Appendix D

Aquatic ecology report

CLIENTS | PEOPLE | PERFORMANCE

Goulburn Mulwaree Council

Highlands Source Project

Aquatic Ecological Investigation

July 2010

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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1. Introduction

1.1 Overview

Goulburn has faced severe drought and water restrictions since 2002. By mid 2007 Goulburn had less then 12 months' water supply available. Goulburn Mulwaree Council (GMC), in conjunction with a State Government Task Force, identified an Emergency Pipeline from Wingecarribee Reservoir as the best means of 'drought-proofing' Goulburn for the future (GMC & DoC, 2007). The Highlands Source Project (hereafter referred to as the Project) was identified as the best solution for improving the city's water security. Under this project, GMC propose to construct and operate a water transfer scheme to transfer water from Wingecarribee Reservoir (*ca.* 9 km east of Moss Vale, NSW) to Goulburn's water supply system. The proposed pipeline would be approximately 83 km in length and would be located within the local government areas (LGAs) of Wingecarribee Shire Council (WSC) and GMC.

An Environmental Assessment (EA) of the Project under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) has been undertaken by GHD Pty Ltd (GHD) on behalf of Goulburn Mulwaree Council. An Ecological Impact Assessment addressing the NSW Department of Planning Director-General's requirements for the Project pertaining to ecology has also been prepared as a technical document to support the EA (GHD 2010). The ecological assessment provides an assessment of the significance of impacts of the Project on threatened terrestrial and aquatic biota listed under the *NSW Threatened Species Conservation Act 1995* (TSC Act) and on 'Matters of National Environmental Significance' pursuant to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

This aquatic assessment is a supplementary report and will form part of the supporting documents to the Preferred Project Report (PPR) which documents modifications to the Part 3A EA for the Highlands Source Project. It has been prepared to reassess the aquatic ecology impacts of the Project following modifications of the proposed watercourse crossing construction techniques assessed in the Ecological Impact Assessment (GHD 2010). The proposed pipeline alignment would cross 138 watercourses. At most crossings, trenching or pipe laying and anchoring methods are now proposed rather than HDD/underboring techniques given the nature of the subject watercourses (drainage lines or ephemeral waterways with little to no permanent flows) or due to technical and physical constraints. This report focuses on the assessment of proposed trenching or pipe laying and anchoring techniques where the Project crosses perennial watercourses given the greater potential for impacts on the aquatic environment at these locations.

1.2 Project Description

The Project involves the installation of an 83 km long pipeline. The majority of the proposed pipeline route is located adjacent to existing subsurface infrastructure easements (gas, electricity and optical fibre). A total of 138 crossings have been identified, of which the majority (93) are minor unnamed tributaries of larger creeks. Ten of the waterways are considered perennial (based on the NOW classification). All of the remaining waterways are drainage lines or ephemeral waterways with little to no permanent water or flows.

1.2.1 Context

The NSW Office of Water (NOW) provides the following guidelines in relation to undertaking waterway crossings:

- Crossings of waterways/riparian land should be underbored or attached to existing structures (such as bridges) to avoid direct impacts on the aquatic and riparian environment, where:
  - there is permanent flow in the waterway; or
  - there is existing native riparian vegetation; or
  - the creek is in good natural condition; or
  - there is a potential fish passage Class 1 or 2.
- The NOW recommends that underboring commence from the outer edge of the riparian land and that it is bored for the full width of the watercourse and riparian land
- Trenching may be an option if:
  - the waterway is a dry intermittent creek;
  - the native riparian vegetation has previously been cleared; and
  - there are no watercourse instability issues.
- If there are areas of the existing creek instability below the pipeline route the creek crossing needs to be designed so as to ensure for the future stability of the waterways and reduce risk to the pipeline itself.

There are a number of constraints related to the choice of methodologies available for waterway crossings in many locations along the pipeline alignment, in particular, the proximity of the crossing point to existing underground services, waterway valley shape and the presence of shallow bedrock, as discussed below.

HDD/underboring methods could be used to cross many of the waterways along the alignment; however, the proposed pipeline alignment for the majority of its length follows the existing APA gas pipelines and the PowerTel fibre optic easements. Where underboring is proposed, the location of the waterway crossing must be offset from the nearest gas pipeline at least the length of the drill distance from one side of the creek to the other. This is to ensure that in case the drill moves off track during the works, it cannot accidentally puncture the nearby gas lines. Many of the waterways assessed in this report were proposed to be underbored by HDD which would avoid direct impacts to the waterway banks and bed; however, in this scenario, the crossing location would need to be moved away from the gas pipeline which in many cases would result in higher riparian vegetation losses (e.g. Jaorimin Creek). In these cases, it is safer and more technically sound to trench the waterway crossings where the water depth and velocity allows and provide rehabilitation of the waterway bed and banks.

At deeper, faster flowing crossings where underboring could be feasibly undertaken away from the gas pipelines, for example the Wollondilly River crossings, geotechnical constraints and the valley shape pose significant constraints to this method. Shallow bedrock has been encountered at some of the waterway crossings and previous drilling attempts for the installation of other services has resulted in the loss of drilling heads under the waterways. Also, waterways situated in steep sided valleys pose greater technical constraints to drilling as the length of the drill needs to be increased significantly and a stable platform for launching is more difficult to facilitate. In these cases, laying the pipe across the bed of the waterway and anchoring it into the banks is considered a more appropriate method for the pipeline installation,

in particular where the waterway depth is sufficient such that the pipeline does not create a geomorphic or ecological barrier in the waterway.

In most locations, it is proposed to use trenching rather than underboring to cross the waterways due to the technical and physical constraints outlined above. Where the water depths or flow velocities are too great to utilise trenching, pipe laying and anchoring has been proposed (see Section 1.2.2). This aquatic ecology report has been prepared in conjunction with a geomorphic assessment to support the methods proposed to cross the waterways encountered along the pipeline (See Environmental Assessment, Chapter 6).

This report focuses on eight perennial watercourse crossings (Table 1) that would require trenching or laying and anchoring of the pipeline across the watercourse bed. A further two perennial watercourse crossings were identified but have not been assessed:

- Kelly's Creek (W3): this crossing was unable to be accessed for assessment at the time of the field investigation; and
- Narambulla Creek (W84): This waterway is classified as a chain of ponds. It is proposed to horizontally directionally drill under the waterway, thus the aquatic environment will not be disturbed and no aquatic impacts are anticipated.

Table 1 Watercourse crossing specifics

Sector	Reference No.	Watercourse Name	Chainage (m)	Proposed Crossing Type
Paddy's River	W52	Paddy's River	37,193	Trench
Paddy's River	W56	Uringalla Creek (at the confluence of Back Creek)	39,627	Trench
Marulan	W69	Jaorimin Creek	47,770	Trench
Towrang	W95	Osborn's Creek	60,589	Trench
Towrang	W105	Wollondilly River	64,073	Pipe Laying and anchoring
Towrang	W106	Wollondilly River	65,269	Trench
Murrays Flat	W119	Wollondilly River	70,753	Pipe Laying and anchoring
Goulburn	W131	Wollondilly River	78,651	Pipe Laying and anchoring

1.2.2 Proposed Crossing Methods

Trenching of Pipeline

Standard open cut trenching is most often utilised in low flow, shallow or dry conditions. This technique involves setting up a stable work platform on each side of the watercourse and then

excavating a trench. The trench is not completed until immediately prior to placement of the pipeline. Tie in points are located on high ground away from the banks. Pipes are then placed into the trench using slings from the excavators at either side of the waterway. The spoil from the watercourse bed and bank and trench spoil material are stored separately.

The pipeline trench would be approximately 1 m wide and excavated to a nominal depth of 1.5 m to 2 m below ground surface using either a tracked excavator or a tracked chain trencher. The excavated material would be deposited within the construction easement adjacent to the trench for backfilling or disposal where appropriate. Excavated material that is greater than 20 mm in diameter when it exits the trenching machine cannot be used for backfilling and alternative material, such as sand would be used to backfill the trench.

Stockpile areas of approximately 10 m by 10 m wide would be located intermittently along the pipeline easement. These stockpile areas would contain sand and other material that would be used for backfill where the natural material is too coarse for use.

Following construction, an easement (of approximately 10 m in width) would be maintained as a cleared landscape to allow access for ongoing maintenance activities.

Where higher water volumes and flows are present, open trenching using streamflow diversion can be used. This technique typically involves creating a dry construction area within which to work by pumping around the area. Other diversion techniques include diverting the water flow through a flume pipe installed between the dams. Diverted flow is maintained at a flow rate and water quality, which would allow the downstream reaches of the waterway to continue to function. The duration of flow diversion is dependent on the construction methodology used and final access arrangements negotiated at particular crossings but in most instances would be unlikely to exceed 3-4 days.

It is anticipated that streamflow diversion will be required at W52 and possibly at W56. The requirement for streamflow diversions at other proposed trenched crossings will be dependent on flows at the time of construction.

Key construction activities include:

- Installation of sediment controls and flow diversions (where required);
- Trench excavations and placement of the pipeline; and
- Reinstatement of the creek profile and stabilisation.

Pipe Laying and Anchoring

In the event that a waterway is unsuitable for trenching, underboring or horizontal directional drilling, there is the option of laying a welded steel pipeline across the river bed as a typical submarine pipeline. The suitability of this approach depends on the likely flow and flood flow velocity conditions in the particular river crossing location.

This technique is only applicable in deeper water way crossings where a pipe section laying across the river can be considered be relatively stable and secure. It is used in backwater and estuary type zones or deep pools where for alignment reasons the pipeline has to cross at this location.

The general process for laying welded steel pipe across the bed of a waterway is as follows:

- The required length and profile of the pipe is matched to the cross section shape of the river bed;

- The pipeline is then weight coated using nominally 75 mm thick concrete coating;
- The pipeline trench would normally be extended down to near the waters edge such that the top of the weight coated pipe would enter the river cross section at about the "low water level";
- Using the trench on the approach to the river as well as the prepared trench down the bank of the river, the pre-welded river crossing section of the pipeline will be pulled across the bed of the river;
- Each end of the welded pipeline will be secured by anchorages in the trench once the pipe has been pulled into position;
- Connections can then be made subsequently to this river crossing section of the pipeline;
- The river banks will be re-established and stabilised with a combination of rock work and geofabric type filter zones; and
- The pipe will tend to settle into the bed of the river and they are normally found in time to be covered by sediments and silts which are generally quite mobile in river channels.

Normally this approach minimises the disturbance to the river and overcomes some of the risks particularly in deeper water crossings where the geotechnical conditions could result in problems for the directional drilling operations.

This approach is proposed at W105, W119 and W131 where the crossings of the Wollondilly River are deep and wide. Construction times will depend significantly on proposed methodology and final access negotiations. At W105, five weeks for bank preparation, one day for pipe installation and two weeks for bank anchorage works is anticipated. At W119, three weeks for bank preparation, one day for pipe installation and one week bank anchorage works are expected. At W131, three weeks bank preparation, one day pipe installation and one week bank anchorage works are expected.

1.3 Aims and Objectives

The primary aims of this aquatic assessment are to identify the aquatic habitats and aquatic fauna species present (and likely to be present) at the eight perrenial watercourse crossings, to assess the likely impacts of the proposed crossing on the aquatic ecology and in particular on threatened species and their habitat and to recommend appropriate impact mitigation measures.

The objectives of this assessment are to:

- Identify and describe attributes of the existing aquatic environment of the survey sites;
- Identify the occurrence or likelihood of occurrence of threatened aquatic species or populations and their habitats listed under the *NSW Threatened Species Conservation Act 1995* (TSC Act), *NSW Fisheries Management Act 1994* (FM Act) and the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- Assess the significance of potential impacts of construction and operation of the Project at the identified crossings on the above in accordance with the draft Part 3A threatened species assessment guidelines (DEC & DPI 2005); and
- Identify measures to avoid, minimise and mitigate impacts on aquatic biodiversity values at the identified crossing sites and downstream habitats.

The potential impacts of the project on threatened aquatic ecological communities listed under the FM Act and the threatened Giant Dragonfly (*Petalura gigantea*) listed under the TSC Act have been assessed in the Ecological Impact Assessment (GHD 2010) prepared for the EA and are not considered further in this report.

2. Site Characteristics

2.1 Investigation Area

The Project comprises approximately 83 km of trunk water main and ancillary infrastructure, extending from Wingecarribee Reservoir within the Wingecarribee LGA to the Goulburn Water Treatment Plant within the Goulburn Mulwaree LGA. The preferred pipeline route corridor would be located mostly adjacent to existing infrastructure easements that have previously been cleared and either remain cleared or have regenerating vegetation present. This report focuses on perrenial creek crossings that would be directly impacted. The Ecological Impact Assessment (GHD 2010) assesses terrestrial and riparian habitats of the entire pipeline route.

2.2 Geology, Soils and Topography

The geological maps show the proposed pipeline route would traverse a number of geological units. These units mainly comprise sedimentary formations, while igneous formations occur around Marulan and Goulburn. The expected geology in sectors relevant to this study is shown in Table 2. A review of published soil landscape maps for the Hawkesbury – Nepean Catchment identified 34 soil landscapes along the proposed alignment. Broadly, these soil landscapes can be grouped into five separate units based on origin and/or surface processes (see Table 3).

Table 2 Geology along proposed pipeline route

Sector	Description of general geology in each sector
Paddy's River	Predominantly underlain by sedimentary rock formations (sandstone)
Marulan	Predominantly underlain by sedimentary rock formations (sandstone and siltstone) in the west portion, while the east portion is predominantly underlain by igneous rock formations
Towrang, Murrays Flat	Predominantly underlain by igneous rock formations in the west portion, but mostly underlain by sedimentary rock formations (shale, sandstone and siltstone) and alluvial sediments
Goulburn	Predominantly underlain by sedimentary rock (limestone)

Table 3 Soil units along proposed pipeline route

Erosional:	Soil formation is affected by the removal of weathered parent material
Transferral:	Similar to alluvial soils but are considered to have undergone less transportation, and often resemble local soil and weathered materials (e.g. "slopewash")
Alluvial:	Soils transported by water down creeks and rivers.
Colluvial:	Soils of colluvial origin are derived from subsurface materials that have undergone or are undergoing mass-movement down slope, primarily due to the influence of gravity
Residual:	Soils that form where weathering of parent material occurs without significant erosion over extended periods of time

The proposed pipeline runs north east to south west between Wingecarribee Dam (approximately 90 km northeast of Goulburn) and the town of Goulburn. The 1:25,000 scale topographic maps for Moss Vale, Canyonleigh, Wingello, Towrang, Bungonia, and Goulburn show that the pipeline route would traverse a series of hill slopes, flood plains, river valleys and low hills. Table 4 summarises the location of these topographical features along the pipeline route.

Table 4 Topography along proposed pipeline easement

Sector	General topographical feature of Sector
Paddy's River	Hills and river valleys
Marulan	Low hills, hills and a river valley (~CH 39 km – CH 41 km)
Towrang	Low hills, rises and a flood plain (~CH 51 km to CH 58 km),
Murrays Flat	River valley and flood plain, low hills (toward Murrays Flat)
Goulburn	Rises and low hills

2.3 Climate

The Commonwealth Bureau of Meteorology website provides climatic information for the study area taken from the Goulburn weather station (site 070037 - closest station to sites). A review of this data indicated that approximately 36.4 mm of rain fell over the period of 4 weeks prior to sampling with 43% (15.8 mm) of this volume falling over one day (8/3/2010). No rainfall was recorded during the week prior to sampling. The mean rainfall peaks in summer ranging from 64.8 mm in January down to 47.8 mm in July, with annual average rainfall of 665.6 mm. Mean daily maximum temperatures range from 28.1°C in summer to 11.4 °C in winter with mean minimum temperatures ranging from 13.2 °C in summer down to 1.3 °C in winter (BoM 2010).

