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Goulburn Mulwaree Council

Report for Highlands Source Project

Soil, Groundwater & Contamination Impact Assessment

April 2010

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

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Glossary of Terms

Acid Sulfate Soils	Acid sulfate soils are the common name given to soils containing iron sulfides. When the iron sulfides in the soil are exposed to air, it produces sulfuric acids. The acid can move through the soil, acidifying soil water, groundwater and, eventually, surface waters.
Aquifer	A below ground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, silt, or clay) in which groundwater can be stored
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.
Consent	Approval to undertake a development received from the consent authority.
Consent Authority	The government agency that determines a development application to undertake a proposed development. In the case of the Highlands Source Project the Consent Authority is the NSW Department of Planning.
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.
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*.
Erosion	A natural process where wind or water detaches a soil particle and provides energy to move the particle.
Erosion and Sedimentation Controls	Physically installed structures or operating procedures that prevent or minimise soil erosion and capture sediment laden stormwater on site
Fill	Re-used earthen material
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.
Igneous rock	Rock formed by the cooling and solidification of magma.
Particulates	Dust and other fine particles.
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.

Receptor	A noise and air quality modelling term used to describe a map reference point where noise or air quality is predicted. A sensitive receptor would be a home, work place, church, school or other place where people spend time.
Salinity hazard	The varying degree of risk of salinity occurrence. Salinity occurs when there is excessive build up of dissolved salts in soil and groundwater.
Scouring	A pipeline maintenance activity that required the release of pipeline water (scour water). The activity is predominantly undertaken when the pipeline needs to be maintained or cleaned internally.
Scour water	Water released from the pipeline during scouring.
Seasonal waterlogging	Soils subject to saturation during seasonally higher rainfall.
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.
Sedimentary rock	Rock formed from the consolidation of sediments
Shallow soils	Areas where the soil layer is thin and rock would likely be encountered at shallow depth.
Sheet erosion hazard	Soils susceptible to the removal of a uniform thin layer of soil by raindrop splash or water run-off.
Site compound	Area enclosing construction machinery, stockpiles and site offices usually adjacent to construction sites.
Sodicity	"Sodic soil" is typically associated with agricultural soil science. Its environmental engineering implications are highly dispersive, erodible soils, prone to waterlogging.
Spoil	Excess of rock and/or earth material resulting from construction activities.
Steep slopes / Mass movement hazard	Soils on steep slopes which is subject to mass movement down slope.

Acronyms & Abbreviations

ASS	Acid Sulfate Soil
ASSMP	Acid Sulfate Soil Management Plan
bgl	Below ground level
DECCW	NSW Department of Environment, Climate Change and Water
EEC	Endangered Ecological Communities
EP&A Act	*Environment Planning and Assessment Act 1979.*
DoP	Department of Planning
DGR(s)	Director-General's Requirement(s)
GMC	Goulburn Mulwaree Council
HSP	Highlands Source Project
km	Kilometres
kV	Kilovolts
LGA	Local Government Area
m	Metres
mm	Millimetres
NSW	New South Wales
PASS	Potential Acid Sulfate Soil
ppm	Parts per million
SCA	Sydney Catchment Authority
SEPP	State Environment Protection Policy
WSC	Wingecarribee Shire Council
WTP	Water Treatment Plant

Executive Summary

This Executive Summary should be read in conjunction with the remainder of the report.

Introduction

Goulburn Mulwaree Council (GMC) proposes to undertake the Highlands Source Project (referred to as 'the Project'). The Project is to construct and operate a water supply scheme that would transfer water from the Wingecarribee Reservoir to Goulburn. This report provides an assessment of the potential construction and operational impacts posed by the Project on soil landscapes, groundwater and potentially contaminated land. Recommended mitigation measures to minimise these impacts are also provided.

Project activities

Project activities that would have the potential to disturb soils, groundwater and any areas of contaminated land include the following:

- Construction of the pumping station mound adjacent to the existing Raw Water Pumping Station at the Wingecarribee WTP site;
- Construction of the pipeline trench to depths of 1.2 m to 1.5 m below ground level through open ground, drainage lines and up to 2.5 m below ground level through minor watercourses;
- Excavations associated with constructing launch and receiving pits associated with thrust boring and horizontal direction drilling;
- Establishing primary and secondary site compounds and pipe lay down areas, which could involve the storage of minor quantities of fuels and chemicals;
- Construction traffic movements and along the pipeline construction corridor;
- Releasing pipeline water during maintenance (scouring); and
- Operating and maintaining the pumping station, which could involve the store of minor quantities of fuels and chemicals on site.

The Project would also involve the implementation of a number of controls during the construction phase. The controls would meet accepted practices for the prevention or management of:

- Sedimentation and erosion controls;
- Rehabilitation of disturbed areas;
- Spoil management;
- Groundwater interception and seepages;
- Acid sulfate soils and saline soils; and
- Scour water releases.

Construction work teams would be educated in the processes, techniques and responsibilities associated with implementing the Project controls.

Existing environment

Topography

The proposed pipeline route would traverse variable topography including:

- Flood plain;
- Rises, low hills and hills; and
- River valleys;

The route would cross some steep terrain, most notably adjacent to Paddy's River around Hanging Rock Road (~Ch 33 750 and Ch 37 100). There are also some locally steep slopes associated with Mount Broughton. Slopes of up to 22 degrees are indicated to exist in the hilly terrain adjacent to Paddy's River. Steeper slopes may occur locally along the proposed pipeline easement.

Regional geology

The proposed pipeline route would traverse a number of geological units. The geology underlying the proposed pipeline route would likely include sedimentary rock (predominantly shales, siltstones and sandstones) or igneous rock (predominantly basalts, granitic formations).

The geology underlying the majority of the watercourses is predominantly sedimentary rock or alluvial deposits (which are likely to be underlaid by sedimentary rock). Igneous rock (most likely overlain 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 at the Wollondilly River (WAT 20).

The geology underlying the road crossings would vary. The geological maps show all road crossings which are proposed to be thrust bored (Hume Highway, Illawarra Highway (Robertson Road), Sheepwash Road) are underlain by sedimentary rock.

The geological maps show all rail crossings are underlain by sedimentary rock except for crossing RAIL 3 (Main Southern Railway) which is underlain by igneous rock.

Soil landscapes

The published soil landscape maps for the Hawkesbury – Nepean Catchment identified 34 soil landscapes along the proposed pipeline route. These soil landscapes can be grouped into the following major soil types; erosional, transferral, alluvial, colluvial and residual. A number of inherent and spatial constraints have been recorded for these soil landscapes including waterlogging, sheet erosion hazards, salinity hazards, sodicity, shallow soil cover and steep slopes.

At the pipeline crossing locations the soil landscapes are expected to be as follows:

- Water Crossings: The soil landscapes present at the majority of proposed watercourse crossings are either alluvial or transferral;

- Road Crossings: The majority of road crossings would be undertaken in erosional soils that are subject to widespread sheet erosion and sodicity; and
- Railway Crossings: The soil landscapes expected at the railway crossings include transferral (RAIL 1 to 3), alluvial (RAIL 4) and erosional (RAIL 5). The soil landscapes at these locations are subject to sheet erosion hazards and sodicity. The erosional soil landscape is also subject to localised salinity.

Groundwater

Information on groundwater within bores located in the vicinity of the pipeline route was obtained from the NSW Office of Water's (formerly the NSW Department of Water and Energy) database of registered groundwater bores located throughout New South Wales (DWE 2004). The data provided was incomplete and it is recognised it's use in determining the local groundwater conditions beneath the proposed pipeline route has limitations. Despite the limitations, the review of information held in the database revealed there are approximately 350 registered groundwater bores located within 2 km from the proposed pipeline route.

The depth of the boreholes has been used to infer the depth to significant aquifers. This assumes that the depth of drilling during bore construction was terminated when a significant source of groundwater was encountered. The majority of these bores have depths of greater than 18 m (many have recorded depths of between 40 m and 90 m below ground level). There are eight bores within 2 km of the pipeline route that may contain shallow groundwater (< 10 m bgl) of which the distance of the nearest bore to the proposed pipeline route is approximately 230 m. Shallow groundwater could also be expected adjacent to watercourse and within flood plains.

Since trenching and excavations would not likely be undertaken to depths over 3 m below ground level, the risk of encountering a significant groundwater resource or a groundwater resource used by nearby landholders is low. Groundwater seepages into the pipeline trench or pit excavations may occur locally in areas that contain shallow groundwater, but this would not be typically expected. If this were to occur the groundwater would be pump out of the excavations and released to a farm dam. If the water is turbid then it could be treated in the farm dam.

The database of register groundwater bores also contained limited information regarding groundwater quality. The information provided some records of the quality (mainly salinity) of the groundwater encountered in the registered bores. Salinity in the bores has been recorded as a qualitative (eg. 'good', 'fair', 'salty' etc) or quantitative (eg. 1001 - 3000 parts per million [ppm]) measure.

The majority of salinity data provided showed the measure of salinity as 'good', 'fair', 'fresh' or <1000 ppm. This demonstrates that groundwater of relatively low salt concentrations would be expected to exist beneath the majority of the proposed pipeline easement.

High quality groundwater would be expected particularly in the area around Lot 122 / DP 802050 (sector Paddy's River) which is located approximately 5 km west-south west of Sallys Corner. This block contains seven bores from which groundwater is extracted and bottled for drinking water. It is expected that the groundwater beneath this site flows in a northerly direction. The shallowest groundwater bore on Lot 122 / DP 802050 is 15 m bgl, which is well below the expected trenching depth of 1.5 m bgl.

Of bores located within 2 km of the pipeline route, poor quality groundwater (recorded as 'bad', 'stock', `1001-3000 ppm', 'hard' or 'salty') was recorded in thirteen bores. These bores have depths of 18 m bgl or greater. The nearest bore containing poor quality groundwater would be 640m from the proposed pipeline easement. It is considered that 'poor' quality groundwater is not likely to be encountered during the construction of operation of the proposed Project.

In general, the localised groundwater flow directions beneath the proposed pipeline easement are likely to vary spatially by sub-catchment reflecting the variable topography along the proposed route.

It is considered that excavations associated with thrust boring at crossings (crossings ROAD 3, 6, 22/23, and 71 and RAIL 1 to 5) have the greatest potential to impact shallow groundwater as depths of the launch and receiving pits could be up to 3m below ground level. Trenching is not expected to be greater than 1.5 m below groundwater and the in situ nature of horizontal direction drilling would not likely create significant groundwater disturbance. The bores depths (and hence the likely groundwater resources being accessed by the groundwater bores) down stream of these crossing are typically greater that 18 m bgl. There are three bores that are 10 m bgl or less downstream of crossing ROAD 71 (Crookwell Road). These bores are however located at least 820 m from the proposed ROAD 71 crossing. Impacts to significant groundwater resources are therefore not expected.

Contaminated land

The *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites* (ANZECC & NHMRC 1992) lists 'railway yards' as a potentially contaminated activity. Weed management on railway lines often included the spraying weedicides and herbicides onto the tracks. As such, excavations adjacent to, and boring beneath, the railway line may encounter contaminated soil.

During route selection fieldwork, four 'areas of potential concern' (being areas where potentially contaminating activities have or may have taken place) were observed adjacent to or within the pipeline easement. The areas included piles of discarded materials, an area containing discarded drums and stockyards.

The proposed pipeline route does not traverse any properties that have had notices issued under the *Contaminated Land Management Act 1997*.

Impact assessment

A detailed impact risk assessment (risk assessment) has been conducted to identify and assess the potential construction and operational impacts of the Project on the existing environment (soils, groundwater and contamination). A qualitative risk assessment framework was used.

The assessment of the risks (likelihood and consequence) of construction and operational related events occurring (which would lead to impacts to soils, groundwater and contamination) concluded the following:

- The risk of most events occurring is 'negligible' or 'low'. This is primarily due to the construction techniques that would be adopted and the extensive Project controls that would be implemented. Negligible or low risks are consider acceptable in the context of the Project; and
- The risk of encountering contaminated soil on effluent irrigated land near Goulburn is considered to be 'medium'. There is the potential that disturbance of contaminated land on effluent irrigated land has the potential to cause health impacts to construction works and impacts to surface water quality. Mitigation measures to prevent these impacts are recommended. The residual risk of this mitigated event occurring is considered to be 'low' as the likelihood of disturbing contaminated soil in the effluent irrigation area would be eliminated following an investigation and subsequent remediation of any significantly contaminated soil.

Mitigation measures

Prior to construction, a contaminated soil investigation should be undertaken in the effluent irrigation area on Lots 1 and 2 / DP 1126788.

Based on the results of the proposed investigation, plans for protecting the health of constructions workers and for managing and re-using excavated spoil should be prepared and included in the Construction Environmental Management Plan. This could include remediation of any significantly contaminated soil.

Conclusions

The risks of events occurring that would result in significant impacts to soils and groundwater during the construction and operational phases of the Project are considered to be 'negligible' or 'low' if the proposed project controls are implemented, maintained and audited; and the recommended mitigation measures are undertaken.

As such it is considered that the Project would not result in any significant impacts to soil, groundwater or contamination.

1. Introduction

1.1 General

Goulburn Mulwaree Council (GMC) proposes to undertake the Highlands Source Project (referred to as 'the Project'). The Project is to construct and operate a water supply scheme that would transfer water from the Wingecarribee Reservoir to Goulburn. This report provides an assessment of the potential impacts to the existing topography, geology, soil and groundwater, which could result during the construction and operation of the Project. It also considers the constraints posed by the existing topography, geology, soil and groundwater on the Project.

1.2 Project overview

The Project is to construct and operate a water supply scheme that would transfer water from the Wingecarribee Reservoir to Goulburn. The scheme comprises approximately 83 km of DN 300 mm to DN 375 mm diameter pipeline, a pump station at the Wingecarribee Reservoir site, and a telemetry system.

It is proposed to have the Project operational by June 2011.

Key construction activities include:

- Establishing pipe lay down areas and site compounds;
- Establishing access points to the pipeline construction corridor;
- Construction of a pump station at the Wingecarribee Reservoir site;
- Earthworks (excavations and trenching);
- Construction of railway, road and river crossings by either trenching, thrust boring or horizontal direction drilling; and
- Rehabilitating disturbed ground.

Key operational activities would include:

- Regular maintenance of the pumping station;
- Regular maintenance of the air valves and scour valves;
- Less frequent maintenance of the pipeline (*e.g.* pigging to remove blockages, or repairing bursts as required); and
- Maintenance of rehabilitated areas.

The Project is located from the Wingecarribee Reservoir within the Wingecarribee Local Government Area (LGA), to Goulburn within the Goulburn Mulwaree LGA. The Wingecarribee LGA is located in the Southern Highlands and centred approximately 150 km south of Sydney. The majority of the LGA is elevated > 640 m (above sea level). The Goulburn Mulwaree LGA is situated to the south west of the

Wingecarribee LGA. The pipeline corridor follows an upward sloping gradient to Goulburn, *ca.* 702 m (above sea level).

The Project would either transfer raw water directly from the Wingecarribee Reservoir or treated water from the Wingecarribee WTP. If raw water is transferred to Goulburn, the water would be transferred to an existing reservoir at the Goulburn WTP (WTP), which is located near the corner of Clinton Street and River Street, Goulburn. If treated water is transferred to Goulburn, it would be transferred to a new reservoir, which would be located on the eastern side of Goulburn in the Murray's Flat area, or would be connected directly into Goulburn's main water supply network at a location on the eastern side of Goulburn. Both the raw water transfer scheme and the treated water transfer scheme are considered in this report.

The proposed pipeline would be laid within an approximately 10 m wide pipeline easement. This easement would located predominantly adjacent to existing infrastructure easements that have previously been cleared. These existing easements include Transgrid's 330kV powerline easement and the Moomba to Sydney Pipeline easement (which contains two gas pipelines). As described above, depending on whether raw water or treated water is transferred from Wingecarribee, the route of the pipeline easement would vary depending on which receiving reservoir or connection point would be used.

