected to be impacted. For 18 pools, less than 30% are expected to be impacted and for 14 pools, less than 50% are expected to be impacted (HEC 2020a). Thus, there may be loss of a proportion of aquatic pool habitat in Dog Trap Creek as a result of the proposal. In addition, there may be changes to the quality of the aquatic habitat through subsidence related impacts on water quality. It is possible however that cracking would be naturally infilled over time due to the nature of the substrate upstream of this area. The potential for erosion to occur is a balance between erosional forces (velocity) and erosional resistance of the bed and banks (bed shear stress). In general flow velocity is high in Dog Trap Creek due to the relatively steep bed gradient. The lowest velocities occur in the upper reaches where the drainage channel is flatter and the flows are more dispersed. Velocities increase as the creek gradient steepens and becomes more defined further downstream. Peak flow velocity is predicted to decrease in some areas and to increase in other areas. Significant increases in velocity (i.e. between 0.8 and 0.9 m/s) were predicted in isolated sections overlying longwalls 103B to 106B. Relatively smaller increases in velocity (0.25 to 0.3 m/s) were predicted in areas overlying longwalls 101B, 102B and 109B (HEC 2020a). The predicted changes in bed shear stress were generally small with increases generally between 10 and 50%. The higher increases occurred in isolated sections overlying and downstream of pillars between longwalls 105B and 106B. The maximum predicted reduction in flow is relatively small in terms of mean daily flow but represents a substantial proportion (51.9 %). It is expected that reduction in baseflow would be most noticeable during periods of low flow, which would normally be dominated by baseflow (HEC 2020a).
Tributary 1 to Dog Trap Creek	2nd Order	Located directly above the proposed LW101B to LW108B, with a total length of 2.6 kilometres directly mined beneath.	
Tributary 2 to Dog Trap Creek	2nd Order	Located directly above the proposed LW101B to LW107B,with a total length of 2.4 kilometres directly mined beneath.	
Hornes Creek	4th Order	Not directly mined beneath, located 540 m south-west of LW108B at its closest point to mining.	Subsidence related impacts in this creek are likely to be low based on their distance to longwalls (MSEC 2020). Thus, loss of water in pools and changes to water quality from subsidence related impacts are unlikely to impact the aquatic habitat in Hornes Creek.
Tea Tree Hollow	3rd Order	Located directly above the proposed LW101A to LW106A, with a total length of 2.1 kilometres directly mined beneath. LW1 and LW2 have been previously mined beneath a 500 metre section downstream of LW101A.	The substrate overlying the proposed longwalls along these sections of creek consists of mostly mud, with some areas of bedrock and boulders. There are limited wet areas in the upper reaches as this creek is highly ephemeral and there are a number of rock knickpoints. During monitoring, the creek upstream of the discharge point was highly ephemeral in nature with flows only following rainfall. There was little visual evidence of human related disturbance in the upstream areas. Downstream of the Licensed Discharge Point was observed to be flowing on all monitoring occasions and the waters appeared turbid and some foam was present on the surface of the water. Instream evidence of disturbance included the presence of Mosquito Fish, filamentous algae, gravel and thick coating of a dark coloured precipitate over the substrate of unknown composition. There was also evidence of disturbance of the riparian vegetation, with some tracks in the vegetation and exotic grasses. There were 14 pools mapped in Tea Tree Hollow Creek within the Project area. Most of these pools are located in areas where there is a low risk of fracture and altered stream flow. One pool on the tributary of Tea Tree Hollow is predicted to have a total closure of less than 290 mm (MSEC 2020), (less than 20% of pools are expected to be impacted). Two pools on the tributary of Tea Tree Hollow have a predicted total closure of 300 and 325 mm respectively (MSEC, 2020). At this total closure prediction, less than 30% of pools are expected to be impacted (Barbato et al. 2014; HEC 2020a). Thus, there is risk of loss of aquatic pool habitat in two-three pools in Tea Tree Hollow as a result of the proposal. In addition, there may be changes to the quality of the aquatic habitat through subsidence related impacts on water quality. It is possible however that cracking would be naturally infilled over time due to the nature of the substrate upstream of this area. In general flow velocity in Tea Tree Hollow is high due to the relatively steep bed gradient. The lowest velocities occur in the upper reaches where the drainage channel is flatter and sections of the creek immediately upstream of main culvert constrictions beneath Remembrance Driveway and the railway line. Velocities are higher downstream of the culvert constrictions and in downstream reaches, which have steeper bed gradients. The highest simulated velocities were between 2.5 and 3.5 m/s in areas overlying LW101A and LW103A. Peak flow velocity is predicted to decrease in some areas and increase in other areas. The most significant increases in velocity (i.e. between 0.7 and 1m/s) are predicted in isolated sections overlying longwalls 103A and 105A (HEC 2020a) . The most notable changes were simulated on the south-western sides of LW 102A (30-140 Pa) and 103A (30-70 Pa). These have the potential to cause localised increased erosion, depending on the specific nature of the bed materials (HEC 2020a) The maximum reduction in percentage of mean daily baseflow in Tea Tree Hollow is 0.70%. The reduction in flow in Tea Tree Hollow would be offset by ongoing licensed discharge from LDP1 (HEC 2020a).
Tributary to Tea Tree Hollow	3rd Order	Located directly above the proposed LW101A to LW103A, and LW105B to 106B, with a total length of 1.2 kilometres directly mined beneath.	

6.7 Aquatic biota

6.7.1 Subsidence

The ground movements induced by longwall mining can have indirect impacts on aquatic biota through: the diversion of surface water flows to the dilated substrata, reducing water holding capacity of pools and stream connectivity, increased levels of ponding, and changes in water quality (DoP 2008). Drainage of pools resulting from mine subsidence in areas (discussed in Section 6.5.2) will impact aquatic biota inhabiting these pools, including macroinvertebrates and native fish, with high mortalities likely in areas of complete pool drainage. Areas of medium to high risk of impact on water holding capacity of pools include Tea Tree Hollow and Dog Trap Creek (HEC 2020a).

Hydro and Engineering Consulting (HEC 2020a) identified that some pools are likely to be impacted through reduced water holding capacity from longwall mining (Section 6.5.2). While there may be loss of water (temporary or permanent) to sections of streams, the overall catchment yield is not expected to change (HEC 2020a; MSEC 2020). For invertebrates, while there will be loss of habitat in sections of streams, and changes to invertebrate composition, density and family richness where these impacts occur, it is unlikely that at a sub- catchment to catchment scale changes to overall assemblage and family richness will be measurable, however total biomass is likely to be reduced.

6.7.2 Localised short-term impacts

The sudden drainage of pools or rapid drop in stream flow due to subsidence are likely to have localised, significant impacts to aquatic biota, particularly on organisms that are unable to move to areas that are damp or submerged. Aquatic plants and sessile animals are particularly vulnerable to desiccation, because of their inability to move elsewhere to other available habitat. The survival of mobile organisms is difficult to predict, as it depends on a number of factors such as their tolerance and response to desiccation and rapid changes in water level, their ability to move, weather conditions, the underlying substratum and duration of exposure (Larned et al. 2010). Streams with soft sediment banks are likely to contain moisture with interstices which may prolong the survival of stranded animals. In the streams with a bedrock substrate where there are few natural refugia, with the exception of cracks and cavities, few organisms may survive complete pool drainage. The majority of freshwater fish species recorded in the Project Area are likely to asphyxiate when exposed to air.

6.7.3 Recovery potential of stream biota

There is capacity for recovery of some stream biota, particularly macroinvertebrate fauna. Ephemeral/ intermittent streams function as meta-communities (i.e. part of a larger community), with variable hydrological connectivity and multiple dispersal pathways (water, air, dry river bed) (Larned et al. 2010). Aquatic insects with aerial stages may be the most common migrants to and from disconnected aquatic habits. As well as those invertebrates that can persist for years as cysts, eggs, copodites, cocoons and dehydrated larvae and adults, and crayfish (*C. destructor* and *E. spinifer*), which retreat to their burrows or disperse overland. Most taxa identified are able to adapt to drying conditions and have the potential to recruit back to pools once and if pool holding capacity is re-established. Animals with long larval stages and limited distribution, have niche habitat requirements, or that are poor dispersers will be most impacted. Fish may be limited in their capacity to re-establish if river connectivity is reduced. However surface flow will remain connected in higher flow periods (HEC 2020a) enabling movement of fish. Submerged and floating macrophytes generally require permanent water however they can, in time, recolonise dry areas if and when water levels return.

6.7.4 Long term impacts

Although there is potential for recovery, long term impacts may persist. Some pools may not self-heal; either being permanently dry; or have a permanently reduced holding capacity (of both volume and retention); and thus contribute to reduced stream connectivity. This could lead to permanent changes to stream biota within the affected pools and restrict recovery of animals that require stream connectivity e.g. fish.

6.7.5 Potential for increased levels of ponding

Mining can potentially result in increased levels of ponding and scouring of the stream beds. While the potential for increased scouring is not expected to be significant within the Project Area, there is a predicted reversal of grade along a naturally flat section of Dog Trap Creek, upstream of the tailgate of LW103B, which results in increased potential for ponding in an area which is estimated to be up to 0.2 m deep and 150 m long.

Increased ponding is likely to provide localised increase in available habitat for aquatic macroinvertebrates and if there is stream connectivity in the area of ponding, it may also provide additional habitat for fish and macrophytes.

6.7.6 Baseflow reduction

HEC (2020a) assessment of baseflow reduction found that will mostly impact Dog Trap Creek and upstream Tea Tree Hollow. This may reduce the habitat available in low flows for periods of time, as pools will dry out more often. This is not expected to change the overall ecology of the waterways as the fauna are already the result of highly variable flows and complete drying out. However, there will likely be a reduction in abundance of fauna that use pool habitat at certain periods of time as they will dry more rapidly in low flows. Other locations in Carters Creek, Eliza Creek, Bargo River, and Cow Creek the small changes in baseflow will have negligible effect on aquatic ecology.

6.7.7 Changes in water quality

The potential impacts of subsidence on water quality in overlying waterways include the liberation of contaminants from subsidence induced fracturing in watercourses. This causes localised and transient increases in iron concentrations and other constituents due to flushing of freshly exposed fractures in the sandstone rocks which contain iron and other minerals. This sort of impact has the potential to affect biota in Tea Tree Hollow and Dog Trap Creek, and downstream watercourses (e.g. Bargo River). Changes to chemical characteristics of surface flows can also occur as a result of changes in base flow. One of the effects of longwall subsidence on watercourses commonly reported is the emergence of ferruginous springs, often accompanied by iron flocs (DoP 2008), staining of the bed, increased turbidity and the build-up of iron rich slimes. This furruginous deposition occurs within sandstone streams in the Sydney Basin and was particularly prevalent at Horne Creek potential impact site and Eliza Creek and Stonequarry Creek control sites.

Studies have shown considerable impact to flora and fauna from iron depositional related impacts (Wellnitz *et al*.1994; Johnson and Ritchie 2003). Invertebrate communities are impacted through a reduction in abundance, richness and changes to community composition (Johnson and Ritchie 2003; Wellnitz *et al*.1994; Rassmussan and Lindegaard 1988; Peters *et al*. 2011). It is thought that invertebrates are impacted through: reduction of habitat complexity, interference of holdfast mechanisms, affecting food supply, coating respiratory surfaces, and inhibiting ion exchange (Johnson and Ritchie 2003; Wellnitz *et al*. 1994). A commonly affected insect order is Mayflies, in particular the family Leptophlebiidae (SIGNAL 8) (Johnson and Ritchie 2003; Wellnitz *et al*.1994; Rassmussan and Lindegaard 1988; et al 2011). The sensitivity of

Mayflies is likely to be related to the exposure of gills and the dependence on periphytic algae (Johnson and Richie 2003).

Leptophlebiidae was a common taxa found throughout most sites however they were depauperate in both Horne Creek sites but not in Eliza Creek. It is possible that increased iron precipitation in anoxic streams can impact macroinvertebrates through decrease in density, richness and changes to community composition.

Iron is known to precipitate on the gills of fish and eggs, prevent oxygen uptake (Peuranen *et al*. 1994) and also affect the food supply (Wellnitz *et al*.1994). Scouring of iron flocculent increases turbidity and suspended solids and may inhibit fish feeding (Peuranen *et al*.1994).

The degree of impact will be related to the alkalinity of the stream. Streams that are acidic (low pH) are likely to be impacted more than alkaline streams (Johnson and Ritchie 2003; Wellnitz *et al*.1994; Peters *et al.* 2011) that have greater buffering capacity. The impact of metals (iron, manganese, and zinc) is also expected to be localised and transient (HEC 2020a) and dependent upon stream flow. The impacts to stream fauna similarly are expected to be localised, and fauna are likely be able to recover from transient spikes in concentration. Localised long-term changes to fauna may occur if metal concentration is elevated for extended periods of time.

Drainage of strata gas and expression to the surface through surface water has occurred to varying degrees in the Southern Coalfields however it does not affect the quality of surface waters that it drains through, and therefore unlikely to impact aquatic biota (HEC 2020a) . Although gas emissions have been known to cause rare and isolated dieback of riparian vegetation in the Southern Coalfields (DoP 2008).

6.7.8 Mine water discharge impacts

Mine water contains elevated concentrations of dissolved salts and metals and can pose environmental risks to aquatic biota. In times of low rainfall however, mine water may be the only source of water for creeks, although at other times, the water may be diluted by other sources of runoff. The potential effects of the discharge decrease with increasing distance from the source.

Many factors, including the chemical composition of discharged water, conductivity, volume and periodicity of flow and habitat characteristics, combine to determine the abundance and composition of aquatic biota which, in turn, determines ecosystem viability (CEL 2011). There are three main impacts associated with mine water discharge at Tea Tree Hollow. These are: heavy metals and barium precipitate, increased salinity, and an altered hydrological regime.

Heavy metals and barium precipitate

Heavy metals have been shown to affect macroinvertebrate and algae composition (Niyogi 2002; Scheiring 1993; Holand *et al*. 1994; Pollard and Yuan 2006) through the reduction in abundance and diversity. Increases in heavy metals in mine water discharge are not predicted from the Tahmoor South Project (HEC 2020a) and it is expected that the re-commissioning of the WWTP will reduce the presence of heavy metals in the streams. Therefore future impacts from the development to aquatic ecology from heavy metals are unlikely.

A precipitate barium coal leachate present within Tea Tree Hollow downstream of LDP1 from the mine discharge has resulted in the benthos of Tea Tree Hollow being smothered by a hard black barium precipitate (Plate 3). The precipitate is likely to be impairing the benthic fauna and habitat. This precipitate consists of barium, iron, aluminium and manganese and is inert, however it is possible that the structural changes to the benthos are affecting the flora and fauna that use this habitat. The lack of interstitial spaces and covering of organic matter are thought to be limiting habitat and food supply. There is likely to be a reduction in the barium precipitate with the upgrade of the WWTP required by PRP22- Stage 3. Completion of PRP22 – Stage 3 would most likely result in enhanced water quality in Tea Tree Hollow and the Bargo River downstream and thus improved habitat for primary producers and aquatic fauna.

Whilst not anticipated, accidental spills could also occur which could result in transient impacts to water quality. The risk of these occurring is not likely to increase as a result of the Project and would be managed as part of the site environmental management system (HEC 2020a).

Salinity

Previous studies conducted on Tea Tree Hollow Creek and the Bargo River reported that despite high conductivity levels as a result of mine water, AUSRIVAS analyses indicated that 68% of the expected number of taxa was present in Tea Tree Hollow Creek, but that upstream of the confluence, only 64% of the expected number was recorded (TEL 2005), suggesting that other factors were influencing the composition and abundance of macroinvertebrates (CEL 2010d). In salinity gradient studies, conductivity was observed to correlate weakly with macroinvertebrate abundance and number of taxa (CEL 2010d). Their studies concluded that factors other than the discharge from Tahmoor Mine are responsible for the smaller number of taxa than might be expected and that conductivity is not always the best, or even a good indicator of ecosystem “health” (CEL 2010d). A recent study conducted under PRP23 (CEL 2016) concluded that while there was evidence of an effect of the discharge on the aquatic ecology of Tea Tree Hollow and at locations on the Bargo River, these effects appear to be localised to areas immediately downstream of the discharge point in the Bargo River. The study recommended no further reductions in EC levels.

HEC (2020a) simulated estimate of water quality found a very slight increase in the concentration of sodium and electrical conductivity at Bargo River downstream. The estimated concentration of sodium and electrical conductivity is predicted to remain below the ANZECC (2000) and Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG) (2018) default guideline trigger values for protection of aquatic ecosystems and recreational use (HEC 2020a).

This assessment assumes that increases in salinity will not occur with the development of the Tahmoor South Project as the proposed WWTP (PRP22- Stage 3) (SIMEC 2019a) will facilitate discharge of treated water at 500 µS/cm (a reduction in EC). Therefore it is expected that, although the salinity of mine water discharge may be slightly elevated with respect to background levels, no further impact to aquatic biota would be incurred under this water management strategy.

Altered hydrology

The other impact to Tea Tree Hollow from mine water discharge is the impact of hydrology itself. The hydrology and its effect on fluvial geomorphology are inconsistent with streams in the area. The consistent flow of water differentiates the habitat present from the slow to no flow, poorly connected pools of other streams of similar size. Cardno Ecology Lab (CEL 2010d) found that physical conditions, such as water depth and substratum best “explained” the spatial distribution of invertebrates in Tea Tree Hollow. For this reason it is often difficult to ascertain whether the difference in faunal assemblages are the result of water quality or are the result of a constant flow of water that alters the flow dynamics, geomorphology, and thus habitat with in Tea Tree Hollow. Despite this, the discharge is providing habitat that would normally be dry and does contribute to flows in Bargo River.

The results of predictive modelling (HEC 2020d) of the water management system over the remaining mine life indicate that release to LDP1 is unlikely to increase above the EPL 1389 volume limits. On the basis of the above, it is not expected that the Tahmoor South Project would result in adverse water quality impacts due to releases and spills from the site water management system (HEC 2020a).

6.8 Cumulative impacts

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 future actions in a defined area and the interactions between these developments.

This assessment identified four major cumulative impacts to the aquatic environment. These are impacts to: water quality, stream connectivity, stream habitat and aquatic ecology and communities and threatened species.

6.8.1 Cumulative water quality impacts

It was concluded in section 6.5.4 that mine water discharge is unlikely to cause further adverse effects to the environment as there will be no negative change in discharge management. With the implementation of the heavy metals water treatment plant (under PRP 22 - Stage 3) future cumulative impacts of minewater discharge is considered neutral. However, mine water discharge currently contributes to poor water quality in Bargo River and there is an interaction with past water infrastructure developments, that is Picton Weir. This potentially has a cumulative effect to water quality as discharge is less diluted from upstream flow. This cumulative impact however is existing, and is partially offset by the potential habitat, and connectivity provided by mine water discharge from Tea Tree Hollow to Bargo River.

The combined water quality effects of the Project itself could be considered cumulative as discharge related impacts to water quality and subsidence water quality impacts can potentially contribute to increased poor water quality than would be experienced otherwise.

Land use from past and current activities contributes to poor water quality in streams in the Project Area. The main land use, agriculture (poultry, cattle, sheep, cropping), can contribute to point source (licensed discharges) and non-point source pollution through increased nutrients, sedimentation and other potential chemical inputs. Thus, combined impacts from existing and future agricultural landuse, with subsidence and discharge water quality impacts from the Project, are cumulative. Water extraction from these waterways for either agriculture or stock and domestic use, could also contribute to lower water level and exacerbate Project impacts through concentration of poor water quality.

6.8.2 Cumulative impacts to stream connectivity

Stream connectivity is naturally limited; however, subsidence is likely to accentuate poor stream connectivity in the streams. In addition to this, Bargo River is disconnected from upstream reaches by Picton Weir and the Nepean dam disconnects the Nepean River. This is combined with other instream dams/weirs in some of the smaller water ways (e.g. Eliza Creek). Impacts to stream connectivity may particularly impact the movement of small fish in the lower order streams and their overall distribution.

6.8.3 Cumulative impacts to loss of pool habitat

In general, temporary or permanent loss of pool habitat resulting from subsidence is not expected to change aquatic macroinvertebrate communities present in the river system at a sub-catchment to catchment scale. It is expected the same invertebrates will inhabit the streams where appropriate habitat is provided. However, with the net loss of available habitat, there is likely to be less biomass in the system as a whole. The temporary loss or alteration of pool habitat is in addition to the loss of pool habitat from current mining activities such as Tahmoor North (Redbank Creek and Myrtle Creek) and accentuated by degradation from agricultural land use (land clearing and sedimentation).

6.8.4 Cumulative impacts to aquatic ecology and communities

The aquatic ecology is affected by the combined influence of water quality, stream connectivity and habitat loss and is therefore susceptible to cumulative impacts to these environmental variables. The cumulative effects to ecology are difficult to predict and are likely to be spatially and temporally variable. Impacts may be localised (e.g. to a pool), transient (e.g. occur in prolonged low flow condition only), gradational impacts (e.g. downstream from a point source) and maybe triggered when one or more environmental thresholds are met. Impacts to stream and biological processes may alter aquatic communities through: localised reduced abundances of sensitive flora and fauna, increased abundance on tolerant flora and fauna, reduction of abundances of all aquatic flora and fauna, and a reduction of fauna richness. However, there is potential for partial recovery of stream fauna as: Pollution Reduction Programs are to be implemented (e.g. PRP 22), and with re-establishment of aquatic communities following natural repair of some pool habitat.

7. Safeguards and management

During construction, management of drainage and sediment flows, in order to minimise sediment-laden scouring, run-off and subsequent deposition into adjoining areas are required.

7.1 Subsidence

It is recommended that subsidence monitoring of macroinvertebrates be conducted two years prior to longwall extraction. The monitoring program may require adding or relocating sites according to the final mine plan and using the same sampling methods as used in this monitoring conducted thus far. It is recommended that a BACI (Before After Control Impact) designed monitoring program be implemented to compliment the baseline information collected and to assess potential impacts in an adaptive management framework.

It is also recommended that appropriate stream rehabilitation measures be applied to areas that undergo significant impacts due to subsidence, as discussed further below. This should be undertaken in conjunction with mitigation and contingency measures outlined in the Surface Water Impact assessment (HEC 2020a).

7.1.1 Creek remediation

Tahmoor Coal has developed a Corrective Management Action Plan (CMAP) for the remediation of creeks previously undermined in the Tahmoor North mining area (Redbank Creek and Myrtle Creek). This CMAP forms part of the 2019/2020 Tahmoor Coal Mining Operations Plan (SIMEC 2019b), approved by DPIE. The aims and objectives of the CMAP are based on the geomechanical and hydrogeological conditions of the ground conditions in the creeks.

The objectives of the remediation plan are to conduct rehabilitation works when required, as follows:

- Conducting remediation works that protect to the greatest practicable extent the ecological values of the area.
- Repairing aesthetic values where necessary.
- Reducing the interaction of surface and groundwater flow where enhanced through mining.
- Having creeks and pools function in a similar manner to the pre-impact state.
- Having surface flows and pool water quality continue to provide suitable aquatic habitat. Re-establishing the ecological values to a similar state to before mining;
- Creeks and catchments yielding similar water quantity and quality following mining.
- Monitoring and reporting effectiveness of the program.

Trials are currently being conducted in Myrtle Creek which will further inform Tahmoor Coal's operations and the management of impacted waterways. These remediation measures include the trial grouting of pool 23 with the objective of restoring pool holding capacity, the details of which are outlined in the Mine Operations Plan 2019-2020 (SIMEC 2019b).

The specific rehabilitation rationale and rehabilitation approach, and subsequent performance measures will be determined and agreed between key stakeholders and relevant Government Agencies. Before an agreed rationale and approach can be established, a robust understanding of the ground and environmental conditions will be required.

Additionally, aquatic ecology is currently monitored in Myrtle Creek to determine the response of stream health to remediation measures. This will inform the effectiveness of the CMAP measures in restoring ecological values, stream functionality, and the provision of aquatic habitat.

The CMAP developed for Redbank and Myrtle Creeks, as well as the lessons learned from the implementation of this action plan, will be applied to streams potentially affected by subsidence by the Tahmoor South Project.

7.2 Mine water discharge

It is recommended that:

- The requirements of PRP22 - Stage 3 are implemented and the WWTP upgrades discussed in section 2.4 be implemented to improve the water quality of the mine water discharge.
- An investigation of Tea Tree Hollow downstream of LDP1 be undertaken to determine methods of potential remediation of the creek to remove the impacts of the barium precipitate on the aquatic habitat.
- An aquatic ecology monitoring program aimed at identifying any future changes and improvements in aquatic health due to the discharge from LDP1 be established.
- It is recommended that, in light of field surveys and the previous studies (CEL 2010 a, b, c, d), monitoring focuses on the barium precipitate in Tea Tree Hollow, as using EC as the measure of stream health and its correlation to invertebrate assemblages is poor. Although artificial sampling methods were used in the Cardno Ecology Lab study (2010d), monitoring could include quantitative benthic suction sampling that specifically samples the benthos *in situ*, as used in this study. The artificial sampling (although provides a standard substrate) is likely to miss invertebrates that colonise the interstitial spaces of the benthos and as such may not be representative of the habitat and or the impact. Sampling using artificial substrate is also subject to lengthy deployment making it susceptible to high flow events. Quantitative sampling of benthic algae *in situ* is also recommended, as well as the sampling of the inorganic benthic precipitate itself.

7.3 Aquatic habitat

In terms of general aquatic habitat, DPI (2013) enforces a 'no net loss' habitat policy for key fish habitat. There are two types of activity which can be used to mitigate damage to fish habitat, which are:

- Habitat rehabilitation - involves repairing damage caused by past activities.
- Environmental compensation - the creation or enhancement of fish habitats or fisheries resources in order to compensate for anticipated adverse or actual environmental effects of proposed developments. Environmental compensation may include:
  - Structures which represent an integral part of the development (e.g. groynes, pylons, artificial waterways).
  - Works which are undertaken as compensation for disturbance of ecologically important habitats (e.g. transplanting vegetation, fishways, environmental flows, removal of barriers to fish passage, removal of polluted areas).
  - Money to pay for the value of the habitat lost (DPI 2013).

Significant environmental impacts (direct and indirect) are to be offset by environmental compensation. Compensation to offset fisheries resource or habitat losses will be considered by DPI only after it is demonstrated that the proposed loss is unavoidable, in the best interest of the community in general and is in accordance with the FM Act, regulations and their policies and guidelines.

In addition, scientific research and monitoring programs should be established to quantify the impacts of development and the effectiveness of environmental mitigation and compensation measures. Management should be adaptive to incorporate the findings of these programs (DPI 2013).

Based on Key Fish Habitat mapping prepared for the local government area (i.e. Wollondilly), the following waterways within the Project Area have been mapped as Key Fish Habitat: Bargo River; Hornes Creek; Tea Tree Hollow; Dog Trap Creek; Eliza Creek; Carters Creek; and Cow Creek (DPI 2017c). First and second order streams are not classified as Key Fish Habitat under NSW legislation (DPI 2013), however 3rd order streams and above are. The Tahmoor South Project has 3rd Order Streams and above that contain both highly sensitive Key Fish Habitat (Type1) "Freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 metres in length, or native aquatic plants" and minimal Key Fish Habitat (Type 3) "Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation" (DPI 2013).

Section 6.7 discusses the likely loss of potential fish and macroinvertebrate pool habitat in the Project Area and the potential recovery with in these systems. While it is difficult to quantify the potential habitat loss and recovery, modelling by HEC (2020a) and MSEC (2020) have predicted 16 pools with a high likelihood of suffering partial or total drainage from the proposed development. This is likely to affect both Type 1 and Type 3 habitat that occurs in the Project Area.

In addition, the quality of the water in the creeks within the Project Area will potentially be impacted by the liberation of contaminants from subsidence, changes to chemical characteristics of surface flows and contamination of surface waters by gas drainage (HEC 2020a) which are discussed further in Section 6.5.

Tahmoor Coal will negotiate with NSW DPIE any rehabilitation and compensation measures that may be deemed necessary to ensure the longevity and ongoing management of Key Fish Habitat during and post coal extraction.

8. Conclusion

8.1 Subsidence and groundwater drawdown impacts

The following conclusions were made from the assessment of subsidence and groundwater drawdown impacts:

- The dominant aquatic macroinvertebrates recorded in streams within the Project Area include *Leptophlebiidae* (may fly), *Chironomidae, Tanypodinae, Othocladinae* (non-biting midges), and Oligochaeta (worm) larvae. Other families such as *Leptoceridae* (caddis fly) were also common.
- Fracturing and loss of water would result in loss of aquatic habitat in sections of Dog Trap Creek and Tea Tree Hollow, and subsequently loss of aquatic biota inhabiting pools.
- Native fish recorded in the Project Area may be subject to desiccation and a range of macroinvertebrates would also suffer mortalities in areas where pools are drained.
- Migration of fish maybe limited by temporary or permanent changes to pool connectivity.
- There will potentially be localised changes to macroinvertebrate community assemblages, mean density and mean family richness.
- There is expected to be some recovery of aquatic fauna once pool holding capacity is re-established.
- At a catchment scale there is likely to be an overall reduction in faunal biomass, however, the overall catchment composition of macroinvertebrates is not expected to change.
- Increased iron floc precipitation from subsidence impacts may locally affect some macroinvertebrates such as *Leptophlebiidae* (mayfly) and has been known to affect fish.
- No threatened macroinvertebrates were identified with in the Project Area.
- There is potential habitat for Sydney Hawk dragonfly however it was concluded that it will not be impacted by the proposed development.
- No threatened fish or aquatic flora were identified as being affected by the Project within the streams in the Project Area.
- No subsidence related impacts are expected for the Nepean and Bargo rivers.
- No impacts are predicted to aquatic ecology in Bargo River, Carters Creek, Eliza Creek and Cow Creek as result of small reduction in baseflows.
- No impact to aquatic ecology is expected for Thirlmere Lakes.

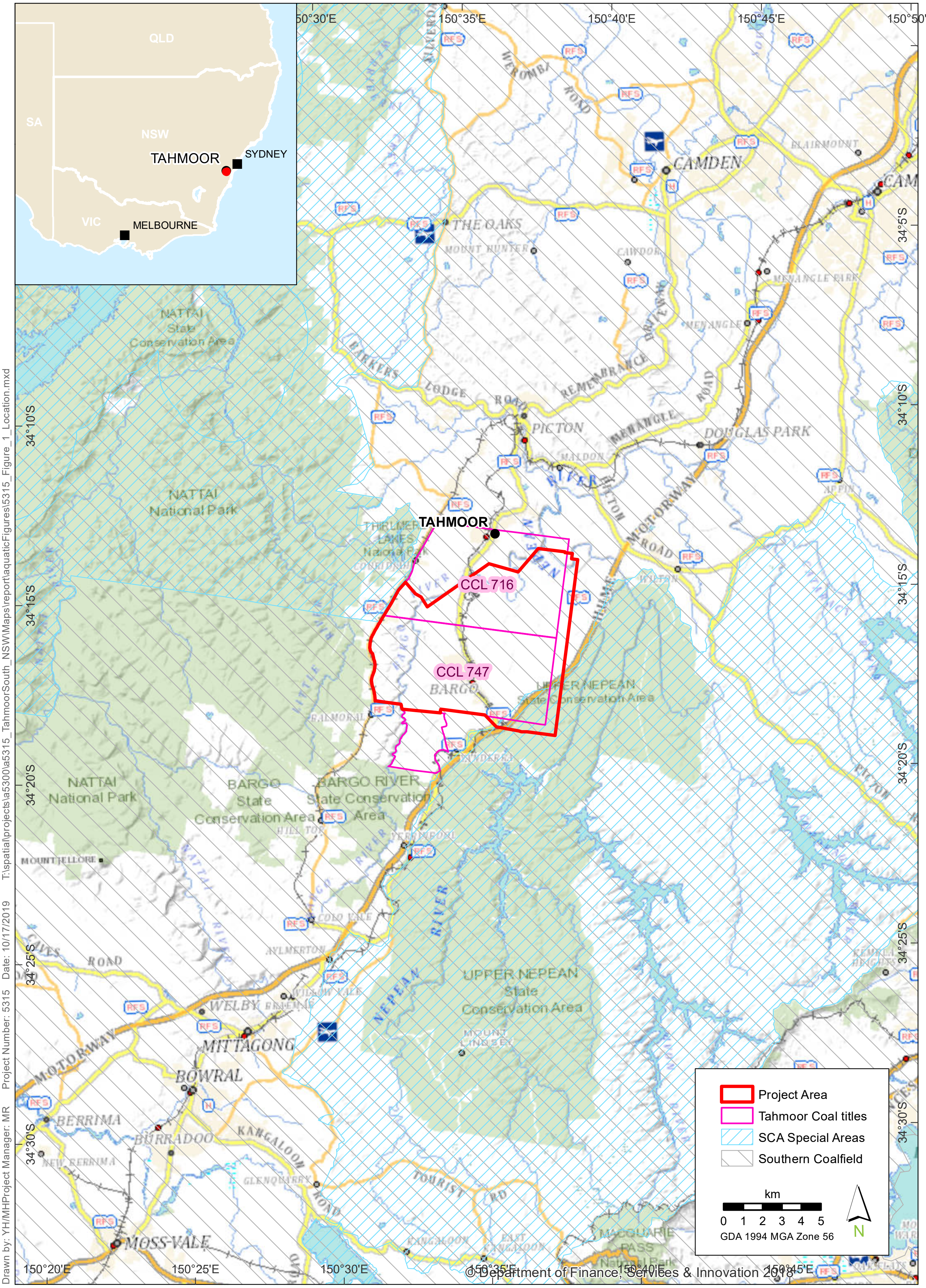
8.2 Mine water discharge impacts

The following conclusions were made from the assessment of mine water discharge impact:

- There was significant difference between impact and control groups, however this difference could not be directly related to mine water discharge impacts.
- These differences were reductions in *Leptophlebiidae, Oligochaeta, Elmidae* and increases in *Chironominae* and *Caenidae* at affected sites.
- Although no direct relationship could be established between faunal differences and mine water discharge, these taxa could be potentially useful indicators in a quantitative benthic monitoring program.
- A barium precipitate was identified as having a potential impact on benthic substrate and is thought to be impacting benthic processes and fauna.
- The implementation of a WWTP (PRP 22 – Stage 3) is likely to reduce heavy metal from mine water discharge, EC, and reduce barium precipitation.
- Studies of salinity from mine water discharge in the Southern Coalfield have not shown a direct link between salinity and effects on macroinvertebrates.

- Tea Tree Hollow has an affected hydrology with the constant flow of water making it geomorphically different from other streams downstream of LDP1.
- It is expected that no further impacts to aquatic ecology will occur as a result of mine water discharge from the Tahmoor South Project, as hydrology is not expected to differ significantly from the current regime, and water quality is expected to improve with the implementation of the WWTP (PRP 22- Stage 3).
- It is expected that reductions in salinity concentrations will improve aquatic ecology downstream of the mine water discharge.

9. Figures



Location map

Aquatic Ecology Impact Assessment

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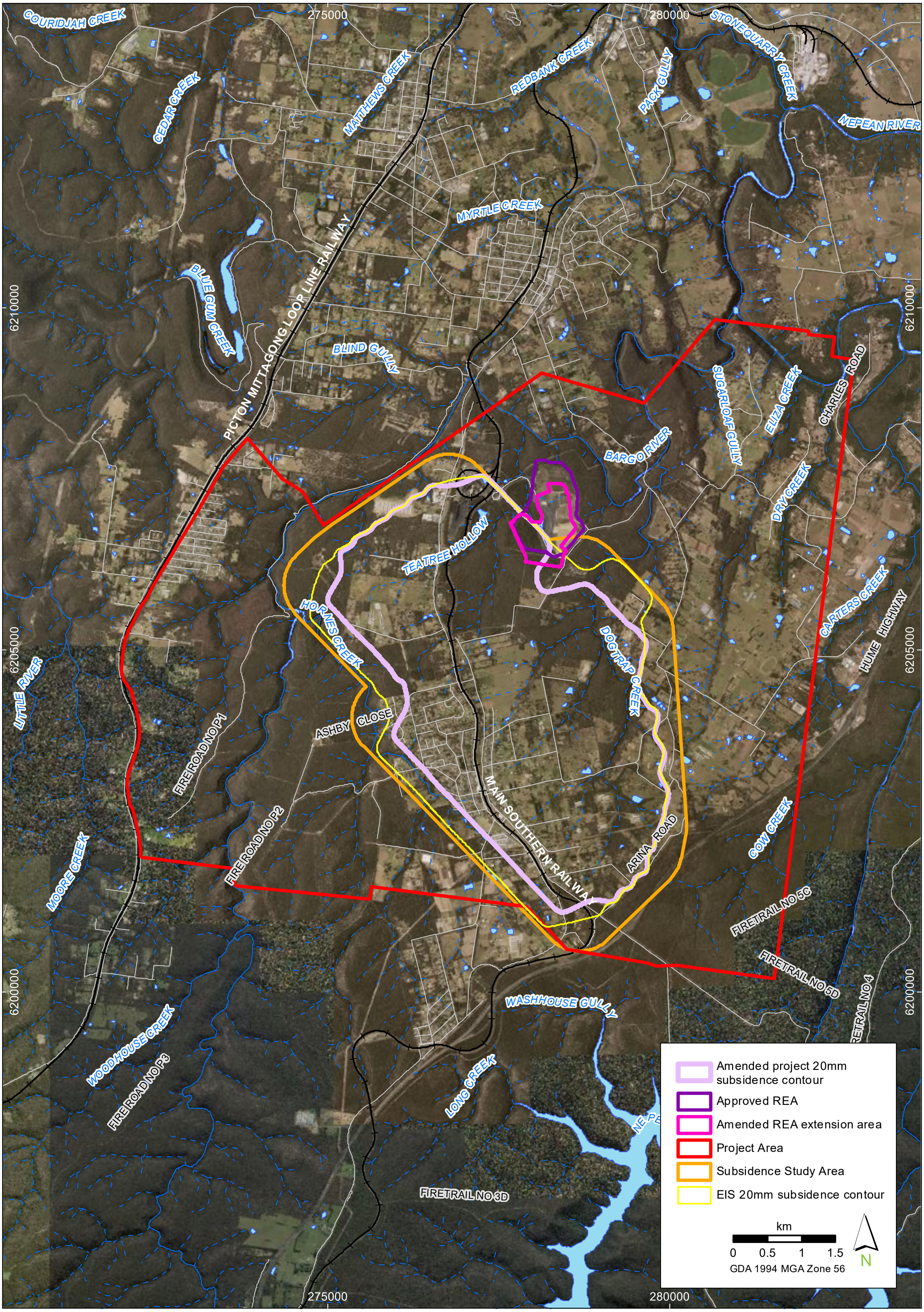
FIGURE 1



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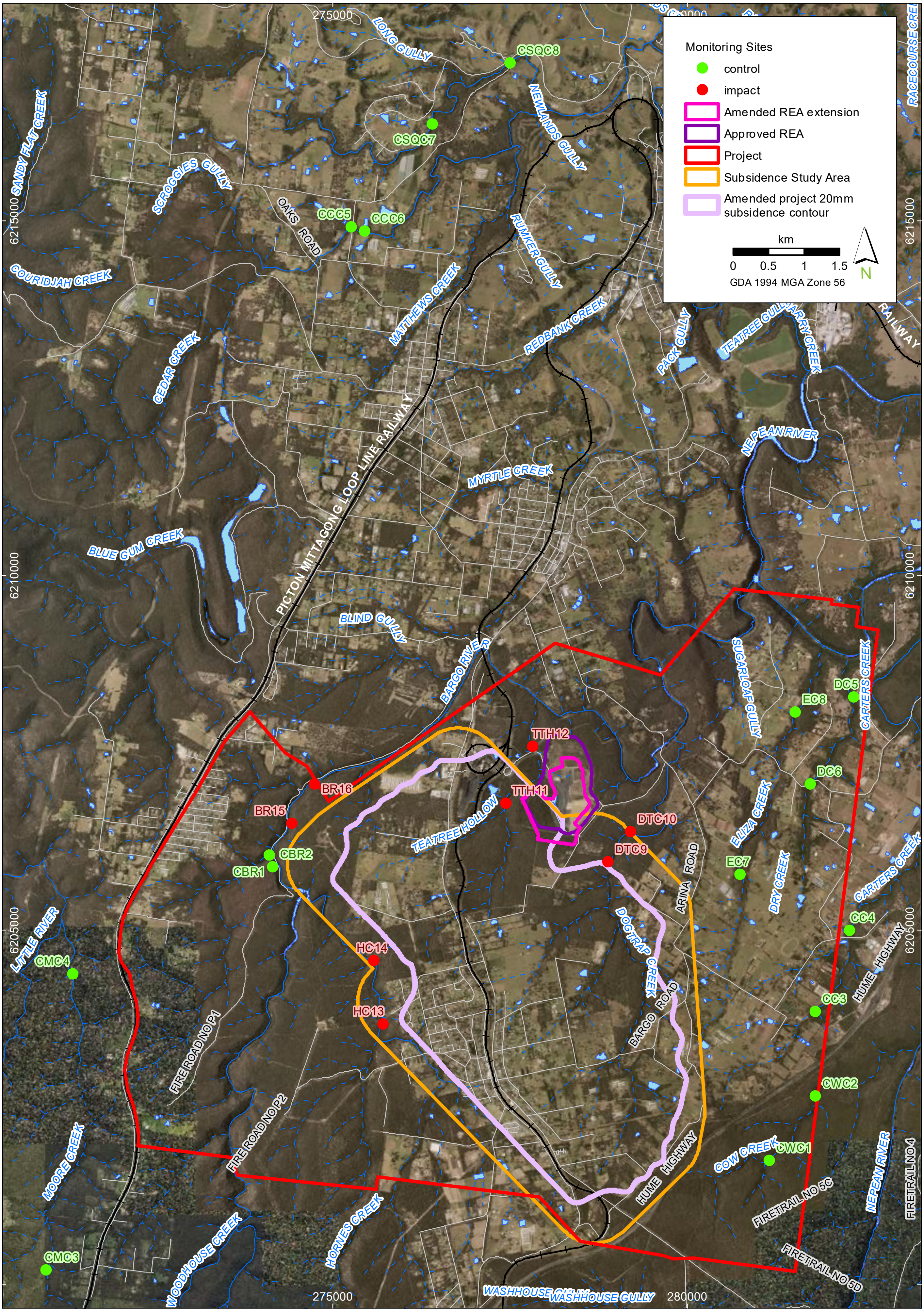
Project Area

Aquatic Ecology Impact Assessment

FIGURE 2

Imagery: (c) LPI 2016



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Monitoring sites - Subsidence