2.4 Hydrology

The Wollondilly River catchment forms part of the Warragamba Dam catchment, which is a major source of Sydney's drinking water supply. The River itself is approximately 156 km in length and the entire catchment area is approximately 9050 square kilometres. The major tributaries of the Wollondilly River catchment are Nattai River, Cox's River, Kowmung River, and Kedumba River. A large proportion of the Wollondilly River catchment is under the care and control of the Sydney Catchment Authority.

2.5 Surrounding Land Uses

The typical land use adjacent to the pipeline watercourse crossings is agricultural land which is generally used for grazing. The proposed pipeline would travel through much of this agricultural land via or adjacent to existing gas or electricity infrastructure easements which also extend through the area. Refer to the EA document for details on land use.

3. Methods

3.1 Literature Review and Assessment

A review of relevant available literature, background information and searches of databases was undertaken for threatened aquatic species, populations and aquatic ecological communities recorded within the locality. Information and databases reviewed included:

- Department of Environment, Climate Change and Water (DECCW) Atlas of NSW Wildlife Database Records for threatened species and endangered ecological communities listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and *Fisheries Management Act 1994* (FM Act);
- NSW Government's BioNet database of records from the collections of the Australian Museum, DECCW and Industries and Investment NSW (Department of Primary Industries – DPI) (including NSW Fisheries); and
- Department of Environment, Water, Heritage and the Arts (DEWHA) Protected Matters Search Tool for NES Matters listed under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

3.2 Aquatic Surveys

Two GHD aquatic ecologists undertook aquatic flora and fauna surveys at the eight survey sites (Table 5) from 22nd to the 25th March 2010. Aquatic habitat assessments, fish and macroinvertebrate surveys, and water quality sampling was undertaken. GPS coordinates were recorded at each site.

The survey methodology is described in detail below.

Table 5 Survey sites

Reference No.	GPS coordinates (easting, northing)	Watercourse Name	Catchment
W52	784711, 6162410	Paddy's River	Paddy's River
W56	782414, 6161660	Uringalla Creek	Paddy's River
W69	774824, 6158710	Jaorimin Creek	Wollondilly River
W95	763038, 6154230	Osborn's Creek	Wollondilly River
W105	759523, 6153810	Wollondilly River	Wollondilly River
W106	758369, 6153830	Wollondilly River	Wollondilly River
W119	753174, 6154740	Wollondilly River	Wollondilly River
W131	746709, 6153300	Wollondilly River	Wollondilly River

3.2.1 Aquatic Habitat Assessments

Detailed documentation of aquatic habitats and features were conducted at the proposed crossings in order to determine the condition of aquatic habitats and to assess the potential presence of native fauna, including threatened species or populations listed under the FM Act and/or EPBC Act. Assessments were undertaken following the Australian River Assessment Systems: AUSRIVAS Physical Assessment Protocol (AUSRIVAS, 2009) and included descriptions of a number of characteristics at each site e.g. water quality, local impacts, landuse, floodplain features, riparian zone composition and condition, in-stream physical characteristics, bank form and stability, sediment composition and condition and macrophyte species presence. Macrophyte species were identified in the field using *Waterplants in Australia, 4th Edition* (Sainty & Jacobs, 2003). Incidental sightings of other aquatic species were also recorded.

Fish habitat classes were assigned based on waterway characteristics according to the classifications of Fairfull and Witheridge (2003). See Table 6 for an explanation of these classifications.

Table 6 Fish Habitat Classifications (taken from Fairfull and Witheridge (2003)).

Fish Habitat Classification	Characteristics of Waterway Type
Class 1 Major fish habitat	Major permanently or intermittently flowing waterway (e.g. river or major creek), habitat of a threatened fish species.
Class 2 Moderate fish habitat	Named permanent or intermittent stream, creek or waterway with clearly defined bed and banks with semi - permanent to permanent waters in pools or in connected wetland areas. Marine or freshwater aquatic vegetation is present. Known fish habitat and/or fish observed inhabiting the area.
Class 3 Minimal fish habitat	Named or unnamed waterway with intermittent flow and potential refuge, breeding or feeding areas for some aquatic fauna (e.g. fish, yabbies). Semi - permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or recognised aquatic habitats.
Class 4 Unlikely fish habitat	Named or unnamed waterway with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free standing water or pools after rain events (e.g. dry gullies or shallow floodplain depressions with no permanent aquatic flora present).

3.2.2 Water Quality Assessment

Basic physico-chemical water quality parameters were measured using a TPS 900 portable water quality meter. The variables measured were as follows:

- temperature (^{o}C);
- pH;
- turbidity (NTU);
- dissolved oxygen (DO) (mg/L and % saturation); and

- Electrical conductivity (EC) ($\mu S/cm^2$).

The meter was calibrated at the beginning of each field day and checked for accuracy against standards at the end of each day of sampling. A minimum of three readings of each parameter were taken and averaged to increase accuracy.

3.2.3 Macroinvertebrate Sampling

Surveys were undertaken in accordance with NSW AUSRIVAS Sampling and Processing Manual (Turak *et al.,* 2004). Two samples were collected at each site. Where possible, one edge and one riffle sample was collected; alternatively, where no riffle habitat was available, two edge samples were collected.

Macroinvertebrate sampling was undertaken using a kick net of 250 micron mesh (0.25 mm) along a total length of 10 m of edge or riffle habitat. Samples were collected using a variety of swishing / sweeping motions and scraping of hard surfaces, including the bank. Where possible, sampling incorporated a variety of habitat types, including trailing bank vegetation, benthic leaf litter, macrophyte beds and undercut banks. Whole samples were then placed in sorting trays and sorted using the AUSRIVAS methods described below.

Live sorting of samples involved a minimum picking time of 40 minutes. The process for picking was as follows:

- For the first 5 minutes, active and common taxa were collected whilst avoiding bias towards the larger, more colourful ones;
- For the next 20 minutes, the concentration was on picking new taxa;
- If by 25 minutes no new taxa were found, the focus was on the collection of more specimens over the next 5 minutes;
- At 30 minutes a mental note of what had been collected was taken and picking continued for at least 10 more minutes taking note as to whether any new taxa (i.e. taxa not collected in the first 30 minutes) were found;
- If new taxa were collected between 30 and 40 minutes, picking continued for 10 more minutes; and
- If new taxa were collected between 40 and 50 minutes, picking continued until 60 minutes had elapsed.

The specimens were placed in labelled jars and temporarily preserved in Isocol until being returned to the laboratory for identification and statistical analysis.

3.2.4 Fish Surveys

Fish species present at each site were assessed via both active and passive sampling methods electrofishing, fyke netting and bait trapping (in order of preference) or a combination of these survey methods. Available habitat and water quality variables at each site determined the methods most suitable for conducting surveys. Where the watercourse was unsuitable for fyke net deployment, bait trapping was employed. Table 7 shows the survey method(s) employed at each site and site specific variables restricting unused methods.

Table 7 Survey methods employed at pipeline watercourse crossings

Site Reference No.	Electro-fishing	Fyke Net	Bait Trap
W52	**Y**	N (insufficient watercourse)	**Y**
W56	N (too electrically conductive)	N (insufficient watercourse)	**Y**
W69	**Y**	**Y**	N (fyke net suitable)
W95	N (too electrically conductive)	N (insufficient watercourse)	N (insufficient watercourse)
W105	**Y**	N (watercourse >1.5 m deep)	**Y**
W106	**Y**	**Y**	N (fyke net suitable)
W119	**Y**	N (lack of water flow)	**Y**
W131	**Y**	N (watercourse >1.5 m deep)	**Y**

Electrofishing

Electrofishing was conducted along a 50 m reach at suitable sites (all but one site). All habitat types were targeted with stunned fish specimens dip netted from the water and placed into a bucket for recovery prior to being processed.

Electrofishing activities were conducted in compliance with the *Electrofishing Code of Practice* using a NIWA Electric Fishing Machine (EFM300).

Fyke Netting

Fyke nets were employed in more open areas of river (two sites) with the aim of collecting a range of larger, migratory and more mobile species. All nets were set to ensure that a diversity of available structural habitat was sampled (open water, amongst or against vegetation and woody material). On site habitat information was used to inform the appropriate sampling approaches to achieve the required outcomes of characterising the aquatic faunal assemblages of the study area.

Single wing fyke nets (small mesh) were used. Nets have a central wing (8 m x 1.2 m) attached to the first supporting hoop (diameter = 0.65 m) with a stretched mesh size of 5 mm.

Bait Trapping

Bait traps were employed at five sites, where fyke netting was unsuitable. They are an efficient method of sampling small fish amongst woody debris, dense vegetation, steep banks and deep water; habitat variables that featured at the study sites. Bait traps have a funnelled opening at each end (0.22m x 0.22m x 0.4m, with 2 mm stretched mesh) and were set in the littoral zone close to emergent vegetation, submerged macrophytes and woody debris.

All traps were baited with glow sticks and set in the afternoon and retrieved in the morning for specimen removal and processing.

Specimen Processing

All specimens collected were identified, measured and recorded prior to being returned to the watercourse from which they came. All specimens were identified to species level in the field using *Field Guide to the Freshwater Fishes of Australia* (Allen *et al*., 2002).

All noxious species declared under relevant state and federal legislation were euthanased with the use of Benzocaine (ethyl amino benzoate) solution. Noxious species were removed from the site and disposed of appropriately.

GHD currently holds a Scientific Research Permit (P07/0142-1.3, NSW, Expiry date: 1/4/2010) for the collection of aquatic biota, which also complies with Animal Ethics Legislation.

All water quality results were compared to the Australian and New Zealand Environment Conservation Council (ANZECC) 2000 water quality guidelines for upland (>150 m elevation) rivers/streams.

3.3 Macroinvertebrate Analysis

3.3.1 Laboratory Identification

Macroinvertebrate specimens were identified to family level where possible using the latest taxonomic keys. A total of 16 macroinvertebrate samples were analysed with the resulting samples stored in site specific vials for retention by GHD for internal quality assurance procedures.

3.3.2 Statistical Analysis

Sample sites were assessed using a variety of indices as well as a comparison with the expected “natural condition” of the creeks. The analyses compared the sites (spatial analyses) and determined relationships between the various sites and linked these to water quality parameters and surrounding landuse. The following methods were undertaken when analysing the data:

Community Composition

Total invertebrate abundance and the number of taxa were calculated and presented as graphs. The percentage composition of major groups at each site is also presented as a graph.

SIGNAL2

GHD use the most recent working of Signal Invertebrate Grade Number – Average Level, SIGNAL2 (Chessman, 2001). Within Chessman (2001), each macroinvertebrate family is assigned a “grade number” between 1 and 10, with 1 indicating those organisms with a high tolerance of a range of environmental conditions. Scores can be calculated with or without abundance weighting. GHD calculated the SIGNAL 2 scores with abundance weighting, as this is consistent with the method employed by NSW Streamwatch “Water Bug Survey”.

The grade number for each macroinvertebrate type is multiplied by the corresponding abundance weight factor. The weight factors of all macroinvertebrate types are added (A) and the products of grade numbers and weight factors are also added (B). The sum of the products (B) is divided by the sum of the weight factors (A) to produce the abundance-weighted SIGNAL

2 score (C). The resulting score provides a simple assessment that gives some indication of the condition of a site. The scores are determined for both edge and riffle habitat separately.

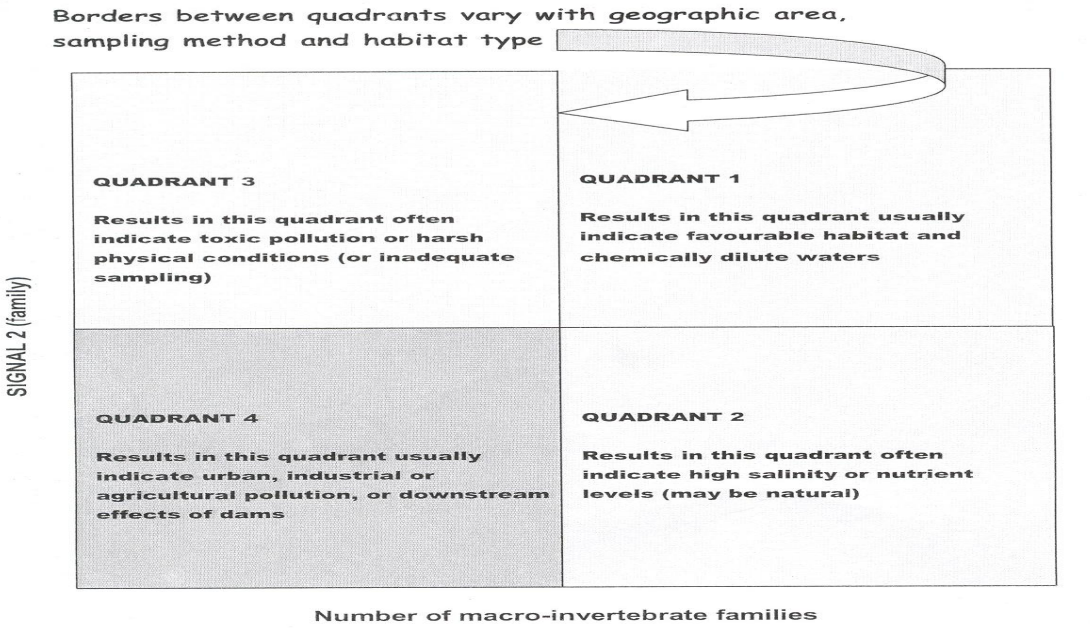
Some families identified have not been assigned a family grade number (e.g., mites, worms), and in these cases the order-class-phylum grades have been used in the family-level calculation (Chessman, 2001).

For easier interpretation, SIGNAL 2 scores and the diversity of macroinvertebrates are graphed using a biplot (Figure 1). The resulting biplot is placed into context using a quadrant diagram that divides the results into:

- High SIGNAL 2 values and number of macroinvertebrate types;
- Lower SIGNAL 2 scores and high diversity of macroinvertebrate types;
- High values of SIGNAL 2 but few macroinvertebrate types; and
- Low values of both SIGNAL 2 scores and the number of macroinvertebrate types.

The quadrant boundaries are set according to the interim guidelines suggested for NSW.

Figure 1 SIGNAL 2 Biplot



Ephemeroptera : Plecoptera : Trichoptera (EPT) Ratios

EPT is a widely used measure in North America based on Ephemeroptera, Plecoptera and Trichoptera orders to assess stream condition. These three orders have been identified as being intolerant to pollution and their use as indicators of disturbance has also been tested in NSW. GHD calculated EPT percentages as part of the analysis of macroinvertebrates. The following steps determine the percentage Index:

- To calculate the total EPT - density sum of the total number of EPT in the sample;
- To calculate the percentage EPT - divide EPT Total by Total Sample Individuals; and
- Convert to a percentage.

This percentage value gives an indication of general water quality.

3.4 Conservation Significance

Conservation status of species and communities recorded across the study area were determined with reference to the following:

- The TSC Act and FM Act for State significance; and
- The EPBC Act for National significance.

3.5 Survey Limitations

The site inspection for the aquatic ecological assessment was undertaken in early autumn with no seasonal replication. Autumn is considered an acceptable time to sample freshwater fish in upland rivers and ideal for the sampling of macroinvertebrates, as this season is when many dragon and mayfly larvae mature and leave the water body, meaning that they are highly active and easily detected during this season if present. Field surveys undertaken as part of the terrestrial assessment were conducted in late spring and summer (GHD 2010), during the flight season of the Giant Dragonfly.

