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Goulburn Mulwaree Council

Highlands Source Project

Surface Water Quality Assessment

February 2010

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

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Glossary of Terms

Bund	An impervious embankment of earth or a brick wall, which may form part or all of the perimeter of a compound that is provided to retain liquid.
Chainage	The chainage at a location along a pipeline is the distance of that point in relation to the start of the pipeline based on 0.000 kilometres being located at the off-take at Wingecarribee Reservoir.
Concept design	Initial functional layout of a concept, such as for the proposed duplication, to provide a level of understanding to later establish detailed design parameters.
Consent	Approval to undertake a development received from the consent authority.
Construction Environmental Management Plan	A document setting out the management, control and monitoring measures to be implemented during construction of a development, to avoid or minimise the potential environmental impacts identified during an environmental impact assessment process.
Cut	An excavation for constructing below the natural ground level.
Cut and fill balance	Difference between earthwork cut and fill volumes.
Cut batters	The side slopes of cuttings.
Detailed design stage	The stage at which the project design is detailed on the basis of an approved concept design.
Director-General's Requirements	Requirements for an environmental assessment issued by the Director-General of the NSW Department of Planning in accordance with the *Environment Planning and Assessment Act 1979*.
Emission	The release of material into the surroundings (for example, gas, noise, water).
Erosion	A natural process where wind or water detaches a soil particle and provides energy to move the particle.
Fill	Earth used to construct an embankment.
Geotechnical	A discipline of engineering associated with studying the ground and its geology.
Gradient	The degree of ascent or descent with a uniform slope.
Groundwater	Subsurface water stored in pores of soil or rocks.
Hydrology	The study of rainfall and surface water run-off processes.
Mitigation	Reduction in severity.
Operation Environmental Management Plan	A document setting out the management, control and monitoring measures to be implemented during operation of a development, to avoid or minimise the potential environmental impacts identified during an environmental impact assessment process.

Option	A concept design alternative developed for consideration.
Plant	Construction machinery, vehicles or equipment needed to carry out mechanical or construction activities.
Proponent	Goulburn Mulwaree Council (GMC).
Project	Refers to the proposed Highlands Source Project. Broadly, the Project comprises of a proposed pipeline *ca.* 83 km in length to deliver water from the Wingecarribee Reservoir to the City of Goulburn in NSW.
Sediment	Material of varying sizes that has been or is being moved from its site of origin by the action of wind, water or gravity.
Site compound	Area enclosing construction machinery, stockpiles and site offices usually adjacent to construction sites.
Spoil	Excess of rock and/or earth material resulting from construction activities.
Study area	The study area for this project is defined as described in Section 1 of this document.

Acronyms & Abbreviations

ANZECC	Australian and New Zealand Environment and Conservation Council
bgl	below ground level
BOM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
CMA	Catchment Management Authority
DECC	Department of Environment and Climate Change
DECCW	Department of Environment, Climate Change and Water
DGR(s)	Director-General's Requirement(s)
DICL	ductile iron cement mortar lined (pipe)
DoP	Department of Planning
DWE	Department of Water and Energy
EP&A Act	*Environment Planning and Assessment Act 1979*
GMC	Goulburn Mulwaree Council
HSP	Highlands Source Project
LGA	Local Government Area
NHMRC	National Health and Medical Research Council
NSW	New South Wales
OEMP	Operation Environmental Management Plan
SCA	Sydney Catchment Authority
WSC	Wingecarribee Shire Council
WTP	Water Treatment Plant

Units

cfu	Colony forming units
d	Days
g	Grams
ha	Hectares
Hu	Hazen units
kL	Kilolitres
km	Kilometres
L	Litres
m	Metres
mg	Milligrams
mL	Millilitres
ML	Megalitres
mm	Millimetres
NTU	Nephelometric Turbidity Units
ppm	Parts per million

1. Introduction

1.1 Background

Goulburn has faced severe drought and water restrictions since 2002. By mid 2007 Goulburn had critically low reserves of water. Goulburn Mulwaree Council (GMC), in conjunction with a State Government Task Force, identified an Emergency Pipeline from Wingecarribee Reservoir as the best means of overcoming the emergency and drought proofing Goulburn for the future (GMC & DoC, 2007). Subsequent rains in June 2007 removed the emergency aspect of the project; however the need for improved water security remains.

Since 2007, a range of options for securing Goulburn's water supply have been investigated. GMC has prepared an Integrated Water Cycle Management (IWCM) Strategy that outlines actions for improving long term water sustainability. The Highlands Source Project ('the Project'), which would involve piping water from the Wingecarrbee Reservir to Goulburn's water supply, is an integral part of this Strategy. Additionally, GMC has undertaken a Goulburn Water Supply Strategy Review, in which the Project was identified as the best solution for improving the city's water security.

1.2 Project overview

The Project comprises a trunk water main and ancillary infrastructure, extending from Wingecarribee Reservoir within the Wingecarribee Local Government Area (LGA), to the Goulburn Water Treatment Plant (WTP) within the Goulburn Mulwaree LGA. The Wingecarribee LGA is located in the Southern Highlands and centred approximately 150 km south of Sydney.

The pipeline would deliver a flow of 5 ML/d (over a 22 hour period) with the potential to increase the flow to 7.5 ML/d in the future (perhaps in 15 to 20 years time) to accommodate potential growth in demand. The mode of operation of the system, whether it would be continuous or intermittent, would be determined during detailed design.

The pipeline easement would be constructed predominantly adjacent to existing infrastructure easements. The easement would traverse mostly rural land and would cross various waterways, existing services, and road and rail infrastructure.

There are two water transfer schemes under consideration. Only one transfer scheme however would be constructed. The schemes under consideration are:

- Raw water transfer scheme, which would involve transferring raw (untreated) water from the Wingecarribee Reservoir to the Goulburn Water Treatment Plant (WTP); and
- Treated water transfer scheme, which would involve transferring treated water from the Wingecarribee WTP to a reservoir at Governor's Hill (east of Goulburn) or directly into the town water supply system.

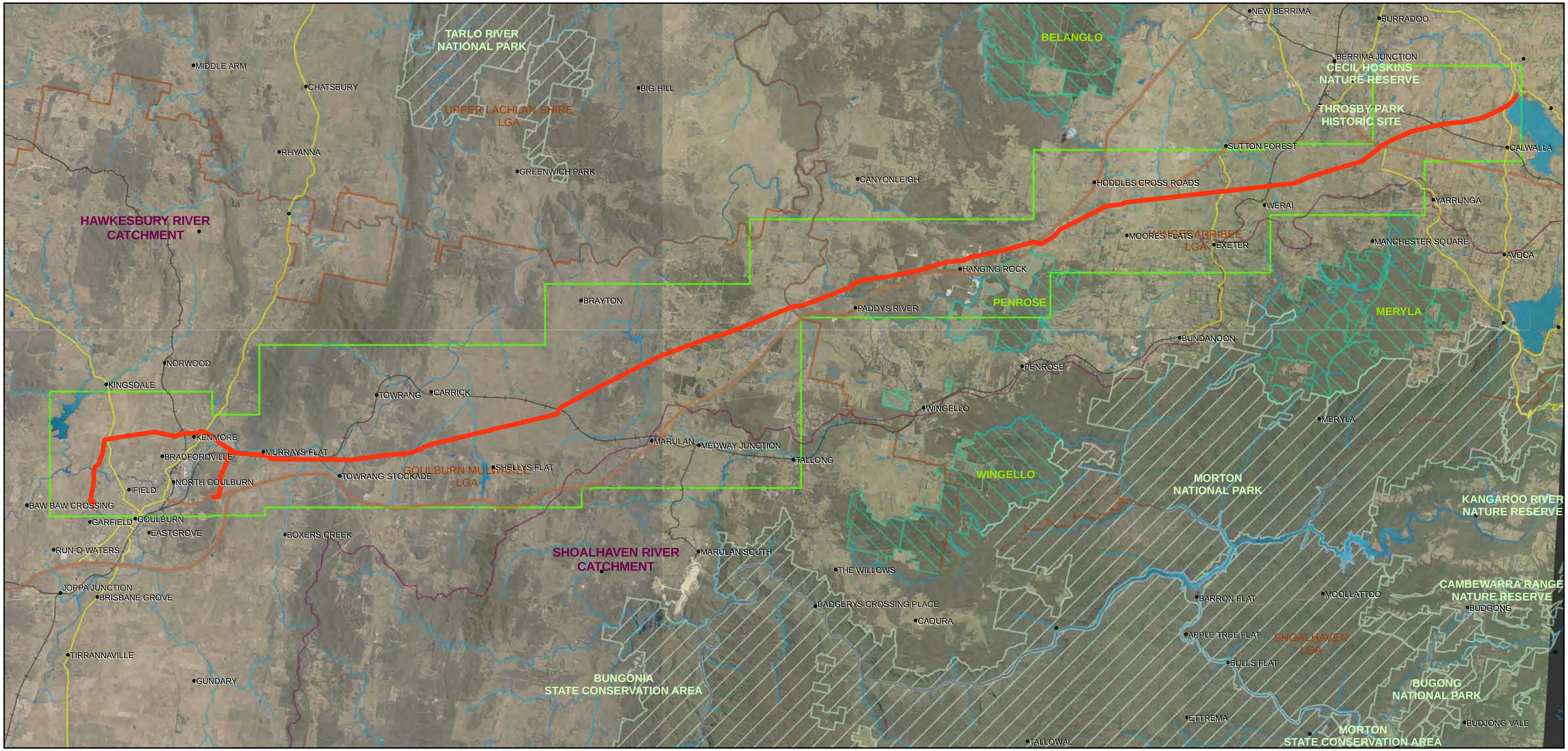
The scheme comprises approximately 83 km of DN 300 mm and DN 375 mm diameter pipeline, a pump station at the Wingecarribee Reservoir, power and controls and a telemetry system. The study area of the Project is provided at Figure 1. It is proposed to have the transfer scheme operational by June 2011. The Project's timeframe is set by the conditions governing the provision of government funding under the Australian Government Water Smart Australia Program.

1.3 Objectives of this report

As part of the approval process for the Project, an Environmental Assessment is required as outlined under Part 3A of the *Environmental Planning and Approval Act 1979* (EP&A Act)[1]. This report documents the scope, methods and outcomes of a surface water quality impact assessment that was undertaken in support of the overall Environmental Assessment, with the objective of:

- Assessing the potential impacts of the construction and operation of the Project on the surface water quality generally in the vicinity of the Project;
- Demonstrating specifically how the Project would be designed and managed to achieve a neutral or beneficial effect on water quality in the Sydney drinking water catchment consistent with the intention of the NSW *Drinking Water Catchments Regional Environmental Plan No. 1*; and
- Identifying and describing monitoring and actions that would be required to manage or mitigate the risks associated with those hydrology and surface water impacts. These were developed based on a consideration of the risk associated with the potential impacts on water quality (*i.e.* by conducting a risk assessment).

[1] Department of Planning Reference D07/1829



Legend

Proposed Pipeline Alignment	Locality	LGA Boundary
Study Area	PrimaryRoad	Lakes, Dams
	ArterialRoad	Reserve
	Railway	State Forest
	Rivers, Creeks	Catchment Boundary

1:200,000 (at A3)

0 2 4 6 8 10

Kilometres

N

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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Goulburn Mulwaree Council
Highlands Source Project

Study Area

Job Number	23-13312
Revision	0
Date	19 JAN 2010

Figure 1

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Data Source: NSW Lands Dept: Placepoint, roadsegments,railway,hydroarea,hydroline,npwreserve,stateforest - 2007; GMC: aerial imagery - 2008; NSW DECC: rbasin_polygon - 2008. Created by: ccharalambou

2. Project details

An overview of the Project was provided at Section 1.2. Further details, relevant to the assessment of water quality impacts, is provided below.

2.1 Key Project activities

Key *construction activities* would include:

- Constructing the water intake infrastructure at the Wingecarribee Reservoir site;
- Trench excavations and placement of the pipeline to the off-take point at Goulburn;
- Constructing railway, road, services and river crossings;
- Reinstatement/revegetation of the construction corridor; and
- Commissioning of the water transfer scheme.

Key *operational activities* would include:

- Pumping of water from the Wingecarribee Reservoir to Goulburn;
- Regular maintenance of the pumping station;
- Regular maintenance of the air and scour valves; and
- Periodic maintenance of the pipeline (*e.g.* pigging to remove blockages, or repairing leakages as required).

2.2 Pipeline route

The majority of the proposed pipeline route is located adjacent to existing subsurface infrastructure easements (for gas, electricity and optical fibre).

As described earlier, there are two water transfer schemes under consideration. Each proposed scheme has a different pipeline route at the Goulburn end of the pipeline. However the majority of the pipeline route is common to both schemes (Figure 1).

From the Wingecarribee Reservoir (chainage 0 km) the proposed pipeline route is located through cleared pasture. From chainage 9 km to 25 km, the proposed pipeline route is located immediately adjacent to an existing power line easement. From approximately chainage 25 km to chainage 70 km, it is located immediately adjacent to the existing Moomba to Sydney gas pipeline easement (on the easement’s southern side). From this point, the pipeline route differs depending on the proposed water transfer scheme. The pipeline route for the treated water transfer scheme runs south from the chainage 70 km to Governor’s Hill. The pipeline route for the raw water transfer scheme continues adjacent to the Moomba – Sydney gas pipeline to chainage 77 km, where it then runs south to the Goulburn Water Treatment Plant.

The raw water transfer scheme pipeline would be approximately 83 km long, while the pipeline for the treated water transfer scheme would be approximately 75 km long.

2.3 Pipeline infrastructure

The pipeline material is yet to be determined and a number of materials are currently being considered, including mild steel and glass reinforced polyester (GRP). A final decision on the pipe material used would not be made until the tender phase. As the construction methodology and associated impacts are essentially the same for each material, DICL has been selected for the purposes of this Environmental Assessment. The DICL, rubber ring jointed pipes would be located approximately 1.2 m below surface level.

Air valves, scour valves and divide valves would be located at regular intervals along the pipeline to provide air release and entry, and to allow cleaning of the pipeline. A summary of the key pipeline components is presented in Table 1.