Aquatic Ecology Impact Assessment

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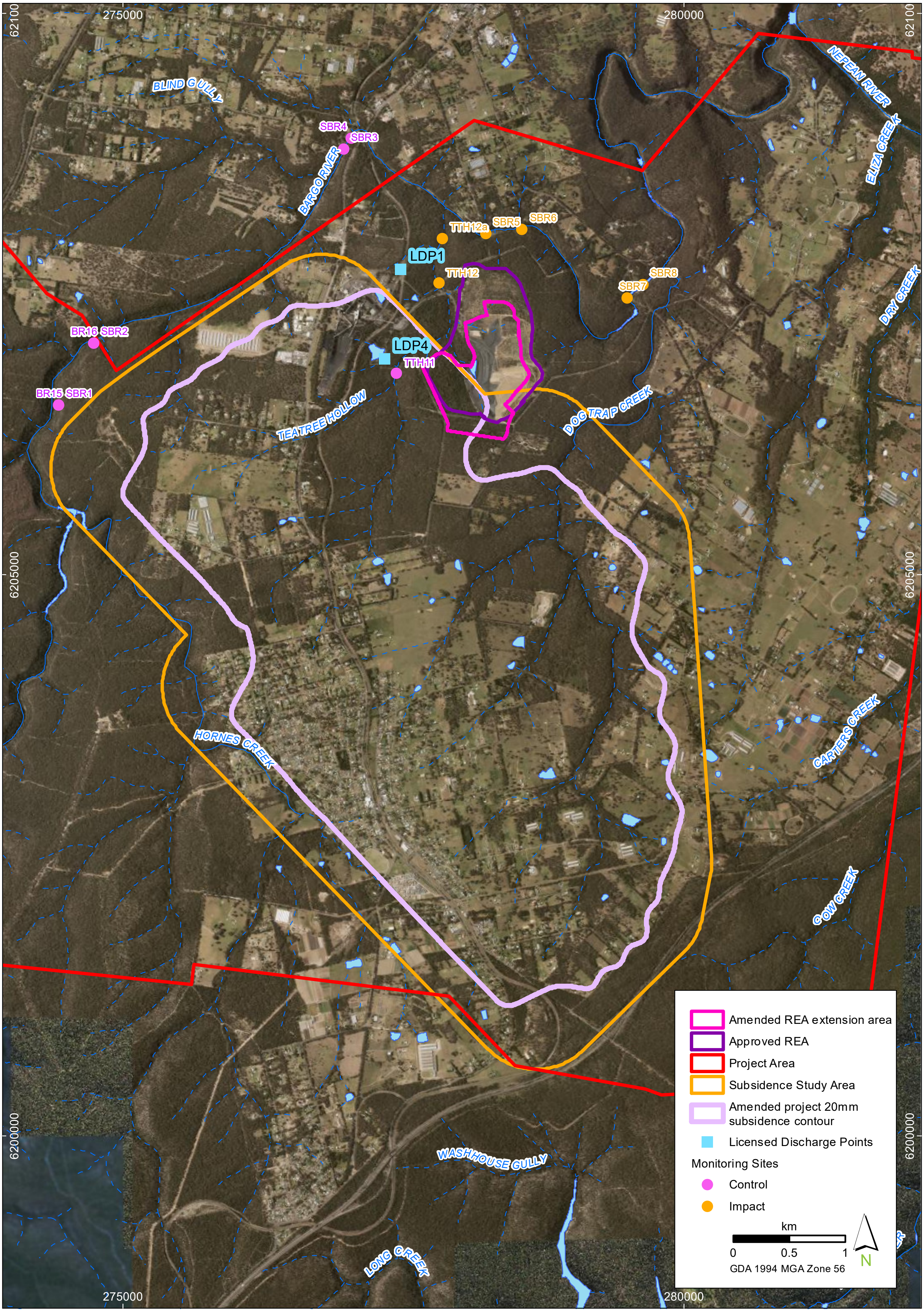
FIGURE 3

Imagery: (c) LPI 2016-11-04



Monitoring sites - Discharge

Aquatic Ecology Impact Assessment

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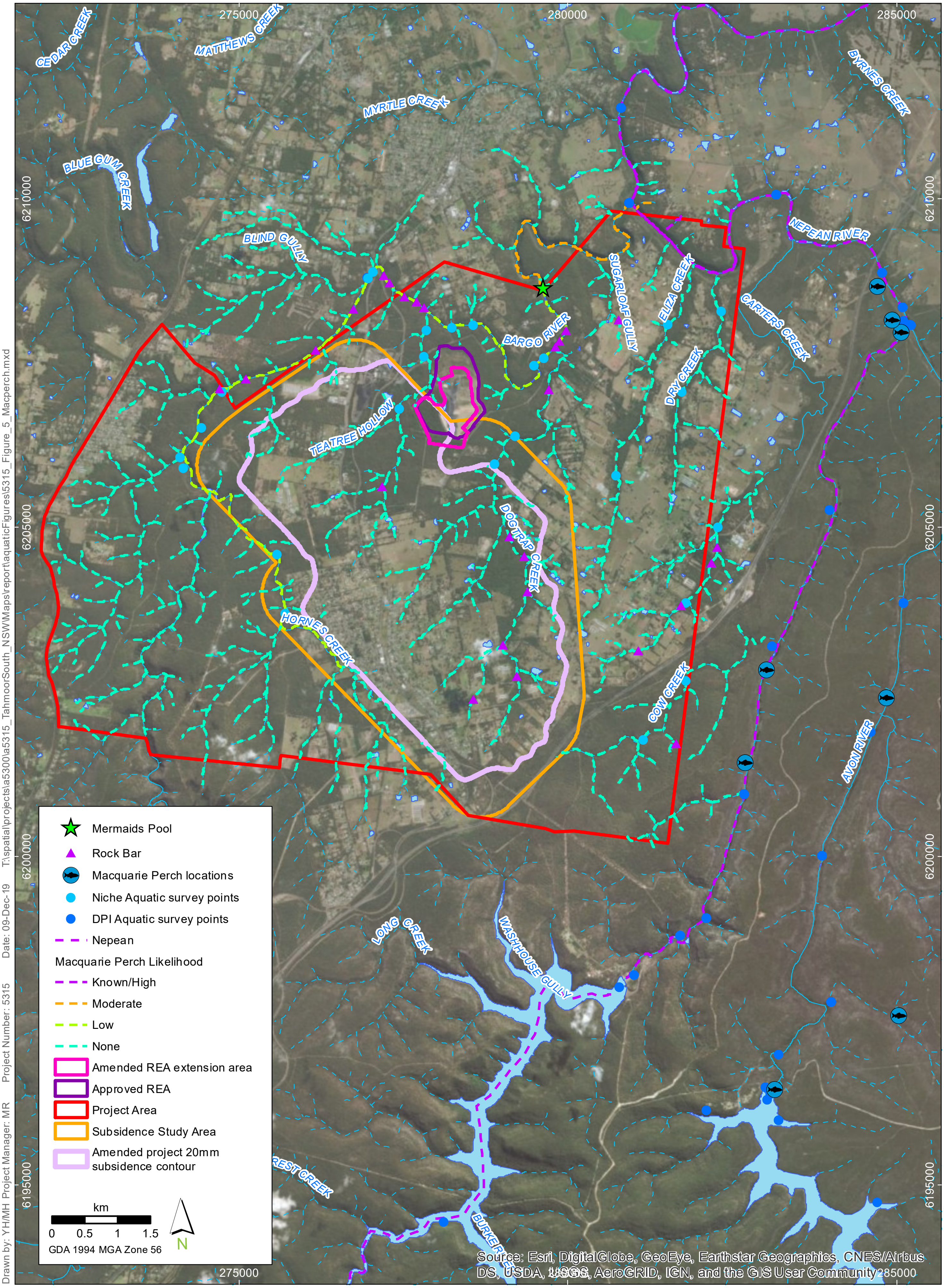
FIGURE 4

Imagery: (c) LPI 2016



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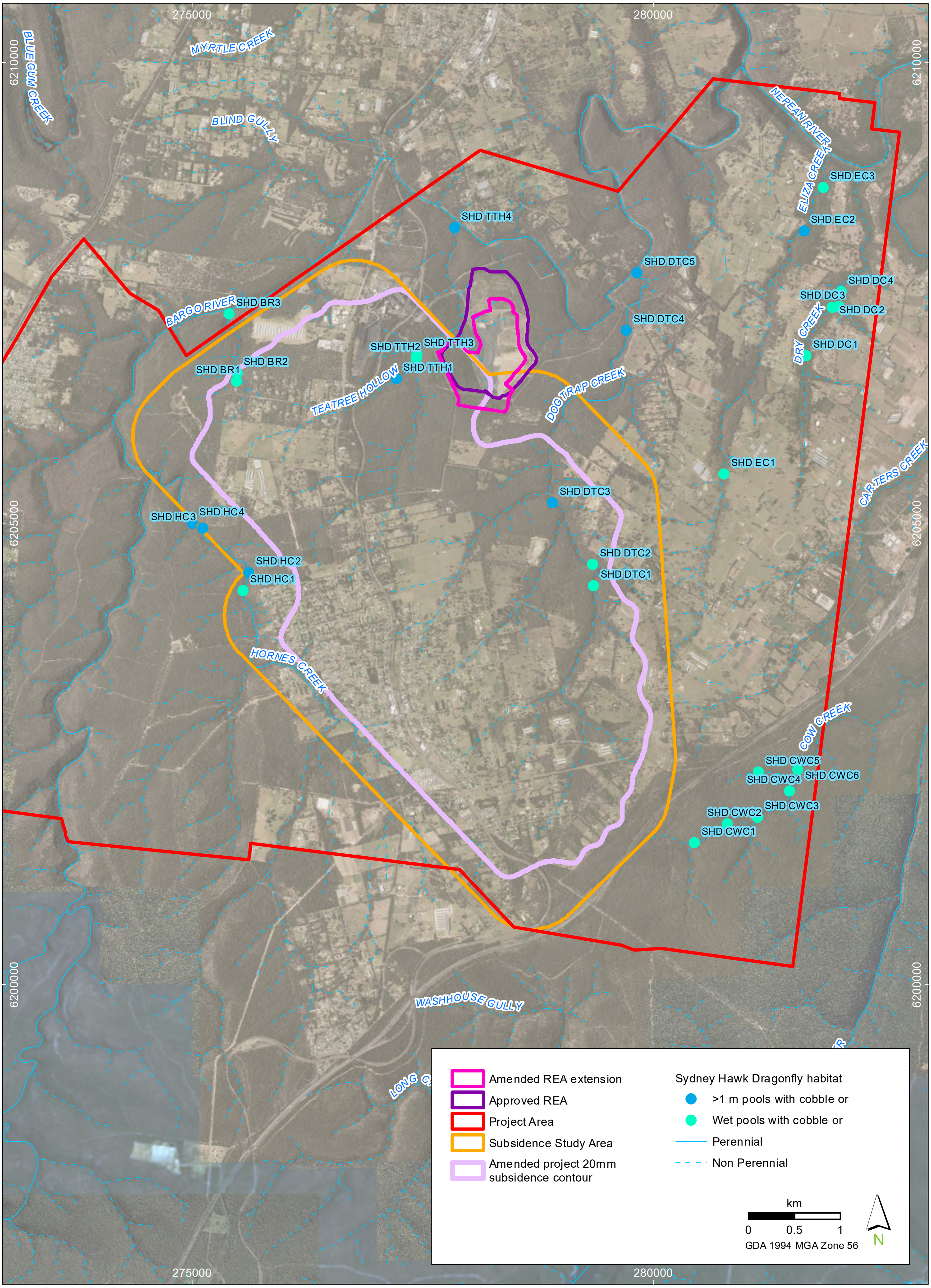
Macquarie Perch Habitat Analysis

Aquatic Ecology Impact Assessment

FIGURE 5

Imagery: (c) DigitalGlobe 2016



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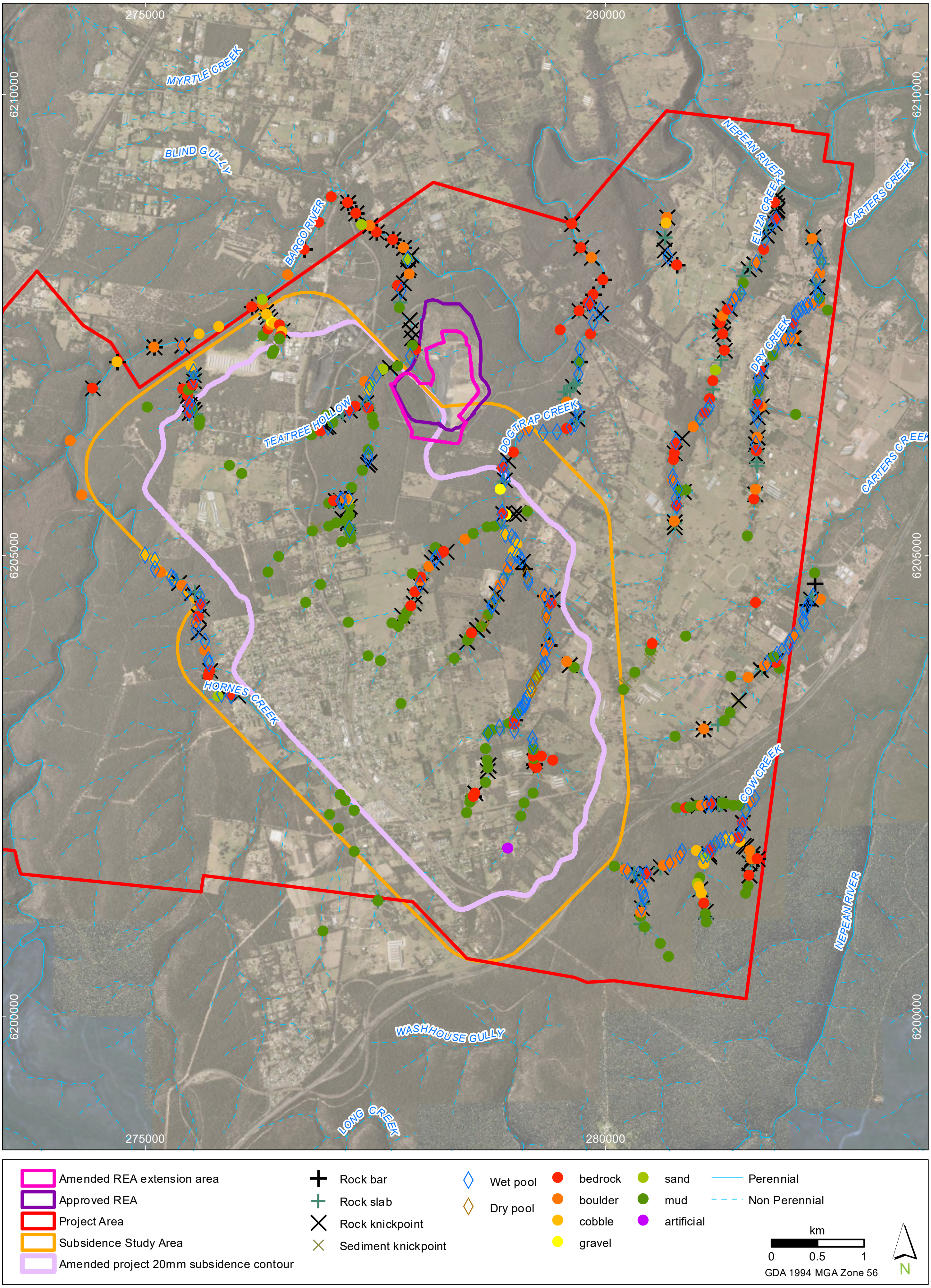
Threatened Dragonfly Habitat

Aquatic Ecology Impact Assessment

FIGURE 6

Imagery: (c) LPI 2016



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Date: 09-Dec-19

Project Number: 5315

Drawn by: YH/MH Project Manager: MR

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General Stream Geomorphology

Aquatic Ecology Impact Assessment

FIGURE 7

Imagery: (c) LPI 2016

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11.Plates

a)

b)

c)

d)

Plate 1: Fish sampling techniques

Fish sampling techniques used in baseline surveys. a) Bait traps deployed at each site; b) dip netting for macroinvertebrate and fish sampling; (c) Yabby *Cherax destructor* caught in both bait traps and dip nets in creeks throughout the Project Area; and d) Firetail Gudgeon *Hypseleotris galii* caught in dip net at Dry Creek.

a)

b)

c)

d)

Plate 2: Aquatic macroinvertebrate collecting techniques

Aquatic macroinvertebrate collecting techniques used in baseline surveys. a) AUSRIVAS macroinvertebrate edge sampling technique; b) macroinvertebrate artificial collector; c) macroinvertebrate artificial collector *in situ* and d) benthic suction sampler.

Plate 3: Barium precipitate sample

Barium precipitate sample collected from TTH12a in autumn 2013.

12. Appendices

Appendix A. Likelihood of occurrence of threatened aquatic fauna within the Project Area

Threatened species [1]	Habitat requirements[2]	Status	Likelihood occurrence in Project Area	Consideration in this assessment
Austrocordulia leonardi Sydney Hawk Dragonfly	The Sydney Hawk Dragonfly has a very restricted distribution. The known distribution of the species includes three locations in a small area south of Sydney, from Audley to Picton. The species is known from the Hawkesbury-Nepean, Georges River, Port Hacking and Karuah drainages. The Sydney Hawk dragonfly spends most of its life underwater as an aquatic larva, before metamorphosing and emerging from the water as an adult. Adults are thought to only live for a few weeks. All dragonflies are predatory. The larvae stalk or ambush their aquatic prey while the adults capture their prey on their wings. The Sydney Hawk Dragonfly has specific habitat requirements, and has only ever been collected from deep and shady riverine pools with cooler water. Larvae are found under rocks where they co-exist with *Austrocordulia refracta* (NSW DPI, 2011a).	E FM Act	Moderate	While there are limited recorded occurrences of this species, they are known from the Hawkesbury-Nepean river catchment and the Project Area does contain habitat where this species is known to occur (deep and shady riverine pools). Targeted surveys were conducted at sites defined as having suitable habitat based on geomorphology mapping (Fluvial Systems, 2013, Figure 7) and failed to locate any specimens. An assessment of significance has been prepared for this species (see Appendix I).
Archaeophya adamsi Adam's Emerald Dragonfly	Adam's Emerald Dragonfly is one of Australia's rarest dragonflies. Only five adults have ever been collected, and the species is only known from a few sites in the greater Sydney region: Somersby Falls and Floods Creek in Brisbane Waters National Park near Gosford, Berowra Creek near Berowra and Hornsby; Bedford Creek in the Lower Blue Mountains; and Hungry Way Creek in Wollemi National Park (Fisheries Scientific Committee, 2008). Larvae have been found in small creeks with gravel or sandy bottoms, in narrow, shaded riffle zones with moss and rich riparian vegetation. The larvae live for approximately 7 years and undergo various moults before metamorphosing into adults. Adults probably live for a few months at most. Adult dragonflies generally fly away from the water to mature before returning to breed. Males congregate at breeding sites and often guard a territory. Females probably lay their eggs into the water. All dragonflies are predatory and the larvae stalk or ambush their aquatic prey while the adults capture their prey on the wing. This species seem to have a low natural rate of recruitment and limited dispersal abilities (NSW DPI, 2011a).	E FM Act	Low	There are no records of Adam's Emerald Dragonfly occurring within the Bargo or Upper Nepean sub-catchments. Based on the known habitat requirements of this species, only one area of suitable habitat (i.e. a riffle section) occurs within the Project Area. Identification of suitable habitat was based on aquatic field surveys and geomorphology mapping (Fluvial Systems, 2013; Figure 7) conducted as part of this proposal. The riffle section is located on the Bargo River which will not be impacted by the Proposal (MSEC 2020). Targeted surveys were conducted at this site however no specimens were recorded.

[1] Threatened species identified for inclusion in this assessment based on the EPBC Act Protected Matters Search Tool. Accessed April 2013.

[2] Unless otherwise stated information for the threatened species habitat requirements have been sourced from the Office of Environment and Heritage – threatened species website: http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/index.aspx. Additional information has been sourced from the SEWPAC EPBC Act web page http://www.environment.gov.au/biodiversity/ . Each individual reference has not been reproduced in this report.

				Not considered further.
Petalura gigantean Giant Dragonfly	The Giant Dragonfly is found along the east coast of NSW from the Victorian border to northern NSW. It is not found west of the Great Dividing Range. There are known occurrences in the Blue Mountains and Southern Highlands, in the Clarence River catchment, and on a few coastal swamps from north of Coffs Harbour to Nadgee in the south. Giant Dragonfly live in permanent swamps and bogs with some free water and open vegetation. Adults emerge from late October and are short-lived, surviving for one summer after emergence. The adults spend most of their time settled on low vegetation on or adjacent to the swamp. They hunt for flying insects over the swamp and along its margins. Females lay eggs into moss, under other soft ground layer vegetation, and into moist litter and humic soils, often associated with groundwater seepage areas within appropriate swamp and bog habitats. The species does not utilise areas of standing water wetland, although it may utilise suitable boggy areas adjacent to open water wetlands. Larvae dig long branching burrows under the swamp. Larvae are slow growing and the larval stage may last 10 years or more. It is thought that larvae leave their burrows at night and feed on insects and other invertebrates on the surface and also use underwater entrances to hunt for food in the aquatic vegetation (OEH 2012).	E BC Act	Low	The Project Area has no suitable habitat (i.e. absence of swamps and bogs) for this species. Not considered further.
Macquaria australasica Macquarie Perch	Macquarie perch are found in the Murray-Darling Basin (particularly upstream reaches) of the Lachlan, Murrumbidgee and Murray rivers, and parts of south-eastern coastal NSW, including the Hawkesbury and Shoalhaven catchments. The conservation status of the different populations is not well known, but there have been long-term declines in their abundance. Macquarie Perch are found in both river and lake habitats, especially the upper reaches of rivers and their tributaries. They are quiet, furtive fish that feed on aquatic insects, crustaceans and molluscs. Sexual maturity occurs at two years for males and three years for females. Macquarie Perch spawn in spring or summer in shallow upland streams or flowing parts of rivers and females produce around 50,000-100,000 eggs which settle among stones and gravel of the stream or river bed. Populations from the eastward-flowing Shoalhaven and Hawkesbury rivers are genetically distinct and may represent an undescribed species (Allen et al., 2002).	E FM Act; EPBC Act	Low	The creeks within the Project Area have None to Low Likelihood of containing Macquarie Perch habitat. This is based on the highly fragmented habitat, with rock bars and other barriers to fish movement, along with the ephemeral nature of the 1st and 2nd order streams within the Project Area. The creeks also lack suitable spawning habitat. Whilst there are some sections on the Bargo River within the Project Area that contain suitable habitat for Macquarie Perch, they occur above Mermaid Falls and below Picton Weir. It is considered unlikely that a viable population of Macquarie Perch exists in this limited range and there are no recorded occurrences of this species within this section of the Bargo River despite surveys being conducted as part of this assessment and surveys by NSW DPI. Figure 6 shows the quality of Macquarie Perch habitat in the broader area based on the likelihood of occurrence criteria described in

				Diagram 1. None of the creeks within the Project Area are defined as moderate or above and as such, this species is unlikely to occur within the Project Area. There are recorded occurrences of Macquarie Perch downstream in the Nepean River. The proposed water treatment plant (refer Section 5.3.2.1) will improve water quality to receiving waters and will not adversely impact the quality of the habitat for this species. Not considered further.

Key: CE = Critically Endangered; E, E1 = Endangered; EP = Endangered Population; V = Vulnerable.

Appendix B. Site descriptors used to calculate RCE Scores (after Chessman et al, 1997)

Descriptor	Category	Score
1. Landuse pattern beyond the immediate riparian zone	Undisturbed native vegetation	4
	Mixed native vegetation and pasture/exotics	3
	Mainly pasture, crops or pine plantation	2
	Urban	1
2. Width of riparian strip of woody vegetation	More than 30m	4
	Between 5-30m	3
	Less than 5 m	2
	No woody vegetation	1
3. Completeness of riparian strip of woody vegetation	Riparian strip without breaks in vegetation	4
	Breaks at intervals of more than 50m	3
	Breaks at intervals of 10-50m	2
	Breaks at intervals of less than 10m	1
4. Vegetation of riparian zone within 10m of channel	Native tree and shrub species	4
	Mixed native and exotic trees and shrubs	3
	Exotic trees and shrubs	2
	Exotic grasses/weeds only	1
5. Stream bank structure	Banks fully stabilised by trees, shrubs	4
	Banks firm but held mainly by grass and herbs	3
	Banks loose, partly held by sparse grass	2
	Banks unstable, mainly loose sand or soil	1
6. Bank undercutting	None, or restricted by tree roots	4
	Only on curves and at constrictions	3
	Frequent along all parts of stream	2
	Severe, bank collapses common	1
7. Channel form	Deep: width/depth ratio less than 7:1	4
	Medium: width/depth ration 8:1 to 15:1	3
	Shallow: width/depth ration greater than 15:1	2
	Artificial: concrete or excavated channel	1
8. Riffle/pool sequence	Frequent alternation of riffles and pools	4
	Long pools with infrequent short riffles	3
	Natural channel without riffle/pool sequence	2
	Artificial channel, no riffle/pool sequence	1
9. Retention devices in stream	Many large boulders and/or debris dams	4
	Rocks/logs present; limited damming effect	3
	Rocks/logs present but unstable, no damming	2
	Stream with few or no rocks/logs	1
10. Channel sediment accumulations	Little or no accumulation of loose sediments	4
	Some gravel bars but little sand or silt	3

	Bars of sand and silt common	2
	Braiding by loose sediment	1
11. Stream bottom	Mainly clean stones with obvious interstices	4
	Mainly stones with some cover of algae/silt	3
	Bottom heavily silted but stable	2
	Bottom mainly loose and mobile sediments	1
12. Stream detritus	Mainly unsilted wood, bark, leaves	4
	Some wood, leaves etc. with much fine detritus	3
	Mainly fine detritus mixed with sediment	2
	Little or no organic detritus	1
13. Aquatic vegetation	Little or no macrophyte or algal growth	4
	Substantial algal growth; few macrophytes	3
	Substantial macrophyte growth; little algae	2
	Substantial macrophyte and algal growth	1

Appendix C. Sampling dates, weather Conditions and site locations

(a) Sampling dates

Season	Date
Autumn 2012	09/05/12, 10/05/12, 11/05/12, 14/05/12, 15/05/12, 16/05/12
Autumn 2012	07/06/12, 08/06/12, 12/06/12, 13/06/12, 27/06/12, 28/06/12
Spring 2012	15/10/12, 16/10/12, 17/10/12, 18/10/12, 24/10/12
Spring 2012	26/11/12, 27/11/12, 28/11/12, 29/11/12
Autumn 2013	21/03/13, 22/03/13, 25/03/13, 26/03/13, 27/03/13, 02/04/013, 03/04/13
Autumn 2013	29/04/13, 30/04/13, 01/05/13, 02/05/13
Spring 2013	11/09/13, 12/09/13, 13/09/13, 16/09/13, 17/09/13, 18/09/13, 19/09/13
Spring 2013	14/10/13; 15/10/13; 16/10/13; 17/10/13

b) Weather conditions

Date	Temperature (°C)	Rain (mm) [a]	Wind Dir/Spd [b]
09/05/12	15.0-24.3	0	NE 13
10/05/12	18.7-26.8	0	SE 15
11/05/12	16.5-23.5	0	NE 22
14/05/12	8.5-16.6	0	SSW 30
15/05/12	10.2-18.1	0	S 26
16/05/12	12.1-18.0	0	SSE 20
07/06/12	9.4-15.7	6.2	SSE 26
08/06/12	7.1-15.2	0	SSE 17
12/06/12	12.2-17.4	18.2	SSW 19
13/06/12	11.5-16.6	10.2	S 24
27/06/12	9.6-14.5	10.0	S 13
28/06/12	7.9-16.9	0.8	NE 15
15/10/12	13.2-23.7	0	NW 13
16/10/12	16.6-30.9	0	ESE 6
17/10/12	16.8-19.3	0	SE 24
18/10/12	15.7-19.9	0	NNE 17
26/11/12	18.9-22.8	0	SSW 15
27/11/12	18.6-21.2	0	SSW 19
28/11/12	18.3-21.1	10.8	SSW 17
29/11/12	18.4-24.1	0	ENE 6
21/03/13	19.4-24.8	0	NE 46
22/03/13	21.1-31.1	0	NNW 24
25/03/13	19.0-24.9	0	S 30
26/03/13	20.4-26.2	0	NNE 20
27/03/13	21.4-25.9	0	NNE 24
02/04/13	15.3-23.2	0.4	SSE 15
03/04/13	15.1-19.1	18.8	SSW 31
29/04/13	16.1-22.5	0	WNW 22
30/04/13	17.3-21.1	0	S 20
01/05/13	17.4-21.8	0	S 20
02/05/13	12.3-18.2	0	SSW30
11/09/13	13.4-23.1	0	W 24
12/09/13	11.4-20.7	0	ENE 13
13/09/13	9.3-16.2	0	ESE 6
16/09/13	14.4-17.4	0	NE 37
17/09/13	15.1-22.2	57.8	NNW 22
18/09/13	15.7-23.7	0	WNW 24
19/09/13	13.8-22.7	0.8	W 15
14/10/13	12.5-17.5	1.4	SE 19
15/10/13	10.0-19.9	0	NE 15
16/10/13	12.2-25.6	0	NE 41
17/10/13	19.2-33.0	0	NW 50

a = Precipitation in the 24 hrs to 9am; b = Direction and Speed in kilometres/hour at 3 pm. Source: Bureau of Meteorology, Bellambi AWS (station 068228).

(c) Geographic coordinates

Watercourse	Site	Easting	Northing	Location
Potential Subsidence Impact Sites				
Dog Trap Creek	DTC9	278879	6205973	Upstream
Dog Trap Creek	DTC10	279194	6206395	Downstream
Tea Tree Hollow	TTH11	277437	6206801	Upstream
Tea Tree Hollow	TTH12	277815	6207605	Downstream
Tea Tree Hollow	TTH12a	277845	6208001	Downstream
Hornes Creek	HC13	275705	6203691	Upstream
Hornes Creek	HC14	275575	6204588	Downstream
Bargo River	BR15	274424	6206513	Upstream
Bargo River	BR16	274739	6207065	Downstream
Subsidence Control Sites				
Cow Creek	CWC1	281150	6201769	Upstream
Cow Creek	CWC2	281800	6202674	Downstream
Carters Creek	CC3	281793	6203862	Upstream
Carters Creek	CC4	282280	6205005	Downstream
Dry Creek	DC5	282336	6208295	Upstream
Dry Creek	DC6	281729	6207068	Downstream
Eliza Creek	EC7	280740	6205795	Upstream
Eliza Creek	EC8	281517	6208087	Downstream
Bargo River	CBR1	274097	6206068	Upstream
Bargo River	CBR2	274152	6205906	Downstream
Moore Creek	CMC3	270959	6200225	Upstream
Moore Creek	CMC4	271328	6204392	Downstream
Cedar Creek	CCC5	275305	6214919	Upstream
Cedar Creek	CCC6	275344	6214869	Downstream
Stonequarry Creek	CSQC7	276399	6216376	Upstream
Stonequarry Creek	CSQC8	277499	6217234	Downstream
Surface Facilities Monitoring Sites				
Bargo River: Downstream Picton Weir	SBR1	274424	6206513	Upstream
Bargo River: Downstream Picton Weir	SBR2	274739	6207065	Downstream
Bargo River: Remembrance Driveway	SBR3	276964	6208797	Upstream
Bargo River: Remembrance Driveway	SBR4	277034	6208893	Downstream
Bargo River: Tea Tree Hollow Confluence	SBR5	278231	6208039	Upstream
Bargo River: Tea Tree Hollow Confluence	SBR6	278555	6208082	Downstream
Bargo River: Rockford Bridge	SBR7	279490	6207467	Upstream
Bargo River: Rockford Bridge	SBR8	279630	6207585	Downstream

C = Control monitoring sites; S = Surface facilities monitoring sites

Appendix D. Water quality: subsidence monitoring sites

Mean (±S.E.) water quality results for subsidence monitoring sites measured during the Tahmoor South baseline aquatic monitoring surveys conducted in (a) autumn: May 2012 (b) autumn: June 2012 (c) spring: October 2012 (d) spring: November 2012 (e) autumn: March 2013 (f) autumn: April 2013 (g) spring: September 2013 (h) spring: October 2013 (n=3).

a) Autumn: May 2012

Location	Site	Temp. °C		Cond. µS/cm		Turb. NTU		Sal.ppt		pH		ORP mV		DO% sat'n		DO mg/L		Alk. ppm
ANZECC default trigger values				**3-350**		**2-25**				**6.5-7.5**				**90-110**				
Potential Impact Sites		**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	
DTC9	U	11.32	0.05	317.00	1.53	5.57	0.07	0.21	0.00	7.49	0.06	275.33	1.86	92.90	0.62	10.17	0.03	14
DTC10	D	10.79	0.05	292.00	2.31	4.40	0.00	0.20	0.01	7.27	0.09	250.00	3.46	**62.47**	1.59	6.93	0.15	18
TTH11	U	10.19	0.02	274.33	0.33	6.33	0.13	0.19	0.00	6.81	0.02	240.67	7.31	**81.87**	0.65	9.17	0.07	30
TTH12	D	10.85	0.01	**1535.33**	3.84	2.30	0.00	0.94	0.00	**8.91**	0.01	274.33	2.96	98.83	0.26	10.87	0.03	14
HC13	U	9.83	0.03	345.67	1.33	2.53	0.03	0.22	0.00	7.34	0.04	258.33	0.67	**84.07**	1.52	9.50	0.15	16
HC14	D	9.77	0.04	**393.33**	4.10	4.80	0.00	0.24	0.00	7.45	0.06	267.67	0.67	**82.83**	1.89	9.37	0.17	16
BR15	U	11.12	0.01	209.00	0.00	3.20	0.20	0.15	0.01	6.81	0.03	269.33	3.84	**80.13**	1.95	8.73	0.15	10
BR16	D	10.95	0.01	212.67	1.33	2.80	0.00	0.14	0.00	6.89	0.03	263.33	1.86	**89.13**	0.91	9.83	0.09	10
Control Sites																		
CWC1	U	11.75	0.06	193.00	13.43	7.60	0.12	0.12	0.01	**6.39**	0.03	264.00	10.82	**45.27**	2.01	4.83	0.19	40
CWC2	D	13.31	0.07	135.33	1.33	5.07	0.26	0.11	0.00	6.86	0.14	254.33	9.70	**81.20**	2.43	8.47	0.23	100
CC3	U	11.81	0.03	327.00	0.00	5.53	0.15	0.21	0.00	7.35	0.02	227.67	1.45	**80.57**	1.24	8.67	0.12	14
CC4	D	13.19	0.04	**462.00**	1.00	3.97	0.07	0.27	0.01	**7.54**	0.10	279.33	2.91	95.23	4.88	9.90	0.45	13
DC5	U	13.13	0.00	**382.00**	0.00	6.07	0.07	0.23	0.01	6.99	0.06	283.33	3.48	**76.97**	1.58	8.03	0.13	18

Location	Site	Temp. °C		Cond. µS/cm		Turb. NTU		Sal.ppt		pH		ORP mV		DO% sat'n		DO mg/L		Alk. ppm
DC6	D	13.28	0.12	**502.33**	3.84	7.93	0.07	0.28	0.01	6.98	0.08	277.33	1.20	95.00	2.50	9.23	0.30	16
EC7	U	12.66	0.03	231.33	1.33	19.23	0.03	0.15	0.00	6.85	0.02	278.00	1.15	**56.83**	1.70	6.00	0.15	15
EC8	D	15.25	0.02	**1139.33**	1.45	8.37	0.07	0.67	0.00	6.99	0.01	203.67	2.85	101.67	0.80	10.13	0.09	15
CBR1	U	11.42	0.05	203.00	0.00	3.30	0.10	0.14	0.00	7.08	0.09	253.33	0.88	**82.00**	1.51	8.90	0.10	10
CBR2	D	10.30	0.00	264.33	0.33	0.13	0.07	0.17	0.01	6.71	0.07	259.33	0.88	**89.40**	0.87	10.00	0.12	10
CMC3	U	8.68	0.02	181.00	0.00	0.23	0.03	0.12	0.00	**5.76**	0.03	306.33	5.55	**60.37**	0.93	7.03	0.09	4
CMC4	D	9.28	0.01	210.67	1.67	0.37	0.07	0.14	0.00	**5.92**	0.01	306.67	0.88	**77.30**	1.36	8.83	0.13	4
CCC5	U	10.60	0.01	**433.00**	1.53	4.47	0.07	0.26	0.00	**6.42**	0.00	311.00	4.73	**73.30**	0.15	8.23	0.09	4
CCC6	D	11.24	0.04	**394.33**	2.60	4.93	0.07	0.26	0.00	6.67	0.07	237.67	2.91	**78.90**	1.04	8.63	0.09	4
CSQC7	U	10.83	0.04	**680.33**	4.06	6.67	0.03	0.41	0.00	7.30	0.02	242.00	0.00	92.27	0.37	10.30	0.06	17
CSQC8	D	10.35	0.01	**673.33**	2.33	3.20	0.00	0.42	0.00	7.14	0.00	259.00	0.58	**89.33**	0.43	10.00	0.06	16

Temp = Temperature; Cond. = Conductivity; Turb. = Turbidity; Sal. = salinity; ORP = Oxidation-Reduction Potential; DO% = percentage Dissolved Oxygen; Alk = Alkalinity. N/A = readings were below the detection levels of field titration kits. NB: Default trigger values (ANZECC, 2000) are only available for DO%, pH, Turbidity and Salinity (Conductivity µS/cm). Values in bold are outside the default trigger values recommended by ANZECC (2000) for upland rivers in South-east Australia.

(b) Autumn: June 2012

Location	Sit e	Temp. °C		Cond. µS/cm		Turb. NTU		Sal.ppt		pH		ORP mV		DO% sat'n		DO mg/L		Alk. ppm
ANZECC default trigger values				**3-350**		**2-25**				**6.5-7.5**				**90-110**				
Potential Impact Sites		**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	
DTC9	U	11.05	0.02	286.67	3.33	**59.80**	0.80	0.19	0.00	7.15	0.06	257.00	2.08	97.50	0.78	10.73	0.09	15
DTC10	D	11.07	0.00	286.00	0.00	**43.93**	0.34	0.19	0.00	7.49	0.01	265.33	0.88	94.47	1.09	10.57	0.03	17
TTH11	U	10.85	0.00	281.67	2.67	17.27	0.18	0.19	0.00	7.22	0.01	223.33	4.41	90.03	0.30	9.97	0.03	20
TTH12	D	11.10	0.01	**1026.67**	1.33	**47.00**	0.40	0.62	0.00	**8.80**	0.00	231.67	0.67	93.93	0.30	10.33	0.03	12

Location	Site	Temp. °C		Cond. µS/cm		Turb. NTU		Sal.ppt		pH		ORP mV		DO% sat'n		DO mg/L		Alk. ppm
HC13	U	11.59	0.03	348.67	1.33	**39.27**	0.13	0.24	0.01	7.48	0.02	247.33	8.51	96.87	0.41	10.53	0.03	17
HC14	D	11.46	0.01	349.33	1.67	**63.83**	0.70	0.23	0.00	**7.61**	0.01	274.33	0.33	95.30	0.52	10.40	0.06	17
BR15	U	10.51	0.01	225.00	0.00	3.30	0.10	0.16	0.00	7.02	0.02	297.00	0.58	88.40	0.38	9.83	0.03	15
BR16	D	10.60	0.00	225.33	3.18	3.33	0.07	0.16	0.00	7.07	0.01	297.33	1.45	91.83	0.30	10.23	0.03	15
Control Sites																		
CWC1	U	9.29	0.03	217.67	2.03	4.33	0.07	0.15	0.01	6.91	0.09	228.33	2.85	**54.47**	1.52	6.23	0.15	100
CWC2	D	9.69	0.02	14.37	0.13	5.23	0.13	0.12	0.00	7.16	0.05	236.67	2.60	**77.57**	0.55	8.80	0.06	130
CC3	U	10.95	0.01	280.67	1.33	4.13	0.03	0.19	0.00	**8.05**	0.09	234.67	2.33	95.23	0.79	10.53	0.09	14
CC4	D	11.37	0.01	**381.00**	0.00	7.43	0.09	0.24	0.01	**7.75**	0.04	241.67	0.88	95.53	1.02	10.43	0.09	15
DC5	U	9.80	0.03	**441.00**	4.16	5.37	0.18	0.27	0.00	7.23	0.09	259.00	2.31	**73.20**	1.05	8.23	0.09	70
DC6	D	9.44	0.01	**449.67**	1.67	11.37	0.07	0.27	0.00	7.28	0.03	272.67	1.45	**79.27**	0.03	9.10	0.00	24
EC7	U	10.16	0.00	**238.33**	1.67	**25.27**	0.07	0.17	0.00	7.20	0.03	270.67	0.88	**82.47**	1.28	9.27	0.12	25
EC8	D	11.45	0.02	**609.00**	2.31	13.90	0.10	0.38	0.00	7.36	0.03	243.33	6.44	95.93	0.46	10.47	0.07	20
CBR1	U	10.39	0.00	221.00	0.00	3.77	0.07	0.15	0.01	7.37	0.07	280.67	0.67	89.10	0.52	10.00	0.06	8
CBR2	D	10.77	0.01	253.00	0.00	5.20	0.10	0.16	0.00	7.10	0.05	290.33	0.33	89.77	0.33	9.97	0.03	8
CMC3	U	11.63	0.03	164.00	0.00	5.93	0.07	0.11	0.00	**5.84**	0.06	321.00	5.29	80.60	1.70	8.67	0.12	4
CMC4	D	11.22	0.03	171.33	1.33	3.33	0.07	0.13	0.01	**6.37**	0.19	268.67	12.81	95.17	0.58	10.47	0.09	4
CCC5	U	11.36	0.00	330.00	0.00	20.67	0.07	0.21	0.00	**6.38**	0.02	303.67	0.67	76.57	0.33	8.40	0.06	4
CCC6	D	11.36	0.01	337.67	1.33	20.40	0.00	0.21	0.00	**6.48**	0.02	304.33	0.33	77.27	0.98	8.43	0.09	4
CSQC7	U	11.25	0.01	**522.67**	0.33	7.73	0.24	0.31	0.00	**7.56**	0.01	276.33	2.40	90.47	0.27	9.93	0.03	20
CSQC8	D	11.27	0.01	**549.33**	1.33	10.60	0.10	0.33	0.00	**7.52**	0.02	280.00	3.21	88.83	0.13	9.73	0.03	15

Temp = Temperature; Cond. = Conductivity; Turb. = Turbidity; Sal. = salinity; ORP = Oxidation-Reduction Potential; DO% = percentage Dissolved Oxygen; Alk = Alkalinity. N/A = readings were below the detection levels of field titration kits. NB: Default trigger values (ANZECC, 2000) are only available for DO%, pH, Turbidity and Salinity (Conductivity µS/cm). Values in bold are outside the default trigger values recommended by ANZECC (2000) for upland rivers in South-east Australia.

c) Spring: October 2012

Location	Site	Temp. °C		Cond. µS/cm		Turb. NTU		Sal.ppt		pH		ORP mV		DO% sat'n		DO mg/L		Alk. ppm
ANZECC default trigger values				**3-350**		**2-25**				**6.5-7.5**				**90-110**				
Potential Impact Sites		**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	
DTC9	U	Dry																
DTC10	D	Dry																
TTH11	U	16.49	0.04	**421.67**	0.33	13.57	0.41	0.29	0.00	**6.40**	0.06	346.00	2.31	**33.73**	2.09	3.30	0.25	50.00
TTH12	D	16.71	0.21	**590.33**	8.76	**222.33**	13.62	0.40	0.01	**8.60**	0.02	312.33	4.84	**53.30**	2.74	5.00	0.21	11.00
HC13	U	17.00	0.05	144.33	19.41	11.43	0.13	0.10	0.01	7.47	0.10	353.00	1.00	94.53	0.79	9.10	0.21	60.00
HC14	D	20.52	0.30	216.67	0.33	18.67	0.17	0.14	0.01	7.42	0.12	335.00	1.00	**113.33**	0.33	10.20	0.06	22.00
BR15	U	17.61	0.03	204.33	1.20	15.63	2.46	0.15	0.00	**6.35**	0.00	365.00	1.53	**62.17**	0.38	5.93	0.03	8.00
BR16	D	16.32	0.00	172.67	24.33	9.20	0.49	0.11	0.02	**6.13**	0.11	372.33	2.03	**81.07**	1.03	7.97	0.12	8.00
Control Sites																		
CWC1	U	14.39	0.01	130.67	0.67	17.33	0.07	0.09	0.00	6.61	0.03	318.00	2.52	**23.23**	2.39	2.43	0.28	100.00
CWC2	D	16.03	0.12	120.33	0.67	22.50	0.90	0.08	0.00	6.69	0.13	328.67	1.20	**44.43**	0.87	4.40	0.06	100.00
CC3	U	12.87	0.04	345.33	0.88	20.90	0.00	0.23	0.01	7.18	0.02	334.00	1.15	93.13	0.26	9.83	0.03	18.00
CC4	D	14.73	0.01	**475.67**	1.20	**74.73**	0.73	0.33	0.00	6.88	0.01	327.00	0.58	**50.87**	1.11	5.17	0.12	23.00
DC5	U	16.23	0.09	229.33	3.67	**74.23**	1.18	0.15	0.00	**6.15**	0.02	307.67	3.18	**50.47**	1.59	5.03	0.18	100.00
DC6	D	13.60	0.00	**572.33**	1.33	12.27	0.43	0.39	0.00	**6.43**	0.02	335.33	4.06	**32.03**	0.58	3.30	0.06	100.00