This survey was not designed to enable all species, either resident or transitory to the study area, to be detected. Instead it was aimed at providing an overall assessment of the ecological values at each site, with particular emphasis on assessing the habitats present and the likelihood of occurrence of threatened biota. The level of assessment undertaken in this survey is considered to be adequate to provide an overall assessment of the aquatic ecological values of each study site with emphasis on threatened aquatic species and their habitats.

4. Results

4.1 Survey Conditions

The weather from the 22nd - 25th March 2010 was generally warm, calm and fine. Temperatures reached approximately 27.1°C during the day, down to 5.5°C during the night. No rainfall was experienced during the field survey period. Table 8 shows the diurnal temperatures and rainfall data during the survey period.

Table 8 Daily weather observations (Goulburn) during the survey period (BoM, 2010)

Date	Minimum Temperature (°C)	Maximum Temperature (°C)	Rainfall (mm)
22/03/2010	10.1	24.3	0
23/03/2010	5.5	26.5	0
24/03/2010	5.6	24.2	0
25/03/2010	8.0	27.1	0

4.2 Database Searches

The results of the DECCW Atlas of NSW Wildlife and BioNet database searches showed no records of threatened fish species in the locality. The DEWHA Protected Matters Search Tool indicated that the preferred habitat of two threatened species, the Macquarie Perch (*Macquaria australasica*) and the Australian Grayling (*Prototroctes mareana*) may, or have the potential to, occur within the study area (Table 9).

Table 9 Listed threatened aquatic species potentially occurring within the study area

Scientific name	Common name	Status		Records/Comments
		TSC/FM Act	EPBC Act	
Macquaria australasica	Macquarie Perch	E	E	No records within 10km (DECCW 2010).
Prototroctes maraena	Australian Grayling	-	V	No records within 10km (DECCW 2010). The nearest known population occurs in the eastward-flowing Shoalhaven River.

No endangered or threatened riparian or aquatic ecological communities of relevance to the survey sites were identified during the desktop analysis. Threatened plants previously recorded within 10km of the study sites that could potentially occur in riparian and wetland areas have been identified and assessed as part of the terrestrial ecology assessment report for the Project (GHD 2010) and are not considered further in this report.

4.2.1 Threatened Aquatic Species and Habitat Descriptions

Australian Grayling

The Australian Grayling is generally found in clear, moderate to fast flowing waters in both coastal and upper reaches of rivers. This species spends only part of its lifecycle in freshwater, where running ripe specimens have been captured. The species prefers gravel type substrates and often forms aggregations below barriers to upstream migration. The species is relatively uncommon in the coastal drainages of south-eastern Australia, from the Grose River (NSW) to the Hopkins River (Vic.) (Allen *et al*., 2002).

Macquarie Perch

Macquarie Perch occur in cool, clear waters of rivers, lakes and reservoirs and prefer slow flowing, deep rocky pools. The species occurs between the middle and upper reaches of the Murray River and its tributaries in New South Wales and Victoria. Populations from the eastward-flowing Shoalhaven and Hawkesbury rivers (NSW) are genetically distinct and may represent an undescribed species (Allen *et al*., 2002).

4.3 Aquatic Habitat Assessments

Descriptions of aquatic habitats in the study area are provided below. Tabulated observations/site characteristics are included in Appendix C.

4.3.1 Site W52 – Paddy's River

The proposed watercourse crossing point consists of run (60%), riffle (30%) and pool (10%) bed form features. The channel width ranges from approximately 3 m (run) to 6 m (pool) wide and was between 0.5 (run) to 0.1 m (riffle) deep. The site has been impacted by the removal of riparian vegetation, grazing (horse) access, moderate exotic vegetation invasion and the previous trenching of a gas pipeline across the river. This impact has lead to the creation of a shallow riffle section between the run and pool features. This riffle section acts to restrict fish passage during periods of base to low flow with base flow observed at the time of assessment.

Riparian vegetation was semi continuous along either side of the river with some exotic species present and minor regeneration occurring. 26 to 50% of the channel was in shade. Trailing bank vegetation presence was moderate to extensive. Overall, the vegetation disturbance was rated as high. Favourable aquatic habitat was present with seven species (one introduced) of macrophytes (70% cover) and in stream woody debris (2% cover) observed. Local land use (facing downstream) was native forest adjacent to the left bank and grazing land adjacent to the right bank. No sediment oils or odours were observed. Small shallow backwaters have a slight silver sheen in parts with no odour noted across the site. Water was only slightly turbid however, coloured.

This site was assessed as Class 2 – moderate fish habitat based on waterway characteristics (Fairfull and Witheridge 2003). Whilst theoretically suitable habitat for the Australian Grayling (a clear, gravel-bottomed stream with alternating pools and riffle habitat) occurs at this site, this species is not expected to occur in the locality (see Section 5.6.2).

Figure 2 Site W52 upstream

Figure 3 Site W52 downstream

4.3.2 Site W56 – Uringalla Creek

The proposed watercourse crossing point consists of an isolated pool (100%) bed form feature. The channel width ranges from approximately 2 m to 4 m and was between 0.6 to 0.1 m deep. The site has been impacted by the removal of riparian vegetation, grazing (sheep) access, moderate exotic vegetation invasion and the (previous) trenching of a gas pipeline across the creek. This impact has lead to the creation of a shallow ford like section through the pool. This shallowed section acts to restrict fish passage during low flows.

Riparian vegetation was semi-continuous along either side of the river with some exotic species present. Trailing bank vegetation presence was moderate. Less than five percent of the channel was in shade. Overall, the vegetation disturbance was rated as high. Aquatic habitat present included three species (one introduced) of macrophytes (95% cover - Para grass dominant) and minimal in-stream woody debris observed (<1% cover). Local land use (facing downstream) was grazing fields adjacent to the left bank and cropped land adjacent to the right bank. No sediment oils were observed. Anaerobic sediment odours were noted when disturbed. No water oils / sheens or odours were observed. Water was only slightly turbid however, it was coloured.

This site was assessed as Class 3 – minimal fish habitat based on waterway characteristics (Fairfull and Witheridge 2003).

Figure 4 Site W56 upstream

Figure 5 Site W56 downstream

4.3.3 Site W69 – Jaorimin Creek

The proposed watercourse crossing point consists of an isolated pool (85%) and run (15%) bed form feature. The channel width ranges from approximately 2 m to 3 m and was between 0.4 to 0.1 m deep. The site has been impacted by the removal of riparian vegetation, grazing (sheep) access, a 4WD crossing, minor exotic vegetation invasion and the (previous) trenching of a gas pipeline across the creek. This impact has lead to the creation of a raised section through the run section restricting water flow and fish passage during periods of base to low flow. Water was not flowing at the time of assessment.

Riparian vegetation (trees) was semi continuous along the left bank and occurring in occasional clumps along the right bank (facing downstream) and dominated by native species (90%) with some regeneration occurring. Grasses occur along the majority of the bank margin. Trailing bank vegetation occurrence was slight. Six to 25% of the channel was in shade. Overall, the vegetation disturbance was rated as moderate. Aquatic habitat present included five species (one introduced) of macrophytes (60% cover) and substantial in stream woody debris (30% cover) observed. Local land use was native forest (regenerating) adjacent to both banks. Unvegetated side point and mid channel bars, dominated by sandy sediments, were present. No sediment oils were observed. Anaerobic sediment odours were noted when disturbed. Surface flecks / oil /sheens were observed with no odour noted. Water was only slightly turbid however, it was coloured.

This site was assessed as Class 3 – minimal fish habitat based on waterway characteristics (Fairfull and Witheridge 2003).

Figure 6 Site W69 upstream

Figure 7 Site W69 downstream

4.3.4 Site W95 Osborn's Creek

The proposed watercourse crossing point consists of an isolated pool (100%) bed form feature. The channel width ranged from approximately 2 m to 3 m and was approximately 0.4 m deep. The site has been impacted by the removal of riparian vegetation, grazing (sheep) access and the (previous) trenching of a gas pipeline across the creek. This impact has lead to the creation of a raised section through the run section restricting water flow and fish passage during periods of base to low flow. Water was not flowing at the time of assessment.

Riparian trees (facing downstream) occurred in occasional clumps along the left bank and was semi continuous along the right bank and was dominated by native species (80%) with little regeneration occurring. Trailing bank vegetation occurrence was slight. Six to 25% of the channel was in shade. Overall, the vegetation disturbance was rated as high. Aquatic habitat was minor with one native species of macrophyte and no in stream woody debris observed. Local land use was private cleared land adjacent to both banks. No sediment oils or anaerobic odours were observed. Surface flecks / oil /sheens were observed with no odour noted. Water was only slightly turbid however, it was coloured.

This site was assessed as Class 3 – minimal fish habitat based on waterway characteristics (Fairfull and Witheridge 2003).

Figure 8 Site W95 upstream

Figure 9 Site W95 downstream

4.3.5 Site W105 Wollondilly River

The proposed watercourse crossing point consists of pool (100%) bed form features. The channel width was approximately 40 m wide and was between 6 to 8 m deep. The site has been impacted by the removal of riparian vegetation, grazing (sheep) access, moderate exotic vegetation invasion. Base flow conditions were observed at the time of assessment. Riparian tree vegetation was semi continuous along either side of the river with exotic species (Weeping Willow) dominant. Six to 25% of the channel was in shade. Trailing bank vegetation presence was moderate. Overall, the vegetation disturbance was rated as high. Aquatic habitat included five species (one introduced) of macrophytes (70% cover) and in-stream woody debris present (40% cover) observed. Local land use (facing downstream) was grazing (sheep) pasture adjacent to the left bank and a combination of private land and grazing (horse) land adjacent to the right bank. No sediment oils were observed. Anaerobic sediment odours were noted when disturbed. Surface flecks / oil /sheens were observed with no odour noted. Water was only slightly turbid however, it was coloured.

This site was assessed as Class 2 – moderate fish habitat based on waterway characteristics (Fairfull and Witheridge 2003). Whilst theoretically suitable habitat for the Macquarie Perch (slow flowing deep pool characteristics) is present at this site, this species is not expected to occur in the locality (see Section 5.6.1)

Figure 10 Site W105 upstream

Figure 11 Site W105 downstream

4.3.6 Site W106 Wollondilly River

The proposed watercourse crossing point consists of riffle (60%) and pool (40%) bed form features. The channel width was approximately 1 m (riffle) to 5 m (pool) wide and was between 0.2 m (riffle) to 1 m (pool) deep. The site has been impacted by the removal of riparian vegetation, grazing (sheep) access and minor exotic vegetation invasion. Base flow conditions were observed at the time of assessment. Riparian vegetation was restricted to single native trees regularly spaced along either side of the river with no regeneration occurring. Less than 5% of the channel was in shade. Trailing bank vegetation presence was moderate. Overall, the vegetation disturbance was rated as very high. Aquatic habitat present included eight species (one introduced) of macrophyte (70% cover) and in stream woody debris (5% cover) observed. Local land use was grazing (sheep) pasture adjacent to the left bank and right bank. No sediment or water oils were observed. Anaerobic sediment odours were noted when disturbed. Water was only slightly turbid however, it was coloured.

This site was assessed as Class 2 – moderate fish habitat based on waterway characteristics (Fairfull and Witheridge 2003). Whilst theoretically suitable habitat for the Australian Grayling (a clear, gravel-bottomed stream with alternating pools and riffle habitat) occurs at this site, this species is not expected to occur in the locality (see Section 5.6.2).

Figure 12 Site W106 upstream

Figure 13 Site W106 downstream

4.3.7 Site W119 Wollondilly River

The proposed watercourse crossing point consists of pool (100%) bed form feature. The channel width was approximately 30 m wide and 0.4 m deep. The site has been impacted by the removal of riparian vegetation, cropping, 4WD crossing, exotic vegetation invasion and the (previous) trenching of a gas pipeline across the creek. This impact has lead to the creation of a raised section through the pool restricting water flow and fish passage during periods of base to low flow. Water was not flowing at the time of assessment.

The riparian vegetation (facing downstream) included occasional clumps of trees along the left bank and isolated/scattered trees along the right bank with no regeneration occurring. Six to 25% of the channel was in shade. Trailing bank vegetation presence was slight. Overall, the vegetation disturbance was rated as very high. Aquatic habitat included one introduced species of macrophyte (15% cover) and in stream woody debris (5% cover) observed. Local land use was grazing (sheep) pasture and irrigated playing fields adjacent to the left bank and irrigated cropping adjacent to the right bank. Sediment and water oils were light. Anaerobic sediment odours were noted when disturbed. Water was turbid and coloured.

This site was assessed as Class 2 – moderate fish habitat based on waterway characteristics (Fairfull and Witheridge 2003). Whilst theoretically suitable habitat for the Macquarie Perch (slow flowing deep pool characteristics) is present at this site, this species is not expected to occur in the locality (see Section 5.6.1).

Figure 14 Site W119 upstream

Figure 15 Site W119 downstream

4.3.8 Site W131 Wollondilly River

The proposed watercourse crossing point consists of a pool (100%) bed form feature and was located upstream from the town weir. The channel width was approximately 20 m wide and was between 2 m and 3 m deep. The site has been impacted by the removal of riparian vegetation, grazing (sheep) access and minor exotic vegetation invasion. No water flow was observed at the time of assessment.

The riparian trees were limited to single clumps along each bank with no regeneration occurring. Six to 25% of the channel was in shade. Trailing bank vegetation presence was slight. Overall, the vegetation disturbance was rated as very high. Aquatic habitat included five species (one introduced) of macrophyte (30% cover) and in-stream woody debris (5% cover) observed. Local land use was grazing (sheep) pasture adjacent to the left bank and right bank. Sediment and water oils were light. Anaerobic sediment odours were noted when disturbed. Water was only slightly turbid however, it was coloured.

This site was assessed as Class 2 – moderate fish habitat based on waterway characteristics (Fairfull and Witheridge 2003). Whilst theoretically suitable habitat for the Macquarie Perch (slow flowing deep pool characteristics) is present at this site, this species is not expected to occur in the locality (see Section 5.6.1).

Figure 16 Site W131 upstream

Figure 17 Site W131 downstream

4.4 Aquatic Flora Recorded

4.4.1 Macrophytes

A total of 20 species of macrophyte were recorded in the study area during the field surveys. Fifteen of the 20 species recorded were native with five introduced species present (Table 10). One species belonging to the *Myriophyllum* genus was unidentified to species level. This genus has both native and introduced variations. The Weeping Willow (*Salix babylonica*) was present at two of the eight sites. A list of recorded macrophyte species and occurrences is included in Appendix A.

Table 10 Macrophyte species recorded at proposed pipeline watercourse crossings

Scientific name	Common Name	Status
Alisma plantago-aquatica	Water Plantain	Native
Azolla filiculoides	Pacific Azolla	Native
Ceratophyllum demersum	Hornwort	Native
Cyperus involucratus	Umbrella Sedge	Introduced
Elatine gratioloides	Waterwort	Native
Eleocharis acuta	Common Spikerush	Native
Eleocharis sphacelata	Tall Spikerush	Native
Elodea canadensis	Elodea	Introduced
Isolepis fluitans	Floating Clubrush	Native
Juncus acutus	Spiny Rush	Introduced
Juncus usitatus	Common rush	Native
Lemna spp.	Duckweed	Native
Myriophyllum sp.	Water milfoil	Native/introduced
Myriophyllum papillosum	Common Watermilfoil	Native
Nymphoides indica	Water Snowflake	Native
Salix babylonica	Weeping Willow	Introduced
Schoenoplectus validus	River/Great Clubrush	Native
Triglochlin procerum	Water Ribbons	native
Typha domingensis	Cumbingi	Native
Urochloa mutica	Para Grass	Introduced
Vallisneria nana	Ribbonweed	Native

4.5 Aquatic Fauna Recorded

4.5.1 Aquatic Vertebrates and Large Crustaceans

A total of 900 individuals, representing ten species from nine families (comprising five fish, one reptile, one frog and two large crustacean families) were recorded during the field surveys, none of which are threatened species. Six of the ten species recorded were native with three introduced species present. Numerous tadpoles were sighted at sites W56, W69 and W95 but were not identified to species level. Note that eight species of frog (no threatened species) were identified in the terrestrial surveys (GHD 2010). An aquatic fauna species list is included in Table 11, with additional data included in Appendix B.

