BROWN

West Belconnen

Sewer and Water Concept Plan Report

Prepared for Riverview

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Urban Development

Smart Consulting

COMMERCIAL IN CONFIDENCE

Brown Consulting (ACT) Pty Ltd
Level 6
121 Marcus Clarke Street
Canberra City, ACT, 2612

Ph: (02) 6211 7100

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Table of Contents

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

Riverview Projects (ACT) Pty Ltd (Riverview) has engaged Brown Consulting to provide civil engineering advice for the proposed West Belconnen Development including preparation of services concept plans. This report details the sewer and potable water servicing requirements for the development.

The total area of the study area is approximately 1,640 hectare (600ha in NSW and 1040ha in ACT). Approximately 32 percent of the NSW land and 35 percent of the ACT land is expected to be zoned as river corridor for conservation purposes. The balance of the land is anticipated to yield approximately 6,500 dwellings in the ACT and 5,000 dwellings in the NSW. The total population in development is estimated to be 30,000. Development is intended to commence at Stockdill Drive and initially extend westward in stages to the ACT/NSW border. The current ACT Government Land Release program nominates 300 blocks a year to be released from West Belconnen with the ACT component of the project. It is expected it will take approximately 30-40 years to complete at this rate.

A Structure Plan is being prepared by Riverview in accordance with the ACT Planning legislation to facilitate rezoning of the land to residential and inform rezoning of the NSW land, which will occur at the same time as the ACT rezoning. The services concept planning input to the Master Plan by Brown Consulting includes sewer, potable water, stormwater, electricity, gas and communications. This report presents the sewer and potable water services concept planning required to support the West Belconnen development Master Plan and the Structure Plan submission. It also provides preliminary advice on staging and cost opinions for the critical sewer and water infrastructure to suit the proposed development in ACT and NSW lands.

Sewer Concept Plan

A main ridge line runs east-west through the site dividing the development into a northern and southern catchment. The northern catchment falling towards Ginninderra Creek and the southern catchment falls towards the Murrumbidgee River.

ACTEW Water has confirmed that the southern catchment can discharge to the existing overflow structure on the Ginninderra Sewer Tunnel (GST) and the northern catchment can discharge at the existing vortex drop structure on the GST. ACTEW Water have also confirmed that the GST has adequate capacity to service the entire West Belconnen development.

Two options (G1 and G2) have been investigated to service the Ginninderra Creek Catchment and five options (M1 to M5) have been investigated to service the Murrumbidgee River Catchment. These options are significantly different in methodology. Therefore, the associated costs for these options are expected to vary significantly. Options G1 and M2 are expected to be the most expensive options in terms of the initial capital costs due to the extent of microtunneling involved. These options will however have minimal ongoing operation and maintenance costs compared with other options and results in significantly less impact on the existing sensitive environmental habitat.

Details of these options and comparison are summarised in the table below.

Trunk Sewer	Option No.	Total Sewer Length (km)	Capital Costs ($M)[1]	O&M Costs $0.2/kwh ($M/yr)[2]	O&M Costs $0.4/kwh ($M/yr)[3]	NPV for $0.2/kwh ($M Year2015)	NPV for $0.4/kwh ($M Year2015)	Comments
Ginninderra Creek	G1	6.5	12.7	-	-	$3.6	$3.6	6.2km long gravity sewer including 5.2km open trench and 1km microtunnel sewer Removal of 12 poor to high quality trees
	G2	6.0	8.6	$0.04	$0.04	$3.1	$3.2	Two pump stations 4.5km long open trench gravity sewer No trees removal
Murrumbidgee River	M1	12.2	10.6	-	-	$4.8	$4.8	12.2km open trench gravity sewer Affects 5.3ha PTWL habitat[4] or 4% of the total PTWL habitat Removal of 16 trees No pump station Less developable area
	M2	9.1	34.9	-	-	$18.2	$18.2	7.5km open trench and 1.6km microtunnel sewer through river corridor Affects 0.05ha BGW habitat or less than 0.01% of the total BGW habitat Removal of 16 poor to medium quality trees No pump station

Trunk Sewer	Option No.	Total Sewer Length (km)	Capital Costs ($M)[1]	O&M Costs $0.2/kwh ($M/yr)[2]	O&M Costs $0.4/kwh ($M/yr)[3]	NPV for $0.2/kwh ($M Year2015)	NPV for $0.4/kwh ($M Year2015)	Comments
	M3	10.9	29.5	$0.5	$0.9	$24.5	$32.1	Largest pump station in ACT 7.5km open trench and 0.6km microtunnel sewer through river corridor Pipe works in river corridor Removal of 16 poor to medium quality trees
	M4	9.2	26.5	$0.2	$0.3	$17.3	$19.8	Large Pump Station 7.5km open trench gravity sewer Trenched pipes in river corridor Affects 1.4ha BGW habitat or 1.8% of the total BGW habitat Removal of 16 poor to medium quality trees
	M5	11.1	25.4	$0.2	$0.3	$16.3	$18.6	Large Pump Station Gravity Sewer discharges to Ginninderra Creek catchment Additional trunk sewer main in Ginninderra Creek catchment No pipe works in river corridor Removal of 16 poor to medium quality trees

1. Costs in Year 2014 $
2. Assumed the maintenance costs is 1.5% of the capital costs of the proposed pump station and the operational costs (energy costs) is $0.20/kwh (ActewAG's ACT standard retail electricity supply schedule of charges from 1 July 2014).
3. Sensitivity analysis for each option if energy costs increases to $0.4/kwh (200% increase)
4. An 18m wide construction reservation/corridor is proposed for the proposed open trench trunk sewer alignment. The construction reservation includes silt fence, 5m wide access track zone, sewer trench and trench spoil area. Impact on the existing environmental habitat is measured within the construction corridor.

Discussion of Sewer Options

Ginninderra Creek Catchment

- The capital costs for Option G1 (microtunnel) is approximately 48% more expensive than Option G2 (pump station).
- The NPV costs over 50 years for Option G1 (microtunnel) is approximately 16% more expensive than Option G2 (pump station).
- Both Options G1 and G2 have no impact on the existing Golden Sun Moth habitat.
- Option G1 needs to remove approximately 12 trees, 9 of which are high quality trees. The pipe could either be bored under these trees or alternative construction methodology be adopted to minimise impact on the high quality trees. No tree removal is required for Option G2.

Murrumbidgee River Catchment

- Option M1 (trench) has the cheapest capital and NPV costs yet more impact on the existing sensitive habitat within the river corridor. Should this option be adopted, the proposed trunk sewer will affect approximately 5.3 ha of PTWL habitat or 4% of the total PTWL habitat to be protected within the West Belconnen Conservation Corridor.
- Option M2 (microtunnel) has the highest capital costs, which is approximately 2.3 times more than Option M1 and 37% more than the cheapest pump station option M5. Compared with Option M1, M2 has insignificant impact on the existing sensitive environmental habitat.
- Option M5 is the cheapest pump station option, which is approximately 1.4 times more than the capital costs of Option M1.
- The net present value for Options M2 and M5 is comparable over 50 years. Should the energy costs be increased significantly (i.e. 200% or more), Option M5 will be more expensive than M2.