Location	Site	Temp. °C		Cond. µS/cm		Turb. NTU		Sal.ppt		pH		ORP mV		DO% sat'n		DO mg/L		Alk. ppm
EC7	U	14.72	0.06	238.33	1.33	**69.63**	4.86	0.16	0.00	6.90	0.02	369.67	0.88	**29.43**	0.66	3.07	0.09	17.00
EC8	D	19.14	0.54	**1175.67**	1.45	9.00	0.06	0.79	0.00	6.75	0.01	338.33	3.71	**89.43**	0.34	8.23	0.09	100.00
CBR1	U	19.45	0.06	187.00	1.53	10.97	0.62	0.12	0.00	6.38	0.02	357.67	0.33	**78.00**	1.08	7.20	0.10	10.00
CBR2	D	18.49	0.01	187.33	3.93	7.00	0.20	0.12	0.00	**6.47**	0.01	371.00	1.53	**62.83**	0.61	5.90	0.06	10.00
CMC3	U	15.26	0.00	165.33	2.33	1.93	0.03	0.11	0.00	**4.44**	0.00	442.00	3.79	**68.10**	0.15	6.83	0.03	4.00
CMC4	D	-	-	-	-	-	-	-	-	-	-	-	-	**-**	-	-	-	-
CCC5	U	18.91	0.01	186.67	2.03	3.33	0.20	0.12	0.00	6.59	0.05	347.67	1.45	**61.60**	0.53	5.70	0.06	4.00
CCC6	D	18.91	0.01	186.67	2.03	3.33	0.20	0.12	0.00	6.59	0.05	347.67	1.45	**61.60**	0.53	5.70	0.06	4.00
CSQC7	U	15.25	0.02	**724.33**	17.07	15.97	0.97	0.49	0.01	**5.70**	0.01	351.67	5.81	**64.57**	3.32	6.80	0.26	13.00
CSQC8	D	15.06	0.03	**603.33**	12.72	13.17	0.07	0.41	0.01	**6.43**	0.02	331.33	4.06	**42.80**	0.97	4.27	0.07	13.00

Temp = Temperature; Cond. = Conductivity; Turb. = Turbidity; Sal. = salinity; ORP = Oxidation-Reduction Potential; DO% = percentage Dissolved Oxygen; Alk = Alkalinity. N/A = readings were below the detection levels of field titration kits. NB: Default trigger values (ANZECC, 2000) are only available for DO%, pH, Turbidity and Salinity (Conductivity µS/cm). Sample sites on Dog Trap Creek were dry at the time of sampling.

d) Spring November 2012

Location	Site	Temp. °C		Cond. µS/cm		Turb. NTU		Sal.ppt		pH		ORP mV		DO% sat'n		DO mg/L		Alk. ppm
ANZECC default trigger values				**3-350**		**2-25**				**6.5-7.5**				**90-110**				
Potential Impact Sites		**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	
DTC9	U	Dry																
DTC10	D	Dry																
TTH11	U	20.21	0.03	**369.67**	0.33	**197.67**	1.45	0.24	0.00	7.03	0.04	275.00	0.58	**19.43**	0.39	1.73	0.03	14.00
TTH12	D	21.27	0.04	**1333.33**	75.86	**43.17**	0.94	0.92	0.06	**8.76**	0.00	292.00	0.00	**67.20**	0.15	5.90	0.00	11.00

Location	Site	Temp. °C		Cond. µS/cm		Turb. NTU		Sal.ppt		pH		ORP mV		DO% sat'n		DO mg/L		Alk. ppm
HC13	U	20.45	0.02	82.00	0.00	**48.80**	1.50	0.05	0.00	7.04	0.04	262.67	0.88	**57.67**	1.17	5.17	0.07	30.00
HC14	D	20.02	0.01	246.00	0.00	11.03	0.18	0.16	0.00	6.80	0.04	287.67	1.20	**67.90**	0.25	6.13	0.03	25.00
BR15	U	21.03	0.00	172.00	0.00	7.83	1.01	0.11	0.00	6.67	0.06	302.00	2.00	**52.97**	1.52	4.70	0.10	10
BR16	D	20.62	0.01	168.00	1.00	5.90	0.12	0.11	0.00	6.61	0.01	296.67	3.53	**70.83**	0.20	6.37	0.03	10
Control Sites																		
CWC1	U	22.29	0.03	108.00	2.00	**54.37**	1.54	0.07	0.00	**6.19**	0.01	260.33	0.33	**15.97**	0.33	1.37	0.03	26.00
CWC2	D	23.94	0.15	86.33	0.88	21.17	0.54	0.07	0.00	**6.18**	0.00	275.00	1.53	**40.40**	1.11	3.40	0.10	100.00
CC3	U	25.53	0.54	302.33	1.20	16.67	0.20	0.19	0.00	6.71	0.04	287.00	2.31	90.57	1.07	7.43	0.13	16.00
CC4	D	25.76	0.28	**420.33**	0.33	**62.07**	0.07	0.29	0.00	7.06	0.01	278.67	0.33	**33.27**	1.53	2.73	0.09	17.00
DC5	U	20.92	0.06	240.33	9.28	**69.50**	0.50	0.17	0.01	7.03	0.02	292.33	1.33	**20.03**	0.98	1.80	0.06	16.00
DC6	D	23.64	0.03	339.00	4.36	**49.74**	0.37	0.23	0.01	6.92	0.01	287.33	0.67	**39.41**	0.67	3.29	0.07	16.67
EC7	U	23.95	0.64	194.00	2.31	**136.33**	3.71	0.13	0.01	6.95	0.02	271.67	0.33	**25.97**	3.33	2.10	0.26	13.00
EC8	D	23.40	0.20	**951.00**	28.88	7.67	0.07	0.63	0.03	6.88	0.03	294.00	4.93	**83.20**	0.26	7.03	0.03	60.00

Temp = Temperature; Cond. = Conductivity; Turb. = Turbidity; Sal. = salinity; ORP = Oxidation-Reduction Potential; DO% = percentage Dissolved Oxygen; Alk = Alkalinity. N/A = readings were below the detection levels of field titration kits. NB: Default trigger values (ANZECC, 2000) are only available for DO%, pH, Turbidity and Salinity (Conductivity µS/cm). Sample sites on Dog Trap Creek were dry at the time of sampling.

e) Autumn: March 2013

Location	Site	Temp. °C		Cond. µS/cm		Turb. NTU		Sal.ppt		pH		ORP mV		DO% sat'n		DO mg/L		Alk. ppm
ANZECC default trigger values				**3-350**		**2-25**				**6.5-7.5**				**90-110**				
Potential Impact Sites		**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	

Location	Sit e	Temp. °C		Cond. µS/cm		Turb. NTU		Sal.ppt		pH		ORP mV		DO% sat'n		DO mg/L		Alk. ppm
DTC9	U	21.18	0.04	55.67	0.33	12.07	0.79	0.13	0.00	6.58	0.04	278.67	2.03	90.47	0.37	8.03	0.03	18.00
DTC10	D	20.00	0.05	38.67	0.88	18.33	0.34	0.12	0.00	**6.14**	0.01	267.33	2.03	**45.83**	0.41	4.17	0.03	15.00
TTH11	U	19.37	0.00	81.00	0.00	**44.40**	0.32	0.18	0.00	6.68	0.01	287.00	1.15	**51.20**	0.06	4.70	0.00	18.00
TTH12	D	20.92	0.00	**419.00**	0.00	**52.90**	0.20	0.61	0.00	**8.59**	0.02	291.33	1.20	91.13	0.03	8.10	0.00	10.00
HC13	U	17.71	0.02	50.67	0.33	6.10	0.10	0.15	0.00	**6.13**	0.03	267.67	11.29	**65.67**	0.38	6.27	0.03	25.00
HC14	D	21.76	0.02	39.67	0.33	9.50	0.10	0.11	0.00	7.74	0.08	273.67	0.88	**118.33**	4.10	10.47	0.32	23.00
BR15	U	21.50	0.00	0.00	0.00	10.50	1.01	0.06	0.00	6.66	0.05	288.33	0.88	**55.50**	16.8 0	6.40	0.00	N/A
BR16	D	21.19	0.02	0.00	0.00	17.93	1.39	0.06	0.00	6.76	0.07	281.67	2.60	**82.33**	0.24	7.30	0.00	N/A
Control Sites																		
CWC1	U	18.63	0.12	0.00	0.00	12.20	0.17	0.07	0.00	**5.81**	0.01	247.33	3.28	**23.03**	0.22	2.10	0.06	50.00
CWC2	D	19.30	0.05	0.00	0.00	9.43	0.24	0.07	0.00	**6.05**	0.14	244.67	0.33	**27.47**	0.62	2.57	0.07	40.00
CC3	U	21.85	0.39	71.67	0.33	21.60	0.80	0.16	0.01	6.79	0.02	261.33	1.45	**79.13**	1.02	6.97	0.09	14.00
CC4	D	20.40	0.26	118.67	2.33	16.20	0.10	0.22	0.01	**6.40**	0.01	263.67	1.45	**62.37**	1.45	5.73	0.15	13.50
DC5	U	19.82	0.00	68.67	0.67	5.67	0.27	0.16	0.00	**6.43**	0.03	252.67	1.76	**32.23**	0.30	2.93	0.03	20.00
DC6	D	19.72	0.00	138.67	0.88	18.60	0.44	0.25	0.00	**6.35**	0.00	267.00	1.15	**27.57**	0.09	2.50	0.00	18.00
EC7	U	22.60	0.00	11.67	0.33	**55.53**	2.15	0.08	0.00	**5.93**	0.01	267.00	1.73	**56.67**	0.82	4.93	0.09	18.00
EC8	D	23.41	0.03	**403.67**	1.76	**36.37**	0.23	0.58	0.00	7.29	0.13	285.00	2.52	98.87	0.61	8.40	0.06	18.00
CBR1	U	22.29	0.01	0.00	0.00	14.83	0.41	0.06	0.00	**6.40**	0.01	287.33	1.45	**72.20**	0.38	6.27	0.03	N/A
CBR2	D	22.28	0.01	0.00	0.00	14.90	0.42	0.06	0.00	**6.39**	0.01	287.33	0.88	**72.13**	0.39	6.23	0.03	N/A
CMC3	U	19.38	0.12	0.00	0.00	4.33	0.33	0.07	0.00	**5.63**	0.01	294.67	4.33	**79.80**	0.31	7.40	0.00	6.00
CMC4	D	19.37	0.09	0.00	0.00	4.43	0.23	0.07	0.00	**5.62**	0.00	295.00	4.04	**79.93**	0.29	7.40	0.00	6.00
CCC5	U	20.90	0.00	67.00	0.00	11.50	0.36	0.15	0.00	6.34	0.03	289.33	0.88	**66.67**	0.03	5.97	0.03	12.00
CCC6	D	20.91	0.00	67.33	0.33	11.43	0.30	0.15	0.00	6.35	0.03	289.00	1.15	**66.63**	0.03	6.00	0.06	12.00

Location	Site	Temp. °C		Cond. µS/cm		Turb. NTU		Sal.ppt		pH		ORP mV		DO% sat'n		DO mg/L		Alk. ppm
CSQC7	U	18.93	0.00	248.00	0.00	15.70	2.20	0.39	0.00	6.76	0.05	297.00	1.15	**79.73**	0.26	7.37	0.03	16.00
CSQC8	D	19.02	0.00	198.00	1.00	34.73	0.23	0.31	0.00	6.60	0.04	294.33	0.67	**61.77**	0.29	5.73	0.03	16.00

Temp = Temperature; Cond. = Conductivity; Turb. = Turbidity; Sal. = salinity; ORP = Oxidation-Reduction Potential; DO% = percentage Dissolved Oxygen; Alk = Alkalinity. N/A = readings were below the detection levels of field titration kits. NB: Default trigger values (ANZECC, 2000) are only available for DO%, pH, Turbidity and Salinity (Conductivity µS/cm).

f) Autumn: April 2013

Location	Site	Temp. °C		Cond. µS/cm		Turb. NTU		Sal.ppt		pH		ORP mV		DO% sat'n		DO mg/L		Alk. ppm
ANZECC default trigger values				**3-350**		**2-25**				**6.5-7.5**				**90-110**				
Potential Impact Sites		**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	
DTC9	U	20.55	0.18	254.67	0.67	8.00	0.68	0.12	0.00	6.79	0.04	303.67	0.33	96.63	1.18	8.63	0.09	18.00
DTC10	D	17.72	0.01	248.33	0.33	8.10	0.00	0.13	0.00	**6.07**	0.00	291.67	0.33	**38.10**	0.90	3.60	0.06	17.00
TTH11	U	18.15	0.17	319.67	2.03	14.33	0.13	0.16	0.01	**6.42**	0.07	293.67	0.67	**76.10**	1.59	7.13	0.12	30.00
TTH12	D	17.02	0.07	**973.67**	4.98	11.17	0.38	0.51	0.00	**8.02**	0.00	294.00	0.58	**80.70**	2.01	7.67	0.12	N/A
HC13	U	17.99	0.03	**361.33**	1.33	9.70	1.10	0.17	0.00	**6.21**	0.06	290.33	5.78	**83.33**	0.19	7.90	0.00	26.00
HC14	D	14.52	0.01	307.67	0.33	1.37	0.03	0.16	0.00	7.37	0.01	312.67	0.33	**73.23**	0.09	7.50	0.00	24.00
BR15	U	16.74	0.02	167.67	0.33	2.63	0.07	0.08	0.00	**6.44**	0.06	300.33	2.03	**61.27**	0.38	5.93	0.03	10.00
BR16	D	16.44	0.01	169.00	0.00	2.50	0.20	0.08	0.00	6.63	0.04	306.33	0.33	**78.97**	0.43	7.73	0.03	10.00
Control Sites																		
CWC1	U	16.76	0.01	116.00	0.00	10.00	0.50	0.06	0.00	**6.01**	0.01	292.67	0.88	**22.53**	2.77	2.23	0.27	30.00
CWC2	D	17.38	0.10	118.67	0.33	5.17	0.26	0.06	0.00	**6.18**	0.02	297.33	0.88	**51.30**	5.84	5.07	0.58	30.00
CC3	U	16.69	0.03	23.33	0.33	14.03	0.38	0.10	0.01	**6.34**	0.06	271.67	2.60	**78.77**	1.34	7.63	0.09	15.00
CC4	D	17.03	0.02	76.67	0.33	11.60	0.70	0.17	0.00	**6.53**	0.03	281.33	0.33	**62.03**	2.34	5.97	0.20	14.00

Location	Site	Temp. °C		Cond. µS/cm		Turb. NTU		Sal.ppt		pH		ORP mV		DO% sat'n		DO mg/L		Alk. ppm
DC5	U	17.74	0.00	28.00	0.58	12.53	0.44	0.11	0.00	**6.09**	0.02	271.33	0.33	**36.10**	2.60	3.33	0.19	25.00
DC6	D	17.55	0.05	58.67	0.33	15.13	0.09	0.15	0.00	**6.17**	0.01	278.67	0.33	**36.80**	1.60	3.43	0.03	19.00
EC7	U	16.08	0.01	153.00	0.00	13.53	0.15	0.07	0.01	**6.39**	0.00	305.00	0.58	**36.10**	0.31	3.53	0.03	25.00
EC8	D	15.94	0.01	**1000.00**	0.00	6.47	0.20	0.53	0.00	6.99	0.01	312.00	0.00	90.10	0.15	8.87	0.03	18.00

Temp = Temperature; Cond. = Conductivity; Turb. = Turbidity; Sal. = salinity; ORP = Oxidation-Reduction Potential; DO% = percentage Dissolved Oxygen; Alk = Alkalinity. N/A = readings were below the detection levels of field titration kits. NB: Default trigger values (ANZECC, 2000) are only available for DO%, pH, Turbidity and Salinity (Conductivity µS/cm).

g) Spring: September 2013

Location	Site	Temp. °C		Cond. µS/cm		Turb. NTU		Sal.ppt		pH		ORP mV		DO% sat'n		DO mg/L		Alk. ppm
ANZECC default trigger values				**3-350**		**2-25**				**6.5-7.5**				**90-110**				
Potential Impact Sites		**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	
DTC9	U	14.17	0.02	196.33	0.33	12.60	1.45	0.09	0.00	7.36	0.08	613.33	5.24	**76.47**	0.49	7.82	0.06	26.00
DTC10	D	13.74	0.15	204.67	0.33	14.10	0.67	0.09	0.00	7.17	0.02	645.00	0.00	**72.03**	0.09	7.45	0.01	20.00
TTH11	U	15.11	0.01	165.33	0.33	16.43	0.20	0.09	0.00	7.10	0.15	512.00	2.52	**83.17**	1.31	8.33	0.11	20.00
TTH12	D	17.85	0.01	**2106.33**	0.33	19.07	1.30	1.13	0.00	**8.65**	0.00	500.33	5.49	**78.40**	0.38	7.39	0.04	1400.00
HC13	U	13.99	0.01	283.33	0.33	14.77	0.09	0.13	0.00	7.03	0.06	387.67	1.20	**73.40**	0.17	7.58	0.02	24.00
HC14	D	12.83	0.01	265.67	0.33	16.67	1.07	0.13	0.00	7.24	0.07	577.33	0.67	**68.63**	0.30	7.25	0.03	22.00
BR15	U	12.84	0.01	156.00	0.00	3.17	0.87	0.06	0.00	**6.37**	0.06	529.67	2.33	**62.13**	0.61	6.56	0.04	10.00
BR16	D	12.62	0.01	164.00	0.00	0.20	0.00	0.06	0.00	6.85	0.20	334.33	6.36	**73.33**	0.62	7.79	0.06	8.00
Control Sites																		

Location	Site	Temp. °C		Cond. µS/cm		Turb. NTU		Sal.ppt		pH		ORP mV		DO% sat'n		DO mg/L		Alk. ppm
CWC1	U	11.12	0.03	129.00	0.00	11.50	0.20	0.07	0.00	**6.07**	0.09	445.33	11.35	**10.50**	0.68	1.15	0.06	16.00
CWC2	D	12.23	0.01	104.00	0.00	1.50	0.10	0.03	0.00	**6.22**	0.08	524.67	3.76	**45.53**	0.75	4.86	0.07	8.00
CC3	U	13.69	0.06	306.33	0.33	5.47	0.97	0.16	0.00	6.85	0.01	362.33	3.38	**84.17**	1.13	8.72	0.10	34.00
CC4	D	13.85	0.05	**817.00**	1.53	N/A		0.40	0.00	7.22	0.01	646.00	1.53	**89.77**	0.54	9.43	0.09	56.00
DC5	U	13.53	0.04	327.67	0.88	N/A		0.16	0.00	**6.45**	0.04	446.33	4.63	**60.43**	0.84	6.27	0.09	14.00
DC6	D	13.72	0.01	**685.33**	0.33	19.63	0.32	0.33	0.00	7.33	0.10	540.00	1.15	**81.87**	0.73	8.45	0.07	14.00
EC7	U	15.05	0.01	159.00	0.00	**38.67**	0.12	0.09	0.00	6.83	0.13	541.33	6.67	**74.20**	1.23	7.46	0.12	16.00
EC8	D	14.22	0.01	**850.00**	11.00	**98.03**	0.99	0.43	0.01	7.16	0.04	319.00	1.53	**77.23**	0.09	7.90	0.01	18.00
CBR1	U	11.43	0.02	156.00	0.00	N/A		0.06	0.00	6.72	0.09	292.00	7.00	**66.30**	0.85	7.22	0.08	16.00
CBR2	D	12.56	0.01	157.67	0.33	3.93	1.43	0.06	0.00	6.56	0.11	444.33	3.84	**68.43**	0.60	7.29	0.06	8.00
CMC3	U	11.33	0.06	168.67	2.33	N/A	0.00	0.06	0.00	**5.22**	0.17	338.00	18.50	**68.63**	0.81	7.54	0.06	2.00
CMC4	D	12.32	0.03	159.00	0.00	N/A	0.00	0.06	0.00	**4.92**	0.01	395.67	7.88	**70.03**	0.71	7.49	0.06	4.00
CCC5	U	19.13	0.01	302.67	1.33	12.17	0.23	0.16	0.00	6.63	0.04	279.33	0.88	91.77	0.23	8.50	0.00	8.00
CCC6	D	19.02	0.00	300.00	0.00	6.37	0.23	0.16	0.00	6.94	0.01	280.00	1.15	**89.23**	0.09	8.30	0.00	8.00
CSQC7	U	19.07	0.23	**969.33**	6.01	22.50	0.86	0.53	0.01	**5.85**	0.03	268.33	7.31	99.83	1.99	9.27	0.15	6.00
CSQC8	D	20.37	0.09	**836.00**	32.51	**27.87**	0.33	0.44	0.01	6.40	0.03	273.67	1.45	**80.43**	0.32	7.23	0.03	44.00

Temp = Temperature; Cond. = Conductivity; Turb. = Turbidity; Sal. = salinity; ORP = Oxidation-Reduction Potential; DO% = percentage Dissolved Oxygen; Alk = Alkalinity. N/A = Water quality probe was faulty. NB: Default trigger values (ANZECC, 2000) are only available for DO%, pH, Turbidity and Salinity (Conductivity µS/cm).

(h) Spring: October 2013

Location	Site	Temp. °C		Cond. µS/cm		Turb. NTU		Sal.ppt		pH		ORP mV		DO% sat'n		DO mg/L		Alk. ppm
ANZECC default trigger values				**3-350**		**2-25**				**6.5-7.5**				**90-110**				
Potential Impact Sites		**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	
DTC10	D	15.79	0.34	263.33	1.45	**25.50**	1.40	0.13	0.00	6.93	0.04	256.00	2.89	**87.87**	0.93	8.77	0.15	28.00
TTH11	U	12.58	0.07	**514.67**	2.40	**38.97**	0.15	0.27	0.00	6.66	0.07	234.33	3.84	**47.73**	1.05	5.10	0.12	35.00
TTH12	D	12.84	0.03	**2471.00**	1.73	9.03	1.20	1.36	0.00	**9.06**	0.04	261.33	0.88	92.73	0.34	9.73	0.03	1400.00
HC13	U	12.80	0.15	**711.67**	1.20	**77.13**	0.87	0.36	0.01	**6.14**	0.03	288.33	7.26	**35.60**	0.74	3.83	0.09	10.00
HC14	D	12.56	0.06	**391.00**	0.58	2.77	0.67	0.19	0.00	**8.73**	0.03	218.67	4.06	**81.23**	0.67	8.63	0.07	24.00
BR15	U	14.37	0.08	200.33	1.86	**36.50**	3.16	0.10	0.01	**6.44**	0.01	255.33	2.03	**77.60**	1.47	7.97	0.15	10.00
BR16	D	14.42	0.06	203.33	0.33	21.97	0.60	0.09	0.00	7.09	0.05	264.67	0.33	92.70	1.06	9.53	0.09	12.00
Control Sites																		
CWC1	U	11.29	0.04	124.00	0.00	24.90	0.83	0.06	0.01	7.47	0.12	215.67	6.89	**10.80**	0.26	1.20	0.06	16.00
CWC2	D	12.31	0.03	127.67	1.67	16.73	1.03	0.07	0.00	6.87	0.03	264.00	0.58	**43.17**	0.58	4.67	0.07	10.00
CC3	U	14.82	0.00	**384.33**	2.60	17.03	0.95	0.19	0.01	7.20	0.10	245.33	2.91	**60.23**	0.30	6.10	0.00	36.00
CC4	D	14.94	0.03	**562.33**	0.33	**29.17**	2.08	0.28	0.00	7.74	0.02	251.00	2.65	**56.77**	0.30	5.73	0.03	80.00
DC5	U	15.85	0.00	**360.67**	1.33	**28.67**	0.81	0.18	0.00	7.19	0.08	264.33	1.45	**68.20**	0.44	6.77	0.07	16.00
DC6	D	15.62	0.22	**602.67**	1.86	**30.70**	0.40	0.31	0.01	6.45	0.03	249.67	2.60	**38.40**	0.82	3.87	0.12	22.00
EC7	U	17.29	0.36	192.67	2.60	**74.47**	0.23	0.10	0.00	6.85	0.04	233.00	2.31	**76.23**	2.03	7.33	0.20	22.00
EC8	D	19.49	1.07	**1411.33**	7.31	**27.00**	2.58	0.74	0.01	6.81	0.05	258.00	2.31	96.40	1.25	8.97	0.42	14.00
DTC9	U	18.34	0.04	269.33	1.20	**28.03**	0.47	0.13	0.01	6.79	0.01	256.33	2.03	95.73	0.67	9.03	0.09	25.00

Temp = Temperature; Cond. = Conductivity; Turb. = Turbidity; Sal. = salinity; ORP = Oxidation-Reduction Potential; DO% = percentage Dissolved Oxygen; Alk = Alkalinity. N/A = readings were below the detection levels of field titration kits. NB: Default trigger values (ANZECC, 2000) are only available for DO%, pH, Turbidity and Salinity (Conductivity µS/cm)

Appendix E. Water quality: mine water discharge monitoring sites

Mean (±S.E.) water quality results for mine water discharge monitoring sites on Bargo River measured during the Tahmoor South baseline aquatic monitoring surveys conducted in spring: October 2012 and autumn: March 2013 (n=3).

Site	Temp. °C		Cond. µS/cm		Turb. NTU		Sal.ppt		pH		ORP mV		DO% sat'n		DO mg/L		Alk. ppm
ANZECC default trigger values			**3-350**		**2-25**				**6.5-7.5**				**90-110**				
Spring 2012	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	
SBR1	17.61	0.03	204.33	1.20	15.63	2.46	0.15	0.00	**6.35**	0.00	365.00	1.53	**62.17**	0.38	5.93	0.03	8.00
SBR2	16.32	0.00	172.67	24.33	9.20	0.49	0.11	0.02	**6.13**	0.11	372.33	2.03	**81.07**	1.03	7.97	0.12	8.00
SBR3	20.51	0.01	136.0	0.0	4.73	0.07	0.09	0.00	6.74	0.00	328.33	0.88	**84.53**	0.26	7.63	0.03	4.00
SBR4	20.51	0.01	136.0	0.0	4.73	0.07	0.09	0.00	6.74	0.00	328.33	0.88	**84.53**	0.26	7.63	0.03	4.00
SBR5	19.22	0.02	**774.0**	5.6	4.10	0.00	0.52	0.00	**9.04**	0.01	325.67	1.76	**75.30**	0.40	6.93	0.03	12.00
SBR6	20.48	0.01	**879.0**	9.7	7.60	0.12	0.60	0.01	**8.75**	0.01	306.67	0.33	91.83	0.45	8.23	0.03	12.00
SBR7	22.49	0.12	**1091.0**	2.9	12.20	0.56	0.74	0.00	**8.68**	0.00	293.33	0.33	**86.97**	0.43	7.47	0.03	12.00
SBR8	22.55	0.02	**1052.7**	15.7	8.43	0.24	0.70	0.01	**8.66**	0.01	293.00	0.00	98.27	0.61	8.50	0.06	12.00
Autumn 2013																	
SBR1	21.50	0.00	0.00	0.00	10.50	1.01	0.06	0.00	6.66	0.05	288.33	0.88	**55.50**	16.80	6.40	0.00	N/A
SBR2	21.19	0.02	0.00	0.00	17.93	1.39	0.06	0.00	6.76	0.07	281.67	2.60	**82.33**	0.24	7.30	0.00	N/A
SBR3	21.75	0.20	11.7	0.3	24.93	0.43	0.08	0.00	**6.01**	0.02	278.33	0.88	104.87	0.82	9.27	0.09	6.00
SBR4	20.78	0.15	7.0	0.0	7.60	0.00	0.08	0.00	7.14	0.01	283.67	0.33	**89.60**	0.06	8.00	0.00	10.00
SBR5	20.69	0.00	457.3	0.9	3.40	0.00	0.66	0.01	9.36	0.00	288.33	0.33	80.43	0.23	7.17		
SBR6	20.74	0.00	458.0	0.0	2.70	0.10	0.67	0.00	9.24	0.00	284.00	0.00	83.80	0.06	7.50		
SBR7	21.62	0.00	414.3	0.7	0.30	0.00	0.60	0.00	9.03	0.00	282.00	0.00	71.37	0.07	6.30		

Site	Temp. °C		Cond. µS/cm		Turb. NTU		Sal.ppt		pH		ORP mV		DO% sat'n		DO mg/L		Alk. ppm
SBR8	21.65	0.02	414.3	0.3	0.95	0.03	0.62	0.02	9.04	0.01	282.00	0.00	71.33	0.17	6.47		

Temp = Temperature; Cond. = Conductivity; Turb. = Turbidity; Sal. = salinity; ORP = Oxidation-Reduction Potential; DO% = percentage Dissolved Oxygen; Alk = Alkalinity. N/A = readings were below the detection levels of field titration kits. NB: Default trigger values (ANZECC, 2000) are only available for DO%, pH, Turbidity and Salinity (Conductivity µS/cm)

Values in bold are outside the default trigger values recommended by ANZECC (2000) for upland rivers in South-east Australia.

Appendix F. Aquatic fauna trapping: subsidence monitoring sites

Aquatic fauna caught in bait traps and dip nets at subsidence monitoring sites during the Tahmoor South baseline aquatic surveys conducted in (a) Autumn: May 2012 (b) autumn: June 2012 (c) spring: October 2012 (d) spring: November 2012 (e) autumn: March 2013 (f) autumn: April 2013 (g) spring: September 2013 (h) spring: October 2013 (n=3).

a) Autumn: May 2012

May 2012		**Sites**																
	Method	**CWC1**	**CWC2**	**CC3**	**CC4**	**DC5**	**DC6**	**EC7**	**EC8**	**DTC9**	**DTC10**	**TTH11**	**TTH12**	**HC13**	**HC14**	**BR15**	**BR16**	**Total**
Yabby	BT	4	1	1	0	8	1	0	0	0	2	0	0	0	0	0	0	17
Cherax destructor	DN	0	0	1	0	7	4	2	0	10	7	1	0	0	0	0	0	32
Common Freshwater Shrimp	BT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paratya australiensis	DN	0	0	3	30	0	0	0	0	0	3	0	0	0	17	0	8	70
Mosquito Fish	BT	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	2
Gambusia holbrooki	DN	0	0	4	4	7	0	7	0	3	0	1	1	6	1	0	1	35

BT = Bait traps; DN = Dip nets. Control Locations: Bait trap and dip net surveys recorded no aquatic fauna at control locations.

(b) Autumn: June 2012

October 2012		**Sites**																
	Method	**CWC1**	**CWC2**	**CC3**	**CC4**	**DC5**	**DC6**	**EC7**	**EC8**	**DTC9**	**DTC10**	**TTH11**	**TTH12**	**HC13**	**HC14**	**BR15**	**BR16**	**Total**
Yabby	BT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cherax destructor	DN	6	0	0	0	1	3	1	0	0	1	0	0	0	0	0	0	12
Common Freshwater Shrimp	BT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paratya australiensis	DN	20	15	30	15	1	0	0	0	2	15	1	0	0	1	10	0	110
Mosquito Fish	BT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gambusia holbrooki	DN	0	0	9	4	4	5	4	6	0	1	1	2	4	1	1	0	42
Firetail Gudgeon	BT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hypseleotris galii	DN	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	2

BT = Bait traps , DN = Dip nets. Control Locations: Bait trap and dip net surveys recorded no aquatic fauna at control locations.

c) Spring: October 2012

October 2012		Sites																
	Method	**CWC1**	**CWC2**	**CC3**	**CC4**	**DC5**	**DC6**	**EC7**	**EC8**	**DTC9**	**DTC10**	**TTH11**	**TTH12**	**HC13**	**HC14**	**BR15**	**BR16**	**Total**
Yabby *Cherax destructor*	BT	0	0	1	0	12	0	0	0	dry	dry	1	0	0	0	0	0	14
	DN	1	1	2	0	2	0	5	0	dry	dry	2	8	1	0	0	0	22
Common Freshwater Shrimp *Paratya australiensis*	BT	0	0	0	0	0	0	0	0	dry	dry	0	0	0	0	0	0	0
	DN	1	10	16	15	10	0	1	0	dry	dry	0	0	0	0	0	0	53
Mosquito Fish *Gambusia holbrooki*	BT	0	0	0	0	3	0	0	0	dry	dry	0	0	0	0	0	0	3
	DN	0	0	13	0	0	0	4	0	dry	dry	6	1	0	0	0	0	24
Australian Smelt *Retropinna semoni*	BT	0	0	0	0	0	0	0	0	dry	dry	0	0	0	0	0	0	0
	DN	0	0	0	0	0	0	0	0	dry	dry	0	0	0	0	2	0	2

BT = Bait traps; DN = Dip nets. NB. Dog Trap Creek sites (DTC9 & DTC10) were not sampled due to insufficient water depth. Control Locations: Bait trap and dip net surveys recorded no aquatic fauna at control locations.

d) Spring: November 2012

November 2012		Sites																
	Method	**CWC1**	**CWC2**	**CC3**	**CC4**	**DC5**	**DC6**	**EC7**	**EC8**	**DTC9**	**DTC10**	**TTH11**	**TTH12**	**HC13**	**HC14**	**BR15**	**BR16**	**Total**
Yabby *Cherax destructor*																		
	DN	4	14	10	2	0	4	1	0			0	0	0	0	0	0	35
Common Freshwater Shrimp *Paratya australiensis*																		
	DN	8	0	0	20	0	0	0	0			0	0	0	0	0	0	28
Mosquito Fish *Gambusia holbrooki*																		
	DN	0	0	0	0	3	0	1	0	dry	dry	0	0	0	2	0	0	6

DN = Dip nets. NB. Dog Trap Creek sites (DTC9 & DTC10) were not sampled due to insufficient water depth. Control Locations: Bait trap and dip net surveys recorded no aquatic fauna at control locations.

e) Autumn: March 2013

March 2013		Sites																
	Method	**CWC1**	**CWC2**	**CC3**	**CC4**	**DC5**	**DC6**	**EC7**	**EC8**	**DTC9**	**DTC10**	**TTH11**	**TTH12**	**HC13**	**HC14**	**BR15**	**BR16**	**Total**
Yabby	BT	3	25	13	0	22	10	18	1	3	20	10	6	0	1	0	0	131
Cherax Destructor	DN	3	1	1	0	6	2	9	0	9	8	1	3	0	0	0	0	43
Common Freshwater Shrimp	BT	3	13	5	4	0	0	0	2	0	0	0	0	0	2	1	4	27
Paratya australiensis	DN	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Mosquito Fish	BT	0	0	314	1	0	0	0	0	0	0	0	0	54	0	24	8	315
Gambusia holbrooki	DN	0	0	7	10	0	0	1	0	0	1	1	12	0	0	0	0	32
Common Jollytail	BT	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Galaxias maculatus	DN	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Mountain Galaxias	BT	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Galaxias olidus	DN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Australian Smelt	BT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	9
Retropinna semoni	DN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

BT = Bait traps; DN = Dip nets. Control Locations: The following were caught using bait traps: CMC3 – Yabby (2) and Common Jollytail (5); CMC4 - Spiny crayfish *Euastacus spinifer* (3) and Common Jollytail (9); CCC5 – Mosquito Fish (1); CCC6 – Mosquito Fish (2); CSQC8 – Empire Gudgeon *Hypseleotris compressa* (1).

f) Autumn: April 2013

April 2013		Sites																
	Method	**CWC1**	**CWC2**	**CC3**	**CC4**	**DC5**	**DC6**	**EC7**	**EC8**	**DTC9**	**DTC10**	**TTH11**	**TTH12**	**HC13**	**HC14**	**BR15**	**BR16**	**Total**
Yabby																		
Cherax destructor	DN	3	5	4	0	0	9	4	1	4	3	4	5	0	0	0	0	42
Common Freshwater Shrimp																		
Paratya australiensis	DN	3	15	20	2	0	0	0	2	10	8	0	0	0	6	5	9	80
Mosquito Fish																		
Gambusia holbrooki	DN	0	0	30	12	0	0	7	3	1	0	3	4	50	7	2	0	119

DN = Dip nets. Control Locations: No fish were observed.

g) Spring: September 2013

September 2013		Sites																
	Method	CWC1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	DTC9	DTC10	TTH11	TTH12	HC13	HC14	BR15	BR16	Total
Yabby *Cherax destructor*	BT	0	0	6	0	0	0	0	0	3	4	2	0	0	0	0	1	16
	DN	0	0	0	0	0	2	4	0	6	1	0	0	0	0	0	0	13
Common Freshwater Shrimp *Paratya australiensis*	BT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	DN	0	0	0	10	0	0	0	0	5	0	1	0	0	0	0	0	16
Mosquito Fish *Gambusia holbrooki*	BT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	DN	0	0	0	0	1	0	0	0	0	0	0	0	5	0	0	0	6
Common Jollytail *Galaxias maculatus*	BT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	DN	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1

BT = Bait traps; DN = Dip nets. Control Locations: The following were caught using bait traps: CMC3 – Spiny Crayfish (4); CMC4 - Spiny Crayfish (3).

h) Spring: October 2013

October 2013		Sites																
	Method	CWC1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	DTC9	DTC10	TTH11	TTH12	HC13	HC14	BR15	BR16	Total
Yabby *Cherax destructor*	BT	12	8	10	0	6	6	5	0	20	13	0	0	0	0	0	0	80
	DN	5	5	5	0	10	7	19	1	0	8	5	0	0	0	0	0	65
Common Freshwater Shrimp *Paratya australiensis*	BT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	DN	2	10	8	2	0	0	0	0	0	0	3	0	0	0	2	5	32
Mosquito Fish *Gambusia holbrooki*	BT	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
	DN	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Common Jollytail *Galaxias maculatus*	BT	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
	DN	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
Firetail Gudgeon *Hypseleotris galii*	BT	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2
	DN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

BT = Bait traps; DN = Dip nets. Control Locations: No fish were observed.

Appendix G. Aquatic fauna trapping: mine water discharge monitoring sites

Aquatic fauna caught in bait traps and dip nets at mine water discharge monitoring sites during the Tahmoor South baseline aquatic surveys conducted in (a) spring: October 2012 and (b) autumn: March 2013 (n=3).

a) Spring: October 2012

October 2012		Sites								
	Method	SBR1	SBR2	SBR3	SBR4	SBR5	SBR6	SBR7	SBR8	Total
Yabby *Cherax destructor*	BT	0	0	0	0	1	0	0	1	2
	DN	0	0	0	0	0	0	0	0	0
Common Freshwater Shrimp *Paratya australiensis*	BT	0	0	0	0	0	0	0	0	0
	DN	0	0	0	10	0	0	0	0	10
Mosquito Fish *Gambusia holbrooki*	BT	0	0	0	0	0	0	1	0	1
	DN	0	0	0	0	2	0	0	0	2
Australian Smelt *Retropinna semoni*	BT	0	0	0	2	6	0	22	1	31
	DN	2	0	0	0	0	0	0	0	2

BT = Bait traps; DN = Dip nets.

b) Autumn: March 2013

March 2013		Sites								
	Method	SBR1	SBR2	SBR3	SBR4	SBR5	SBR6	SBR7	SBR8	Total
Common Freshwater Shrimp *Paratya australiensis*	BT	1	4	0	0	0	0	0	0	5
	DN	0	0	20	0	0	0	0	0	20
Mosquito Fish *Gambusia holbrooki*	BT	24	7	19	2	0	3	1	4	60
	DN	0	1	1	1	10	10	1	3	27
Australian Smelt *Retropinna semoni*	BT	1	2	0	8	23	19	3	11	67
	DN	0	0	0	0	0	0	0	0	0

BT = Bait traps; DN = Dip nets.

Appendix H. Macrophyte sampling

All macrophytes recorded at sample locations during the Tahmoor South baseline aquatic monitoring surveys...

Scientific Name	Common Name
Baumea juncea	
Carex appressa	
Cotula australis	
Cyperus eragrostis	Umbrella Sedge
Cyperus gracilis	
Cyperus polystachyos	
Elodea canadensis	Canadian Pondweed
Eleocharis sphacelata	Tall Spikerush
Gahia clarkei	Saw Sedge
Geranium homeanum	
Geranium solanderi	
Isolepis prolifera	
Juncus aciculatus	
Juncus acuminatus	
Juncus planifolius	
Juncus usitatus	
Persicaria dicipens	Slender knotweed
Potamogeton tricarinatus	Floating pond weed
Ranunculus muricatus	
Rorippa laciniata	
Rumex brownie	
Schoenus melanostachys	
Spirodela spp	
Typha orientalis	Cumbungi

Appendix I. BC Act Assessment of Significance

Sydney Hawk Dragonfly ***Austrocordulia leonardi***	
Assessment of Significance criteria (Seven Part Test) **Note: Assessment conducted under transitional aarngements.**	**Discussion of criteria**
a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	The following is known about the life cycle of Sydney Hawk dragonfly:: The Sydney Hawk dragonfly has a very restricted distribution The known distribution of the species includes three locations in a small area south of Sydney, from Audley to Picton. . However have recently have been located north of the Hunter increasing its known distribution (Theischinger et al.2013). The species was discovered in 1968 from Woronora River and Kangaroo Creek, south of Sydney and later recorded from the Nepean River at the Maldon Bridge near Wilton. The Sydney Hawk dragonfly spends most of its life underwater (1-2 years) as an aquatic larva, before metamorphosing and emerging from the water as an adult. Adults are thought to only live for a few weeks. All dragonflies are predatory. The larvae stalk or ambush their aquatic prey while the adults capture their prey on their wings. The Sydney Hawk dragonfly has specific habitat requirements, and has only ever been collected from deep and shady riverine pools with cooler water and is thought to occur in larger streams in the Sydney basin (Theischinger et al. 2013). Larvae are found under rocks where they co-exist with *Austrocordulia refracta* (DPI, 2011a). Due to their 1-2 year larval development, Sydney-Hawk dragonfly are thought to require good stream connectivity. Sampling for the threatened dragonfly by target sampling and the baseline monitoring program failed to detect the presence of Sydney Hawk dragonfly however potential habitat is likely in the larger streams such as Bargo River and Nepean River. Subsidence is not predicted to impact these streams therefore no impact to dragonfly lifecycle or population is expected. Mine water discharge is not expected to change the current condition of these streams and may actually improve as a result of the installation of a heavy metal treatment plant. Therefore mine water discharge is not expected to impact the dragonfly's lifecycle or population.
b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction	N/A
c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	N/A

i. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or ii. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	
d) In relation to the habitat of a threatened species, population or ecological community: i. The extent to which habitat is likely to be removed or modified as a result of the action proposed, and ii. Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and iii. The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.	<u>Extent of habitat</u> As this species is so rare and there are few recorded occurrences, little is known of its exact habitat requirements and preferences. Targeted surveys were conducted using the limited information available regarding habitat preferences (i.e. deep pools with a cobble substrate). Due to their long life cycle, good stream connectivity is also thought to be important. The most appropriate habitat with in the study area includes the larger streams such as the Bargo River and Nepean River. These streams are unlikely to be modified by the proposed action. <u>Fragmentation</u> The habitat is unlikely to become fragmented as Bargo River and Nepean River will not experience subsidence impacts. Also no known populations occur in the Project Area. Importance of habitat to be impacted It is unclear as to how important the habitat is to the sustainability of the species. However given no Sydney Hawk dragonfly has been observed in the Bargo River and they have only been recorded in the Nepean River at Maldon Bridge that the potential habitat in the Project Area is of low-moderate importance.
e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)	No areas of critical habitat for the Sydney Hawk dragonfly have been recommended or declared in NSW.
f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or TAP	There are no recovery plans or threat abatement plans relevant to this species. Conservation and recovery actions listed in DPI (2007) include: Allocate and manage environmental water through water sharing planning processes, to lessen the impacts of altered flows. • Prevent sedimentation and poor water quality by using conservation farming and grazing practices, conserve and restore riparian (river bank) vegetation and use effective erosion and sediment control measures. • Rehabilitate degraded habitats. Protect riparian vegetation and encourage the use of effective sediment control measures in catchments where the dragonfly may occur. • Protect the few remaining sites with the potential to support the species, and address key threats such as habitat degradation and water quality decline. • Conduct further research into the species’ biology, ecology and distribution.