Table 11 Aquatic fauna species recorded at proposed pipeline watercourse crossings

Scientific name	Common Name	Status
Cherax spp.	Freshwater Cray	Native
Parataya sp.	Freshwater Shrimp	Native
Carassius auratus	Goldfish	Introduced
Gambusia holbrooki	Mosquito Fish	Introduced
Gobiomorphus coxii	Cox's Gudgeon	Native
Hypseleotris galii	Firetail Gudgeon	Native
Perca fluviatilis	Redfin Perch	Introduced
Retropinna semoni	Australian Smelt	Native
Lymnodynastes peroni	Striped Marsh Frog	Native
Emydura macquarii	Macquarie Turtle	Native

4.5.2 Macroinvertebrates

A total of 1,058 macroinvertebrate individuals were collected from a total of 45 taxa within 44 families. Larval specimens of the Giant Dragonfly family (Petularidae) were not identified in any of the macroinvertebrate samples, and no adults were observed during these or the terrestrial surveys (GHD 2010). Table 12 outlines all taxa that represented greater than 5% of the total sample composition. The species descriptions (below) were taken from Gooderham & Tsyrlin (2005).

The Chironominae were the most abundant taxon comprising 12% of all invertebrates collected. Chironomids are a highly diverse family of Diptera (two winged flies) within Australia, and occupy many different roles and functions within aquatic ecosystems. They are generally omnivorous and the family contains many species tolerant to disturbance/pollution.

Ostracods (micro crustaceans) are herbivore/ detritivores filter feeders. They are commonly found on soft sediments at the bottom of ponds, pools and wetlands.

Dytiscids (Beetles) are found in a number of different freshwater habitats but are most common to ponds, lakes, dams and short lived seasonally flowing streams / rivers.

Coenagrionids (Damselflies) are common with extensive distributions. They are an opportunistic species with a short life span which allows rapid colonisation of ephemeral water bodies.

Calocids (Caddis flies) are commonly found in the slower sections of clear streams. They prefer areas that accumulate decaying plant matter and are usually associated with good water quality.

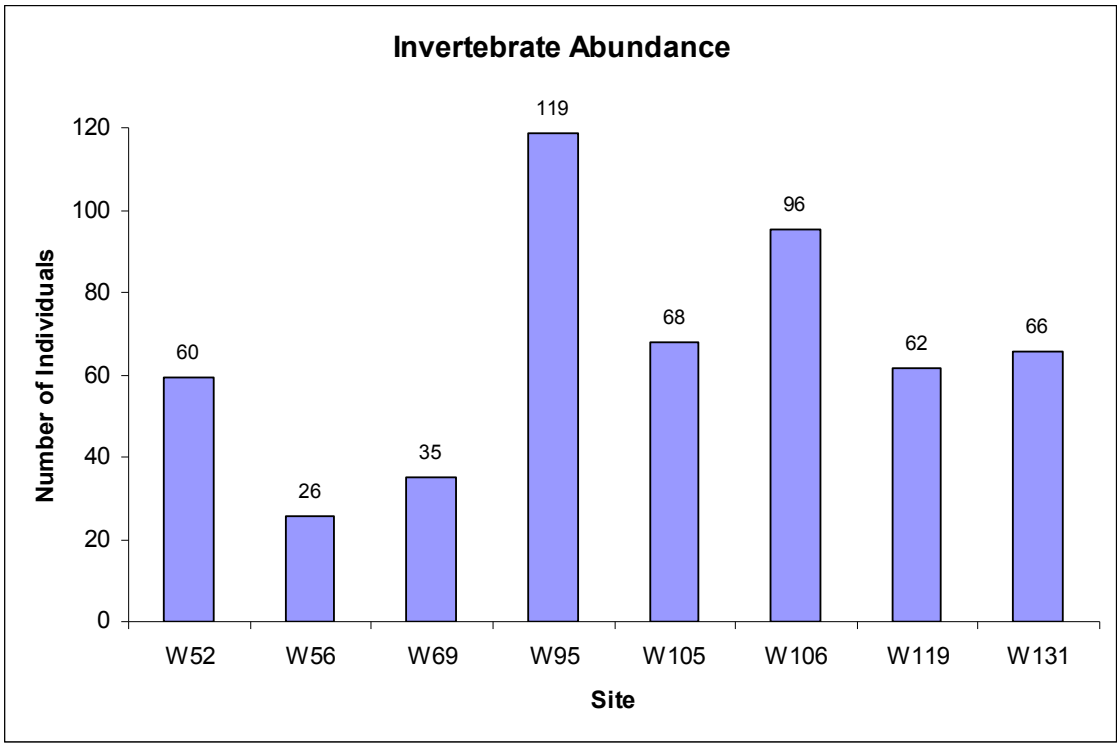
Table 12 Dominant macroinvertebrate families

Phylum/Order	Family	% Of Total Composition
Diptera	Chironominae	12%
Ostracoda	Notodromadidae	11.1%
Coleoptera	Dytiscidae	9.6%
Zygoptera	Coenagrionidae	8%
Trichoptera	Calocidae	5.7%

Invertebrate Abundance

- Species abundance at each site was averaged between the two samples collected (
- Figure 18). These results show that:
- W95 had the highest abundance of macroinvertebrates with an average of 119 individuals collected per sample.
- W106 had the second highest abundance with an average of 96 individuals collected per sample.
- W56 was the most depauperate site with an average of 26 individuals collected per sample.
- W69 was the second most depauperate site with an average of 35 individuals collected per sample.

Figure 18 Species abundance at pipeline watercourse crossings

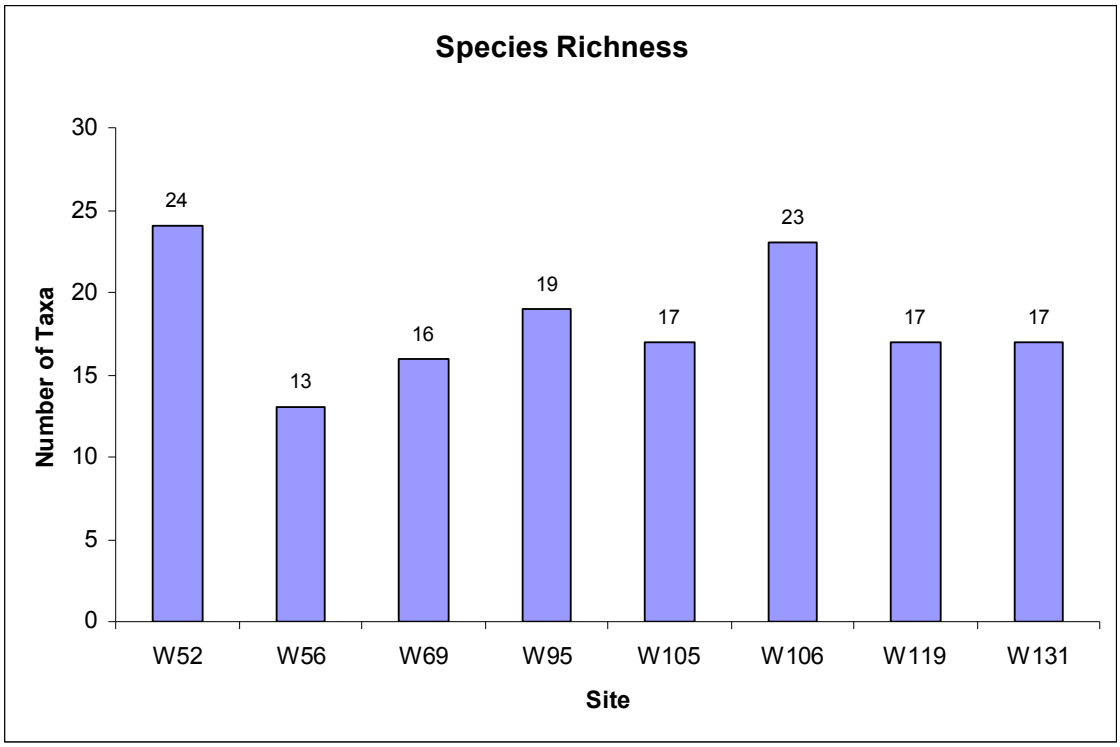


Invertebrate Richness

Species richness of each site was reached by totalling the diversity of site replicates (Figure 19). These results show that:

- Site W52 had the highest species diversity with a total of 24 taxa sampled at the site.
- Site W106 had the second highest species diversity with a total of 23 taxa sampled at the site.
- W56 had the lowest species diversity with a total of 13 taxa sampled at the site.
- The remaining sites (W69, W95, W105, W119 and W131) were similar in terms of diversity with between 16 and 19 taxa sampled at these sites.
- The two sites with the highest diversity (W52 and W106) were the only two sites at which a riffle sample could be collected, and riffles are well known to have a higher species richness than edge communities

Figure 19 Species richness (or number of species) at pipeline watercourse crossings



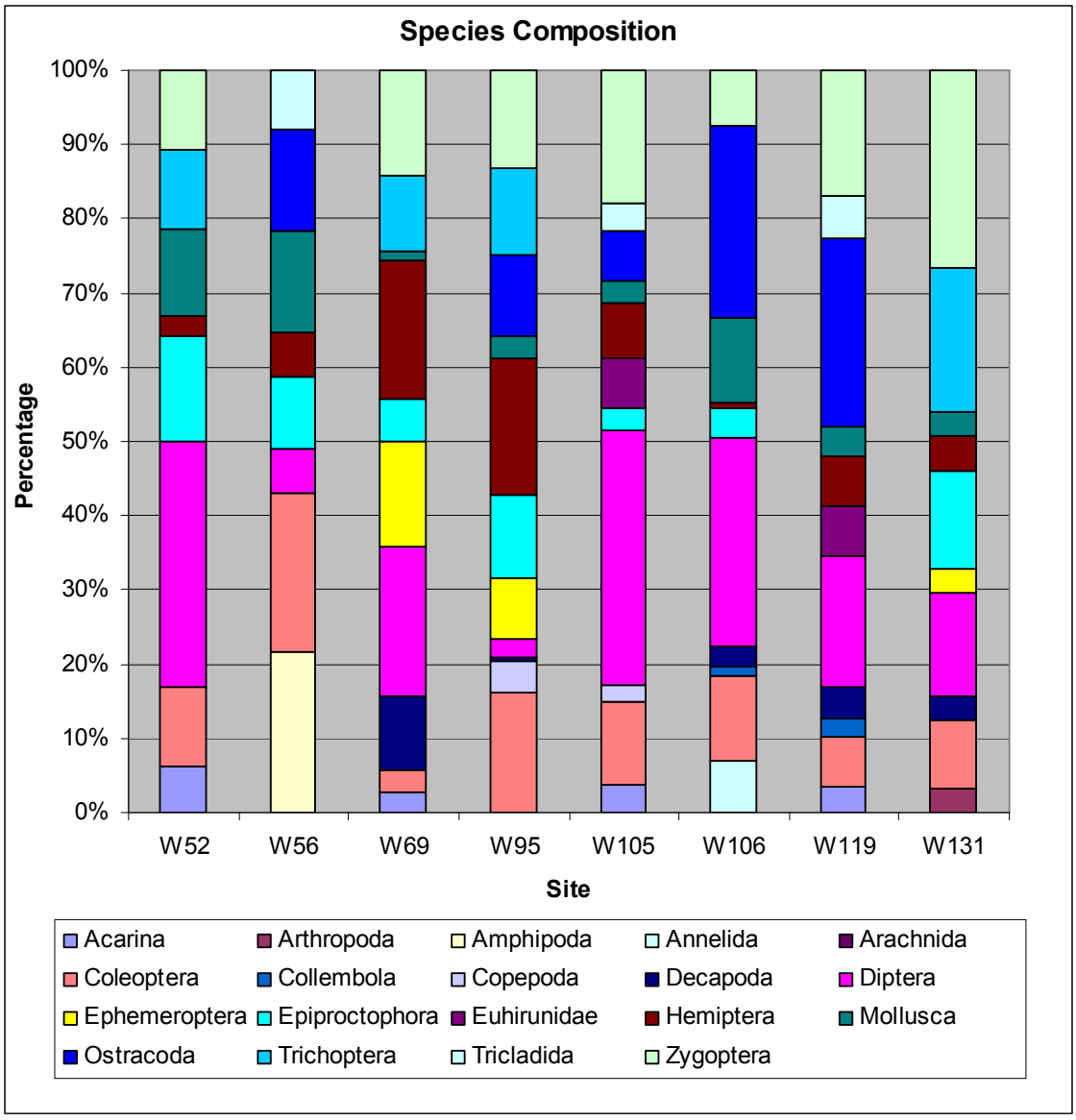
Invertebrate Species Composition

Community composition results (Figure 20) indicate that:

- Dipteran families dominated communities at sites W52, W69, W105 and W106;
- Ostracods contributed high percentages to community composition at sites W106 and W119 only;
- Amphipods were present at site W106 only; and
- Sites W69, W95, W105 and W119 had the most families (11) contributing to the overall community composition.

It should be noted that families contributing <2% to the overall community composition were excluded from this analysis.

Figure 20 Species composition at pipeline watercourse crossings



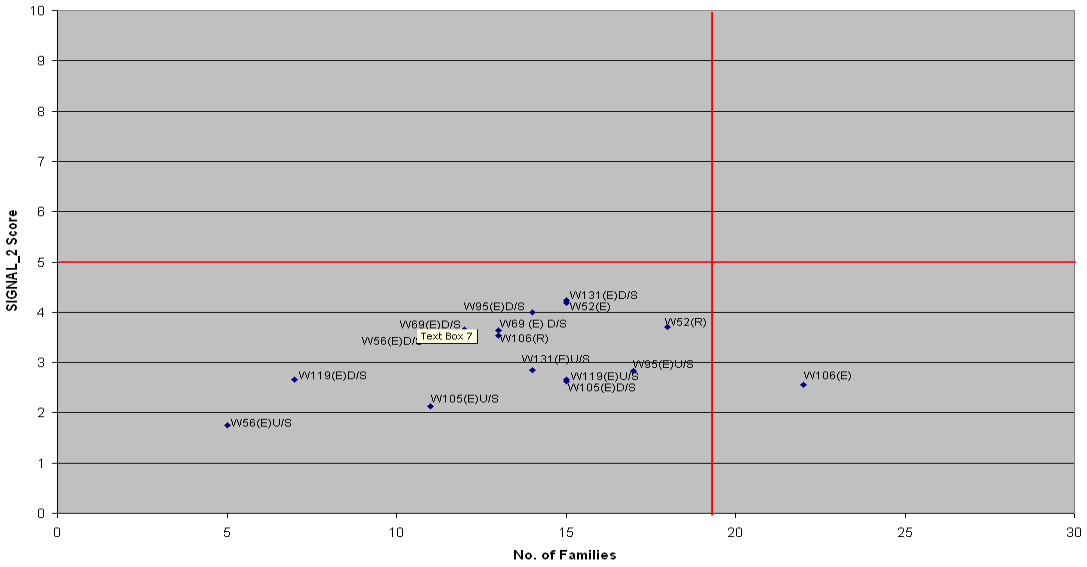
SIGNAL 2

Figure 21 shows the results of the SIGNAL 2 analysis. It is evident from the analysis that all but one site have fallen into Quadrant 4. Quadrant 4 represents samples with low SIGNAL2 scores and low faunal diversity. Results in this quadrant may indicate that sites are affected by agricultural impacts (Chessman, 2001).