Table 1 Key pipeline components and details

Component	Key data
Transfer pipeline	Nominal diameter – 300 mm and 375 mm Total length – approximately 83 km (raw water) and 75 km (treated water) Location – underground Trench depth – 1.5 m to 2 m Material – TBA (assumed to be ductile iron cement lined for the purpose of this Environmental Assessment) Coating – corrosion protection and polyethylene sleeving
Air valves, scour valves and other valves	Air valves would be used to exhaust air from the pipeline at high points. Scour valves would be used to release scour water from the pipeline at low points.
Connection/outlet points	The treated pipeline would connect into the existing Goulburn supply network at a new reservoir to be constructed at Governor's Hill. The raw water pipeline would be pumped to an existing tank located behind the Goulburn WTP.
Spoil generation	Approximately 150 000 m^3 of spoil, of which approximately half would be used as backfill material and the remainder to remediate the 20 m wide construction impact zone.
Supply of pipe	Pipes are expected to be delivered at a rate of approximately 24 pipes lengths per truck, with each pipe length 6 m long. This equates to approximately 510 deliveries over approximately a 6 month period.
Construction – work crews	4 crews (3 pipeline crews, 1 pump station & connections crew) 20 to 30 personnel per crew
Construction corridor	Typically up to 20 m wide construction corridor area directly adjacent to the existing gas pipeline easement. It is likely that this width would be reduced to less than 10 m or less where possible in specific areas where additional constraints exist or more or less width is required).
Pipeline easement	Likely to be a maximum of 10 m wide

2.4 Pipeline construction

2.4.1 Pipeline trenching and placement

The pipeline construction corridor would be a maximum of 20 m wide while the pipeline is being constructed. Preparation of the construction easement would include clearing of trees and vegetation where present and removal of topsoil and other obstacles such as rocks with a bulldozer. The proposed construction easement width would provide sufficient space to construct the trench while providing enough space for excavated material to be placed beside the trench, a trench safety area, pipes to be strung out beside the trench prior to installation and the movement of vehicles such as trucks, cranes and excavators beside the trench. Where specific obstacles such as large trees, endangered ecological communities and large boulders or significant landscapes are identified along the route, the construction corridor would be narrowed to less than 10 m wide.

Pipes would be stockpiled at 5 km to 10 km centres adjacent to an existing road or access that is suitable for a semi-trailer truck. The pipes would then be transported to the cleared construction corridor and would be strung out along the edge of the existing gas pipeline easement, thus acting as a barrier to construction activities entering the gas easement.

The pipeline trench would be approximately 1 m wide and excavated to a nominal depth of 1.5 m to 2.0 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 cannot be used for backfilling and alternative material, such as sand, would be used to backfill the trench.

The corrosive sleeve protection wrapped pipeline would be lifted into the trench using an excavator or crane. The pipeline segments would then be pushed together. Tipper trucks would be used to place backfill sand around the trench and to transport material to and from stockpile areas. Scour valves, air valves and divide valves would be constructed periodically along the pipeline which would involve installing pre-cast concrete components and some concrete pours where required.

2.5 Pipeline construction corridor, site compounds and stockpile areas

Site compounds, storage, stockpile and lay down areas would be required at various locations along the pipeline. The proposed locations of the facilities would generally be selected to occupy existing cleared areas or areas that would be cleared for the excavation of the pipeline trench.

2.5.1 Construction corridor

A 20 m wide (maximum) construction corridor would be required along the pipeline route to allow for trench excavation; equipment storage and movement of construction vehicles along the pipeline corridor; storage of topsoil, backfill and spoil; and bi-directional right of way access.

Clearing and grading would be minimised where practicable to the extent necessary for construction of the pipeline and would not exceed the 20 m construction corridor. The area that would be directly impacted upon by construction activities would range in width from 8 m to 20 m, depending on a range of factors that include occurrences of critical habitats for endangered species and communities, vegetation sensitivity and quality, constructability, construction management and safety considerations, land form, slopes and anticipated sub-soil structures. Direct impacts would be reduced as far as practicable with narrower construction corridors proposed where feasible. In some areas this may only require a 6 m to 8 m wide corridor (for short stretches). In areas of steep terrain (that impact on construction methodologies available and construction safety) and problematic sub-soil conditions, the impact area would be wider than 10 m, but would always be less than 20 m.

Access to land for the purposes of construction, rehabilitation and operation of the pipeline is the subject of discussions and negotiations between GMC and the landowners.

2.5.2 Main construction office and site compounds

Primary and secondary site compounds would be required for the construction phase of the Project. Primary compounds would predominately be used for site offices, amenities, storage of major plant and equipment and storage of materials. Primary compounds would be located in close proximity to major construction sites and would provide adequate access and sighting for the Project.

Secondary site compounds would be predominately used for storage of minor plant, equipment and materials. Nominal amenities may also be provided in these locations. Secondary site compounds would also be located in areas close to major construction works. However, the area of secondary site compounds would generally be smaller than primary site compounds.

Each site would be securely fenced with temporary fencing. All necessary signage advising the general public of access restrictions relevant to each site would be provided. These sites would be reinstated at completion of use.

Location of the site offices would be determined and arranged by the nominated Construction Contractor. Marulan is a central location that would likely be used, with other options including Goulburn, Moss Vale or Exeter. It is likely that some site offices would be established within or adjacent to the Wingecarribee Water Treatment Plant area. Being essentially a linear project, plant and equipment would be progressively advancing along the pipeline route rather than being located at one site for a long period of time; hence it is unlikely that there would be large groups of equipment in one location at any point in time.

The site compound will be located on previously leased, disturbed land,

2.5.3 Stockpile and spoil areas

Stockpile and spoil areas would be located within the 20 m wide construction impact zone. Excavated material from the trench would be stockpiled adjacent to the trench and used to backfill the area of the trench above the laid pipeline. Generally for this size pipeline (approximately 40 km of 375 mm diameter pipeline and 40 km of 300 mm diameter pipeline) it is found that the volume of excess material is relatively small as compared to the disturbed area required for construction, and is generally able to be used for reinstating the pipeline corridor. In this case it would equate to an approximate spread depth of less than 50 mm of excess material across the construction impact zone (20 m wide by 83 km long). Additionally, there is an opportunity to provide the excess material to landholders who have erosion problems on their properties that they may like to remediate.

Imported backfill material (*i.e.* sand) would be stockpiled in approximate 10 m × 10 m areas at approximate 200 m to 300 m intervals along the construction zone. These stockpile areas would contain sand and other material that would be used for backfill where the natural material is too coarse to be used. It is estimated that approximately 40 000 m^3 of imported backfill material would be required along the pipeline.

Temporary stockpile areas would be protected by sediment and erosion controls including temporary sediment fences. Stockpiles would be covered or controlled by wetting down where necessary to prevent impacts from dust.

2.5.4 Pipe lay down

Pipes would be delivered by semi-trailers to pipe lay down areas nearby to the pipeline route and adjacent to existing roads and accesses at approximately 5 km to 10 km intervals. The pipes would be removed from the trucks and placed in the lay down areas using mobile cranes.

Pipe lay down areas located within Council road reserves and private land would be fenced and public safety warning erected. Drainage controls would also be constructed where required.

Pipe lay down areas would also be located within the construction impact corridor, in many cases along the boundary of the existing 25 m wide gas pipeline easement. This easement is totally cleared and access would generally be available on one side of this corridor.

2.6 Pumping station

For both the raw water and treated water options, a new high lift pumping station would be located on the Wingecarribee WTP site. Both schemes would be designed for a flow of 5 ML/d. However, as noted previously the scheme would be designed to accommodate a potential upgrade to supply of 7.5 ML/d. If this is required (in approximately 15 – 20 years) a booster pump station in the vicinity of Marulan could be required.

2.7 Outlet point

2.7.1 Raw water transfer scheme

The pipeline would be constructed to an existing water balance tank at the Goulburn WTP. Raw water would be discharged into this reservoir. From there, it would be treated at the water treatment plant and released into Goulburn's town water supply.

The Project includes constructing the connections of the pipeline to the outlet point into the reservoir.

2.7.2 Treated water transfer scheme

Two outlet points for the treated water transfer scheme are being considered.

One outlet point would see treated water discharged into a proposed new reservoir on Governor's Hill, to the east of Goulburn. The reservoir would be connected to the town water supply system on the eastern side of Goulburn. Planning approval to develop this reservoir is not being sought as part of the Project. An application seeking approval to develop the reservoir and connect it to the town's water supply system would be made in the future, if this is required.

The other outlet point being considered would involve directly connecting the pipeline to the town's water reticulation system at a point east of Goulburn's central business district and in the vicinity of Governor's Hill.

2.8 Waterway crossings

2.8.1 Overview

The pipeline would cross various water bodies (including the Wollondilly River).

Based on a preliminary consideration of technical issues and environmental and geological constraints, a number of common construction methods have been proposed to construct the crossings. The methods that would be adopted include:

- Trenching;
- Thrust boring; and
- Horizontal directional drilling (sometimes termed 'under boring').

Bridge crossings can also be used to construct crossings. This would involve attaching a pipeline to a purposely built bridge structure or to an existing bridge. This method is also a common crossing construction method. At this stage, bridge crossings have not been identified as required at any point along the pipeline route, however requirements for pipe bridging may be identified during detailed design.

The NSW Office of Water advocates the following guidelines in relation to undertaking waterway crossings (DWE, 2008a):

- Crossings of waterways/riparian land should be under bored 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.
- That under boring 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.

Each waterway that would be crossed by the proposed pipeline has been classified in general accordance with the parameters set out in Table 2. These classifications were undertaken to assist in determining the appropriate type of crossing method at each waterway, *i.e.* the method for crossing each waterway was determined based on a combination of the waterway classification, the type and geomorphic condition of the waterways at the crossing location as well as the environmental sensitivity of the waterway. The type and geomorphic condition of waterways at each crossing location was defined using the River Styles framework (Brierley & Fryirs, 2005). The general topography at the proposed watercourse crossing locations was recorded during the geomorphologic investigation of the crossing. Further details are provided in a separate geomorphology impact assessment of this Project (GHD, 2010a).

The waterways that would be crossed, and the method proposed for crossing them (as determined based on a consideration of the descriptors in Table 2), are described in Section 3.2 and in particular in Table 3 of this report.

Table 2 Waterway Crossing Classification Descriptions

Waterway Classification	Catchment Area (ha)	Stream Order*	Valley/Channel Definition
Minor Waterway	< 20	Unmapped to first order	No defined channel and valley floor fill < 10 metres wide
Moderate Waterway	20 to 100	First to second order	Defined channel and/or valley floor fill > 10 metres wide.
Major Waterway	> 100	Second order and higher	Defined channel and/or valley floor fill > 10 metres wide.

* Based on NSW Department of Lands 1: 25 000 drainage layer

2.9 Operation of the Project

2.9.1 Water transfers

The water transfers would be made by a pump at a station located at the Wingecarribee Reservoir. The pipeline would be designed to accommodate a flow of approximately 7.5 ML/d (over a 22 hour period). Initially the pipeline would deliver 5 ML/d.

For the raw water transfer option, the water would be delivered from the pipeline into an existing water balance tank upstream of the Goulburn WTP, prior to treatment there.

For the treated water transfer option, the water would either be delivered from the pipeline into a proposed new covered balance reservoir at Governor's Hill in East Goulburn prior to distribution throughout the Goulburn water reticulation system, or directly into the piped distribution network.

There are two options in regard to the mode of operation of the water transfer pipeline:

- Continuous operation – where water from the Wingecarribee Reservoir would be delivered daily to Goulburn so as to contribute some set percentage of the overall daily water demand; or
- Intermittent operation – where water from the Wingecarribee Reservoir would be pumped to the Goulburn water supply system only on occasions where the existing water supply resources were measured to be below some trigger level.

2.9.2 Maintenance activities

During the operation phase of the Project, GMC staff would periodically traverse the route to undertake routine maintenance and ensure the pipeline is functioning adequately. The maintenance crews would remain in the cleared pipeline easement at all times and cause minimal disturbance to the natural environment.

Key activities would include:

- Regular maintenance of the pumping station;
- Regular visual inspection of the air valves and scour valves; and
- Less frequent maintenance of the pipeline including scouring the pipeline to remove sludge building up. If raw water is selected to be transferred to Goulburn, then it is likely that the water would need to be pumped from the pipe, removed by tanker and handled or discarded in an appropriate manner. If treated water is selected to be transferred, then water may be discharged to an adjacent waterway, farm dam, or pumped and removed by tanker.

2.10 Standard Project construction controls (protection of surface water quality)

2.10.1 General

This section provides an overview of the standard construction and operational controls that would be adopted for this Project and that would provide protection against the contamination of surface water resources. These standard practices and project controls relate to the management of the following:

- Soil erosion and sedimentation;
- In-stream construction works;
- Rehabilitation and maintenance of disturbed areas;
- Spoil;
- Groundwater;
- Acid sulphate soils;
- Saline soils;
- Contaminated soil; and
- Education of the construction work teams with respect to their responsibilities and legislated requirements to prevent surface water and groundwater contamination.

It is anticipated that these procedures and controls would form part of a construction environmental management plan (CEMP) and/or an operational environmental management plan (OEMP). It is assumed the implementation of the CEMP would be audited by a third party to ensure the practices and controls are maintained and continually improved throughout the construction phase.

The practices and control are described below.

2.10.2 Erosion and sediment control

Changes to land uses have the potential to cause disturbance to soils, destroy vegetation, and alter drainage pathways. Construction activities involving groundwater drawdown or deeper excavations have the potential to degrade the groundwater resource in an area. Such impacts can be minimised or eliminated by adopting recommended sediment and erosion control practices. Erosion and sediment control prevention measures would be implemented as part of all project construction activities. Significant effort and attention would be given to preventing soil erosion and sedimentation of surface water runoff.

Standard controls to prevent erosion and sedimentation would be implemented for each construction activity. The controls that would be implemented are described in Appendix B and are considered to be part of the construction activities for the project. The practices and controls are based on the recommended practices described in the following guidelines:

- *Managing Stormwater: Urban Soils and Construction Vol 1* (Landcom, 2004);
- *Managing Stormwater: Urban Soils and Construction Vol 2A Installation of Services* (DECC, 2008a); and
- *Managing Stormwater: Urban Soils and Construction Vol 2C Unsealed Roads* (DECC, 2008b).

All erosion and sediment control measures would be designed, implemented and maintained in accordance with the above guidelines.

The guiding principles for effective soil and water management that would be adopted during project construction and post construction periods include:

- Prioritising the prevention of erosion rather than controlling sediment and capturing sediment laden stormwater;
- Phasing and conducting work within the construction corridor to minimise the area of soil disturbance and vegetation removal;
- Managing topsoil so that it is excavated and temporarily stockpiled separately from sub soils and reused on site during rehabilitation;
- Agreeing on the rehabilitation outcomes with the landowner prior to commencement of construction. Progressively rehabilitating disturbed areas and maintaining these areas until the agreed rehabilitation outcomes are achieved.