	The most relevant action is water quality decline, as mine water discharge may change water quality in areas of potential habitat. However the proposed action will not negatively alter water quality. With the installation of a heavy metal treatment plant the water quality from mine water discharge is expected to improve. The proposed action is therefore unlikely to degrade any potential habitat in the Bargo River and Nepean River.
g) Whether the action proposed constitutes or is part of a KTP or is likely to result in the operation of, or increase the impact of, a KTP	While longwall mining resulting in the alteration of habitat is listed as a Key Threatening Process (KTP) under the BC Act 2016, the proposed action is not classed as a KTP under the FM Act 1994, under which Sydney Hawk dragonfly are listed. Human induced climate change is listed as a KTP under the FM Act. There is physical evidence that human-caused climate change is affecting biodiversity globally, in terrestrial, freshwater and marine systems. The International Panel on Climate Change (IPCC 2013) stated that "observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature changes". Climate change is also predicted to have an impact on freshwater communities through the changes in the seasonality of rainfall (increases and decreases) and the frequency and severity of storm events. Annually, the numbers of extreme warm events is likely to increase. The regional scenario for NSW freshwater aquatic systems is for drying of aquatic areas, increased drought occurrence, higher water temperatures with diminished water flows, which will produce low oxygen levels and increased conductivity (salinity). Freshwater communities of fish and invertebrates in rivers, swamps and floodplains are likely to experience additional impacts as most species have specialised habitat and dietary requirements. Compared to the open estuaries and ocean waters, freshwater rivers are geographically constrained and limit the migratory options for aquatic plants, invertebrates and fish. Freshwater flows are a stimulus for breeding in many Australian freshwater fish species and thus the changes in volume and timing of spring floods are predicted to significantly impact fish recruitment. With low or reduced flow, freshwater river systems will shift towards lotic rather than lentic environments with a corresponding shift in the biological communities. In shallow freshwater rivers and lakes there is a balance between the phytoplankton communities (heterotrophy) and the bacterial biofilm (mostly autotrophs) on the substrate as the primary producers. Under some climate change scenarios a metabolic shift from heterotrophic communities to autotrophic communities is predicted. Coal extraction of up to 4.4 million tonnes of ROM coal per annum is proposed as part of the development. The Proposed developments main sources of Green House Gas (GHG) emissions include fugitive methane from mine ventilation, pre and post-drainage and flaring. Other emissions include diesel, unleaded petrol consumption, post-mining activities, electricity use and use of SF6 (sulphur hexafluoride gas) (Pacific Environment 2018). The GHG Assessment prepared for Tahmoor Coal found that the proposed developments contribution to the projected climate change and the associated impacts would be in proportion with its contribution to global GHG emissions. Average annual scope 1 emissions from the proposed development (0.5 million tonnes (Mt CO2-e) would represent approximately 0.1% of Australia's commitment under the Kyoto Protocol (591.5 Mt CO2-e) and a very small portion of global greenhouse emissions, given that Australia contributed approximately 1.5% of global GHG emissions in 2005 (Pacific Environment 2018). This value does not include the energy use to produce both thermal and coking coal and the combustion of product coal, which is by far the greatest contributing factor to GHG emissions. While the majority of the product coal will be combusted in other countries, the burning of coal is the largest contributor to CO2 emissions and will contribute to climate change regardless of where it is burned. Tahmoor Coal will employ a number of mitigation measures at the Project site to minimise the generation of GHG emissions. Such measures will include fugitive methane abatement such as the use of flares and recycling through a co-generation plant and Continuous Emissions Monitoring of fugitive emissions (Pacific Environment 2018). The extraction and later burning of coal is likely to contribute to human-induced climate change in the long term and as such the proposal is considered likely to increase a KTP listed under the FM Act.

Conclusion: The proposed action will not have a significant impact on the Sydney Hawk Dragonfly.

Appendix J. AUSRIVAS macroinvertebrate results

a) Autumn May 2012

SITE	CWC1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	DTC9	DTC10	TTH11	TTH12	HC13	HC14	BR15	BR16
Acarina	0	1	1	2	1	3	2	5	1	2	5	13	3	3	6	3
Aeshnidae	0	1	1	1	2	1	1	4	0	1	1	0	3	0	0	0
Atriplectididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Atyidae	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetidae	0	0	0	0	4	1	2	0	11	19	9	108	0	0	0	0
Caenidae	0	0	2	0	0	1	0	2	3	0	0	4	0	0	0	0
Calamoceratidae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Ceinidae	0	3	1	9	1	0	0	6	0	0	2	0	0	7	6	4
Ceratopogonidae	0	0	0	1	0	0	0	0	0	0	1	0	1	0	1	0
Chaoboridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironominae	2	1	15	2	12	7	26	3	7	10	14	1	36	16	2	2
Cladocera	0	0	6	0	0	0	1	0	0	1	0	0	1	0	0	0
Coenagrionidae	0	0	5	22	0	2	2	1	0	3	0	3	11	10	0	1
Collembola	0	0	0	0	0	0	0	1	1	3	3	0	0	1	0	0
Corbiculidae	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	1	0	0	0
Culicidae	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0
Diphlebidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dixidae	1	7	0	11	0	4	1	0	2	1	4	3	0	5	0	0
Dytiscidae	6	3	3	3	5	2	4	2	10	3	7	5	0	0	0	0
Ecnomidae	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Gelastocoridae	0	0	3	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	1	0	1
Gyrinidae	2	0	0	0	0	0	0	2	5	0	1	0	0	0	2	1
Harpacticoida	0	1	0	0	4	3	11	1	6	5	1	0	2	0	0	0

Hemicorduliidae	0	0	6	2	2	1	0	1	0	0	0	0	25	4	0	0
Hydraenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Hydrobiosidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Hydrophilidae	0	0	0	1	0	0	1	0	0	0	0	0	0	4	0	1
Isostictidae	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0
Leptoceridae	27	26	14	10	1	17	1	21	1	4	23	13	0	6	37	12
Leptophlebiidae	21	33	25	22	23	33	50	65	57	41	19	24	6	3	84	44
Lymnaeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Megapodagrionidae	9	4	5	0	0	2	0	19	0	0	1	0	9	0	1	2
Odontoceridae	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1
Oligochaeta	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0
Orthocladiinae	0	0	0	0	0	0	0	1	4	0	0	3	4	2	0	1
Ostracoda	0	0	0	0	2	5	2	0	0	2	3	0	0	0	0	0
Parastacidae	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Philorheithridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Physidae	0	0	0	4	0	0	0	0	0	0	1	5	0	1	0	0
Pleidae	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Polycentropodidae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Scirtidae	6	15	2	2	3	1	1	0	0	1	0	0	0	4	3	4
Simuliidae	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	4
Sisyridae	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Stratiomyidae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Styloniscidae	0	0	2	0	0	0	0	0	0	0	1	1	0	0	0	0
Synlestidae	0	0	0	0	0	0	0	8	0	0	8	5	0	0	0	0
Synthemistidae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Talitridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tanypodinae	0	3	0	0	2	1	4	1	1	0	11	5	7	2	2	0

Telephlebiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Tipulidae	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
Turbellaria	0	0	0	1	0	0	0	1	0	0	0	0	3	0	1	0
Veliidae	0	0	0	0	1	0	1	0	2	0	0	0	0	1	0	0

b) Autumn June 2012

SITE	CWC1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	DTC9	DTC10	TTH11	TTH12	HC13	HC14	BR15	BR16
Acarina	1	5	0	1	1	3	0	2	0	0	0	9	6	4	3	12
Aeshnidae	0	0	2	2	1	0	0	11	0	0	0	0	2	1	0	0
Ancylidae	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Atyidae	0	1	0	4	0	0	0	0	1	0	1	0	0	0	0	0
Baetidae	0	2	1	7	16	2	11	0	60	46	3	8	0	0	5	2
Caenidae	0	0	1	0	1	0	0	1	2	0	0	3	0	0	0	0
Ceinidae	0	6	0	18	0	0	0	10	0	0	9	0	0	2	3	3
Ceratopogonidae	2	2	0	0	0	0	1	3	0	2	0	1	0	1	0	1
Chironominae	6	2	39	10	4	4	58	5	23	11	27	3	57	34	3	3
Cladocera	0	0	1	1	0	0	2	0	0	23	2	0	0	2	12	1
Coenagrionidae	0	0	12	12	1	0	4	1	0	0	0	2	13	3	0	0
Collembola	0	0	1	0	0	0	0	1	5	5	1	0	2	1	0	0
Corbiculidae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Cordulephyidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Corixidae	0	2	13	1	0	0	0	0	24	0	5	10	0	5	1	0
Culicidae	0	0	1	0	0	0	1	0	0	3	0	0	0	1	0	0
Cyclopoida	2	4	10	5	16	0	8	1	14	6	5	1	9	7	0	0
Dixidae	3	2	0	31	4	0	4	0	3	0	7	4	5	5	0	0
Dytiscidae	5	6	1	13	8	1	8	3	6	0	9	3	0	8	0	0
Ecnomidae	2	0	0	0	0	0	0	4	0	0	0	0	0	1	0	0
Empididae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1

Gelastocoridae	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0
Gyrinidae	3	0	1	0	0	0	0	0	4	11	2	8	0	0	0	1
Hemicorduliidae	0	0	2	2	0	0	0	0	0	0	0	0	12	2	0	0
Hydraenidae	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0
Hydridae	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrobiosidae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Hydrophilidae	0	0	0	0	0	0	1	0	0	0	0	2	0	4	0	0
Hydroptilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Isostictidae	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Leptoceridae	33	29	0	25	6	30	11	19	8	9	18	18	8	40	22	34
Leptophlebiidae	40	87	28	54	9	63	45	92	21	51	13	21	7	23	75	32
Libellulidae	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Megapodagrionidae	3	5	0	1	0	6	0	24	0	0	0	2	2	1	0	0
Mesoveliidae	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Naucoridae	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Nematoda	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Notonectidae	10	9	6	3	7	7	9	4	19	12	6	13	1	3	7	5
Odontoceridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Oligochaeta	0	0	0	1	1	1	1	0	0	0	0	1	0	1	0	0
Orthocladiinae	0	0	2	0	0	1	0	0	3	1	0	0	14	8	0	0
Ostracoda	0	1	2	10	4	4	2	2	6	0	8	0	0	1	0	2
Philorheithridae	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	1
Physidae	0	0	0	0	0	0	0	1	0	0	4	5	1	1	0	0
Psephenidae	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Psychodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Scirtidae	2	4	1	0	2	2	3	3	1	2	0	1	0	4	0	0
Simuliidae	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0

Sisyridae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Styloniscidae	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Synlestidae	0	0	1	0	0	0	0	11	0	0	16	2	0	0	0	0
Talitridae	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Tanypodinae	1	4	4	9	0	2	0	14	2	4	10	4	6	9	5	2
Telephlebiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Tipulidae	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0
Turbellaria	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0
Veliidae	0	0	0	1	0	1	1	0	1	0	1	0	0	0	0	0

c) Spring October 2012

SITE	CWC1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	TTH11	TTH12	HC13	HC14	BR15 (SBR1)	BR16 (SBR2)	SBR 3	SBR4	SBR5	SBR6	SBR7	SBR8
Dugesiidae	0	0	0	1	0	0	0	0	0	0	2	0	0	1	1	1	1	1	0	0
Glossiphoniidae	0	0	0	0	0	0	1	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	1	1	2		
Pyralidae	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
Ancylidae	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Physidae	0	0	0	5	0	0	0	0	5	1	0	1	0	0	0	0	0	0	0	0
Corbiculidae	0	0	0	5	0	0	0	1	0	0	0	5	4	0	0	2	1	6	0	0
Nematoda	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Oligochaeta	0	0	0	1	0	0	1	0	2	0	4	1	0	0	0	1	0	0	1	0
Gripopterygidae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Acarina	3	4	0	0	0	0	3	0	1	3	0	1	3	0	3	1	4	5	5	8
Talitridae	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1
Ostrocoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	3	0	0	0	0
Ceinidae	0	1	0	27	0	0	1	0	12	0	0	0	1	0	27	0	1	0	5	15
Oniscidae	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2	0	1	2

Atyidae	4	5	5	1	0	0	1	0	0	0	0	0	3	2	0	0	1	0	2	0
Dytiscidae	2	3	1	3	1	0	5	0	6	4	4	3	2	0	1	0	4	0	1	2
Gyrinidae	0	2	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	1
Elmidae	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	18	6
Hydrophilidae	1	0	2	1	2	1	4	0	0	1	1	0	0	0	0	0	0	0	0	0
Hydraenidae	0	0	1	2	0	1	5	0	1	1	1	1	1	0	0	0	0	0	0	0
Scirtidae	4	3	0	3	0	4	1	0	0	6	1	1	5	4	0	0	0	0	0	1
Psephenidae	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrochidae	0	0	0	1	0	0	0	0	0	0	0	0	0	0	4	0	0	1	3	1
Tipulidae	0	1	1	1	0	0	0	0	3	0	0	0	0	1	0	0	0	0	0	6
Chaoboridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0
Dixidae	0	0	11	29	4	2	2	0	12	2	0	0	1	24	6	4	24	5	10	1
Culicidae	1	0	1	1	0	3	53	0	2	0	0	0	1	0	0	0	0	0	0	0
Ceratopogonidae	0	0	2	0	0	1	0	1	1	2	0	7	1	1	0	1	13	1	5	11
Tanypodinae	0	1	0	1	0	0	0	3	5	0	3	16	2	2	9	1	10	6	7	10
Podonominae	0	0	0	0	0	0	1	1	0	0	1	3	0	0	3	0	0	0	0	0
Orthocladiinae	0	0	0	0	0	0	0	0	0	0	2	2	0	0	16	64	1	8	4	1
Chironominae	0	2	4	6	2	2	5	0	3	2	23	3	0	5	0	1	28	4	8	2
Baetidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
Leptophlebiidae	26	26	16	36	7	2	45	35	2	2	0	2	71	22	0	0	0	1	0	0
Caenidae	1	0	0	0	0	0	0	0	0	4	0	0	0	1	0	0	0	0	1	0
Veliidae	1	1	2	0	1	5	8	1	1	0	0	0	0	1	3	1	12	4	7	1
Gelastocoridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	8	0
Gerridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7
Corixidae	0	1	8	1	0	4	0	0	9	14	0	0	0	0	2	1	0	0	0	0
Notonectidae	7	4	1	3	2	1	2	5	4	2	0	0	5	0	0	0	0	0	0	0
Hydrometridae	3	1	0	0	1	0	0	1	1	0	0	0	0	0	11	2	2	2	8	0
Pleidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Sisyridae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0

Coenagrionidae	1	0	2	15	0	0	2	0	3	0	32	6	0	0	0	0	0	0	0	0
Isostictidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0
Lestidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Megapodagrionidae	3	0	0	0	3	2	0	1	4	0	14	1	1	6	0	4	0	1	0	0
Synlestidae	0	1	1	0	0	0	0	3	2	2	0	0	3	0	0	0	0	0	1	0
Aeshnidae	0	0	0	1	0	0	0	1	0	0	5	0	0	0	2	0	0	0	0	0
Gomphidae	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
Corduliidae	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
Telephlebiidae	1	0	2	0	0	0	0	1	0	0	1	0	0	1	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
Hemicorduliidae	0	0	0	1	0	0	0	0	0	1	39	3	0	0	0	0	0	0	0	0
Hydrobiosidae	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	1	1	4	0	0	0	4	3
Ecnomidae	0	0	1	0	0	0	0	0	0	4	0	1	0	0	1	1	5	0	3	5
Odontoceridae	0	0	0	1	0	0	0	1	0	0	0	0	6	0	0	1	0	0	0	0
Atriplectididae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	4	0	0	0	0
Calamoceratidae	0	0	0	0	0	0	0	2	0	0	0	0	4	2	0	4	0	4	2	0
Leptoceridae	23	25	13	25	6	28	4	11	35	11	2	12	3	54	14	26	2	2	17	6

d) Spring November 2012

SITE	CWC1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	TTH11	TTH12	HC13	HC14	BR15	BR16
Dugesiidae	0	0	0	6	0	0	1	0	0	0	1	0	0	0
Glossiphoniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sialidae	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Lymnaeidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Pyralidae	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Ancylidae	1	0	0	0	0	0	0	0	2	0	0	0	0	0
Planorbidae	0	0	0	4	0	0	0	0	0	0	0	0	0	0

Physidae	0	0	0	0	0	0	0	0	0	1	1	2	0	0
Corbiculidae	0	0	0	18	0	0	0	0	0	0	0	3	5	0
Nematoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oligochaeta	0	2	0	4	0	1	9	0	0	0	0	2	1	1
Gripopterygidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acarina	1	3	1	1	0	0	1	0	1	1	0	0	0	1
Talitridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ceinidae	0	3	0	7	0	1	0	0	1	0	0	0	0	0
Oniscidae	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Atyidae	8	12	3	8	0	0	0	0	0	0	0	0	5	3
Dytiscidae	6	7	0	0	10	9	11	0	16	2	0	7	0	1
Gyrinidae	0	2	0	0	0	0	0	0	1	0	0	1	3	0
Elmidae	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Hydrophilidae	1	0	0	2	0	0	2	0	0	0	0	2	0	0
Hydraenidae	0	0	0	0	1	0	3	0	6	4	0	0	0	0
Scirtidae	2	1	0	0	0	1	0	0	1	0	0	0	1	4
Hydrochidae	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Tipulidae	0	0	0	0	1	1	0	1	0	0	0	1	1	0
Dixidae	0	0	0	0	2	0	0	0	0	2	0	0	0	14
Culicidae	0	0	0	0	0	19	3	1	0	6	0	2	3	0
Ceratopogonidae	0	0	0	0	0	0	0	1	0	0	0	2	2	0
Tanypodinae	0	5	0	1	6	10	0	1	16	0	0	1	0	0
Podonominae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Orthocladiinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironominae	12	1	8	1	6	1	21	30	12	0	0	32	1	0
Baetidae	0	0	0	0	0	0	0	0	4	0	0	0	0	0
Leptophlebiidae	44	73	17	27	21	32	56	34	53	4	2	4	26	17
Caenidae	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Veliidae	1	0	1	4	0	17	5	0	2	1	0	0	1	0

Gelastocoridae	0	0	0	1	0	0	0	0	0	2	0	2	0	0
Gerridae	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Corixidae	0	1	16	1	1	1	5	0	17	5	4	5	0	0
Notonectidae	7	13	0	2	1	4	8	1	9	1	0	3	3	3
Hydrometridae	0	0	0	0	0	3	0	0	2	1	0	1	0	0
Pleidae	0	0	0	0	0	0	0	1	0	0	2	0	1	0
Sisyridae	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	6	6	0	0
Diphlebidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lestidae	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Megapodagrionidae	0	6	0	1	0	0	0	7	0	0	3	5	1	1
Synlestidae	0	3	0	1	0	0	0	3	4	0	0	3	8	13
Aeshnidae	0	0	0	0	0	0	0	0	0	0	3	0	0	0
Gomphidae	0	0	0	0	0	0	1	2	0	0	0	0	0	2
Corduliidae	0	0	0	6	0	0	0	0	1	0	0	0	0	0
Telephlebiidae	0	0	0	1	0	0	0	3	0	0	0	0	0	1
Synthemistidae	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Hemicorduliidae	0	0	0	0	0	0	0	0	0	0	33	7	0	0
Polycentropodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ecnomidae	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Philorheithridae	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Odontoceridae	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Atriplectididae	0	0	0	0	0	0	0	0	0	0	0	0	3	1
Calamoceratidae	0	0	0	1	0	0	0	0	0	0	0	0	5	1
Leptoceridae	25	28	1	22	1	7	3	16	11	1	0	21	35	37

e) Autumn March 2013

SITE	CWC1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	DTC9	DTC10	TTH11	TTH12	HC13	HC14	BR15 (SBR1)	BR16 (SBR2)	SBR3	SBR4	SBR5	SBR6	SBR7	SBR8
Turbellaria	0	0	0	0	0	0	0	0	0	0	0	0	1	7	0	3		3				
Sialidae	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0		1				
Physidae	0	0	0	2	0	0	0	0	0	0	1	1	0	8	0	0						
Corbiculidae	0	0	0	1	0	0	0	1	0	0	0	0	0	4	7	0		1	1	1		
Oligochaeta	0	0	0	6	0	0	0	0	0	0	0	0	0	0	1	3		2				
Gripopterygidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3						
Acarina	1	2	1	0	0	1	2	4	1	2	2	0	0	0	4	3	3	6	1	11	16	2
Cladocera	0	0	0	0	2	2	1	0	0	0	0	0	0	0	0	0						
Ostracoda	0	2	0	1	3	1	1	0	0	0	0	0	0	0	0	0						
Ceinidae	0	1	0	0	0	0	0	9	0	0	1	0	0	0	8	3	1	1				
Atyidae	3	13	5	4	0	0	0	2	0	0	0	0	0	1	1	4	23	1	3			10
Parastacidae	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0				1		
Dytiscidae	6	5	0	2	7	4	14	0	11	30	14	8	1	5	3	2	3		4	1	2	
Gyrinidae	0	1	0	0	0	0	0	0	2	2	1	1	0	0	1	1		1				
Elmidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	1				
Hydrophilidae	0	0	0	0	0	0	1	0	0	0	0	5	0	0	0	2		2		1		
Hydraenidae	1	0	0	2	0	0	0	0	0	0	1	0	6	3	0	3						
Scirtidae	2	0	0	0	0	0	0	1	0	1	0	0	0	0	0	2						
Tipulidae	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0		1				
Dixidae	0	0	1	3	0	0	0	0	0	1	0	0	0	0	0	2						
Culicidae	0	0	0	0	1	1	3	0	0	0	0	0	0	0	1	0						
Ceratopogonidae	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	1		2				
Tanypodinae	1	1	1	2	0	0	0	1	2	0	0	0	6	5	4	1	1	5	2		1	
Orthocladiinae	0	0	0	2	0	0	0	0	2	0	0	0	10	23	0	0		1		1	2	4
Chironominae	0	0	4	4	2	7	4	11	5	2	6	2	73	21	1	1		8	34	11	7	11

Baetidae	0	1	3	2	12	0	2	0	4	2	1	4	7	1	0	0	1		8	2		4
Leptophlebiidae	40	46	20	38	19	74	46	27	52	89	2	5	17	5	61	51	4	27	3	8	1	5
Caenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		2	3	1		6
Veliidae	0	0	0	2	3	0	1	2	0	1	3	0	0	2	0	0		2				
Gelastocoridae	0	1	1	0	0	0	0	0	0	1	1	0	0	4	0	0		1				
Belostomatidae	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0						
Gerridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			1			
Corixidae	0	1	8	5	2	0	3	0	0	1	24	0	0	1	0	3	3	3	21	25	9	5
Notonectidae	7	5	3	0	0	0	11	4	7	0	0	3	3	0	0	0						
Hydrometridae	0	1	0	1	2	0	0	0	0	0	0	0	0	0	0	0						
Coenagrionidae	0	0	6	2	1	0	4	3	1	1	1	2	39	21	3	3	41	5	2	6	2	2
Isostictidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					3	
Megapodagrionidae	2	1	0	0	0	2	0	8	0	0	0	0	9	8	2	2	2					
Synlestidae	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0						
Aeshnidae	0	0	0	0	0	0	0	2	0	0	0	2	2	3	0	0					1	
Gomphidae	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0				1		
Telephlebiidae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0		1	1			1
Synthemistidae	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0		1				
Hemicorduliidae	0	0	1	0	1	1	1	0	0	0	0	0	18	17	0	1	1					1
Cordulephyidae	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0						
Protonourida e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					8	1
Libellulidae	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0		1				

Polycentropodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
Ecnomidae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0		1	8	2		2
Philorheithridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0						
Odontoceridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1						
Atriplectididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1						
Calamoceratidae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	3			1			
Leptoceridae	5	2	0	8	1	4	2	8	1	0	0	0	0	26	29	43	13		2	20	10	20

f) Autumn April 2013

SITE	CWC 1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	DTC9	DTC10	TTH11	TTH12	HC13	HC14	BR15	BR16
Turbellaria	0	0	0	7	0	0	0	0	0	0	0	0	3	0	0	0
Sialidae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Lymnaeidae	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Physidae	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0
Corbiculidae	0	0	0	12	0	0	0	0	0	0	0	0	1	3	0	0
Oligochaeta	0	0	0	1	0	0	0	0	1	0	0	0	2	1	0	0
Pyrilidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Acarina	1	12	0	0	1	0	1	0	2	1	3	0	0	1	3	0
Ceinidae	0	0	0	17	0	0	0	2	0	0	2	0	0	2	1	3
Atyidae	3	5	3	1	0	0	0	2	0	0	0	0	0	1	2	6
Parastacidae	1	0	1	0	3	1	2	0	4	2	1	3	0	0	0	0
Dytiscidae	0	3	1	5	2	3	8	0	11	15	2	11	1	3	1	5
Gyrinidae	2	0	1	0	0	1	0	1	1	3	0	4	0	1	3	2
Elmidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrophilidae	0	1	0	1	0	0	2	0	0	0	1	0	0	3	0	0

Hydraenidae	2	0	0	3	1	0	3	2	2	0	3	2	1	2	0	0
Scirtidae	3	0	0	6	0	0	2	0	1	0	0	0	0	1	0	0
Psephenidae	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Chrysomeliidae	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Hydrochidae	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0	0	3	1	1	0	0	0	0	0	1
Dixidae	0	0	0	2	0	0	0	0	2	3	0	0	0	1	0	1
Culicidae	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0
Ceratopogonidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Tanypodinae	3	0	2	1	0	1	0	1	0	3	2	1	3	10	0	3
Orthocladiinae	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0
Chironominae	3	2	1	4	3	0	0	2	4	2	4	0	29	34	2	1
Baetidae	0	0	1	0	0	1	0	1	2	2	0	13	0	1	0	4
Leptophlebiidae	51	16	14	58	17	49	6	27	24	38	11	6	13	1	67	16
Caenidae	0	0	0	1	0	0	0	0	0	3	0	0	0	0	1	0
Veliidae	0	0	0	1	2	0	2	0	2	1	1	0	1	2	0	0
Gelastocoridae	1	1	3	1	0	0	0	0	1	0	0	0	1	3	0	1
Belostomatidae	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Gerridae	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Corixidae	0	1	0	1	0	3	1	3	3	2	11	20	1	1	0	9
Notonectidae	7	9	12	8	4	0	0	0	3	0	0	0	0	0	0	0
Hydrometridae	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
Pleidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Coenagrionidae	0	0	4	25	0	0	0	0	0	2	0	4	24	11	0	1
Isostictidae	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0
Megapodagrionidae	0	0	1	10	1	0	0	10	0	0	0	1	8	3	0	1
Synlestidae	0	0	0	0	0	0	0	2	0	0	0	1	0	1	0	0
Aeshnidae	0	1	1	3	1	0	0	1	0	0	0	5	0	3	0	0

Gomphidae	0	0	0	1	0	0	0	5	0	1	0	0	0	1	0	1
Telephlebiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Synthemistidae	0	0	0	0	1	0	1	0	1	1	0	0	0	0	0	0
Hemicorduliidae	0	0	0	0	0	0	0	1	1	0	0	0	18	10	0	0
Cordulephyidae	0	0	0	0	0	0	0	0	0	0	0	0	4	4	2	1
Austrocorduliidae	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Protonouridae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Libellulidae	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0
Polycentropodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Hydroptilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Ecnomidae	1	0	1	0	0	0	0	0	3	0	0	0	0	0	0	0
Odontoceridae	0	0	0	4	0	0	0	3	0	0	0	0	0	0	0	0
Atriplectididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Calamoceratidae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Leptoceridae	3	18	2	32	16	2	21	10	8	10	24	7	7	22	12	30

g) Spring September 2013

SITE	CWC1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	DTC9	DTC10	TTH11	TTH12	HC13	HC14	BR15	BR16
Turbellaria	0	0	0	5	0	0	0	0	0	0	2	0	0	0	0	0
Sialidae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Lymnaeidae	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Ancylidae	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Physidae	0	0	0	2	0	0	0	0	0	0	1	0	3	0	0	0
Corbiculidae	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
Oligochaeta	0	0	0	0	0	0	0	1	0	2	0	0	1	4	2	4
Acarina	1	9	0	0	0	1	3	3	0	2	0	5	0	0	3	3
Ceinidae	0	0	0	2	1	0	1	2	0	0	2	0	0	3	1	3

Atyidae	0	1	3	4	0	0	0	0	4	0	1	0	0	0	5	0
Parastacidae	1	1	5	0	2	1	5	0	7	0	0	0	0	0	0	0
Dytiscidae	4	3	1	0	6	10	4	3	13	8	7	10	4	3	0	1
Gyrinidae	0	1	0	1	0	0	0	1	1	0	0	1	0	0	1	0
Elmidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
Hydrophilidae	0	0	0	1	1	2	1	1	0	1	1	0	0	3	4	2
Hydraenidae	1	0	0	1	0	4	1	4	2	2	8	0	1	0	0	0
Scirtidae	5	0	3	4	15	11	2	3	10	2	2	0	4	3	1	1
Psephenidae	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrochidae	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0	1	0	0	8	6	0	0	0	0	0
Dixidae	0	1	0	11	15	0	10	0	16	4	7	1	3	11	0	0
Simuliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Stratiomiyidae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Culicidae	0	0	0	3	1	0	5	0	1	3	1	0	0	0	3	0
Ceratopogonidae	0	2	0	0	0	0	1	1	5	1	2	0	1	4	3	7
Tanypodinae	3	0	0	0	0	0	0	9	1	2	0	11	5	15	6	5
Orthocladiinae	1	2	0	0	0	0	0	4	1	0	0	0	6	12	0	1
Chironominae	12	4	2	2	1	27	4	8	2	3	4	6	46	65	5	8
Baetidae	0	0	0	2	2	1	2	0	13	5	7	1	1	4	5	18
Leptophlebiidae	44	28	27	23	14	6	18	21	31	47	12	36	22	3	52	44
Caenidae	0	0	1	0	0	0	0	0	1	3	1	15	0	1	0	1
Veliidae	2	0	0	3	2	4	2	1	0	3	0	0	1	2	1	1
Gelastocoridae	1	1	1	2	0	0	0	2	0	2	0	0	2	2	0	0
Gerridae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Corixidae	0	0	7	11	1	4	1	0	3	1	2	1	0	0	0	1
Notonectidae	8	3	1	3	4	4	9	3	4	1	2	2	9	0	0	0
Hydrometridae	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
Coenagrionidae	0	0	1	10	0	0	0	1	1	1	0	3	18	7	3	1

Isostictidae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Megapodagrionidae	0	1	1	3	0	0	0	17	0	0	0	0	11	4	0	0
Synlestidae	0	0	0	0	0	0	0	2	0	0	0	3	0	0	0	1
Aeshnidae	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Gomphidae	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0
Telephlebiidae	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1
Synthemistidae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Hemicorduliidae	0	0	0	0	1	0	0	0	7	0	0	2	7	3	1	2
Cordulephyidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Libellulidae	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Polycentropodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Ecnomidae	0	1	1	0	0	0	0	0	3	0	0	1	0	0	0	1
Philorheithridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Odontoceridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
Atriplectididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Calamoceratidae	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
Leptoceridae	26	23	1	18	9	7	21	19	21	15	16	2	7	32	22	30

h) Spring October 2013

SITE	CWC 1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	DTC9	DTC10	TTH11	TTH12	HC13	HC14	BR15	BR16
Turbellaria	0	0	0	1	0	1	0	0	0	0	0	0	2	0	0	0
Sialidae	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0

Corydalidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Physidae	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0
Corbiculidae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Oligochaeta	0	1	3	2	0	0	0	0	0	0	0	0	1	0	0	0
Acarina	0	1	0	3	1	0	2	0	0	0	1	2	0	0	0	2
Ceinidae	0	0	0	13	0	0	0	0	0	0	7	0	0	1	0	0
Atyidae	0	6	5	6	0	0	0	0	1	1	2	0	0	3	3	2
Parastacidae	2	1	2	0	2	3	3	1	0	4	1	0	0	0	0	0
Dytiscidae	11	5	2	7	19	10	10	1	15	19	8	11	12	4	1	2
Gyrinidae	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
Elmidae	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
Hydrophilidae	0	0	0	1	1	0	1	0	0	0	3	1	0	0	0	1
Hydraenidae	1	0	0	3	1	1	0	0	0	0	1	1	0	3	0	0
Scirtidae	2	4	0	3	4	3	2	0	3	1	0	0	5	6	3	2
Psephenidae	0	0	3	1	0	0	0	0	0	1	0	0	0	0	0	0
Hydrochidae	0	0	0	0	1	0	0	2	0	0	1	0	0	0	0	0
Tipulidae	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
Dixidae	1	0	1	11	9	2	3	0	2	0	3	0	1	4	0	1
Simuliidae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Stratiomiyidae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Culicidae	1	3	4	4	6	5	6	0	3	1	1	2	0	4	0	0
Ceratopogonidae	0	0	4	0	0	1	0	0	0	0	0	0	1	2	0	0
Tanypodinae	1	3	2	0	0	2	3	0	0	1	4	14	1	6	2	4
Orthocladiinae	0	0	0	1	1	0	0	0	0	0	0	0	0	2	0	0
Chironominae	11	1	20	4	6	3	4	3	3	9	18	9	91	19	2	1
Baetidae	0	0	4	2	4	0	5	0	1	3	6	0	0	0	0	2
Leptophlebiidae	45	26	73	0	24	48	31	53	22	29	47	9	10	5	16	34
Caenidae	0	0	3	39	0	0	0	1	1	0	0	3	0	0	0	0
Veliidae	1	0	0	0	5	2	3	0	0	0	0	0	0	1	0	0

Gelastocoridae	0	0	0	1	0	0	0	0	1	0	0	0	2	1	0	0
Corixidae	0	0	2	6	2	3	0	0	2	8	13	4	0	0	0	1
Notonectidae	6	2	1	2	1	0	7	2	5	10	2	9	0	2	9	0
Hydrometridae	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0
Coenagrionidae	0	0	0	3	0	0	0	0	0	0	0	5	23	5	0	0
Isostictidae	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	0
Megapodagrionidae	0	0	4	3	1	0	1	12	1	0	1	0	8	7	0	0
Synlestidae	0	0	0	0	0	0	0	1	0	0	0	15	0	1	0	0
Aeshnidae	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
Gomphidae	0	0	0	0	0	0	0	3	0	0	0	0	0	3	0	0
Telephlebiidae	0	0	0	0	0	0	0	0	1	0	0	3	1	0	0	1
Synthemistidae	0	0	0	0	2	0	8	1	0	0	0	0	0	0	0	0
Hemicorduliidae	0	0	1	4	2	0	0	0	1	0	1	0	10	6	1	0
Cordulephyidae	0	0	0	0	0	0	0	0	1	0	2	2	0	3	0	0
Libellulidae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Polycentropodidae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Hydroptilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Ecnomidae	0	0	0	0	0	0	0	2	2	1	0	5	0	0	0	0
Odontoceridae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Calamoceratidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Leptoceridae	6	21	1	23	10	2	6	12	5	2	10	1	5	13	2	3

Appendix K. Quantitative macroinvertebrate benthic data

Quantitative macroinvertebrate benthic data - mean density (3 replicates at each site) of each taxa at each site for (a) spring 2012 (b) autumn 2013 (c) spring 2013. Subsampled data (35%) was multiplied by 100/35 to estimate macroinvertebrate family densities.

a) Spring 2012

	CWC1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	TTH11	TTH12	HC13	HC14	BR15 SBR1	BR16 SBR2	CBR1	CBR2	CMC3	CMC4	CCC5	CCC6	CSQC7	CSQC8	SBR3	SBR4	SBR5	SBR6	SBR7	SBR8
Gordiidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00
Nemertea	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nematoda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90	0.00	0.00	0.00	0.00
Tricladida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	1.90	0.95	0.00	0.00	0.00	0.00	0.00	0.00	3.62	0.00	0.00	0.95	0.00	0.00	0.95	0.00
Oligochaeta	0.00	5.19	3.81	8.57	1.62	4.67	98.89	5.71	4.92	38.10	10.48	0.95	4.76	10.48	1.29	25.71	1.62	1.90	1.90	2.86	7.00	0.00	0.00	78.10	0.00	10.48	4.76	4.76
Ceinidae	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90	0.00	0.00	0.00	0.00
Atyidae	0.00	0.00	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.24	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sphaeriidae	0.00	0.00	0.00	9.52	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	3.81	0.95	4.14	0.95	0.33	0.00	0.00	0.00	2.57	0.00	0.00	20.95	1.90	0.95	0.00	0.00
Ancylidae	0.00	2.57	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Physidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Baetidae	0.00	0.00	0.00	1.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00
Caenidae	0.00	0.00	0.95	1.29	0.00	0.00	0.00	0.00	1.90	19.05	0.00	0.00	3.81	0.95	0.00	0.95	0.33	0.95	0.00	0.00	0.00	0.95	0.95	6.67	51.43	41.90	40.00	9.52
Leptophlebiidae	54.29	137.81	2.86	27.19	17.62	22.67	53.65	41.90	20.79	14.29	0.00	0.00	55.24	48.57	36.76	34.05	59.19	33.33	19.05	3.81	12.95	10.48	4.76	27.62	1.90	0.95	0.00	0.95
Chorismagrionidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90	0.00	0.00	0.00	0.00	0.00	0.00
Coenagrionidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90	0.00	0.00	0.00	0.00	0.00	0.00	8.57	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Magapodagrionidae	0.00	0.33	0.00	0.00	0.00	0.00	0.00	1.90	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.95	0.00	0.00	1.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Synlestidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Austrocorduliidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cordulephyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00
Gomphidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90	1.90	0.95	0.00
Libulllidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hemicorduliidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.86	0.00	3.81	0.00	0.33	0.00	0.00	0.00	1.90	4.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Synthemistidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Telephlebiidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00
Gripopterygidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sialidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corixidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.95	1.90	0.00	0.00
Notonectidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	CWC1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	TTH11	TTH12	HC13	HC14	BR15 SBR1	BR16 SBR2	CBR1	CBR2	CMC3	CMC4	CCC5	CCC6	CSQC7	CSQC8	SBR3	SBR4	SBR5	SBR6	SBR7	SBR8
Dytiscidae	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0.95	0.00	0.00	0.00	0.00	2.86	0.95	0.00	0.00	2.24	11.43	0.00	0.00	0.00	0.00	0.95	0.00
Dytiscidae (adult)	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.86	0.00	0.00	0.00	0.00	0.00	0.00
Elmidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90	3.81	0.67	6.05	0.33	0.00	0.00	0.00	0.00	0.00	0.95	3.81	0.00	0.95	0.00	0.00
Elmidae (adult)	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0.00	0.00	0.00	2.86	0.95	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gyrinidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.95	0.00	0.00	0.00	0.00	0.00	0.00	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydraenidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrophilidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrophilidae(adult)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Psephenidae	0.00	1.90	1.90	5.71	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00
Scirtidae	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aphroteniinae	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ceratopogonidae	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	3.81	2.86	0.00	0.00	9.52	8.57	1.90	7.05	0.67	2.86	13.33	2.86	0.67	4.76	0.95	4.76	0.00	2.86	2.86	1.90
Chironominae	24.76	16.29	104.76	78.38	82.81	49.33	259.21	20.00	237.94	116.19	221.90	50.10	23.81	91.43	4.86	8.67	64.76	77.14	198.10	212.38	330.71	393.33	76.19	131.43	92.38	30.48	40.00	110.48
Tanypodininae	8.57	26.52	7.62	23.43	1.29	1.67	10.95	24.76	60.32	34.29	11.43	0.95	26.67	29.52	18.14	13.14	13.38	18.10	17.14	46.67	77.24	23.81	23.81	12.38	122.86	39.05	51.43	52.38
Orthocladininae	0.95	0.00	3.81	1.29	0.00	0.00	0.00	0.95	0.00	0.95	3.81	2.62	1.90	3.81	0.95	0.00	9.52	3.81	1.90	0.00	1.90	1.90	0.95	3.81	3.81	9.52	9.52	9.52
Podinae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Culicidae	0.00	0.00	0.00	0.00	0.00	0.33	8.10	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	5.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixidae	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Empididae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00
Psychodidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Simuliidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stratiomyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dolichopodidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tabanidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tipulidae	0.95	0.00	0.00	1.90	0.00	0.00	0.00	0.00	1.90	0.00	0.95	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atriplectididae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Calamoceratidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.86	1.90	0.00	0.00	0.33	0.00	0.00	1.90	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00
Conoesucidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ecnomidae	8.57	0.00	2.86	0.00	0.00	0.00	0.00	0.95	0.00	3.81	0.00	1.00	8.57	3.81	2.24	0.33	1.29	1.90	1.90	0.00	2.29	0.00	5.71	0.95	4.76	0.00	0.00	16.19
Hydrobiosidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroptilidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Leptoceridae	0.00	0.00	0.00	2.29	0.00	0.33	0.00	0.00	0.95	0.00	0.00	0.00	2.86	0.00	5.71	6.67	0.33	0.00	3.81	0.00	2.24	0.00	0.00	1.90	1.90	0.95	0.00	0.00
Odontoceridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	CWC1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	TTH11	TTH12	HC13	HC14	BR15 SBR1	BR16 SBR2	CBR1	CBR2	CMC3	CMC4	CCC5	CCC6	CSQC7	CSQC8	SBR3	SBR4	SBR5	SBR6	SBR7	SBR8
Polycentropodidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	1.90	0.00	0.00	0.00	0.95	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pyralidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Glossiphoniidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acarina	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00
Parastacidae	0.00	0.00	0.00	0.00	0.00	0.33	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00

b) Autumn 2013

	CWC1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	TTH11	TTH12	HC13	HC14	BR15 SBR1	BR16 SBR2	CBR1	CBR2	CMC3	CMC4	CCC5	CCC6	CSQC7	CSQC8	SBR3	SBR4	SBR5	SBR6	SBR7	SBR8
Gordiidae	0.00	0.00	0.00	0.33	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nemertea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nematoda	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00
Tricladida	0.95	17.14	0.00	3.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	4.76	1.43	0.00	0.67	0.67	0.00	0.00	0.00	1.90	0.00	0.00	0.95	0.00	0.00	0.00
Oligochaeta	0.00	0.00	18.48	55.33	0.67	1.33	1.62	6.00	3.00	3.90	1.00	4.76	0.00	0.00	1.93	8.10	6.81	20.71	0.95	3.81	2.86	3.81	17.86	1.29	3.95	5.71	0.67	0.67
Ceinidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atyidae	0.00	0.00	0.00	2.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.24	4.14	0.00	0.00	0.00	0.00	1.62	2.29	0.00	0.00	0.00	0.00
Sphaeriidae	0.00	0.00	0.00	1.29	0.00	0.00	0.00	0.67	0.00	0.00	0.00	0.00	1.29	3.81	2.86	0.95	0.00	12.43	0.00	0.00	0.00	0.00	0.33	0.00	3.19	8.57	2.24	2.86
Ancylidae	0.00	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Physidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.95	0.00	0.00	0.00	0.00	0.00	0.00
Baetidae	0.00	0.00	4.81	3.57	3.33	0.00	0.33	0.67	5.33	2.57	4.00	9.90	2.86	0.95	1.50	1.67	1.33	2.67	0.95	0.00	19.05	7.62	0.00	2.29	1.29	0.00	1.67	0.00
Caenidae	0.00	0.00	0.95	0.00	0.33	0.00	0.00	2.00	1.29	0.00	0.33	0.00	0.00	0.00	0.00	2.33	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	2.29	5.19
Leptophlebiidae	80.95	321.14	10.29	28.90	5.24	24.00	10.19	23.67	39.62	6.14	7.00	1.33	0.95	0.00	34.71	60.76	29.86	23.14	11.43	33.33	5.71	18.10	4.76	2.67	4.76	11.43	1.00	0.67
Chorismagrionidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coenagrionidae	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90	0.00	0.00	0.00	0.67	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.95	0.00	0.00	0.00
Magapodagrionidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Synlestidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Austrocorduliidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cordulephyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gomphidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00	0.67	0.00	0.33	0.00	0.00	0.00	1.29	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.33	0.00	2.24	2.00
Libulllidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hemicorduliidae	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Synthemistidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90	0.95	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00