The edge sample from site W106 fell into Quadrant 2. Quadrant 2 contains samples with low SIGNAL2 scores and high levels of macroinvertebrate diversity. Samples that appear in this quadrant may indicate high nutrient levels which can be naturally occurring (Chessman, 2001).

The biplot also suggests that, of the total sites sampled, W52 is the least affected by agricultural / anthropogenic impacts, based on the fact that both samples are located towards the centre of the quadrants. The site W56 edge sample is the most affected based on its location (farthest from the quadrant centre).

Figure 21 SIGNAL 2 biplot analyses



EPT

The Ephemeroptera:Plecoptera:Trichoptera (EPT) ratios of samples (Table 13) indicate that:

- Samples from W56 and W 105 contained no Ephemeroptera, Plecoptera or Trichoptera specimens.
- Site W52 returned the highest EPT ratio with 22%
- Samples W69, W95 and to a lesser extent W131 had similar EPT ratios relative to the other samples.
- All other samples had comparatively lower EPT ratios.

Lower or zero EPT ratios in samples may suggest that the habitat was unsuitable or could be the result of anthropogenic disturbances. Sites with higher EPT ratios may suggest more pristine environments, complex habitat or larger natural variations in aquatic life.

Table 13 EPT ratio results

Site Reference No.	Total Taxa	E:P:T Taxa	E:P:T Ratio
W52	27	6	22%
W56	14	0	0%
W69	18	3	17%
W95	22	4	18%
W105	19	0	0%
W106	26	1	4%
W119	18	1	6%
W131	20	3	15%

4.6 Water Quality

The water quality results show that:

- pH values were within the guideline range at all sites except at site W95;
- Turbidity was very low at sites W106 and W52 but exceeded guideline range at site W119;
- Dissolved Oxygen was below the guideline range at all sites; and
- Electrical conductivity was generally above the upper limit trigger value at all sites, except at sites W52 and W131.

In situ water quality results are displayed in Table 14. All exceedances of guideline ranges are highlighted in blue. It must be noted that guideline trigger values are indicative only and provide environmental managers with a set of values upon which to assess future potential impacts on a stream. Some values may not be entirely reliable as regional influences (geology, nutrients etc) can differ between catchments. A broad set has been derived (used herein) which provide a measure until such time that more site specific trigger values can be developed, given adequate time. Exceedances, in this case, may not necessarily indicate a negative effect is occurring.

Table 14 In situ water quality results

Site (chainage(m))	Temperature (°C)	pH	Turbidity (NTU)	Dissolved Oxygen (%)	Electrical Conductivity (µs/cm)
ANZECC (2000) Trigger value	**No value**	**6.5-7.5**	**2-25**	**90-110**	**30-350**
W52	17.6	6.5	1.5	46	143
W56	18.2	7.2	11.7	43	2240
W69	19.2	7.2	2.7	59	665
W95	24.7	7.7	4.2	41	8515
W105	18.4	7.2	17.1	20	525
W106	18.3	7.1	1.2	25	650
W119	21.3	7.2	99	41	487
W131	23.3	7.2	2.4	10	261

4.7 Threatening Processes

A 'key threatening process' (KTP) is a threatening process specified in Schedule 6 of the FM Act. A 'threatening process' is "a process that threatens, or may have the capability to threaten the survival or evolutionary development of species, populations or ecological communities".

There is direct evidence of the following KTPs currently operating at the survey sites:

- The introduction of fish to fresh waters within a river catchment outside their natural range. The introduced Redfin Perch species (*Perca fluviatilis*) was collected at W106, Goldfish

(*Crassius auratus*) were collected in high numbers at W69, and Mosquitofish (*Gambusia holbrooki*) at W52, W105, W106, W119 and W131; and

- Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams. Reduction of water flow due to upstream weir and water extraction for crop irrigation was noted at two of the eight sites, and previous trenching of a gas pipeline was noted at five sites (W52, W56, W69, W95 and W119).

The following four KTPs would have operated previously, given the modified landscape and vegetation communities present at the survey sites:

- Degradation of native riparian vegetation along New South Wales water courses (evident at all survey sites); and
- Removal of large woody debris from New South Wales rivers and streams. Removal of dead wood and dead trees (de-snagging) of the Wollondilly River and associated creeks.

The proposed activity has the potential to further contribute to the operation of the following KTPs:

- Degradation of native riparian vegetation along New South Wales water courses;
- Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams; and
- Removal of large woody debris from New South Wales rivers and streams.

These KTPS and specific mitigation measures to minimise potential adverse impacts on the riparian and aquatic environment are discussed in more detail in Section 5.6.

4.8 Summary of Results

Table 15 summarises the results of survey effort and habitat assessments at each of the survey sites. A number of common native and exotic fish species were encountered at all sites, although diversity was low. Habitat assessments indicated the sites provided minimal (Class 3) to moderate (Class 2) fish habitat (Fairfull and Witheridge 2003), with mild to moderate, and sometimes high, disturbance to riparian and aquatic vegetation, hydrology and water quality. All sites had relatively low macroinvertebrate abundance and species richness and evidence of mild degradation.

Table 15 Summary of results (inter-site comparison)

Site and Crossing Type	Water Quality and Depth	Aquatic Habitat	Aquatic Flora	Aquatic Fauna	Macroinvertebrates	General Comments
W52 **Trench**	Water quality generally good. DO level low. Water flowing. 0.1-0.5 m	Moderately degraded. Impacted due to anthropogenic activities. Run and riffle habitat occurring. Class 2 – moderate fish habitat. Theoretically suitable habitat for Australian Grayling but not expected to occur (see aquatic fauna).	Relatively diverse with seven species (one introduced) occurring in high percent cover.	One species of amphibian and numerous tadpoles (unidentified) recorded. Four species of fish (one introduced) and two species of crustacean encountered. No threatened species encountered and none expected to occur based on absence of records in the locality and known distributions.	Moderately abundant and highest species richness of all sites. Endangered Giant Dragonfly not observed.	Overall, the site has the hi values, compared to the o trenching work has acted t creating a riffle section.
W56 **Trench**	Water quality moderate. DO low and EC elevated. No water flow. 0.1-0.6 m	Highly degraded. Impacted due to anthropogenic activities. No potential habitat for threatened species.	Low diversity with three species occurring. Dominant species exotic and well established.	Low diversity, one species of introduced fish encountered One frog species was recorded. No threatened species encountered and none expected to occur based on the absence of habitat, no records in the locality and known distributions.	Lowest invertebrate abundance and richness of all sites. Endangered Giant Dragonfly not observed.	Overall, the site is highly d moderate to low ecologica macrophytes dominate the large numbers of the introd *Gambusia holbrooki*, were observed. Previous trench to infill the channel.
W69 **Trench**	Water quality moderate. Low DO and EC above guidelines. No flow with isolated pools present. 0.1-0.4 m	Moderately degraded. Impacted due to anthropogenic activities. No preferred habitat for threatened species.	Low diversity with five species (one introduced) occurring. Water milfoil dominant with other species present as individuals.	Seven species encountered in total, three species of fish (one introduced), one amphibian, one reptile and two species of crustacean. No threatened species encountered and none expected to occur based on the absence of habitat,	Second lowest site in invertebrate abundance and species richness. Endangered Giant Dragonfly not observed.	Overall, the site is modera isolated shallow pools pres occur extensively across th on the inside of bends. Ov value of the site is low to m trenching work has acted t

				no records in the locality and known distributions.		
W95 **Trench**	Water quality moderate. Low DO and pH and EC (highest) approximately 25 times above guidelines. No flow with isolated pools present. 0.4 m	Moderately to highly degraded. Impacted due to anthropogenic activities. No preferred habitat for threatened species.	Low diversity with one native species occurring (limited cover).	One native crustacean species encountered in low numbers. No fish species present. No threatened species encountered and none expected to occur based on the absence of habitat, no records in the locality and known distributions.	High invertebrate abundance, moderate species richness. Endangered Giant Dragonfly not observed.	Overall, the site is highly d shallow pools with little aq species of macrophyte occ ecological value of the site Previous trenching work ha channel.
W105 **Pipe Laying and Anchoring**	Water quality moderate. Low DO and elevated EC. No visible water flow. 6-8 m	Moderately degraded. Impacted due to anthropogenic activities. Class 2 – moderate fish habitat. Theoretically suitable habitat for Macquarie Perch but not expected to occur (see aquatic fauna).	Low diversity. Submerged, emergent and floating species (4 species total) occurring. Exotic Weeping Willows dominant riparian vegetation >10m.	Two species of fish encountered (one introduced). No species encountered and none expected to occur based on absence of records in the locality and known distributions.	Moderate invertebrate abundance and richness. Endangered Giant Dragonfly not surveyed or observed.	Overall, the site is modera low to moderate ecologica
W106 **Trench**	Water quality moderate. Lowest turbidity recorded and EC elevated. Water flowing. 0.2-1 m	Moderately degraded. Impacted due to anthropogenic activities. Class 2 – moderate fish habitat. Theoretically suitable habitat for Australian Grayling but not expected to occur (see aquatic fauna).	Most diverse site with 8 species (one introduced) occurring.	Second highest site for species abundance and richness. No threatened species encountered and none expected to occur based on absence of records in the locality and known distributions.	Riffle habitat occurs. Second highest invertebrate abundance and richness. Endangered Giant Dragonfly not observed.	Overall, the site has highe than other sites and mildly Numerous macrophytes sp species were encountered and riffle) are present.
W119	Water quality moderate. Highest turbidity recorded, DO	Highly degraded. Impacted due to anthropogenic activities. No preferred habitat for	Second lowest diversity with two introduced species occurring.	Low diversity with two species of fish encountered (one introduced), one	Moderate invertebrate abundance and species richness. Endangered Giant Dragonfly not	Overall, the site is degrade values are moderate. Prev has acted to infill the chan

Pipe Laying and Anchoring	low and EC elevated. No visible water flow. 0.4 m	threatened species. Class 2 – moderate fish habitat.		crustacean and one reptile. No threatened species encountered and none expected to occur based on the absence of habitat, no records in the locality and known distributions.	observed.	
W131 **Pipe Laying and Anchoring**	Water quality good for all parameters recorded however, lowest DO occurring. Water flowing. 2-3 m	Moderately degraded and a weir pool. Impacted due to anthropogenic activities. Class 2 – moderate fish habitat. Theoretically suitable habitat for Macquarie Perch but not expected to occur (see aquatic fauna).	Moderate diversity. Five species occurring however, one introduced species well established.	Diversity low. One species of native fish occurring and two species of crustacean. No threatened species encountered and none expected to occur based on absence of records in the locality and known distributions.	Moderate invertebrate abundance and species richness. Endangered Giant Dragonfly not observed.	Overall, the site is modera Ecological values are mod

5. Impact Assessment

This Section assesses the potential impacts of the development during construction on the aquatic flora and fauna of the study area. An assessment of the potential impacts of the development on aquatic threatened species and populations has been undertaken in accordance with the draft Part 3A Guidelines for Threatened Species Assessment (DEC & DPI 2005).

5.1 Construction Impacts

5.1.1 Pipeline trenching and placement

Standard open cut trenching is most often utilised in low flow, shallow or dry conditions. The pipeline trench would be approximately 1 m wide and excavated to a nominal depth of 1.5 m to 2 m below ground surface. The trench is not completed until immediately prior to placement of the pipeline. Following construction, an easement (of approximately 10 m in width) on the adjacent river banks would be maintained as a cleared landscape to allow access for ongoing maintenance activities. This crossing method may also be applied in sensitive streams where rapid construction is considered the best means of minimising environmental impacts.

Streamflow diversion may be required in some situations. Water would be diverted down half the channel in wider, more shallow areas. This technique typically involves creating a dry construction area within which to work by pumping water past the section. Other diversion techniques include diverting the water flow through a flume pipe installed between the dams. Diverted flow is maintained at a flow rate and water quality, which would allow the downstream reaches of the waterway to continue to function.

The primary risk of impact associated with trenching is the potential for release of high sediment loads during excavation and backfilling. If managed inappropriately, it could increase turbidity, impacting upon downstream water quality and ecology. Special care will be required at watercourse crossings to reinstate the natural layering of material that is representative of the geomorphological balance in that particular reach of the channel. The pipe may be surrounded by a rock scour protective layer of material depending on the natural stability of the bed materials. Where the natural materials are more mobile the depth of the trench will need to be increased, whereas channel beds that are rockier will require minimal excavation as the pipe is generally concreted into the bed with a layer of 'plum' concrete – i.e. the natural rocks are set back into the upper layer of the concrete. Reinstatement of the watercourse bed will be appropriately designed by a geomorphologist to return the existing condition and profile of the channel and minimise the potential for sediment build up and obstruction of flows or fish passage post-construction.

The following general impacts could potentially occur during trenching and construction operations:

- Disturbance to bed and banks of waterway channels;
- Disturbance to floodplains;
- Stream bed degradation;
- Potential stream bank erosion; and
- Scour potential from poor pipeline orientation:

- The impact of erosion from bed and bank disturbance can include water quality impacts on the downstream environment. General construction activities (e.g. stockpiling of material, etc.) may lead to sedimentation issues.
- Impacts to riparian and aquatic flora and fauna.
- Disturbances or loss of native vegetation (including seedbank, instream and riparian vegetation).

Mitigation measures to reduce the environmental impact of trenching include temporary flow diversion, sediment capture devices and strict environmental management controls (See Section 6).

5.1.2 Pipe Laying and Anchoring

Use of a substrate anchored pipe is only applicable in deeper waterway crossings where a pipe section laying across the river can be installed and be relatively stable and secure. It is used in backwater and estuary type zones or deep pools where for alignment reasons the pipeline has to cross at this location. In the study area, this technique will be used at two crossings on the Wollondilly River, site W105 and site W131. Normally this approach minimises the disturbance to the river and overcomes some of the risks particularly in deeper water crossings where the geotechnical conditions could result in problems for the directional drilling operations.

It is proposed to install a submarine pipeline, with the pipe prepared in existing cleared areas on the banks and installed by bottom pulling techniques. Potential impacts are primarily associated with bank and stream bed disturbance and release of sediment loads during installation. If managed inappropriately, it could increase turbidity, impacting upon downstream water quality and ecology.

The pipe will tend to settle into the bed of the river and they are normally found over time to be covered by sediments and silts which are generally quite mobile in river channels. Given the water depth at proposed locations the pipeline will not create a geomorphic or ecological barrier in the waterway and as such, impacts on the waterway following construction are likely to be minimal.

5.1.3 Water Contamination

Potential sources of contaminated surface water applicable to the development include:

- Runoff from areas stripped of riparian vegetation;
- Runoff from material stockpiles;
- Leakage or spillage of hydrocarbon products from vehicle wash down areas and workshops;
- Refuelling bays and fuel, oil and grease storages; and
- Discharge of extraction pit waters.

Given the implementation of the proposed mitigation measures that will be described in a Soil and Water Management Plan, the development is unlikely to result in significant impacts on surface waters at the site.

5.2 Long-term Impacts

Without appropriate rehabilitation measures in place, long-term impacts on aquatic fauna may include the loss of ecological functions and habitat resources that take a long time to develop. These include:

- Structurally diverse aquatic vegetation, with a number of age classes and mature emergents; and
- A healthy soil seed bank, with sufficient number and diversity of propagules to allow the native aquatic vegetation to regenerate following disturbances such as flooding.

Provided sufficient mitigation measures are adopted; in particular the rehabilitation of disturbed channel substrates and banks, the development is unlikely to result in permanent or irreversible impacts on native biodiversity. This includes local populations of native aquatic flora and fauna, which are likely to recolonise the site after pipeline installation is complete.