A site Sediment and Erosion Management Plan (SEMP) would be prepared and incorporated into a CEMP.

2.10.3 In-stream works

The design and construction of in-stream works would be consistent with the NSW Department of Water and Energy's (now the NSW Office of Water within the Department of Environment, Climate Change and Water) *Guidelines for Controlled Activities - In-stream Works* (DWE, 2008a) and *Guidelines for controlled activities - Laying Pipes and Cables in Watercourses* (DWE, 2008b). The following design principles would be adopted based on these guidelines:

- The full width of the riparian corridor is to be considered when designing and constructing the watercourse crossing;
- The extent of disturbances to soil and vegetation within the watercourse and riparian corridor is to be minimised;
- All major water courses are to be crossed at points adjacent to existing infrastructure easements;
- The natural hydraulic, hydrologic, geomorphic and ecological function of the watercourses, and the natural geomorphic processes such as natural bed and bank profiles, chains of ponds, surface water pools and riffles are to be maintained;
- Rehabilitation is to occur immediately following the completion of the crossing construction to re-establish the integrity of the riparian zone. Topsoiling, revegetation, mulching, weed control and maintenance are to be undertaken to stabilise disturbed areas;
- Existing channel bed and bank degradation at the crossing points are to be rehabilitated;

- All rehabilitation work is to be monitored and maintained until the riparian zone and channel bed and banks are suitably stabilised;
- Trenches are to remain open for a minimal length of time;
- The channel shape and bed level is to be restored to preconstruction condition;
- Cave-ins or 'frac-outs' are to be avoid by investigating the underlying geology and boring at an appropriate depth;
- Bore entry and exit locations are to be located outside riparian corridors; and
- All drilling mud, construction plant and materials are to be recovered and removed following completion of construction.

2.10.4 Rehabilitation

All disturbed ground would be rehabilitated in general accordance with the following principles:

- Rehabilitation objectives would be agreed with the landholder prior to construction. The agreed rehabilitation objectives would be included in the land acquisition agreement negotiated with the landholder;
- The basis of the rehabilitation objectives would be to establish stabilised ground of a nature similar to the pre-construction condition, over approximately 80% of the disturbed area;
- Rehabilitation of the disturbed areas would be undertaken progressively, immediately after a section of pipeline trench has been backfilled or a crossing has been constructed;
- Erosion and sediment controls would remain in place until the rehabilitation objectives are achieved. GMC would remove all controls once the rehabilitation objectives are achieved;
- Rehabilitated areas would be periodically inspected, reinstated (if required) and maintained by GMC on an on-going basis until the rehabilitation objectives are achieved.

2.10.5 Management of spoil

Spoil would be managed in accordance with the resource management hierarchy of:

1. Avoid generating spoil;
2. Reuse spoil on site;
3. Reuse spoil off site; and (as a last resort option)
4. Appropriate disposal of spoil off site.

Spoil generation would be minimised by keeping the area of ground disturbance as small as possible. If spoil is generated, it would be reused to rehabilitate the disturbed areas. Topsoil would be separated from sub surface materials and used in its original location as final ground cover. Excess spoil materials would be utilised by the property landowners wherever appropriate. Disposal of spoil material off site would occur in accordance with *Waste Classification Guidelines*, (DECCW 2009).

2.10.6 Management of acid sulfate soils

If Acid Sulfate Soils were suspected along the pipeline route (soils typically containing a sulfuric odour and dark in colour), then works in the area would cease and a qualified soil scientist engaged to undertake an Acid Sulfate Soil Assessment in accordance with the *Acid Sulfate Soil Manual* (Stone *et al.*, 1998).

2.10.7 Management of saline soils

There is a possibility that the proposed pipeline route would traverse areas where localised dry land salinity has been recorded. If areas impacted by dry land salinity were encountered, the following measures would be implemented:

- Disturbance of saline soils would be minimised wherever possible;
- Following earthworks, reinstatement of the disturbed areas would be undertaken to avoid the creation of surface depressions or drainage barriers, which would lead to waterlogging of soils;
- Rehabilitation of the surface vegetation would consider the use of salt tolerant species;
- Topsoils would be treated with gypsum or fertilisers as appropriate.

The overall aim would be to ensure the following;

- Rehabilitated areas are well drained;
- Reuse of excavated materials is maximised;
- Topsoil is treated to aid in the re-establishment of a vegetated ground cover; and
- The excavations do not contribute to additional surface water infiltration

2.10.8 Management of contaminated soil

If during construction works potentially contaminated material is encountered or if soil becomes contaminated during construction or operation of the Project (such as from a fuel spill for example), works in the vicinity of the contaminated area would cease and a qualified environmental consultant with experience in contaminated land investigations would be engaged to investigate the potential risks posed. Soil sampling and laboratory analyses would be undertaken to delineate the degree and extent of contamination if deemed necessary.

Consideration of the duty to notify DECCW of a site that poses or may pose a significant risk of harm to the environment or human health (as required under the *Contaminated Land Management Act 2000*) would be given following any contaminated land investigations.

If appropriate, remediation of contaminated land would be undertaken to ensure the use of the land within the construction corridor and pipeline easement is not inappropriate because of the presence of contamination. In the unlikely event that significant contamination is encountered within the construction corridor, the area would be avoided by rerouting the construction corridor around the contaminated area.

All material removed off site for disposal or re-use would be managed in accordance with the *Waste Classification Guidelines* (DECCW, 2009).

To prevent soils from becoming contaminated through construction activities, the storage of all fuels, oils and chemicals would be kept to a minimum. All fuels, oils and chemicals would be stored within the primary site compound in appropriate storage containers as specified in relevant Australian Standards. Storage within the construction corridor would be avoided.

2.10.9 Informing construction workers of responsibilities

All members of construction work crews would undergo informal training to inform them of the Project's 'best practice' approaches to preventing soil erosion and sedimentation. Construction worker's responsibilities and legal requirements with respect to the prevention of soil erosion, surface water pollution and groundwater pollution would be included in the training.

3. Existing Environment

3.1 System boundaries

This assessment considered surface waterways and water resources that would have:

- Infrastructure constructed within the natural flow area of the resource;
- New infrastructure constructed within its current catchment area; or
- Flow diversions (temporarily or permanently) to cater for the project;

3.2 Potentially impacted water resources

3.2.1 Catchments and water resource values

The pipeline would be constructed entirely within the Sydney Catchment Authority's drinking water catchments. The pipeline corridor runs north of, and roughly parallel to, the catchment boundary separating the Hawkesbury-Nepean River catchment from the Southern Rivers catchment.

The site mainly falls within the area managed by the Hawkesbury-Nepean Catchment Management Authority (CMA). The pipeline follows an upward sloping gradient from an altitude of approximately 675 m at Moss Vale to 702 m above sea level at Goulburn. The pipeline route is mostly gently undulating in topography, crossing creeks, rivers and other infrastructure. The area through which the proposed pipeline would traverse generally drains north, with the eastern section of the pipeline route draining naturally into the Wingecarribee River, and the western section of the pipeline route draining into the Wollondilly River. The confluence of these two rivers is within the Wollondilly Nature Reserve.

The surface water resources in these catchments support a variety of activities and values, including drinking water supply, agriculture, and recreational/aesthetic values.

3.2.2 Watercourses

A description and mapping of the waterways that would be crossed by the proposed pipeline is provided at Appendix B. Table 3 contains a listing of the major water crossings and how it is proposed that they would be crossed during the construction of the pipeline. The proposed construction methods were based on an assessment of the waterway, the flow conditions, geomorphology and other conditions (GHD, 2010a) in accordance with guidance provided by the NSW Office of Water (DWE, 2008a; 2008b). HDD is proposed for waterways with permanent flow. For ephemeral waterways the construction would be programmed to be undertaken when there was no flow in the stream.

Table 3 Water crossings and proposed crossing methods

Crossing Reference	Name	Proposed construction method
WAT 1	Kellys Creek	Trenched
WAT 2	Medway Rivulet	Trenched
WAT 3	Wells Creek	Trenched
WAT 4	Black Bobs Creek	Trenched
WAT 5	Long Swamp Creek	Trenched
WAT 6	Paddys River	Horizontal Directional Drilling
WAT 7	Uringalla Creek	Horizontal Directional Drilling
WAT 8	Jaormin Creek	Horizontal Directional Drilling
WAT 9	Lockyersleigh Creek	Trenched
WAT 10	Narambulla Creek*	Trenched
WAT 11	Osborns Creek	Trenched
WAT 12	Wollondilly River	Horizontal Directional Drilling
WAT 13	Wollondilly River	Horizontal Directional Drilling
WAT 14	Boxers Creek	Trenched
WAT 15	Wollondilly River	Horizontal Directional Drilling
WAT 16	Kenmore Creek	Trenched
WAT 17	Kenmore Creek	Trenched
WAT 18	Kenmore Creek	Trenched
WAT 19	Kenmore Creek	Trenched
WAT 20	Wollondilly River	Horizontal Directional Drilling

* Seasonal flooding/waterlogging on a floodplain associated with Narambulla Creek is mapped just north of the proposed alignment. This feature may warrant consideration for alternative site access or crossing construction techniques (*e.g.* horizontal direction drilling).

3.2.3 Wetlands

A search of the Protected Matters database search tool that is maintained by the Department of Environment, Water Heritage and the Arts[2] did not identify any protected wetlands within the vicinity of the construction impact zone of the proposed pipeline.

[2] http://www.environment.gov.au/erin/ert/epbc/index.html

3.3 Flooding

The estimated Project construction timeframe is 12 months. The likelihood of a flood event occurring over the timeframe of the construction phase is demonstrated in **Error! Not a valid bookmark self-reference.** in accordance with the procedures of the *Australian Rainfall and Runoff* (Institution of Engineers Australia, 2001).

Table 4 Likelihood of flood occurrence during construction phase

Construction timeframe	Probability of occurrence for flood event of given Average Recurrence Interval (ARI)		
	5-Year ARI	20-Year ARI	100-Year ARI
1 Year	18%	5%	1%

3.4 Water quality

3.4.1 Water Quality of the water in the proposed pipeline

The quality of the water that would be transferred via the proposed pipeline is of interest because it may need to be released from the pipeline during certain management activities, such as pipeline scouring (this is discussed in more detail in the impact assessment at Section 4).

The quality of the water that would typically be sourced from the Wingecarribee Reservoir and so, under the raw water transfer scenario, would nominally be in the pipeline is described in Table 5.

Table 5 Water quality in the proposed pipeline (raw water transfer scenario)*

Parameter	Observation
Turbidity	Typically < 10 NTU; always < 15 NTU
E.coli	Often > 10 / 100 mL and spike up to 16 000 / 100 mL
Manganese	0.025 - 0.062 mg/L
True colour	Typically 30 - 60 Hu
pH	6.9 – 9.8
Alkalinity	15 - 20 mg/L as calcium carbonate $CaCO_3$
Hardness	20 - 25 mg/L as calcium carbonate $CaCO_3$
Dissolved Organic Carbon	5 mg/L
Cyanobacterial counts	Total cyanobacterial counts up to 622 000 cells/mL; median *ca.* 100 000 cells/mL. Toxic species – higher levels in summer, overall median < 2000 cells/mL
Total Dissolved Solids	Approx. 50 mg/L at surface; 160 mg/L at depth of 10 - 15 m

*Based on water quality data from the Wingecarribee Reservoir courtesy of Sydney Catchment Authority and Wingecaribee Shire Council

The physico-chemical properties of the raw water in Wingecarribee Reservoir are generally within the water quality guideline values provided in the *Fresh and Marine Water Quality Guidelines* (ANZECC,

2000) for the maintenance of aquatic systems and for the use of the water for crop irrigation or livestock watering. The exception is that *E. coli* and cyanobacteria (blue-green algae) levels can fluctuate to beyond the ANZECC (2000) and other guidance for these parameters (see Figure 2 and Figure 3), and some consideration or management of these would likely be required in the event that the pipeline would need to be drained or scoured (Table 6).

If the treated water transfer scheme is constructed then the quality of the water being released during, say, scouring activities would be of a quality suitable for drinking by humans, and would contain less contaminant than what is typically found in environmental waters. The Wingecarribee WTP has a history of providing water adequate for human consumption, even when challenged, for example, by blue-green algae bloom events in its feed water (*e.g.* DECC, 2008c). Hence, the water would be appropriate for stock and domestic uses, for example, in accordance with the guidance in Chapter 4 of ANZECC (2000) water quality guidelines. Therefore, the release of this water would not likely cause significant environmental impact to receivers such as sheep, cattle or horses. The most pertinent issue would be that the scour water would contain a chlorine residual following chlorination at the Wingecarribee WTP and boosters along the pipeline. The target chlorine residual levels of the piped water would be in the order of 0.02 mg/L at the point of entry to the Goulburn reticulation system in accordance with the guidance set out in the *Australian Drinking Water Guidelines* (NHMRC, 2004), to provide some protection of the supply against microbial contamination (GHD, 2010b). This level of chlorine is greater than the ANZECC (2000) guideline (0.003 mg/L) for the protection of aquatic systems in waterways. The management of this is discussed further in Section 4.