Staged Sewer Infrastructure

The development will commence from Stockdill Drive and Parkwood Road and progress towards the border. The tunnelled options and pump station options require a large upfront expenditure to the project if undertaken at the start of the project. The following staged works could be undertaken to allow the first few stages of the development to be developed prior to having to fully construct the main sewer schemes.

Ginninderra Creek Catchment

The Staged trunk sewerage infrastructure for the Ginninderra Creek catchment can service approximately 95ha catchment (i.e. Sewer Node 5N-8), which has a PWWF of 83L/s from approximately 2,104 dwellings in 7 years. This will service Stages 2, 3, 4, 5 and 5A of the development. The opinion of cost to construct the following Stage 1 sewer infrastructure is **$1.1million** GST inclusive:

- 0.7km long 225mm diameter sewer at minimum of 0.62% grade.
- 1.4km long 300mm diameter sewer at minimum of 0.68% grade.
- 0.44km long 375mm diameter sewer at minimum of 0.6% grade.

Murrumbidgee River Catchment

The Staged trunk sewerage infrastructure for the Murrumbidgee River catchment tunnelled sewer option M1 can service approximately 92.8ha catchment (i.e. Sewer Node 5W-16), which has a PWWF of 63L/s from approximately 1,262 dwellings in 4 years. This will service Stages 1, 1A, 3 and 8 of the development. The opinion of cost to construct the following sewerage infrastructure is **$4.4 million** GST inclusive:

- 1.1km long 300mm diameter sewer at minimum of 0.42% grade;
- 3.3km long 600mm diameter trunk sewer to be constructed via open trench, including a 18m wide construction corridor;
- Connection to existing overflow structure at GST; and
- The propose works will affect 3.5ha of PTWL habitat.

Should Option M2 be adopted to service Stages 1, 1A, 3 and 8 of the development, the opinion of cost to construct the following sewerage infrastructure is **$7.7 million** GST inclusive:

- 1.1km long 225mm diameter sewer at minimum of 0.4% grade;
- 1.6km long trenched 375mm diameter sewer at minimum of 0.28% grade;
- 405m long 600mm diameter trunk sewer to be constructed via microtunneling technology, including 3 shafts ranges from 1.3m deep to 17.4m deep for microtunneling the DN600 trunk sewer;
- 155m long 600 mm diameter trunk sewer to be constructed via open trench and connection to the existing overflow structure on GST; and
- Connection to the existing 450mm diameter stub (West Macgregor Trunk Sewer) at RL536.8.

The microtunnel sewer option requires high upfront costs but is not abortive works.

Should a pump station option be adopted, a packaged pump station can be installed as a temporary infrastructure to service the 92.8ha catchment, which has a PWWF of 63L/s from approximately 1,262 dwellings in 4 years. The packaged pump station will pump flows to a high point then discharge to Ginninderra Creek Trunk Sewer via gravity, which follows Option M5's trunk sewer alignment. The proposed gravity sewer can then service Stages 2, 3, 4, 5 & 5A and 1, 1A, 3, 8 of the development in Ginninderra Creek and Murrumbidgee River Catchment.

The opinion of cost to construct the following Stage 1 sewerage infrastructure is **$3.4 million** GST inclusive:

- A packaged pump station with duty of 62L/s at 31m head;
- 446kL emergency storage;
- 0.5km long 375mm diameter rising main;
- 0.4km long 225mm diameter gravity sewer at minimum grade of 0.38%; and
- 2.6km long 375mm diameter gravity sewer at minimum grade of 0.48 %.

The temporary pump station would be demolished once the main pump station is constructed and become operational. The rising main and gravity mains could possibly be reused. The costs for the potential abortive works are estimated to be $1.1 million GST inclusive (mainly on the packaged pump station). However, the

pump station may be reused to service the Ginninderra Creek Catchment subject to further investigation in concept design.

Conclusion

The open trench options are the cheapest in both capital costs and net present value. However, additional costs for potential remediation of the affected environmental habitat areas should also be considered against the expensive microtunnel options.

The microtunneling sewer options are considered in the design due to the following reasons:

- Compared with open trench gravity sewer options in the Murrumbidgee River catchment, microtunneling technology minimises impact to the existing sensitive environmental habitat and maximise size of the catchment serviced by gravity sewer. A site walk was conducted along the M2 microtunnel alignment on 12 March 2014 with ACTEW Water, Riverview, Will Osborne and David Shorthouse. During the site inspection, the proposed alignment and the shaft locations were deemed in principle to be suitable to minimise impact on the PTWL habitat and worthy of further investigation.
- Whilst the initial capital costs associated with the microtunneling options far exceed the costs of the alternative open trench (M1) and pump station options (G2 and M2 to M5), the ongoing maintenance and operation costs are minimal.
- Reduced impact on the sensitive environmental habitat areas from both construction and potential sewer overflow from a sewer pump station.
- Ability to stage construction and delay costly infrastructure capital expenses.
- No requirements for noise and odour buffers as required for a pump station.

The net present value for the pump station options are comparable to the microtunnel options. However, the potential increase in energy costs will make the pump station options less viable then the gravity sewer options.

The trunk sewer options and staging for both the Ginninderra Creek and Murrumbidgee River catchments require further detailed analysis and consultation with the relevant government agencies and authorities.

Water Concept Plan

The water supply concept plan is shown on drawings C13080-CP020 to 022.

Preparation of the water concept plan is based on the ACTEW Corporation- Water Supply and Sewerage Standard (AWSSS). Subject to development and finalisation of the development sustainability objectives related to Water Sensitive Urban Design (WSUD) and water recycling, this report and concept plans for water are based on meeting the current AWSSS to provide a based case concept for servicing the site.

ACTEW Water is investigating the Water Supply Strategy and proposed bulk water supply infrastructure for servicing the proposed West Belconnen development. To date, ACTEW Water have not provided conclusive advice nor any written advice on the Water Supply Strategy. The substance of the water concept plan provided are based on the information discussed in a number of meetings with ACTEW Water and EDD.

Water Pressure Zones

ACTEW Water advised that there are four water pressure zones within the proposed West Belconnen development as shown in the table below.

Water Zone	Lowest Served Area (RL)	Highest Served Area (RL)
Intermediate	600	625
Low	560	600
Extra Low	530	565
Ultra Low	500	530

Majority of the West Belconnen development is located in the 'Low' and 'Extra Low' pressure areas. A small area near Stockdill Drive south of the site is located within the Intermediate Pressure Zone. There are also some low lying areas in the north-western side of the NSW development near the river corridor located within the Ultra Low Pressure Zone.

Water Supply Infrastructure Options

The total peak hourly demand for the proposed development is approximately 674 L/s based on the current in peak demand rate in AWSSS. ACTEW Water undertook preliminary network analysis and proposed two options to service the development:

Option 1 – Trunk Main + Reservoirs within Development

- A 3.2km long trunk water main (indicative size 1050mm diameter) running along Drake Brockman Drive, from Higgins Reservoir to the site boundary for servicing the Low Zone areas and filling the Extra Low Zone reservoir (refer drawing C13080 – CP022 in **APPENDIX D**).
- A 10ML to 15ML reservoir within the site to service the Extra Low Zone. The reservoir can be constructed at ground level at RL585 with 10m head or as an elevated reservoir at RL568 with approximately height of 20m head. Refer to Drawing C13080 – CP020 in **APPENDIX D** for possible tank locations within the development.