	CWC1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	TTH11	TTH12	HC13	HC14	BR15 SBR1	BR16 SBR2	CBR1	CBR2	CMC3	CMC4	CCC5	CCC6	CSQC7	CSQC8	SBR3	SBR4	SBR5	SBR6	SBR7	SBR8
Telephlebiidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gripopterygidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sialidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corixidae	0.00	0.00	0.00	2.29	1.29	1.33	0.00	0.00	0.00	0.00	5.33	5.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.95	0.95	2.95	0.00	9.48	4.33
Notonectidae	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.67	0.00	0.00	0.00	0.50	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
Dytiscidae	0.00	0.00	0.95	0.67	0.67	0.00	0.00	0.00	1.33	2.29	0.33	0.95	0.00	0.95	1.00	0.00	0.00	0.00	0.00	0.95	3.81	8.57	0.00	1.62	0.00	0.00	1.90	0.00
Dytiscidae (adult)	0.00	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90	0.00	0.00	0.95	0.00	0.00	0.33	0.00
Elmidae	0.95	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.50	10.62	2.00	21.76	0.00	0.00	0.00	0.00	0.00	0.00	2.24	3.81	0.00	0.33
Elmidae (adult)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gyrinidae	0.00	0.95	0.00	0.00	0.00	0.33	0.00	0.67	0.00	0.00	0.33	0.00	0.00	0.00	1.50	0.95	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00
Hydraenidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrophilidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.81	0.00	1.00	0.00	1.29	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.95	0.00	0.00
Hydrophilidae(adult)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.67	0.00	0.95	0.00
Psephenidae	0.00	0.00	1.90	1.33	0.00	0.00	0.00	2.00	0.00	0.00	0.33	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00
Scirtidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aphroteniinae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ceratopogonidae	0.95	0.00	0.00	0.00	0.00	0.95	0.00	0.67	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	6.67	13.33	0.95	0.00	0.95	0.00	0.95	0.00
Chironominae	20.33	4.48	70.48	9.86	8.81	47.48	14.14	12.67	167.90	30.29	33.33	30.19	100.52	280.00	6.86	5.62	6.67	36.52	12.38	18.10	417.14	470.48	43.76	90.19	72.33	147.62	98.52	33.10
Tanypodininae	1.90	3.19	19.86	9.95	3.00	1.00	0.00	32.00	4.24	4.86	5.00	6.95	7.33	8.57	6.29	6.52	21.33	6.48	46.67	33.33	43.81	83.81	8.48	4.57	13.71	11.43	12.14	4.52
Orthocladininae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	3.67	0.00	0.00	1.95	0.95	64.76	2.00	19.95	0.95	0.00	0.95	0.95	1.90	1.90	0.00	1.62	0.00	1.90	1.29	1.95
Podinae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Culicidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dixidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Empididae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Psychodidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Simuliidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stratiomyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dolichopodidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tabanidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tipulidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atriplectididae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00

	CWC1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	TTH1 1	TTH1 2	HC13	HC14	BR15 SBR1	BR16 SBR2	CBR1	CBR 2	CMC 3	CMC 4	CCC5	CCC6	CSQC7	CSQC8	SBR3	SBR4	SBR5	SBR6	SBR7	SBR8
Calamoceratidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.86	3.19	0.95	0.00	0.00	0.00	0.95	0.00	0.00	0.33	0.95	0.00	1.00	1.29
Conoesucidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ecnomidae	0.00	0.00	1.90	0.00	0.00	0.00	0.00	2.33	1.29	0.00	0.00	3.62	0.00	0.00	3.93	1.33	3.86	1.33	2.86	1.90	0.00	1.90	0.00	0.00	6.57	7.62	5.48	6.95
Hydrobiosidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroptilidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Leptoceridae	0.00	0.00	1.62	3.19	0.33	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	2.86	4.19	1.00	1.33	0.95	0.95	1.90	0.95	3.81	0.33	8.57	0.00	0.95	1.29
Odontoceridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polycentropodidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00
Pyralidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Glossiphoniidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acarina	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Parastacidae	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.67	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.95	0.00	0.00	0.00	0.00	0.00	0.00

c) Spring 2013

	CWC1	CWC2	CC3	CC4	DC5	DC6	EC7	EC8	TTH11	TTH12	HC13	HC14	BR15 SBR1	BR16 SBR2	CBR1	CBR2	CMC3	CMC4	CCC5	CCC6	CSQC7	CSQC8	SBR3	SBR4	SBR5	SBR6	SBR7	SBR8
Gordiidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nemertea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00
Nematoda	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	1.90	0.00	0.00	0.00	0.00	0.00	1.00
Tricladida	0.00	0.00	0.00	1.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.33	0.00	0.00	0.00	0.33	0.00	0.00	0.00	1.67
Oligochaeta	7.67	16.19	29.00	5.67	2.00	0.00	2.67	1.00	0.33	0.33	6.67	0.00	5.00	0.33	3.81	3.62	7.00	252.38	38.00	51.48	41.67	71.43	1.29	0.67	7.67	16.19	29.00	5.67
Ceinidae	0.00	0.00	0.00	7.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.14	0.00	0.00	5.71	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.33
Atyidae	0.00	0.00	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	1.00	0.95	0.00	0.00	0.00	0.00	0.95	0.33	0.00	0.00	0.00	0.67
Sphaeriidae	0.00	0.00	0.00	9.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.90	0.00	0.00	13.33	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	9.00
Ancylidae	0.00	2.86	0.00	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	2.86	0.00	0.00
Physidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Baetidae	0.00	0.00	0.33	0.33	0.67	0.33	0.00	0.00	1.33	0.33	0.33	0.95	0.00	0.00	1.29	0.33	3.00	8.57	0.00	0.00	0.33	0.00	0.95	0.00	0.00	0.00	0.33	0.33
Caenidae	0.00	0.00	0.33	0.00	0.67	0.33	0.00	0.33	9.81	0.67	0.00	0.95	0.33	0.00	0.00	1.62	0.67	1.90	0.00	0.00	0.00	0.00	1.33	0.00	0.00	0.00	0.33	0.00
Leptophlebiidae	10.33	221.90	10.00	37.00	2.67	5.00	2.62	23.00	9.52	15.00	1.67	6.67	0.00	0.00	134.86	54.86	35.33	60.00	90.67	122.67	0.67	0.95	13.19	6.67	10.33	221.90	10.00	37.00
Chorismagrionidae	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.33	0.00	0.00	0.00	0.33
Coenagrionidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Magapodagrionidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.95	0.00	0.00	0.00	0.00	0.00
Synlestidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.67	0.33	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Austrocorduliidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Cordulephyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gomphidae	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.67	0.33	0.00	0.00	2.86	0.00	0.00	0.00	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33
Libulllidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hemicorduliidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	3.90	0.33	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Synthemistidae	0.00	0.00	0.00	0.00	0.00	0.00	3.19	0.33	1.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Telephlebiidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gripopterygidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.33	6.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sialidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corixidae	0.00	0.00	0.00	0.33	0.67	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.33	0.00	0.00	0.00	0.00	0.33
Notonectidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dytiscidae	0.00	0.00	1.33	0.00	0.33	0.00	0.00	0.00	4.95	0.00	0.00	1.90	0.00	0.00	0.67	0.00	0.00	0.95	0.00	3.81	0.67	2.86	0.33	0.33	0.00	0.00	1.33	0.00
Dytiscidae (adult)	0.33	1.90	0.00	0.00	0.33	0.33	0.00	0.00	5.48	0.00	0.67	0.00	0.33	1.90	0.00	0.00	0.00	0.00	0.67	0.00	0.00	0.95	0.00	0.00	0.33	1.90	0.00	0.00
Elmidae	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.67	0.00	11.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Elmidae (adult)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gyrinidae	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.29	0.00	0.00	0.95	0.00	1.29	0.00	0.00	0.33	0.00	0.33	0.00	0.00	0.00
Hydraenidae	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00
Hydrophilidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrophilidae(adult)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.33	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Psephenidae	0.00	0.00	4.33	1.33	0.33	0.00	0.00	0.33	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.67	0.00	0.00	4.33	1.33
Scirtidae	0.67	0.95	0.67	0.00	0.00	1.33	0.00	0.00	0.00	1.33	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.67	0.95	0.67	0.00
Aphroteniinae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ceratopogonidae	4.67	0.00	2.33	2.00	0.67	32.67	7.10	2.67	5.81	6.67	1.67	2.24	4.00	0.00	0.00	3.24	1.00	9.52	0.33	1.00	9.33	8.57	2.24	1.00	4.67	0.00	2.33	2.00
Chironominae	25.00	6.67	46.00	21.67	42.33	21.33	21.62	10.33	102.48	19.67	39.33	298.48	69.33	101.29	11.24	9.33	7.33	135.24	78.67	75.86	64.67	46.67	44.90	34.33	25.00	6.67	46.00	21.67
Tanypodininae	8.33	5.71	10.00	37.67	0.33	14.33	1.67	32.33	7.24	1.00	4.33	82.29	15.00	12.67	15.71	26.29	22.33	99.05	29.67	33.95	9.67	8.57	26.19	2.33	8.33	5.71	10.00	37.67
Orthocladininae	0.00	0.00	3.00	0.67	0.00	0.00	4.52	21.67	2.67	0.00	3.00	1.62	7.67	72.67	1.62	1.29	0.33	3.81	30.00	28.24	0.00	0.00	3.29	4.00	0.00	0.00	3.00	0.67
Podinae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Culicidae	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.67	0.00	0.00	0.00
Dixidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Empididae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Psychodidae	0.00	0.00	0.00	0.00	0.00	5.67	0.00	0.00	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Simuliidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stratiomyidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00
Dolichopodidae	0.00	0.00	0.00	0.00	0.00	0.67	2.57	0.00	0.00	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tabanidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tipulidae	0.00	0.00	0.67	0.00	0.00	4.00	2.00	0.00	1.95	1.00	4.33	0.95	0.33	0.00	0.00	0.67	0.00	0.00	0.33	0.00	0.00	1.90	0.67	0.67	0.00	0.00	0.67	0.00

Atriplectididae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Calamoceratidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.67	0.00	0.00	0.00	0.67	0.95	0.00	0.00	0.00	0.00	0.00	0.00
Conoesucidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ecnomidae	0.33	0.00	1.67	0.33	0.00	0.00	0.00	6.67	7.24	0.00	0.00	12.52	0.33	1.62	2.24	0.33	2.33	13.33	0.67	0.95	0.00	0.00	2.00	0.00	0.33	0.00	1.67	0.33
Hydrobiosidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroptilidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Leptoceridae	1.67	0.95	0.33	2.33	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.33	0.00	6.71	13.10	0.00	0.00	1.00	4.76	1.67	0.00	11.43	0.00	1.67	0.95	0.33	2.33
Odontoceridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polycentropodidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pyralidae	0.00	0.00	0.00	0.00	0.00	0.00	1.90	0.00	0.95	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Glossiphoniidae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acarina	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Parastacidae	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	1.90	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix L. SIMPER procedure results

a) Subsidence results

SIMPER
Similarity Percentages - species contributions

One-Way Analysis

Data worksheet
Name: Data2
Data type: Abundance
Sample selection: All
Variable selection: All

Parameters
Resemblance: S17 Bray Curtis similarity
Cut off for low contributions: 90.00%

Factor Groups

Sample	Stream
CWC1 SPR12	CWC
CWC2 SPR12	CWC
CWC1 AUT13	CWC
CWC2 AUT13	CWC
CWC1 SPR13	CWC
CWC2 SPR13	CWC
CC3 SPR12	CC
CC4 SPR12	CC
CC3 AUT13	CC
CC4 AUT13	CC
CC3 SPR13	CC
CC4 SPR13	CC
DC5 SPR12	DC
DC6 SPR12	DC
DC5 AUT13	DC
DC6 AUT13	DC
DC5 SPR13	DC
DC6 SPR13	DC
EC7 SPR12	EC
EC8 SPR12	EC
EC7 AUT13	EC
EC8 AUT13	EC
EC7 SPR13	EC
EC8 SPR13	EC
TTH11 SPR12	TTH
TTH12 SPR12	TTH
TTH11 AUT13	TTH
TTH12 AUT13	TTH
TTH11 SPR13	TTH
TTH12a SPR13	TTH
HC13 SPR12	HC
HC14 SPR12	HC
HC13 AUT13	HC
HC14 AUT13	HC
HC13 SPR13	HC
HC14 SPR13	HC
BR15 SPR12	BR
BR16 SPR12	BR
BR15 AUT13	BR
BR 16 AUT13	BR
BR15 SPR13	BR

BR 16	SPR13	BR
CBR1	SPR12	CBR
CBR2	SPR12	CBR
CBR1	AUT13	CBR
CBR2	AUT13	CBR
CBR1	SPR13	CBR
CBR2	SPR13	CBR
CMC3	SPR12	CMC
CMC4	SPR12	CMC
CMC3	AUT13	CMC
CMC4	AUT13	CMC
CMC3	SPR13	CMC
CMC4	SPR13	CMC
CCC5	SPR12	CCC
CCC6	SPR12	CCC
CCC5	AUT13	CCC
CCC6	AUT13	CCC
CCC5	SPR13	CCC
CCC6	SPR13	CCC
CSQC7	SPR12	CSQC
CSQC8	SPR12	CSQC
CSQC7	AUT13	CSQC
CSQC8	AUT13	CSQC
CSQC7	SPR13	CSQC
CSQC8	SPR13	CSQC
DTC9	AUT13	DTC
DTC10	AUT13	DTC
DTC9	SPR13	DTC
DTC10	SPR13	DTC

Group CWC
Average similarity: 54.59

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Leptophlebiidae	3.17	20.63	3.63	37.79	37.79
Chironominae	1.94	13.62	5.62	24.95	62.73
Tanypodininae	1.62	10.85	8.04	19.87	82.61
Dytiscidae (adult)	0.64	2.50	0.76	4.57	87.18
Oligochaeta	0.86	2.30	0.48	4.21	91.39

Group CC
Average similarity: 64.02

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Chironominae	2.60	12.10	3.70	18.89	18.89
Tanypodininae	2.00	9.51	10.64	14.86	33.75
Leptophlebiidae	1.99	8.96	6.89	13.99	47.74
Oligochaeta	1.96	8.68	5.41	13.56	61.30
Psephenidae	1.25	5.98	7.12	9.35	70.65
Leptoceridae	0.95	3.37	1.29	5.27	75.92
Baetidae	0.91	2.97	1.23	4.64	80.56
Orthocladininae	0.78	2.14	0.76	3.34	83.91
Ecnomidae	0.73	2.13	0.74	3.32	87.23
Caenidae	0.63	1.98	0.77	3.09	90.31

Group DC
Average similarity: 57.51

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Chironominae	2.45	19.91	3.96	34.63	34.63
Leptophlebiidae	1.79	14.26	3.18	24.80	59.43
Tanypodininae	1.20	8.87	4.12	15.43	74.85
Oligochaeta	0.96	6.64	1.33	11.55	86.40
Corixidae	0.51	1.69	0.48	2.93	89.33

Ceratopogonidae	0.71	1.43	0.48	2.49	91.82

Group EC
Average similarity: 46.42

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Chironominae	2.32	11.91	4.09	25.66	25.66
Leptophlebiidae	2.12	10.97	3.94	23.64	49.30
Oligochaeta	1.61	7.39	4.25	15.92	65.22
Tanypodininae	1.66	5.89	1.27	12.69	77.91
Orthocladininae	0.92	2.12	0.76	4.57	82.48
Parastacidae	0.50	1.57	0.48	3.37	85.85
Ceratopogonidae	0.64	1.05	0.47	2.26	88.12
Ecnomidae	0.64	1.03	0.48	2.23	90.34

Group TTH
Average similarity: 54.94

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Chironominae	3.10	15.29	6.53	27.82	27.82
Tanypodininae	2.13	9.98	4.37	18.16	45.98
Leptophlebiidae	1.59	7.76	4.57	14.13	60.11
Oligochaeta	1.34	5.26	1.31	9.57	69.68
Ceratopogonidae	0.84	2.65	0.78	4.83	74.51
Orthocladininae	0.77	2.42	0.78	4.40	78.90
Baetidae	0.82	2.23	0.73	4.06	82.96
Dytiscidae	0.66	2.10	0.78	3.82	86.78
Caenidae	0.84	2.07	0.77	3.76	90.55

Group HC
Average similarity: 52.77

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Chironominae	3.31	22.18	11.10	42.03	42.03
Tanypodininae	1.67	10.93	5.06	20.71	62.75
Orthocladininae	1.85	10.10	3.28	19.13	81.88
Oligochaeta	0.84	2.98	0.75	5.65	87.53
Sphaeriidae	0.58	1.39	0.48	2.63	90.17

Group BR
Average similarity: 61.34

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Leptophlebiidae	2.79	10.00	15.53	16.31	16.31
Tanypodininae	2.01	6.90	8.03	11.24	27.55
Chironominae	2.01	6.46	10.97	10.53	38.08
Oligochaeta	1.49	5.16	12.45	8.41	46.49
Orthocladininae	1.34	4.39	9.98	7.16	53.65
Ecnomidae	1.26	4.09	4.06	6.67	60.32
Elmidae	1.25	4.07	6.07	6.64	66.96
Leptoceridae	1.26	3.54	1.34	5.77	72.73
Calamoceratidae	1.02	2.87	1.33	4.68	77.41
Sphaeriidae	0.97	2.72	1.33	4.43	81.84
Gyrinidae	0.86	2.56	1.35	4.17	86.02
Caenidae	0.79	1.54	0.78	2.51	88.53
Baetidae	0.68	1.52	0.76	2.48	91.00

Group CBR
Average similarity: 61.42

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Leptophlebiidae	2.44	11.09	7.21	18.06	18.06
Tanypodininae	2.17	8.97	5.77	14.61	32.67

Chironominae	2.05	7.77	8.52	12.65	45.32
Oligochaeta	2.11	7.24	4.41	11.79	57.11
Ecnomidae	1.27	4.93	4.50	8.03	65.14
Elmidae	1.28	3.69	1.28	6.00	71.14
Ceratopogonidae	1.09	3.47	1.32	5.64	76.79
Atyidae	0.98	3.33	1.30	5.41	82.20
Sphaeriidae	1.03	2.31	0.76	3.77	85.97
Leptoceridae	0.87	2.28	0.76	3.71	89.68
Baetidae	0.90	2.09	0.78	3.40	93.08

Group CMC
Average similarity: 64.18

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Chironominae	2.61	12.16	6.57	18.94	18.94
Leptophlebiidae	2.64	12.03	9.84	18.75	37.69
Tanypodininae	2.29	11.31	6.22	17.62	55.30
Orthocladininae	1.63	6.49	4.54	10.12	65.42
Oligochaeta	1.64	6.31	4.72	9.83	75.25
Ecnomidae	1.10	5.41	4.49	8.43	83.68
Leptoceridae	0.87	3.08	1.30	4.80	88.49
Dytiscidae	0.78	2.12	0.78	3.30	91.78

Group CCC
Average similarity: 59.84

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Chironominae	3.70	16.44	6.46	27.47	27.47
Tanypodininae	2.29	10.15	7.59	16.95	44.43
Ceratopogonidae	1.70	8.17	5.43	13.66	58.09
Oligochaeta	1.77	7.14	2.90	11.93	70.02
Leptophlebiidae	1.50	6.10	4.03	10.19	80.21
Dytiscidae	0.89	2.18	0.78	3.64	83.85
Leptoceridae	0.78	2.15	0.77	3.59	87.44
Calamoceratidae	0.68	2.02	0.78	3.38	90.81

Group CSQC
Average similarity: 56.91

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Chironominae	3.23	14.57	6.00	25.60	25.60
Tanypodininae	1.97	8.47	5.60	14.88	40.48
Leptophlebiidae	1.66	8.12	6.97	14.26	54.74
Orthocladininae	1.04	3.98	1.33	6.99	61.73
Oligochaeta	1.12	3.80	1.28	6.67	68.40
Ceratopogonidae	0.93	3.51	1.30	6.17	74.57
Atyidae	0.85	3.28	1.29	5.77	80.34
Dytiscidae	0.95	2.97	1.28	5.22	85.56
Leptoceridae	0.87	2.09	0.74	3.67	89.23
Psephenidae	0.48	0.99	0.48	1.73	90.96

Group DTC
Average similarity: 57.23

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Chironominae	2.81	13.90	5.67	24.29	24.29
Leptophlebiidae	1.95	10.06	5.84	17.57	41.86
Tanypodininae	1.39	7.27	3.79	12.70	54.56
Baetidae	1.16	5.67	3.00	9.91	64.47
Oligochaeta	1.06	5.19	2.31	9.08	73.55
Dytiscidae	0.95	3.28	0.89	5.73	79.28
Ceratopogonidae	0.98	2.61	0.84	4.57	83.85
Caenidae	0.93	2.48	0.90	4.34	88.19

Parastacidae	0.71	2.09	0.90	3.66	91.85	

Groups CWC & CC
Average dissimilarity = 53.52

Species	Group CWC Av.Abund	Group CC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptophlebiidae	3.17	1.99	4.12	1.54	7.69	7.69
Oligochaeta	0.86	1.96	3.84	1.36	7.17	14.86
Psephenidae	0.20	1.25	3.35	2.30	6.26	21.12
Baetidae	0.00	0.91	2.81	1.71	5.25	26.37
Chironominae	1.94	2.60	2.45	1.51	4.57	30.94
Ecnomidae	0.41	0.73	2.36	1.32	4.40	35.35
Leptoceridae	0.35	0.95	2.32	1.43	4.34	39.69
Orthocladininae	0.16	0.78	2.32	1.23	4.33	44.02
Sphaeriidae	0.00	0.76	2.21	0.95	4.13	48.15
Tricladida	0.50	0.42	2.11	0.91	3.95	52.10
Caenidae	0.00	0.63	2.08	1.35	3.89	55.98
Ancylidae	0.64	0.00	2.02	0.98	3.77	59.76
Dytiscidae (adult)	0.64	0.00	2.01	1.29	3.75	63.51
Dytiscidae	0.00	0.62	1.95	1.35	3.64	67.15
Ceratopogonidae	0.41	0.57	1.92	1.07	3.58	70.74
Atyidae	0.00	0.55	1.75	0.94	3.28	74.01
Tanypodininae	1.62	2.00	1.50	1.48	2.80	76.82
Ceinidae	0.00	0.44	1.26	0.67	2.35	79.16
Tipulidae	0.16	0.35	1.25	0.80	2.34	81.50
Scirtidae	0.32	0.15	1.13	0.79	2.11	83.61
Nematoda	0.22	0.17	1.01	0.61	1.90	85.51
Corixidae	0.00	0.33	0.98	0.66	1.82	87.33
Gyrinidae	0.29	0.00	0.91	0.68	1.70	89.03
Elmidae	0.16	0.13	0.79	0.61	1.48	90.51

Groups CWC & DC
Average dissimilarity = 49.76

Species	Group CWC Av.Abund	Group DC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptophlebiidae	3.17	1.79	5.98	1.89	12.02	12.02
Oligochaeta	0.86	0.96	3.64	1.76	7.32	19.35
Ceratopogonidae	0.41	0.71	3.07	1.05	6.16	25.51
Ancylidae	0.64	0.28	2.69	1.19	5.41	30.92
Chironominae	1.94	2.45	2.66	1.47	5.34	36.26
Dytiscidae (adult)	0.64	0.25	2.37	1.18	4.77	41.02
Tanypodininae	1.62	1.20	2.29	1.52	4.60	45.62
Tricladida	0.50	0.00	2.17	0.64	4.37	49.99
Corixidae	0.00	0.51	2.10	0.97	4.23	54.22
Baetidae	0.00	0.50	2.00	0.89	4.02	58.24
Leptoceridae	0.35	0.25	1.83	0.98	3.67	61.91
Ecnomidae	0.41	0.00	1.73	0.62	3.47	65.38
Caenidae	0.00	0.40	1.58	0.98	3.17	68.55
Scirtidae	0.32	0.18	1.55	0.80	3.11	71.66
Gyrinidae	0.29	0.13	1.39	0.79	2.80	74.46
Tipulidae	0.16	0.24	1.35	0.63	2.71	77.17
Parastacidae	0.00	0.29	1.27	0.69	2.55	79.72
Dytiscidae	0.00	0.28	1.14	0.69	2.28	82.00
Psephenidae	0.20	0.13	1.14	0.61	2.28	84.28
Elmidae	0.16	0.13	1.05	0.61	2.10	86.38
Culicidae	0.15	0.13	0.98	0.62	1.98	88.36
Nematoda	0.22	0.00	0.96	0.44	1.93	90.29

Groups CC & DC
Average dissimilarity = 48.92

Group CC Group DC

Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Psephenidae	1.25	0.13	3.78	3.01	7.72	7.72
Oligochaeta	1.96	0.96	3.26	1.65	6.66	14.38
Tanypodininae	2.00	1.20	2.76	2.18	5.64	20.02
Orthocladininae	0.78	0.00	2.62	1.25	5.36	25.38
Ecnomidae	0.73	0.00	2.55	1.25	5.20	30.58
Leptoceridae	0.95	0.25	2.52	1.67	5.16	35.74
Ceratopogonidae	0.57	0.71	2.49	1.11	5.08	40.82
Sphaeriidae	0.76	0.00	2.33	0.95	4.77	45.59
Baetidae	0.91	0.50	2.29	1.25	4.68	50.28
Atyidae	0.55	0.00	1.86	0.94	3.81	54.08
Chironominae	2.60	2.45	1.81	1.29	3.70	57.79
Corixidae	0.33	0.51	1.81	1.07	3.69	61.48
Dytiscidae	0.62	0.28	1.80	1.19	3.68	65.16
Caenidae	0.63	0.40	1.75	1.15	3.57	68.72
Leptophlebiidae	1.99	1.79	1.59	1.52	3.26	71.98
Tipulidae	0.35	0.24	1.47	0.82	3.01	74.99
Ceinidae	0.44	0.00	1.32	0.67	2.70	77.70
Tricladida	0.42	0.00	1.31	0.68	2.68	80.37
Parastacidae	0.00	0.29	1.01	0.68	2.06	82.43
Ancylidae	0.00	0.28	0.94	0.69	1.92	84.35
Scirtidae	0.15	0.18	0.87	0.62	1.79	86.14
Dytiscidae (adult)	0.00	0.25	0.76	0.69	1.56	87.70
Psychodidae	0.00	0.26	0.75	0.44	1.54	89.25
Elmidae	0.13	0.13	0.68	0.61	1.38	90.63

Groups CWC & EC
Average dissimilarity = 54.43

	Group CWC	Group EC				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptophlebiidae	3.17	2.12	4.27	1.37	7.84	7.84
Oligochaeta	0.86	1.61	3.90	1.37	7.16	15.00
Tanypodininae	1.62	1.66	2.93	1.08	5.39	20.39
Orthocladininae	0.16	0.92	2.75	1.20	5.05	25.44
Ecnomidae	0.41	0.64	2.33	1.03	4.28	29.72
Ceratopogonidae	0.41	0.64	2.30	1.02	4.22	33.94
Ancylidae	0.64	0.00	2.24	0.94	4.12	38.06
Dytiscidae (adult)	0.64	0.00	2.23	1.22	4.09	42.15
Chironominae	1.94	2.32	2.00	0.83	3.68	45.83
Parastacidae	0.00	0.50	1.99	0.95	3.66	49.49
Tricladida	0.50	0.16	1.97	0.71	3.63	53.12
Psephenidae	0.20	0.49	1.66	0.97	3.05	56.17
Gomphidae	0.00	0.53	1.60	0.96	2.93	59.10
Magapodagrionidae	0.13	0.49	1.54	1.00	2.82	61.93
Leptoceridae	0.35	0.29	1.53	0.88	2.81	64.74
Scirtidae	0.32	0.30	1.43	0.88	2.64	67.38
Culicidae	0.15	0.28	1.30	0.60	2.39	69.77
Gyrinidae	0.29	0.15	1.18	0.77	2.17	71.93
Synthemistidae	0.00	0.35	1.14	0.64	2.09	74.03
Baetidae	0.00	0.28	1.09	0.68	2.00	76.03
Tipulidae	0.16	0.20	1.08	0.61	1.99	78.02
Sphaeriidae	0.00	0.32	0.96	0.69	1.77	79.79
Caenidae	0.00	0.32	0.94	0.67	1.73	81.52
Polycentropodidae	0.00	0.29	0.89	0.68	1.63	83.16
Notonectidae	0.16	0.13	0.85	0.58	1.56	84.71
Nematoda	0.22	0.00	0.80	0.43	1.46	86.18
Dolichopodidae	0.00	0.21	0.74	0.44	1.35	87.53
Pyralidae	0.00	0.20	0.68	0.44	1.25	88.78
Elmidae	0.16	0.00	0.61	0.43	1.11	89.89
Aphroteniinae	0.16	0.00	0.59	0.43	1.08	90.97

Groups CC & EC
Average dissimilarity = 48.77

Species	Group CC Av.Abund	Group EC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Psephenidae	1.25	0.49	2.37	1.31	4.87	4.87
Chironominae	2.60	2.32	2.37	1.51	4.86	9.73
Tanypodininae	2.00	1.66	2.31	0.88	4.74	14.47
Oligochaeta	1.96	1.61	2.22	1.39	4.55	19.02
Orthocladininae	0.78	0.92	2.19	1.19	4.49	23.51
Leptoceridae	0.95	0.29	2.18	1.46	4.48	27.99
Sphaeriidae	0.76	0.32	2.07	1.07	4.25	32.24
Baetidae	0.91	0.28	2.06	1.44	4.23	36.47
Ecnomidae	0.73	0.64	1.99	1.15	4.08	40.55
Ceratopogonidae	0.57	0.64	1.90	1.10	3.90	44.45
Dytiscidae	0.62	0.00	1.78	1.29	3.64	48.09
Caenidae	0.63	0.32	1.72	1.19	3.54	51.62
Parastacidae	0.00	0.50	1.60	0.95	3.27	54.90
Atyidae	0.55	0.00	1.60	0.92	3.27	58.17
Leptophlebiidae	1.99	2.12	1.49	1.29	3.05	61.22
Gomphidae	0.13	0.53	1.38	1.02	2.84	64.06
Tricladida	0.42	0.16	1.30	0.79	2.67	66.73
Magapodagrionidae	0.00	0.49	1.25	0.94	2.55	69.28
Tipulidae	0.35	0.20	1.21	0.78	2.47	71.76
Ceinidae	0.44	0.00	1.15	0.66	2.36	74.12
Scirtidae	0.15	0.30	0.98	0.78	2.01	76.13
Synthemistidae	0.00	0.35	0.95	0.64	1.95	78.08
Corixidae	0.33	0.00	0.89	0.65	1.83	79.91
Culicidae	0.00	0.28	0.80	0.44	1.63	81.54
Polycentropodidae	0.00	0.29	0.75	0.68	1.54	83.08
Dolichopodidae	0.00	0.21	0.61	0.44	1.25	84.32
Hydraenidae	0.13	0.13	0.57	0.60	1.16	85.48
Pyralidae	0.00	0.20	0.56	0.44	1.16	86.64
Nemertea	0.16	0.00	0.54	0.43	1.11	87.75
Elmidae (adult)	0.00	0.17	0.48	0.44	0.99	88.74
Coenagrionidae	0.16	0.00	0.46	0.43	0.94	89.68
Austrocorduliidae	0.00	0.16	0.44	0.44	0.90	90.59

Groups DC & EC

Average dissimilarity = 51.95

Species	Group DC Av.Abund	Group EC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Tanypodininae	1.20	1.66	3.48	1.61	6.69	6.69
Orthocladininae	0.00	0.92	3.01	1.20	5.80	12.49
Ceratopogonidae	0.71	0.64	2.94	1.08	5.66	18.15
Chironominae	2.45	2.32	2.76	1.37	5.31	23.46
Oligochaeta	0.96	1.61	2.57	0.92	4.94	28.40
Leptophlebiidae	1.79	2.12	2.04	1.53	3.92	32.32
Ecnomidae	0.00	0.64	2.00	0.96	3.85	36.17
Parastacidae	0.29	0.50	1.98	0.98	3.82	39.99
Baetidae	0.50	0.28	1.91	1.02	3.68	43.67
Corixidae	0.51	0.00	1.88	0.92	3.63	47.29
Gomphidae	0.00	0.53	1.69	0.96	3.25	50.54
Caenidae	0.40	0.32	1.65	1.04	3.18	53.72
Psephenidae	0.13	0.49	1.61	1.00	3.10	56.83
Magapodagrionidae	0.00	0.49	1.56	0.94	3.00	59.82
Leptoceridae	0.25	0.29	1.40	0.88	2.69	62.52
Culicidae	0.13	0.28	1.36	0.60	2.63	65.14
Scirtidae	0.18	0.30	1.29	0.77	2.49	67.63
Tipulidae	0.24	0.20	1.28	0.61	2.47	70.11
Synthemistidae	0.00	0.35	1.21	0.63	2.33	72.44
Dolichopodidae	0.15	0.21	1.11	0.60	2.13	74.58
Ancylidae	0.28	0.00	1.06	0.67	2.04	76.61
Sphaeriidae	0.00	0.32	1.02	0.69	1.96	78.58
Dytiscidae	0.28	0.00	1.02	0.66	1.96	80.54
Polycentropodidae	0.00	0.29	0.94	0.68	1.81	82.35
Dytiscidae (adult)	0.25	0.00	0.84	0.68	1.62	83.97

Psychodidae	0.26	0.00	0.83	0.43	1.60	85.57
Gyrinidae	0.13	0.15	0.81	0.61	1.56	87.13
Pyralidae	0.00	0.20	0.73	0.44	1.40	88.53
Elmidae (adult)	0.00	0.17	0.62	0.44	1.20	89.73
Tricladida	0.00	0.16	0.56	0.44	1.07	90.81

Groups CWC & TTH

Average dissimilarity = 55.07

	Group CWC	Group TTH				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptophlebiidae	3.17	1.59	5.42	1.88	9.85	9.85
Chironominae	1.94	3.10	3.79	1.48	6.89	16.73
Oligochaeta	0.86	1.34	3.35	1.32	6.09	22.82
Baetidae	0.00	0.82	2.80	1.17	5.08	27.90
Caenidae	0.00	0.84	2.75	1.15	4.99	32.89
Ecnomidae	0.41	0.78	2.68	1.12	4.86	37.76
Ceratopogonidae	0.41	0.84	2.48	1.27	4.51	42.27
Orthocladininae	0.16	0.77	2.36	1.29	4.28	46.54
Tanypodininae	1.62	2.13	2.30	1.31	4.18	50.73
Dytiscidae	0.00	0.66	2.22	1.37	4.02	54.75
Corixidae	0.00	0.63	2.20	0.90	4.00	58.75
Ancylidae	0.64	0.00	2.14	0.98	3.89	62.64
Tipulidae	0.16	0.60	1.98	1.01	3.59	66.23
Dytiscidae (adult)	0.64	0.28	1.89	1.24	3.43	69.66
Tricladida	0.50	0.00	1.72	0.64	3.13	72.79
Leptoceridae	0.35	0.16	1.35	0.80	2.45	75.24
Notonectidae	0.16	0.28	1.19	0.80	2.16	77.41
Scirtidae	0.32	0.13	1.17	0.81	2.12	79.53
Culicidae	0.15	0.29	1.17	0.80	2.12	81.65
Gyrinidae	0.29	0.13	1.12	0.80	2.03	83.67
Nematoda	0.22	0.16	1.11	0.62	2.01	85.69
Gomphidae	0.00	0.34	1.11	0.68	2.01	87.70
Psephenidae	0.20	0.13	0.95	0.63	1.72	89.41
Elmidae	0.16	0.00	0.58	0.44	1.05	90.46

Groups CC & TTH

Average dissimilarity = 43.65

	Group CC	Group TTH				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Psephenidae	1.25	0.13	3.10	3.29	7.10	7.10
Leptoceridae	0.95	0.16	2.30	1.72	5.28	12.38
Chironominae	2.60	3.10	2.28	1.53	5.21	17.60
Oligochaeta	1.96	1.34	2.26	1.27	5.17	22.76
Ecnomidae	0.73	0.78	2.14	1.34	4.91	27.68
Sphaeriidae	0.76	0.00	1.97	0.95	4.51	32.18
Baetidae	0.91	0.82	1.90	1.25	4.34	36.53
Corixidae	0.33	0.63	1.86	1.03	4.27	40.80
Ceratopogonidae	0.57	0.84	1.86	1.11	4.27	45.07
Caenidae	0.63	0.84	1.85	1.21	4.23	49.30
Orthocladininae	0.78	0.77	1.70	1.10	3.90	53.20
Tipulidae	0.35	0.60	1.68	1.06	3.86	57.06
Tanypodininae	2.00	2.13	1.68	1.70	3.85	60.91
Leptophlebiidae	1.99	1.59	1.58	1.55	3.61	64.52
Atyidae	0.55	0.00	1.54	0.95	3.54	68.06
Dytiscidae	0.62	0.66	1.37	1.12	3.15	71.21
Ceinidae	0.44	0.00	1.12	0.67	2.57	73.77
Tricladida	0.42	0.00	1.10	0.68	2.53	76.30
Gomphidae	0.13	0.34	1.03	0.78	2.36	78.67
Culicidae	0.00	0.29	0.81	0.69	1.86	80.53
Notonectidae	0.00	0.28	0.78	0.69	1.79	82.32
Dytiscidae (adult)	0.00	0.28	0.78	0.69	1.78	84.10
Nemertea	0.16	0.13	0.74	0.61	1.69	85.79
Nematoda	0.17	0.16	0.73	0.61	1.67	87.46

Chorismagrionidae	0.13	0.15	0.65	0.61	1.48	88.94
Scirtidae	0.15	0.13	0.64	0.62	1.48	90.42

Groups DC & TTH
Average dissimilarity = 46.96

Species	Group DC Av.Abund	Group TTH Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Tanypodininae	1.20	2.13	3.50	1.58	7.44	7.44
Ceratopogonidae	0.71	0.84	2.98	1.35	6.36	13.80
Chironominae	2.45	3.10	2.94	1.36	6.26	20.06
Orthocladininae	0.00	0.77	2.69	1.35	5.72	25.78
Ecnomidae	0.00	0.78	2.69	0.97	5.72	31.50
Baetidae	0.50	0.82	2.62	1.16	5.59	37.09
Oligochaeta	0.96	1.34	2.56	1.33	5.45	42.54
Caenidae	0.40	0.84	2.52	1.12	5.37	47.92
Corixidae	0.51	0.63	2.44	1.19	5.19	53.11
Tipulidae	0.24	0.60	2.21	1.00	4.71	57.82
Dytiscidae	0.28	0.66	2.05	1.24	4.37	62.19
Leptophlebiidae	1.79	1.59	1.71	1.34	3.65	65.84
Dytiscidae (adult)	0.25	0.28	1.26	0.89	2.69	68.52
Parastacidae	0.29	0.13	1.22	0.80	2.60	71.13
Leptoceridae	0.25	0.16	1.22	0.82	2.60	73.73
Culicidae	0.13	0.29	1.20	0.80	2.55	76.28
Gomphidae	0.00	0.34	1.18	0.68	2.50	78.78
Notonectidae	0.00	0.28	1.00	0.69	2.14	80.92
Ancylidae	0.28	0.00	1.00	0.70	2.13	83.06
Scirtidae	0.18	0.13	0.87	0.63	1.85	84.91
Dolichopodidae	0.15	0.15	0.84	0.61	1.79	86.69
Psychodidae	0.26	0.00	0.80	0.44	1.70	88.39
Gyrinidae	0.13	0.13	0.77	0.61	1.64	90.03

Groups EC & TTH
Average dissimilarity = 50.95

Species	Group EC Av.Abund	Group TTH Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironominae	2.32	3.10	3.27	1.43	6.42	6.42
Tanypodininae	1.66	2.13	3.09	1.02	6.06	12.48
Ecnomidae	0.64	0.78	2.39	1.11	4.68	17.16
Oligochaeta	1.61	1.34	2.36	1.12	4.63	21.79
Caenidae	0.32	0.84	2.32	1.08	4.56	26.35
Orthocladininae	0.92	0.77	2.28	1.22	4.47	30.82
Baetidae	0.28	0.82	2.25	1.21	4.41	35.23
Ceratopogonidae	0.64	0.84	2.23	1.15	4.38	39.61
Leptophlebiidae	2.12	1.59	2.02	1.54	3.96	43.57
Dytiscidae	0.00	0.66	2.01	1.30	3.94	47.51
Corixidae	0.00	0.63	1.99	0.87	3.91	51.42
Tipulidae	0.20	0.60	1.83	0.97	3.59	55.02
Parastacidae	0.50	0.13	1.65	1.01	3.23	58.24
Gomphidae	0.53	0.34	1.64	1.08	3.21	61.46
Culicidae	0.28	0.29	1.44	0.80	2.82	64.28
Psephenidae	0.49	0.13	1.35	1.01	2.66	66.94
Magapodagrionidae	0.49	0.00	1.31	0.94	2.57	69.50
Leptoceridae	0.29	0.16	1.06	0.77	2.08	71.58
Synthemistidae	0.35	0.00	1.00	0.64	1.97	73.55
Polycentropodidae	0.29	0.16	1.00	0.78	1.96	75.51
Scirtidae	0.30	0.13	0.99	0.78	1.93	77.44
Notonectidae	0.13	0.28	0.96	0.76	1.89	79.33
Dolichopodidae	0.21	0.15	0.94	0.61	1.84	81.18
Sphaeriidae	0.32	0.00	0.85	0.69	1.68	82.85
Dytiscidae (adult)	0.00	0.28	0.85	0.68	1.67	84.52
Pyralidae	0.20	0.13	0.85	0.61	1.66	86.18
Sialidae	0.15	0.16	0.72	0.61	1.41	87.59
Gyrinidae	0.15	0.13	0.68	0.61	1.33	88.92

Elmidae (adult)	0.17	0.00	0.51	0.44	1.00	89.93
Chorismagrionidae	0.00	0.15	0.49	0.43	0.96	90.89