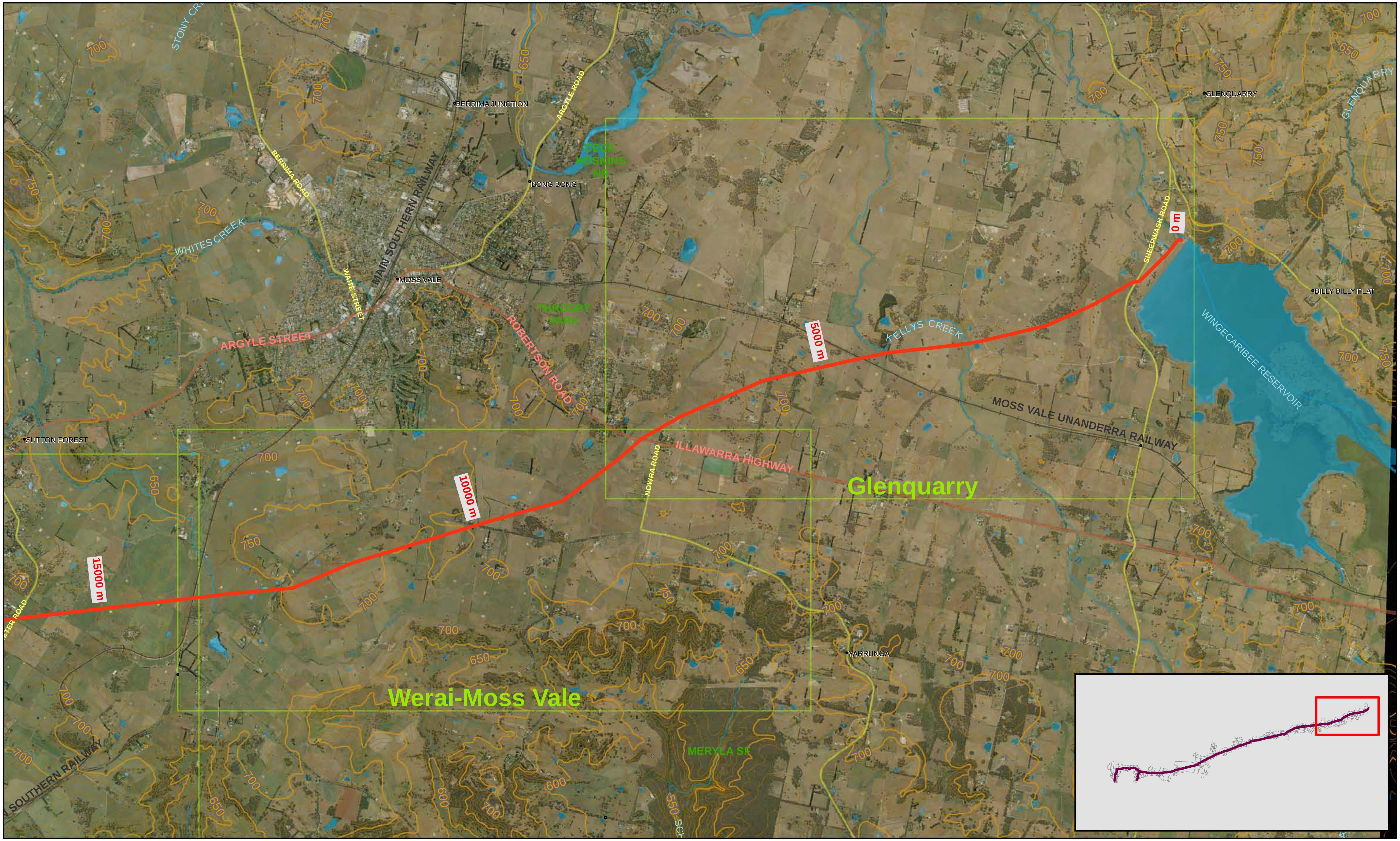
The proposed route of the pipeline easement is shown in Figure 1.

1.3 Objectives and purpose of this report

The purpose of this report is to inform the Environmental Assessment (EA) of the Project. The Environmental Assessment is being prepared in accordance with the requirements of Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The report also addresses the requirements of the Director-General of the NSW Department of Planning (the Director-General's Requirements) dated 14 December 2009.

The objectives of this report are to:

- Identify the existing environment with respect to topography, geology, soils and groundwater the Project site;
- Assess potential construction and operational impacts of the Project on soils and groundwater;
- Assess the potential for contaminated soils to be encountered during the construction of the pipeline;
- Identify geological constraints that have the potential to impact the construction of the Project; and
- Address the relevant Director General's Requirements (DGRs) and other statutory agency's requirements for the Environmental Assessment of the Project.



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Metres

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

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Legend

- Proposed Pipeline Alignment (Raw Water)
- (Treated Water)
- Sector boundary
- PrimaryRoad
- ArterialRoad
- Railway
- Lakes, Dams
- Rivers, Creeks
- Local Government Area
- 50m Contour (Labelled)
- 10m Contour

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Goulburn Mulwaree Council
Highlands Source Project

Job Number	23-13312-15
Revision	0
Date	14 JAN 2010

Locality Map
Sector: Werai - Glenquarry

Figure 1(a)

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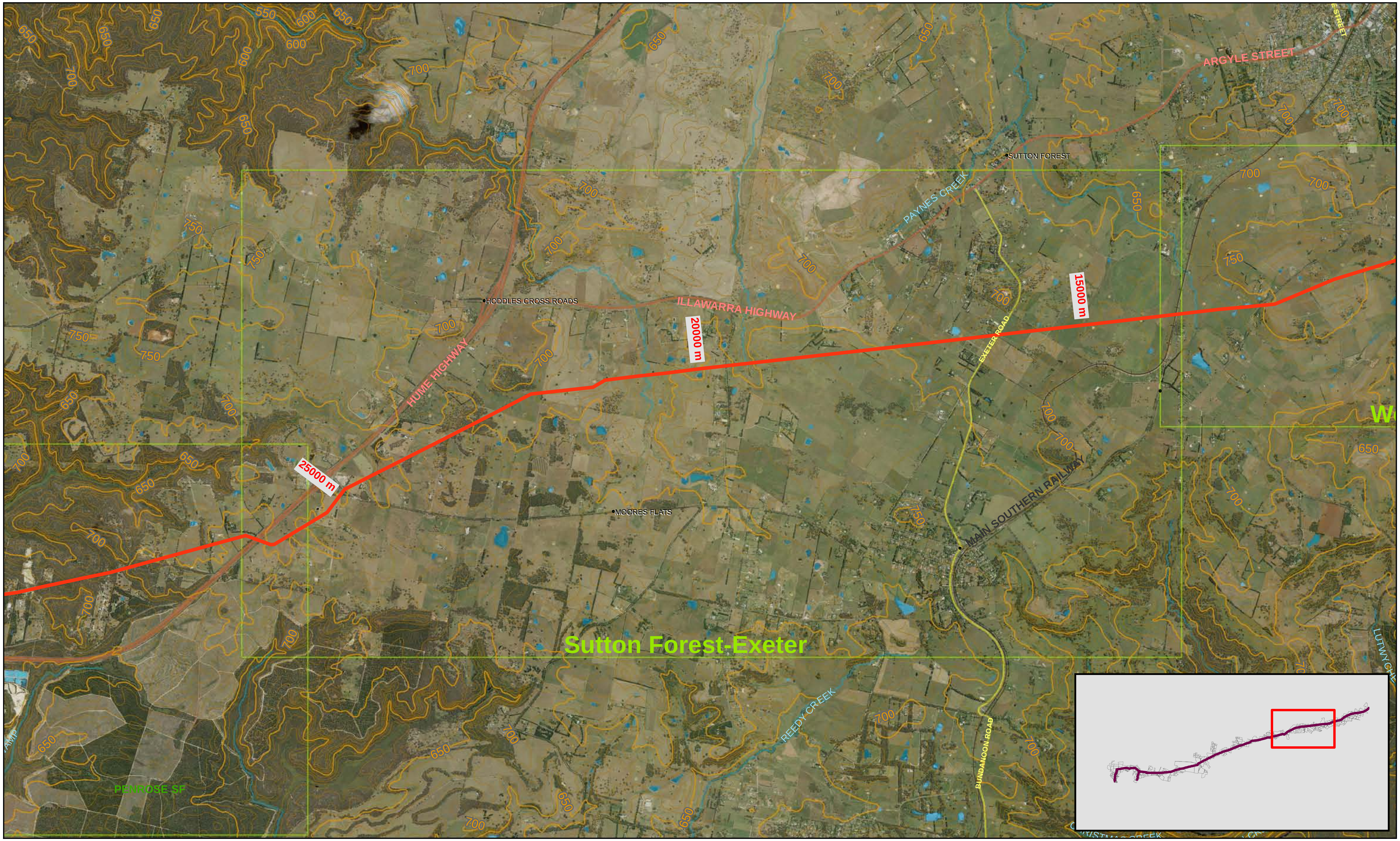
Level 7, 16 Marcus Clarke Street Canberra ACT 2601 **T** 61 2 6113 3200 **F** 61 2 6113 3299 **E** cbrmail@ghd.com.au **W** www.ghd.com.au

Data Source: NSW Lands Dept: crownlands,roadsegments,railways,hydroarea,hydroline,logalgovernmentarea,npwreserve,stateforest - 2007. Created by: ccharalambou, trbellwood



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GOULBURN MULWAREE COUNCIL

Goulburn Mulwaree Council
Highlands Source Project

Job Number	23-13312-15
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Locality Map
Sector: Sutton Forest-Exeter

Figure 1(b)

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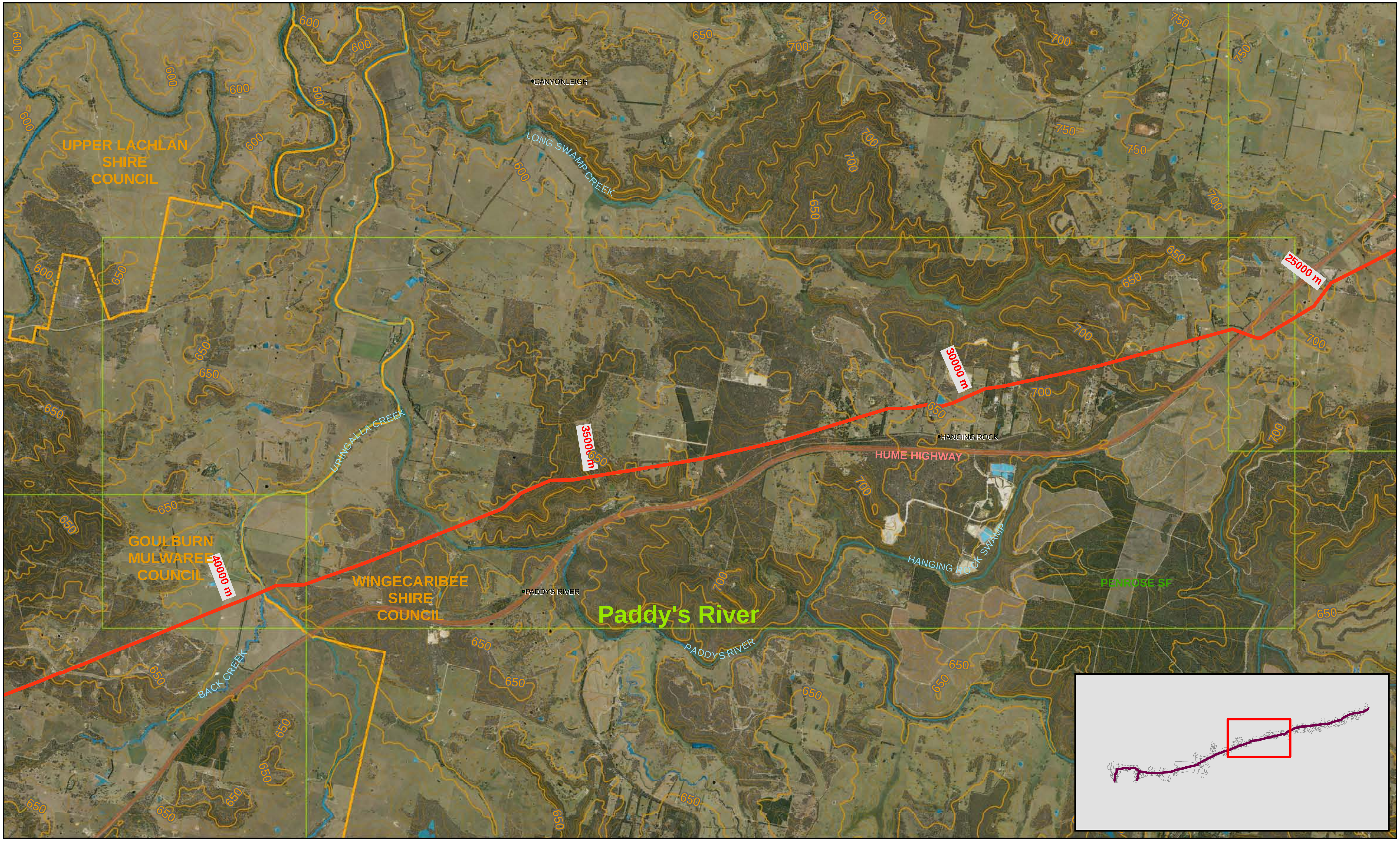
Data Source: NSW Lands Dept: crownlands,roadsegments,railways,hydroarea,hydroline,logalgovernmentarea,npwreserve,stateforest - 2007. Created by: ccharalambou, trbellwood



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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

Job Number	23-13312-15
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Locality Map
Sector: Paddys River

Figure 1(c)

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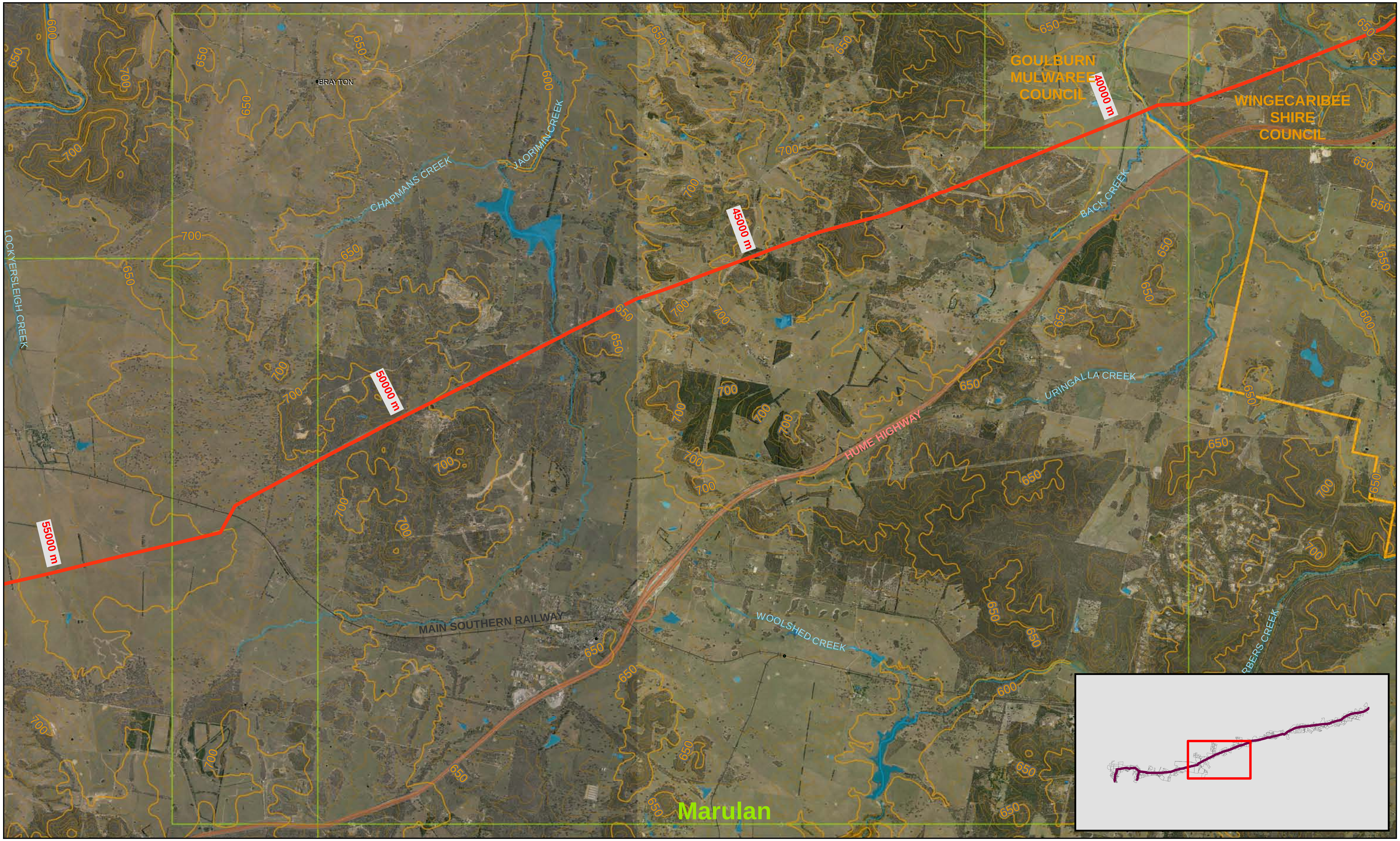