- A smaller trunk main (indicative size 300mm diameter) from the Intermediate Zone in Hawker or connected to the Stromlo Bulk Supply Main, both of which are located near the Higgins Reservoir, extending to the West Belconnen Intermediate Zone.
- A 0.5ML reservoir south of the site to service the Intermediate Zone. The reservoir could be constructed at RL648 on a nearby hill.
- Pressure Reduction Valves (PRVs) to service the Ultra Low Zone.

Option 2 – Trunk Mains Only with PRVs within Development

- Two 3.2km long trunk water main (indicative size 1050mm diameter each) running along Drake Brockman Drive, from Higgins Reservoir to the site boundary for servicing the Low Zone areas (refer drawing C13080 – CP022 in **APPENDIX D**).
- Pressure reduction valves off the low zone water mains within the site to supply extra low zone areas (refer to Drawing C13080 – CP020).
- Two smaller mains (indicative size 300mm diameter each) off the Stromlo Bulk Main to Intermediate Zone.

ACTEW Water will confirm the trunk water main sizes after completing the water network modelling and strategy for the West Belconnen Development.

Staged Water Supply Infrastructure

ACTEW Water advised that the initial stages of the development can be serviced by extending the existing 600mm diameter trunk water main from MacNaughton Street to the site boundary. The new DN600 trunk water main is approximately 1.6km long and can service up to 1,000 dwellings within Low Zone.

Advice on increases in infrastructure size due to the NSW development has been requested for ACTEW Water.

Conclusion

Options 1 and 2 will be subject to more detailed analysis and consultation with the relevant government agencies and service authorities. It is noted that the capital costs associated with Option 2 (PRV) are likely to be significantly less than Option 1 (Reservoir) and less land take is required for Option 2 by not requiring a large reservoir. However, Option 1 may be considered as a more appropriate servicing solution, providing higher water supply security and reliability to the development.

1. INTRODUCTION

1.1 Overview

Riverview Projects (ACT) Pty Ltd (Riverview) is the project manager for the planning of West Belconnen, acting on behalf of the ACT Government with respect to the ACT land, and on behalf of the landowners within the NSW section. The ACT Land Development Agency (LDA) is the responsible ACT Government's development agency with respect to the ACT lands.

Riverview has engaged Brown Consulting to provide civil engineering advice for the proposed West Belconnen Development including preparation of services concept plans. This report details the concept sewer and potable water servicing requirements for the development.

The project study area is bounded by the Canberra Substation, the West Macgregor development and the Belconnen Magpies Golf Course to the east, Stockdill Drive to the south, Murrumbidgee River to the west, Ginninderra Creek to the north. Refer **Figure 1** for the extent of study area.

The total area of the study area is approximately 1,640 hectare (600ha in NSW and 1040ha in ACT). Approximately 32 percent of the NSW land and 35 percent of the ACT land is expected to be zoned as river corridor for conservation purposes. The balance of the land is anticipated to yield approximately 6,500 dwellings in the ACT and 5,000 dwellings in the NSW. The total population in development is estimated to be 30,000[1].

Development is intended to commence at Stockdill Drive and initially extend westward. The current ACT Government Land Release program nominates 300 blocks a year to be released from West Belconnen. It is expected it will take approximately 30 to 40 years to complete the development at this rate. It has been agreed that sales in NSW cannot commence until completion of at least 2,000 blocks in the ACT first which is approximately seven years away.

The West Belconnen project has been the vision of Riverview for a number of years now, with major investment in background studies to inform the project having been already undertaken. In 2013, Riverview entered into a Heads of Agreement arrangement with the ACT Government, Riverview acting as the Project Manager for the Territory Plan rezoning and delivery of the ACT development on behalf of the ACT Government.

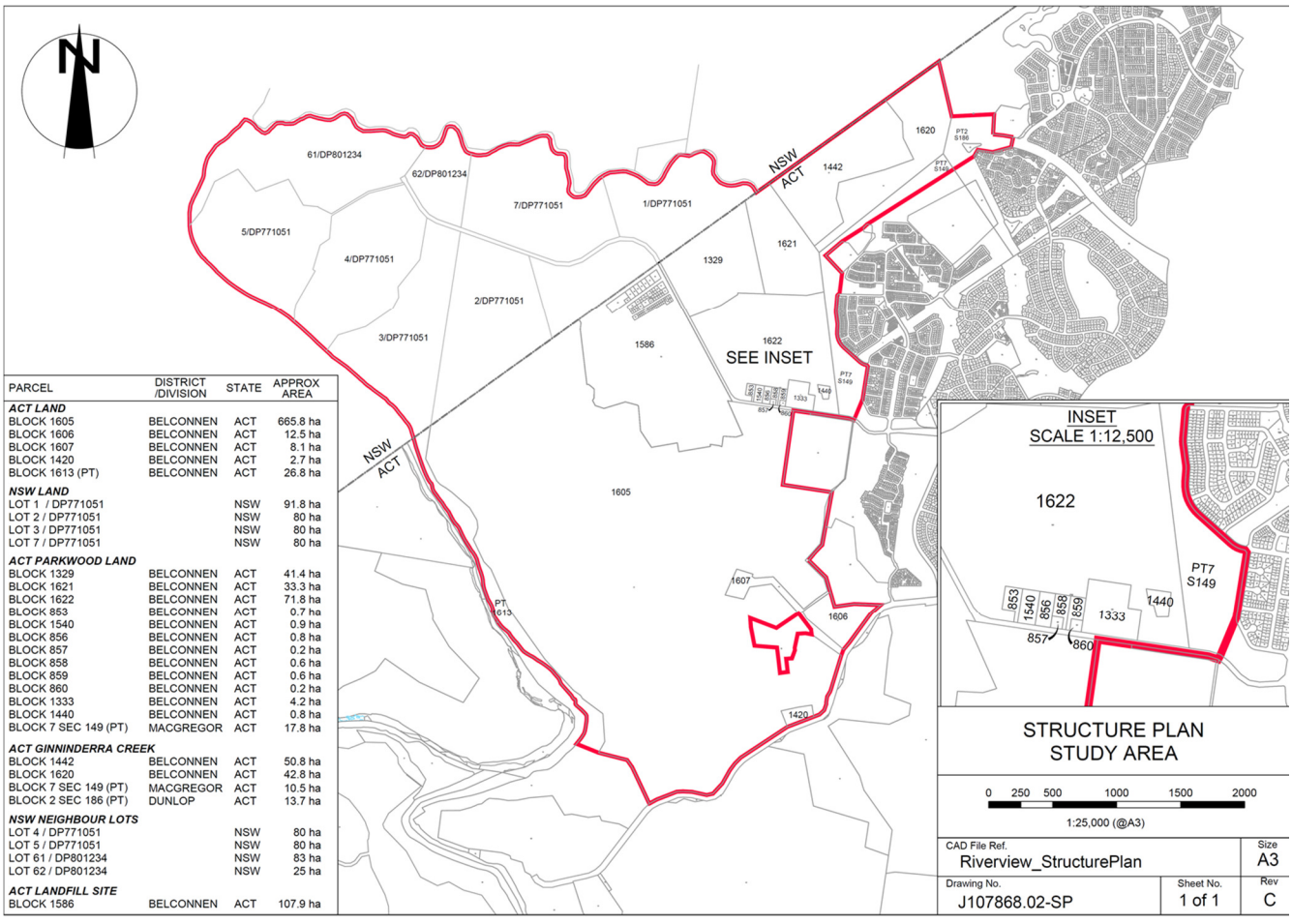
The project has been identified in previous ACT Government studies as development capable and currently identified as an Urban Investigation Area in the ACT Planning Strategy. A Structure Plan is being prepared by Riverview in accordance with the ACT Planning legislation to facilitate rezoning of the land to residential and inform rezoning of the NSW land which will occur at the same time as the ACT rezoning. The development on the ACT land is being planned together with the proposed NSW development to ensure the NSW land is considered in all planning with servicing infrastructure to be provided from the ACT. A consistent estate design is proposed across the ACT and NSW, hence the concept planning needs to satisfy design requirements of both the ACT Government Agencies as well as Yass Valley Council.