Groups CWC & HC
Average dissimilarity = 62.95

Species	Group CWC Av.Abund	Group HC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptophlebiidae	3.17	0.16	11.54	3.23	18.33	18.33
Orthocladininae	0.16	1.85	6.33	2.06	10.06	28.38
Chironominae	1.94	3.31	5.13	2.42	8.15	36.53
Oligochaeta	0.86	0.84	3.39	1.34	5.39	41.92
Tricladida	0.50	0.41	2.54	0.90	4.04	45.96
Ancylidae	0.64	0.00	2.45	0.98	3.89	49.85
Ecnomidae	0.41	0.48	2.36	1.09	3.75	53.60
Dytiscidae (adult)	0.64	0.49	2.13	1.18	3.38	56.98
Sphaeriidae	0.00	0.58	2.09	0.97	3.32	60.30
Ceratopogonidae	0.41	0.24	1.93	0.80	3.06	63.36
Tanypodininae	1.62	1.67	1.55	1.37	2.46	65.82
Leptoceridae	0.35	0.13	1.47	0.81	2.33	68.15
Hemicorduliidae	0.00	0.38	1.46	0.69	2.33	70.48
Baetidae	0.00	0.38	1.40	0.68	2.23	72.71
Tipulidae	0.16	0.29	1.36	0.79	2.16	74.87
Dytiscidae	0.00	0.33	1.29	0.69	2.05	76.92
Nematoda	0.22	0.17	1.29	0.62	2.04	78.97
Coenagrionidae	0.00	0.32	1.20	0.67	1.91	80.88
Scirtidae	0.32	0.00	1.17	0.69	1.85	82.73
Gyrinidae	0.29	0.00	1.10	0.68	1.75	84.48
Podinae	0.00	0.24	1.04	0.44	1.66	86.14
Hydrophilidae	0.00	0.23	0.81	0.44	1.29	87.43
Psephenidae	0.20	0.00	0.74	0.44	1.18	88.60
Cordulephyidae	0.00	0.18	0.68	0.44	1.09	89.69
Notonectidae	0.16	0.00	0.66	0.44	1.05	90.74

Groups CC & HC
Average dissimilarity = 52.62

Species	Group CC Av.Abund	Group HC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptophlebiidae	1.99	0.16	5.57	3.72	10.58	10.58
Psephenidae	1.25	0.00	3.87	6.00	7.36	17.94
Oligochaeta	1.96	0.84	3.59	1.57	6.82	24.76
Orthocladininae	0.78	1.85	3.43	1.25	6.51	31.27
Leptoceridae	0.95	0.13	2.62	1.79	4.97	36.24
Chironominae	2.60	3.31	2.36	1.35	4.48	40.72
Sphaeriidae	0.76	0.58	2.35	1.20	4.46	45.18
Baetidae	0.91	0.38	2.34	1.39	4.44	49.62
Caenidae	0.63	0.13	1.90	1.28	3.62	53.24
Ecnomidae	0.73	0.48	1.89	1.19	3.59	56.84
Ceratopogonidae	0.57	0.24	1.82	1.02	3.46	60.30
Tricladida	0.42	0.41	1.75	0.92	3.32	63.62
Atyidae	0.55	0.00	1.73	0.94	3.28	66.90
Dytiscidae	0.62	0.33	1.69	1.16	3.21	70.11
Dytiscidae (adult)	0.00	0.49	1.50	0.94	2.85	72.97
Ceinidae	0.44	0.13	1.41	0.82	2.68	75.65
Tipulidae	0.35	0.29	1.36	0.93	2.59	78.24
Hemicorduliidae	0.13	0.38	1.33	0.82	2.53	80.77
Tanypodininae	2.00	1.67	1.28	1.09	2.43	83.20
Coenagrionidae	0.16	0.32	1.19	0.79	2.26	85.47
Corixidae	0.33	0.00	0.96	0.66	1.83	87.29
Nemertea	0.16	0.16	0.91	0.61	1.72	89.02
Podinae	0.00	0.24	0.83	0.44	1.57	90.59

Groups DC & HC

Average dissimilarity = 59.67

Species	Group DC Av.Abund	Group HC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Orthocladininae	0.00	1.85	7.49	2.51	12.56	12.56
Leptophlebiidae	1.79	0.16	6.79	2.59	11.38	23.94
Chironominae	2.45	3.31	3.48	1.45	5.84	29.78
Ceratopogonidae	0.71	0.24	2.91	0.96	4.87	34.65
Oligochaeta	0.96	0.84	2.73	1.47	4.57	39.22
Tanypodininae	1.20	1.67	2.41	1.81	4.04	43.26
Baetidae	0.50	0.38	2.31	1.03	3.87	47.14
Sphaeriidae	0.00	0.58	2.24	0.96	3.75	50.89
Corixidae	0.51	0.00	2.06	0.96	3.46	54.35
Ecnomidae	0.00	0.48	2.06	0.94	3.45	57.80
Dytiscidae (adult)	0.25	0.49	2.00	1.03	3.34	61.14
Dytiscidae	0.28	0.33	1.75	0.91	2.93	64.07
Tipulidae	0.24	0.29	1.66	0.82	2.79	66.86
Tricladida	0.00	0.41	1.59	0.68	2.67	69.53
Caenidae	0.40	0.13	1.58	0.99	2.65	72.17
Hemicorduliidae	0.00	0.38	1.57	0.68	2.64	74.81
Coenagrionidae	0.00	0.32	1.29	0.66	2.17	76.98
Parastacidae	0.29	0.00	1.25	0.69	2.09	79.06
Leptoceridae	0.25	0.13	1.24	0.78	2.07	81.14
Ancylidae	0.28	0.00	1.16	0.69	1.95	83.08
Podinae	0.00	0.24	1.14	0.44	1.90	84.99
Psychodidae	0.26	0.00	0.90	0.44	1.51	86.50
Hydrophilidae	0.00	0.23	0.87	0.44	1.45	87.95
Cordulephyidae	0.00	0.18	0.74	0.44	1.23	89.19
Nematoda	0.00	0.17	0.69	0.44	1.15	90.34

Groups EC & HC
Average dissimilarity = 60.85

Species	Group EC Av.Abund	Group HC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptophlebiidae	2.12	0.16	6.60	3.02	10.85	10.85
Chironominae	2.32	3.31	4.18	2.00	6.87	17.72
Orthocladininae	0.92	1.85	4.15	1.18	6.82	24.54
Oligochaeta	1.61	0.84	3.25	1.21	5.34	29.88
Tanypodininae	1.66	1.67	2.83	1.03	4.65	34.54
Ecnomidae	0.64	0.48	2.15	1.15	3.53	38.07
Ceratopogonidae	0.64	0.24	2.15	0.95	3.53	41.60
Parastacidae	0.50	0.00	1.96	0.94	3.22	44.82
Sphaeriidae	0.32	0.58	1.92	1.01	3.16	47.98
Dytiscidae (adult)	0.00	0.49	1.66	0.91	2.73	50.71
Baetidae	0.28	0.38	1.66	0.96	2.72	53.44
Gomphidae	0.53	0.00	1.57	0.96	2.59	56.02
Tricladida	0.16	0.41	1.53	0.77	2.51	58.54
Magapodagrionidae	0.49	0.00	1.45	0.94	2.39	60.92
Psephenidae	0.49	0.00	1.45	0.95	2.38	63.30
Tipulidae	0.20	0.29	1.33	0.79	2.19	65.49
Hemicorduliidae	0.00	0.38	1.32	0.66	2.16	67.66
Dytiscidae	0.00	0.33	1.16	0.67	1.91	69.57
Synthemistidae	0.35	0.00	1.12	0.64	1.84	71.41
Caenidae	0.32	0.13	1.11	0.79	1.82	73.23
Leptoceridae	0.29	0.13	1.09	0.78	1.79	75.02
Coenagrionidae	0.00	0.32	1.09	0.65	1.78	76.80
Culicidae	0.28	0.00	0.95	0.44	1.55	78.36
Scirtidae	0.30	0.00	0.94	0.67	1.54	79.90
Podinae	0.00	0.24	0.93	0.43	1.53	81.43
Polycentropodidae	0.29	0.00	0.88	0.68	1.44	82.87
Hydroptilidae	0.13	0.16	0.77	0.60	1.26	84.13
Hydrophilidae	0.00	0.23	0.73	0.43	1.21	85.34
Dolichopodidae	0.21	0.00	0.72	0.44	1.19	86.53
Pyralidae	0.20	0.00	0.67	0.44	1.10	87.63

Cordulephyidae	0.00	0.18	0.62	0.43	1.01	88.64
Elmidae (adult)	0.17	0.00	0.58	0.44	0.95	89.59
Nematoda	0.00	0.17	0.57	0.43	0.94	90.53

Groups TTH & HC
Average dissimilarity = 53.08

Species	Group TTH Av.Abund	Group HC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptophlebiidae	1.59	0.16	4.68	2.56	8.81	8.81
Orthocladiinae	0.77	1.85	3.65	1.23	6.88	15.70
Oligochaeta	1.34	0.84	2.92	1.36	5.51	21.21
Ceratopogonidae	0.84	0.24	2.58	1.27	4.87	26.07
Caenidae	0.84	0.13	2.58	1.13	4.86	30.94
Chironominae	3.10	3.31	2.54	1.54	4.78	35.72
Baetidae	0.82	0.38	2.54	1.17	4.78	40.50
Ecnomidae	0.78	0.48	2.52	1.32	4.75	45.24
Tanypodininae	2.13	1.67	2.28	1.40	4.30	49.55
Corixidae	0.63	0.00	2.17	0.90	4.08	53.63
Tipulidae	0.60	0.29	1.96	1.09	3.69	57.32
Dytiscidae	0.66	0.33	1.88	1.20	3.55	60.86
Sphaeriidae	0.00	0.58	1.81	0.97	3.42	64.28
Dytiscidae (adult)	0.28	0.49	1.63	1.07	3.07	67.34
Tricladida	0.00	0.41	1.29	0.68	2.43	69.78
Hemicorduliidae	0.00	0.38	1.26	0.69	2.37	72.15
Gomphidae	0.34	0.00	1.09	0.68	2.05	74.20
Coenagrionidae	0.00	0.32	1.04	0.67	1.96	76.16
Culicidae	0.29	0.00	0.96	0.69	1.82	77.98
Notonectidae	0.28	0.00	0.93	0.69	1.75	79.73
Nematoda	0.16	0.17	0.90	0.61	1.70	81.43
Podinae	0.00	0.24	0.88	0.44	1.66	83.09
Leptoceridae	0.16	0.13	0.82	0.62	1.54	84.63
Nemertea	0.13	0.16	0.82	0.62	1.54	86.17
Hydrophilidae	0.00	0.23	0.71	0.44	1.33	87.51
Cordulephyidae	0.00	0.18	0.59	0.44	1.11	88.62
Acarina	0.00	0.16	0.55	0.44	1.03	89.64
Chorismagrionidae	0.15	0.00	0.53	0.44	1.00	90.65

Groups CWC & BR
Average dissimilarity = 56.94

Species	Group CWC Av.Abund	Group BR Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Orthocladiinae	0.16	1.34	3.03	2.26	5.32	5.32
Elmidae	0.16	1.25	2.80	2.34	4.92	10.25
Leptoceridae	0.35	1.26	2.67	1.59	4.69	14.94
Calamoceratidae	0.00	1.02	2.60	2.08	4.56	19.50
Ecnomidae	0.41	1.26	2.58	2.10	4.52	24.03
Sphaeriidae	0.00	0.97	2.52	2.04	4.43	28.46
Oligochaeta	0.86	1.49	2.34	1.42	4.11	32.57
Leptophlebiidae	3.17	2.79	2.02	1.48	3.54	36.11
Ceratopogonidae	0.41	0.80	2.01	1.13	3.54	39.65
Caenidae	0.00	0.79	1.94	1.37	3.40	43.05
Baetidae	0.00	0.68	1.83	1.33	3.22	46.27
Tricladida	0.50	0.54	1.80	1.07	3.17	49.44
Gyrinidae	0.29	0.86	1.72	1.41	3.03	52.47
Ancylidae	0.64	0.00	1.65	0.98	2.91	55.38
Dytiscidae (adult)	0.64	0.00	1.65	1.29	2.89	58.27
Hemicorduliidae	0.00	0.59	1.50	0.92	2.63	60.89
Elmidae (adult)	0.00	0.55	1.32	0.98	2.32	63.21
Tanypodininae	1.62	2.01	1.27	1.49	2.23	65.44
Chironominae	1.94	2.01	1.23	1.31	2.17	67.61
Ceinidae	0.00	0.40	1.03	0.66	1.80	69.41
Gomphidae	0.00	0.39	1.01	0.69	1.77	71.18
Scirtidae	0.32	0.14	0.94	0.80	1.65	72.83

Dytiscidae	0.00	0.32	0.90	0.69	1.58	74.41
Telephlebiidae	0.00	0.33	0.87	0.70	1.53	75.95
Polycentropodidae	0.00	0.36	0.86	0.70	1.52	77.46
Hydrophilidae	0.00	0.33	0.85	0.70	1.49	78.95
Synlestidae	0.00	0.32	0.84	0.69	1.47	80.42
Nematoda	0.22	0.13	0.79	0.61	1.39	81.81
Hydrophilidae(adult)	0.00	0.31	0.78	0.68	1.37	83.18
Psephenidae	0.20	0.14	0.78	0.63	1.36	84.55
Aphroteniinae	0.16	0.20	0.77	0.62	1.36	85.90
Odontoceridae	0.00	0.32	0.77	0.68	1.35	87.25
Hydrobiosidae	0.00	0.29	0.72	0.69	1.27	88.53
Notonectidae	0.16	0.14	0.71	0.62	1.24	89.77
Tipulidae	0.16	0.15	0.69	0.62	1.20	90.97

Groups CC & BR
Average dissimilarity = 46.18

Species	Group CC Av.Abund	Group BR Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Elmidae	0.13	1.25	2.51	2.63	5.45	5.45
Psephenidae	1.25	0.14	2.43	3.13	5.26	10.71
Calamoceratidae	0.00	1.02	2.25	2.07	4.86	15.57
Gyrinidae	0.00	0.86	1.92	2.09	4.15	19.72
Leptophlebiidae	1.99	2.79	1.84	1.43	3.97	23.70
Chironominae	2.60	2.01	1.82	1.45	3.95	27.65
Sphaeriidae	0.76	0.97	1.79	1.52	3.88	31.53
Ceratopogonidae	0.57	0.80	1.74	1.23	3.78	35.31
Orthocladininae	0.78	1.34	1.48	1.11	3.20	38.51
Leptoceridae	0.95	1.26	1.43	1.13	3.10	41.60
Ecnomidae	0.73	1.26	1.37	1.24	2.96	44.56
Tricladida	0.42	0.54	1.34	1.07	2.90	47.47
Hemicorduliidae	0.13	0.59	1.30	1.00	2.82	50.28
Ceinidae	0.44	0.40	1.30	0.91	2.82	53.10
Caenidae	0.63	0.79	1.29	1.23	2.80	55.90
Baetidae	0.91	0.68	1.27	1.25	2.76	58.66
Atyidae	0.55	0.16	1.24	1.00	2.69	61.35
Oligochaeta	1.96	1.49	1.22	1.23	2.65	64.00
Dytiscidae	0.62	0.32	1.19	1.18	2.59	66.59
Elmidae (adult)	0.00	0.55	1.15	0.97	2.49	69.08
Gomphidae	0.13	0.39	0.96	0.80	2.08	71.15
Tipulidae	0.35	0.15	0.87	0.80	1.88	73.03
Tanypodininae	2.00	2.01	0.79	1.51	1.71	74.74
Polycentropodidae	0.00	0.36	0.75	0.69	1.63	76.37
Telephlebiidae	0.00	0.33	0.75	0.69	1.63	78.00
Hydrophilidae	0.00	0.33	0.73	0.70	1.59	79.58
Synlestidae	0.00	0.32	0.72	0.69	1.56	81.14
Corixidae	0.33	0.00	0.70	0.66	1.52	82.67
Hydrophilidae(adult)	0.00	0.31	0.68	0.68	1.46	84.13
Odontoceridae	0.00	0.32	0.67	0.68	1.45	85.58
Coenagrionidae	0.16	0.20	0.64	0.62	1.39	86.97
Hydrobiosidae	0.00	0.29	0.63	0.69	1.36	88.34
Nemertea	0.16	0.16	0.63	0.61	1.36	89.69
Chorismagrionidae	0.13	0.20	0.59	0.61	1.28	90.97

Groups DC & BR
Average dissimilarity = 60.92

Species	Group DC Av.Abund	Group BR Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Orthocladininae	0.00	1.34	3.63	3.58	5.96	5.96
Ecnomidae	0.00	1.26	3.40	4.23	5.58	11.53
Elmidae	0.13	1.25	3.06	2.59	5.03	16.56
Leptoceridae	0.25	1.26	2.96	1.91	4.85	21.42
Calamoceratidae	0.00	1.02	2.72	2.06	4.47	25.89
Leptophlebiidae	1.79	2.79	2.66	2.06	4.37	30.25

Sphaeriidae	0.00	0.97	2.64	2.01	4.34	34.59
Ceratopogonidae	0.71	0.80	2.43	1.25	3.99	38.58
Tanypodininae	1.20	2.01	2.25	2.13	3.70	42.28
Gyrinidae	0.13	0.86	2.10	1.79	3.45	45.73
Chironominae	2.45	2.01	1.93	1.54	3.17	48.90
Caenidae	0.40	0.79	1.75	1.38	2.87	51.76
Baetidae	0.50	0.68	1.64	1.24	2.70	54.46
Hemicorduliidae	0.00	0.59	1.57	0.92	2.57	57.03
Tricladida	0.00	0.54	1.44	0.97	2.37	59.40
Oligochaeta	0.96	1.49	1.42	1.24	2.33	61.73
Elmidae (adult)	0.00	0.55	1.38	0.98	2.26	63.99
Corixidae	0.51	0.00	1.36	0.97	2.24	66.23
Dytiscidae	0.28	0.32	1.15	0.90	1.88	68.11
Ceinidae	0.00	0.40	1.08	0.66	1.77	69.87
Gomphidae	0.00	0.39	1.06	0.69	1.73	71.61
Telephlebiidae	0.00	0.33	0.92	0.69	1.50	73.11
Polycentropodidae	0.00	0.36	0.90	0.70	1.48	74.59
Hydrophilidae	0.00	0.33	0.89	0.70	1.46	76.05
Synlestidae	0.00	0.32	0.88	0.69	1.44	77.49
Tipulidae	0.24	0.15	0.86	0.63	1.40	78.89
Hydrophilidae(adult)	0.00	0.31	0.82	0.68	1.34	80.24
Parastacidae	0.29	0.00	0.81	0.69	1.33	81.57
Odontoceridae	0.00	0.32	0.80	0.68	1.32	82.88
Hydrobiosidae	0.00	0.29	0.76	0.69	1.24	84.13
Ancylidae	0.28	0.00	0.76	0.69	1.24	85.37
Scirtidae	0.18	0.14	0.74	0.63	1.21	86.59
Psephenidae	0.13	0.14	0.63	0.61	1.04	87.63
Dytiscidae (adult)	0.25	0.00	0.63	0.69	1.04	88.66
Psychodidae	0.26	0.00	0.63	0.44	1.03	89.69
Chorismagrionidae	0.00	0.20	0.50	0.44	0.82	90.51

Groups EC & BR

Average dissimilarity = 53.43

Species	Group EC Av.Abund	Group BR Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Elmidae	0.00	1.25	2.98	3.53	5.58	5.58
Leptoceridae	0.29	1.26	2.57	1.65	4.81	10.39
Calamoceratidae	0.15	1.02	2.19	1.69	4.10	14.49
Ecnomidae	0.64	1.26	1.98	1.34	3.71	18.21
Orthocladininae	0.92	1.34	1.92	1.24	3.59	21.80
Ceratopogonidae	0.64	0.80	1.90	1.12	3.56	25.36
Tanypodininae	1.66	2.01	1.87	0.90	3.51	28.87
Sphaeriidae	0.32	0.97	1.86	1.37	3.49	32.36
Gyrinidae	0.15	0.86	1.84	1.59	3.44	35.79
Leptophlebiidae	2.12	2.79	1.72	1.19	3.22	39.01
Caenidae	0.32	0.79	1.63	1.24	3.05	42.06
Chironominae	2.32	2.01	1.63	0.95	3.05	45.11
Baetidae	0.28	0.68	1.43	1.29	2.67	47.77
Hemicorduliidae	0.00	0.59	1.38	0.91	2.58	50.36
Gomphidae	0.53	0.39	1.35	1.04	2.52	52.88
Parastacidae	0.50	0.00	1.30	0.96	2.43	55.31
Tricladida	0.16	0.54	1.28	0.98	2.39	57.70
Elmidae (adult)	0.17	0.55	1.25	0.99	2.34	60.04
Oligochaeta	1.61	1.49	1.24	0.92	2.32	62.37
Magapodagrionidae	0.49	0.16	1.11	0.99	2.08	64.44
Psephenidae	0.49	0.14	1.10	1.01	2.07	66.51
Polycentropodidae	0.29	0.36	1.04	0.91	1.94	68.45
Ceinidae	0.00	0.40	0.95	0.65	1.77	70.22
Telephlebiidae	0.13	0.33	0.89	0.79	1.66	71.88
Synlestidae	0.13	0.32	0.85	0.78	1.60	73.48
Dytiscidae	0.00	0.32	0.83	0.68	1.55	75.02
Scirtidae	0.30	0.14	0.82	0.78	1.54	76.57
Synthemistidae	0.35	0.00	0.80	0.64	1.49	78.06
Hydrophilidae	0.00	0.33	0.78	0.69	1.46	79.52

Hydrophilidae(adult)	0.00	0.31	0.72	0.67	1.35	80.87
Odontoceridae	0.00	0.32	0.71	0.68	1.33	82.20
Tipulidae	0.20	0.15	0.71	0.62	1.33	83.53
Hydrobiosidae	0.00	0.29	0.67	0.68	1.25	84.79
Culicidae	0.28	0.00	0.66	0.44	1.24	86.03
Sialidae	0.15	0.16	0.57	0.61	1.06	87.09
Notonectidae	0.13	0.14	0.54	0.60	1.02	88.11
Dolichopodidae	0.21	0.00	0.50	0.44	0.95	89.05
Pyralidae	0.20	0.00	0.47	0.44	0.88	89.93
Chorismagrionidae	0.00	0.20	0.44	0.44	0.83	90.76

Groups TTH & BR
Average dissimilarity = 53.94

	Group TTH	Group BR				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Elmidae	0.00	1.25	2.91	4.07	5.40	5.40
Chironominae	3.10	2.01	2.81	1.59	5.21	10.61
Leptophlebiidae	1.59	2.79	2.80	2.26	5.18	15.80
Leptoceridae	0.16	1.26	2.69	1.84	4.98	20.78
Calamoceratidae	0.00	1.02	2.34	2.08	4.35	25.12
Sphaeriidae	0.00	0.97	2.27	2.04	4.21	29.33
Ecnomidae	0.78	1.26	1.89	1.48	3.51	32.84
Ceratopogonidae	0.84	0.80	1.87	1.27	3.46	36.30
Gyrinidae	0.13	0.86	1.80	1.82	3.33	39.63
Caenidae	0.84	0.79	1.70	1.22	3.14	42.78
Baetidae	0.82	0.68	1.57	1.34	2.91	45.69
Corixidae	0.63	0.00	1.51	0.90	2.80	48.49
Orthocladininae	0.77	1.34	1.48	1.00	2.74	51.23
Tanypodininae	2.13	2.01	1.41	1.58	2.62	53.85
Tipulidae	0.60	0.15	1.38	1.02	2.56	56.41
Hemicorduliidae	0.00	0.59	1.35	0.92	2.50	58.91
Oligochaeta	1.34	1.49	1.33	1.15	2.46	61.37
Dytiscidae	0.66	0.32	1.32	1.23	2.44	63.81
Tricladida	0.00	0.54	1.24	0.97	2.30	66.12
Gomphidae	0.34	0.39	1.20	0.94	2.23	68.34
Elmidae (adult)	0.00	0.55	1.20	0.98	2.22	70.56
Ceinidae	0.00	0.40	0.93	0.66	1.72	72.28
Polycentropodidae	0.16	0.36	0.92	0.80	1.70	73.98
Hydrophilidae(adult)	0.13	0.31	0.80	0.79	1.49	75.47
Telephlebiidae	0.00	0.33	0.78	0.70	1.45	76.92
Notonectidae	0.28	0.14	0.78	0.79	1.45	78.37
Hydrophilidae	0.00	0.33	0.76	0.70	1.42	79.79
Synlestidae	0.00	0.32	0.75	0.69	1.39	81.18
Odontoceridae	0.00	0.32	0.70	0.68	1.29	82.48
Chorismagrionidae	0.15	0.20	0.68	0.63	1.27	83.75
Culicidae	0.29	0.00	0.68	0.69	1.26	85.01
Hydrobiosidae	0.00	0.29	0.66	0.69	1.22	86.22
Dytiscidae (adult)	0.28	0.00	0.65	0.69	1.20	87.43
Sialidae	0.16	0.16	0.59	0.61	1.09	88.52
Nematoda	0.16	0.13	0.57	0.62	1.06	89.58
Nemertea	0.13	0.16	0.56	0.62	1.04	90.63

Groups HC & BR
Average dissimilarity = 59.90

	Group HC	Group BR				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptophlebiidae	0.16	2.79	6.68	4.67	11.16	11.16
Chironominae	3.31	2.01	3.42	1.94	5.72	16.87
Elmidae	0.00	1.25	3.19	4.03	5.33	22.20
Leptoceridae	0.13	1.26	3.03	1.92	5.06	27.26
Calamoceratidae	0.00	1.02	2.57	2.07	4.28	31.54
Gyrinidae	0.00	0.86	2.19	2.08	3.66	35.20
Ecnomidae	0.48	1.26	2.04	1.58	3.41	38.61

Oligochaeta	0.84	1.49	1.96	1.43	3.27	41.88
Ceratopogonidae	0.24	0.80	1.95	1.02	3.26	45.14
Orthocladininae	1.85	1.34	1.85	1.14	3.09	48.23
Caenidae	0.13	0.79	1.83	1.38	3.05	51.29
Sphaeriidae	0.58	0.97	1.72	1.21	2.87	54.15
Baetidae	0.38	0.68	1.64	1.24	2.73	56.88
Hemicorduliidae	0.38	0.59	1.61	1.07	2.68	59.57
Tricladida	0.41	0.54	1.53	1.08	2.55	62.12
Elmidae (adult)	0.00	0.55	1.30	0.98	2.18	64.30
Dytiscidae (adult)	0.49	0.00	1.23	0.95	2.06	66.35
Tanypodininae	1.67	2.01	1.16	1.31	1.94	68.29
Dytiscidae	0.33	0.32	1.14	0.89	1.91	70.20
Ceinidae	0.13	0.40	1.14	0.79	1.90	72.10
Hydrophilidae	0.23	0.33	1.13	0.83	1.89	73.99
Coenagrionidae	0.32	0.20	1.01	0.79	1.69	75.68
Gomphidae	0.00	0.39	1.00	0.69	1.66	77.34
Tipulidae	0.29	0.15	0.88	0.79	1.47	78.81
Telephlebiidae	0.00	0.33	0.86	0.70	1.44	80.25
Polycentropodidae	0.00	0.36	0.85	0.70	1.43	81.67
Synlestidae	0.00	0.32	0.83	0.69	1.38	83.05
Hydrophilidae(adult)	0.00	0.31	0.77	0.68	1.29	84.34
Odontoceridae	0.00	0.32	0.76	0.68	1.27	85.61
Cordulephyidae	0.18	0.18	0.75	0.61	1.26	86.87
Hydrobiosidae	0.00	0.29	0.72	0.69	1.20	88.06
Nemertea	0.16	0.16	0.69	0.61	1.14	89.21
Podinae	0.24	0.00	0.66	0.44	1.11	90.32

Groups CWC & CBR
Average dissimilarity = 54.67

Species	Group CWC Av.Abund	Group CBR Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Oligochaeta	0.86	2.11	3.99	1.43	7.29	7.29
Elmidae	0.16	1.28	3.34	1.71	6.12	13.41
Ecnomidae	0.41	1.27	2.96	2.27	5.41	18.81
Sphaeriidae	0.00	1.03	2.94	1.32	5.38	24.20
Atyidae	0.00	0.98	2.88	1.99	5.27	29.47
Leptophlebiidae	3.17	2.44	2.84	1.67	5.19	34.66
Ceratopogonidae	0.41	1.09	2.59	1.51	4.74	39.40
Baetidae	0.00	0.90	2.51	1.37	4.59	43.99
Leptoceridae	0.35	0.87	2.35	1.20	4.30	48.28
Ancylidae	0.64	0.00	1.90	0.97	3.48	51.76
Dytiscidae (adult)	0.64	0.00	1.89	1.28	3.46	55.22
Orthocladininae	0.16	0.69	1.86	1.29	3.40	58.62
Tanypodininae	1.62	2.17	1.81	1.53	3.32	61.94
Tricladida	0.50	0.30	1.81	0.87	3.30	65.24
Chironominae	1.94	2.05	1.65	1.49	3.01	68.25
Caenidae	0.00	0.51	1.45	0.98	2.65	70.91
Ceinidae	0.00	0.52	1.35	0.69	2.47	73.38
Gripopterygidae	0.00	0.41	1.30	0.63	2.38	75.76
Gyrinidae	0.29	0.16	1.01	0.79	1.85	77.62
Calamoceratidae	0.00	0.32	0.97	0.70	1.78	79.39
Scirtidae	0.32	0.00	0.91	0.69	1.67	81.06
Sialidae	0.00	0.28	0.88	0.69	1.61	82.67
Hemicorduliidae	0.00	0.25	0.80	0.70	1.46	84.13
Tipulidae	0.16	0.13	0.76	0.62	1.39	85.51
Notonectidae	0.16	0.13	0.75	0.62	1.38	86.89
Nematoda	0.22	0.00	0.67	0.44	1.22	88.12
Psephenidae	0.20	0.00	0.58	0.44	1.05	89.17
Gomphidae	0.00	0.16	0.55	0.44	1.00	90.17

Groups CC & CBR
Average dissimilarity = 41.58

Group CC Group CBR

Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Psephenidae	1.25	0.00	3.13	5.55	7.53	7.53
Elmidae	0.13	1.28	2.91	1.74	6.99	14.52
Chironominae	2.60	2.05	2.25	1.54	5.42	19.94
Sphaeriidae	0.76	1.03	2.25	1.24	5.41	25.35
Ceratopogonidae	0.57	1.09	1.93	1.27	4.64	29.99
Oligochaeta	1.96	2.11	1.86	1.26	4.47	34.46
Baetidae	0.91	0.90	1.68	1.25	4.03	38.50
Atyidae	0.55	0.98	1.64	1.19	3.96	42.46
Leptoceridae	0.95	0.87	1.62	1.24	3.89	46.34
Ceinidae	0.44	0.52	1.59	0.92	3.83	50.17
Orthocladininae	0.78	0.69	1.54	1.22	3.71	53.89
Ecnomidae	0.73	1.27	1.52	1.24	3.66	57.54
Dytiscidae	0.62	0.16	1.48	1.24	3.56	61.10
Caenidae	0.63	0.51	1.34	1.14	3.22	64.32
Tricladida	0.42	0.30	1.28	0.96	3.09	67.41
Leptophlebiidae	1.99	2.44	1.26	1.15	3.03	70.44
Gripopterygidae	0.00	0.41	1.09	0.63	2.63	73.06
Tanypodininae	2.00	2.17	1.03	1.28	2.48	75.54
Tipulidae	0.35	0.13	0.96	0.81	2.31	77.85
Calamoceratidae	0.00	0.32	0.82	0.69	1.97	79.82
Corixidae	0.33	0.00	0.79	0.66	1.90	81.71
Hemicorduliidae	0.13	0.25	0.77	0.78	1.85	83.56
Sialidae	0.00	0.28	0.74	0.69	1.78	85.34
Coenagrionidae	0.16	0.15	0.66	0.61	1.58	86.92
Gomphidae	0.13	0.16	0.64	0.60	1.53	88.45
Nemertea	0.16	0.00	0.46	0.44	1.12	89.57
Hydrophilidae	0.00	0.18	0.44	0.44	1.05	90.62

Groups DC & CBR
Average dissimilarity = 55.87

Species	Group DC Av.Abund	Group CBR Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Ecnomidae	0.00	1.27	3.88	4.84	6.95	6.95
Elmidae	0.13	1.28	3.62	1.73	6.47	13.42
Oligochaeta	0.96	2.11	3.35	1.42	6.00	19.42
Sphaeriidae	0.00	1.03	3.10	1.31	5.56	24.98
Atyidae	0.00	0.98	3.04	1.95	5.45	30.43
Tanypodininae	1.20	2.17	3.02	2.04	5.40	35.83
Ceratopogonidae	0.71	1.09	2.84	1.49	5.08	40.91
Leptoceridae	0.25	0.87	2.55	1.32	4.57	45.47
Chironominae	2.45	2.05	2.47	1.58	4.41	49.89
Baetidae	0.50	0.90	2.29	1.29	4.11	53.99
Orthocladininae	0.00	0.69	2.09	1.36	3.74	57.73
Leptophlebiidae	1.79	2.44	1.95	1.69	3.49	61.22
Corixidae	0.51	0.00	1.58	0.96	2.83	64.04
Caenidae	0.40	0.51	1.57	1.15	2.80	66.84
Ceinidae	0.00	0.52	1.42	0.69	2.54	69.38
Gripopterygidae	0.00	0.41	1.38	0.63	2.47	71.85
Dytiscidae	0.28	0.16	1.03	0.80	1.85	73.70
Calamoceratidae	0.00	0.32	1.03	0.69	1.84	75.54
Tipulidae	0.24	0.13	0.95	0.63	1.70	77.24
Parastacidae	0.29	0.00	0.94	0.68	1.69	78.93
Sialidae	0.00	0.28	0.93	0.69	1.67	80.60
Tricladida	0.00	0.30	0.93	0.69	1.66	82.27
Ancylidae	0.28	0.00	0.88	0.69	1.58	83.84
Hemicorduliidae	0.00	0.25	0.84	0.69	1.51	85.35
Dytiscidae (adult)	0.25	0.00	0.72	0.69	1.29	86.65
Psychodidae	0.26	0.00	0.71	0.44	1.28	87.92
Gyrinidae	0.13	0.16	0.69	0.63	1.24	89.17
Gomphidae	0.00	0.16	0.58	0.44	1.04	90.21

Groups EC & CBR
Average dissimilarity = 51.88

Species	Group EC Av.Abund	Group CBR Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Elmidae	0.00	1.28	3.35	1.76	6.45	6.45
Atyidae	0.00	0.98	2.63	1.87	5.08	11.53
Oligochaeta	1.61	2.11	2.46	1.26	4.74	16.27
Sphaeriidae	0.32	1.03	2.46	1.26	4.73	21.00
Tanypodininae	1.66	2.17	2.42	0.92	4.67	25.67
Ecnomidae	0.64	1.27	2.27	1.36	4.38	30.05
Ceratopogonidae	0.64	1.09	2.22	1.28	4.28	34.33
Leptoceridae	0.29	0.87	2.19	1.18	4.21	38.54
Chironominae	2.32	2.05	2.10	1.09	4.04	42.58
Baetidae	0.28	0.90	2.08	1.48	4.00	46.58
Orthocladininae	0.92	0.69	1.99	1.26	3.83	50.42
Parastacidae	0.50	0.00	1.50	0.95	2.89	53.30
Caenidae	0.32	0.51	1.42	1.06	2.73	56.03
Gomphidae	0.53	0.16	1.36	0.98	2.62	58.65
Leptophlebiidae	2.12	2.44	1.30	1.16	2.51	61.17
Ceinidae	0.00	0.52	1.25	0.68	2.40	63.57
Gripopterygidae	0.00	0.41	1.19	0.62	2.28	65.85
Magapodagrionidae	0.49	0.00	1.18	0.94	2.28	68.14
Psephenidae	0.49	0.00	1.18	0.95	2.27	70.41
Calamoceratidae	0.15	0.32	1.00	0.77	1.92	72.33
Tricladida	0.16	0.30	0.97	0.79	1.87	74.21
Polycentropodidae	0.29	0.17	0.93	0.77	1.79	75.99
Sialidae	0.15	0.28	0.93	0.77	1.78	77.78
Synthemistidae	0.35	0.00	0.90	0.64	1.74	79.51
Tipulidae	0.20	0.13	0.78	0.62	1.50	81.02
Scirtidae	0.30	0.00	0.76	0.67	1.46	82.48
Culicidae	0.28	0.00	0.75	0.44	1.45	83.93
Elmidae (adult)	0.17	0.16	0.75	0.61	1.45	85.38
Hemicorduliidae	0.00	0.25	0.72	0.68	1.40	86.77
Gyrinidae	0.15	0.16	0.61	0.61	1.18	87.95
Dolichopodidae	0.21	0.00	0.57	0.44	1.11	89.06
Synlestidae	0.13	0.13	0.56	0.60	1.08	90.14

Groups TTH & CBR
Average dissimilarity = 50.72

Species	Group TTH Av.Abund	Group CBR Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironominae	3.10	2.05	3.28	1.54	6.46	6.46
Elmidae	0.00	1.28	3.25	1.85	6.42	12.88
Sphaeriidae	0.00	1.03	2.62	1.32	5.17	18.05
Atyidae	0.00	0.98	2.56	1.99	5.05	23.10
Oligochaeta	1.34	2.11	2.56	1.27	5.05	28.14
Leptoceridae	0.16	0.87	2.22	1.24	4.38	32.53
Leptophlebiidae	1.59	2.44	2.22	1.96	4.38	36.91
Ecnomidae	0.78	1.27	2.18	1.60	4.30	41.21
Baetidae	0.82	0.90	1.98	1.26	3.90	45.11
Caenidae	0.84	0.51	1.89	1.15	3.72	48.83
Ceratopogonidae	0.84	1.09	1.76	1.20	3.48	52.31
Tanypodininae	2.13	2.17	1.74	1.84	3.44	55.75
Corixidae	0.63	0.00	1.72	0.90	3.39	59.14
Dytiscidae	0.66	0.16	1.65	1.25	3.25	62.40
Tipulidae	0.60	0.13	1.56	1.04	3.08	65.47
Orthocladininae	0.77	0.69	1.56	1.23	3.07	68.54
Ceinidae	0.00	0.52	1.22	0.69	2.40	70.94
Gripopterygidae	0.00	0.41	1.15	0.63	2.27	73.21
Gomphidae	0.34	0.16	1.08	0.81	2.13	75.34
Sialidae	0.16	0.28	0.94	0.81	1.85	77.19
Calamoceratidae	0.00	0.32	0.86	0.70	1.70	78.88
Notonectidae	0.28	0.13	0.85	0.79	1.67	80.56
Tricladida	0.00	0.30	0.78	0.70	1.55	82.11
Culicidae	0.29	0.00	0.77	0.69	1.52	83.63

Dytiscidae (adult)	0.28	0.00	0.74	0.69	1.45	85.08
Polycentropodidae	0.16	0.17	0.70	0.61	1.39	86.47
Hemicorduliidae	0.00	0.25	0.70	0.69	1.39	87.85
Gyrinidae	0.13	0.16	0.60	0.63	1.19	89.04
Hydrophilidae(adult)	0.13	0.16	0.59	0.63	1.16	90.19

Groups HC & CBR
Average dissimilarity = 59.43

	Group HC	Group CBR				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptophlebiidae	0.16	2.44	6.62	4.95	11.14	11.14
Chironominae	3.31	2.05	4.05	1.86	6.82	17.96
Oligochaeta	0.84	2.11	3.69	1.50	6.22	24.18
Elmidae	0.00	1.28	3.60	1.85	6.06	30.24
Orthocladininae	1.85	0.69	3.47	1.33	5.83	36.07
Ceratopogonidae	0.24	1.09	2.89	1.71	4.86	40.93
Atyidae	0.00	0.98	2.84	1.97	4.78	45.71
Leptoceridae	0.13	0.87	2.53	1.27	4.26	49.97
Sphaeriidae	0.58	1.03	2.48	1.30	4.18	54.15
Ecnomidae	0.48	1.27	2.30	1.58	3.87	58.02
Baetidae	0.38	0.90	2.21	1.24	3.72	61.74
Tanypodininae	1.67	2.17	1.57	1.15	2.65	64.39
Ceinidae	0.13	0.52	1.51	0.84	2.54	66.92
Tricladida	0.41	0.30	1.46	0.94	2.46	69.38
Caenidae	0.13	0.51	1.44	1.04	2.42	71.81
Dytiscidae (adult)	0.49	0.00	1.41	0.94	2.38	74.19
Hemicorduliidae	0.38	0.25	1.38	0.97	2.32	76.51
Gripopterygidae	0.00	0.41	1.28	0.63	2.16	78.67
Dytiscidae	0.33	0.16	1.10	0.77	1.86	80.52
Coenagrionidae	0.32	0.15	1.10	0.79	1.86	82.38
Hydrophilidae	0.23	0.18	0.98	0.62	1.65	84.03
Tipulidae	0.29	0.13	0.97	0.79	1.64	85.67
Calamoceratidae	0.00	0.32	0.96	0.70	1.61	87.28
Sialidae	0.00	0.28	0.87	0.69	1.46	88.74
Podinae	0.24	0.00	0.77	0.44	1.30	90.04

Groups BR & CBR
Average dissimilarity = 40.27

	Group BR	Group CBR				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Atyidae	0.16	0.98	1.83	1.65	4.55	4.55
Ceratopogonidae	0.80	1.09	1.81	1.40	4.50	9.05
Calamoceratidae	1.02	0.32	1.70	1.54	4.23	13.28
Gyrinidae	0.86	0.16	1.64	1.57	4.07	17.35
Sphaeriidae	0.97	1.03	1.60	1.44	3.96	21.31
Oligochaeta	1.49	2.11	1.58	1.09	3.91	25.22
Leptoceridae	1.26	0.87	1.57	1.23	3.90	29.12
Orthocladininae	1.34	0.69	1.53	1.22	3.81	32.93
Baetidae	0.68	0.90	1.40	1.31	3.49	36.42
Caenidae	0.79	0.51	1.34	1.20	3.33	39.75
Ceinidae	0.40	0.52	1.34	0.93	3.33	43.08
Elmidae	1.25	1.28	1.32	1.33	3.29	46.37
Chironominae	2.01	2.05	1.27	1.10	3.15	49.52
Hemicorduliidae	0.59	0.25	1.25	1.10	3.11	52.63
Tricladida	0.54	0.30	1.15	1.07	2.85	55.48
Elmidae (adult)	0.55	0.16	1.12	1.00	2.78	58.26
Gomphidae	0.39	0.16	0.96	0.81	2.39	60.66
Gripopterygidae	0.00	0.41	0.92	0.63	2.29	62.94
Tanypodininae	2.01	2.17	0.92	1.27	2.28	65.23
Polycentropodidae	0.36	0.17	0.86	0.80	2.13	67.35
Hydrophilidae	0.33	0.18	0.84	0.79	2.09	69.45
Leptophlebiidae	2.79	2.44	0.83	1.15	2.07	71.51
Dytiscidae	0.32	0.16	0.83	0.78	2.05	73.56

Synlestidae	0.32	0.13	0.78	0.81	1.94	75.50
Hydrophilidae(adult)	0.31	0.16	0.77	0.79	1.91	77.40
Sialidae	0.16	0.28	0.75	0.81	1.87	79.27
Ecnomidae	1.26	1.27	0.74	1.36	1.84	81.11
Telephlebiidae	0.33	0.00	0.72	0.69	1.78	82.89
Odontoceridae	0.32	0.00	0.64	0.68	1.60	84.49
Hydrobiosidae	0.29	0.00	0.60	0.69	1.50	85.99
Coenagrionidae	0.20	0.15	0.60	0.63	1.49	87.48
Tipulidae	0.15	0.13	0.51	0.62	1.26	88.74
Notonectidae	0.14	0.13	0.50	0.61	1.25	89.99
Chorismagrionidae	0.20	0.00	0.40	0.44	0.99	90.97