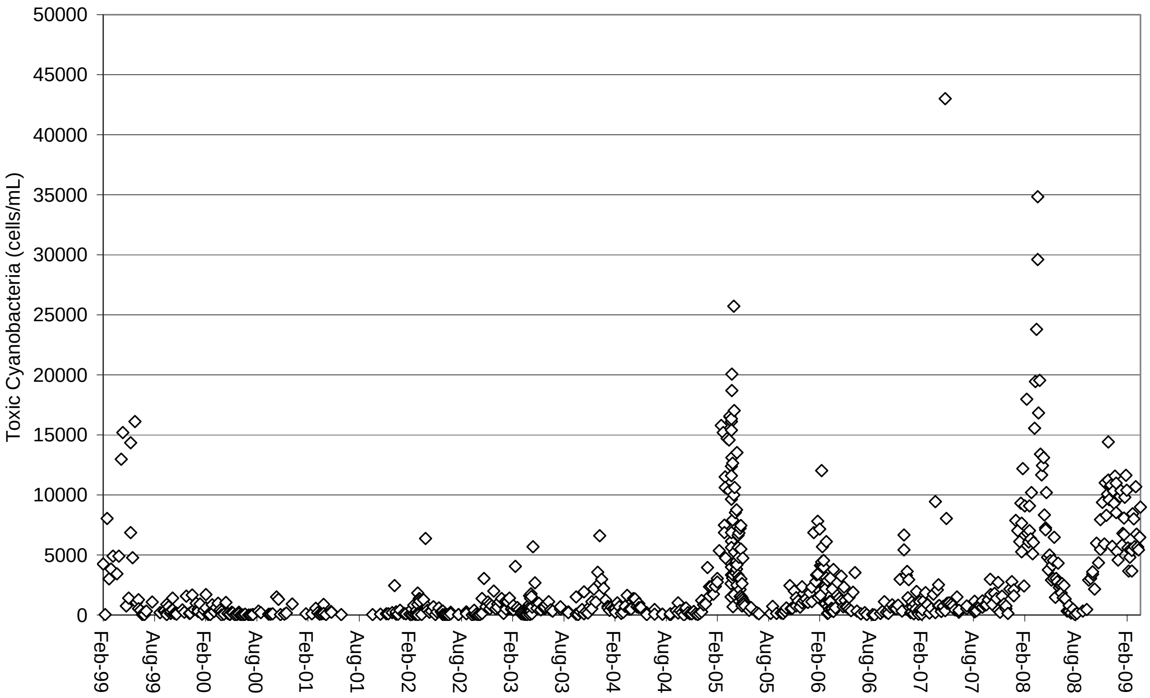

Figure 2 Toxic cyanobacteria (all species) counts in Wingecarribee Reservoir

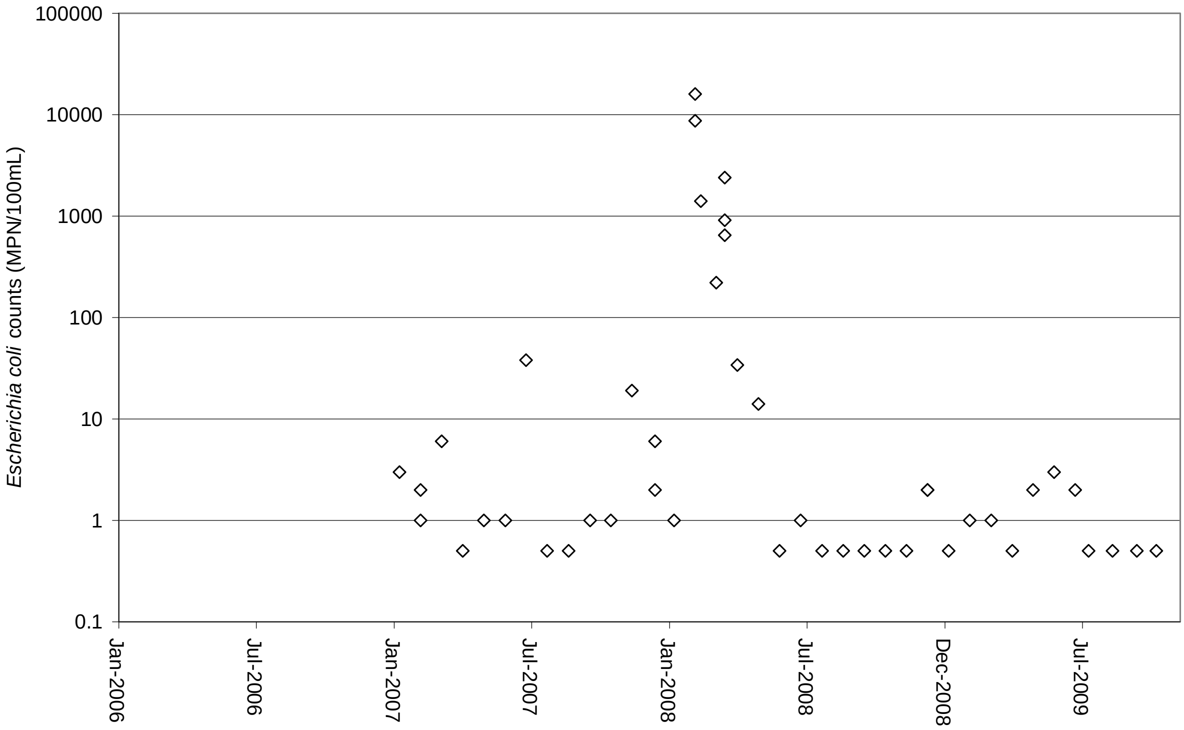

Figure 3 ***E.coli* counts in Wingecarribee Reservoir**

3.4.2 Surface waterways in Sydney drinking-water catchment

Two documents provide a comprehensive overview of the existing water quality and the health of the Sydney drinking water catchments:

- *Sydney Catchment Authority Annual Water Quality Monitoring Report 2007-08* (SCA, 2008); and
- *2007 Audit of the Sydney Drinking Water Catchment* (DECC, 2008c).

A summary of some of the water quality sampling results from the Sydney Catchment Authority's recent water quality monitoring report is provided at Figure 4. In short, some of the waterways in the vicinity of the Project, such as the Wollondilly River, have had a recent history of exceeding water quality guidelines adopted by the SCA particularly for chlorophyll-a, nutrient levels and dissolved oxygen levels; this indicates that there can be a relatively high blue-green algae bloom potential in these waters. An imperative point of the management of the Project would be that it is done in a manner so as not to exacerbate (and ideally improve) any water quality issues that exists in the Sydney drinking-water catchment.

The SCA guideline values for the monitored values are:

- pH 6.5 – 8.5
- Chlorophyll-a (µg/L) 0 – 5
- Total Nitrogen (mg/L) 0 – 0.25
- Dissolved oxygen (%sat) 80 – 110

- Total Phosphorus (mg/L) 0 – 0.02
- Turbidity (NTU) 0 – 15
- Thermotolerant coliforms (CFU/100mL) 0 – 150

Groundwater discharge

During the construction phase it is possible that groundwater will infiltrate the trench. This groundwater will need to be pumped from the trench. The groundwater will be pumped to a tank and tested prior to discharge to a farm dam. The water would be tested to ensure it meets the ANZECC Guidelines for water quality appropriate to this purpose, *i.e.* water for stock use or irrigation. It is generally anticipated that the groundwater quality will be good (Refer Chapter G).

3.5 Geology and soils

The nature of the geology and soils in the vicinity of the pipeline is of interest as these, when disturbed and/or stockpiled, would be a primary source of potential contamination of waterways unless appropriate management strategies were in place. The nature and the management of soils and waste produced in association with the Project were described in detail in another report (GHD, 2010d). In summary:

- There is a sheet erosion hazard associated with the soils along the majority of the proposed pipeline corridor, that would require management during the construction phase;
- There is low potential for acid sulphate soils or significantly contaminated soils to be disturbed during the excavation and construction process; and
- At water crossing points, sedimentary rock or alluvial deposits (which are likely to be underlaid by sedimentary rock) are the predominant structures. Igneous rock (most likely underlain by minor alluvial deposits at the watercourse crossing locations) is expected to underlie the crossing at Jaormin Creek (WAT 8), Lockyersleigh Creek (WAT 9), Narambulla Creek (WAT 10) and the Wollondilly River (WAT 20). Of these crossing points underlain by igneous rock, it is proposed to horizontal direction drill the crossing of the Wollondilly River (WAT 20).

3.6 Recreational water quality

As identified above, a number of creek crossings will be required under the Project. By managing pathways for contaminants to enter waterways through implementation of good construction practices in accordance with the controls set out in *Managing Stormwater: Urban Soils and Construction Vol 1* (Landcom, 2004) and by meeting the SCAs Neutral or Beneficial Effect test, impacts to the recreational use of these creeks.

Due to the progressive nature of the construction activities only localised disturbances to water quality would arise and these will be mitigated by the standard controls and additional mitigation measures as outlined in Section 5.

Table 6 Water quality considerations when draining/scouring the proposed pipeline

Parameter	Observation in Wingecarribee Reservoir water	ANZECC (2000) guidance on water quality requirements for certain purposes	Other comments
E.coli	Often < 10 / 100 mL though isolated spikes up to 16 000 / 100 mL have been observed	*The following guidance refers to Total Coliforms, an alternative microbial quality indicator, as E. coli was not directly addressed in the guidelines.* **Raw human food crops in direct contact with irrigation water** (e.g. via sprays, irrigation of salad vegetables): <10 cfu / 100 mL **Raw human food crops not in direct contact with irrigation water** (edible product separated from contact with water, e.g. by peel, use of trickle irrigation); or crops sold to consumers cooked or processed <1000 cfu / 100 mL **Pasture and fodder for dairy animals** (without withholding period) <100 cfu / 100 mL **Pasture and fodder for dairy animals** (with withholding period of 5 days) <1000 cfu / 100 mL	*E. coli* is a type of coliform, and so the levels of coliforms observed in the Wingecarribee Reservoir are usually well below the guidance provided by ANZECC (2000) for Total Coliforms.
Cyanobacterial counts	Total cyanobacterial counts up to 622 000 cells/mL; median *ca.* 100 000 cells/mL	**Livestock** "An increasing risk to livestock health is likely when cell counts of Microcystis [as opposed to total cell counts reported to the left] exceed 11 500 cells/mL and/or concentrations of microcystins exceed 2.3 µg/L expressed as microcystin-LR toxicity equivalents. There are insufficient data available to derive trigger values for other species of cyanobacteria." **Irrigation** "Cyanobacteria (blue-green algae) form part of the natural microbial population in most waterbodies. Under certain natural or human-induced circumstances, toxic blooms can occur and these may adversely affect the suitability of waters for irrigation If an algal bloom occurs, it is recommended that an alternative source of irrigation water be used, and that the water be tested for microbial composition and (if necessary) toxicity. There is presently insufficient information available for use in deriving trigger values for cyanobacteria in irrigation water."	Cyanobacteria is a naturally occurring contaminant in water bodies. Water Directorate (2009) have more recently advised that concentrations of microcystins exceeding 1.2 µg/L expressed as microcystin-LR toxicity equivalents may be hazardous to cattle over the longer term. There has also been a move toward considering other toxic cyanobacteria (*e.g.* saxitoxins) when considering appropriate uses for water.

Figure 4 Sydney Catchment Authority Annual Water Quality Monitoring Summary 2007-08

Key

- Within guideline range
- <25% of samples exceeded guidelines
- 25-50% samples exceeded guidelines
- >50% samples exceeded guidelines

Catchment	Location	Wet/ dry	pH	Chlorophyll-a (µg/L)	Total Nitrogen (mg/L)	Dissolved Oxygen (% Sat)	Total Phosphorus (mg/L)	Turbidity (NTU)	Thermotolerant Coliform (cfu/100mL)
Warragamba	Coxs River at Kelpie Point		0%	0%	0%	0%	0%	0%	10%
	Kowmung River at Cedar Ford		0%	0%	10%	9%	0%	0%	0%
	Kedumba River at Maxwells Crossing		0%	0%	46%	8%	0%	0%	23%
	Gibbergunyah Creek at Braemer STP		0%	42%	100%	33%	100%	17%	33%
	Nattai River at The Crags	Dry	0%	0%	100%	28%	55%	9%	9%
		Wet	0%	0%	100%	0%	100%	0%	0%
	Nattai River at Smallwoods Crossing	Dry	0%	33%	58%	25%	8%	8%	0%
		Wet	0%	0%	100%	0%	0%	0%	0%
	Little River	Dry	10%	0%	8%	25%	8%	0%	0%
		Wet	0%	0%	0%	0%	0%	0%	0%
	Wingecarribee River at Berrima Weir	Dry	0%	100%	91%	55%	36%	100%	18%
		Wet	0%	100%	100%	0%	50%	100%	0%
	Wollondilly River at Murrays Flat		0%	69%	100%	77%	33%	17%	0%
	Wollondilly River at Golden Valley	Dry	0%	25%	82%	25%	9%	0%	0%
		Wet	0%	100%	100%	0%	0%	0%	100%
	Mulwaree River at The Towers Weir		100%	100%	100%	100%	100%	100%	0%
	Wollondilly River at Jooriland	Dry	0%	100%	100%	9%	27%	25%	0%
		Wet	0%	50%	100%	50%	100%	100%	50%
	Werriberri Creek at Werombi	Dry	0%	8%	73%	75%	9%	0%	8%
		Wet	0%	0%	100%	100%	0%	0%	0%
Nepean	Burke River Nepean Reservoir Inflow	Dry	0%	0%	0%	8%	0%	0%	0%
		Wet	0%	0%	0%	0%	0%	0%	0%
	Nepean River at Maguires Crossing	Dry	0%	33%	100%	17%	36%	0%	8%
		Wet	0%	100%	100%	0%	0%	0%	0%
Woronora	Woronora River at the Needles	Dry	0%	0%	8%	25%	0%	0%	42%
		Wet	100%	0%	0%	0%	0%	0%	0%
Shoalhaven	Kangaroo River at Hampden Bridge	Dry	0%	0%	89%	11%	33%	0%	67%
		Wet	0%	25%	75%	0%	50%	50%	100%
	Mongarlowe River at Mongarlowe	Dry	0%	0%	0%	25%	8%	0%	0%
		Wet	0%	0%	0%	0%	0%	0%	0%
	Shoalhaven River at Fossikers Flat	Dry	0%	18%	45%	9%	18%	36%	9%
		Wet	0%	33%	100%	0%	67%	100%	33%
	Shoalhaven River downstream Tallowa Dam	Dry	9%	0%	100%	0%	27%	9%	27%
		Wet	0%	0%	100%	0%	0%	100%	0%
	Sholhaven River at Mountview	Dry	0%	0%	36%	0%	18%	0%	0%
		Wet	0%	0%	50%	0%	50%	0%	0%
	Shoalhaven River at Hillview	Dry	0%	17%	58%	17%	17%	9%	17%
		Wet	0%	0%	100%	0%	0%	0%	0%
	Gillamatong Creek	Dry	0%	8%	83%	83%	0%	0%	0%
		Wet	0%	0%	100%	0%	100%	0%	0%

4. Impact Assessment

4.1 Impact identification (overview)

Broadly, surface water quality may be impacted in the following manners.

Construction activities and associated increases in heavy vehicle traffic may lead to an impact on water quality in various waterways through the generation of sediment-laden overland run-off, spillage of oils (*e.g.* machinery fuels or maintenance), litter (*e.g.* from the construction workers and activities) and alkaline cement materials. Should they enter the waterways, these pollutants have the potential to impact on water quality by increasing turbidity and suspended particle levels, altering pH (*e.g.* due to alkaline cement material) or increasing hydrocarbon levels in the water. If inadequately controlled, changes to water quality could impact on the aquatic ecology of the river and any downstream water users.