[1] The development parameters, (dwelling numbers, stages etc.) referred to in this report may vary over time. The figures contained herein are estimates; they represent a good approximation of likely development outcomes to a sufficient level of accuracy for the purposes of this report.

Riverview has established a Consultant Team to undertake the various inputs to enable the preparation of the developments master plan which is being used to determine dwelling yields and development typologies and to inform engineering concept planning work in support of the Master Plan.

The services concept planning input to the Master Plan by Brown Consulting includes sewer, potable water, non-potable water, stormwater, electricity, gas and communications. AECOM has been engaged by Riverview to prepare the water sensitive urban design strategy for the development which informs much of the stormwater concept planning for the site as well as inputting into the sewer, potable water and non-potable water concept planning by defining recycled water strategy.

This report presents the sewer and water services concept planning required to support the West Belconnen development master plan and the Structure Plan submission. It also provides preliminary advice on staging and cost opinion of the trunk sewer and water infrastructure to suit the proposed development stages in ACT and NSW lands.



PARCEL	DISTRICT /DIVISION	STATE	APPROX AREA
ACT LAND			
BLOCK 1605	BELCONNEN	ACT	665.8 ha
BLOCK 1606	BELCONNEN	ACT	12.5 ha
BLOCK 1607	BELCONNEN	ACT	8.1 ha
BLOCK 1420	BELCONNEN	ACT	2.7 ha
BLOCK 1613 (PT)	BELCONNEN	ACT	26.8 ha
NSW LAND			
LOT 1 / DP771051		NSW	91.8 ha
LOT 2 / DP771051		NSW	80 ha
LOT 3 / DP771051		NSW	80 ha
LOT 7 / DP771051		NSW	80 ha
ACT PARKWOOD LAND			
BLOCK 1329	BELCONNEN	ACT	41.4 ha
BLOCK 1621	BELCONNEN	ACT	33.3 ha
BLOCK 1622	BELCONNEN	ACT	71.8 ha
BLOCK 853	BELCONNEN	ACT	0.7 ha
BLOCK 1540	BELCONNEN	ACT	0.9 ha
BLOCK 856	BELCONNEN	ACT	0.8 ha
BLOCK 857	BELCONNEN	ACT	0.2 ha
BLOCK 858	BELCONNEN	ACT	0.6 ha
BLOCK 859	BELCONNEN	ACT	0.6 ha
BLOCK 860	BELCONNEN	ACT	0.2 ha
BLOCK 1333	BELCONNEN	ACT	4.2 ha
BLOCK 1440	BELCONNEN	ACT	0.8 ha
BLOCK 7 SEC 149 (PT)	MACGREGOR	ACT	17.8 ha
ACT GINNINDERRA CREEK			
BLOCK 1442	BELCONNEN	ACT	50.8 ha
BLOCK 1620	BELCONNEN	ACT	42.8 ha
BLOCK 7 SEC 149 (PT)	MACGREGOR	ACT	10.5 ha
BLOCK 2 SEC 186 (PT)	DUNLOP	ACT	13.7 ha
NSW NEIGHBOUR LOTS			
LOT 4 / DP771051		NSW	80 ha
LOT 5 / DP771051		NSW	80 ha
LOT 61 / DP801234		NSW	83 ha
LOT 62 / DP801234		NSW	25 ha
ACT LANDFILL SITE			
BLOCK 1586	BELCONNEN	ACT	107.9 ha

Figure 1 West Belconnen Development Structure Plan Study Area

1.2 Project Objectives

The Riverview has prepared a statement against which the West Belconnen project will continue to be assessed at all stages of the project including concept planning and preparation of the Structure Plan. This vision is encapsulated in their sustainability vision which is:

"Creating a sustainable community of international significance in the Nation's capital"

A copy of this Vision Statement is attached in **Appendix A**. The Master Planning phase of the West Belconnen project is a critical phase in which to benchmark the project against industry best practice and set many of the fundamental sustainability outcomes for the development and incorporate these into development assessment requirements against which Development Applications and designs will be assessed.

The vision is to create a community that exemplifies world's best practice in its design, construction and long term liveability. To achieve this, the development is to be assessed using the Green Star Communities Pilot scheme which is a rating tool developed by the Green Building Council of Australia in order to benchmark the development. The aim is to achieve a six-star 'world leader' green community which is driving some of the key outcomes for this development.

The Master Plan phase of the project is also a critical stage of the project in which to gain community support for the development before proceeding to the next stage of the project. As such, community, stakeholder and authority consultation has formed an important part of this approval phase of the project to ensure long term support for the project.

The goal of the Master Plan stage in the project is to achieve rezoning of the ACT Government land to residential land use. Once this has occurred, Riverview will be able to lodge an Estate Development Plan and Development Application for the first stage of residential development. The Master Plan will also facilitate the rezoning process for the NSW land.

1.3 Project Background

The following background information and previous reports and studies were provided by Riverview to inform this Services Concept Plan study:

- *West Molonglo Residential Development – Existing Services Investigation*, Sellick Consultants, February 2009.
- *West Belconnen Proposed Subdivision Options and Costing Report*, Sellick Consultants, February 2011.
- *West Belconnen Urban Subdivision – Review of Opinion of Cost*, Brown Consulting, March 2011.
- *West Belconnen Proposed Subdivision Costing Report*, Sellick Consultants, April 2011.
- *West Belconnen Woodland Areas – Confirmatory Ecological Assessment, David Hogg Pty Ltd, May 2013*
- *Flora and Fauna Assessment, Kevin Mills and Associates, January 2009*
- *Landfill Risk Report, GHD, February 2012*
- *Extent of Habitat for Vulnerable Pink Worm Tail Lizard in the West Belconnen – Ginninderra Creek Investigation Area, Will Osbourne, May 2013*

Riverview has been active in undertaking the necessary ecological studies of the site in order to inform the appropriate extent of the Murrumbidgee River Conservation Corridor. This boundary defines the limit of development adjacent the river. The river corridor boundary is shown on **Figure 2**.