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Metres

Map Projection: Transverse Mercator
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Goulburn Mulwaree Council
Highlands Source Project

Job Number	23-13312-15
Revision	0
Date	14 JAN 2010

Locality Map
Sector: Marulan

Figure 1(d)

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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

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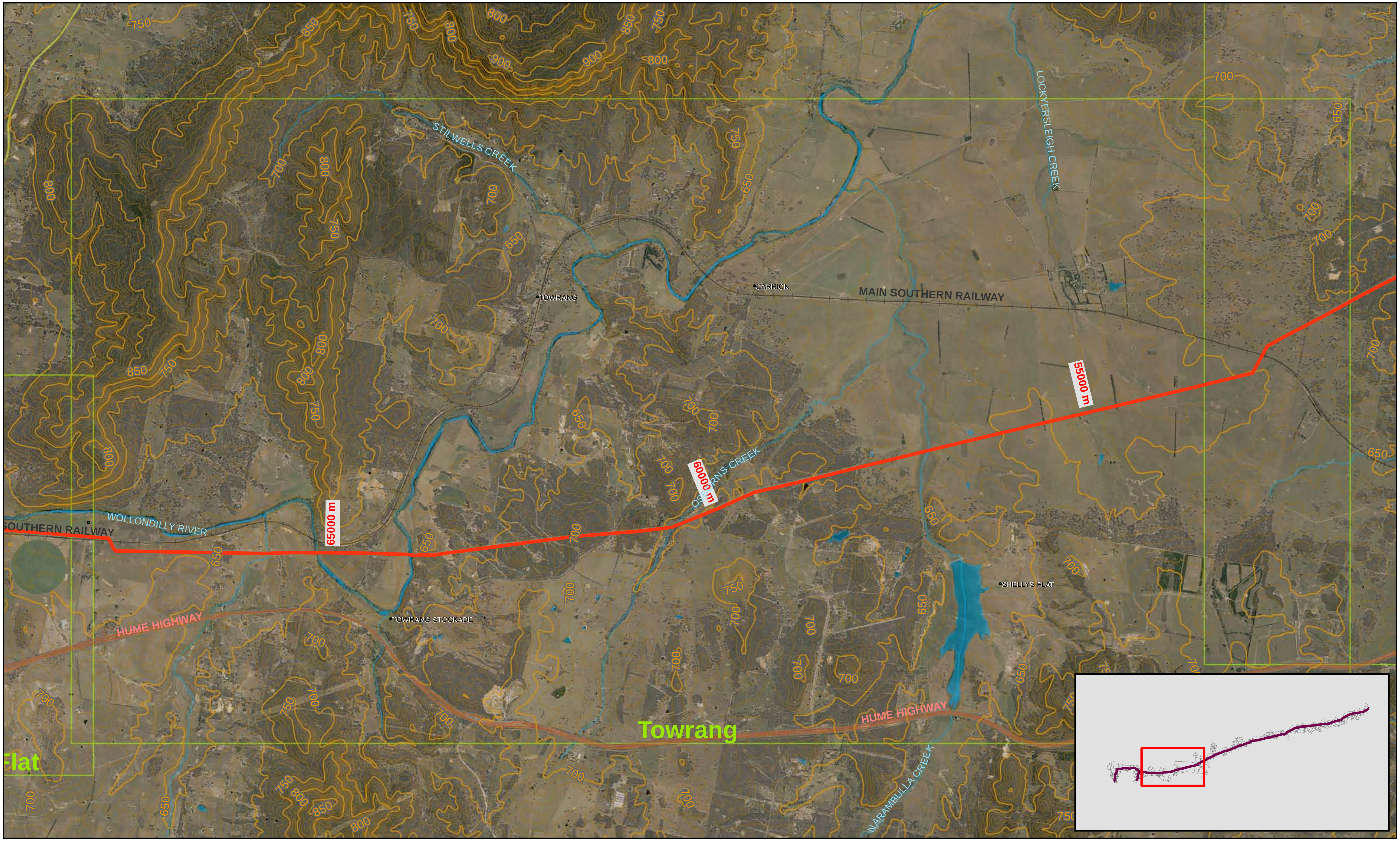

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Grid: Map Grid of Australia 1994, Zone 55

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Goulburn Mulwaree Council
Highlands Source Project

Job Number	23-13312-15
Revision	0
Date	14 JAN 2010

Locality Map
Sector: Towrang

Figure 1(e)

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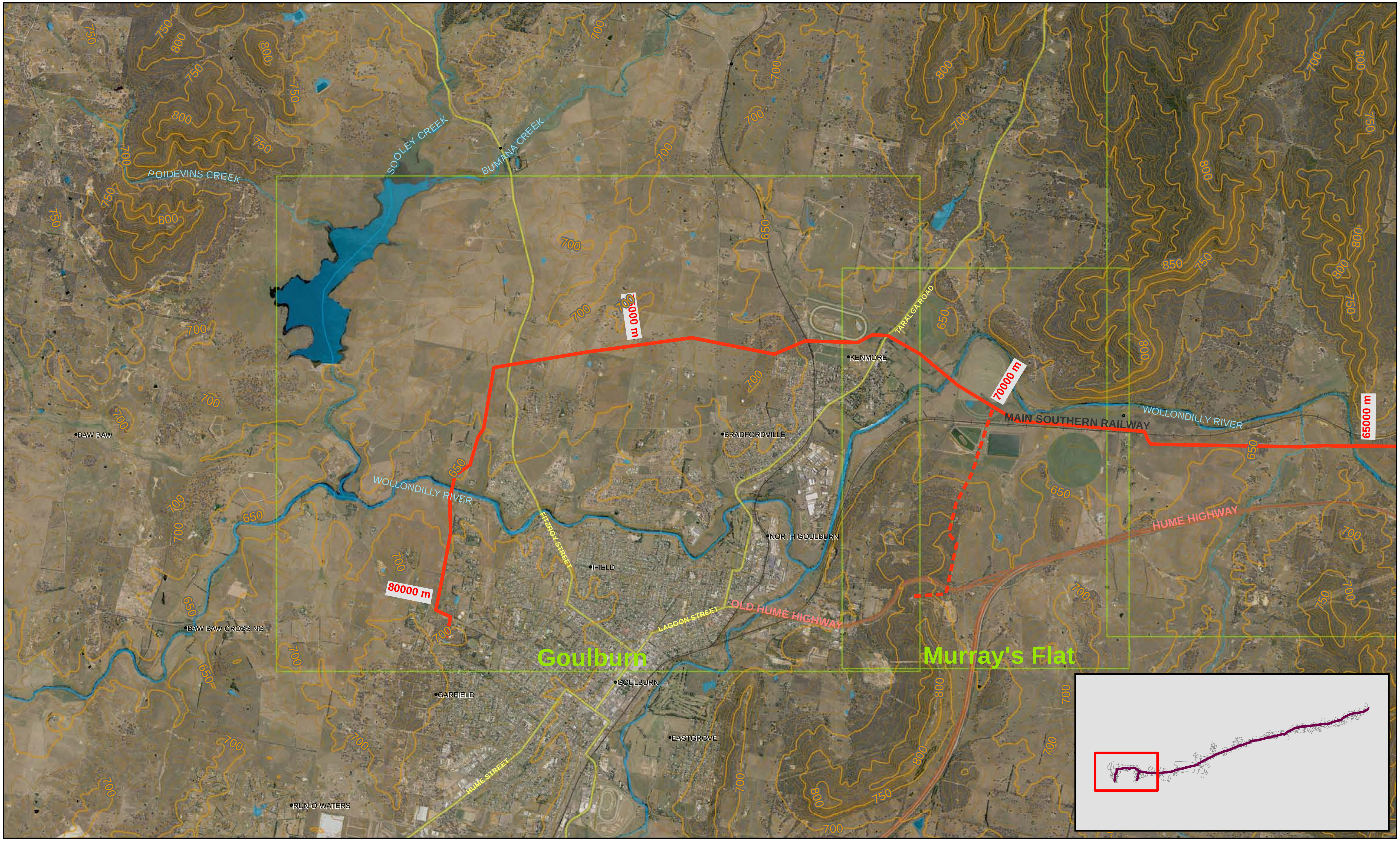
Level 7, 16 Marcus Clarke Street Canberra ACT 2601 **T** 61 2 6113 3200 **F** 61 2 6113 3299 **E** cbrmail@ghd.com.au **W** www.ghd.com.au

Data Source: NSW Lands Dept: crownlands,roadsegments,railways,hydroarea,hydroline,logalgovernmentarea,npwreserve,stateforest - 2007. Created by: ccharalambou, trbellwood



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 Pipeline Alignment (Raw Water)
- (Treated Water)
- Sector boundary
- PrimaryRoad
- ArterialRoad
- Railway
- Lakes, Dams
- Rivers, Creeks
- Local Government Area
- 50m Contour (Labelled)
- 10m Contour

CLIENTS | PEOPLE | PERFORMANCE

Goulburn Mulwaree Council
Highlands Source Project

Job Number	23-13312-15
Revision	0
Date	14 JAN 2010

Locality Map
Sector: Goulburn-Murrays Flat

Figure 1(f)

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The DGRs identify general construction impacts, including impacts relating to potential risks to groundwater quality as key issues for the Environmental Assessment. Groundwater is discussed in Section 4.6 and the potential impacts to groundwater are assessed in Section 5.

Table 1 outlines the other statutory agency's requirements relating to soil erosion, groundwater and contamination issues. Sections within this report where the agencies requirements are addressed are also listed.

Table 1 Statutory agency requirements

Agency	Agency EA Requirements	Where addressed in this report
DECCW	Description of measures to control erosion and sedimentation during construction activities	Section 2.3 and Appendix B
	Description of a process to ensure all personnel involved in the construction works are aware of the details of work plans, legislation and pollution control measures before work commences	Section 2.3
	Identification of fuel and chemical storage areas and a description of the measures proposed to minimise the potential of leakage or mitigation of pollutants into soil and groundwater	Section 2.1.4
	Provision of details and design specifications of appropriate sediment and erosion controls to mitigate impact on the environment	Section 2.3.1 and Appendix B
	Identification of the likelihood of disturbance of acid sulphate soils	Section 4.5.1
	Identification of pre-existing site contamination	Section 4.7
	Description of contingency plans to manage acid sulphate soils and contaminated soils	Sections 2.3.6 and 2.3.9
NSW Office of Water	Description of how the Proposal meets the requirements and objectives of relevant NSW policies for groundwater quality management, groundwater quality protection, groundwater dependant ecosystems, rivers and estuaries, wetlands and farm dams to the Proposal	Section 3.1
	Identification of groundwater issues and potential degradation of groundwater sources, including:	
	Highest groundwater table at the site;	Section 4.6
	Any works likely to intercept, connect with or infiltrate the groundwater sources;	Section 4.6 and Section 5

Agency	Agency EA Requirements	Where addressed in this report
	Any proposed groundwater extraction, including purpose, location and construction details of all proposed bores and expected annual extraction volumes;	No extraction proposed. Additional information provided in Section 2.3.5
	A description of the flow directions and rates of physical and chemical characteristics of the groundwater source;	Section 4.6
	The predicted impacts of the final landform on the groundwater regimes;	Section 5
	An assessment of groundwater contamination	Section 4.6
	How the Proposal will not potentially diminish the current quality of groundwater in the short term and long term;	Section 4.6
	Measures to prevent groundwater pollution	Section 2.3.5
	Methods for the disposal of wastewater	Section 2.3.5
	Proposed groundwater monitoring programs	None proposed
	Assessment of and groundwater source that may be sterilized from future use as a consequence of the Proposal	Section 5
	Identification of thresholds criteria for impact levels beyond which remedial measures would be initiated (groundwater)	No monitoring proposed as risk of potential significant impact is low
	Remedial measures (groundwater)	None proposed as risk of potential significant impact is low
	Funding assurances for post development maintenance of groundwater	None proposed as risk of potential significant impact is low
	Identification of the requirement to obtain a Water License under the Water Act 1912	Section 3.1.2
SCA	Incorporation of the Current Recommended Practices endorse by SCA into the Proposal construction measures	Section 2.3.1 and Appendix B
	Identification of pollutants of concern that may impact groundwater during the construction and operational phases of the Proposal	Section 2.3.1
	Identification of the potential impacts on groundwater during construction and operation of the Proposal	Section 5

Agency	Agency EA Requirements	Where addressed in this report
	Provision of a conceptual Erosion and Sediment Control Plan containing sample measures that would be used at primary and secondary site compounds, under-boring sites, watercourses and drainage depression crossings	Section 2.3.1 and Appendix B
WSC	Assessment of the Proposal on saline soils	Section 4.5

2. Project Activities

2.1 Construction activities

2.1.1 Intake pump structure

The arrangements for the water intake and pump structures would vary depending on whether raw water or treated water is transferred to Goulburn. The alternative water transfer arrangements are described below and are shown in Figure 2.

Raw water transfer option

If raw water is to be transferred to Goulburn, it would be drawn from SCA existing meter pit, located adjacent to the toe of the Wingecaribee Reservoir outlet structure. A proposed pumping station would be constructed adjacent to the meter pit. As this area is located close to Wingecaribee River and is subject to flooding, the pump station would be constructed on an elevated pad. This would likely necessitate importing material.

The pump station would be a small single level building with a footprint of approximately 8 m x 15 m.

Treated water transfer option

If treated water is to be transferred to Goulburn, it would be drawn from the existing clear water storage tanks associated with the Wingecarribee WTP (WTP). The water treatment plant's pumps would be utilised and supplemented by a proposed booster pump station, which would be constructed at the same location as described in the raw water transfer scheme. It is anticipated that minor excavations would be required to construct the building's foundations.