Potential construction impacts can be managed by the implementation of standard construction environmental management measures that would be described throughout a dedicated CEMP. Provided these measures are implemented, the potential for impacts on water quality is considered to be low to negligible.

The potential impacts during the *operational phase* would be associated with the potential for pollution of the waterways from or during maintenance activities (including during access to the pipeline by workers, scouring or the release of water from the pipeline for various reasons *etc.*). These activities would require some management or standard operating protocols to limit the risk of waterway contamination.

4.2 Risk assessment

The Project provides an opportunity to have some beneficial impacts on the surface water quality within the Sydney drinking water catchments, for example by revegetation and by offsetting land clearing, as described in the ecological assessment report undertaken for this Project (GHD, 2010a). However, the Project would have impacts on and introduce new risks to the overall surface water quality that would require careful management. A detailed assessment of the identified impacts (listed above) was undertaken by considering the risks that would be associated with the impacts.

A risk assessment was conducted to:

1. Prioritise the identified impacts in terms of the potential relative risk each may pose to the surface water quality and the consequences that may arise from any changes; and
2. Identify targeted actions and initiatives that would need to be adopted to monitor and manage the risks during the proposed Project operations.

A qualitative risk assessment approach was used. The relative risk for each identified impact was determined as a function of the likelihood of a certain impact event occurring as well as the consequences that may be associated with it. Initially the risk was assessed on the basis of the Project description, the water quality data and system understanding (*i.e.* how the current systems operate, the values of the waterways, *etc.*) provided throughout this report. In particular, the risk assessment was initially undertaken with consideration for the standard Project controls described in Section 2.10. For the impacts with the higher relative risk scores, additional management and control activities have been identified, and the risks were reassessed assuming that these controls/actions would have been implemented. The impact mitigation measures described in Section 5 are basically an overarching description of these additional identified management activities and controls.

The risk matrix and the risk assessment outputs relevant to this report are both presented in Appendix A.

Generally, it can be considered that the Project would pose some new, though manageable risks to surface water quality in the Sydney drinking water catchments. The standard set of project controls described in Section 2.10 would broadly provide adequate control against the greater majority of risks to surface water quality. However, some additional measures would be necessary. These are described in Section 5.

4.3 Neutral or Beneficial Effect on Water Quality

The Sydney Catchment Authority (2006) has developed a guidance manual to assist proponents of projects to assess whether the proposal would have a neutral or beneficial effect on water quality in the Sydney catchments. Broadly, the effect can be considered neutral if (SCA, 2006:10):

"a) pollutant loads that occur as a result of the development/activity can be transported to acceptable downstream treatment and disposal facilities without adverse off-site water quality impacts, and/or

b) any water quality issues can be effectively managed on-site such that there are no adverse water quality impacts occurring off-site, and

c) there are no adverse water quality impacts that arise or are likely to arise indirectly as a result of changes to factors that affect the treatment, assimilation of pollutants, or affect the quality of water as part of the hydrological cycle (such as changes to flow or flow paths, water courses or riparian corridors) that can adversely affect water quality off the site."

In terms of water quality, it is considered that the project would have a neutral effect on the quality of water discharging to the receiving environment. Specifically:

- The construction phase is reasonably short at 12 months duration, and all construction phase impacts would be managed in accordance with the measures outlined in Section 2.10. While a large portion of the project is not located in the vicinity of drainage lines, in areas where drainage lines are in close proximity, construction techniques can be used to minimise disturbance to creeks. For larger waterways, crossing methods such as thrust boring, horizontal directional drilling (HDD) and pipe bridges would be adopted (as described in 3.2.2);
- The pipeline would be buried throughout the route. The land within the pipeline easement would be rehabilitated post construction, and therefore little opportunity would exist for long-term water quality impacts, and rehabilitation and land clearing offset requirements for this Project offers the opportunity to improve long-term catchment health in some places (GHD, 2010a);
- There would be negligible alterations to the erosion potential at the nominated water crossings (GHD, 2010a);
- Pipeline scour water would not be released directly to the environment (see Section 5.3). For the raw water transfer option, and in the event that the water quality is considered unsuitable for release to nominated farm dams, then on-site treatment or tankering and suitable disposal would need to be arranged. The volumes released can be quite small for each valve operation exercise and would be manageable with tankering to a nearby farm dam where it could be treated on-site depending on the

specific water quality issue. More on the management of scour water, and the role that could be played by DECCW and/or the SCA, is provided at Section 5.3.

5. Mitigation Measures

Broadly, the greatest risks to waterway contamination occurs during the construction phase and is associated with excavation activities and stock piling of material introducing a pathway for mobilized sediment to enter the waterways at localized points. The standard set of project controls described in Section 2.10 would generally provide adequate control against the greater majority of these risks to surface water quality, and ensure a neutral effect on water quality in the Sydney drinking water catchment. They also comply with the recommended practices that have been endorsed by the Sydney Catchment Authority[3]. However, some additional specific measures would be beneficial, as described below.

5.1 Construction phase

All construction activities would be supported by a Construction Environmental Management Plan for the works. This plan would address water quality management, and would incorporate those things described in Section 2.10, such as:

- Allocation of general site practices and responsibilities;
- Material management practices;
- Stockpile practices;
- Topsoil practices; and
- Surface water and erosion control practices (earth sediment basins, straw bales, sediment fences, turbidity barriers, stabilised site accesses, diversions and catch drains).

Generally, appropriate measures would be provided to prevent the entry of soils or In addition, the following would provide additional protection against waterway contamination:

- Placing plant and site equipment outside the 1 in 20-yr ARI flood affected area whenever possible, and storing plant and machinery that is not in use outside of flood affected areas;
- Placing spoil outside flood affected areas and disposed of in accordance with relevant guidelines and legislation;
- Undertaking construction during dry seasons as much as possible as this would minimise the potential for rain/flood events to wash contaminants from the construction sites into local waterways;
- Visual monitoring would be undertaken to ensure that stormwater management measures are working effectively. Visual inspections should be undertaken at creeks and areas where infrastructure has been provided as part of the project, for example the pump station, access roads, and locations of scour facilities. The visual inspections would assess whether there were large amounts of debris, spills, runoff, *etc.* entering any waterways, and would also assess that systems and barriers to prevent contamination were in place and operating. A general indication of frequencies for inspections is provided in Table 7. An inspection log detailing the monitoring program should be kept.
- Monitoring for turbidity, suspended solids and nutrients should also be undertaken prior to and following construction activities on permanent, major waterways. Monitoring should begin 4 months

[3] http://www.sca.nsw.gov.au/the-catchments/regional-plan/regional-plan-current-recommended-practices accessed at 10 January 2010.

prior to construction activities on a monthly basis and continue until 4 – 6 months after the construction has been undertaken. All samples will be taken on a monthly basis.

Table 7 Visual inspection monitoring program

Sample location	Collection mechanism	Frequency first six months	Frequency normal operation
Sediment Basins	Visual Inspection	Every runoff event	First runoff event of any month
Drainage and diversion channels	Visual Inspection	Every runoff event	First runoff event of any month
Overland flow paths	Visual Inspection	Every runoff event	First runoff event of any month
Trafficable areas	Visual Inspection	Every month	
Bunded areas	Visual Inspection	Every runoff event	
Other works areas, potentially contaminating stormwater such as at scour locations	Visual Inspection and system operation testing	Every month	

5.2 Operational phase - general

As the construction impact zone would be rehabilitated and offsets would be provided for cleared vegetation (as outlined in the ecological assessment report, GHD 2010a), there would not likely be long-term consequences to catchment or surface water quality as a result of the project, provided good construction management practices were followed. In general, the following would facilitate the management of operational phase water quality impacts:

- Development of a standard operating procedure for access to the pipe during maintenance activities, chemical/fuel storage, and for pipe flushing that meets statutory requirements;
- Ensuring that revegetation of rehabilitated areas is undertaken in accordance with a Vegetation Management Plan that provides for vegetation which protects against erosion. In certain areas additional armouring of embankments may be required using environmentally sensitive strategies such as rock; and
- Developing a protocol for the management of drainage/scour water from the pipeline.

The third point is discussed further below.

5.3 Operational phase - handling of scour water

The preferred approach to the management of scour water would be to utilise the water on the properties where scouring occurs. Typically this would involve pumping (via collapsible fabric pipes) the scour water to a nearby existing farm dam. Where no suitably located farm dam exists, a small dam could be constructed with the approval of the landholder. This is normally viewed as advantageous by landholders, because of a universal need for water. No scour water would be directly released to watercourses.

The approach to managing the scour water would vary slightly depending on whether the treated water transfer scheme or the raw water transfer scheme is constructed.

5.3.1 Treated water transfer scheme

If the treated water transfer scheme is constructed then the water quality of the water being released during scouring would be of a quality suitable for drinking by humans, and would contain less contaminant than what is typically found in environmental waters. Therefore, the release of this water would not likely cause significant environmental impact to receivers such as sheep, cattle or horses. Hence, the water would be appropriate for stock and domestic uses, in accordance with the guidance in Chapter 4 of ANZECC (2000) water quality guidelines.

The most pertinent issue would be that the scour water would contain a chlorine residual following chlorination at the Wingecarribee WTP and boosters along the pipeline. The target chlorine residual levels of the piped water would be in the order of 0.02 mg/L at the point of entry to the Goulburn reticulation system, to provide some protection of the supply against microbial contamination. This level of chlorine is greater than the ANZECC (2000) guideline (0.003 mg/L) for the protection of aquatic systems in waterways. However this would be managed in the following ways:

- Maintenance scheduling - the timing for scour activities would be agreed in advance. This would allow the pipeline to be isolated from the Goulburn water reticulation system and the Wingecarribee WTP, and the shut-down of booster chlorinators for some time period in advance of the scheduled scouring. This would allow the free chlorine residual in the pipeline to decay prior to the scouring, which would not be a problem as the water was not being provided for drinking at these times.
- The chlorine would breakdown on exposure to sunlight once the water enters the dam.
- A standard practice procedure would be prepared in consultation with the SCA and DECCW to guide the management of scour water. As mentioned above, a component of this plan would be that the water would not be released into environmental waterways, and would be pumped into a receiving farm dam for appropriate (stock and domestic) uses agreed to by the landholder and other relevant bodies. The farm dam would be designed, adequately sized and the scour activities coordinated in a manner to prevent the risk of the dam spilling into any nearby waterways.

5.3.2 Raw water transfer scheme

A standard practice procedure would be prepared in consultation with the SCA and DECCW to guide the management of scour water. The procedure would form part of an Operation Environmental Management Plan for the pipeline. The procedure for managing scour water would typically involve the following:

- Maintenance scheduling - maintenance of pipeline sections and valves would be undertaken in winter when the likelihood of blue-green algae blooms in the Wingecarribee Reservoir are significantly lower. In the periods June-August the total cyanobacteria counts in the reservoir are typically observed at < 30 000 cells/mL, toxic species counts are < 1 000 cells/mL, and so it would be likely that toxic Microcystis counts would be <<< 11 500 cells/mL (though this would need to be confirmed);
- Assessing water prior to release from valve - the routine cyanobacteria and *E. coli* monitoring undertaken at the Wingecarribee Reservoir by SCA would be analysed to assess the likely water quality in the portion of pipeline that is being scoured. If the microbial water quality were considered to be undesirable for scouring and release to the farm dam, then management would involve either:

  1. Delaying the scour activity until such time that the monitoring suggests the risks of undesirable quality water being placed in the farm dam were sufficiently low (triggers would be agreed to by the receiving landowner and the SCA and DECCW); or

2. Providing on-site treatment (filtration or disinfection) by use of a portable treatment plant prior to release of the water to the farm dam (appropriate treatment would be agreed to by the receiving landowner and the SCA and DECCW);

- Release of water into an onsite reservoir. As mentioned above, a component of this plan would be that the water would not be released into environmental waterways, and would be pumped into a receiving farm dam for appropriate (stock and domestic) uses agreed to by the landholder and other relevant bodies. The farm dam would be designed, adequately sized and the scour activities coordinated in a manner to prevent the risk of the dam spilling into any nearby waterways.

6. Conclusion

Generally, as described in the risk assessment at Appendix A, it can be considered that the Project would pose some new, though manageable, risks to surface water quality in the Sydney Drinking Water catchments. The standard set of project controls described in Section 2.10 would broadly provide adequate control against the greater majority of risks to surface water quality. However, some additional mitigation measures would be necessary, as described in Section 5.

The key to these control measures is the prevention of erosion and run off from disturbed areas and the management of scour water from maintenance activities.

The implementation of the above control measures would minimize the impacts to water quality that would result from the Project.