As noted above, the proposed construction methods will be designed and located to minimise the potential to create a geomorphic or ecological barrier in the waterway and as such, impacts on the waterways following construction are likely to be minimal at most.

5.3 Impacts on Riparian Vegetation and Aquatic Habitats

5.3.1 Aquatic Flora and Riparian Vegetation

Impacts to riparian vegetation and in-stream flora will be limited due to the location of crossings and existing disturbances. The majority of the proposed pipeline route is located adjacent to existing subsurface infrastructure easements (gas, electricity and optical fibre) and crossing locations are typically already cleared of riparian vegetation or support introduced species.

In selecting appropriate crossing methods at particular sites, consideration was also given to minimising the requirement for clearing of riparian vegetation. In some instances, trenching was selected over underboring which would have resulted in more extensive riparian vegetation loss given offset distances required from the existing gas pipeline and fibre optic easements and the necessity to move out of the cleared easement.

The development will involve varying degrees of disturbance to a relatively low diversity of native and exotic species of macrophytes and riparian vegetation at all pipeline crossing sites. Impacts on macrophytes at crossing locations will be highly localised and will not constitute a substantial impact on the aquatic environment at these locations. Aquatic flora would likely recolonise disturbance sites after pipeline installation is complete.

No threatened aquatic flora a species were recorded at the survey sites and none are anticipated to occur. Impacts on riparian vegetation (considering a worse case scenario of trenching all sites) were assessed in the terrestrial flora and fauna assessment (GHD 2010). No endangered riparian or aquatic ecological communities listed under the TSC or FM Acts occur at the crossing locations and no significant impacts on riparian vegetation or habitats are anticipated as a result of the Project (GHD 2010).

5.3.2 Aquatic Habitat

The GHD (2010) field survey confirmed that, although moderately degraded, the aquatic habitat of the Wollondilly River and associated creeks currently provide refuge, breeding and / or feeding areas for a range of aquatic fauna species and has varying condition from site to site (low to moderate). The survey sites support Class 3 - minimal or Class 2 - moderate fish habitat based on characteristics of the individual waterways (Fairfull and Witheridge 2003).

Development activities such as the removal of macrophytes, riparian vegetation and other associated habitat resources, and alterations to hydrological characteristics of crossing sites, have the potential to impact on these, and downstream, aquatic habitats of the Wollondilly River and associated creeks. These activities can result in potential impacts that cause the decline in habitat value through:

- Alterations to riparian and floodplain geomorphology;
- Alterations to hydrology;
- Reduced water quality (nutrient and sediment input); and
- Loss of in-stream and riparian habitat through construction and potentially increased erosion risks.

The major potential impacts to aquatic habitats are associated with sedimentation of the Wollondilly River and associated creeks through increased erosion risks and changes to water quality and flows. The potential for these impacts can be avoided or minimised through the implementation of appropriate mitigation measures as outlined in Section 6.

There is also the potential for proposed in-stream structures to alter flows and fish passage. As noted above, the proposed construction methods will be designed and located to minimise the potential to create a geomorphic or ecological barrier in the waterway and as such, impacts on the waterways following construction are likely to be minimal at most (see Section 5.1).

5.4 Impacts on Aquatic Fauna Species

A relatively low abundance and diversity of both native and introduced fish species, macroinvertebrates species and crustacean species was evident at the crossing locations. Potential impacts on these species will be generally low and primarily associated with habitat disturbance during the installation of the pipeline which will be highly localised and short term in nature. Native aquatic fauna would only be temporarily displaced and would likely recolonise the site after pipeline installation is complete. Flow diversions where required will be of short duration (generally 1-2 days and up to 4 days maximum) and downstream flows will be maintained. Appropriate sediment control measures will be implemented to minimise the potential for the release of sediment downstream during and following construction activities. There are unlikely to be any major impacts associated with the operation of the pipeline due to its subterranean nature. The pipeline crossings will not impede flows following installation and adverse impacts on fish passage are not anticipated as a result of the project (see Section 5.1).

Given the existing disturbance at the proposed crossing locations, the highly localised and short term nature of the impacts the proposed watercourse crossings are considered highly unlikely to threaten the persistence of any aquatic fauna species in the study area.

5.5 Key Threatening Processes

The proposed activity has the potential to contribute to several KTPs at the proposed creek crossing locations. Relevant KTPs and mitigation measures to avoid or minimise impacts are discussed below.

5.5.1 Degradation of Native Riparian Vegetation

Impacts on riparian vegetation have been assessed in the terrestrial flora and fauna assessment (GHD 2010) and will not be of a magnitude to contribute to the degradation of watercourses in the study area. The pipeline is mainly aligned along existing cleared easements, and will thus largely avoid impacts to riparian vegetation. Furthermore, in selecting appropriate crossing methods at particular sites, consideration has been given to minimising the requirement for clearing of riparian vegetation. In this respect, trenching was selected over underboring in some instances where the latter would have resulted in more extensive riparian vegetation loss given offset distances required from the existing gas pipeline and fibre optic easements and the necessity to move out of the cleared easement. It is possible that some small areas of riparian vegetation will be impacted by the trenching and/or anchoring of the pipeline, although in most cases this constitutes introduced species and would be of a very limited extent.

5.5.2 Installation and operation of Instream structures

Trenching of the existing gas pipeline and excessive backfilling at a number of sites has lead to the creation of a raised area through the run section restricting water flow and potentially fish passage during periods of base to low flow. Careful and appropriate installation of the pipeline at proposed crossings and reinstatement to maintain existing streambed morphology and flows will avoid the potential for similar impacts to arise as a result of the Project. Given the deeper water depth at proposed pipe laying crossings, the pipeline will not create a geomorphic or ecological barrier in the waterway and as such, impacts on flow and fish passage are not anticipated .

5.5.3 Removal of Large Woody Debris

As part of the project, large woody debris and snags may need to removed to allow trenching or anchoring works to proceed. Any large woody debris that is removed during the construction activities will be re-instated following the installation of the pipeline. No permanent impacts are considered likely.

5.6 Assessment of Likely Significance of Impacts

Section 3A of the EP&A Act requires an assessment of potential impacts of the Project on threatened species, populations or ecological communities listed under the FM and/or EPBC Acts. Potential impacts on threatened aquatic fauna are discussed below.

As noted previously, an assessment of the potential impacts of the proposed watercourse crossings on the Giant Dragonfly (a threatened invertebrate listed under the TSC Act) and riparian EECs listed under the TSC or FM Acts have been undertaken in the Ecological Assessment for the Project (GHD 2010). The assessment concluded that the project is not likely to have a significant impact on the Giant Dragonfly or endangered ecological communities listed under these Acts.

5.6.1 NSW Threatened Aquatic Fauna

Wildlife database searches revealed no records of threatened fish species in the locality of the crossing sites. However, the EPBC Act protected matters search tool indicated that suitable habitat may be present for the Macquarie Perch a threatened species listed under the TSC and EPBC Acts. The Macquarie Perch was not recorded during the fish sampling surveys. Sites W105 and W131 contain slow flowing deep pools and provide theoretically suitable habitat for this species. Although no specimens of this species were collected, the depth of these pools made survey efforts difficult and littoral habitat was surveyed only.

The Macquarie Perch has not been recorded from the sections of the waterways surveyed for this study and these areas are considered outside the known range of the species. It is known to occur in gorge country/rivers with bedrock dominated substrates (Bob Creese *pers*. *comm*. I&I NSW) and is reported in recreational fishing reports in the lower reaches of the Wollondilly River but also in Wingecarribee Dam (Dan Hartwell, Hawkesbury Nepean CMA, pers. comm., May 2010).

Given the above considerations, the Macquarie Perch is unlikely to occur in the watercourses to be impacted by the Project. Nevertheless, a conservative approach has been taken and a significance assessment in accordance with the Draft Part 3A threatened species assessment guidelines (DEC & DPI 2005) for this species has been prepared (see Appendix D). The Project would impact theoretically suitable habitat at two crossing sites where pipe laying and anchoring is proposed. The area of impact is small in comparison to available habitat, and impacts would be highly localised and temporary in nature. As a result of the deeper water depth at these crossing sites the proposed pipeline will not create a geomorphic or ecological barrier in the waterway and as such, impacts on flow and fish passage are not anticipated. On the basis of these considerations and given the Project is outside the currently known range of the Macquarie Perch a significant impact on the species or its habitat as a result of the Project is highly unlikely.

5.6.2 Commonwealth Threatened Aquatic Fauna

Wildlife database searches revealed no records of threatened fish species listed under the EPBC Act in the locality of the crossing sites. However, the EPBC Act protected matters search tool indicated that suitable habitat may be present for the Macquarie Perch and Australian Grayling.

The Macquarie Perch is listed as Endangered under the EPBC Act. A significance assessment according to the EPBC Act *Significant Impact Guidelines* (DEH 2009) is provided for this species in Appendix D. Whilst the Project would impact theoretically suitable habitat at two crossing sites, there is no evidence of this species presence and it is considered unlikely to occur based on its known occurrence and distribution (see above). In addition, the area of impact will be localised and small in comparison to available habitat, and impacts would be temporary in nature. On the basis of these considerations, the assessment concluded that a significant impact on this species or its habitat was unlikely (Appendix D).

The Australian Grayling is listed as Vulnerable under the EPBC Act. No evidence of this species was recorded during the sampling surveys but theoretically suitable habitat for this species (a clear, gravel-bottomed stream with alternating pools and riffle habitat) occurs at sites W52 and W106. The nearest known population of the Australian Grayling occurs in the eastward-flowing Shoalhaven River. According to the National Recovery Plan for this species (DSE 2008), important populations necessary to the long term survival and recovery of the species in NSW occur in the

Shoalhaven, Bega and Clyde Rivers. A population that may occur in the locality of the crossing sites is therefore not considered an important population. As the Australian Grayling needs to move between rivers and coastal seas to complete its life cycle, barriers block upstream migration, and can interfere with downstream migration, and can cause local extinction in the section of river upstream from the barrier. Given that the study area is upstream of Wingecarribee Dam, the Australian Grayling is unlikely to occur in the study area. No assessment of significance has been prepared, as no important population would be impacted, the species is unlikely to occur, and any impacts would be limited in area and temporary in nature.

6. Mitigation Measures

6.1 General

The management of adverse effects arising from the development has been presented according to the hierarchy of:

1. Avoidance;
2. Mitigation; and
3. Offsetting of impacts.

Potential impacts of the project on aquatic biota and their habitats are associated with direct habitat loss and modification during trenching and pipe laying and anchoring activities. Potential impacts of the project, will however, will be highly localised and temporary in nature and are not anticipated to result in any long-term adverse impacts on the aquatic environment following construction.

The watercourse crossings have been specifically designed to avoid and minimise impacts where possible and mitigation measures have been incorporated into the development design to minimise impacts on aquatic biota at the crossing sites and downstream environments.

6.2 Avoidance of Impacts

Direct impacts resulting from the proposed pipeline have been avoided to a large extent by aligning the proposed pipeline along an existing pipeline and fibre optic easement and hence locating proposed crossings in previously disturbed areas and avoiding the requirement for additional clearing of riparian vegetation. In addition, in selecting appropriate crossing methods at particular sites, clearing of riparian vegetation has been further avoided or minimised. In this respect, trenching was selected over underboring in some instances where the latter would have resulted in more extensive riparian vegetation loss given offset distances required from the existing gas pipeline and fibre optic easements and the necessity to move out of the cleared easement.

6.3 Mitigation of Impacts

The trenching or laying and anchoring of the pipeline will potentially impact upon habitat resources which support a range of native fauna, including fish, frogs, turtles and macroinvertebrates, including crustaceans. Mitigation measures are recommended below to minimise impacts to aquatic habitats and species at the proposed crossing sites and in habitats downstream. These recommendations should be included in the Construction Environmental Management Plan (CEMP) and Flora and Fauna Management Plan (FFMP) for the Project.

6.3.1 Timing of construction

The timing of construction can help to reduce the potential impacts, associated with the construction of the pipeline across the waterways, on aquatic flora and fauna species. Periods of drier conditions should be targeted for trenching activities to reduce:

- The length of time a crossing point is disturbed;
- The potential disturbance to migration movements of aquatic fauna species;

- The potential for flow driven adverse downstream impacts on aquatic flora and fauna species and habitat resources.

Specific measures include:

- Waterway crossings / trenching would be avoided during periods of heavy rainfall and flooding; and
- Contingency plans to address heavy rainfall and flood events during construction would be included in a CEMP. The contingency plan should address:
  - Limiting stormwater entering excavation areas;
  - Enhancement of controls when heavy rain is forecast;
  - Siting of facilities;
  - Clean up procedures;
  - A flood warning system for crossings on Major waterways; and
  - Procedures for limiting loss of spoil and other hazardous materials.

6.3.2 Minimise site disturbance

Actions to be taken to avoid site-based disturbance during the construction period would include:

- Minimising the width and effective footprint of works across waterways;
- Avoiding the need for access of heavy machinery to the bed of the waterways as works would be undertaken from the top of the banks where possible;
- Vehicles will cross waterways where there is an existing crossing within the construction easement. Alternatively, vehicles will approach the watercourse from either side for construction purposes;
- At W69, the existing ford will be likely be used as a crossing for vehicles during construction. It is recommended that the ford be upgraded through construction of a rock dissipation ramp with provision of rock bank protection immediately downstream of the ford to avoid the potential for ford failure leading to exposure of the pipe and channel instability.
- Using permeable, temporary paving (such as Ecoflex) for access across waterways if required; and
- Avoiding disturbance of surrounding banks by machinery or other construction works.

6.3.3 Stream flow maintenance

Stream flow diversion measures would be implemented during construction where high water volumes and flows are present and unavoidable. Construction should be undertaken during dry conditions to limit the requirement for flow diversion as far as possible. Diversions would be of as short duration as possible (4 days maximum) and downstream flows would be maintained.

As noted above, the proposed construction methods will be designed and located to minimise the potential to create a geomorphic or ecological barrier in the waterway and as such, impacts on the waterways following construction are likely to be minimal at most (see Section 5.1). At trenched crossings, reinstatement of the watercourse bed will be appropriately designed by a geomorphologist to return the existing condition and profile of the channel and minimise the

potential for sediment build up and obstruction of flows or fish passage post-construction. Given the water depth at proposed pipe laying and anchoring locations, the pipeline will not create a geomorphic or ecological barrier in the waterway and as such, impacts on the waterway following construction are likely to be minimal.

6.3.4 Aquatic fauna management

Where stream flow diversion is unavoidable, a trained aquatic ecologist should be present to arrange safe transfer of aquatic fauna to adjacent non-impacted areas of the waterway, if required.

6.3.5 Depth of pipeline at waterway crossings

When installing the pipeline

- Depending on depth to bedrock, provide a minimum of 1 metre from the top of the pipe to the bed of the channel for Moderate Creeks, Minor Creeks and Drainage Lines;
- Depending of depth to bedrock, provide a minimum of 2 m from the top of the pipe to the bed of the channel for Major Creeks; and
- For Valley Fill and Chain of Ponds systems, the minimum depth should be maintained across the entire width of the valley to reduce the risk of exposure of the pipe in the event a channel develops in the valley fill surfaces in the future.

6.3.6 Reinstate profile and stability

Rehabilitation actions to reinstate the creek profile and promote stability in disturbed waterways would include:

- Replace sediments in order they were removed;
- Reshape according to current profile;
- Design recommendations informed by the geotechnical investigation to address the potential for differential settlements in areas containing soft or compressible soil types.
- Reinstating bank soils over pipeline with a soil-rock mix (~100-300 mm), jute matting and re-grassing to reduce risk of bank erosion; and
- Reinstating bed and banks with rock in erosion sensitive areas to protect from bank erosion.