2.1.2 Pipeline

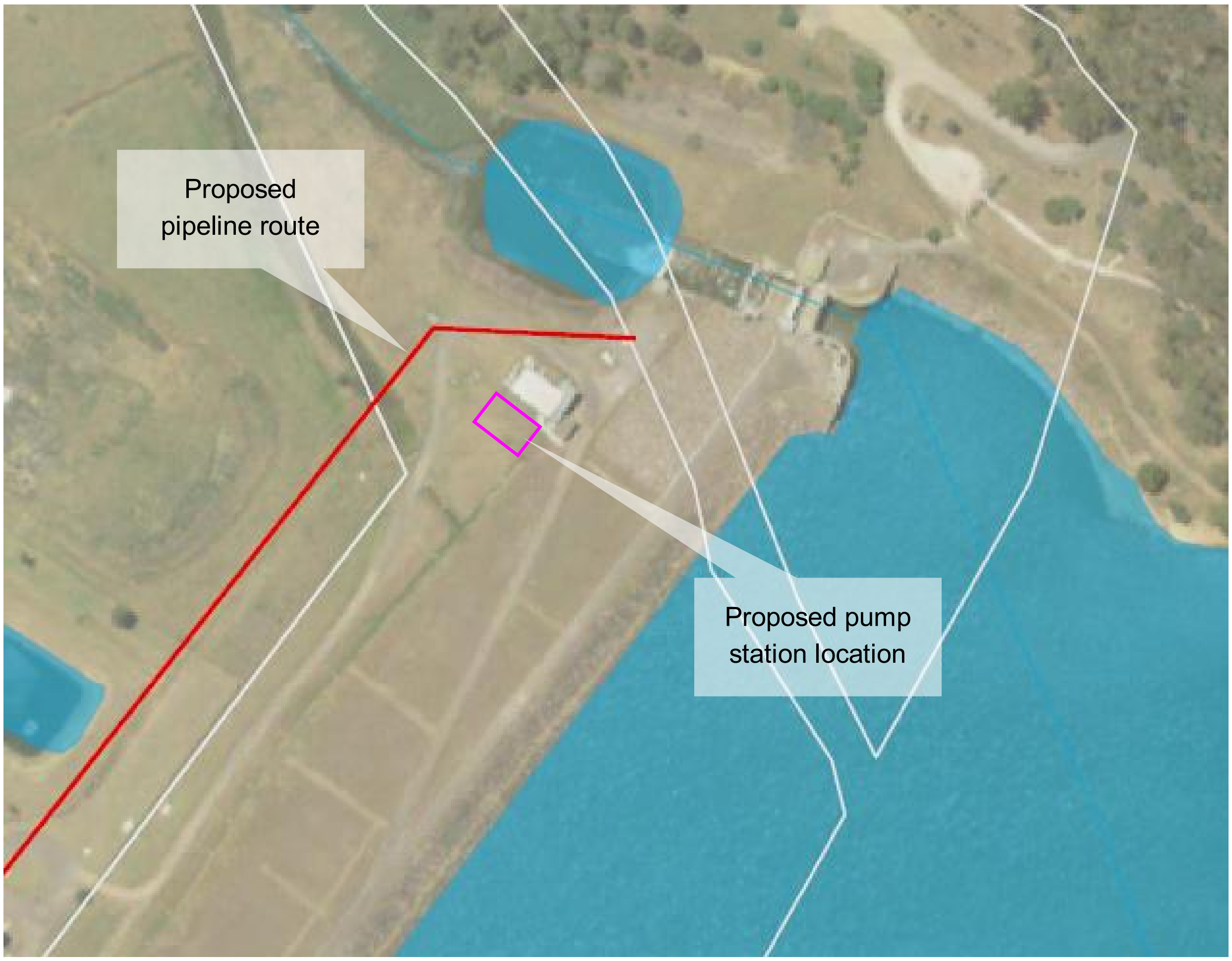
Pipeline easement

The pipeline would be constructed within an approximately 10 m wide pipeline easement. The easement would be cleared of significant vegetation (trees, shrubs etc), rehabilitated with ground cover vegetation following pipeline installation and permanently maintained as an accessible easement for ongoing maintenance purposes. Where significant vegetation exists within the pipeline easement, the width of vegetation clearing within the pipeline easement could be reduced to create a minimal 4 m wide area for pipeline installation.

Construction corridor

All construction activities associated with the installation of the pipeline would occur within a nominal maximum 20 m wide construction corridor, which would include the 10 m wide pipeline easement.

Figure 2 Proposed pump station location



The pipeline construction corridor would be subject to earthworks, construction traffic movements, materials storage, soil stockpiling, and other general construction activities.

It is expected that surface and subsurface soil materials within the pipeline construction corridor would be disturbed during the construction phase. There is the potential that subsurface excavations may intercept shallow groundwater (if present) within the area of the pipeline construction corridor.

The pipeline construction corridor would be progressively rehabilitated and returned to a condition agreed to by the land owner. The approach to rehabilitation is discussed in Section 2.3.4.

Pipeline construction

Trenching

The 300 – 375 mm outside diameter pipeline would be laid in a shallow continuous trench, with an average depth of cover to the top of the pipe of approximately 1 200 mm and total depth of approximately 1.5 m to 2 m below ground level (bgl). It is expected that the trench excavation would be undertaken using conventional earthmoving equipment and / or trench excavating equipment.

The typical volume of excavated material would be approximately 1.5 to 2 m^3 per linear metre of trench. Bedding material (sand) would be placed at the base of the trench and approximately two thirds of the excavated material would be returned to the trench once the pipe section has been laid and connected, as backfill material. The backfilled material would be compacted to approximately 95%.

The residual material (spoil) would be retained and used to rehabilitate the construction corridor (if it is suitable material for that use). Excavated material deemed unsuitable for backfilling the trench excavation would be temporarily stockpiled and transported off site to a reuse facility such as a bulk landscape supply. The quantity of spoil needing off site disposal would increase if trenching were to be undertaken in predominantly weathered rock, as this would likely generate material too course to be used as backfill material or material suitable for rehabilitating the disturbed area in the construction corridor.

Apart from the bedding material, it is not expected that importation of significant volumes of backfill materials would be needed. If weather rock were to be encountered as discussed above, the spoil generated may be unsuitable for use as backfill material and as such imported backfill material would be required; however it is likely that suitable materials would be sourced from other areas along the pipeline.

Table 2 provides estimated volumes of materials that would likely be generated (spoil), imported (bedding material) and exported (residual spoil) during trenching.

Table 2 Estimated quantities of materials

	Volume per linear metre of trench	Volume per entire pipeline (83 km length) trench
Expected volume spoil that would be generated by trenching	1.8/m^3	150 000 m^3
Expected volume of bedding material that would be imported into the pipeline trench	0.48 m^3	40 000 m^3
Expect volume of material used to backfill pipeline trench	1.20 m^3	100 000 m^3
Expected volume of material re-used for rehabilitation	0.36 m^3	30 000 m^3

	Volume per linear metre of trench	Volume per entire pipeline (83 km length) trench
Expected volume of residual spoil that would need to be transported off site	0.24 m^3	20 000 m^3

Pipeline auxiliary infrastructure

The pipeline would also include auxiliary infrastructure at various locations along the pipeline route, such as:

- Stop or divide valves (which allow sections of the pipeline to be shut off);
- Air valves (which allow the release of pressurised air within the pipe and are located at selected topographical high points along the pipeline); and
- Scour valves (which allow for the cleaning out of the pipe and are located at selected topographically low points along the pipeline).

The valves would be encased in circular or square concrete pits, which rise approximately 400 mm above ground level. At the valve pit locations, the pipeline trench would be further excavated to allow joining of the valves and installation of the concrete pits. It is expected that between 1.5 m^3 and 3.0 m^3 of additional material would need to be excavated at valve locations. This material would be used to rehabilitate the construction corridor or would be temporarily stockpiled and transported off site.

2.1.3 Crossings

The pipeline would cross a number of natural and man made features, including:

- Selected watercourses;
- Sealed and unsealed roads;
- The Hume Highway (approximately 1 km south of Sally's Corner) and the Illawarra Highway;
- Railway lines; and
- Existing services (such as off-take pipes from the Moomba – Sydney Pipeline and (potentially) AAPT's optical fibre).

The list of road, rail and watercourse crossings is provided in Appendix A together with plans (Figures A1(a) to A1(f)) showing their location along the proposed pipeline easement. The crossings have been reference using the following reference sequence:

- Road crossings: ROAD 1 to ROAD 73;
- Railway line crossings: RAIL 1 to RAIL 5 and;
- Watercourse crossings (major watercourses only): WAT 1 to WAT 20.

There are a number construction techniques that could be used to construct these crossings including trenching, thrust boring and horizontal direction drilling. Pipeline bridges are not proposed.

The technique used at a particular crossing would be selected to minimise impacts to the particular feature being crossed however, wherever possible, trenching would be adopted. Table 3 lists the construction technique that would most likely be used at each crossing points.

Table 3 Construction techniques proposed at crossings

Technique	Crossing feature
Trenching	Topographical drainage lines Most watercourses (typically watercourses with no flowing water) Unsealed roads Council controlled sealed roads
Thrust boring	RTA controlled roads (most sealed roads and the Hume Highway) Railway tracks
Horizontal direction drilling	Selected watercourses

The crossing construction techniques, associated activities and expected footprint are described below.

Trenching

A general description of trenching is provided in 2.1.2.

It is likely that trenching through watercourse would involve laying the pipeline at a slightly greater depth that is proposed through dry land. Through watercourses it is expected that the trench would be excavated up to 2.5 m bgl. This would allow for sufficient material to be placed over the pipeline to prevent scouring of the pipeline during high velocity water flows in the watercourse.

The material that would be placed over the pipeline in watercourses would vary depending on the watercourse's underlying geology. If the geology is alluvial materials, cobbles or small boulders overlain by natural riverbed materials would be used. If the underlying geology is bedrock, the pipeline would be overlain with concrete.

Trenching of active waterways would involve installing temporary dams upstream and downstream of the crossing point and pumping the dammed water around the crossing point to the downstream channel to create a dry construction area. The temporary dams would be constructed using sandbags or 'aqua-barriers'. The riparian areas would be revegetated and stabilised.

Thrust Boring

Thrust boring would require the excavation of a 'launch pit', at the start of the boring section, of a suitable size to contain the drill equipment, casing and pipe lengths, and sump pumping equipment. Similarly, a 'receiving pit' would be excavated at the end of the directionally drilled section on the opposite side of the crossing. It is envisaged that pit walls would be battered back to approximately 2H:1V slope.

The approximate size of launch pit excavations would be around 2 m to 3 m wide and 6 m to 15 m long.

Horizontal direction drilling (HDD)

Horizontal direction drilling is a technique that uses guided direction drilling equipment to steer a drill head beneath the feature being crossed. The pipeline is then installed in the narrow tunnel created. HDD would require the excavation of a 'receiving pit', at the opposite side of the crossing. A launch pit is not required when using this methodology, however a small pilot hole is excavated.

Typical areas required for horizontal direction drilling are provided in Table 4.

Table 4 Area required for horizontal direction drilling

Under boring	Approximate dimensions
Rig footprint area (width x length)	2.0 m x 6.0 m to 2.5 m x 13.5 m
Depth of drilling	3 m to 9 m below ground level at launch site
Receiving pit dimensions	(Up to) 2 m x 3 m x 5 m
Recommended work area requirements	30 m x 45 m

The quantity of spoil generated during horizontal direction drilling would be less than that which would be generated during trenching and thrust boring. However, some residual spoil is expected following the backfilling of the receiving pit.

Drilling fluid is used to stabilise and lubricate the borehole, cool down machinery, carry spoil away from the borehole, and assist in the cutting process. As such, separate mixing systems, holding tanks, and mud recycling systems are required. Drilling fluid is not released but is recycled during drilling. A minimum boring depth of at least 2 m to 3 m below the major waterway would be drilled as this would minimise the risk of 'frac outs' (which results in the pressurised drilling fluids rising through geological fractures and discharge into the waterway).

2.1.4 Site compounds

Primary site compounds

It is likely that the construction contractor will locate a primary compound at a central location close to the pipeline construction corridor around Marulan, Goulburn, Moss Vale or Exeter. A primary site compound may also be established near the new pump station location at the Wingecaribee WTP site and at the Goulburn end of the pipeline at either the Goulburn WTP (raw water transfer option) or at the proposed reservoir location on Govenor's Hill (treated water transfer scheme). The primary compounds would comprise portable offices, amenities, storage for major plant and equipment and storage of materials. Sites that provide sealed road access, are relatively flat, are away for water features and drainage lines and do not require the removal of vegetation (other that ground cover) would be selected. Primary site compounds would likely have a foot print of approximately 6 000 m^2.

Earthworks are not anticipated to establish primary site compounds. However, disturbance of the ground surface is likely.

The storage of fuels and chemicals would occur at the primary site compounds. Fuels and chemicals would be transported to the working location along the pipeline construction corridor as needed. All fuels and chemical would be stored at the primary site compound in accordance with Australian Standards. It is not expected that placard quantities of fuels and chemicals would need to be stored at the primary site compound.

Secondary site compounds

Secondary site compounds for pipe lay down or material storage would be established along the construction corridor. Pipe lay-down areas would be established at approximately 5 km to 10 km intervals in areas adjacent to the pipeline construction corridor or within existing road reserves. Pipe lay down and material storage area would likely cover an area of between 1 500 m^2 and 5 000 m^2. Sites with similar characteristics to primary site compounds would be selected.

Earthworks are not anticipated to establish secondary site compounds. However, disturbance of the ground surface is likely. Minor quantities of oil or fuel may be stored at secondary compounds.

2.1.5 Spoil and pipe storage

Stockpile and spoil areas would be located within the construction corridor. Excavated material from the trenching would be stockpiled adjacent to the trench and used to backfill the area of the trench above the laid pipeline. It is anticipated that the volume of excess spoil will be minimal and would mostly be used to rehabilitate the construction corridor.

Imported backfill material (i.e. sand) would be stockpiled in approximate 10 m by 10 m areas at approximate 200 m to 300 m intervals along the impacted zone. It is estimated that approximately 40 000 cubic metres of imported backfill material would be required along the pipeline.

2.1.6 Access points

Access to the construction corridor would be required approximately every 3 km to 4 km along the route. The construction corridor would typically be accessed from points where it crosses public roads.

There may be locations where access is difficult due to poor public road access or hillier terrain. In such cases, access to the construction corridor would need to be gained via private properties. Existing tracks would be utilised as much as possible. Construction traffic movements along private tracks and at access points may disturb the ground surface resulting in the potential for soil erosion.

2.1.7 Outlet

Raw water transfer scheme

Raw water would be discharged into an existing reservoir located adjacent to the Goulburn WTP located on the western side of the Goulburn township. It is therefore unlikely that significant earthworks would be required at this location.

Treated water transfer scheme

Treated water would be transfer to a new reservoir or directly into the town water supply. The new reservoir or town water supply connection point would likely be located on the eastern outskirts of Goulburn near the Murray's Flat area. The Project does not include the construction of the reservoir for the treated water transfer scheme.

2.2 Operation activities

2.2.1 Maintenance

Maintenance of the project infrastructure would occur on an on-going basis. Maintenance would likely involve the use of fuels, oils and chemicals, particularly at the pump station. Bunded storage of fuels, oils and chemical would be provided within the pump station or within existing storage facilities at the Wingecarribee WTP. All storage of fuels, oils and chemicals should be in appropriate storage containers as specified in relevant Australian Standards.

2.2.2 Pipeline scouring

Scouring of the pipeline would occur as follows:

- For routine maintenance which would occur once or twice a year to "exercise" the valves; or
- For drain down events to undertake repairs or modifications to a section of the pipeline.

Scour water would be managed as described in Section 2.3.10.

2.3 Project controls

2.3.1 General

During the construction and operational phases of the Project, a number of standard practices and control would be implemented. These standard practices and project controls related 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;
- Education of the construction work teams with respect to their responsibilities and legislated requirements to prevent surface water and groundwater contamination;

- Contaminated soil; and
- Scour water.

It is anticipated that these procedures and control would form part of a construction environmental management plan (CEMP) 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.

2.3.2 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.

Guiding principles

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

- Prioritise the prevention of erosion rather than to 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.

Sediment and Erosion Management Plan

A site Sediment and Erosion Management Plan would be prepared and incorporated into a Construction Environmental Management Plan. The Sediment and Erosion Management Plan would be developed based on the guidelines listed in Section 2.3.2.

2.3.3 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* (Feb 2008) and *Guidelines for controlled activities - Laying pipes and cables in watercourses* (Feb 2008a). 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 rehabilitate;
- All rehabilitation work is to be monitor and maintain 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 a 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.

2.3.4 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 is to be designed in general accordance with the information provided in Appendix B;
- 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.

2.3.5 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. In general, spoil would be managed as follows:

Excess spoil materials would be utilised by the property landowners where ever appropriate. Disposal of spoil material off site would occur in accordance with *Waste Classification Guidelines*, (DECCW 2008).

2.3.6 Management of groundwater

Groundwater seepages into the pipeline trench or pit excavations may occur locally in areas that contain shallow groundwater, but this would not be expected to typically occur.

Groundwater seepage into trenches excavated through minor watercourses would be expected. This groundwater would be pumped out of the excavations into a portable tank to allow for the settlement of sediment and / or treatment by adding a flocculant before being released back into the water course. Alternatively the groundwater seepage would be trucked to a nearby farm dam. Treatment of the water could also occur once release into the farm dam.