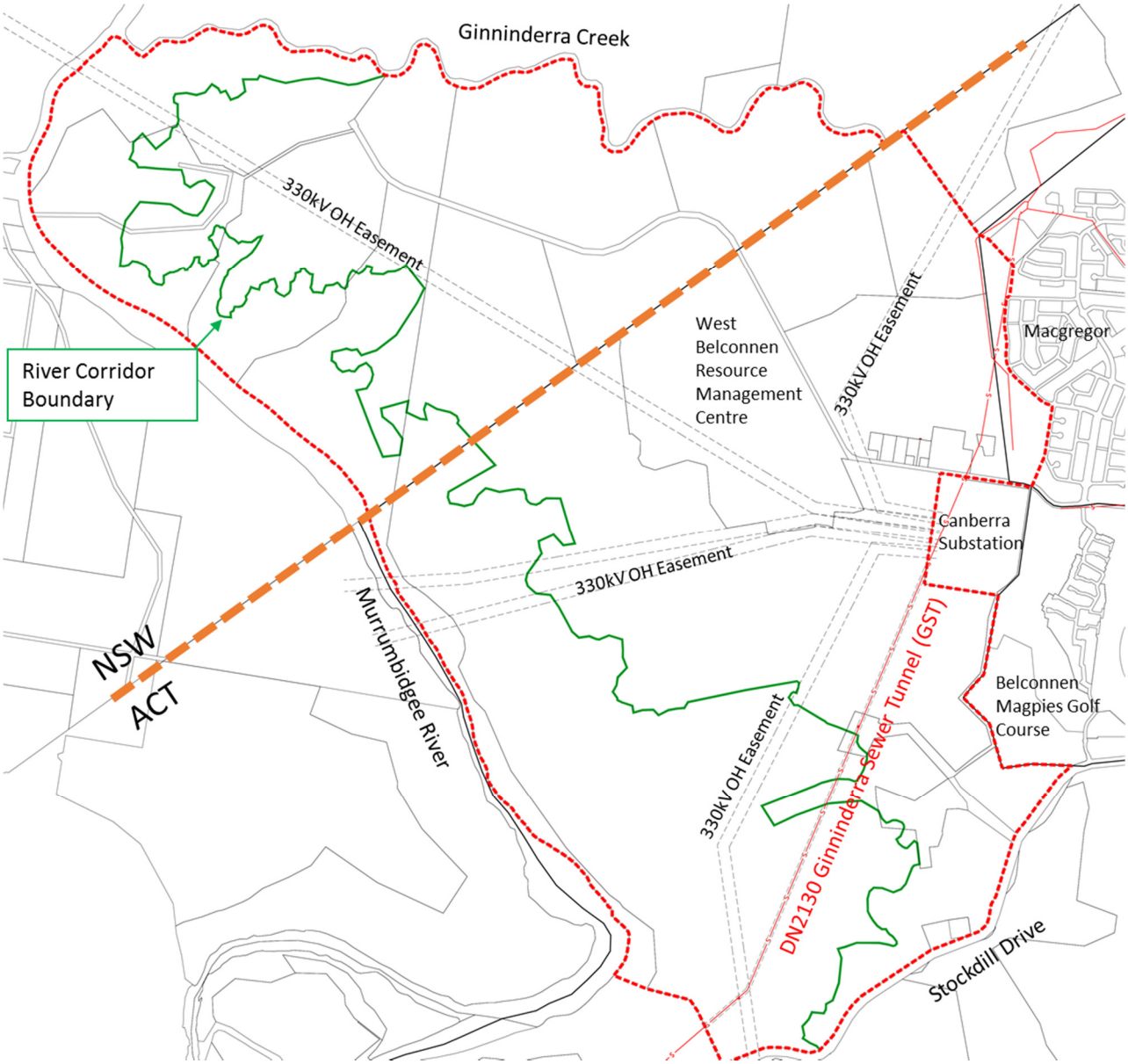


Figure 2 West Belconnen River Corridor Boundary Plan

1.4 West Belconnen Masterplan

The project team has been working together over the last eight months to develop the West Belconnen Masterplan which is being used to inform the Structure Plan. Ongoing community and stakeholder consultation has occurred during this period with contributions from the team and the community, Government Agencies and Service Authorities becoming contributions into the development of the Masterplan. The West Belconnen Masterplan is presented in **Figure 3** below.

Figure 3 West Belconnen Development Master Plan

1.5 Concept Plan Drawings

The sewer and water concept plan drawings have been prepared based on the data provided by the Riverview and asset information provided by the Services Authorities.

The following drawings are prepared as part of the services concept planning and included in **APPENDIX D**. The drawings should be referred to whilst reading the report.

Table 1 Drawing Schedule

Drawing No.	Description
C13080-MP000+	COVER SHEET,LOCALITY PLAN AND DRAWING SCHEDULE
C13080-MP001+	EXISTING SERVICES PLAN
C13080-MP010+	SEWER CONCEPT PLAN – OPTIONS G1 AND M2
C13080-MP011+	GINNINDERRA GRAVITY SEWER DETAIL PLAN - SHEET 1 OF 2
C13080-MP012+	GINNINDERRA GRAVITY SEWER DETAIL PLAN - SHEET 2
C13080-MP013+	MIRRUMBIDGEE GRAVITY SEWER DETAIL PLAN - SHEET 1 OF 2
C13080-MP014+	MIRRUMBIDGEE GRAVITY SEWER DETAIL PLAN - SHEET 2
C13080-MP015	SEWER DATA TABLE
C13080-MP016+	SEWER CONCEPT PLAN OVERLAYED WITH STRUCTURE PLAN
C13080-MP020+	WATER CONCEPT PLAN RESERVOIR OPTION SHEET 1 OF 2
C13080-MP021	WATER CONCEPT PLAN RESERVOIR OPTION SHEET 2
C13080-MP022	WATER CONCEPT PLAN PRV OPTION

2. SEWER CONCEPT PLAN

2.1 Background

The delivery of the sewerage services is a challenging aspect of urban development for the proposed West Belconnen development. Some of the key design constraints for the site include the steep and hilly topography, location and depth of the existing sewer services, sewer odour, presence of sensitive environmental habitat (pink tailed worm lizard and box gum woodland), archaeological constraints and the Murrumbidgee River Corridor.

In order to address the design constraints and meet the land release staging requirements, the sewerage concept planning work reported in this document has considered the following:

- Identify, test and evaluate a series of options to provide sewerage services for all stages of land release in West Belconnen;
- Liaise with ACTEW Water to investigate technical solutions that will be supported by the Service Provider;
- Attend design meetings and undertake design optimisation in order to achieve value for money to Riverview and Land Development Agency (LDA). Consideration of capital, operation and maintenance costs in assessing design options.
- Identify services staging to ensure the delivery of the land release program and management of infrastructure expenditure and delivery; and
- Prepare preliminary opinions of cost for the purpose of the Riverview and LDA's budgeting for the corresponding upcoming Capital Works program for West Belconnen.