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Appendix A

Environmental Risk Assessment Tables

Consequence Table

Aspect	Insignificant	Minor	Moderate	Major	Catastrophic
Waterways and floodplain function	Negligible change to waterway and flow regime	Changes to waterway or flow regime with minor implications	Changes to waterway or floodplain function with moderate implications	Waterway or floodplain function or river health significantly compromised	Extensive impact to waterway or floodplain function, river health irreversibly disturbed
Water quality	Applicable water quality standards met across the region	Isolated exceedance of water quality standards that is short lived	Exceedance of applicable water quality standards in a local area	Exceedance of applicable water quality standards in a number of local areas	Widespread exceedance of applicable water quality standards across the region

Likelihood Table

Likelihood	Description
Almost Certain	The event is expected to occur in most circumstances
Likely	The event would probably occur in most circumstances
Possible	The event could occur
Unlikely	The event could occur but not expected
Rare	The event occurs only in exceptional circumstances

Risk Matrix

Likelihood Level	Consequence Level				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	Low	Medium	High	Extreme	Extreme
Likely	Low	Medium	High	High	Extreme
Possible	Negligible	Low	Medium	High	High
Unlikely	Negligible	Low	Medium	Medium	High
Rare	Negligible	Negligible	Low	Medium	Medium

Environmental Risk Register – Surface Water Quality

Risk Pathway	*Consequence (IMPACT)*	*Project Controls*	*Consequence*	*Likelihood*	*Relative Risk*	*Additional Controls*	*Consequence*	*Likelihood*	*Treated Risk*
Construction activities at Wingecarribee Water Treatment Plant site									
Flooding of the pump station area (raw water option) during construction of the elevated building pad exposes pad (soil) to stormwater erosion.	Loss of soil. Sedimentation of surface water which flows to the Wingecarribee River.	Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction.	Insignificant	Unlikely	Negligible	None	-	-	-
Earthworks at the Wingecarribee Water Treatment Plant site disturb soils. Soils become exposed to stormwater erosion.	Loss of soil particularly topsoil via stormwater erosion.	Minimisation of area of disturbance. Erosion controls implemented in accordance with Soils and Construction: Managing Urban Stormwater Vol 1 (Landcom, 2004) and Soils and Construction: Managing Urban Stormwater Vol 2A Installation of services (DECC 2008) prior to commencement of construction.	Minor	Unlikely	Low	None	-	-	-
Earthworks at the Wingecarribee Water Treatment Plant site disturb soils. Soils become exposed to stormwater. Sediment laded surface water generated.	Degradation of water quality in Wingecarribee River.	Minimisation of area of disturbance. Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction.	Minor	Unlikely	Low	None	-	-	-

Spillages of stored fuels and chemicals during construction work at the Wingecarribee Water Treatment Plant site.	Generation of contaminated soil.	Minimal quantities of fuels and chemicals to be stored on construction areas. Any fuels and chemicals requiring storage on construction areas would be stored in accordance with relevant Australian Standards. Any spills of fuels or chemicals would be immediately cleaned up. Contaminated soil would be disposed of offsite in accordance with *Waste Classification Guidelines* (DECCW, 2008).	Insignificant	Unlikely	Negligible	None	-	-	-	
Spillages of stored fuels and chemicals during construction work at the Wingecarribee Water Treatment Plant site results in contaminated soil. Surface water runoff over contaminated soil becomes contaminated.	Degradation of water quality in Wingecarribee River.	Minimal quantities of fuels and chemicals would be stored on construction areas. Any fuels and chemicals requiring storage on construction areas would be stored in accordance with relevant Australian Standards. Any spills of fuels or chemicals would be immediately cleaned up. Contaminated soil would be disposed of offsite in accordance with Waste Classification Guidelines (DECCW 2008). Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction.	Insignificant	Unlikely	Negligible	None	-	-	-	
Trenching (Dryland)										

Trench construction activities disturb soil within the construction corridor and exposes soil to stormwater runoff.	Sheet erosion causing significant land degradation. Difficulty in re-establishing vegetation post construction, possibly resulting in further land degradation beyond the construction corridor.	Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction. Progressive rehabilitation of areas following pipe installation. Ongoing maintenance until agreed property rehabilitation objectives are achieved.	Minor	Unlikely	Low	None	-	-	-
Trench construction activities through shallow, sodic, saline, highly erosive soils, and / or steep slopes; exposes soils to stormwater and wind.	Soil erosion and land degradation. Temporary degradation of surface water quality in watercourse. Temporary degradation of aquatic habitat health.	Separate stockpiling of sodic and saline soils. Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction. Progressive rehabilitation of areas following pipe installation. Ongoing maintenance until agreed property rehabilitation objectives are achieved.	Minor	Unlikely	Low	None	-	-	-

Trench construction activities disturb soil within the construction corridor and exposes soil to stormwater runoff. Sediment laden stormwater generated and drains to nearby watercourse.	Temporary degradation of surface water quality in watercourse. Temporary degradation of aquatic habitat health	Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction. Progressive rehabilitation of areas following pipe installation Ongoing maintenance until agreed property rehabilitation objectives are achieved.	Insignificant	Unlikely	Negligible	None	-	-	-
Trench construction activities intercept shallow groundwater. Sediment laden water or spills of fuels and chemicals contaminates groundwater. Groundwater flows to watercourse.	Degradation of shallow groundwater (shallow groundwater likely to be greater than 3m bgl). Temporary degradation of surface water quality in watercourse. Temporary degradation of aquatic habitat health.	Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction. Progressive rehabilitation of areas following pipe installation. Ongoing maintenance until agreed property rehabilitation objectives are achieved.	Insignificant	Rare	Negligible	None	-	-	-

Trench construction activities intercept shallow groundwater. Sediment laden water or spills of fuels and chemicals infiltrates to groundwater.	Groundwater quality degraded making it temporarily unusable by downgradient receptors (stock watering, agriculture, garden irrigation, domestic use) which typically source water from aquifers at depths of at least 18m bgl.	Progressive backfilling on trench and rehabilitation of areas following pipe installation. Limit trench excavation depths (max. 2m bgl). Minimal quantities of fuels and chemicals would be stored on construction areas. Any fuels and chemicals requiring storage on construction areas would be stored in accordance with relevant Australian Standards. Any spills of fuels or chemicals would be immediately cleaned up. Contaminated soil would be disposed of offsite in accordance with *Waste Classification Guidelines* (DECCW, 2008)	Moderate	Rare	Low	None	-	-	-
Trench construction activities disturb soil within the construction corridor which results in dust generation.	Dust enters waterways.	Erosion controls established prior to commencement of construction. If potentially contaminated soils are encountered during construction works, the work would cease and the area investigated by a person qualified and experience in soil contamination investigations. Appropriate remediation actions would be undertaken if soil was found to be contaminated. Contaminated soil managed in accordance with the EPA guidelines.	Insignificant	Possible	Negligible	None	-	-	-

Trench construction activities disturb contaminated soils. Disturbed contaminated soil subject to stormwater erosion	Contaminated soil mobilises and contaminates adjoining areas. Surface water runoff over contaminated soil becomes contaminated. Water quality in nearby watercourses is degraded due to contaminated surface water inflows Temporary degradation of aquatic habitat health	Erosion controls established prior to commencement of construction. If potentially contaminated soils are encountered during construction works, the work would cease and the area investigated by a person qualified and experience in soil contamination investigations. Appropriate remediation actions would be undertaken if soil was found to be contaminated. Contaminated soil managed in accordance with the EPA guidelines.	Moderate	Rare	Low	None	-	-	-
Stormwater causes tunnel erosion within pipeline trench.	Ground subsidence causes hazards to livestock and vehicle movement	Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction. Use of seepage collars or bulk heads. Ongoing maintenance until agreed property rehabilitation objectives are achieved.	Minor	Rare	Negligible	None	-	-	-

Backfilled trench results in localised ground subsidence.	Ground subsidence causes hazards to livestock and vehicle movement	Ongoing maintenance until agreed property rehabilitation objectives are achieved.	Minor	Rare	Negligible	None	-	-	-
Construction excavations on steep slopes cause mass movement of soil	Damage to pipeline, mass movement into waterway.	Geotechnical intrusive investigations would be undertaken as part of detailed design. Mass movement hazards would be considered in design.	Moderate	Rare	Low	None	-	-	-
Trenching (Watercourses: drainage lines, gullies, ephemeral streams, creeks)									
Trench construction activities disturb soil within riparian zone. Exposes soil to stormwater runoff.	Loss of soil from disturbed areas and land degradation. Difficulty in re-establishing vegetation post construction, resulting in further land degradation beyond the construction corridor.	Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction. Progressive rehabilitation of areas following pipe installation. Ongoing maintenance until agreed property rehabilitation objectives are achieved.	Minor	Possible	Low	None	-	-	-
Trench construction activities in riparian zone through shallow, sodic, saline, highly erosive soils, and / or steep slopes; exposes soils to stormwater and wind.	Soil erosion and land degradation. Temporary degradation of surface water quality in watercourse.	Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction. Progressive rehabilitation of areas following pipe installation. Ongoing maintenance until agreed property rehabilitation objectives are achieved.	Minor	Possible	Low	None	-	-	-

Trench construction activities intercept shallow groundwater. Sediment laden water or spills of fuels and chemicals contaminates groundwater. Groundwater flows to watercourse.	Degradation of shallow groundwater (shallow groundwater likely to be greater than 3m bgl).	Progressive backfilling on trench and rehabilitation of areas following pipe installation. Limit trench excavation depths (max. 2m bgl). Minimal quantities of fuels and chemicals would be stored on construction areas. Any fuels and chemicals requiring storage on construction areas would be stored in accordance with relevant Australian Standards. Any spills of fuels or chemicals would be immediately cleaned up. Contaminated soil would be disposed of offsite in accordance with *Waste Classification Guidelines* (DECCW, 2008).	Minor	Possible	Low	None	-	-	-
Trench construction activities disturb soil within the construction corridor which results in dust generation	Dust enters waterways.	Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction. Construction would be staged to minimise the duration that materials are stockpiled	Insignificant	Likely	Low	None	-	-	-

Trench construction activities disturb contaminated soils. Disturbed contaminated soil subject to stormwater erosion.	Contaminated soil mobilises and contaminates adjoining areas. Surface water runoff over contaminated soil becomes contaminated. Water quality in nearby watercourses is degraded due to contaminated surface water inflows.	Erosion controls established prior to commencement of construction. If potentially contaminated soils are encountered during construction works, the work would cease and the area investigated by a person qualified and experience in soil contamination investigations. Appropriate remediation actions would be undertaken if soil was found to be contaminated. Contaminated soil managed in accordance with the EPA guidelines.	Minor	Rare	Negligible	None	-	-	-
Stormwater causes tunnel erosion within pipeline trench.	Ground subsidence causes erosion of watercourse bed.	Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction. Use of seepage collars or bulk heads. Ongoing maintenance until agreed property rehabilitation objectives are achieved.	Minor	Possible	Low	None	-	-	-
Backfilled trench results in localised ground subsidence.	Ground subsidence causes erosion of watercourse bed.	Rehabilitation of watercourse bed using appropriate materials in accordance with geomorphology study recommendations. Ongoing maintenance until agreed property rehabilitation objectives are achieved.	Minor	Possible	Low	None	-	-	-
Thrust boring									

Excavation of launch and/or receiver pits disturb soil within the construction corridor and exposes soil to stormwater runoff.	Sheet erosion causing significant land degradation. Difficulty in re-establishing vegetation post construction, resulting in further land degradation beyond the construction corridor	Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction. Progressive rehabilitation of areas following pipe installation. Ongoing maintenance until agreed property rehabilitation objectives are achieved.	Minor	Possible	Low	None	-	-	-
Thrust boring construction activities disturb soil within the construction corridor and exposes soil to stormwater runoff. Sediment laden stormwater flows to nearby watercourse.	Temporary degradation of surface water quality in watercourse Temporary degradation of aquatic habitat health.	Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction. Progressive rehabilitation of areas following pipe installation. Ongoing maintenance until agreed property rehabilitation objectives are achieved	Minor	Rare	Negligible	None	-	-	-
Excavation launch and receiver pits exposes soils to wind resulting in dust generation	Dust settles on water courses.	Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction. Construction would be staged to minimise the duration that materials are stockpiled.	Insignificant	Likely	Low	None	-	-	-

Drilling slurry, fuel or chemical spills in pits infiltrates to shallow groundwater or groundwater seepage into pits becomes contaminated with sediment, drilling fluids, fuels or chemicals.	Local degradation of groundwater quality. Groundwater quality degraded making it temporarily unusable by downgradient receptors (stock watering, agriculture, garden irrigation, domestic use) which typically source water from aquifers at depths of at least 18m bgl.	Groundwater seepages would be pumped out of pits prior to commencement of thrust boring and prior to backfilling and remediation of pits. Remove all drilling slurry from pits before backfilling. Minimal quantities of fuels and chemicals would be stored on construction areas. Any fuels and chemicals requiring storage on construction areas would be stored in accordance with relevant Australian Standards. Any spills of fuels or chemicals would be immediately cleaned up. Contaminated soil would be disposed of offsite in accordance with *Waste Classification Guidelines* (DECCW, 2008).	Minor	Possible	Low	None	-	-	-
Drilling slurry, fuel or chemical spills in pits infiltrates to deeper groundwater resource.	Quality of groundwater resource degraded making it temporarily unusable by downgradient receptors (stock watering, agriculture, garden irrigation, domestic use) which typically source water from aquifers at depths of at least 18m bgl.	Groundwater seepages would be pumped out of pits prior to commencement of thrust boring and prior to backfilling and remediation of pits.	Moderate	Rare	Low	None	-	-	-

Waterlogged soils encountered at thrust boring locations.	Instability of thrust block foundation, rupture of soils into waterways.	Trenching or underboring would be undertaken at locations if soil and geological conditions are not conducive to thrust boring.	Minor	Unlikely	Low	None	-	-	-
Underboring									
Excavation of launch and/or receiver pits disturb soil within the construction corridor and exposes soil to stormwater runoff.	Sheet erosion causing significant land degradation. Difficulty in re-establishing vegetation post construction, resulting in further land degradation beyond the construction corrido.	Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction. Progressive rehabilitation of areas following pipe installation. Ongoing maintenance until agreed property rehabilitation objectives are achieved.	Minor	Rare	Negligible	None	-	-	-
Thrust boring construction activities disturb soil within the construction corridor and exposes soil to stormwater runoff.	Sediment laden stormwater flows to nearby watercourse	Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction. Construction would be staged to minimise the duration that materials are stockpiled.	Minor	Unlikely	Low	None	-	-	-
Excavation of launch and/or receiver pits exposes soils to wind resulting in dust generation.	Dust settles on waterways.	Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction. Construction would be staged to minimise the duration that materials are stockpiled	Insignificant	Likely	Low	None	-	-	-

Drilling slurry, fuel or chemical spills in pits infiltrates to shallow groundwater or groundwater seepage into pits becomes contaminated with sediment, drilling fluids, fuels or chemicals.	Local degradation of groundwater quality.	Groundwater removed from pits and trench would either be pump out into a tank for off site disposal or pumped out and released onto vegetated land or passed through a sediment trap. Remove all drilling slurry from pits before backfilling. Minimal quantities of fuels and chemicals would be stored on construction areas. Any fuels and chemicals requiring storage on construction areas would be stored in accordance with relevant Australian Standards. Any spills of fuels or chemicals would be immediately cleaned up. Contaminated soil would be disposed of offsite in accordance with *Waste Classification Guidelines* (DECCW 2008).	Minor	Possible	Low	None	-	-	-
Frac-out occurs during underboring	Degradation of surface water in water course.	Groundwater seepages would be pumped out of pits prior to commencement of thrust boring and prior to backfilling and remediation of pits.	Minor	Unlikely	Low	None	-	-	-