No sediment laden groundwater seepages would be release to watercourses.

2.3.7 Management of acid sulphate soils

The likelihood of acid sulfate soils (ASS) or potential acid sulfate soils (PASS) being present within the construction corridor is minimal. However, ASS and PASS could occur in waterlogged or swampy areas.

If ASS or PASS were suspected (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 accordance with the *Acid Sulfate Soil Manual* (Stone et al, 1998).

Management of ASS and PASS would be undertaking in accordance with an Acid Sulfate Soil Management Plan (ASSMP) prepared in accordance with the Acid Sulfate Soil Manual.

2.3.8 Management of erosive soils

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.

Sodic soils

Localised and widespread sodic soils are likely to exist in areas intersected by the proposed pipeline construction corridor. Sodic soils are highly erodible and would be managed in the following way:

- In areas of high sodicity, trench reinstatement would include compaction to minimise tunnel erosion;
- Reinstatement of banks would also involve compaction and topsoiling with a soil-rock mixture;
- Disturbed sodic areas would be revegetated immediately and maintained to ensure erosion is minimised.

2.3.9 Informing construction workers of responsibilities

All members of construction work crews would be 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.

2.3.10 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 2008.

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.

2.3.11 Management 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.

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:

1. 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.
2. The chlorine would breakdown on exposure to sunlight once the water enters the dam.
3. 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.

Raw Water Transfer Scheme

The water quality that would typically be in the pipeline is described in the following table:

Table 5 Raw water quality in the proposed pipeline

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

Parameter	Observation
pH	6.9 – 9.8
Alkalinity	15 - 20 mg/L as $CaCO_3$
Hardness	20 - 25 mg/L as $CaCO_3$
DOC	5 mg/L
Cyanobacterial counts	Total cyanobacterial counts up to 622 000 cells/mL; median *ca.* 100 000 cells/mL
TDS	Approx. 50 mg/L at surface; 160 mg/L at depth of 10 - 15 m

The physico-chemical properties of the water are generally within the guideline values provided by ANZECC (2000) for the maintenance of aquatic systems and for the use of the water for crop irrigation or livestock watering. The *E. coli* and cyanobacteria (blue-green algae) levels can fluctuate to beyond the ANZECC and other guidance for these parameters (table below), and some management of these would be required.

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:

1. 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.)
2. 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:
    a. 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
    b. 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);
3. Release of water into 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.

3. Legislation

3.1 NSW legislation and policies

3.1.1 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) is the key pollution control legislation in force in NSW. Amongst other things, it regulates pollution offences, including offences relating to:

- The wilful or negligent disposal of waste in a manner that harms or is likely to harm the environment;
- The wilful or negligent causing of a substance to leak, spill or otherwise escape in a manner that harms or is likely to harm the environment; and
- The pollution of waters through deliberate actions or actions that cause or permit pollution of waters. Under the Act, 'water pollution' includes introducing litter, wash water, soil, debris, detergent, paint, cement slurry, building materials etc. into waters or placing such material where it is likely to be washed or blown into waters or the stormwater system or percolate into groundwater.

The Project involves activities that could potentially cause pollution of waters. The Project includes specific measures to minimise the risks of pollution of waters.

3.1.2 Water Act 1912

The *Water Act 1912* facilitates development and use of water, by controlling the extraction of water, the use of water, the construction of works such as dams and weirs, and the carrying out of activities in or near water sources in NSW. This Act is being progressively phase out and replaced by the *Water Management Act 2000*, however the NSW Office of Water still administers groundwater licences under Part 5 of the *Water Act 1912* in areas where no water sharing plans have been prepared.

The proposed area of excavation is located in the Hawkesbury Nepean water management area and no water sharing plans are in place. Therefore, if the proposed development is likely to intercept or use groundwater, a groundwater licence should be sought from the NSW Office of Water prior to any drilling or bore construction.

3.1.3 Water Management Act 2000

The *Water Management Act 2000* (WMA) provides for the control of certain types of developments and activities that are carried out, in or near a river, lake or estuary. Such developments require a Controlled Activity Approval (CAA).

Under the WMA, a controlled activity means carrying any of the following works within 40 metes from a river, lake or estuary:

- The erection of a building or the carrying out of a work (within the meaning of the *Environmental Planning and Assessment Act 1979*); or

- The removal of material (whether or not extractive material) or vegetation from land, whether by way of excavation or otherwise; or
- The deposition of materials (whether or not extractive material) on land, whether by way of landfill operations or otherwise; or
- The carrying out of any other activity that affects the quantity or flow of water in a water source.

The Project would involve the excavation of soil materials, and the removal of vegetation from various waterways along the pipeline. However, public authorities, such as the Goulburn Mulwaree Council, are exempted under this Act for controlled activities they carry out in, on or under waterfront land.

3.1.4 NSW State Rivers and Estuaries Policy

The NSW State Rivers and Estuaries Policy was prepared in 1993 as the overarching policy for the sustainable management of NSW's rivers, estuaries and wetlands. The objectives of the policy are to manage rivers and estuaries in a ways which:

- Slow, halt or reverse the overall rate of degradation in the systems;
- Ensure the long term sustainability of their essential biophysical functions, and
- Maintain the beneficial use of the natural resources provided by the rivers and estuaries.

These objectives are to be achieved by adopting the six principles for sustainable management listed below.

- Encourage non-degrading uses of rivers and estuaries;
- Non-sustainable resource uses which are not essential should be progressively phased out;
- Environmentally degrading processes and practices should be replaced with more efficient and less degrading alternatives;
- Environmentally degraded areas should be rehabilitated and their biophysical functions restored;
- Remnant areas of significant environmental values should be accorded special protection; and
- An ethos for the sustainable management of river and estuarine resources should be encouraged in all agencies and individuals, who own, manage or use these resources.

The Project proposes to construct pipeline crossings through or under various watercourses including the Wollondilly River, Paddys River and various other creeks. The proposed construction and operational procedures include measures to minimise and prevent any degradation to the existing values of those systems and it is therefore considered that the Project is consistent with the above principles in relation to the potential impacts on soils, land contamination and groundwater.

3.1.5 NSW Sand and Gravel Extraction Policy for Non Tidal Rivers

The NSW Sand and Gravel Extraction Policy for Non Tidal Rivers is a component of the NSW State Rivers and Estuaries Policy (see above). Although the Proposal would not involve extensive extraction of sand and gravel from rivers in NSW, it would involve excavation of materials from river and creek banks, and as such the general intent of this policy has been considered. The three major objectives of this policy are as follows:

- To ensure that extraction of sand and gravel from a State's non tidal rivers is undertaken on a sustainable use basis;
- To manage such extraction in a way which minimizes and detrimental effects on the riverine environment thereby protecting other river uses and values; and
- To ensure that the extraction policy is consistent with the aims of the other Government policies and initiatives.

The Proposal, which involves construction controls and rehabilitation measures to protect and restore the environmental values of the watercourses that would be crossed, is considered to be generally consistent with the policy in relation to the potential impacts to soils and groundwater.

3.1.6 NSW State Groundwater Policy

The sustainable management of the State's groundwater resources is framed by an overarching policy document (NSW State Groundwater Policy Framework Document) and three component policies relating to groundwater quality (NSW Groundwater Quality Protection Policy), groundwater quantity (NSW Groundwater Quantity Management Policy) and groundwater dependant ecosystems (NSW Groundwater Dependant Ecosystem Policy).

The NSW State Groundwater Policy adopts eight principles for the sustainable management of groundwater resources in NSW. These principles, which are listed below, are reflected in the other component policies:

- An ethos for the ecologically sustainable management of groundwater resources should be encouraged in all agencies, communities and individuals who own, manage or use these resources, and its practical application facilitated;
- Non-sustainable resource uses should be phased out;
- Significant environmental and/or social values dependent on groundwater should be accorded special protection;
- Environmentally degrading processes and practices should be replaced with more efficient and ecologically sustainable alternatives;
- Where possible, environmentally degraded areas should be rehabilitated and their ecosystem support functions restored;
- Where appropriate, the management of surface and groundwater resources should be integrated;
- Groundwater management should be adaptive, to account for both increasing understanding of resource dynamics and changing community attitudes and needs; and
- Groundwater management should be integrated with the wider environmental and resource management framework, and also with other policies dealing with human activities and land use, such as urban development, agriculture, industry, mining, energy, transport and tourism.

The Project is considered to be consistent with this Policy as it would not significantly interact with groundwater resources beneath the proposed pipeline easement, and whether the Project may interact with groundwater, control measures would be implemented to minimise any potential significant impacts.

3.1.7 NSW Groundwater Quality Protection Policy

The NSW Groundwater Quality Protection Policy is a component of the NSW Groundwater Policy as discussed above and focuses on the protection of groundwater quality. The objectives of this policy are to:

- Slow and halt, or reverse any degradation in groundwater resources;
- Direct potentially polluting activities to the most appropriate local geological setting so as to minimise the risk to groundwater;
- Establish a methodology for reviewing new developments (industrial/mining/urban and rural) with respect to their potential impact on water resources that will provide protection to the resource commensurate with both the threat that the development poses and the value of the resource; and
- Establish triggers for the use of more advanced groundwater protection tools such as groundwater vulnerability maps, or groundwater protection zones.

The objectives of the policy are achieved by the application of nine groundwater management principals relating to the protection of groundwater quality. The Principals are:

- All groundwater systems should be managed such that their most sensitive identified beneficial use (or environmental value) is maintained;
- Town water supplies should be afforded special protection against contamination;
- Groundwater pollution should be prevented so that future remediation is not required;
- For new developments, the scale and scope of work required to demonstrate adequate groundwater protection shall be commensurate with the risk the development poses to a groundwater system and the value of the groundwater resource;
- A groundwater user shall bear the responsibility for environmental damage or degradation caused by using groundwaters that are incompatible with soil, vegetation or receiving waters;
- Groundwater dependent ecosystems will be afforded protection;
- Groundwater quality protection should be integrated with the management of groundwater quantity;
- The cumulative impacts of developments on groundwater quality should be recognised by all those who manage, use, or impact on the resource; and
- Where possible and practical, environmentally degraded areas should be rehabilitated and their ecosystem support functions restored.

The Project is considered to be consistent with this Policy as it would not significantly interact with groundwater resources beneath the proposed pipeline easement, and where the Project may interact with groundwater, control measures would be implemented to minimise any potential significant impacts to groundwater quality.

3.1.8 NSW Groundwater Quantity Management Policy

The NSW Groundwater Quantity Management Policy is a component of the NSW Groundwater Policy as discussed above and focuses on using groundwater in a sustainable manner. The objectives for managing groundwater quantity in NSW are:

- To achieve the efficient, equitable and sustainable use of the state's groundwater;
- To prevent, halt, or reverse degradation of the State's groundwaters, and their dependent ecosystems;
- To provide opportunities for development which generate the most cultural, social and economic benefits to the community, region, State and nation, within the context of environmental sustainability; and
- To involve the community in the management of groundwater resources.

The policy is implemented by applying thirteen groundwater management principles predominantly dealing with entitlements, licensing extraction, managing actions that recharge aquifers and minimising impacts to groundwater dependant ecosystems.

The Project is considered to be consistent with this policy. The Project does not propose groundwater extraction or use. Rehabilitation of watercourse beds and riparian zones would reduce the potential for disturbed ground to be a source of groundwater contamination.

3.1.9 NSW Groundwater Dependant Ecosystem Policy

The NSW Groundwater Dependant Ecosystem Policy provides a framework maintaining the ecological processes and biodiversity of dependant ecosystems in NSW. There are five principles which guide management actions under the Policy. The principles relate to the following:

- Protecting groundwater dependant ecosystems;
- Limiting extraction of groundwater to sustainable aquifer yields;
- Ensuring the availability of groundwater for dependant ecosystems;
- Applying a precautionary approach to protecting groundwater dependant ecosystems; and
- Ensuring land uses are consistent with minimising impacts to groundwater dependant ecosystems.

The Project is also considered to be consistent with this policy. The Project does not involve actively extracting groundwater. Minor amounts of groundwater seepage into excavation pits (particularly at watercourse crossings might be required, but this would result in insignificant amounts of groundwater being removed from the groundwater system. Minor short term impacts to riparian zones (which may or may not be groundwater dependant would occur, however all disturbed areas would be rehabilitated to restore the environmental values.

3.1.10 Contaminated Land Management Act 1997

The *Contaminated Land Management Act 1997* (CLM Act) establishes a process for investigating and (where appropriate) remediating land that is considered to be significantly contaminated. One objective of the Act is to ensure that contaminated land is managed with regard to the principles of ecologically sustainable development.

Under the CLM Act there is a requirement to notify the DECCW of sites that pose a significant risk of harm to human health or the environment. The *Contaminated Sites – Guidelines on Significant Risk of Harm and Duty to Report* (NSW EPA 1999) supports the implementation of the Act.

3.1.11 State Environmental Planning Policy No.55 – Remediation of Land

State Environmental Planning Policy No.55 (SEPP 55) introduces state-wide planning controls for the remediation of contaminated land. The policy states that land must not be developed if it is unsuitable for a proposed use because it is contaminated. If the land is unsuitable, remediation must take place before the land is developed.

However, SEPP 55 only applies to development applications under Part 4 of the *Environmental Planning and Assessment Act 1979*. Notwithstanding, the principles of SEPP 55 have been considered.

The Policy states:

> ***7 Contamination and remediation to be considered in determining development application***
>
> *(1) A consent authority must not consent to the carrying out of any development on land unless:*
>
> > *(a) it has considered whether the land is contaminated, and*
> >
> > *(b) if the land is contaminated, it is satisfied that the land is suitable in its contaminated state (or will be suitable, after remediation) for the purpose for which the development is proposed to be carried out, and*
> >
> > *(c) if the land requires remediation to be made suitable for the purpose for which the development is proposed to be carried out, it is satisfied that the land will be remediated before the land is used for that purpose.*
>
> *(2) Before determining an application for consent to carry out development that would involve a change of use on any of the land specified in subclause (4), the consent authority must consider a report specifying the findings of a preliminary investigation of the land concerned carried out in accordance with the contaminated land planning guidelines.*

This report includes a desktop assessment of the likelihood of contaminated land occurring within the pipeline easement (see Section 4.7). Based on the desktop assessment it is considered unlikely that the land within the pipeline easement and construction corridor is contaminated.

4. Existing Environment

4.1 General

The existing topography, geology, soil landscapes and groundwater regime in the general vicinity of the pipeline route is described below. The description of these environments is provided for the general pipeline route and at the significant crossing points (such as major roads, watercourses and railway lines). The description of the existing topography, geology, soil landscapes and groundwater environments is provided as this would likely be the location of significant construction activity and hence the location of potential impacts.

For the purposes of describing the proposed route of the pipeline easement, the pipeline route has been divided into sectors. The sectors (from the Wingecarribee Reservoir to Goulburn) are listed in Table 6.