2.2 Design Standards

Preparation of the sewer concept plan is based on the ACTEW Corporation- Water Supply and Sewerage Standard (AWSSS). Yass Valley Council has been consulted and supported AWSSS be used for the design of the proposed sewerage infrastructure in NSW. Subject to development and finalisation of the development sustainability objectives related to Water Sensitive Urban Design (WSUD) and water recycling, this report and concept plans for sewer are based on meeting the current AWSSS to provide a base case workable concept for servicing the site.

2.3 Design Criteria

2.3.1 Dwelling Yield

The Density Plan attached in **APPENDIX B** establishes the proposed land use and density across the development. Supporting information provided by Riverview detailing the indicative dwelling yield and staging for the West Belconnen development is also included in **APPENDIX B**. Calculation of the sewer flows contributing to the proposed and existing trunk sewer is based on the following information (refer to **APPENDIX C**):

- RIV BEL RD1 008 Final Land Budget Density Map;
- RIV BEL RD1 012 Final Land Budget Staging Plan; and

» West Belconnen Land Budget and Staging Table 260314.

The gross development area is approximately 846ha. The West Belconnen Land Budget and Staging Table indicates that 55 percent of the gross development area (i.e. 437ha) will be the net developed area, which is used as the net sewered areas in this study. This excludes open spaces, floodways, arterial roads and matches with the AWSSS net sewered area for the purpose of the masterplanning.

The potential dwelling yield is estimated to be up to 11,954. The net density for each land parcel varies from 10 to 100 dwelling per hectare (dw/ha).

2.3.2 Equivalent Populations

The equivalent population (EP) contribution to the sewer system is calculated as follows:

Residential catchment EP = No. of dwelling x EP per dwelling unit

Table 2 shows the adopted design EP from the AWSSS Table 3-5 data.

Table 2 Design Equivalent Population

Land Use	Gross Land Yield	AWSSS EP	Unit
Low Density Residential	<15 dw/ha	3.6	per dwelling unit
Medium Density	15-80 dw/ha	2.5	per dwelling unit
High Density	>80 dw/ha	2.0	per dwelling unit
School[1]	-	0.2	per student

1. Assume 500 students per school

2.3.3 Grades for Sewers

To minimise operations and maintenance problems and where physically and economically practicable, AWSSS recommend that all gravity sewers shall be designed with grades exceeding the self-cleaning grade (Ssc) and sulphide-slime control grade (Sss) for gravity sewers of nominal diameter 300mm or greater.

Early in the sewer concept design, it was recognised that the site topography is such that gravity mains require a minimum grade close to the minimum self cleasing grade to minimise pumped catchments. ACTEW Water agreed that relaxation of these requirements in trunk mains provided the self-cleaning grade (Ssc) is achieved.

2.4 Existing Sewer Services

An existing 2130mm diameter Ginninderra Sewer Tunnel (GST) runs generally north-south through the site (refer to **Figure 4**). The 2130mm diameter GST runs from the north of Macgregor and transverses the Canberra Substation and the south-eastern part of the West Belconnen development prior to discharging to the Lower Molonglo Water Quality Control Centre (LMWQCC) located approximately 1km southwest of the study area.

ACTMAPi shows that there is a 20m wide easement on the GST alignment between the Canberra Substation and the western boundary of the site. Written advice from ACTEW Water notes that standard, low and medium density residential development can take place over the GST, where the cover is in excess of 12m and the geological strata above the GST has not been excavated previously (refer to **APPENDIX F**). Riverview will be

seeking to negotiate with ACTEW Water to extinguish this easement to avoid adverse implication to consequent leases.

An overflow structure and a sewer vent is located on the GST, approximately 215m east from the western boundary of the site. There is a sewer vent located within Block 1607 Belconnen near Strathnairn. Three mechanised odour/scrubbing control units have recently been constructed over manholes adjacent the West Macgregor development.

The exiting invert levels of the GST were obtained from the Work As Executed (WAE) data provided by ACTEW Water. The GST is approximately 8m to invert at the sewer vent to the west of the site, approximately 50m deep at the vent on Block 1607 and approximately 20-30m adjacent West Macgregor. ACTEW Water uses this large pipe as a detention storage facility to regulate flowrates into LMWQCC and as such is regularly maintained full.

ACTEW Water advised that the GST has sufficient capacity to service the entire ACT and NSW development (refer **APPENDIX F**).

There is an existing West Macgregor gravity sewer running through the eastern part of the site. The sewer main size ranges from 225mm diameter near Parkwood Road to 450mm diameter, where it discharges to the existing 1500mm diameter trunk sewer. The 1500mm diameter trunk sewer is joined by an existing 1350mm diameter trunk sewer then discharge to the GST upstream of a 22m deep vortex drop. Local reticulation mains exist within West Macgregor and the golf course development. These is no existing sewer infrastructure within NSW part of the development.

Based on the discussion with ACTEW Water, the western, southern and/or part of the northern sewer catchments can drain to the GST. Part of or the entire northern sewer catchment can drain to the 450mm West Macgregor Trunk Sewer or the vortex drop on the GST.