6.3.7 Erosion and sediment control measures

The following standard erosion and sediment control measures would be implemented during construction:

- Erosion and sediment control measures would be established prior to construction;
- Erosion and sediment control measures would be regularly inspected, particularly following rainfall events, to ensure their ongoing functionality;
- Riparian vegetation clearance would be avoided where possible to protect soils from erosion. If clearance cannot be avoided, the area of vegetation cleared at any one time should be minimised;
- Reinstatement of stabilised surfaces as quickly as practicable after construction;

- All stockpiled material would be stored in bunded areas and kept away from waterways and floodplains to avoid sediment entering the waterway;
- Diversion drains and bunds would be established during construction works to manage site runoff and minimise the transport of sediment from the construction site into the waterway; and
- Preferably a waterway would be crossed on a straight portion of the waterway to avoid the risk of erosion. Where this is not possible bank stability works should be implemented.

6.3.8 Surface water management

It is recommended that the CEMP include a 'Soil and Water Management Plan' for the subject site. Specific surface water management measures would need to be outlined in this plan to manage surface water from impacting upon aquatic habitats.

6.3.9 Soil management

Soil management should aim to ensure that topsoils are maintained in a form that will maintain their viability for regeneration of the site, minimise risks of erosion, sedimentation and the spread of environmental weeds to maintain the integrity of terrestrial habitats.

A Sediment and Erosion Plan will be incorporated in the CEMP and should contain detailed mitigation measures to reduce soil erosion and pollutant run-off during both construction and operation phases. These should include:

- Stockpile management measures which minimise the potential for erosion and surface water runoff;
- Construction and maintenance of silt fences to capture and isolate any surface water runoff; and
- Immediate removal offsite of excavated fill materials not required for backfilling.

6.3.10 Dust

Appropriate construction measures must be incorporated to minimise the generation of dust and associated impacts on adjacent natural environments. These are likely to include:

- Setting appropriate speed limits for construction traffic to limit dust generation;
- Applying water to stockpiles during windy conditions; and
- Applying water to internal haul roads during construction, where required.

6.3.11 Weed management

It is recommended that the following measures be adopted to manage environmental weeds during construction:

- Stockpiles of fill should be covered and any emerging weeds sprayed;
- Stockpiles of vegetation should not be placed in areas of adjoining remnant vegetation but instead within existing cleared areas;
- Progressive rehabilitation of disturbed vegetation to limit the potential for colonisation by weeds;
- Weed control should occur prior to construction;

- Monitor and control Noxious Weed species in line with legislative obligations; and
- Perform ongoing monitoring of weed infestations within and adjoining the site.

6.3.12 Operational management measures

Additional requirements may need to be addressed during the operational phase of the project in order to minimise the impact on the surface water environment: These would include:

- Monitoring of the downstream bed stability of the waterway where erosion has been identified as a key concern to ensure that mitigation is appropriate to protect the asset and prevent waterway degradation;
- The restriction of vehicles access during inspections in sensitive areas (*e.g.*, waterways) as much as possible; and
- All inspections portals, valves, *etc.* are not installed in the vicinity of the waterway crossings as they may be inundated during periods of high flow.

6.4 Offsetting of Impacts

Given the above consideration of potential impacts and proposed mitigation measures, it is considered unlikely that the development would result in any significant or residual impacts on native aquatic flora and fauna or their habitats or overall biodiversity values in the locality. As such, no specific offset is considered necessary to compensate for impacts to aquatic habitats or fauna as a result of the Project.

7. Conclusion

7.1 Summary of Key Findings

The scope of the current investigation included wildlife database and literature review as well as aquatic field surveys to assess the potential impacts of the proposed pipeline crossings of perennial watercourses on aquatic biodiversity values and in particular threatened fauna species and their habitats. Impact assessment was focussed on threatened aquatic fish listed under the FM and EPBC Acts given that the impacts on other potentially relevant threatened biota, including the Giant Dragonfly and riparian and aquatic EECs had been previously assessed in the Ecological Assessment for the Project (GHD 2010).

Survey techniques and effort expended included the following:

- Aquatic habitat assessments;
- Water quality assessments;
- Fish surveys; and
- AUSRIVAS sampling.

The EPBC Act Protected Matters search suggested that potential habitat for the Macquarie Perch (endangered under both the FM Act and the EPBC Act) and the Australian Grayling (Vulnerable under the EPBC Act may occur within the locality, although there are no records in the locality for these species.

The results of the riparian and aquatic flora surveys identified the presence of 22 aquatic flora species, of which approximately 22 % were introduced. No threatened aquatic flora species or EECs were recorded. The results of the aquatic fauna surveys identified a total of nine aquatic fauna species, of which approximately 33 % were introduced. No threatened or protected fauna species were encountered during the study.

Aquatic habitat at the sites assessed range from having low to moderate overall ecological values. All sites displayed mild to high degradation of riparian and aquatic vegetation and low aquatic species richness/diversity. The natural environment at each site is extensively modified by historical clearing, damming and ongoing sheep/horse grazing activities.

The proposed pipeline crossings are currently utilised by a variety of native and exotic aquatic flora and fauna species. Construction of the proposed crossings would involve highly localised and short term impacts on existing aquatic flora and fauna at the crossing sites. Adverse impacts on downstream habitats are not anticipated given proposed environmental management and mitigation measures to maintain flows and minimise disturbance and control sediment discharge during the construction phase. No modifications of flows or obstruction to fish passage are anticipated post construction given the appropriate design and location of the instream structures. Regarding long term impacts, development of, and adherence to, rehabilitation management plans would leave the sites in an acceptable state for recovery.

7.2 Key Thresholds

According to the DEC and DPI (2005) assessment guidelines for Part 3A projects, a justification of the preferred option based on the following key thresholds must be included.

Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts would maintain or improve biodiversity values.

Direct impacts resulting from the Project have been avoided to a large extent by aligning the proposed pipeline along an existing pipeline and fibre optic easement and hence locating proposed watercourse crossings in previously disturbed areas and avoiding the requirement for additional clearing of riparian vegetation. In addition, in selecting appropriate crossing methods at particular sites, clearing of riparian vegetation has been further avoided or minimised. Potential impacts on aquatic fauna and their habitats will be further avoided through the appropriate design of proposed crossings to ensure maintenance of flows and to avoid obstructing fish passage following construction. Trenching or laying and anchoring the pipeline would cause localised and temporary impacts to the benthic and aquatic environment of the waterways at the crossing sites. These impacts will be small in extent and short-term in nature and flora and fauna will be able to recolonise impacted areas following installation of the pipeline.

Appropriate environmental and impact mitigation measures will be implemented during construction to minimise the potential for adverse impacts at the crossing sites and in downstream habitats. Given the highly localised and short-term nature of potential impacts and the proposed mitigation measures, it is considered unlikely that the development would result in any significant or residual impacts on native aquatic flora and fauna or their habitats and existing biodiversity values will be maintained. As such, no specific offset is considered necessary to compensate for impacts to aquatic habitats or fauna as a result of the Project.

Whether or not the proposal is likely to reduce the long-term viability of a local population of any threatened species, population or ecological community.

No threatened species were recorded at any of the eight crossings, and whilst theoretically suitable habitat exists for the Macquarie Perch and Australian Grayling at some locations, these species are considered unlikely to occur based on an absence of records in the locality and known distributions. Trenching of the pipeline or pipe laying and anchoring at the subject crossing sites will involve only highly localised and short-term disturbance of the riparian and aquatic environment and is considered highly unlikely to reduce the long-term viability of any local population of threatened species even if present in the wider locality. Assessment of the significance of impacts on the Macquarie Perch (see Appendix D) concluded that the project is not likely to have a significant affect on this species or its habitat.

Whether or not the proposal is likely to accelerate the extinction of any species, population or ecological community or place it at risk of extinction.

Given the above considerations, the Project is unlikely to accelerate the extinction of any threatened biota, or place them at risk of extinction.

Whether or not the proposal will adversely affect critical habitat.

No listed critical habitat will be removed or adversely affected as a result of the Project.

7.3 EPBC Act Assessment

On the basis of the assessments undertaken, it is concluded that the proposed development is unlikely to impose a significant impact on the Macquarie Perch or Australian Grayling or any other threatened aquatic fauna species listed under the EPBC Act and hence is unlikely to constitute a controlled action with respect to these Matters of National Environmental Significance.

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Appendix A

Flora List

Flora species recorded within the survey corridor during the current surveys

Scientific name	Common Name	Observed							
		W52	W56	W69	W95	W105	W106	W119	W131
Alisma plantago-aquatica	Water Plantain	X							
Azolla filiculoides	Pacific Azolla					X			
Ceratophyllum demersum	Hornwort	X				X	X		X
Cyperus involucratus *	Umbrella Sedge			X					
Elatine gratioloides	Waterwort						X		
Eleocharis acuta	Common Spikerush						X		
Eleocharis sphacelata	Tall Spikerush								X
Elodea Canadensis *	Elodea								X
Isolepis fluitans	Floating Clubrush	X							
Juncus acutus *	Spiny Rush							X	
Juncus usitatus	Common rush						X		
Lemna spp.	Duckweed					X			
Myriophyllum spp.	Water milfoil	X							
Myriophyllum Papillosum	Common Watermilfoil			X					
Nymphoides indica	Water Snowflake								X
Potamogeton crispus	Curly Pondweed						X		
Salix babylonica *	Weeping Willow					X		X	
Schoenoplectus validus	River/Great Clubrush		X	X					
Triglochlin procerum	Water Ribbons	X		X			X		X
Typha domingensis	Cumbingi		X		X	X			
Urochloa mutica *	Para Grass	X	X				X		
Vallisneria nana	Ribbonweed	X		X			X		

* Introduced species

Appendix B

Fauna Species List

Fauna species recorded during current surveys (GHD 2009)

Scientific name	Common Name	Collected							
		W52	W56	W69	W95	W105	W106	W119	W131
Invertebrates									
Cherax spp	Freshwater Crayfish	X		X	X		X		X
Parataya spp	Freshwater Shrimp	X		X				X	X
Fish									
Crassius auratus *	Goldfish			X					
Emydura macquarii	Freshwater Turtle			X			X	X	
Gambusia holbrookii *	Mosquitofish	X				X	X	X	
Gobiomorphus coxii	Cox's Gudgeon	X	X			X	X	X	X
Hypseleotris galii	Firetail Gudgeon	X		X					
Perca fluviatilis *	Redfin Perch						X		
Retropinna semoni	Australian Smelt	X		X			X		
Frogs									
Lymnodynastes peroni	Striped Marsh Frog		X	X					

* Introduced species

Appendix C

Aquatic Habitat Assessments

	W131	W119	W106	W105
General				
Valley shape	shallow	broad	steep	asymmetrical
Local impacts on streams	Grazing, human access	Grazing, cropping, human access 4WD crossing	Grazing, human access	Grazing, human access
Floodplain features	Flood channel	Flood channel	Flood channel	Flood channel
Local landuse – Left bank	Grazing	Human access	Grazing	Grazing
Local landuse – Right bank	Grazing, rural residential	Cropping (irrigated), human access	Grazing	Grazing
Riparian zone composition (% cover)				
Trees (>10m in height)	10	0	0	40
Trees (<10m in height)	30	70	10	10
Shrubs	5	20	10	0
Grasses/ferns/sedges	40	10	80	50
% Native	70	80	90	40
% Exotic	30	20	10	60
Shading of channel	6-25	6-25	<5%	6-25%
Extent of trailing bank vegetation	Slight	Moderate	Moderate	Moderate
Longitudinal extent of riparian vegetation (L/R)	Occasional clumps / occasional clumps	Occasional clumps / isolated-scattered	Regularly spaced / regularly spaced	Semi-continuous / semi continuous
Regeneration of native woody vegetation	Very limited	Very limited	Very limited	Very limited

Overall vegetation disturbance rating	Very high disturbance	Very high disturbance	Very high disturbance	High disturbance
Channel Composition				
Physical barriers to local fish passage (base flow)	No passage	Very restricted passage	Moderately restricted	Good passage
Type of bars	Absent	Absent	Absent	Absent
Extent of bars (%) of streambed	0	0	0	0
Dominant sediment particle size on bars	n/a	n/a	n/a	n/a
Channel modifications	Weir pool	None	None	none
Channel shape	Flat U-shaped	Flat U-shaped	U-shaped	Deepened U-shape
Bank shape – left bank	Convex	Concave	Concave	Convex
Bank shape – right bank	Convex	Concave	Concave	Concave
Bank slope (L/R)	Low / low	Low / low	Low / low	Moderate / moderate
Factors affecting bank stability	Cleared vegetation, stock access, human access	Cleared vegetation, human access	Cleared vegetation, human access	Stock access, human access
Bedrock outcrops	None	None	None	None
Artificial bank protection measures	None	None	None	None
Artificial features at sampling site	Concrete slab (10 m) set into left bank	Infilling from previous works (gas pipeline), 4WD crossing	None	None
Large woody debris (%)	5	20	0	60

Extent of bed form features	Pool (100%)	Pool (100%)	Riffle (60%) Pool (40%)	Pool (100%)
Bed compaction	Low	Low	Low	Low
Sediment matrix	Framework dilated (32-60% fine sediment, low availability of interstitial spaces)	Framework dilated	Framework dilated	Framework dilated
Sediment angularity	Sub-angular	Sub-angular	Sub-angular	Sub-angular
Water Quality (visual assessment)				
Sediment oils	Light	Light	Absent	Absent
Water oils	Flecks	Globs	None	None
Sediment odours	Anaerobic	Anaerobic	Anaerobic	Anaerobic
Water odours	Normal / none	Normal / none	Normal / none	Normal / none
Turbidity (source)	Slight (dissolved material)	Turbid (dissolved material)	Clear	Slight (dissolved material)
Water Level	No flow	No flow	Base flow, or near base flow	No flow
Macrophyte composition (%)				
Overall % cover	30	15	95	70
Emergent	15	15	65	10
Submerged	10	0	0	30
Floating	5	0	30	30
Aquatic Habitat Assessment (Poor, fair, good or excellent)				
Epifaunal substrate / available cover	Good	Fair	Good	Good
Pool substrate characterization	Good	Fair	Good	Good
Pool variability	Fair	Fair	Excellent	Good

Sediment deposition	Fair	Fair	Fair	Fair to good
Channel flow	Fair to good	Fair	Good	Excellent
Channel alteration	Fair	Fair	Good	Fair to good
Channel sinuosity	Poor	Fair	Good	Poor
Bank stability (L/R)	Fair / fair	Fair / fair	Good / good	Fair / fair
Vegetative protection (L/R)	Good / fair	Fair / fair	Good / good	Fair / fair
Riparian zone width (L/R)	Fair / poor	Fair / poor	Poor / fair	Fair / fair

	W95	**W69**	**W56**	**W52**
General				
Valley shape	Steep	Shallow	Broad	Shallow
Local impacts on streams	Grazing, 4WD crossing	Grazing, 4WD crossing	Grazing, infilled gas pipeline works	Grazing, infilled gas pipeline works
Floodplain features	Flood channel	Flood channel	Flood channel	Flood channel
Local landuse – Left bank	Native forest / grassland	Native forest / grassland	Grazing	Native forest
Local landuse – Right bank	Native forest / grassland	Native forest / grassland	Cropped (irrigated)	Grazing
Riparian zone composition (%)				
Trees (>10m in height)	80	80	60	40
Trees (<10m in height)	15	5	10	10
Shrubs	1	0	2	40
Grasses/ferns/sedges	4	15	28	10
% Native	90	90	90	60
% Exotic	10	10	10	40