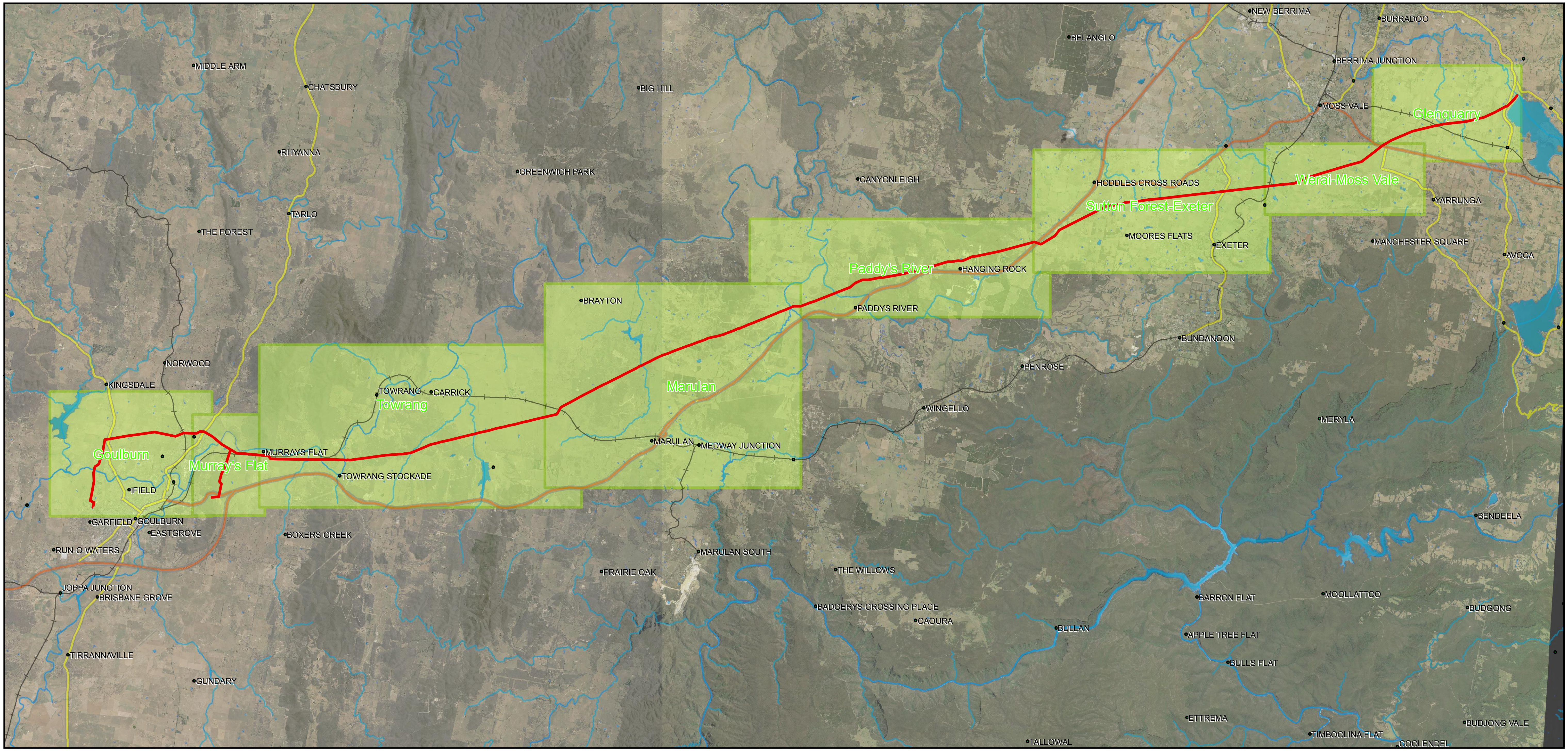
Table 6 Pipeline easement sectors

Sector	Approximate chainage
Glenquarry	0 km to 8.2 km
Werai- Moss Vale	7.3 km to 14.1 km
Sutton Forest- Exeter	13.8 km to 26.6 km
Paddy’s River	25.7 km to 40.9 km
Marulan	39.1 km to 53.5 km
Towrang	51.3 km to 68.6 km
Murrays Flat	68.3 km to 72.3 km
Goulburn	71.3 km to 80.7 km

Figure 3 shows the location of the pipeline easement sectors.

4.2 Methodology

Information used to describe the existing environment with respect to the topography, soil landscapes, groundwater and the presence of contaminated land, has been collated from a review of limited existing and archive sources and from site inspections undertaken.



Sector	ID	From_Chain	To_Chain
Glenquarry	1	0	8213
Werai-Moss Vale	2	7371	14070
Sutton Forest-Exeter	3	13794	26602
Paddy's River	4	25650	40933
Marulan	5	39063	53533
Towrang	6	51279	68557
Murray's Flat	7	68269	72346
Goulburn	8	71252	80721

1:200,000 (at A3)

0 2 4 6 8 10

Kilometers

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

N

Legend

- Proposed Pipeline Alignment
- PrimaryRoad
- ArterialRoad
- Railway
- Lakes, Dams
- Rivers, Creeks
- Sector boundary

CLIENTS | PEOPLE | PERFORMANCE

Goulburn Mulwaree Council
Highlands Source Project

Job Number	23-13312-15
Revision	0
Date	18 JAN 2010

Pipeline Easement Sectors

Figure 3

\\ghdnet\ghd\AU\Canberra\Projects\23\13312\GIS\ArcView\Wkspace\EAFigures\Soil_Specialist\23_13312_Pipeline_Easement_Sectors.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: crownlands,roadsegments,railways,hydroarea,hydroline,localgovernmentarea,npwreserve,stateforest - 2007. Created by: ccharalambou, trbellwood

4.2.1 Topography, geology and soil landscapes

Information regarding the topography, geology and soil landscapes was obtained from a review of the following references:

Topographic maps

- Central Mapping Authority of NSW, *Moss Vale 8928-1-N*, Topographic Map 1:25,000, Second Edition, 1985;
- NSW Department of Lands, *Canyonleigh 8928-4-N*, NSW 1:25,000 Series Topographic Map, Third Edition, 2005;
- NSW Department of Lands, *Wingello 8928-4-S*, NSW 1:25,000 Series Topographic Map, Third Edition, 2005;
- NSW Department of Lands, *Towrang 8828-1-S*, NSW 1:25,000 Series Topographic Map, First Edition, 1971;
- NSW Department of Lands, *Bungonia 8828-2-N*, NSW 1:25,000 Series Topographic Map, Second Edition, 1983;
- NSW Department of Lands, *Kingsdale 8828-4 S*, NSW 1:25,000 Series Topographic Map, Second Edition, 1983;
- NSW Department of Lands, *Goulburn 8828-3-N*, NSW 1:25,000 Series Topographic Map, Second Edition, 1983;

Geological maps and reports

- NSW Mineral Resources, *Southern Coalfield Geological* Map, Notes, and Reference Sheet, 1999;
- NSW Department of Mines, *Wollongong SI 56-9,* Geological Series Sheet 1:250,000, Second Edition, 1966;
- NSW Department of Mines, *Goulburn SI 55-12,* Geological Series Sheet 1:250,000, Second Edition, 1970;
- NSW Department of Primary Industries, *Goulburn 8828,* Geological Sheet Series 1:100,000, First Edition, December 2008; and

Soil Landscape maps and reports

- Department of Environment and Climate Change NSW, Natural Resource Information Unit, *Soil Landscapes of the Hawkesbury-Nepean Catchment*, DVD, August 2009

4.2.2 Groundwater

Groundwater information was obtained from the NSW Department of Water and Energy's (now the NSW Office of Water) database of registered groundwater bores located throughout New South Wales.

4.2.3 Contaminated land

A limited investigation of potentially contaminated sites within the vicinity of the pipeline was undertaken. The investigation undertaken was limited to the following scope of work:

- Consideration of the contaminating potential of land uses along the proposed pipeline route;
- Recording locations of potentially contaminated sites observed during pipeline route alignment site inspections; and
- A search of the NSW Department of Environment and Climate Change (DECC) database of contaminated land notices in the Local Government Areas (LGA) of Goulburn Mulwaree Council and Windgecarribee Shire Council.

No physical investigations involving soil or groundwater sampling and analysis were undertaken.

4.3 Topography

4.3.1 General pipeline route

The 1:25,000 scale topographic maps for Moss Vale, Canyonleigh, Wingello, Towrang, Bungonia, Kingsdale and Goulburn show that the pipeline route would traverse a series of hill slopes, flood plains, river valleys and low hills. Table 7 summarised the location of these topographical features along the pipeline route.

Table 7 Topography along proposed pipeline easement

Sector	General topographical feature of Sector
Glenquarry	Flood plain and rises
Werai-Moss Vale	Low hills and hills
Sutton Forest- Exeter	Low hills and hills
Paddys River	Hills and river valleys
Marulan	Low hills, hills and river valley (~CH 39 km – CH 41 km)
Towrang	Low hills, rises and flood plain (~CH 51 km to CH 58 km),
Murrays Flat	River valley and flood plain, low hills (toward Murrays Flat)
Goulburn	Rises and low hills

The route would cross some steep terrain, most notably adjacent to Paddy's River around Hanging Rock Road CH 33 750 and CH 37 100. There are also some locally steep slopes associated with Mount Broughton. Slopes of up to 22 degrees are indicated to exist in the hilly terrain adjacent to Paddy's River. Steeper slopes may occur locally, which are not shown on the maps reviewed.

4.3.2 Crossings

The general topography at the proposed watercourse crossing locations was recorded during the geomorphologic investigation of the crossing. The general topography at the road and railway line crossings has been inferred from topographical maps listed in Section 4.2.1.

Watercourses

Based on observation made during the geomorphology investigations of the watercourse crossing (see Appendix I), the topography in the general vicinity of the watercourse crossing point is listed in Table 8.

Table 8 Topography

Sector	Crossing Ref	Name	Proposed construction method	General topography at crossing point
Glenquarry	WAT 1	Kellys Creek	Trenched	Floodplains
Werai - Moss Vale	WAT 2	Medway Rivulet	Trenched	Floodplains and rises
Sutton Forest - Exeter	WAT 3	Wells Creek	Trenched	Hills
	WAT 4	Black Bobs Creek	Trenched	Low hills
	WAT 5	Long Swamp Creek	Trenched	Hills
Paddys River	WAT 6	Paddys River	Trenched	Low hills sloping towards river valely
	WAT 7	Uringalla Creek	Trenched	Flood plain and rises
Towrang	WAT 8	Jaormin Creek	Trenched	Low hills sloping towards river valley
	WAT 9	Lockyersleigh Creek	Trenched	Low hills
	WAT 10	Narambulla Creek	Trenched	Flood plain
	WAT 11	Osborns Creek	Trenched	Hills, higher gradient slopes towards creek
	WAT 12	Wollondilly River	HDD	Low hill sloping towards river

Sector	Crossing Ref	Name	Proposed construction method	General topography at crossing point
	WAT 13	Wollondilly River	Trenched	Low hills sloping towards river valley
	WAT 14	Boxers Creek	Trenched	Low hills
Murrays Flat	WAT 15	Wollondilly River	Trenched	Low hills sloping towards river valley
	WAT 16	Kenmore Creek	Trenched	Low hills
	WAT 17	Kenmore Creek	Trenched	Floodplain
	WAT 18	Kenmore Creek	Trenched	Floodplain
	WAT 19	Kenmore Creek	Trenched	Floodplain
Goulburn	WAT 20	Wollondilly River	HDD	Floodplain and rises

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).

Roads

Road crossings (for which trenching is proposed for construction) on steeper gradients (slopes greater than 10%) are listed in Table 9.

Table 9 Road crossings on gradients of 10% or steeper

Sector	Crossing Ref No. (ROAD)	Road name	Proposed construction method
Werai - Moss Vale	Road 12	Mount Broughton Road	Trenched
Paddys River	Road 39	Unnamed	Trenched
	Road 40	Inverary Road	Trenched
	Road 41	Unnamed	Trenched

Sector	Crossing Ref No. (ROAD)	Road name	Proposed construction method
	Road 42	Unnamed	Trenched

The general topography at road crossings that are proposed to be constructed using thrust boring are listed in Table 10.

Table 10 General topography at road crossings that would be thrust bored

Sector	Crossing Ref No. (ROAD)	Road name	General topography at crossing point
Glenquarry	ROAD 3	Sheepwash Road	Flood plain
	ROAD 6	Robertson Road	Flood plain
Sutton Forest -Exeter	ROAD 22/23(duel carriageway)	Hume Highway	Low hills
Goulburn	ROAD 71	Crookwell Road	Low hills

Railways

Based on site inspections, the gradient of the land where the railway crossings would be located was observed to be essentially flat. The topography at railway line crossing points has been interpreted from topographic maps and is listed in Table 11.

Table 11 General topography at railway line crossings (thrust bored)

Sector	Crossing Ref. No. (RAIL)	General topography at crossing point
Glenquarry	RAIL 1	Flood plain
Werai - Moss Vale	RAIL 2	Low hills / flood plain
Marulan	RAIL 3	Low hills / flood plain
Towrang	RAIL 4	Flood plain
Goulburn	RAIL 5	Flood plain

4.4 Regional Geology

4.4.1 General pipeline route

The regional geology underlying the proposed pipeline route is shown in Figure C1 (Appendix C).

According to geological maps listed in Section 4.2.1, the proposed pipeline route would traverse a number of geological units, which are briefly described below. Features associated with each geological unit are summarised in Table 12.

Table 12 Summary of Geological Units

Sectors	Geological Unit	Description	Approximate Length of Route [1]
Glenquarry, Werai-Moss Vale, Sutton Forest - Exeter	Wianamatta Group (Rw)	Ashfied Shale or siltstone (Sedimentary rock). Generally encountered above the Hawkesbury Sandstone.	26 km (~CH 0 km – CH 26 km)
Werai-Moss Vale, Sutton Forest - Exeter	Robertson Basalts (Jss/Tob)	Alkali-Olivine Basalt (Igneous rock). Overlies the Wianamatta Group (probably Ashfield Shale).	~ 2 km (total) (~ CH 9 km- CH 9.5 km, between CH 17 km- CH 22 km (two to three occurrences),
Werai-Moss Vale	Mount Broughton, Mount Misery, Cockatoo Hill (Jes)	Syenite - Microsyenite (Igneous rock)	~2 km (~CH 11 km- CH13 km)
Paddys River	Hawkesbury Sandstone (Rh)	Sandstone (Sedimentary rock) Directly overlies the Berry Siltstone formation	7 km (~CH 25-CH 33.5 km)
Paddys River, Marulan	Shoalhaven Group (Ps)	*Illawarra Coal Measures* – coal, siltstone, sandstone, minor conglomerate. *Berry Siltstone* – Fine grained lithic sandstone, with minor conglomerate *Snapper Point formation* – medium bedded siltstone, sandstone, minor pebble	12 km (total) (~CH 33 km-CH 37 km, ~CH 41 km-CH 46.5 km)

Sectors	Geological Unit	Description	Approximate Length of Route [1]
		conglomerates	
Paddys River, Marulan	Adaminaby Group (Os-s)	Undifferentiated - Sandstone, quartz greywacke, siltstone, quartzite, phyllite, slate (Sedimentary rock)	10 km (total) (~CH 37 km - CH 40 km, ~CH 46.5 km – 47.5 km, ~CH 58 km -CH 64 km)
Paddys River	Marulan Granite (Dgm)	Porphyry (Igneous rock)	1 km (~CH 40 km- CH 41 km)
Marulan	Bindook Group (Dlb)	Granite (Igneous rock)	4 km (~CH 47.5 km- CH 52 km)
Towrang	Lockyersleigh Granite (Cgb)	Granite (Igneous rock)	7 km (~ CH 52 km- CH 58 km)
Towrang, Murrays Flat, Goulburn	Cainozoic Sediments (Cza)	*Alluvial deposits* – Undifferentiated, gravels, sands, clays, claystones, and sandstones.	9 km (~CH 64 km – 65.5 km, ~CH 70 km – 72 km)
Towrang	Towrang Formation (St)	Shale, siltstone, sandstone, quartzite	2 km (~CH 65.5 km- CH 67 km)
Towrang	Saltpetre Andesite (Suv)	Andesite (Igneous rock)	1 km (~CH 67 km – 68 km)
Murrays Flat	Lambie Group (Duc/Dua)	Conglomerate, sandstone, shale, quartzite	2 km (~CH 68 km- CH 70 km)
Goulburn	Bungonia Formation (Su)	Undifferentiated Limestone, shale, chert, quartzite, tuff (sedimentary rock)	7 km (total) (~CH 72 km-CH 76.5 km, ~CH 77 km - CH 78.5 km, 79.5 km – 80.5 km)
Goulburn	Bishopthorpe Dolerite (Ig)	Dolerite (Igneous rock)	1 km (~ CH 78.5 km- CH 79.5 km)

An analysis of the geological maps shows the route proposed pipeline easement would be partly located within the Illawarra Shelf Area, towards the southern end of the Sydney Basin, and partly within the

Lachlan fold belt. The eastern portion of the easement (up to approximately CH 40 km) would generally cross shallow dipping/sub-horizontal strata (refer *Southern Coalfield Geological Map*). However, towards the west (near Goulburn), the bedrock has been affected by folding and faulting (as shown in section Z-Z of the 1:100,000 scale *Goulburn* geological map sheet, 2008).