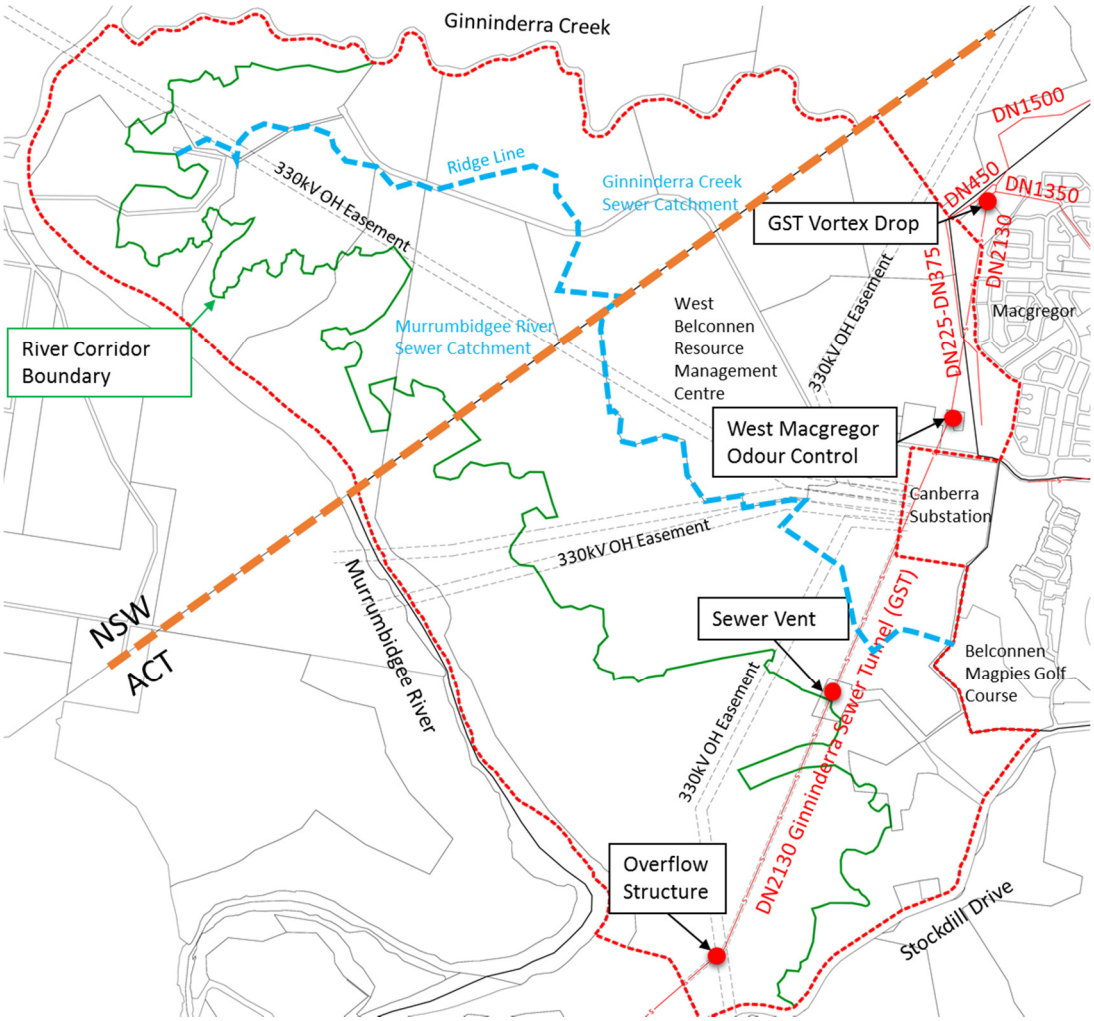


Figure 4 Existing Sewer Services Within and Near the Study Area

2.5 Sewer Odour

ACTEW Water are conducting studies of the odour from the LMWQCC sewage treatment plant to confirm whether their current 1km buffer is appropriate or whether a larger buffer zone would be required. The nearest part of the West Belconnen development is about 1.2km east of the LMWQCC. Therefore, any increase in the buffer zone could impact on the West Belconnen developable areas.

ACTEW Water has completed odour monitoring of the existing two sewer vents within the West Belconnen development over the 2013/2014 summer period and prepared a report on the sewer odour impacts to West Belconnen. The outcome of this report is to recommend further detailed study be undertaken. Economic Development Directorate (EDD) will engage a consultant to investigate options and recommend what to do with the two vents within the development site. EDD has advised that for current masterplanning purposes, it should be assumed the vent adjacent to Strathnairn will be capped and will only require access for maintenance vehicles and that a large odour scrubber device will be fitted onto the vent to the south of the development. This advice will need to be confirmed by the subsequent EDD study.

Three existing odour scrubbers are located over the GST to the north of Parkwood Road. The recently completed West Macgregor development is minimum of 100m from these odour scrubbers. ACTEW Water need to confirm the buffer around these odour scrubbers for odour and noise control.

2.6 Sewer Catchment

2.6.1 Catchment Overview

Sub-catchments contribution to the proposed sewer system were defined based on the ACT 2004 Contours at 1m interval and the NSW Contours at 2m interval provided by the Riverview. A main ridge line runs east-west through the site dividing the development into a northern and southern catchment (refer to **Figure 4**). The northern catchment falling towards Ginninderra Creek and the southern catchment falls towards the Murrumbidgee River.

ACTEW Water has confirmed that the southern catchment can discharge to the existing overflow structure on the GST and the northern catchment can discharge at the existing vortex drop structure.

The catchment has been further subdivided into smaller subcatchments based on natural topography, which consists of undulating natural watercourses across the site.

2.6.2 Ginninderra Creek Northern Catchment

The northern catchment (with dwelling yield) is approximately 328ha, 55% of which (i.e. 189ha) is assumed to be the net sewered areas. Based on the West Belconnen Land Budget and Staging Table dated 26 March 2014, a total of 6,318 dwellings and an equivalent population of 16,205 is proposed within this catchment.

Details of the catchment size and sewer flows calculation for the northern catchment are shown on Drawing C13080-010 to 012 and 015 in **APPENDIX D**.

2.6.3 Murrumbidgee Southern Catchment

The southern catchment (with dwelling yield) is approximately 413ha, 55% of which (i.e. 232ha) is assumed to be the net sewered areas. Based on the West Belconnen Land Budget and Staging Table dated 26 March 2014, a total of 5,598 dwellings and an equivalent population of 17,366 is proposed within this catchment.

Details of the catchment size and sewer flows calculation for the southern catchment are shown on Drawing C13080-010, 013 to 015 in **APPENDIX D**.

2.7 Proposed Sewerage Infrastructure

2.7.1 Overview

The proposed sewer infrastructure, which includes trunk gravity mains and sewer pump stations, has been developed based on the following criteria:

- Maximisation of gravity sewer catchments;
- Minimisation of number, location and catchment of pump stations; and
- Minimisation of impact on the environmental sensitive areas (e.g. Pink Tailed Worm Lizard, Box Gum Woodland and Golden Sun Moth).

The sewage flows from the proposed development were calculated in accordance with AWSSS Section 3.1.1 (iii) c. Mixed landuse catchment formulae based on the EP per dwelling unit as shown in **Table 2**. The proposed sewer infrastructure was sized to achieve the self-cleansing grade.

2.7.2 Ginninderra Creek Trunk Sewer

Two options have been investigated to service the Ginninderra Creek catchment.

Option G1 – Gravity Sewer+Microtunneling

This option aims to service the entire northern catchment via gravity. The gravity sewer catchment will be maximised by using a minimum grade of 0.25% for pipe size 375mm diameter and above. This grade does not achieve slime control, however, ACTEW Water have approved a flatter grade in order to drain the entire site by gravity. Two developable areas within NSW lie below the trunk sewer and will be serviced by two pump stations.

The Ginninderra Creek catchment can be serviced by a 6.2km long gravity main at minimum grades to achieve self-cleansing (refer to sketch plans in **APPENDIX C**). The trunk sewer starts from Lot 5 / DP771051 (Block BS), then follows Ginninderra Creek prior to discharging to the bottom (IL 523.72) of the existing vortex drop structure on GST, which is about 20m deep. The alignment has been designed to avoid impact on the existing Golden Sun Moth (GSM) offset areas adjacent to Ginninderra Creek. ACTEW Water has permitted manholes within the creek flooding areas (above 1 in 2 year ARI event) in order to maximise the gravity sewer catchment areas.

The peak wet weather flow (PWWF) in the proposed Ginninderra Creek Trunk Sewer at discharge to GST is approximately 223.4 L/s (refer to sketch plans in **APPENDIX C**).

The trunk sewer size ranges from 300mm diameter to 525mm diameter. The depth of the trunk sewer ranges from 1m to 23m. Approximately 1km long of the trunk sewer, from Lot 1 / DP771051 to the GST vortex drop structure, needs to be constructed via the microtunneling technology. Microtunnel boring machine will be used to construct sewer with depths exceeding approximately 6m. All other sewer mains upstream are proposed to be trenched.