Groups CWC & CMC
Average dissimilarity = 50.06

	Group CWC	Group CMC				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Orthocladininae	0.16	1.63	4.44	2.54	8.88	8.88
Oligochaeta	0.86	1.64	3.55	1.75	7.09	15.96
Leptophlebiidae	3.17	2.64	2.91	1.35	5.81	21.78
Ecnomidae	0.41	1.10	2.87	2.31	5.73	27.50
Dytiscidae	0.00	0.78	2.38	1.38	4.76	32.26
Chironominae	1.94	2.61	2.29	1.79	4.58	36.84
Tanypodininae	1.62	2.29	2.25	1.72	4.49	41.33
Leptoceridae	0.35	0.87	2.15	1.41	4.30	45.63
Ancylidae	0.64	0.00	2.03	0.97	4.05	49.67
Ceratopogonidae	0.41	0.66	2.02	1.22	4.03	53.70
Dytiscidae (adult)	0.64	0.15	1.92	1.24	3.84	57.55
Tricladida	0.50	0.25	1.85	0.82	3.70	61.24
Synthemistidae	0.00	0.51	1.71	0.94	3.41	64.65
Gyrinidae	0.29	0.34	1.36	0.92	2.71	67.36
Tipulidae	0.16	0.32	1.29	0.77	2.58	69.94
Magapodagrionidae	0.13	0.33	1.22	0.81	2.45	72.39
Gripopterygidae	0.00	0.39	1.07	0.65	2.15	74.53
Polycentropodidae	0.00	0.33	1.06	0.69	2.12	76.65
Scirtidae	0.32	0.00	0.97	0.69	1.94	78.58
Nematoda	0.22	0.13	0.95	0.59	1.90	80.49
Caenidae	0.00	0.29	0.94	0.68	1.89	82.37
Elmidae (adult)	0.00	0.33	0.93	0.69	1.87	84.24
Hydroptilidae	0.00	0.29	0.88	0.67	1.76	86.00
Elmidae	0.16	0.13	0.79	0.61	1.58	87.59
Baetidae	0.00	0.16	0.62	0.44	1.23	88.82
Psephenidae	0.20	0.00	0.61	0.44	1.22	90.04

Groups CC & CMC
Average dissimilarity = 41.70

	Group CC	Group CMC				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Psephenidae	1.25	0.00	3.30	5.52	7.92	7.92
Orthocladininae	0.78	1.63	2.39	1.40	5.74	13.66
Baetidae	0.91	0.16	2.13	1.57	5.11	18.77
Oligochaeta	1.96	1.64	1.99	1.53	4.78	23.55
Leptophlebiidae	1.99	2.64	1.93	1.40	4.64	28.19
Sphaeriidae	0.76	0.13	1.90	1.03	4.56	32.74
Ceratopogonidae	0.57	0.66	1.59	1.17	3.81	36.55
Dytiscidae	0.62	0.78	1.52	1.21	3.65	40.20
Caenidae	0.63	0.29	1.47	1.18	3.53	43.73
Atyidae	0.55	0.00	1.47	0.94	3.53	47.26
Chironominae	2.60	2.61	1.42	1.15	3.41	50.67
Synthemistidae	0.00	0.51	1.42	0.94	3.40	54.07
Leptoceridae	0.95	0.87	1.36	1.16	3.25	57.32
Ecnomidae	0.73	1.10	1.28	1.06	3.07	60.38
Tricladida	0.42	0.25	1.28	0.94	3.06	63.45
Tipulidae	0.35	0.32	1.25	0.89	3.01	66.46

Ceinidae	0.44	0.13	1.19	0.79	2.85	69.30
Tanypodininae	2.00	2.29	1.08	1.39	2.59	71.90
Gripopterygidae	0.00	0.39	0.92	0.64	2.21	74.11
Magapodagrionidae	0.00	0.33	0.92	0.69	2.21	76.31
Polycentropodidae	0.00	0.33	0.89	0.69	2.12	78.44
Gyrinidae	0.00	0.34	0.86	0.69	2.06	80.50
Corixidae	0.33	0.00	0.83	0.66	1.99	82.49
Elmidae (adult)	0.00	0.33	0.80	0.69	1.91	84.40
Hydroptilidae	0.00	0.29	0.74	0.67	1.79	86.19
Nematoda	0.17	0.13	0.61	0.62	1.46	87.65
Gomphidae	0.13	0.15	0.59	0.61	1.41	89.06
Hemicorduliidae	0.13	0.13	0.56	0.60	1.34	90.39

Groups DC & CMC
Average dissimilarity = 51.83

Species	Group DC Av.Abund	Group CMC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Orthocladininae	0.00	1.63	5.27	3.93	10.16	10.16
Ecnomidae	0.00	1.10	3.75	3.91	7.24	17.40
Tanypodininae	1.20	2.29	3.72	2.20	7.18	24.58
Leptophlebiidae	1.79	2.64	2.81	1.98	5.42	30.00
Ceratopogonidae	0.71	0.66	2.48	1.16	4.78	34.79
Oligochaeta	0.96	1.64	2.34	1.15	4.51	39.29
Leptoceridae	0.25	0.87	2.27	1.54	4.38	43.67
Dytiscidae	0.28	0.78	2.24	1.33	4.33	48.00
Synthemistidae	0.00	0.51	1.82	0.93	3.51	51.51
Chironominae	2.45	2.61	1.79	1.35	3.44	54.95
Baetidae	0.50	0.16	1.72	0.96	3.32	58.28
Corixidae	0.51	0.00	1.69	0.96	3.26	61.53
Tipulidae	0.24	0.32	1.52	0.78	2.94	64.47
Caenidae	0.40	0.29	1.44	1.02	2.78	67.25
Gyrinidae	0.13	0.34	1.24	0.82	2.39	69.64
Magapodagrionidae	0.00	0.33	1.18	0.69	2.28	71.91
Gripopterygidae	0.00	0.39	1.13	0.65	2.18	74.09
Polycentropodidae	0.00	0.33	1.12	0.69	2.17	76.26
Parastacidae	0.29	0.00	1.01	0.68	1.95	78.21
Dytiscidae (adult)	0.25	0.15	0.99	0.80	1.91	80.12
Elmidae (adult)	0.00	0.33	0.98	0.69	1.90	82.02
Ancylidae	0.28	0.00	0.94	0.69	1.82	83.84
Hydroptilidae	0.00	0.29	0.93	0.67	1.80	85.64
Psychodidae	0.26	0.00	0.76	0.44	1.46	87.10
Tricladida	0.00	0.25	0.73	0.69	1.42	88.52
Elmidae	0.13	0.13	0.67	0.61	1.30	89.82
Acarina	0.00	0.16	0.58	0.44	1.12	90.94

Groups EC & CMC
Average dissimilarity = 46.53

Species	Group EC Av.Abund	Group CMC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Orthocladininae	0.92	1.63	2.83	1.28	6.08	6.08
Tanypodininae	1.66	2.29	2.56	0.78	5.50	11.57
Chironominae	2.32	2.61	2.24	1.47	4.82	16.40
Dytiscidae	0.00	0.78	2.17	1.33	4.67	21.07
Ecnomidae	0.64	1.10	2.13	1.25	4.58	25.65
Oligochaeta	1.61	1.64	2.05	1.07	4.40	30.05
Leptophlebiidae	2.12	2.64	1.98	1.36	4.25	34.30
Leptoceridae	0.29	0.87	1.96	1.34	4.22	38.52
Ceratopogonidae	0.64	0.66	1.92	1.18	4.13	42.65
Synthemistidae	0.35	0.51	1.66	1.03	3.58	46.23
Parastacidae	0.50	0.00	1.60	0.95	3.44	49.67
Magapodagrionidae	0.49	0.33	1.44	1.00	3.09	52.76
Gomphidae	0.53	0.15	1.40	0.99	3.01	55.77
Psephenidae	0.49	0.00	1.24	0.95	2.67	58.44

Tipulidae	0.20	0.32	1.23	0.75	2.65	61.09
Polycentropodidae	0.29	0.33	1.21	0.87	2.59	63.69
Caenidae	0.32	0.29	1.20	0.90	2.59	66.28
Baetidae	0.28	0.16	1.08	0.81	2.33	68.60
Gyrinidae	0.15	0.34	1.07	0.78	2.29	70.89
Elmidae (adult)	0.17	0.33	1.06	0.77	2.28	73.17
Gripopterygidae	0.00	0.39	0.99	0.64	2.12	75.29
Sphaeriidae	0.32	0.13	0.95	0.80	2.05	77.34
Hydroptilidae	0.13	0.29	0.92	0.76	1.97	79.32
Tricladida	0.16	0.25	0.88	0.80	1.89	81.21
Scirtidae	0.30	0.00	0.80	0.67	1.72	82.93
Culicidae	0.28	0.00	0.80	0.44	1.72	84.64
Synlestidae	0.13	0.16	0.62	0.61	1.34	85.98
Calamoceratidae	0.15	0.13	0.62	0.62	1.33	87.31
Dolichopodidae	0.21	0.00	0.61	0.44	1.31	88.62
Pyralidae	0.20	0.00	0.56	0.44	1.21	89.83
Acarina	0.00	0.16	0.50	0.43	1.06	90.90

Groups TTH & CMC
Average dissimilarity = 45.09

	Group TTH	Group CMC				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptophlebiidae	1.59	2.64	2.88	1.97	6.38	6.38
Orthocladininae	0.77	1.63	2.51	1.37	5.57	11.95
Chironominae	3.10	2.61	2.34	1.43	5.19	17.14
Oligochaeta	1.34	1.64	2.19	1.37	4.86	22.01
Baetidae	0.82	0.16	2.19	1.19	4.85	26.86
Ecnomidae	0.78	1.10	2.16	1.79	4.80	31.66
Leptoceridae	0.16	0.87	2.09	1.61	4.64	36.31
Caenidae	0.84	0.29	2.07	1.13	4.59	40.90
Corixidae	0.63	0.00	1.82	0.90	4.04	44.94
Ceratopogonidae	0.84	0.66	1.80	1.20	3.99	48.94
Tanypodininae	2.13	2.29	1.74	1.83	3.85	52.79
Tipulidae	0.60	0.32	1.70	1.06	3.76	56.55
Dytiscidae	0.66	0.78	1.60	1.21	3.56	60.11
Synthemistidae	0.00	0.51	1.49	0.94	3.31	63.42
Gomphidae	0.34	0.15	1.09	0.80	2.41	65.83
Polycentropodidae	0.16	0.33	1.07	0.78	2.37	68.20
Gyrinidae	0.13	0.34	1.04	0.82	2.30	70.50
Magapodagrionidae	0.00	0.33	0.97	0.70	2.15	72.66
Gripopterygidae	0.00	0.39	0.96	0.65	2.14	74.79
Dytiscidae (adult)	0.28	0.15	0.93	0.79	2.05	76.85
Elmidae (adult)	0.00	0.33	0.83	0.69	1.85	78.70
Culicidae	0.29	0.00	0.82	0.69	1.81	80.51
Notonectidae	0.28	0.00	0.78	0.69	1.74	82.25
Hydroptilidae	0.00	0.29	0.78	0.67	1.73	83.98
Nematoda	0.16	0.13	0.67	0.61	1.48	85.46
Tricladida	0.00	0.25	0.63	0.70	1.39	86.84
Acarina	0.00	0.16	0.48	0.44	1.06	87.91
Chorismagrionidae	0.15	0.00	0.45	0.44	0.99	88.89
Sialidae	0.16	0.00	0.42	0.44	0.93	89.82
Dolichopodidae	0.15	0.00	0.41	0.44	0.91	90.74

Groups HC & CMC
Average dissimilarity = 51.08

	Group HC	Group CMC				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptophlebiidae	0.16	2.64	7.54	5.17	14.77	14.77
Oligochaeta	0.84	1.64	2.97	1.51	5.81	20.58
Chironominae	3.31	2.61	2.46	1.20	4.82	25.40
Orthocladininae	1.85	1.63	2.41	1.29	4.71	30.11
Leptoceridae	0.13	0.87	2.39	1.71	4.69	34.80
Ceratopogonidae	0.24	0.66	2.04	1.26	4.00	38.80

Dytiscidae	0.33	0.78	2.03	1.22	3.97	42.76
Ecnomidae	0.48	1.10	2.02	1.31	3.95	46.72
Tanypodininae	1.67	2.29	2.00	1.34	3.92	50.63
Sphaeriidae	0.58	0.13	1.73	1.03	3.39	54.03
Synthemistidae	0.00	0.51	1.68	0.94	3.29	57.32
Dytiscidae (adult)	0.49	0.15	1.53	0.98	3.00	60.32
Tricladida	0.41	0.25	1.47	0.91	2.87	63.19
Tipulidae	0.29	0.32	1.39	0.88	2.71	65.90
Baetidae	0.38	0.16	1.37	0.79	2.68	68.58
Hemicorduliidae	0.38	0.13	1.31	0.79	2.57	71.15
Magapodagrionidae	0.00	0.33	1.09	0.70	2.14	73.29
Hydroptilidae	0.16	0.29	1.08	0.78	2.11	75.39
Gripopterygidae	0.00	0.39	1.06	0.65	2.08	77.47
Caenidae	0.13	0.29	1.05	0.78	2.06	79.53
Polycentropodidae	0.00	0.33	1.04	0.69	2.04	81.57
Gyrinidae	0.00	0.34	1.00	0.69	1.97	83.53
Coenagrionidae	0.32	0.00	0.99	0.66	1.93	85.46
Elmidae (adult)	0.00	0.33	0.92	0.69	1.80	87.27
Acarina	0.16	0.16	0.87	0.61	1.71	88.98
Podinae	0.24	0.00	0.83	0.44	1.63	90.60

Groups BR & CMC
Average dissimilarity = 43.80

Species	Group BR Av.Abund	Group CMC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Elmidae	1.25	0.13	2.52	2.59	5.76	5.76
Calamoceratidae	1.02	0.13	2.07	1.87	4.73	10.49
Sphaeriidae	0.97	0.13	2.00	1.81	4.56	15.04
Ceratopogonidae	0.80	0.66	1.76	1.42	4.02	19.06
Chironominae	2.01	2.61	1.75	1.60	4.00	23.06
Leptoceridae	1.26	0.87	1.58	1.44	3.61	26.67
Caenidae	0.79	0.29	1.50	1.32	3.43	30.10
Dytiscidae	0.32	0.78	1.46	1.28	3.33	33.44
Gyrinidae	0.86	0.34	1.45	1.26	3.32	36.76
Baetidae	0.68	0.16	1.45	1.27	3.30	40.06
Hemicorduliidae	0.59	0.13	1.30	0.98	2.97	43.03
Oligochaeta	1.49	1.64	1.26	1.43	2.87	45.90
Orthocladininae	1.34	1.63	1.25	1.40	2.86	48.76
Tricladida	0.54	0.25	1.20	1.10	2.74	51.50
Elmidae (adult)	0.55	0.33	1.18	1.03	2.70	54.20
Synthemistidae	0.00	0.51	1.18	0.95	2.70	56.91
Leptophlebiidae	2.79	2.64	1.10	1.23	2.52	59.43
Polycentropodidae	0.36	0.33	1.03	0.91	2.36	61.78
Gomphidae	0.39	0.15	0.98	0.81	2.24	64.03
Ceinidae	0.40	0.13	0.98	0.77	2.24	66.26
Tanypodininae	2.01	2.29	0.90	1.23	2.05	68.31
Tipulidae	0.15	0.32	0.88	0.77	2.00	70.31
Magapodagrionidae	0.16	0.33	0.87	0.78	1.99	72.30
Synlestidae	0.32	0.16	0.83	0.79	1.90	74.20
Gripopterygidae	0.00	0.39	0.79	0.64	1.81	76.01
Telephlebiidae	0.33	0.00	0.75	0.69	1.72	77.73
Hydrophilidae	0.33	0.00	0.73	0.69	1.68	79.40
Hydrophilidae(adult)	0.31	0.00	0.68	0.68	1.55	80.95
Odontoceridae	0.32	0.00	0.67	0.68	1.53	82.48
Ecnomidae	1.26	1.10	0.65	1.63	1.49	83.97
Hydroptilidae	0.00	0.29	0.63	0.67	1.44	85.41
Hydrobiosidae	0.29	0.00	0.63	0.69	1.44	86.85
Acarina	0.13	0.16	0.56	0.62	1.29	88.14
Nematoda	0.13	0.13	0.46	0.61	1.04	89.18
Chorismagrionidae	0.20	0.00	0.42	0.44	0.95	90.13

Groups CBR & CMC
Average dissimilarity = 43.05

Species	Group CBR Av.Abund	Group CMC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Elmidae	1.28	0.13	2.91	1.72	6.77	6.77
Atyidae	0.98	0.00	2.44	1.96	5.68	12.45
Sphaeriidae	1.03	0.13	2.41	1.34	5.60	18.05
Orthocladininae	0.69	1.63	2.40	1.43	5.57	23.62
Oligochaeta	2.11	1.64	2.29	1.38	5.32	28.94
Chironominae	2.05	2.61	2.19	1.82	5.08	34.02
Baetidae	0.90	0.16	2.01	1.36	4.67	38.69
Dytiscidae	0.16	0.78	1.80	1.27	4.18	42.88
Ceratopogonidae	1.09	0.66	1.75	1.25	4.07	46.94
Leptoceridae	0.87	0.87	1.59	1.26	3.68	50.63
Gripopterygidae	0.41	0.39	1.47	0.86	3.41	54.03
Synthemistidae	0.00	0.51	1.34	0.94	3.12	57.15
Ceinidae	0.52	0.13	1.28	0.81	2.98	60.13
Caenidae	0.51	0.29	1.27	1.07	2.95	63.08
Leptophlebiidae	2.44	2.64	1.11	1.43	2.57	65.65
Tanypodininae	2.17	2.29	1.09	1.54	2.54	68.19
Polycentropodidae	0.17	0.33	0.98	0.78	2.28	70.47
Tipulidae	0.13	0.32	0.96	0.76	2.23	72.70
Tricladida	0.30	0.25	0.94	0.91	2.19	74.89
Gyrinidae	0.16	0.34	0.94	0.78	2.18	77.07
Elmidae (adult)	0.16	0.33	0.92	0.78	2.13	79.20
Calamoceratidae	0.32	0.13	0.92	0.80	2.13	81.32
Magapodagrionidae	0.00	0.33	0.87	0.69	2.03	83.35
Hemicorduliidae	0.25	0.13	0.76	0.78	1.76	85.11
Sialidae	0.28	0.00	0.74	0.69	1.72	86.83
Ecnomidae	1.27	1.10	0.73	1.35	1.69	88.51
Hydroptilidae	0.00	0.29	0.71	0.67	1.64	90.16

Groups CWC & CCC
Average dissimilarity = 56.42

Species	Group CWC Av.Abund	Group CCC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptophlebiidae	3.17	1.50	5.45	1.81	9.66	9.66
Chironominae	1.94	3.70	5.29	2.45	9.37	19.03
Ceratopogonidae	0.41	1.70	4.08	2.04	7.24	26.27
Oligochaeta	0.86	1.77	3.89	1.35	6.90	33.16
Baetidae	0.00	0.92	2.66	1.26	4.71	37.87
Dytiscidae	0.00	0.89	2.64	1.35	4.68	42.55
Tanypodininae	1.62	2.29	2.21	1.54	3.92	46.47
Calamoceratidae	0.00	0.68	2.15	1.35	3.82	50.28
Leptoceridae	0.35	0.78	2.12	1.16	3.75	54.04
Ancylidae	0.64	0.16	2.02	1.05	3.57	57.61
Dytiscidae (adult)	0.64	0.36	1.87	1.21	3.31	60.92
Ecnomidae	0.41	0.39	1.83	0.92	3.25	64.17
Tricladida	0.50	0.20	1.81	0.75	3.22	67.39
Orthocladininae	0.16	0.59	1.74	1.02	3.09	70.48
Hemicorduliidae	0.00	0.44	1.46	0.69	2.60	73.07
Coenagrionidae	0.00	0.45	1.36	0.64	2.41	75.49
Nematoda	0.22	0.20	1.13	0.62	2.00	77.49
Tipulidae	0.16	0.20	0.99	0.62	1.75	79.24
Nemertea	0.00	0.33	0.97	0.69	1.72	80.96
Scirtidae	0.32	0.00	0.96	0.69	1.71	82.67
Gyrinidae	0.29	0.00	0.91	0.68	1.60	84.27
Corixidae	0.00	0.29	0.88	0.70	1.57	85.84
Physidae	0.00	0.33	0.88	0.70	1.56	87.40
Parastacidae	0.00	0.33	0.88	0.70	1.56	88.95
Culicidae	0.15	0.16	0.84	0.61	1.48	90.44

Groups CC & CCC
Average dissimilarity = 44.76

	Group CC	Group CCC

Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Psephenidae	1.25	0.00	3.28	5.53	7.34	7.34
Ceratopogonidae	0.57	1.70	3.06	1.66	6.83	14.16
Chironominae	2.60	3.70	2.97	1.71	6.63	20.79
Baetidae	0.91	0.92	1.97	1.41	4.40	25.19
Sphaeriidae	0.76	0.16	1.90	1.03	4.24	29.43
Oligochaeta	1.96	1.77	1.88	1.46	4.20	33.63
Calamoceratidae	0.00	0.68	1.80	1.35	4.02	37.66
Dytiscidae	0.62	0.89	1.78	1.40	3.98	41.63
Leptophlebiidae	1.99	1.50	1.75	1.49	3.91	45.54
Ecnomidae	0.73	0.39	1.74	1.13	3.89	49.43
Orthocladininae	0.78	0.59	1.74	1.12	3.89	53.32
Caenidae	0.63	0.16	1.61	1.22	3.60	56.93
Leptoceridae	0.95	0.78	1.50	1.06	3.36	60.29
Atyidae	0.55	0.00	1.46	0.94	3.26	63.55
Hemicorduliidae	0.13	0.44	1.33	0.82	2.96	66.51
Coenagrionidae	0.16	0.45	1.30	0.75	2.91	69.43
Tanypodininae	2.00	2.29	1.29	1.38	2.89	72.31
Tricladida	0.42	0.20	1.22	0.79	2.73	75.05
Corixidae	0.33	0.29	1.13	0.92	2.52	77.57
Tipulidae	0.35	0.20	1.11	0.79	2.49	80.06
Ceinidae	0.44	0.00	1.07	0.67	2.38	82.44
Nemertea	0.16	0.33	1.00	0.77	2.25	84.68
Dytiscidae (adult)	0.00	0.36	0.89	0.69	1.99	86.68
Nematoda	0.17	0.20	0.79	0.61	1.78	88.45
Physidae	0.00	0.33	0.76	0.69	1.69	90.14

Groups DC & CCC
Average dissimilarity = 49.48

Species	Group DC Av.Abund	Group CCC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Ceratopogonidae	0.71	1.70	4.15	1.97	8.38	8.38
Chironominae	2.45	3.70	3.99	1.71	8.07	16.45
Tanypodininae	1.20	2.29	3.58	2.13	7.23	23.68
Oligochaeta	0.96	1.77	2.89	1.05	5.84	29.53
Baetidae	0.50	0.92	2.56	1.31	5.18	34.71
Dytiscidae	0.28	0.89	2.52	1.36	5.10	39.81
Leptoceridae	0.25	0.78	2.31	1.36	4.66	44.47
Calamoceratidae	0.00	0.68	2.29	1.34	4.62	49.09
Leptophlebiidae	1.79	1.50	1.87	1.21	3.77	52.86
Orthocladininae	0.00	0.59	1.80	0.97	3.63	56.49
Corixidae	0.51	0.29	1.70	1.07	3.43	59.92
Hemicorduliidae	0.00	0.44	1.56	0.69	3.15	63.07
Coenagrionidae	0.00	0.45	1.44	0.63	2.91	65.98
Dytiscidae (adult)	0.25	0.36	1.40	0.95	2.82	68.81
Caenidae	0.40	0.16	1.37	1.02	2.78	71.58
Parastacidae	0.29	0.33	1.37	0.91	2.77	74.35
Ecnomidae	0.00	0.39	1.26	0.69	2.55	76.90
Ancylidae	0.28	0.16	1.19	0.80	2.41	79.30
Tipulidae	0.24	0.20	1.18	0.62	2.37	81.68
Nemertea	0.00	0.33	1.03	0.69	2.08	83.76
Physidae	0.00	0.33	0.92	0.69	1.86	85.62
Culicidae	0.13	0.16	0.86	0.62	1.74	87.36
Psychodidae	0.26	0.00	0.75	0.44	1.52	88.87
Nematoda	0.00	0.20	0.69	0.44	1.39	90.26

Groups EC & CCC
Average dissimilarity = 52.53

Species	Group EC Av.Abund	Group CCC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironominae	2.32	3.70	4.28	1.94	8.14	8.14
Ceratopogonidae	0.64	1.70	3.24	1.37	6.18	14.32
Tanypodininae	1.66	2.29	2.79	0.95	5.31	19.63

Dytiscidae	0.00	0.89	2.41	1.30	4.59	24.22
Orthocladininae	0.92	0.59	2.21	1.20	4.21	28.44
Baetidae	0.28	0.92	2.20	1.30	4.19	32.62
Leptophlebiidae	2.12	1.50	2.18	1.46	4.16	36.78
Oligochaeta	1.61	1.77	2.18	1.01	4.15	40.93
Leptoceridae	0.29	0.78	1.97	1.18	3.75	44.68
Calamoceratidae	0.15	0.68	1.83	1.20	3.49	48.17
Ecnomidae	0.64	0.39	1.78	1.04	3.38	51.55
Parastacidae	0.50	0.33	1.51	0.93	2.87	54.42
Gomphidae	0.53	0.16	1.39	0.99	2.65	57.08
Hemicorduliidae	0.00	0.44	1.33	0.68	2.53	59.61
Magapodagrionidae	0.49	0.13	1.30	1.00	2.47	62.07
Coenagrionidae	0.00	0.45	1.24	0.62	2.37	64.44
Psephenidae	0.49	0.00	1.24	0.95	2.35	66.79
Culicidae	0.28	0.16	1.12	0.61	2.14	68.93
Sphaeriidae	0.32	0.16	1.02	0.77	1.94	70.87
Caenidae	0.32	0.16	1.00	0.79	1.90	72.77
Dytiscidae (adult)	0.00	0.36	0.96	0.68	1.83	74.60
Tipulidae	0.20	0.20	0.96	0.60	1.82	76.42
Synthemistidae	0.35	0.00	0.95	0.64	1.80	78.23
Nemertea	0.00	0.33	0.89	0.68	1.69	79.92
Physidae	0.00	0.33	0.81	0.69	1.54	81.46
Corixidae	0.00	0.29	0.81	0.68	1.54	82.99
Tricladida	0.16	0.20	0.80	0.62	1.52	84.51
Scirtidae	0.30	0.00	0.79	0.67	1.51	86.03
Polycentropodidae	0.29	0.00	0.75	0.68	1.42	87.45
Hydroptilidae	0.13	0.16	0.69	0.59	1.32	88.77
Dolichopodidae	0.21	0.00	0.60	0.44	1.15	89.92
Nematoda	0.00	0.20	0.59	0.43	1.12	91.03

Groups TTH & CCC
Average dissimilarity = 44.22

	Group TTH	Group CCC				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironominae	3.10	3.70	2.72	1.53	6.15	6.15
Ceratopogonidae	0.84	1.70	2.44	1.27	5.51	11.66
Oligochaeta	1.34	1.77	2.36	1.18	5.33	16.99
Baetidae	0.82	0.92	2.24	1.33	5.06	22.05
Caenidae	0.84	0.16	2.18	1.12	4.94	27.00
Ecnomidae	0.78	0.39	2.12	1.10	4.79	31.78
Leptoceridae	0.16	0.78	2.00	1.25	4.51	36.30
Calamoceratidae	0.00	0.68	1.90	1.35	4.29	40.58
Dytiscidae	0.66	0.89	1.87	1.41	4.23	44.82
Tanypodininae	2.13	2.29	1.85	1.52	4.19	49.00
Corixidae	0.63	0.29	1.82	1.06	4.11	53.12
Orthocladininae	0.77	0.59	1.72	1.06	3.89	57.01
Tipulidae	0.60	0.20	1.67	0.99	3.78	60.79
Leptophlebiidae	1.59	1.50	1.42	1.35	3.21	64.00
Hemicorduliidae	0.00	0.44	1.28	0.69	2.91	66.90
Dytiscidae (adult)	0.28	0.36	1.22	0.96	2.77	69.67
Coenagrionidae	0.00	0.45	1.21	0.64	2.73	72.40
Gomphidae	0.34	0.16	1.08	0.80	2.45	74.85
Culicidae	0.29	0.16	1.00	0.79	2.27	77.12
Nemertea	0.13	0.33	0.99	0.81	2.24	79.36
Parastacidae	0.13	0.33	0.94	0.83	2.14	81.50
Nematoda	0.16	0.20	0.86	0.62	1.94	83.43
Physidae	0.00	0.33	0.79	0.70	1.78	85.22
Notonectidae	0.28	0.00	0.78	0.69	1.76	86.98
Ancylidae	0.00	0.16	0.49	0.44	1.10	88.08
Tricladida	0.00	0.20	0.48	0.44	1.08	89.16
Sphaeriidae	0.00	0.16	0.48	0.44	1.08	90.24

Groups HC & CCC
Average dissimilarity = 52.30

Species	Group HC Av.Abund	Group CCC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Ceratopogonidae	0.24	1.70	4.58	2.45	8.76	8.76
Leptophlebiidae	0.16	1.50	4.06	2.30	7.77	16.53
Orthocladininae	1.85	0.59	4.06	1.35	7.76	24.29
Oligochaeta	0.84	1.77	3.44	1.29	6.57	30.86
Baetidae	0.38	0.92	2.48	1.31	4.75	35.61
Chironominae	3.31	3.70	2.48	1.56	4.74	40.35
Dytiscidae	0.33	0.89	2.33	1.34	4.45	44.80
Leptoceridae	0.13	0.78	2.27	1.30	4.35	49.15
Calamoceratidae	0.00	0.68	2.12	1.35	4.05	53.20
Tanypodininae	1.67	2.29	1.99	1.26	3.81	57.02
Hemicorduliidae	0.38	0.44	1.82	0.92	3.47	60.49
Coenagrionidae	0.32	0.45	1.74	0.89	3.32	63.81
Sphaeriidae	0.58	0.16	1.73	1.00	3.31	67.12
Ecnomidae	0.48	0.39	1.72	1.06	3.28	70.40
Dytiscidae (adult)	0.49	0.36	1.63	1.04	3.12	73.52
Tricladida	0.41	0.20	1.43	0.80	2.73	76.25
Tipulidae	0.29	0.20	1.21	0.80	2.32	78.57
Nemertea	0.16	0.33	1.15	0.78	2.20	80.76
Nematoda	0.17	0.20	0.97	0.62	1.86	82.62
Corixidae	0.00	0.29	0.87	0.70	1.67	84.29
Physidae	0.00	0.33	0.87	0.70	1.66	85.94
Parastacidae	0.00	0.33	0.87	0.70	1.66	87.60
Hydroptilidae	0.16	0.16	0.84	0.61	1.60	89.21
Podinae	0.24	0.00	0.82	0.44	1.57	90.78

Groups BR & CCC

Average dissimilarity = 51.89

Species	Group BR Av.Abund	Group CCC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironominae	2.01	3.70	3.78	2.12	7.28	7.28
Leptophlebiidae	2.79	1.50	2.90	2.03	5.60	12.88
Elmidae	1.25	0.00	2.78	3.91	5.36	18.23
Ceratopogonidae	0.80	1.70	2.23	1.21	4.30	22.53
Ecnomidae	1.26	0.39	2.06	1.67	3.97	26.50
Sphaeriidae	0.97	0.16	1.91	1.65	3.69	30.19
Gyrinidae	0.86	0.00	1.91	2.07	3.68	33.87
Orthocladininae	1.34	0.59	1.80	1.15	3.47	37.35
Dytiscidae	0.32	0.89	1.67	1.36	3.23	40.57
Leptoceridae	1.26	0.78	1.67	1.21	3.22	43.79
Baetidae	0.68	0.92	1.64	1.45	3.16	46.95
Caenidae	0.79	0.16	1.58	1.29	3.05	50.00
Hemicorduliidae	0.59	0.44	1.47	1.06	2.84	52.84
Oligochaeta	1.49	1.77	1.31	1.02	2.53	55.37
Calamoceratidae	1.02	0.68	1.28	1.16	2.46	57.83
Tricladida	0.54	0.20	1.22	0.99	2.35	60.19
Tanypodininae	2.01	2.29	1.16	1.52	2.24	62.43
Elmidae (adult)	0.55	0.00	1.14	0.97	2.21	64.64
Coenagrionidae	0.20	0.45	1.13	0.76	2.18	66.82
Gomphidae	0.39	0.16	0.98	0.79	1.88	68.70
Ceinidae	0.40	0.00	0.88	0.66	1.70	70.40
Nemertea	0.16	0.33	0.82	0.78	1.59	71.99
Dytiscidae (adult)	0.00	0.36	0.76	0.69	1.46	73.45
Polycentropodidae	0.36	0.00	0.75	0.69	1.45	74.90
Telephlebiidae	0.33	0.00	0.75	0.69	1.44	76.34
Hydrophilidae	0.33	0.00	0.73	0.69	1.41	77.75
Synlestidae	0.32	0.00	0.72	0.69	1.38	79.13
Hydrophilidae(adult)	0.31	0.00	0.67	0.68	1.30	80.43
Odontoceridae	0.32	0.00	0.67	0.68	1.29	81.72
Tipulidae	0.15	0.20	0.67	0.62	1.29	83.00
Physidae	0.00	0.33	0.65	0.70	1.25	84.26
Parastacidae	0.00	0.33	0.65	0.70	1.25	85.51

Nematoda	0.13	0.20	0.63	0.61	1.22	86.73
Corixidae	0.00	0.29	0.63	0.69	1.21	87.94
Hydrobiosidae	0.29	0.00	0.63	0.69	1.21	89.15
Magapodagrionidae	0.16	0.13	0.54	0.63	1.05	90.20

Groups CBR & CCC

Average dissimilarity = 48.97

Species	Group CBR Av.Abund	Group CCC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironominae	2.05	3.70	4.29	1.96	8.76	8.76
Elmidae	1.28	0.00	3.09	1.83	6.32	15.07
Atyidae	0.98	0.00	2.43	1.96	4.96	20.03
Leptophlebiidae	2.44	1.50	2.38	1.73	4.86	24.89
Sphaeriidae	1.03	0.16	2.36	1.32	4.82	29.71
Ecnomidae	1.27	0.39	2.30	1.67	4.69	34.40
Oligochaeta	2.11	1.77	2.25	1.41	4.59	38.99
Baetidae	0.90	0.92	2.03	1.41	4.15	43.14
Dytiscidae	0.16	0.89	2.03	1.29	4.14	47.28
Leptoceridae	0.87	0.78	1.71	1.17	3.49	50.77
Ceratopogonidae	1.09	1.70	1.67	1.22	3.42	54.19
Orthocladininae	0.69	0.59	1.55	1.27	3.17	57.36
Calamoceratidae	0.32	0.68	1.44	1.16	2.93	60.29
Hemicorduliidae	0.25	0.44	1.36	0.97	2.77	63.06
Tanypodininae	2.17	2.29	1.35	1.57	2.76	65.82
Caenidae	0.51	0.16	1.25	1.00	2.55	68.37
Coenagrionidae	0.15	0.45	1.23	0.75	2.51	70.88
Ceinidae	0.52	0.00	1.16	0.69	2.37	73.25
Gripopterygidae	0.41	0.00	1.09	0.63	2.22	75.47
Tricladida	0.30	0.20	0.96	0.82	1.96	77.43
Dytiscidae (adult)	0.00	0.36	0.85	0.69	1.74	79.17
Nemertea	0.00	0.33	0.78	0.69	1.60	80.77
Sialidae	0.28	0.00	0.74	0.69	1.50	82.27
Tipulidae	0.13	0.20	0.73	0.62	1.48	83.75
Physidae	0.00	0.33	0.72	0.69	1.47	85.23
Parastacidae	0.00	0.33	0.72	0.69	1.47	86.70
Corixidae	0.00	0.29	0.71	0.69	1.44	88.15
Gomphidae	0.16	0.16	0.68	0.60	1.39	89.53
Nematoda	0.00	0.20	0.51	0.44	1.04	90.57

Groups CMC & CCC

Average dissimilarity = 44.91

Species	Group CMC Av.Abund	Group CCC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironominae	2.61	3.70	3.04	1.52	6.77	6.77
Leptophlebiidae	2.64	1.50	3.02	1.85	6.74	13.50
Orthocladininae	1.63	0.59	2.89	1.53	6.44	19.94
Ceratopogonidae	0.66	1.70	2.80	1.66	6.24	26.18
Baetidae	0.16	0.92	2.15	1.27	4.80	30.98
Ecnomidae	1.10	0.39	2.08	1.46	4.63	35.61
Oligochaeta	1.64	1.77	1.95	1.06	4.35	39.96
Dytiscidae	0.78	0.89	1.80	1.23	4.02	43.98
Calamoceratidae	0.13	0.68	1.69	1.30	3.77	47.75
Leptoceridae	0.87	0.78	1.50	1.18	3.34	51.09
Synthemistidae	0.51	0.00	1.41	0.94	3.14	54.23
Hemicorduliidae	0.13	0.44	1.32	0.79	2.93	57.16
Tanypodininae	2.29	2.29	1.21	1.55	2.70	59.85
Coenagrionidae	0.00	0.45	1.15	0.64	2.56	62.42
Tipulidae	0.32	0.20	1.13	0.76	2.51	64.93
Dytiscidae (adult)	0.15	0.36	1.03	0.80	2.29	67.21
Magapodagrionidae	0.33	0.13	1.03	0.82	2.29	69.50
Caenidae	0.29	0.16	0.94	0.78	2.09	71.59
Hydroptilidae	0.29	0.16	0.94	0.77	2.08	73.68
Gripopterygidae	0.39	0.00	0.92	0.64	2.04	75.72

Polycentropodidae	0.33	0.00	0.88	0.69	1.96	77.68
Tricladida	0.25	0.20	0.88	0.81	1.95	79.63
Gyrinidae	0.34	0.00	0.86	0.69	1.91	81.54
Nemertea	0.00	0.33	0.82	0.69	1.84	83.38
Elmidae (adult)	0.33	0.00	0.79	0.69	1.77	85.14
Physidae	0.00	0.33	0.76	0.69	1.68	86.83
Parastacidae	0.00	0.33	0.76	0.69	1.68	88.51
Corixidae	0.00	0.29	0.75	0.69	1.66	90.17

Groups CWC & CSQC
Average dissimilarity = 54.62

	Group CWC	Group CSQC				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptophlebiidae	3.17	1.66	4.99	1.74	9.13	9.13
Chironominae	1.94	3.23	3.96	1.53	7.26	16.39
Oligochaeta	0.86	1.12	3.02	1.36	5.54	21.92
Dytiscidae	0.00	0.95	2.94	1.64	5.38	27.30
Orthocladininae	0.16	1.04	2.90	1.73	5.31	32.62
Atyidae	0.00	0.85	2.74	1.92	5.02	37.64
Leptoceridae	0.35	0.87	2.48	1.25	4.53	42.17
Ceratopogonidae	0.41	0.93	2.43	1.45	4.45	46.62
Ancylidae	0.64	0.16	2.06	1.01	3.78	50.40
Tricladida	0.50	0.36	2.05	0.89	3.75	54.15
Dytiscidae (adult)	0.64	0.38	1.98	1.24	3.62	57.77
Ecnomidae	0.41	0.40	1.82	0.89	3.34	61.11
Tanypodininae	1.62	1.97	1.79	1.37	3.28	64.39
Psephenidae	0.20	0.48	1.71	1.01	3.13	67.52
Corixidae	0.00	0.46	1.53	0.94	2.80	70.32
Chorismagrionidae	0.00	0.47	1.50	0.95	2.74	73.06
Gyrinidae	0.29	0.43	1.41	1.04	2.58	75.64
Culicidae	0.15	0.38	1.24	0.79	2.26	77.90
Tipulidae	0.16	0.30	1.17	0.79	2.14	80.05
Scirtidae	0.32	0.13	1.15	0.81	2.10	82.15
Baetidae	0.00	0.37	1.13	0.68	2.08	84.22
Magapodagrionidae	0.13	0.34	1.10	0.83	2.01	86.23
Sphaeriidae	0.00	0.34	1.04	0.69	1.90	88.14
Caenidae	0.00	0.34	1.02	0.70	1.87	90.01

Groups CC & CSQC
Average dissimilarity = 41.14

	Group CC	Group CSQC				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Oligochaeta	1.96	1.12	2.53	1.40	6.15	6.15
Chironominae	2.60	3.23	2.30	1.32	5.60	11.75
Psephenidae	1.25	0.48	2.02	1.47	4.91	16.66
Baetidae	0.91	0.37	2.02	1.37	4.91	21.57
Sphaeriidae	0.76	0.34	1.98	1.14	4.82	26.39
Ecnomidae	0.73	0.40	1.83	1.12	4.44	30.83
Leptoceridae	0.95	0.87	1.81	1.25	4.39	35.22
Ceratopogonidae	0.57	0.93	1.76	1.19	4.28	39.50
Dytiscidae	0.62	0.95	1.66	1.18	4.03	43.53
Orthocladininae	0.78	1.04	1.61	1.04	3.91	47.45
Atyidae	0.55	0.85	1.60	1.22	3.89	51.34
Caenidae	0.63	0.34	1.54	1.15	3.74	55.08
Tricladida	0.42	0.36	1.43	0.94	3.48	58.55
Tanypodininae	2.00	1.97	1.40	1.52	3.39	61.95
Corixidae	0.33	0.46	1.39	1.06	3.37	65.32
Leptophlebiidae	1.99	1.66	1.27	1.51	3.09	68.41
Chorismagrionidae	0.13	0.47	1.26	0.99	3.05	71.46
Tipulidae	0.35	0.30	1.18	0.91	2.87	74.33
Ceinidae	0.44	0.00	1.08	0.67	2.64	76.97
Gyrinidae	0.00	0.43	1.05	0.97	2.56	79.53
Dytiscidae (adult)	0.00	0.38	1.03	0.69	2.52	82.04

Culicidae	0.00	0.38	0.87	0.65	2.11	84.16
Magapodagrionidae	0.00	0.34	0.79	0.69	1.92	86.08
Coenagrionidae	0.16	0.15	0.66	0.61	1.60	87.68
Scirtidae	0.15	0.13	0.65	0.62	1.58	89.25
Nemertea	0.16	0.00	0.50	0.44	1.22	90.47

Groups DC & CSQC
Average dissimilarity = 49.05

Species	Group DC Av.Abund	Group CSQC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Orthocladininae	0.00	1.04	3.42	2.00	6.97	6.97
Atyidae	0.00	0.85	2.92	1.87	5.95	12.91
Chironominae	2.45	3.23	2.91	1.17	5.93	18.85
Ceratopogonidae	0.71	0.93	2.76	1.37	5.62	24.47
Tanypodininae	1.20	1.97	2.73	1.68	5.56	30.03
Dytiscidae	0.28	0.95	2.61	1.35	5.33	35.36
Leptoceridae	0.25	0.87	2.60	1.28	5.29	40.65
Oligochaeta	0.96	1.12	2.12	1.15	4.32	44.97
Baetidae	0.50	0.37	1.90	1.02	3.87	48.84
Corixidae	0.51	0.46	1.78	1.06	3.62	52.46
Psephenidae	0.13	0.48	1.71	0.98	3.49	55.95
Chorismagrionidae	0.00	0.47	1.59	0.95	3.24	59.18
Caenidae	0.40	0.34	1.58	1.09	3.22	62.40
Dytiscidae (adult)	0.25	0.38	1.57	0.92	3.20	65.60
Tipulidae	0.24	0.30	1.42	0.82	2.90	68.50
Leptophlebiidae	1.79	1.66	1.35	1.41	2.76	71.26
Gyrinidae	0.13	0.43	1.35	1.00	2.76	74.02
Culicidae	0.13	0.38	1.27	0.78	2.58	76.60
Ancylidae	0.28	0.16	1.17	0.80	2.38	78.98
Parastacidae	0.29	0.13	1.14	0.77	2.33	81.31
Ecnomidae	0.00	0.40	1.14	0.69	2.32	83.63
Tricladida	0.00	0.36	1.11	0.69	2.27	85.90
Sphaeriidae	0.00	0.34	1.10	0.69	2.25	88.15
Magapodagrionidae	0.00	0.34	0.97	0.69	1.97	90.12