The 1:100,000 scale geological map for Goulburn shows a number of mapped faults transecting the proposed pipeline route to the west of Goulburn. The faults generally trend north to south, resulting in the formation of a number of "faulted blocks". Numerous sub parallel faults and fold structures have also developed within these faulted blocks.

The main faults that have been mapped include:

- Yarralaw Fault – boundary between the Adaminaby Group and Bindook Group;
- Towrang Fault – boundary between the Adaminaby Group and Lambie Group; and
- Mulwaree Fault – between the Towrang formation and the Bungonia Formation.

4.4.2 Crossings

The geology underlying the proposed crossings is listed in Table C1 (Appendix C), and summarised below.

Water courses

The geology underlying the majority of the watercourses is predominantly sedimentary rock or alluvial deposits (which are likely to be underlaid by sedimentary rock). 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).

Roads

The geology underlying the road crossings would vary. The geological maps show all road crossings which are proposed to be thrust bored (Hume Highway, Robertson Road, Sheepwash Road) are underlain by sedimentary rock.

Railway lines

The geological maps show all rail crossings are underlain by sedimentary rock except for crossing RAIL3 (Main Southern Railway) which is underlain by igneous rock.

4.5 Soil Landscapes

4.5.1 General pipeline route

A review of the published soil landscape maps for the Hawkesbury – Nepean Catchment identified 34 soil landscapes along the proposed project route. Broadly, these soil landscapes can be grouped into five separate units based on origin and / or surface processes. The five units and their limitations in terms of the proposed Project are described in Table 13. The location of these soil landscapes are shown in Figures C2(a) to C2(f) (Appendix C).

Table 13 Soil landscapes likely to be encountered along proposed pipeline easement

Soil landscape type	Description of soil landscape	Potential construction, engineering and maintenance Issues	Approximate total length of route occupied by soil landscape
Erosional	Soil formation is affected by the removal of weathered parent material	Widespread erosion and generally low fertility soils – may present difficulty in reinstating existing vegetation, post construction.	47.9 km
Transferral	Similar to alluvial soils but are considered to have undergone less transportation, and often resemble local soil and weathered materials (e.g. “slopewash”)	Seasonal waterlogging – may limit construction plant access. May provide low foundation strength for thrust blocks. Low fertility – may present difficulty in reinstating existing vegetation, post construction.	17 km
Alluvial	Soils transported by water down creeks and rivers.	Flood hazards and waterlogging – may limit construction plant access. May provide low foundation strength for thrust blocks. Widespread erosion and some low fertility soils – may present difficulty in reinstating existing vegetation, post construction.	8.6 km
Colluvial	Soils of colluvial origin are derived from subsurface materials that have undergone or are undergoing mass-movement down slope, primarily due to the influence of gravity	Steep slopes – limited construction plant access. Mass movement hazard – Trenching in colluvium environment may trigger instability / landsliding. Ongoing soil creep – damage to pipeline / connections at thrust blocks. Ongoing sheet erosion – may present difficulty in reinstating existing vegetation, post construction.	3.7 km

Soil landscape type	Description of soil landscape	Potential construction, engineering and maintenance Issues	Approximate total length of route occupied by soil landscape
Residual	Soils that form where weathering of parent material occurs without significant erosion over extended periods of time	No major issues identified.	3.4 km

A summary of the predominant soil constraints in each sector of the pipeline route is provided in Table 14. Figures C2 to C7 (Appendix C) show the locations of the soil constraints.

Table 14 Dominant soil constraints in Sector

Sectors	Sheet erosion hazard	Shallow soils	Sodicity	Seasonal waterlogging	Salinity hazard	Steep slopes
Glenquarry and Werai - Moss Vale	W	L	W	W & L	-	W (minor extent)
Sutton Forest - Exeter	W	L	W	W & L	-	W (minor extent)
Paddys River	W	-	W & L	-	-	W (minor extent)
Marulan	W	L	W & L	W & L	L	L
Towrang	W	L	W	L	L	-
Murrays Flat and Goulburn	W & L	-	L	W	L	-

Legend: L – Localised occurrence W – Widespread occurrence.

The constraints are described below:

Sodicity	"Sodic soil" is typically associated with agricultural soil science. Its environmental engineering implications are highly dispersive, erodible soils, prone to waterlogging.
Seasonal waterlogging	Poorly drained soils
Sheet erosion hazard	Soils susceptible to the removal of a uniform thin layer of soil by raindrop splash or water run-off.

Salinity hazard	Soils containing excessive salt which impacts health of vegetated ground cover, exposing soils to high erosion hazards
Shallow soils	Areas where the soil layer is thin and rock would likely be encountered at shallow depth
Steep slopes / Mass movement hazard	Soils on steep slopes which is subject to mass movement down slope

Table 14 show that the majority of soil landscapes that would be encountered along the pipeline construction corridor are susceptible to widespread sheet erosion and sodicity. Seasonal waterlogging of soils is also common. Localised salinity hazards, waterlogging and steep slopes would also be expected along the pipeline construction corridor.

Acid sulfate soils are not expected along the proposed pipeline construction corridor. However, there is a possibility that ASS or PASS may be present in waterlogged or swampy areas.

4.5.2 Crossings

The soil landscapes and their constraints which would be expected at the crossing points are listed in Table C1 (Appendix C). Based on the information provided in Table C1, the expected soil landscapes at the crossing points are as follows:

- Watercourse crossings: The soil landscapes present at the majority of proposed watercourse crossings are either Alluvial or Transferral;
- Road crossings: The majority of road crossings would be undertaken in Erosional soils that are subject to widespread sheet erosion and sodicity; and
- Railway line crossings: The soil landscapes expected at the railway crossings include Transferral (RAIL 1 to 3), Alluvial (RAIL 4) and Erosional (RAIL 5). The soil landscapes at these locations are subject to sheet erosion hazards and sodicity. The Erosional soil landscape is also subject to localised salinity.

4.6 Groundwater

4.6.1 Information and limitations

Information on groundwater within bores located in the vicinity of the pipeline route was obtained from the NSW Office of Water's (formerly the Department of Water and Energy) database of registered groundwater bores located throughout New South Wales (DWE 2004). This data is provided in Table D1 (Appendix D).

A review of information held in this database revealed there are approximately 350 registered groundwater bores located within 2 km from the proposed pipeline route. Figures D1(a) to D1(f) (Appendix D) show the locations of these bores.

The data provided was incomplete and its use in determining the local groundwater conditions beneath the pipeline easement has limitations as follows:

- There is a lack of groundwater bore data at some crossing locations included railway crossing RAIL 3, road crossings ROAD 40 and ROAD 45, and watercourse crossings WAT 6, WAT 8, WAT 9, WAT 10 and WAT 11. With the exception of Railway line crossing RAIL 3, these crossing are all proposed to be trenched, and therefore the risk of intersecting groundwater at these crossings is significantly reduced;
- The depth of the bores has been used to indicate the depth to groundwater. This assumes that borehole drilling was terminated when a significant source of groundwater was intercepted;
- The depth to groundwater can vary with distance from the borehole. It is noted that the nearest bore to a major crossing is 150 m; and
- Some bore depth are recorded a 0 metres below ground level (m bgl). This may indicate a data error, or that no data was recorded. The depth of the casing has been used to indicate the depth to groundwater in such cases.

Despite these above limitations the data obtained is considered sufficient to provide a general overview of the likely groundwater conditions beneath the proposed pipeline route.

4.6.2 General pipeline route

Depth to groundwater

Groundwater typically exists in aquifers comprising subsurface permeable materials such as sandy or gravelly lenses, or in fractured rock formations. Aquifers can be unconfined, confined and semi-confined. An unconfined aquifer is an aquifer that does not have an overlying impermeable layer, allowing the groundwater level to rise and fall as recharge waters enter and leave the aquifer. Semi-confined and confined aquifers are aquifers that have overlying confining (impermeable) layer. Groundwater typically occurs under pressure in confined and semi-confined aquifers as the overlying confining layer restricts the groundwater levels from rising when recharge water enters the aquifer. Depths to groundwater measured in boreholes that intercept confined and semi confined aquifers can therefore be significantly shallower than the depth of the aquifer. Thus the recorded standing water depth of groundwater in deep boreholes may not be a reliable indication of the depth of the aquifer (or groundwater) below the surface. The depth of the borehole may provided a more reliable indication of the depth to groundwater, if it is assumed that the borehole drilled was terminated when a significant source of groundwater was encountered.

The DWE 2004 data shows that most of the boreholes within 2 km of the proposed pipeline easement have a depth of greater that 20 m below ground level (m bgl). If it is assumed that the boreholes were terminated at the depth where a significant groundwater source was intercepted, then it could be concluded that significant aquifers beneath the proposed pipeline easement are at depths typically greater than 20 m bgl.

The data also indicates that there are eight bores within 2 km of the pipeline route that may contain shallow groundwater (< 10m bgl). Data on these bores is provided in Table 15.

Table 15 Location of boreholes in shallow groundwater

Sector	Bore ID	Depth of borehole (m)	Depth of casing (m bgl)	Standing water level (m bgl)	Approximate distance from pipeline route (m)
Glenquarry	GW065891	0*	6.0	No data	1180
Sutton Forrest - Exeter	GW034245	0*	3.9	No data	1800
Sutton Forrest - Exeter	GW035156	3	No data	No data	230
Sutton Forrest - Exeter	GW044058	9	No data	No data	850
Sutton Forrest - Exeter	GW066775	0*	6.0	No data	850
Paddys River	GW034230	3	No data	No data	470
Murrays Flat	GW104582	3	No data	No data	380
Murrays Flat	GW104585	7	No data	No data	400
Goulburn	GW105020	9	No data	3.5	950

Where the depth of the borehole has been listed as 0m, the depth of casing has been used to indicate the possible depth of the borehole and the depth to groundwater.

It is expected that deeper confined aquifers would exist in the fractured bedrock (basalts, granites, sandstones, shales), while shallow unconfined aquifers may exist in Transferral or Alluvial deposits, which are typically present adjacent to watercourse. As such, a permanently higher watertable could be expected in alluvial deposits located within the watercourse's floodplains. Therefore, the interception of significant aquifers (expected to be at depths of 20 m bgl or more) is not expected during construction trenching. Shallow or perched unconfined aquifers may be encountered during excavations at watercourse crossings or in lower lying flood plains.

Since trenching and excavations would not likely be undertaken to depths over 3 m below ground level, the risk of encountering a significant groundwater resource or a groundwater resource used by nearby landholders is low.

Groundwater flow direction

In general, groundwater is understood to flow from topographically higher areas toward topographically lower areas. Groundwater may also discharge into watercourses, providing the watercourse with a baseline source of water. This is typically the case in hilly and undulating areas such as is typical of the topography in the Project area.

Localised groundwater flow directions beneath the proposed pipeline easement are likely to vary spatially between the Wingecarribee Reservoir and Goulburn. Table 16 describes the expected direction of groundwater flow in each of the sectors of the pipeline route.

Table 16 Expected groundwater flow directions

Sectors	Expected groundwater flow direction in each Sector from the proposed pipeline easement
Glenquarry	Groundwater flow is likely to be northeast from the centre of the sector (~CH2.5 km) toward Wingecarribee River. From the western side of the sector the groundwater flow is also expected to be northeast from the topographically higher point (~CH5.6 km) towards Kellys Creek.
Werai - Moss Vale	From the topographically high point (~CH12.5 km) groundwater is expected to flow either north and northeast, or southwest toward Medway Rivulet
Sutton Forest - Exeter	The groundwater flow direction would vary with the undulating topography. In the eastern portion of the sector the groundwater flow direction may be trending to the north, while in the western portion of the sector groundwater flows are likely to trend from topographically higher points toward Long Swamp Creek and Black Bobs Creek (typically northeast or southwest from high points)
Paddys River	Again the groundwater flow direction would likely be highly variable with the undulating topography. In the eastern portion of the sector from ~CH35 km, the flow direction would likely trend in a northerly direction. In the western portion of the sector the groundwater flow direction would likely be toward Paddy's River.
Marulan	In the eastern portion of the sector (from ~CH44 km) the groundwater flow direction is likely to be in an easterly direction toward Uringalla Creek. In the western portion of the sector the groundwater flow would likely be toward Jaormin Creek (typically northeast or southwest from high points)
Towrang	The groundwater flow would likely be in a north easterly direction toward the Wollondilly River (~CH52 km – CH60 km)
Murrays Flat	The groundwater flow would likely be in a northerly direction toward the Wollondilly River (~CH65 km – CH70 km). . From the elevated Murrays Flat area the groundwater flow is likely to be in a north easterly direction toward Boxes Creek
Goulburn	The groundwater flow direction is likely to be in a southerly direction toward the Wollondilly River (~CH72 km – CH78 km).

Groundwater quality

Limited information regarding groundwater quality was contained in the database of registered bores held by the NSW Office of Water. The information provided contained incomplete records of the quality (mainly salinity) of the groundwater encountered. Salinity has been recorded as a qualitative (eg. 'good', 'fair', 'salty' etc) or quantitative (eg. 1001 - 3000 ppm) measure.

The majority of salinity data provided showed the measure of salinity as 'good', 'fair', 'fresh' or <1000 ppm (concentration of salts in parts per million). This demonstrates that groundwater of relatively low salt concentrations would be expected to exist beneath the majority of the proposed pipeline easement.

High quality groundwater would be expected particularly in the area around Lot 122 / DP 802050 (sector Paddy's River) which is located approximately 5 km west-south west of Sallys Corner. This block contains seven bores from which groundwater is extracted and bottled for drinking water. It is expected that the groundwater beneath this site flows in a northerly direction.

Bore data for the seven bores that exist on this block are provided in Table 17. Based on an expected northerly groundwater flow direction, Table 17 also lists whether the bores are located upstream or downstream of the proposed pipeline.

Table 17 Bore data (Lot 122 / DP 802050)

Bore ID	Date completed	Bore depth (m bgl)	SWL (m bgl)	Salinity	Groundwater upstream or down stream of proposed pipeline
GW053995	1/11/1982	31	No data	Good	Downstream
GW101583	14/12/1994	30	7.6	No data	Upstream
GW102066	14/12/1994	34	7.1	No data	Downstream
GW107520	7/08/2006	15	12.5	No data	Downstream
GW107521	8/08/2006	35	16.5	No data	Upstream
GW107522	9/08/2006	42	30.4	No data	Downstream
GW107556	24/10/2006	No data	No data	No data	Upstream

SWL: Standing Water Level

The information in Table 17 shows the shallowest groundwater bore is 15 m bgl (GW 107520). This may suggest the shallowest groundwater resource beneath this block is also approximately 15 m bgl and well below the expected trenching depth of 1.5 m bgl.

Of the bores located within 2 km of the pipeline route, poor quality groundwater (recorded as 'bad', 'stock', `1001-3000 ppm', 'hard' or 'salty') was recorded in thirteen bores. These bores are listed in Table 18 and have depths of 18 m bgl or greater. The nearest bore containing poor quality groundwater would be 640 m from the proposed pipeline easement. It is considered that 'Poor' quality groundwater is not likely to be encountered during the construction of operation of the proposed Project.

Table 18 Bores containing ‘poor’ quality groundwater

Sector	Bore ID	Groundwater salinity	Depth of borehole (m)	Approximate distance from pipeline easement (m)
Glenquarry	GW011931	‘Hard’	65	1800
Glenquarry	GW013306	‘Poor’	48	1600
Goulburn	GW014110	‘Bad’	32	1100
Glenquarry	GW015214	‘Stock’	39	1900
Glenquarry	GW015690	1001-3000 ppm	58	640
Paddys River	GW043366	‘Salty’	21	1460
Goulburn	GW038230	1001-3000 ppm	21	1000
Glenquarry	GW025579	1001-3000 ppm	18	890
Sutton Forrest - Exeter	GW057943	1001-3000 ppm	26	800
Goulburn	GW058433	1001-3000 ppm	49	830
Glenquarry	GW059264	1001-3000 ppm	36	645
Werai-Moss Vale	GW025569	‘Salty’	46	1130
Sutton Forrest - Exeter	GW104213	‘Salty’	144	1990

4.6.3 Crossings

Depth to groundwater

A list of the data of groundwater bores located within 1 km from each of the rail, road and watercourse crossings is provided in Table D2 (Appendix D) and summarised in Table 19.