Drilling slurry, fuel or chemical spills in pits infiltrates to deeper groundwater resource	Quality of groundwater resource degraded making it temporarily unusable by downgradient receptors (stock watering, agriculture, garden irrigation, domestic use) which typically source water from aquifers at depths of at least 18m bgl.	Groundwater removed from pits and trench would either be pump out into a tank for off site disposal or pumped out and released onto vegetated land or passed through a sediment trap. Remove all drilling slurry from pits before backfilling. Minimal quantities of fuels and chemicals would be stored on construction areas. Any fuels and chemicals requiring storage on construction areas would be stored in accordance with relevant Australian Standards. Any spills of fuels or chemicals would be immediately cleaned up. Contaminated soil would be disposed of offsite in accordance with *Waste Classification Guidelines* (DECCW, 2008)	Moderate	Rare	Low	None	-	-	-
Soil Management										
Stockpiling of topsoil and subsoils generates dust.	Loss of soils from wind erosion, dust settles on waterways.	Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction. Construction would be staged to minimise the duration that materials are stockpiled.	Minor	Unlikely	Low	None	-	-	-
Stockpiling of topsoil and subsoils generates dust.	Construction workers exposed to dust inhalation.	Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction. Construction would be staged to minimise the duration that materials are stockpiled.	Insignificant	Possible	Negligible	None	-	-	-

Stockpiling of topsoil and subsoil exposes soil to rain and stormwater runoff.	Loss of soils from stormwater erosion.	Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction. Construction would be staged to minimise the duration that materials are stockpiled	Minor	Unlikely	Low	None	-	-	-
Stockpiling of topsoil and subsoils exposes soil to rain and stormwater runoff.	Soil erosion and land degradation. Temporary degradation of surface water quality in watercourse.	Erosion controls implemented in accordance *with Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2A Installation of Services* (DECC, 2008) prior to commencement of construction. Progressive rehabilitation of areas following pipe installation. Ongoing maintenance until agreed property rehabilitation objectives are achieved.	Minor	Unlikely	Low	None	-	-	-
Construction corridor access									
Construction traffic movements disturb soil at access points and along construction corridor exposing soil to stormwater runoff.	Soil erosion (gully or sheet erosion) at access points. Difficulty in re-establishing vegetation post construction, resulting in further land degradation.	Erosion controls implemented in accordance with *Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2C Unsealed Roads* (DECC, 2008a) prior to commencement of construction. Progressive rehabilitation of areas following pipe installation Ongoing maintenance until agreed property rehabilitation objectives are achieved	Minor	Unlikely	Low	None	-	-	-

Construction traffic movements disturb soil (particularly saline and waterlogged soils, shallow soils, sodic soils) at access points and along construction corridor exposing soil to stormwater runoff	Degradation of aquatic habitat health in nearby minor watercourse resulting in significant dieback of aquatic flora and / or decrease in aquatic fauna populations.	Erosion controls implemented in accordance with *Soils and Construction: Managing Urban Stormwater Vol 1* (Landcom, 2004) and *Soils and Construction: Managing Urban Stormwater Vol 2C Unsealed Roads* (DECC, 2008a) prior to commencement of construction. Progressive rehabilitation of areas following pipe installation. Ongoing maintenance until agreed property rehabilitation objectives are achieved.	Minor	Unlikely	Low	None	-	-	-
General contaminated soil management									
Disturbance of contaminated soils. Disturbed contaminated soil subject to stormwater erosion.	Contamination of adjacent (clean) soil.	Erosion controls established prior to commencement of construction. If potentially contaminated soils are encountered during construction works, the work would cease and the area investigated by a person qualified and experience in soil contamination investigations. Appropriate remediation actions would be undertaken if soil was found to be contaminated. Contaminated soil managed in accordance with the EPA guidelines.	Minor	Rare	Negligible	None	-	-	-
Trench / thrust boring / underboring activities disturb contaminated soils. Disturbed contaminated soil subject to stormwater erosion.	Groundwater quality degraded making it unusable to sensitive receptors (stock watering, agriculture, garden irrigation).	Erosion controls established prior to commencement of construction. If potentially contaminated soils are encountered during construction works, the work would cease and the area investigated by a person qualified and experience in soil contamination investigations. Appropriate remediation actions would be undertaken if soil was found to be contaminated. Contaminated soil managed in accordance with the EPA guidelines.	Minor	Rare	Negligible	None	-	-	-

Trench / thrust boring / underboring activities disturb contaminated soils. Disturbed contaminated soil subject to stormwater erosion.	Groundwater quality degraded making it unusable for human use.	Erosion controls established prior to commencement of construction. If potentially contaminated soils are encountered during construction works, the work would cease and the area investigated by a person qualified and experience in soil contamination investigations. Appropriate remediation actions would be undertaken if soil was found to be contaminated. Contaminated soil managed in accordance with the EPA guidelines.	Moderate	Rare	Low	None	-	-	-
Disturbance of contaminated soils. Disturbed contaminated soil subject to stormwater erosion.	Workers and Residents exposed to contaminants by ingestion, inhalation or dermal contact.	Erosion controls established prior to commencement of construction. If potentially contaminated soils are encountered during construction works, the work would cease and the area investigated by a person qualified and experience in soil contamination investigations. Appropriate remediation actions would be undertaken if soil was found to be contaminated. Contaminated soil managed in accordance with the EPA guidelines.	Minor	Rare	Negligible	None	-	-	-
Maintenance activities									
Scour water is discharged into ground with shallow soils, saline soils, sodic soils or on steep slopes.	Discharges cause soil (sheet and or gully) erosion	-	Moderate	Likely	High	No discharges to environmental waterways, make	Minor	Rare	Negligible

Dirty scour water is discharge onto ground and into waterways.	Water quality degraded making it unusable for current activities (especially due to blue-green algae levels).	-	High	Likely	Medium		Moderate	Rare	Low
Spillages of storaged fuels and chemicals during maintenance work at the Wingecarribee Water Treatment Plant site or along the pipeline.	Spilled materials enter nearby waterways.	Minimal quantities of fuels and chemicals to be stored at the pumping station. Any fuels and chemicals requiring storage would be stored in accordance with relevant Australian Standards. Any spills of fuels or chemicals would be immediately cleaned up. Contaminated soil would be disposed of offsite in accordance with *Waste Classification Guidelines* (DECCW, 2008)	Insignificant	Unlikely	Negligible	None	-	-	-

Appendix B

Creek and River Crossings

1:45,000 (at A3)

0 500 1,000 1,500 2,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Proposed Route (29/11/2009)
- Properties Intersected By Corridor
- Natural Drainage Line
- River/Creek
- Railways
- PrimaryRoad
- ArterialRoad
- SubArterialRoad
- LocalRoad
- Track-Vehicular
- UrbanServiceLane
- GMC / WSC LGA Boundary
- Sector boundary
- HydroArea

Waterway Class

- Drainage Line
- Minor Creek
- Moderate Creek
- Major Creek/River

CLIENTS | PEOPLE | PERFORMANCE

Goulburn Mulwaree Council
Highlands Source Project

Waterway crossings
Sector: Werai - Glenquarry

Job Number	23-13312
Revision	0
Date	09 FEB 2010

Figure A1

G:\23\13312\GIS\ArcView\Wkspace\EAFigures\23_13312_EA_WaterwaysCrossings.mxd

Level 7, 16 Marcus Clarke Street Canberra ACT 2601 **T** 61 2 6113 3200 **F** 61 2 6113 3299 **E** cbrmail@ghd.com.au **W** www.ghd.com.au

Data Source: NSW Lands Dept: roadsegments, railways,hydroarea, hydroline - 2007; GMC: aerial imagery - 2008; GMC/WSC: Cadastral data - 2009. Created by: ccharalambou

1:45,000 (at A3)

0 500 1,000 1,500 2,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Proposed Route (29/11/2009)
- Properties Intersected By Corridor
- Railways
- Natural Drainage Line
- River/Creek
- PrimaryRoad
- ArterialRoad
- SubArterialRoad
- LocalRoad
- Track-Vehicular
- UrbanServiceLane
- GMC / WSC LGA Boundary
- Sector boundary
- HydroArea

Waterway Class

- Drainage Line
- Minor Creek
- Moderate Creek
- Major Creek/River

GHD
CLIENTS | PEOPLE | PERFORMANCE

Goulburn Mulwaree Council
Highlands Source Project

Waterway crossings
Sector: Sutton Forest-Exeter

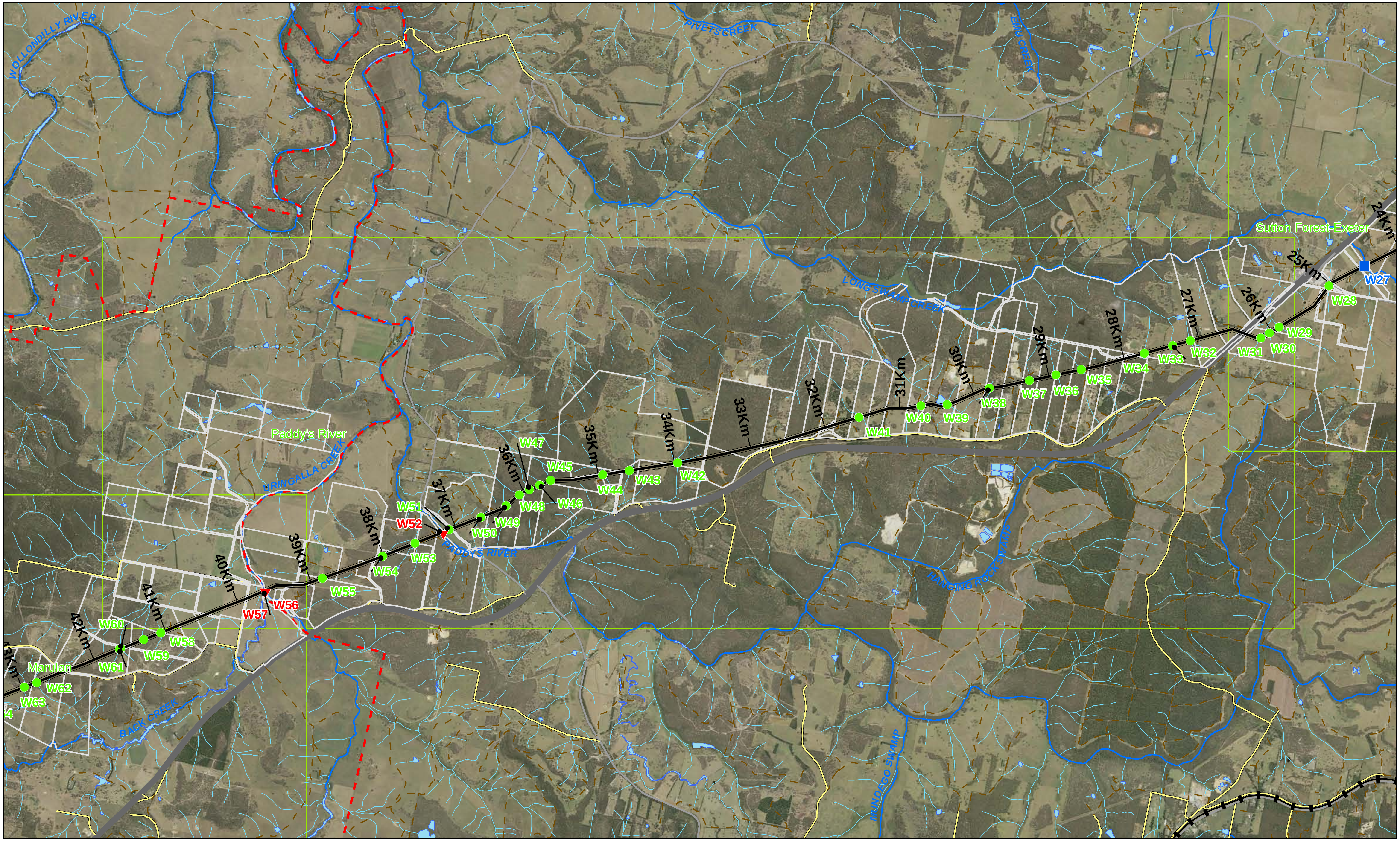
Job Number	23-13312
Revision	0
Date	09 FEB 2010

Figure A2

G:\23\13312\GIS\ArcView\Wkspace\EAFigures\23_13312_EA_WaterwaysCrossings.mxd

Level 7, 16 Marcus Clarke Street Canberra ACT 2601 **T** 61 2 6113 3200 **F** 61 2 6113 3299 **E** cbrmail@ghd.com.au **W** www.ghd.com.au

Data Source: NSW Lands Dept: roadsegments, railways,hydroarea, hydroline - 2007; GMC: aerial imagery - 2008; GMC/WSC: Cadastral data - 2009. Created by: ccharalambou



1:45,000 (at A3)

0 500 1,000 1,500 2,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

Proposed Route (29/11/2009)	Properties Intersected By Corridor
Natural Drainage Line	River/Creek
Railways	
PrimaryRoad	ArterialRoad
SubArterialRoad	LocalRoad
Track-Vehicular	UrbanServiceLane
GMC / WSC LGA Boundary	Sector boundary
HydroArea	

Waterway Class

- Drainage Line
- Minor Creek
- Moderate Creek
- Major Creek/River

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CLIENTS | PEOPLE | PERFORMANCE