Groups EC & CSQC
Average dissimilarity = 52.32

Species	Group EC Av.Abund	Group CSQC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironominae	2.32	3.23	3.43	1.51	6.56	6.56
Dytiscidae	0.00	0.95	2.68	1.56	5.12	11.68
Tanypodininae	1.66	1.97	2.65	1.03	5.06	16.74
Atyidae	0.00	0.85	2.49	1.78	4.76	21.50
Oligochaeta	1.61	1.12	2.34	1.08	4.48	25.98
Leptoceridae	0.29	0.87	2.25	1.19	4.31	30.29
Orthocladininae	0.92	1.04	2.22	1.21	4.24	34.53
Ceratopogonidae	0.64	0.93	2.14	1.27	4.10	38.63
Ecnomidae	0.64	0.40	1.79	1.04	3.41	42.04
Leptophlebiidae	2.12	1.66	1.71	1.56	3.27	45.31
Parastacidae	0.50	0.13	1.60	0.96	3.06	48.37
Psephenidae	0.49	0.48	1.56	1.05	2.98	51.35
Culicidae	0.28	0.38	1.43	0.75	2.74	54.08
Magapodagrionidae	0.49	0.34	1.42	1.02	2.72	56.80
Corixidae	0.00	0.46	1.39	0.91	2.65	59.45
Gomphidae	0.53	0.00	1.37	0.95	2.62	62.08
Baetidae	0.28	0.37	1.37	0.95	2.61	64.69
Chorismagrionidae	0.00	0.47	1.36	0.93	2.60	67.29
Sphaeriidae	0.32	0.34	1.29	0.93	2.46	69.75
Caenidae	0.32	0.34	1.28	0.91	2.44	72.19
Gyrinidae	0.15	0.43	1.20	1.00	2.30	74.49
Tipulidae	0.20	0.30	1.16	0.79	2.22	76.70
Tricladida	0.16	0.36	1.16	0.80	2.22	78.92
Dytiscidae (adult)	0.00	0.38	1.13	0.67	2.15	81.07

Synthemistidae	0.35	0.13	1.11	0.75	2.13	83.20
Scirtidae	0.30	0.13	0.97	0.78	1.86	85.06
Polycentropodidae	0.29	0.00	0.76	0.68	1.46	86.51
Empididae	0.13	0.16	0.69	0.60	1.32	87.83
Calamoceratidae	0.15	0.13	0.65	0.61	1.24	89.07
Dolichopodidae	0.21	0.00	0.62	0.44	1.18	90.25

Groups TTH & CSQC
Average dissimilarity = 44.79

Species	Group TTH Av.Abund	Group CSQC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironominae	3.10	3.23	2.44	1.28	5.46	5.46
Atyidae	0.00	0.85	2.41	1.93	5.38	10.83
Leptoceridae	0.16	0.87	2.27	1.26	5.08	15.91
Oligochaeta	1.34	1.12	2.27	1.32	5.06	20.97
Baetidae	0.82	0.37	2.17	1.16	4.84	25.81
Ecnomidae	0.78	0.40	2.16	1.05	4.82	30.62
Caenidae	0.84	0.34	2.13	1.11	4.76	35.38
Tanypodininae	2.13	1.97	1.97	1.36	4.41	39.79
Corixidae	0.63	0.46	1.89	1.21	4.22	44.01
Dytiscidae	0.66	0.95	1.74	1.21	3.89	47.90
Ceratopogonidae	0.84	0.93	1.69	1.15	3.76	51.66
Tipulidae	0.60	0.30	1.68	1.08	3.76	55.42
Orthocladininae	0.77	1.04	1.62	0.98	3.62	59.04
Psephenidae	0.13	0.48	1.41	1.00	3.14	62.18
Chorismagrionidae	0.15	0.47	1.35	1.00	3.01	65.19
Dytiscidae (adult)	0.28	0.38	1.35	0.95	3.01	68.20
Culicidae	0.29	0.38	1.30	0.94	2.89	71.10
Gyrinidae	0.13	0.43	1.14	1.00	2.54	73.64
Leptophlebiidae	1.59	1.66	1.08	1.49	2.41	76.05
Gomphidae	0.34	0.00	0.94	0.67	2.10	78.14
Tricladida	0.00	0.36	0.93	0.68	2.08	80.23
Sphaeriidae	0.00	0.34	0.92	0.69	2.05	82.28
Magapodagrionidae	0.00	0.34	0.83	0.70	1.84	84.12
Notonectidae	0.28	0.00	0.80	0.68	1.78	85.89
Scirtidae	0.13	0.13	0.62	0.61	1.38	87.27
Parastacidae	0.13	0.13	0.57	0.60	1.27	88.54
Empididae	0.00	0.16	0.46	0.44	1.04	89.58
Nematoda	0.16	0.00	0.46	0.44	1.02	90.59

Groups HC & CSQC
Average dissimilarity = 53.53

Species	Group HC Av.Abund	Group CSQC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptophlebiidae	0.16	1.66	4.67	3.48	8.73	8.73
Orthocladininae	1.85	1.04	2.88	1.02	5.38	14.12
Ceratopogonidae	0.24	0.93	2.72	1.70	5.09	19.20
Atyidae	0.00	0.85	2.70	1.90	5.04	24.25
Leptoceridae	0.13	0.87	2.54	1.24	4.75	29.00
Chironominae	3.31	3.23	2.54	1.48	4.74	33.74
Oligochaeta	0.84	1.12	2.50	1.28	4.67	38.41
Dytiscidae	0.33	0.95	2.42	1.38	4.52	42.93
Sphaeriidae	0.58	0.34	1.85	1.12	3.46	46.39
Tanypodininae	1.67	1.97	1.78	1.47	3.32	49.71
Ecnomidae	0.48	0.40	1.77	1.07	3.30	53.02
Dytiscidae (adult)	0.49	0.38	1.75	1.05	3.27	56.29
Tricladida	0.41	0.36	1.67	0.95	3.12	59.41
Baetidae	0.38	0.37	1.61	0.89	3.01	62.42
Psephenidae	0.00	0.48	1.60	0.95	2.98	65.40
Corixidae	0.00	0.46	1.51	0.93	2.82	68.21
Chorismagrionidae	0.00	0.47	1.47	0.95	2.75	70.97
Tipulidae	0.29	0.30	1.28	0.90	2.39	73.36
Gyrinidae	0.00	0.43	1.22	0.97	2.28	75.64

Hemicorduliidae	0.38	0.00	1.21	0.68	2.27	77.90
Coenagrionidae	0.32	0.15	1.16	0.77	2.16	80.06
Caenidae	0.13	0.34	1.15	0.82	2.15	82.22
Culicidae	0.00	0.38	1.00	0.65	1.86	84.08
Magapodagrionidae	0.00	0.34	0.91	0.70	1.69	85.78
Podinae	0.24	0.00	0.85	0.44	1.58	87.36
Hydrophilidae	0.23	0.00	0.68	0.44	1.27	88.63
Cordulephyidae	0.18	0.00	0.57	0.44	1.06	89.69
Nematoda	0.17	0.00	0.53	0.44	0.99	90.68

Groups BR & CSQC
Average dissimilarity = 52.24

	Group BR	Group CSQC				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironominae	2.01	3.23	2.93	1.57	5.61	5.61
Elmidae	1.25	0.00	2.83	3.83	5.41	11.02
Leptophlebiidae	2.79	1.66	2.58	2.45	4.93	15.95
Ecnomidae	1.26	0.40	2.16	1.61	4.14	20.10
Calamoceratidae	1.02	0.13	2.08	1.88	3.99	24.09
Ceratopogonidae	0.80	0.93	1.83	1.60	3.51	27.60
Leptoceridae	1.26	0.87	1.78	1.23	3.42	31.01
Sphaeriidae	0.97	0.34	1.78	1.54	3.41	34.42
Dytiscidae	0.32	0.95	1.71	1.42	3.27	37.70
Atyidae	0.16	0.85	1.69	1.60	3.23	40.93
Caenidae	0.79	0.34	1.51	1.21	2.89	43.82
Baetidae	0.68	0.37	1.42	1.20	2.72	46.54
Oligochaeta	1.49	1.12	1.41	1.35	2.69	49.23
Gyrinidae	0.86	0.43	1.37	1.26	2.62	51.85
Tricladida	0.54	0.36	1.31	1.13	2.51	54.36
Hemicorduliidae	0.59	0.00	1.31	0.92	2.51	56.87
Tanypodininae	2.01	1.97	1.19	1.44	2.28	59.15
Elmidae (adult)	0.55	0.00	1.16	0.97	2.23	61.37
Chorismagrionidae	0.20	0.47	1.14	1.01	2.18	63.56
Psephenidae	0.14	0.48	1.12	1.01	2.15	65.71
Corixidae	0.00	0.46	1.06	0.94	2.03	67.74
Orthocladininae	1.34	1.04	1.03	0.79	1.98	69.72
Ceinidae	0.40	0.00	0.90	0.66	1.72	71.44
Gomphidae	0.39	0.00	0.88	0.69	1.69	73.12
Dytiscidae (adult)	0.00	0.38	0.87	0.69	1.66	74.79
Magapodagrionidae	0.16	0.34	0.81	0.79	1.56	76.35
Tipulidae	0.15	0.30	0.79	0.78	1.51	77.85
Polycentropodidae	0.36	0.00	0.76	0.69	1.46	79.31
Telephlebiidae	0.33	0.00	0.76	0.69	1.46	80.77
Culicidae	0.00	0.38	0.75	0.65	1.43	82.20
Hydrophilidae	0.33	0.00	0.74	0.69	1.42	83.62
Synlestidae	0.32	0.00	0.73	0.69	1.40	85.02
Hydrophilidae(adult)	0.31	0.00	0.68	0.68	1.31	86.33
Odontoceridae	0.32	0.00	0.68	0.68	1.30	87.63
Hydrobiosidae	0.29	0.00	0.64	0.69	1.22	88.85
Coenagrionidae	0.20	0.15	0.60	0.62	1.15	89.99
Scirtidae	0.14	0.13	0.55	0.61	1.04	91.03

Groups CBR & CSQC
Average dissimilarity = 48.94

	Group CBR	Group CSQC				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironominae	2.05	3.23	3.40	1.55	6.96	6.96
Elmidae	1.28	0.00	3.15	1.81	6.44	13.39
Oligochaeta	2.11	1.12	2.70	1.27	5.51	18.90
Ecnomidae	1.27	0.40	2.42	1.61	4.95	23.86
Sphaeriidae	1.03	0.34	2.32	1.36	4.73	28.59
Dytiscidae	0.16	0.95	2.19	1.45	4.47	33.06
Leptophlebiidae	2.44	1.66	2.00	2.42	4.09	37.15

Leptoceridae	0.87	0.87	1.94	1.27	3.95	41.11
Baetidae	0.90	0.37	1.93	1.24	3.95	45.06
Orthocladininae	0.69	1.04	1.61	1.25	3.28	48.34
Tanypodininae	2.17	1.97	1.53	1.46	3.12	51.46
Ceratopogonidae	1.09	0.93	1.41	1.14	2.89	54.35
Caenidae	0.51	0.34	1.32	1.03	2.70	57.05
Psephenidae	0.00	0.48	1.28	0.94	2.61	59.65
Corixidae	0.00	0.46	1.20	0.94	2.46	62.11
Chorismagrionidae	0.00	0.47	1.19	0.95	2.43	64.54
Ceinidae	0.52	0.00	1.18	0.69	2.41	66.95
Atyidae	0.98	0.85	1.17	1.00	2.40	69.35
Tricladida	0.30	0.36	1.16	0.96	2.37	71.72
Gripopterygidae	0.41	0.00	1.11	0.63	2.27	73.99
Gyrinidae	0.16	0.43	1.07	1.02	2.20	76.18
Dytiscidae (adult)	0.00	0.38	0.98	0.68	2.01	78.19
Calamoceratidae	0.32	0.13	0.93	0.81	1.91	80.10
Tipulidae	0.13	0.30	0.87	0.80	1.79	81.88
Culicidae	0.00	0.38	0.83	0.65	1.70	83.58
Magapodagrionidae	0.00	0.34	0.75	0.69	1.54	85.12
Sialidae	0.28	0.00	0.75	0.69	1.53	86.65
Hemicorduliidae	0.25	0.00	0.68	0.69	1.39	88.04
Coenagrionidae	0.15	0.15	0.60	0.60	1.23	89.27
Gomphidae	0.16	0.00	0.46	0.44	0.94	90.21

Groups CMC & CSQC
Average dissimilarity = 44.46

Species	Group CMC Av.Abund	Group CSQC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptophlebiidae	2.64	1.66	2.57	1.91	5.79	5.79
Chironominae	2.61	3.23	2.36	1.25	5.30	11.09
Atyidae	0.00	0.85	2.29	1.90	5.16	16.25
Ecnomidae	1.10	0.40	2.24	1.47	5.05	21.30
Oligochaeta	1.64	1.12	2.15	1.28	4.84	26.14
Orthocladininae	1.63	1.04	1.96	1.18	4.41	30.55
Leptoceridae	0.87	0.87	1.82	1.41	4.09	34.64
Dytiscidae	0.78	0.95	1.77	1.24	3.99	38.63
Tanypodininae	2.29	1.97	1.65	1.45	3.72	42.35
Ceratopogonidae	0.66	0.93	1.55	1.11	3.49	45.85
Synthemistidae	0.51	0.13	1.43	1.00	3.21	49.06
Psephenidae	0.00	0.48	1.35	0.94	3.04	52.10
Corixidae	0.00	0.46	1.27	0.93	2.86	54.96
Gyrinidae	0.34	0.43	1.27	1.07	2.85	57.81
Chorismagrionidae	0.00	0.47	1.26	0.95	2.83	60.64
Tipulidae	0.32	0.30	1.21	0.89	2.72	63.36
Magapodagrionidae	0.33	0.34	1.19	0.88	2.69	66.05
Caenidae	0.29	0.34	1.17	0.91	2.63	68.67
Dytiscidae (adult)	0.15	0.38	1.16	0.79	2.61	71.28
Baetidae	0.16	0.37	1.15	0.79	2.58	73.86
Tricladida	0.25	0.36	1.11	0.91	2.49	76.34
Sphaeriidae	0.13	0.34	0.98	0.80	2.21	78.55
Gripopterygidae	0.39	0.00	0.93	0.64	2.10	80.65
Polycentropodidae	0.33	0.00	0.90	0.69	2.02	82.68
Culicidae	0.00	0.38	0.87	0.65	1.96	84.64
Elmidae (adult)	0.33	0.00	0.81	0.69	1.82	86.45
Hydroptilidae	0.29	0.00	0.76	0.67	1.70	88.15
Calamoceratidae	0.13	0.13	0.57	0.61	1.27	89.43
Acarina	0.16	0.00	0.46	0.44	1.04	90.47

Groups CCC & CSQC
Average dissimilarity = 44.55

Species	Group CCC Av.Abund	Group CSQC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironominae	3.70	3.23	2.63	1.45	5.89	5.89

Oligochaeta	1.77	1.12	2.48	1.18	5.56	11.45
Atyidae	0.00	0.85	2.28	1.90	5.11	16.56
Baetidae	0.92	0.37	2.15	1.27	4.83	21.39
Ceratopogonidae	1.70	0.93	2.09	1.49	4.70	26.09
Dytiscidae	0.89	0.95	1.92	1.31	4.30	30.39
Leptoceridae	0.78	0.87	1.90	1.23	4.27	34.66
Orthocladininae	0.59	1.04	1.81	1.07	4.07	38.73
Tanypodininae	2.29	1.97	1.78	1.47	3.99	42.72
Calamoceratidae	0.68	0.13	1.71	1.31	3.84	46.56
Ecnomidae	0.39	0.40	1.36	0.88	3.05	49.61
Dytiscidae (adult)	0.36	0.38	1.35	0.91	3.03	52.64
Psephenidae	0.00	0.48	1.34	0.94	3.01	55.65
Coenagrionidae	0.45	0.15	1.29	0.73	2.89	58.54
Corixidae	0.29	0.46	1.27	1.02	2.86	61.40
Leptophlebiidae	1.50	1.66	1.26	1.57	2.84	64.24
Chorismagrionidae	0.00	0.47	1.25	0.95	2.80	67.04
Hemicorduliidae	0.44	0.00	1.24	0.68	2.78	69.82
Tricladida	0.20	0.36	1.11	0.81	2.49	72.31
Culicidae	0.16	0.38	1.09	0.79	2.45	74.77
Tipulidae	0.20	0.30	1.07	0.80	2.39	77.16
Sphaeriidae	0.16	0.34	1.06	0.82	2.38	79.54
Gyrinidae	0.00	0.43	1.05	0.96	2.35	81.90
Caenidae	0.16	0.34	1.01	0.79	2.26	84.15
Magapodagrionidae	0.13	0.34	0.95	0.83	2.14	86.29
Parastacidae	0.33	0.13	0.88	0.81	1.98	88.27
Nemertea	0.33	0.00	0.84	0.69	1.87	90.14

Groups CWC & DTC
Average dissimilarity = 54.72

Species	Group CWC Av.Abund	Group DTC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptophlebiidae	3.17	1.95	4.46	1.55	8.15	8.15
Baetidae	0.00	1.16	3.98	3.05	7.27	15.41
Dytiscidae	0.00	0.95	3.18	1.62	5.81	21.23
Oligochaeta	0.86	1.06	2.97	1.80	5.42	26.65
Chironominae	1.94	2.81	2.85	1.35	5.22	31.87
Caenidae	0.00	0.93	2.84	1.60	5.19	37.06
Ceratopogonidae	0.41	0.98	2.76	1.34	5.05	42.11
Ecnomidae	0.41	0.68	2.35	1.07	4.29	46.40
Parastacidae	0.00	0.71	2.19	1.67	4.00	50.39
Ancylidae	0.64	0.00	2.18	0.95	3.99	54.38
Dytiscidae (adult)	0.64	0.57	2.09	1.35	3.82	58.20
Orthocladininae	0.16	0.67	2.08	1.03	3.80	62.00
Tricladida	0.50	0.00	1.76	0.63	3.21	65.22
Tipulidae	0.16	0.55	1.70	1.00	3.10	68.32
Gomphidae	0.00	0.42	1.45	0.89	2.65	70.96
Scirtidae	0.32	0.27	1.44	0.84	2.63	73.59
Synthemistidae	0.00	0.44	1.31	0.98	2.39	75.98
Tanypodininae	1.62	1.39	1.27	1.19	2.33	78.31
Leptoceridae	0.35	0.00	1.17	0.68	2.13	80.44
Psephenidae	0.20	0.25	1.10	0.68	2.01	82.45
Gyrinidae	0.29	0.00	0.98	0.67	1.79	84.24
Notonectidae	0.16	0.19	0.91	0.66	1.67	85.91
Sphaeriidae	0.00	0.25	0.86	0.56	1.57	87.48
Hydraenidae	0.00	0.25	0.86	0.56	1.57	89.04
Nematoda	0.22	0.00	0.77	0.43	1.41	90.46

Groups CC & DTC
Average dissimilarity = 44.45

Species	Group CC Av.Abund	Group DTC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Psephenidae	1.25	0.25	2.95	1.92	6.63	6.63
Leptoceridae	0.95	0.00	2.59	1.93	5.82	12.45

Oligochaeta	1.96	1.06	2.44	1.65	5.48	17.93
Ceratopogonidae	0.57	0.98	2.18	1.34	4.91	22.84
Sphaeriidae	0.76	0.25	2.03	1.05	4.58	27.42
Ecnomidae	0.73	0.68	2.00	1.23	4.50	31.92
Orthocladininae	0.78	0.67	1.95	1.08	4.39	36.31
Chironominae	2.60	2.81	1.89	1.53	4.26	40.57
Parastacidae	0.00	0.71	1.84	1.65	4.14	44.71
Dytiscidae	0.62	0.95	1.77	1.28	3.97	48.68
Caenidae	0.63	0.93	1.73	1.23	3.89	52.57
Tanypodininae	2.00	1.39	1.70	1.65	3.83	56.40
Atyidae	0.55	0.00	1.56	0.92	3.52	59.91
Tipulidae	0.35	0.55	1.50	1.04	3.38	63.29
Dytiscidae (adult)	0.00	0.57	1.50	0.95	3.38	66.67
Baetidae	0.91	1.16	1.39	1.03	3.12	69.79
Leptophlebiidae	1.99	1.95	1.27	1.35	2.86	72.65
Gomphidae	0.13	0.42	1.19	0.93	2.67	75.33
Ceinidae	0.44	0.00	1.13	0.66	2.54	77.87
Tricladida	0.42	0.00	1.12	0.67	2.51	80.38
Synthemistidae	0.00	0.44	1.10	0.97	2.48	82.87
Scirtidae	0.15	0.27	0.97	0.70	2.18	85.05
Hydraenidae	0.13	0.25	0.88	0.70	1.99	87.03
Corixidae	0.33	0.00	0.88	0.65	1.97	89.00
Hemicorduliidae	0.13	0.19	0.66	0.67	1.49	90.49

Groups DC & DTC
Average dissimilarity = 45.04

Species	Group DC Av.Abund	Group DTC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Ceratopogonidae	0.71	0.98	3.22	1.37	7.15	7.15
Dytiscidae	0.28	0.95	2.91	1.45	6.45	13.60
Baetidae	0.50	1.16	2.83	1.33	6.27	19.88
Caenidae	0.40	0.93	2.48	1.37	5.50	25.38
Chironominae	2.45	2.81	2.42	1.55	5.37	30.75
Orthocladininae	0.00	0.67	2.13	0.94	4.73	35.47
Ecnomidae	0.00	0.68	2.09	0.97	4.64	40.12
Parastacidae	0.29	0.71	2.01	1.32	4.47	44.59
Tipulidae	0.24	0.55	1.96	1.02	4.35	48.94
Dytiscidae (adult)	0.25	0.57	1.92	1.06	4.26	53.20
Corixidae	0.51	0.00	1.83	0.94	4.06	57.26
Leptophlebiidae	1.79	1.95	1.62	1.48	3.60	60.86
Oligochaeta	0.96	1.06	1.56	1.30	3.46	64.32
Gomphidae	0.00	0.42	1.55	0.88	3.45	67.76
Tanypodininae	1.20	1.39	1.45	1.81	3.22	70.99
Psychodidae	0.26	0.23	1.40	0.72	3.10	74.09
Synthemistidae	0.00	0.44	1.38	0.97	3.07	77.16
Scirtidae	0.18	0.27	1.26	0.68	2.80	79.96
Ancylidae	0.28	0.00	1.02	0.68	2.28	82.23
Leptoceridae	0.25	0.00	0.96	0.68	2.13	84.36
Psephenidae	0.13	0.25	0.95	0.72	2.11	86.47
Sphaeriidae	0.00	0.25	0.91	0.56	2.03	88.50
Hydraenidae	0.00	0.25	0.91	0.56	2.03	90.52

Groups EC & DTC
Average dissimilarity = 48.86

Species	Group EC Av.Abund	Group DTC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Dytiscidae	0.00	0.95	2.88	1.51	5.90	5.90
Baetidae	0.28	1.16	2.68	1.82	5.49	11.39
Chironominae	2.32	2.81	2.66	1.32	5.44	16.84
Tanypodininae	1.66	1.39	2.66	1.40	5.44	22.28
Orthocladininae	0.92	0.67	2.46	1.17	5.04	27.32
Ceratopogonidae	0.64	0.98	2.44	1.18	4.99	32.30
Caenidae	0.32	0.93	2.33	1.35	4.77	37.07

Ecnomidae	0.64	0.68	2.12	1.12	4.35	41.41
Oligochaeta	1.61	1.06	1.96	0.95	4.00	45.42
Dytiscidae (adult)	0.00	0.57	1.64	0.93	3.35	48.77
Parastacidae	0.50	0.71	1.62	1.11	3.32	52.09
Gomphidae	0.53	0.42	1.61	1.06	3.30	55.39
Tipulidae	0.20	0.55	1.60	0.96	3.28	58.67
Leptophlebiidae	2.12	1.95	1.59	1.42	3.25	61.92
Synthemistidae	0.35	0.44	1.51	1.02	3.09	65.01
Psephenidae	0.49	0.25	1.42	1.00	2.91	67.91
Magapodagrionidae	0.49	0.00	1.32	0.92	2.71	70.62
Scirtidae	0.30	0.27	1.26	0.81	2.57	73.19
Sphaeriidae	0.32	0.25	1.20	0.81	2.46	75.66
Pyralidae	0.20	0.25	1.00	0.67	2.05	77.70
Hydraenidae	0.13	0.25	0.94	0.68	1.92	79.63
Culicidae	0.28	0.00	0.85	0.43	1.74	81.37
Leptoceridae	0.29	0.00	0.84	0.66	1.72	83.09
Polycentropodidae	0.29	0.00	0.80	0.67	1.63	84.72
Psychodidae	0.00	0.23	0.70	0.55	1.44	86.15
Notonectidae	0.13	0.19	0.66	0.68	1.34	87.50
Dolichopodidae	0.21	0.00	0.65	0.43	1.33	88.83
Glossiphoniidae	0.00	0.19	0.59	0.55	1.21	90.03

Groups TTH & DTC
Average dissimilarity = 42.12

Species	Group TTH Av.Abund	Group DTC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironominae	3.10	2.81	2.38	1.26	5.65	5.65
Ecnomidae	0.78	0.68	2.38	1.15	5.64	11.29
Tanypodininae	2.13	1.39	2.25	1.17	5.35	16.64
Caenidae	0.84	0.93	2.24	1.24	5.33	21.97
Ceratopogonidae	0.84	0.98	2.19	1.26	5.20	27.17
Orthocladininae	0.77	0.67	2.02	1.13	4.79	31.96
Oligochaeta	1.34	1.06	1.98	1.41	4.69	36.65
Baetidae	0.82	1.16	1.96	1.36	4.66	41.31
Corixidae	0.63	0.00	1.95	0.88	4.63	45.94
Dytiscidae	0.66	0.95	1.82	1.26	4.33	50.26
Tipulidae	0.60	0.55	1.82	1.06	4.32	54.58
Parastacidae	0.13	0.71	1.78	1.49	4.22	58.80
Dytiscidae (adult)	0.28	0.57	1.63	1.12	3.86	62.66
Leptophlebiidae	1.59	1.95	1.53	1.28	3.62	66.28
Gomphidae	0.34	0.42	1.46	1.06	3.47	69.75
Synthemistidae	0.00	0.44	1.16	0.98	2.75	72.51
Scirtidae	0.13	0.27	0.99	0.71	2.34	74.85
Notonectidae	0.28	0.19	0.98	0.81	2.33	77.18
Culicidae	0.29	0.00	0.87	0.68	2.07	79.25
Psephenidae	0.13	0.25	0.83	0.72	1.97	81.22
Pyralidae	0.13	0.25	0.80	0.72	1.91	83.13
Sphaeriidae	0.00	0.25	0.75	0.56	1.78	84.90
Hydraenidae	0.00	0.25	0.75	0.56	1.78	86.68
Psychodidae	0.00	0.23	0.68	0.56	1.61	88.29
Glossiphoniidae	0.00	0.19	0.57	0.56	1.35	89.64
Leptoceridae	0.16	0.00	0.50	0.43	1.20	90.83

Groups HC & DTC
Average dissimilarity = 54.25

Species	Group HC Av.Abund	Group DTC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptophlebiidae	0.16	1.95	5.96	3.13	10.99	10.99
Orthocladininae	1.85	0.67	4.35	1.25	8.01	19.00
Baetidae	0.38	1.16	2.95	1.56	5.43	24.43
Ceratopogonidae	0.24	0.98	2.87	1.36	5.30	29.73
Chironominae	3.31	2.81	2.68	1.40	4.94	34.67
Caenidae	0.13	0.93	2.64	1.53	4.86	39.53

Dytiscidae	0.33	0.95	2.57	1.37	4.73	44.27
Ecnomidae	0.48	0.68	2.17	1.21	4.00	48.27
Oligochaeta	0.84	1.06	2.17	1.40	4.00	52.26
Parastacidae	0.00	0.71	2.16	1.66	3.97	56.24
Dytiscidae (adult)	0.49	0.57	2.00	1.25	3.68	59.92
Sphaeriidae	0.58	0.25	1.88	1.00	3.46	63.38
Tipulidae	0.29	0.55	1.71	1.07	3.16	66.54
Hemicorduliidae	0.38	0.19	1.45	0.81	2.67	69.20
Gomphidae	0.00	0.42	1.42	0.89	2.62	71.83
Tanypodininae	1.67	1.39	1.42	1.56	2.61	74.44
Tricladida	0.41	0.00	1.31	0.67	2.42	76.86
Synthemistidae	0.00	0.44	1.29	0.98	2.37	79.23
Coenagrionidae	0.32	0.00	1.06	0.65	1.95	81.18
Scirtidae	0.00	0.27	0.91	0.56	1.67	82.85
Podinae	0.24	0.00	0.90	0.43	1.66	84.52
Hydraenidae	0.00	0.25	0.84	0.56	1.55	86.07
Psychodidae	0.00	0.23	0.76	0.56	1.40	87.47
Hydrophilidae	0.23	0.00	0.72	0.43	1.32	88.80
Psephenidae	0.00	0.25	0.65	0.56	1.19	89.99
Glossiphoniidae	0.00	0.19	0.64	0.56	1.18	91.17

Groups BR & DTC
Average dissimilarity = 54.10

Species	Group BR Av.Abund	Group DTC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptoceridae	1.26	0.00	2.98	1.96	5.51	5.51
Elmidae	1.25	0.00	2.94	3.67	5.43	10.93
Calamoceratidae	1.02	0.00	2.36	2.00	4.37	15.30
Chironominae	2.01	2.81	2.21	1.53	4.09	19.38
Gyrinidae	0.86	0.00	2.02	2.01	3.73	23.11
Orthocladininae	1.34	0.67	1.99	1.22	3.69	26.80
Leptophlebiidae	2.79	1.95	1.99	1.64	3.68	30.48
Ceratopogonidae	0.80	0.98	1.96	1.24	3.63	34.11
Ecnomidae	1.26	0.68	1.96	1.40	3.63	37.74
Sphaeriidae	0.97	0.25	1.90	1.47	3.51	41.25
Dytiscidae	0.32	0.95	1.79	1.46	3.31	44.56
Caenidae	0.79	0.93	1.59	1.23	2.93	47.49
Parastacidae	0.00	0.71	1.55	1.65	2.87	50.36
Tanypodininae	2.01	1.39	1.44	1.62	2.67	53.03
Hemicorduliidae	0.59	0.19	1.37	0.98	2.53	55.56
Baetidae	0.68	1.16	1.29	1.23	2.39	57.95
Dytiscidae (adult)	0.00	0.57	1.26	0.94	2.33	60.28
Tricladida	0.54	0.00	1.25	0.95	2.32	62.60
Gomphidae	0.39	0.42	1.25	1.10	2.31	64.91
Elmidae (adult)	0.55	0.00	1.20	0.96	2.23	67.13
Tipulidae	0.15	0.55	1.20	1.02	2.21	69.34
Oligochaeta	1.49	1.06	1.01	1.49	1.87	71.22
Synthemistidae	0.00	0.44	0.94	0.97	1.73	72.95
Ceinidae	0.40	0.00	0.93	0.65	1.72	74.67
Scirtidae	0.14	0.27	0.82	0.72	1.51	76.18
Telephlebiidae	0.33	0.00	0.79	0.68	1.46	77.65
Polycentropodidae	0.36	0.00	0.79	0.69	1.46	79.11
Hydrophilidae	0.33	0.00	0.77	0.69	1.42	80.53
Synlestidae	0.32	0.00	0.76	0.68	1.40	81.93
Hydrophilidae(adult)	0.31	0.00	0.71	0.67	1.31	83.25
Psephenidae	0.14	0.25	0.71	0.70	1.30	84.55
Odontoceridae	0.32	0.00	0.70	0.67	1.30	85.85
Glossiphoniidae	0.16	0.19	0.67	0.71	1.24	87.10
Hydrobiosidae	0.29	0.00	0.66	0.68	1.22	88.32
Notonectidae	0.14	0.19	0.60	0.67	1.12	89.43
Hydraenidae	0.00	0.25	0.59	0.56	1.09	90.53

Groups CBR & DTC
Average dissimilarity = 51.12

Species	Group CBR Av.Abund	Group DTC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Elmidae	1.28	0.00	3.29	1.78	6.43	6.43
Chironominae	2.05	2.81	2.67	1.58	5.22	11.65
Oligochaeta	2.11	1.06	2.65	1.41	5.19	16.84
Atyidae	0.98	0.00	2.59	1.90	5.06	21.91
Sphaeriidae	1.03	0.25	2.44	1.29	4.78	26.69
Leptoceridae	0.87	0.00	2.42	1.24	4.73	31.42
Dytiscidae	0.16	0.95	2.32	1.44	4.53	35.95
Ecnomidae	1.27	0.68	2.25	1.46	4.40	40.35
Tanypodininae	2.17	1.39	2.02	1.68	3.96	44.31
Ceratopogonidae	1.09	0.98	1.91	1.24	3.74	48.05
Caenidae	0.51	0.93	1.82	1.26	3.56	51.61
Orthocladininae	0.69	0.67	1.80	1.31	3.52	55.13
Parastacidae	0.00	0.71	1.75	1.64	3.42	58.55
Baetidae	0.90	1.16	1.64	1.14	3.21	61.76
Leptophlebiidae	2.44	1.95	1.45	1.61	2.83	64.59
Dytiscidae (adult)	0.00	0.57	1.42	0.95	2.79	67.37
Tipulidae	0.13	0.55	1.34	1.06	2.63	70.00
Ceinidae	0.52	0.00	1.23	0.68	2.40	72.40
Gomphidae	0.16	0.42	1.19	0.96	2.33	74.73
Gripopterygidae	0.41	0.00	1.16	0.62	2.27	77.01
Synthemistidae	0.00	0.44	1.05	0.97	2.06	79.06
Calamoceratidae	0.32	0.00	0.87	0.68	1.70	80.76
Hemicorduliidae	0.25	0.19	0.84	0.80	1.64	82.40
Tricladida	0.30	0.00	0.79	0.68	1.55	83.95
Sialidae	0.28	0.00	0.79	0.68	1.54	85.49
Scirtidae	0.00	0.27	0.72	0.56	1.41	86.90
Hydraenidae	0.00	0.25	0.67	0.56	1.31	88.21
Notonectidae	0.13	0.19	0.61	0.68	1.20	89.41
Psychodidae	0.00	0.23	0.61	0.56	1.19	90.59

Groups CMC & DTC
Average dissimilarity = 46.32

Species	Group CMC Av.Abund	Group DTC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Orthocladininae	1.63	0.67	3.08	1.44	6.64	6.64
Baetidae	0.16	1.16	2.81	2.20	6.06	12.70
Tanypodininae	2.29	1.39	2.58	2.22	5.58	18.28
Leptoceridae	0.87	0.00	2.39	1.91	5.16	23.44
Ecnomidae	1.10	0.68	2.12	1.37	4.57	28.01
Leptophlebiidae	2.64	1.95	2.09	1.58	4.52	32.52
Caenidae	0.29	0.93	2.08	1.40	4.49	37.01
Ceratopogonidae	0.66	0.98	2.04	1.31	4.41	41.42
Chironominae	2.61	2.81	1.90	1.49	4.10	45.52
Parastacidae	0.00	0.71	1.84	1.64	3.98	49.50
Oligochaeta	1.64	1.06	1.84	1.27	3.97	53.47
Dytiscidae	0.78	0.95	1.75	1.12	3.79	57.26
Dytiscidae (adult)	0.15	0.57	1.54	1.02	3.33	60.59
Tipulidae	0.32	0.55	1.53	1.02	3.30	63.89
Synthemistidae	0.51	0.44	1.50	1.05	3.23	67.12
Gomphidae	0.15	0.42	1.22	0.93	2.63	69.75
Magapodagrionidae	0.33	0.00	0.98	0.68	2.12	71.87
Gripopterygidae	0.39	0.00	0.97	0.64	2.10	73.97
Polycentropodidae	0.33	0.00	0.94	0.68	2.04	76.01
Gyrinidae	0.34	0.00	0.91	0.68	1.97	77.98
Sphaeriidae	0.13	0.25	0.88	0.70	1.90	79.88
Elmidae (adult)	0.33	0.00	0.84	0.68	1.82	81.70
Hydroptilidae	0.29	0.00	0.79	0.66	1.71	83.41
Scirtidae	0.00	0.27	0.76	0.56	1.65	85.06
Hydraenidae	0.00	0.25	0.71	0.56	1.54	86.60
Psychodidae	0.00	0.23	0.64	0.56	1.39	87.98
Tricladida	0.25	0.00	0.63	0.68	1.36	89.34

Hemicorduliidae	0.13	0.19	0.62	0.69	1.34	90.69

Groups CCC & DTC
Average dissimilarity = 45.96

Species	Group CCC Av.Abund	Group DTC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironominae	3.70	2.81	3.05	1.53	6.65	6.65
Tanypodininae	2.29	1.39	2.43	1.71	5.29	11.94
Ceratopogonidae	1.70	0.98	2.34	1.05	5.10	17.04
Caenidae	0.16	0.93	2.23	1.43	4.85	21.89
Oligochaeta	1.77	1.06	2.17	1.03	4.73	26.61
Leptoceridae	0.78	0.00	2.17	1.27	4.71	31.33
Baetidae	0.92	1.16	2.07	1.51	4.51	35.84
Calamoceratidae	0.68	0.00	1.92	1.31	4.18	40.02
Dytiscidae	0.89	0.95	1.91	1.21	4.15	44.17
Orthocladininae	0.59	0.67	1.83	1.06	3.98	48.15
Ecnomidae	0.39	0.68	1.82	1.08	3.97	52.11
Leptophlebiidae	1.50	1.95	1.75	1.33	3.82	55.93
Dytiscidae (adult)	0.36	0.57	1.66	1.15	3.61	59.55
Parastacidae	0.33	0.71	1.62	1.32	3.53	63.08
Tipulidae	0.20	0.55	1.47	0.98	3.20	66.28
Hemicorduliidae	0.44	0.19	1.43	0.81	3.12	69.40
Gomphidae	0.16	0.42	1.24	0.95	2.70	72.10
Coenagrionidae	0.45	0.00	1.22	0.63	2.66	74.76
Synthemistidae	0.00	0.44	1.10	0.97	2.39	77.15
Sphaeriidae	0.16	0.25	0.95	0.68	2.06	79.21
Nemertea	0.33	0.00	0.87	0.68	1.90	81.11
Physidae	0.33	0.00	0.80	0.68	1.73	82.84
Corixidae	0.29	0.00	0.79	0.68	1.72	84.56
Scirtidae	0.00	0.27	0.76	0.56	1.65	86.21
Hydraenidae	0.00	0.25	0.71	0.56	1.54	87.75
Psychodidae	0.00	0.23	0.64	0.56	1.39	89.14
Nematoda	0.20	0.00	0.57	0.43	1.25	90.39

Groups CSQC & DTC
Average dissimilarity = 47.24

Species	Group CSQC Av.Abund	Group DTC Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironominae	3.23	2.81	2.53	1.34	5.36	5.36
Baetidae	0.37	1.16	2.52	1.53	5.33	10.69
Atyidae	0.85	0.00	2.44	1.83	5.17	15.86
Leptoceridae	0.87	0.00	2.41	1.20	5.10	20.96
Caenidae	0.34	0.93	2.11	1.31	4.47	25.42
Orthocladininae	1.04	0.67	2.05	1.08	4.34	29.77
Ceratopogonidae	0.93	0.98	1.95	1.31	4.12	33.89
Ecnomidae	0.40	0.68	1.84	1.07	3.90	37.79
Dytiscidae	0.95	0.95	1.84	1.20	3.89	41.68
Tanypodininae	1.97	1.39	1.79	1.35	3.79	45.47
Dytiscidae (adult	0.38	0.57	1.75	1.14	3.71	49.18
Parastacidae	0.13	0.71	1.74	1.45	3.69	52.86
Oligochaeta	1.12	1.06	1.72	1.33	3.63	56.50
Tipulidae	0.30	0.55	1.48	1.06	3.13	59.63
Psephenidae	0.48	0.25	1.47	0.97	3.11	62.74
Corixidae	0.46	0.00	1.36	0.91	2.88	65.62
Chorismagrionidae	0.47	0.00	1.34	0.93	2.83	68.44
Sphaeriidae	0.34	0.25	1.24	0.88	2.62	71.06
Gomphidae	0.00	0.42	1.21	0.90	2.56	73.62
Synthemistidae	0.13	0.44	1.16	1.00	2.45	76.07
Leptophlebiidae	1.66	1.95	1.15	1.13	2.44	78.51
Gyrinidae	0.43	0.00	1.11	0.95	2.36	80.87
Scirtidae	0.13	0.27	0.97	0.71	2.06	82.93
Tricladida	0.36	0.00	0.94	0.67	2.00	84.93
Culicidae	0.38	0.00	0.92	0.64	1.94	86.87

Magapodagrionidae	0.34	0.00	0.83	0.68	1.76	88.63
Hydraenidae	0.00	0.25	0.72	0.56	1.53	90.16

b) Discharge monitoring result

SIMPER

Similarity Percentages - species contributions

One-Way Analysis

Data worksheet
Name: Data2
Data type: Abundance
Sample selection: All
Variable selection: All

Parameters
Resemblance: S17 Bray Curtis similarity
Cut off for low contributions: 50.00%

Factor Groups

Sample	impact/control
TTH11 SPR12	control
SBR1 SPR12	control
SBR2 SPR12	control
SBR3 SPR12	control
SBR4 SPR12	control
TTH11 AUT13	control
SBR1 AUT13	control
SBR2 AUT13	control
SBR3 AUT13	control
SBR4 AUT13	control
TTH11 SPR13	control
SBR1 SPR13	control
SBR 2 SPR13	control
TTH12 SPR12	impact
SBR5 SPR12	impact
SBR6 SPR12	impact
SBR7 SPR12	impact
SBR8 SPR12	impact
TTH12 AUT13	impact
SBR5 AUT13	impact
BR6 AUT13	impact
SBR7 AUT13	impact
SBR8 AUT13	impact
TTH12a SPR13	impact

Group control
Average similarity: 53.59

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Chironominae	2.59	10.01	2.73	18.68	18.68
Leptophlebiidae	2.21	8.21	4.67	15.33	34.00
Tanypodininae	1.97	8.03	5.00	14.99	48.99
Oligochaeta	1.46	5.06	2.14	9.44	58.43

Group impact
Average similarity: 63.14

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Chironominae	3.11	15.66	5.01	24.80	24.80
Tanypodininae	2.34	11.46	4.36	18.14	42.94
Caenidae	1.69	7.09	1.68	11.22	54.17

Groups control & impact
Average dissimilarity = 47.34

	Group control	Group impact				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptophlebiidae	2.21	0.98	3.17	1.61	6.70	6.70
Caenidae	0.71	1.69	2.98	1.45	6.30	13.00
Oligochaeta	1.46	0.96	2.30	1.26	4.85	17.85
Chironominae	2.59	3.11	2.28	1.44	4.81	22.66
Elmidae	0.96	0.16	2.18	1.54	4.59	27.25
Corixidae	0.35	0.89	2.07	1.27	4.38	31.63
Sphaeriidae	0.85	0.43	1.94	1.14	4.10	35.73
Leptoceridae	0.88	0.58	1.90	1.26	4.00	39.73
Ecnomidae	1.03	1.28	1.88	1.08	3.97	43.71
Ceratopogonidae	0.83	0.66	1.84	1.20	3.88	47.59
Gomphidae	0.24	0.71	1.69	1.22	3.57	51.16

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