Table 19 Groundwater bore data summary for crossings (Source: DWE, 2004)

Crossing Type	No. of bores (within 1 km of crossing point)	Range of bore depth (m bgl)	Range of SWL (m bgl)
Railway Crossings	14	50 – 150	23 - 94
Highway Crossings	11	18 – 156	13 – 41.6
RTA and major council Road	109	3 – 175	3.2 - 94

Crossings			
Watercourse Crossings	83	3 – 156	3.5 - 94

The information provided in Table 19 shows that, in general, aquifers containing significant groundwater are likely to exist between 18 m and 175 m bgl. Groundwater bores have been drilled to 3 m bgl near road and watercourse crossings. This could indicate that groundwater could exist from 3 m depth (bgl) at some locations (such as within flood plains). As listed in Table 10 and Table 11, road crossings ROAD 3 and 6 (which are proposed to be thrust bored) and all railway line crossings would be located on or adjacent to a flood plain. Shallow groundwater could be expected at these locations.

It is expected that groundwater depths immediately adjacent to watercourse crossings could be shallower than 3 m bgl.

Table 20 Groundwater bores located nearby to crossing locations

Crossing ref no.	Crossing name	Bore ID	Approx distance from crossing (m)	Depth of Bore (m bgl)	Standing Water Level (m bgl)
Road 11	Bibbys Lane	GW035156	400	3	No data
Road 12	Mount Broughton Road	GW035156	400	3	No data
Road 68	Taralga Road	GW104582	450	3	No data
		GW104585	600	7	No data
WAT 15	Wollondilly River	GW104585	800	7	No data
		GW104582	850	3	No data
WAT 16	Kenmore Creek	GW104585	850	7	No data
		GW104582	900	3	No data
WAT 17	Kenmore Creek	GW104585	600	7	No data
		GW104582	500	3	No data
WAT 18	Kenmore Creek	GW104585	700	7	No data
		GW104582	600	3	No data
WAT 19	Kenmore Creek	GW104585	800	7	No data
		GW104582	700	3	No data
WAT 20	Wollondilly River	GW105020	900	9	3.5

Groundwater flow direction

The groundwater flow directions at the crossing points would vary, reflecting the changing topography along the proposed pipeline easement.

The direction of groundwater flow on either side of the watercourse crossings would in general be expected to be toward the watercourse. The groundwater flow directions that would be expected at crossing that are proposed to be thrust bored (crossings ROAD 3, 6, 22/23, and 71 and RAIL 1 to 5) are listed in Table 21. This Table also contains a list of boreholes that are within 1 km down gradient of these crossings.

The information in Table 21 indicates that the groundwater resources being accessed by the groundwater bores down stream of the crossing which are proposed to be thrust bored, are typically greater that 18 m bgl. There are three bores that are 10 m bgl or less downstream of crossing ROAD 71 (Crookwell Road). These bores are however located at least 820 m from the proposed ROAD 71 crossing.

The bore depths for a number of the boreholes listed in Table 21 were not recorded. Of these bores, the distance from the crossing point to the nearest bore in 325 m. Thus, even if the bores that do not have there depth recorded contain shallow groundwater, interaction with the groundwater is not likely due to the significant distances from the crossings

Groundwater quality

None of the bores that have records of 'poor' quality groundwater (see Table 18) are located near proposed crossing points. Therefore the quality of groundwater that would be expected beneath the proposed crossings has been interpreted to be of a quality suitable for stock watering and irrigation.

There are a number of minor road crossings that would be constructed in the vicinity of Lot 122 / DP 802050 (groundwater bottling site). The minor road crossings at this location would be constructed using trenching to depths less than 2 m bgl. It is likely that the construction of these road crossings would intercept the groundwater in the area which is assessed to be approximately 15 m bgl.

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Table 21 Bores down gradient of crossings that would be constructed by thrust boring

Sector	Crossing Ref. No.	Crossing name	Likely groundwater flow direction	Bores down gradient of crossing	Distance from crossing (m)	Borehole depth (m bgl)
Glenquarry	ROAD 3	Sheepwash Road	North	GW069121	390	44
				GW057831	495	46
				GW108160	710	57
	RAIL 1	Moss Vale Unanderra Railway	North East	None	-	-
Werai - Moss Vale	ROAD 6	Robertson Road	North	GW015941	284	61
				GW028879	1800	31
				GW064205	1900	136
	RAIL 2	Main Southern Railway	North East	None	-	-
Sutton Forest - Exeter	ROAD 22 / 23	Hume Highway	North	GW057687	145	90
				GW108058	325	NR
				GW104765	332	108
				GW035924	350	76
				GW051537	898	92

Sector	Crossing Ref. No.	Crossing name	Likely groundwater flow direction	Bores down gradient of crossing	Distance from crossing (m)	Borehole depth (m bgl)
Marulan	RAIL 3	Main Southern Railway	Northwest	GW055436	2160	76
Towrang	RAIL 4	Main Southern Railway	North	None		
Goulburn	ROAD 71	Crookwell Road	South	GW049788	470	53
				GW063634	822	7
				GW107167	1122	NR
				GW106139	1240	NR
				GW105981	1330	NR
				GW043473	1258	18
				GW065885	1377	NR (SWL recorded as 10 m blg)
				GW105738	1518	NR
				GW105323	1526	30
				GW105518	1612	38
				GW104500	1630	30
				GW105764	1673	NR

Sector	Crossing Ref. No.	Crossing name	Likely groundwater flow direction	Bores down gradient of crossing	Distance from crossing (m)	Borehole depth (m bgl)
				GW105842	1866	NR
				GW105843	1857	NR
				GW105333	1931	24
				GW105020	1934	9
	RAIL 5	Goulburn Crookwell Railway	East / Southeast	GW107193	440	NR
				GW107893	475	NR
				GW106788	805	NR

NR: Not recorded

4.7 Land contamination

Based on the site inspection and search of the DECC database, it is considered unlikely that significantly contaminated land occurs immediately adjacent to or within the pipeline construction corridor.

4.7.1 Potentially contaminating activities

The *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites* (ANZECC & NHMRC 1992) lists ‘railway yards’ as a potentially contaminated activity. Furthermore, weed management on railway lines often included the spraying weedicides and herbicides onto the tracks. As such, excavations adjacent to, and boring beneath, the railway line may encounter contaminated soil.

4.7.2 Observations made during pipeline easement selection

Five ‘areas of potential concern’ (being areas where potentially contaminating activities have or may have taken place) were observed adjacent to or within the pipeline easement. The areas are described in Table 22 together with an assessment of the likelihood of significant ground contamination occurring at the location. A location plan of the four areas of potential concern are provided in Figures E1 to E5 (Appendix E).

Table 22 Locations of areas of potential concern

Pipeline Route Sector	Location (Lot No. / DP)	Area of concern / Contaminants of concern	Likelihood of significant ground contamination occurring
Paddy’s River	137 / 751298	Material stockpiles: Piles of scrap metal	Unlikely: Stockpiled material is not likely to be a source of ground contamination.
Sutton Forest – Exeter	10 / 811912	Old Drums. Potential for ground chemical or fuel contamination associated with drums	Unlikely: Area does not appear to be an actual former drum storage location and therefore the drums do not appear to be a source of significant contamination.
Towrang	122 / 750050	Stockyard: Potential for chemical contamination from drenching of livestock.	Unlikely: Past activities undertaken at this location are not likely to be a source of significant ground contamination. (Note: significant contamination could occur if the location contains a sheep dip)
Murray’s Flat	102 / 791867	Stockyard: Potential for chemical contamination from drenching of livestock.	Unlikely: Past activities undertaken at this location are not likely to be a source of significant ground contamination. (Note: significant contamination could occur if the location contains a sheep dip)
Goulburn	1/1126788	Area of effluent irrigation: Potential for heavy	Likely: Current effluent irrigation may have caused elevated

Pipeline Route Sector	Location (Lot No. / DP)	Area of concern / Contaminants of concern	Likelihood of significant ground contamination occurring
	2/1126788	metals, pesticides, thermo tolerant coliforms, oil and grease, pH.	concentrations of contaminants in soil

No other areas of potential concern were observed during the site visits to determine the pipeline route alignment.

4.7.3 Contaminated land database searches

A search of a database of orders made under Part 3 of the CLM Act was undertaken. Part 3 of the CLM Act provides for the EPA to order a site investigation to be undertaken at a site. The search was undertaken for the Goulburn Mulwaree LGA and Wingecarribee LGA.

The search results are provided in Appendix E and summarised in Table 23. It shows that four sites, all located in the Wingecarribee LGA had or formerly had notices imposed under the CLM Act. These sites are at least 4 km from the proposed pipeline construction corridor and are not expected to impact the soils located within the proposed alignment.

Table 23 Notices under Part 3 of CLM Act

Suburb	Lot and DP	Site name	Notices	Approx. distance from pipeline easement
Goulburn Mulwaree LGA				
None	-	-	-	-
Wingecarribee LGA				
Bowral	Lot 120 DP 790331 and Lot 11 DP 749485	Former gas works site, Bowral	1 current	8.5 km
Joadja	Lot 11 DP 858859	Shale Oil Refinery	1 current	21 km
Mittagong	Lot 1 DP 577450	Former Shale Oil Plant	0 current 9 former	10.5 km
Moss Vale	Lot 1, 2 and 3 DP 33517 and Lot 1 DP 103122	Moss Vale North Depot	1 current	4 km

Source: http://www.environment.nsw.gov.au/clmapp/searchregister.aspx [accessed 5 January 2010]

5. Assessment of Potential Impacts

5.1 Impact assessment methodology

A detailed impact risk assessment (risk assessment) has been conducted to assess the risk of certain events occurring, which would lead to an impact, during the construction and operational phases of the Project. A qualitative risk assessment framework was used.

The relative risk for each identified potential impact was determined as a function of the likelihood of a certain potential impact event occurring as well as the consequences that may be associated with the potential impact event occurring. The risk was assessed on the basis of the likely interaction of the Project activities on the existing soil, groundwater and contaminated soils identified in this report.

To assess risks consistently, Consequence and Likelihood tables were developed that clearly define levels of consequence (from insignificant to catastrophic in terms of magnitude, space and time) and likelihood (ranging from rare to almost certain) of identified potential impacts. The implementation of specific project controls and standard construction and operational control measures (as described in Section 2.3) were considered when determining the consequence and likelihood of each potential impact. The consequence table relevant to this study and the likelihood descriptions are provided in Appendix F.

The risk ranking was calculated via the risk matrix, considering both consequence and likelihood allocations. The risk ranking table is also provided in Appendix F.

5.2 Impact risk assessment

The impact risk assessment is provided in the risk register (Appendix F).

5.2.1 Potential construction impacts

Potential impacts that could occur during the construction phase of the Project are generally the result of the following:

- Soil erosion and land degradation, and the associated degradation of surface water quality generated by sediment laden stormwater;
- Degradation of groundwater quality and the reduction in groundwater availability;
- Dust generation;
- Instability of excavations;
- Ground subsidence; and
- The contamination of soil.

Events that would lead to the above soils and groundwater impacts were considered in the risk assessment. These events included:

- Disturbance of soils during earthworks at the Wingecarribee WTP site associated with the construction of the proposed pumping station;
- Disturbance of soils by construction traffic along the construction corridor and at points along the access routes to the construction corridor;

- Disturbance of highly erosive, shallow, sodic, saline, contaminated or acid sulfate soils within the construction corridor leading to sedimentation and erosion of soils and / or dust generation;
- Disturbance of soils on steep slopes;
- Disturbance of riparian zones;
- Stability of excavations in colluvial soils;
- Interception of groundwater during trenching and / or pit excavations associated with crossing construction by HDD or thrust boring;
- Management of groundwater seepage into excavations;
- Management and use of drilling fluids, fuels and chemicals during construction;
- Subsidence of backfilled excavations; and
- 'Frac outs' occurring during thrust boring.

5.2.2 Potential operational impacts

The potential impacts that could occur during the operational phase of the Project are generally the result of the following:

- Soil erosion;
- The contamination of soil; and
- Degradation of groundwater quality

The following operational events that would potentially lead to impacts to soils and / or groundwater were assessed in the risk assessment:

- Release of dirty scour water containing blue-green algae or high sediment loads; and
- Use of fuels and chemicals.

5.2.3 Outcome

The assessment of the risks (likelihood and consequence) of construction and operational related events occurring (which would lead to impacts to soils, groundwater and contamination) concluded the following:

- The risk of most events occurring is 'negligible' or 'low'. This is primarily due to the construction techniques that would be adopted and the extensive Project controls that would be implemented. Negligible or low risks are consider acceptable in the context of the Project; and
- The risk of encountering contaminated soil on effluent irrigated land near Goulburn is considered to be 'medium'. There is the potential that disturbance of contaminated land on effluent irrigated land has the potential to cause health impacts to construction works and impacts to surface water quality. Mitigation measures to prevent these impacts are recommended (see Section 6). The risk of this mitigated event occurring is considered to be 'low' as the likelihood of disturbing contaminated soil in the effluent irrigation area would be eliminated following an investigation and subsequent remediation of any significantly contaminated soil. As such, no significant residual impacts are likely to occur.

6. Mitigation Measures

Most of the identified potential impacts are considered to pose a negligible or low risk. The basis of this assessment has assumed that the approaches, principles, construction techniques and project controls described in Section 2.3 would be adopted, and the existing soil, groundwater and contaminated soil environment described in Section 4 would be encountered.

Soil in the effluent irrigated area on Lot 1 / DP 1126788 and Lot 2 / DP 1126788 may be contaminated. If disturbed, the potential contaminated soil may pose a risk to construction workers and the environment. As such, it is recommended that the following mitigation measures are implemented.

Investigate potentially contaminated soil in effluent irrigation area

Prior to construction, a contaminated soil investigation should be undertaken in the effluent irrigation area on Lots 1 and 2 / DP 1126788.

The investigations should be undertaken in accordance with guidelines approved by the NSW DECC&W under Section 105 of the *Contaminated Land Management Act, 1997* including:

1. Australia and New Zealand Environment and Conservation Council and the National Health Environment and Medical Research Council (ANZECC & NHMRC), 1992 *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites;* and
2. National Environment Protection Council (NEPC).1999. *National Environment Protection (Assessment of Site Contamination) Measure 1999*.

Based on the results of the proposed investigation, plans for protecting the health of constructions workers and for managing and re-using excavated spoil should be prepared and included in the Construction Environmental Management Plan. This could include remediation of any significantly contaminated soil. Any waste spoil generated should be managed in accordance with the *Waste Classification Guidelines*, DECCW 2008.

7. Conclusions

It is consider the Project would not cause any significant impacts (or residual impact) to soil and groundwater.

The risks of events occurring that would result in significant impacts to soils and groundwater during the construction and operational phases of the Project are considered to be 'negligible' or 'low' if the proposed project controls are implemented, maintained and audited; and the recommended mitigation measures are undertaken.

The proposed Project controls included the following:

- Soil erosion and sedimentation controls;
- Controls for in-stream works;
- Rehabilitation and maintenance of disturbed areas;
- Management of spoil;
- Management of groundwater;
- Management of acid sulphate soils;
- Management of saline soils;
- Education of the construction work teams with respect to their responsibilities and legislated requirements to prevent surface water and groundwater contamination; and
- Management of contaminated soil.

It is anticipated that these control would form part of a construction environmental management plan (CEMP) 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 recommended mitigation measure is to undertake a soil investigation to identify any significantly contaminated soil in the effluent irrigated areas on Lots 1 and 2 / DP 1126788, which has the potential to impact on the health of nearby persons and the quality of stormwater. Based on the results of the proposed investigation, plans for protecting the health of constructions workers and for managing and re-using excavated spoil should be prepared and included in the Construction Environmental Management Plan. This could include remediation of any significantly contaminated soil.

8. References

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