Shading of channel (%)	6-25	6-25	<5	26-50
Extent of trailing bank vegetation	Slight	Moderate	Moderate	Extensive
Longitudinal extent of riparian vegetation (L/R)	Occasional clumps / semi continuous	Semi continuous / occasional clumps	Semi continuous / semi continuous	Semi continuous / semi continuous
Regeneration of native woody vegetation	Present	Present	Very limited	Present
Overall vegetation disturbance rating	High disturbance	Moderate disturbance	High disturbance	High disturbance
Channel Composition				
Physical barriers to local fish passage (base flow)	No passage	No passage	No passage	Moderately restricted passage
Type of bars	absent	Unvegetated side points/bars and mid-channel bars	Absent	Absent
Extent of bars (%) of streambed	0	30	0	0
Dominant sediment particle size on bars	n/a	Sand	n/a	n/a
Channel modifications	None	None	None	None
Channel shape	Deepened U-shape	Flat U-shaped	Flat U-shaped	Trapezoid
Bank shape – left bank	Concave	Convex	Concave	Concave
Bank shape – right bank	Concave	Concave	Concave	Convex
Bank slope (L/R)	Moderate / moderate	Moderate / moderate	Low / low	Low / low

Factors affecting bank stability	Human access	Human access	Stock access, human access	Stock access, human access
Bedrock outcrops	None	None	None	None
Artificial bank protection measures	None	None	None	None
Artificial features at sampling site	None	Infilled 4WD access track	Infilled	Infilled post trenched gas pipeline
Large woody debris (%)	0	30	1	2
Extent of bed form features	Pool (100%)	Pool (85%) Run (15%)	Pool (100%)	Riffle (30%) Run (60%) Pool (10%)
Bed compaction	Low	Low	Low	Low
Sediment matrix	Framework dilated	Matrix dominated (>60% fine sediment, interstitial spaces virtually absent.	Matrix dominated	Framework dilated
Sediment angularity	Sub -angular	Cobble, pebble and gravel fractions not present.	Cobble, pebble and gravel fractions not present.	Sub -angular
Water Quality (visual assessment)				
Sediment oils	Absent	Absent	Absent	Absent
Water oils	None	Flecks	None	isolated sheen
Sediment odours	Normal / none	Anaerobic	Anaerobic	Normal / none
Water odours	None	None	Normal / none	Normal / none
Turbidity	Slight (dissolved material)	Slight (dissolved material)	Turbid (dissolved material)	Clear
Water Level	No flow	No flow	Baseflow	Baseflow

Macrophyte composition (%)				
Overall % cover	40	20	90	70
Emergent	40	20	88	2
Submerged	0	0	0	0
Floating	0	0	2	98
Aquatic Habitat Assessment (Poor, fair, good or excellent)				
Epifaunal substrate / available cover	Fair	Poor	Fair to good	Excellent
Pool substrate characterization	Fair to good	Fair	Fair to good	Good to excellent
Pool variability	Poor	Fair	Fair	Good to excellent
Sediment deposition	Fair	Fair	Fair	Good to excellent
Channel flow	Poor	Poor	Fair	Good to excellent
Channel alteration	Fair	Good	Good	Good to excellent
Channel sinuosity	Fair	Good	Fair to good	Good
Bank stability (L/R)	Fair / fair	Fair / poor	Good / good	Good to excellent / good to excellent
Vegetative protection (L/R)	Fair / fair	Fair / fair	Good / good	Good / good
Riparian zone width (L/R)	Fair / fair	Poor / poor	Fair / fair	Excellent / fair

Appendix D

Assessments of Significance

Part 3A Assessment of Impacts for Macquarie Perch

Criteria	Macquarie Perch
i) How is the project likely to affect the lifecycle of a threatened species and/or population?	
a) displaces or disturbs threatened species and/or populations;	The Macquarie Perch was not recorded during the field surveys and the sections of watercourses to be impacted by the are located outside the known range of this species. As such the Project is highly unlikely to displace or disturb individua species. Theoretically suitable habitat for the Macquarie Perch was recorded at sites W105 and W131 which displayed slow flowi pool characteristics. The proposed pipeline will be laid and anchored to the substrate at these crossing locations and inst of the pipeline (via bottom-pulling techniques) will only take 1 day. This disturbance would be highly localised and short-t would not substantially displace or disturb individuals so as to affect the lifecycle of a threatened species even if present.
b) disrupts breeding cycle;	The Macquarie Perch was not recorded during the field surveys and the sections of watercourses to be impacted by the are located outside the known range of this species. Mitigation measures will be implemented to minimise the potential fo adverse impacts on fish habitats downstream of the construction sites. Given these considerations, the Project is highly u to disrupt the breeding cycle of this species.
c) disturbs the dormancy period;	Not relevant to Macquarie Perch.
d) disrupts roosting behaviour;	Not relevant to Macquarie Perch
e) changes foraging behaviour;	The Macquarie Perch was not recorded during the field surveys and the sections of watercourses to be impacted by the are located outside the known range of this species. Impacts will be highly localised and temporary at crossing sites and measures will be implemented to minimise the potential for adverse impacts on fish habitats downstream of the construc as a result of sediment discharge. Given these considerations, the Project is highly unlikely to disrupt the foraging behav individuals of this species.

f) disrupts pollination cycle; g) disturbs seedbanks; or h) disrupts recruitment (i.e. germination and establishment of plants);	Not relevant to this species.
i) affects the interaction between threatened species and other species in the community (eg. Pollinators, host species, micorrhizal associations).	Not relevant to this species.
j) affects migration and dispersal ability;	The Macquarie Perch was not recorded during the field surveys and the sections of watercourses to be impacted by the are located outside the known range of this species. Consequently, the Project is highly unlikely to affect the migration a dispersal ability of this species. The pipeline will be laid and anchored at the two crossing sites that have been identified constituting theoretically suitable habitat for this species and no flow diversion will be required. Given the depth of water sites, the pipeline will not obstruct flows or create a barrier to the movement of fish species. As such, the Project is highl to affect the migration and dispersal ability of the Macquarie Perch even if present.
ii) How is the project likely to affect the habitat of a threatened species, population or ecological community?	
a) disturbs any permanent, semi permanent or ephemeral water bodies;	The Macquarie Perch was not recorded during the field surveys and the sections of watercourses to be impacted by the are located outside the known range of this species. As such, the proposed crossings do not constitute known habitat fo species. The pipeline crossing construction will involve localised and temporary impacts on a number of perennial waterways at p crossing sites. The pipeline will be laid and anchored at the two crossing sites that have been identified as constituting theoretically suitable habitat for the Macquarie Perch and no flow diversion will be required. Given the depth of water at t sites, the pipeline will not obstruct flows or create a barrier to the movement of fish species. Appropriate mitigation meas be implemented to minimise the potential for adverse impacts on downstream habitats as a result of erosion and sedime discharge. As such, the Project is highly unlikely to disturb any permanent water body that provides habitat for the Macq Perch even if present.

b) degrades soil quality;	NA
c) clears or modifies native vegetation;	The Macquarie Perch was not recorded during the field surveys and the sections of watercourses to be impacted by the are located outside the known range of this species. As such, the proposed crossings do not constitute known habitat fo species. Construction of the proposed pipeline will require the permanent removal of negligible areas of riparian vegetation, as we temporary disturbance of instream vegetation at proposed crossing sites. The proposed clearing or modification of native vegetation is unlikely to have a significant negative effect on the habitats at the proposed crossing locations.
d) introduces weeds, vermin or feral species or provides conditions for them to increase and/or spread;	Moderate to severe weed infestations occurred near some drainage lines. Construction vehicles have the potential to intr new weeds, including aquatic weeds. Mitigation measures, such as vehicle wash downs, are recommended to limit the introduction of weeds. In this context, construction activities are unlikely to introduce or encourage the spread of weeds i locality. Three species of introduced fish were recorded across the study area. The project is not likely to lead to the introduction fish to any streams or rivers.
e) removes or disturbs key habitat features such as trees with hollows, caves and rock crevices, foraging habitat;	The Macquarie Perch was not recorded during the field surveys and the sections of watercourses to be impacted by the are located outside the known range of this species. As such, the proposed crossings do not constitute known habitat fo species. The placement of the pipeline in the two areas of theoretically suitable habitat will involve temporary removal or disturban large woody debris, rocks and instream vegetation. The areas of disturbance would be small in relation to the available surrounding habitat, and disturbance will be temporary in nature, with any logs etc removed relocated in areas of adjoinin habitat.
f) affects natural revegetation and recolonisation of existing species following disturbance.	The Macquarie Perch was not recorded during the field surveys and the sections of watercourses to be impacted by the are located outside the known range of this species. As such, the proposed crossings do not constitute known habitat fo species. Disturbance at the two crossing sites that provide theoretically suitable habitat for this species would be highly localised a temporary in nature. A small area of in-stream vegetation may be removed under the pipeline but aquatic vegetation wou able to recolonise any surrounding disturbed areas following installation of the pipeline.

iii) Does the project affect any threatened species or populations that are at the limit of its known distribution?	The natural range of the Macquarie Perch includes the cooler upper reaches of the southern tributaries of the Murray-Da system, and the east flowing waterways in the Hawkesbury and Shoalhaven River catchments. The Macquarie Perch wa recorded during the field surveys and the sections of watercourses to be impacted by the Project are located outside the range of this species.
iv) How is the project likely to affect current disturbance regimes?	
a) modifies the intensity and frequency of fires;	The Project is not predicted to directly affect the intensity and frequency of fires.
b) modifies flooding flows;	The Project is not predicted to directly modify flooding flows.
v) How is the project likely to affect habitat connectivity?	
a) creates a barrier to fauna movement;	The Macquarie Perch was not recorded during the field surveys and the sections of watercourses to be impacted by the are located outside the known range of this species. The pipeline will be laid and anchored at the two crossing sites that been identified as constituting theoretically suitable habitat for this species and no flow diversion will be required. Given t of water at these sites, the pipeline will not obstruct flows or create a barrier to the movement of fish species. As such, th is highly unlikely to affect the migration and dispersal ability of the Macquarie Perch even if present.
b) removes remnant vegetation or wildlife corridors; and	Not relevant for this species.
c) modifies remnant vegetation or wildlife corridors.	Not relevant for this species
iv) How is the project likely to affect critical habitat?	There is no listed critical habitat that will be impacted of relevance to this species.

Conclusion	The Macquarie Perch has not been recorded in the waterways in the locality of the proposed crossing sites. The subject crossings are on sections of watercourses outside of the species currently known range with the nearest records from th reaches of the Wollondilly River and Wingecarribee Reservoir. The Project would temporarily affect a very small area of theoretically suitable habitat for this species at crossings W105 and W131 and would be highly unlikely to adversely impa lifecycle of this species even if it was present at these locations. On the basis of the above considerations the Project is n to have a significant negative effect on a local population of this species.

EPBC Act Assessment of Significance of Impact– Macquarie Perch

Macquarie Perch is listed as an endangered species under the EPBC Act.

Critically endangered and endangered species significant impact criteria

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it would:

Lead to a long-term decrease in the size of a population

The Macquarie Perch was not recorded in the watercourses in the locality of the proposed crossings, and no previous records exist in the locality. The sections of watercourses of relevance for the Project are located outside the known range of this species and it is considered unlikely to occur. The project would impact theoretically suitable habitat at two crossing sites - W105 and W131. The area of impact is small in comparison to available habitat, and impacts would be temporary. A population of this species if present is unlikely to decrease over the long-term as a result of the proposed works.

Reduce the area of occupancy of the species

The natural range of the Macquarie Perch includes the cooler upper reaches of the southern tributaries of the Murray-Darling river system, and the east flowing waterways in the Hawkesbury and Shoalhaven River catchments (DEWHA 2010). This species has been recorded in gorge country in the lower reaches of the Wollondilly River a long way downstream of the Project study area and is not known from the sections of the watercourses to be impacted by the proposed crossings. Given these considerations the proposed crossings are highly unlikely to reduce the area of occupancy of the species.

Fragment an existing population into two or more populations

No populations of the Macquarie Perch are known to exist in the sections of the watercourses to be impacted by proposed crossings. Known populations occur much further downstream in the lower reaches of the Wollondilly River and the Project will not fragment any existing population.

The pipeline will be laid and anchored at the two crossing sites that have been identified as constituting theoretically suitable habitat for this species and no flow diversion will be required. Given the depth of water at these sites, the pipeline will not obstruct flows or create a barrier to the movement of fish species. As such, the Project is highly unlikely to affect the migration and dispersal ability of the Macquarie Perch even if present.

Adversely affect habitat critical to the survival of a species

No critical habitat listed under legislation for this species will be impacted by the Project. The watercourses to be impacted by the proposed crossings do not constitute known habitat for this species and the project is unlikely to impact the survival of the species.

Disrupt the breeding cycle of a population

The Macquarie Perch was not recorded in the watercourses in the locality of the proposed crossings, and no previous records exist in the locality. The sections of watercourses of relevance for the Project are located outside the known range of this species and do not constitute known habitat for this species. The project would impact theoretically suitable habitat at two crossing sites - W105 and W131. The area of impact is small in comparison to available habitat, and impacts would be temporary in nature. A population of this species if present is highly unlikely to decrease over the long-term as a result of the proposed works.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Macquarie Perch was not recorded in the watercourses in the locality of the proposed crossings, and no previous records exist in the locality. The sections of watercourses of relevance for the Project are located outside the known range of this species and do not constitute known habitat for this species. The construction of crossings on watercourses that provide theoretically suitable habitat (W105 and W131) will not involve flow diversion and the pipeline will not impede flows or obstruct flows or fish passage following construction. Appropriate mitigation measures will be implemented to minimise the potential for habitat disturbance at the crossing site and for adverse impacts on habitats downstream as a result of erosion and sediment discharge. On the basis of these considerations, the Project is unlikely to significantly modify, isolate, or decrease the availability or quality of habitat for the Macquarie Perch to the extent that the species is likely to further decline.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

Three species of introduced fish were recorded across the study area: Goldfish, Redfin Perch and Mosquitofish. The project is not likely to lead to an invasive species becoming further established within the habitat of this species.

Introduce disease that may cause the species to decline

Alien fish are likely to be the carriers of a number of diseases and parasites. The viral disease Epizootic Haematopoietic Necrosis Virus has been responsible for the death of large numbers of Redfin Perch. There is evidence that Macquarie Perch is also highly susceptible to the virus, and the virus may have been partly responsible for the rapid decline of a number of populations. Goldfish and Mosquitofish are implicated as the source of the introduced tapeworm *Bothriocephalus acheilognathi*, which has been recorded in native fish species (DEWHA 2010). These three alien fish were recorded in the study area, however the project is not likely to result in the further introduction ore establishment of alien fish and their associated diseases that would cause the Macquarie Perch to decline.

Interfere with the recovery of the species

A Recovery Plan has not yet been published for the Macquarie Perch, however habitat protection and enhancement is a particular concern (DEWHA 2010). NSW DPI (2005) lists a number of priority recovery actions for the management of the Macquarie Perch. Of potential relevance to the project is the prevention of hydrological degradation.

The watercourses to be impacted by the proposed crossings are outside the known range of the Macquarie Perch and do not constitute known habitat for this species. Consequently, the project is unlikely to adversely impact the lifecycle and survival of the Macquarie Perch or interfere with the recovery of the species. The proposed crossings have been designed to minimise the potential for adverse impacts on the subject watercourses and are highly unlikely to result in adverse impacts on habitats for fish or other aquatic fauna at the crossing locations or habitats downstream.

Conclusion

Consideration of the above assessment criteria concludes that the Project is unlikely to have a significant impact on the Macquarie Perch which is listed as endangered under the EPBC Act.

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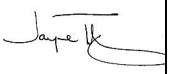
0	A. Dunlop S. Lukies	I. Campbell	*Ian Campbell*	Jayne Tipping		01/06/10
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