GOULBURN MULWAREE COUNCIL

Goulburn Mulwaree Council
Highlands Source Project

Waterway crossings
Sector: Paddys River

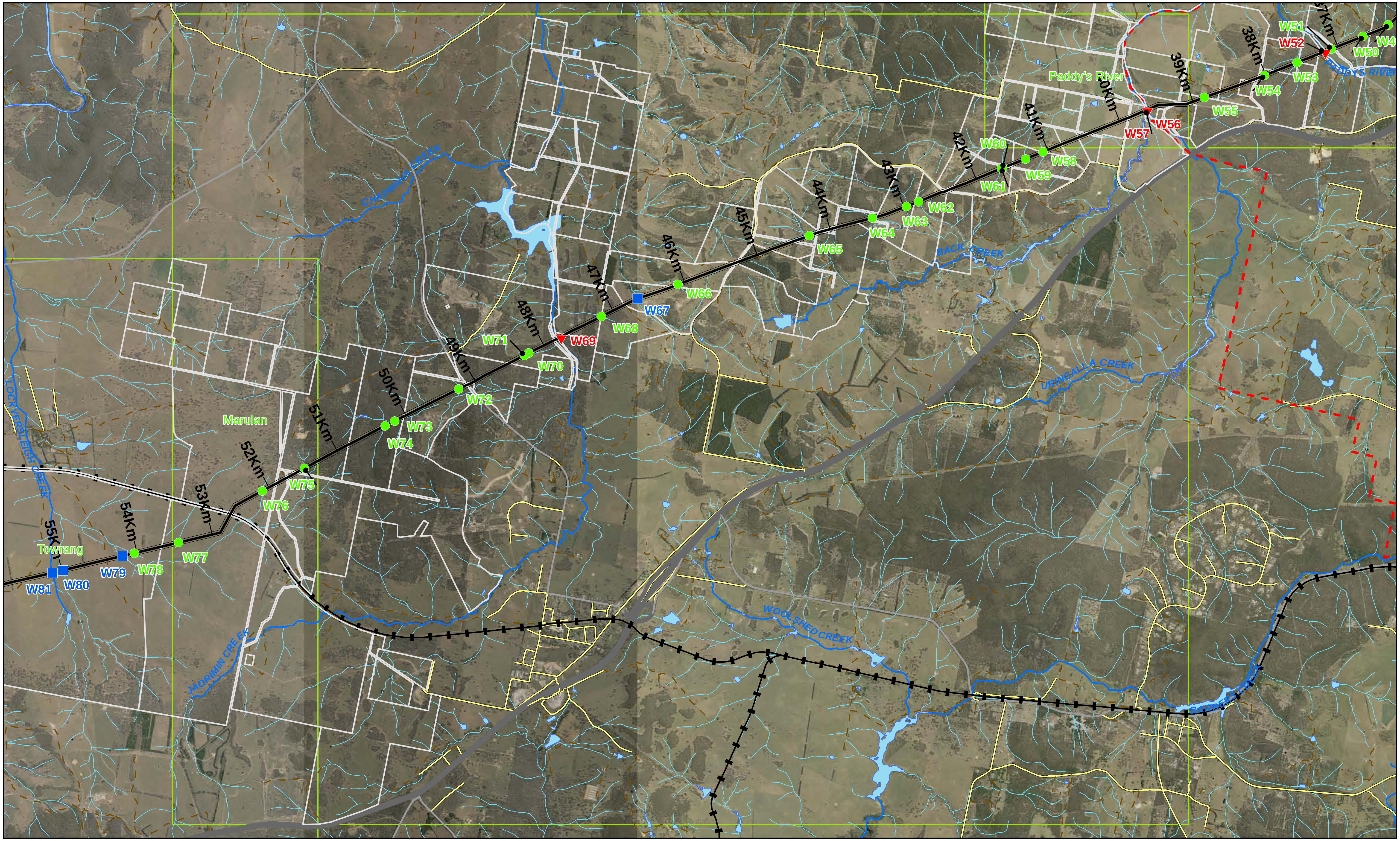
Job Number	23-13312
Revision	0
Date	09 FEB 2010

Figure A3

G:\23\13312\GIS\ArcView\Wkspace\EAFigures\23_13312_EA_WaterwaysCrossings.mxd

Level 7, 16 Marcus Clarke Street Canberra ACT 2601 T 61 2 6113 3200 F 61 2 6113 3299 E cbrmail@ghd.com.au W www.ghd.com.au

Data Source: NSW Lands Dept: roadsegments, railways,hydroarea, hydroline - 2007; GMC: aerial imagery - 2008; GMC/WSC: Cadastral data - 2009. Created by: ccharalambou



1:45,000 (at A3)

0 500 1,000 1,500 2,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

Proposed Route (29/11/2009)
Properties Intersected By Corridor
Natural Drainage Line
River/Creek
Railways
PrimaryRoad
ArterialRoad
SubArterialRoad
LocalRoad
Track-Vehicular
UrbanServiceLane
GMC / WSC LGA Boundary
Sector boundary
HydroArea

Waterway Class

Drainage Line
Minor Creek
Moderate Creek
Major Creek/River

GHD
CLIENTS | PEOPLE | PERFORMANCE

Goulburn Mulwaree Council

Goulburn Mulwaree Council
Highlands Source Project

Waterway crossings
Sector: Marulan

Job Number	23-13312
Revision	0
Date	09 FEB 2010

Figure A4

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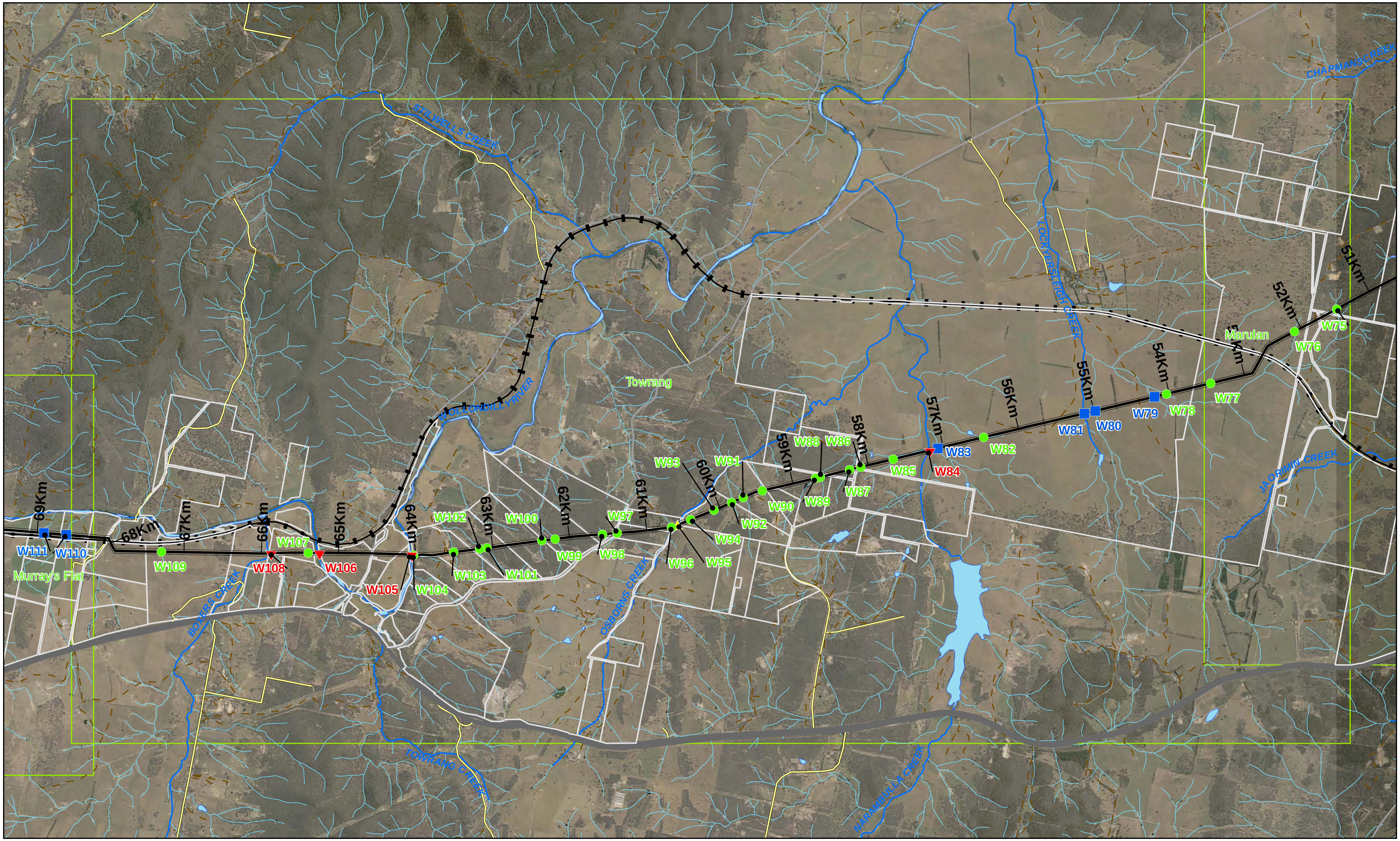
Level 7, 16 Marcus Clarke Street Canberra ACT 2601 **T** 61 2 6113 3200 **F** 61 2 6113 3299 **E** cbrmail@ghd.com.au **W** www.ghd.com.au

Data Source: NSW Lands Dept: roadsegments, railways,hydroarea, hydroline - 2007; GMC: aerial imagery - 2008; GMC/WSC: Cadastral data - 2009. Created by: ccharalambou



1:45,000 (at A3)

0 500 1,000 1,500 2,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Proposed Route (29/11/2009)
- Properties Intersected By Corridor
- Natural Drainage Line
- River/Creek
- Railways
- PrimaryRoad
- ArterialRoad
- SubArterialRoad
- LocalRoad
- Track-Vehicular
- UrbanServiceLane
- GMC / WSC LGA Boundary
- Sector boundary
- HydroArea

Waterway Class

- Drainage Line
- Minor Creek
- Moderate Creek
- Major Creek/River

CLIENTS | PEOPLE | PERFORMANCE

Goulburn Mulwaree Council
Highlands Source Project

Waterway crossings
Sector: Towrang

Job Number	23-13312
Revision	0
Date	09 FEB 2010

Figure A5

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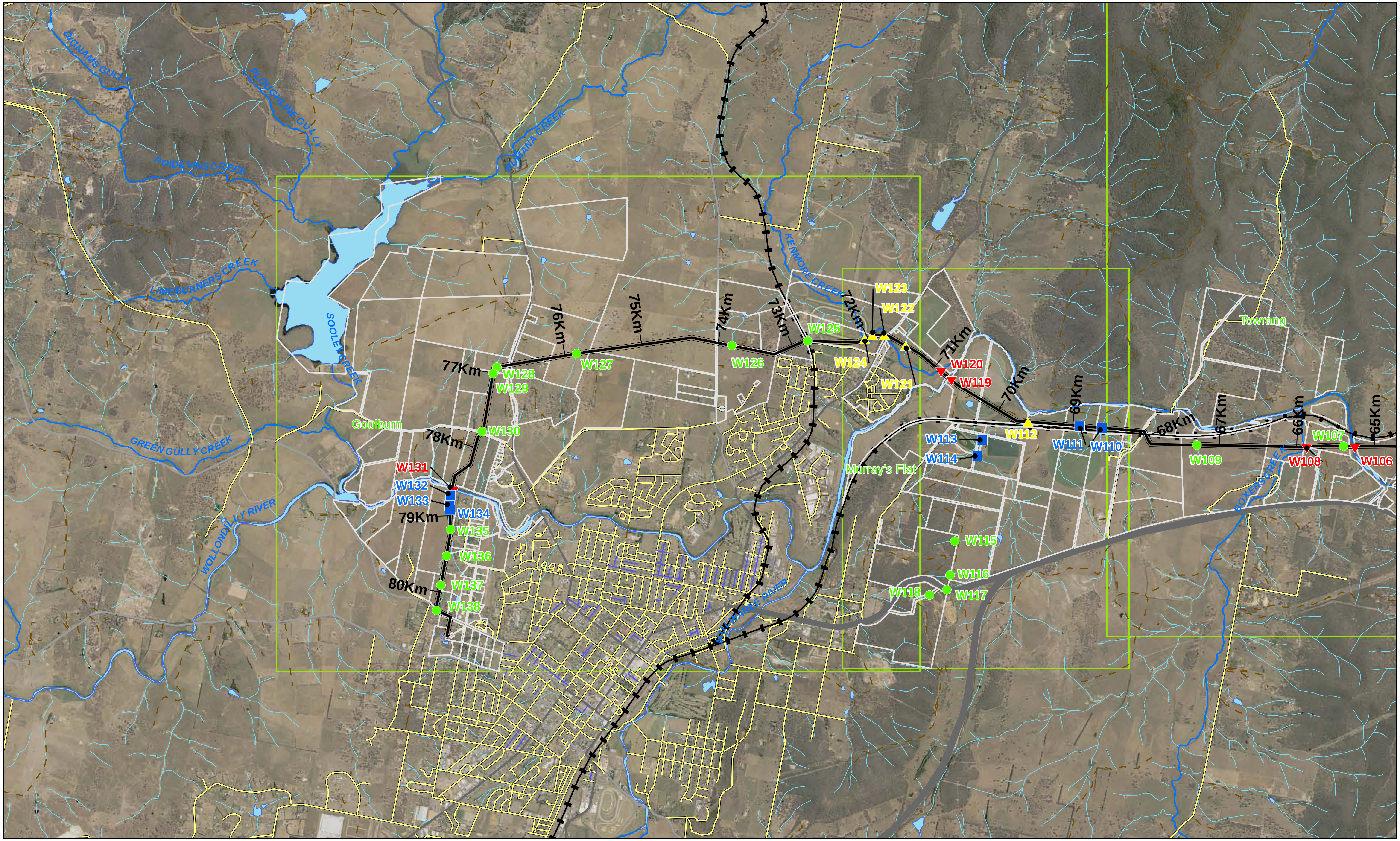
Level 7, 16 Marcus Clarke Street Canberra ACT 2601 T 61 2 6113 3200 F 61 2 6113 3299 E cbrmail@ghd.com.au W www.ghd.com.au

Data Source: NSW Lands Dept: roadsegments, railways,hydroarea, hydroline - 2007; GMC: aerial imagery - 2008; GMC/WSC: Cadastral data - 2009. Created by: ccharalambou



1:45,000 (at A3)

0 500 1,000 1,500 2,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Proposed Route (29/11/2009)
- Properties Intersected By Corridor
- Natural Drainage Line
- River/Creek
- Railways
- PrimaryRoad
- ArterialRoad
- SubArterialRoad
- LocalRoad
- Track-Vehicular
- UrbanServiceLane
- GMC / WSC LGA Boundary
- Sector boundary
- HydroArea

Waterway Class

- Drainage Line
- Minor Creek
- Moderate Creek
- Major Creek/River

CLIENTS | PEOPLE | PERFORMANCE

Goulburn Mulwaree Council
Highlands Source Project

Waterway crossings

Sector: Goulburn-Murrays Flat

Job Number	23-13312
Revision	0
Date	09 FEB 2010

Figure A6

G:\23\13312\GIS\ArcView\Wkspace\EAFigures\23_13312_EA_WaterwaysCrossings.mxd

Level 7, 16 Marcus Clarke Street Canberra ACT 2601 **T** 61 2 6113 3200 **F** 61 2 6113 3299 **E** cbrmail@ghd.com.au **W** www.ghd.com.au

Data Source: NSW Lands Dept: roadsegments, railways,hydroarea, hydroline - 2007; GMC: aerial imagery - 2008; GMC/WSC: Cadastral data - 2009. Created by: ccharalambou

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		Name	Signature	Name	Signature	Date
0	W Lee / R Berg	DRAFT	-	DRAFT	-	27 Nov 2009
1	W Lee / R Berg	R Signor	R Signor	J Earle	J Earle	27 Jan 2010
2	R Signor	R Kwan	*R Kwan	C Allard	*C Allard	09 Feb 2010