Microtunneling is a trenchless method to construct pipelines or tunnels up to about 175m under highways, railroads, runways, rivers and environmentally sensitive areas (refer to **Figure 5**). In general, the microtunnel boring machine (MTBM) size varies from 0.61 to 1.5m diameter (0.85m diameter assumed for this project). The machines are controlled by an operator remotely on the ground surface. Microtunneling requires excavation of a vertical shaft of approximately 6m x 4m at each end of the bore (refer to **Figure 6** for examples). MTBM has a circular cutting head and is pushed by hydraulic jacks mounted and aligned in one shaft. Once the tunnel is completed, the MTBM equipment is removed. Pipes are then lowered into the shaft and jacked through the tunnel (refer to **Figure 5**). The pipes are then grouted in place within the tunnel. Laser guided technology allows flat pipe grades to be achieved with high accuracy and long tunnels (about 350m long) to be constructed by boring from each end and meeting in the middle.

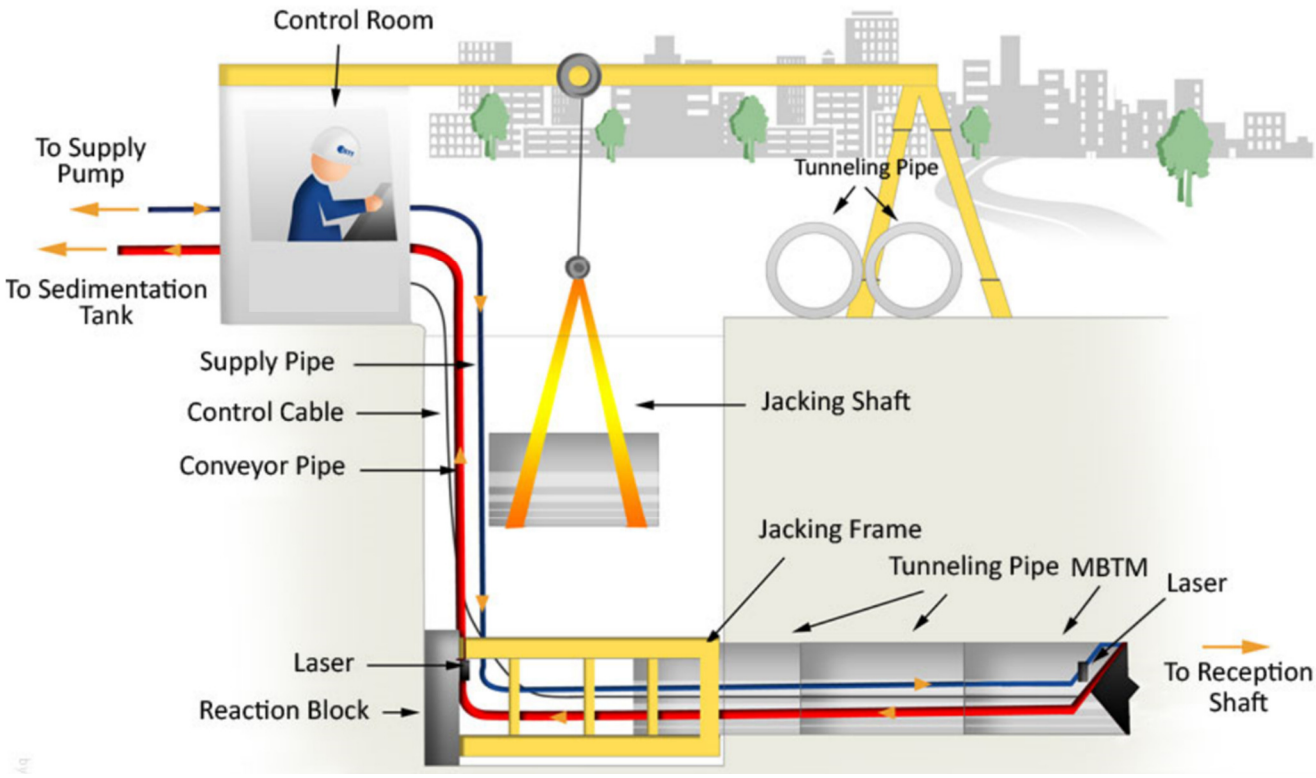


Figure 5 Microtunneling Technology / Pipe Jacking (image sourced from www.istt.com)

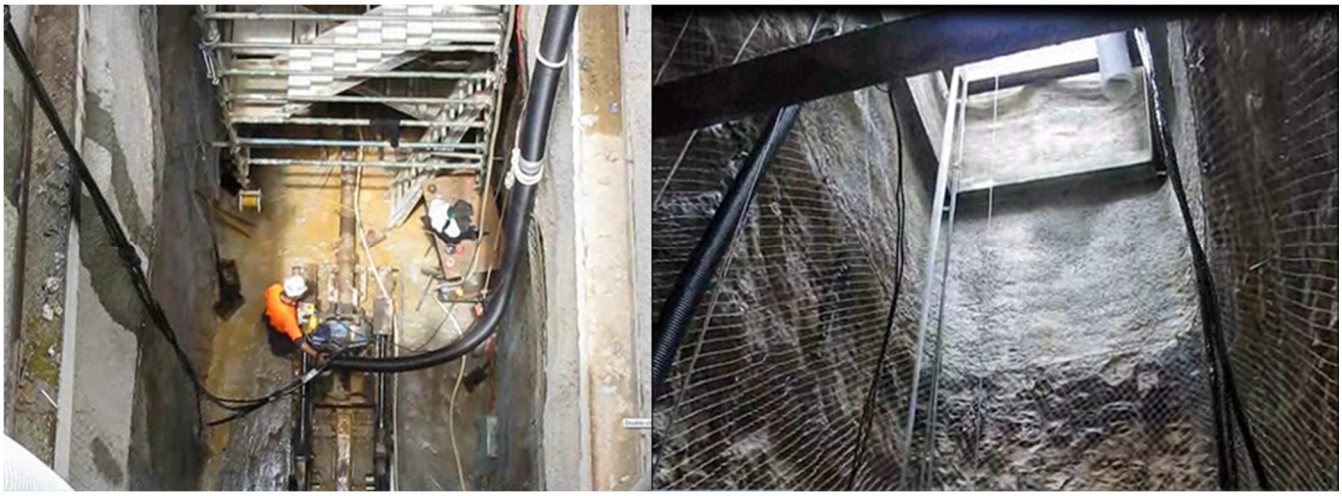


Figure 6 Photos of Deep Shaft for Microtunneling (Photos provided by Pezzimenti)

Brown Consulting consulted with Pezzimenti Tunnelbore, who advised that the maximum microtunnel length they can achieve in hard rock between two shafts is 350m. Based on this advice, a total of three shafts will be required to microtunnel 1km long trunk sewer. The depth of the shaft ranges from 6.8m to 16.3m deep (refer to **Figure 7)**. Pezzimenti advised that the microtunnel boring machine could break into the existing vortex drop structure, which will require further investigation to confirm specific details. Approximately 190m long and 2-8m deep filling would be required for the two sections of pipe within Lot 7/DP771051 to maintain minimum pipe cover of 600mm. The filling embankment surface can be stabilised with dry land grass mix.

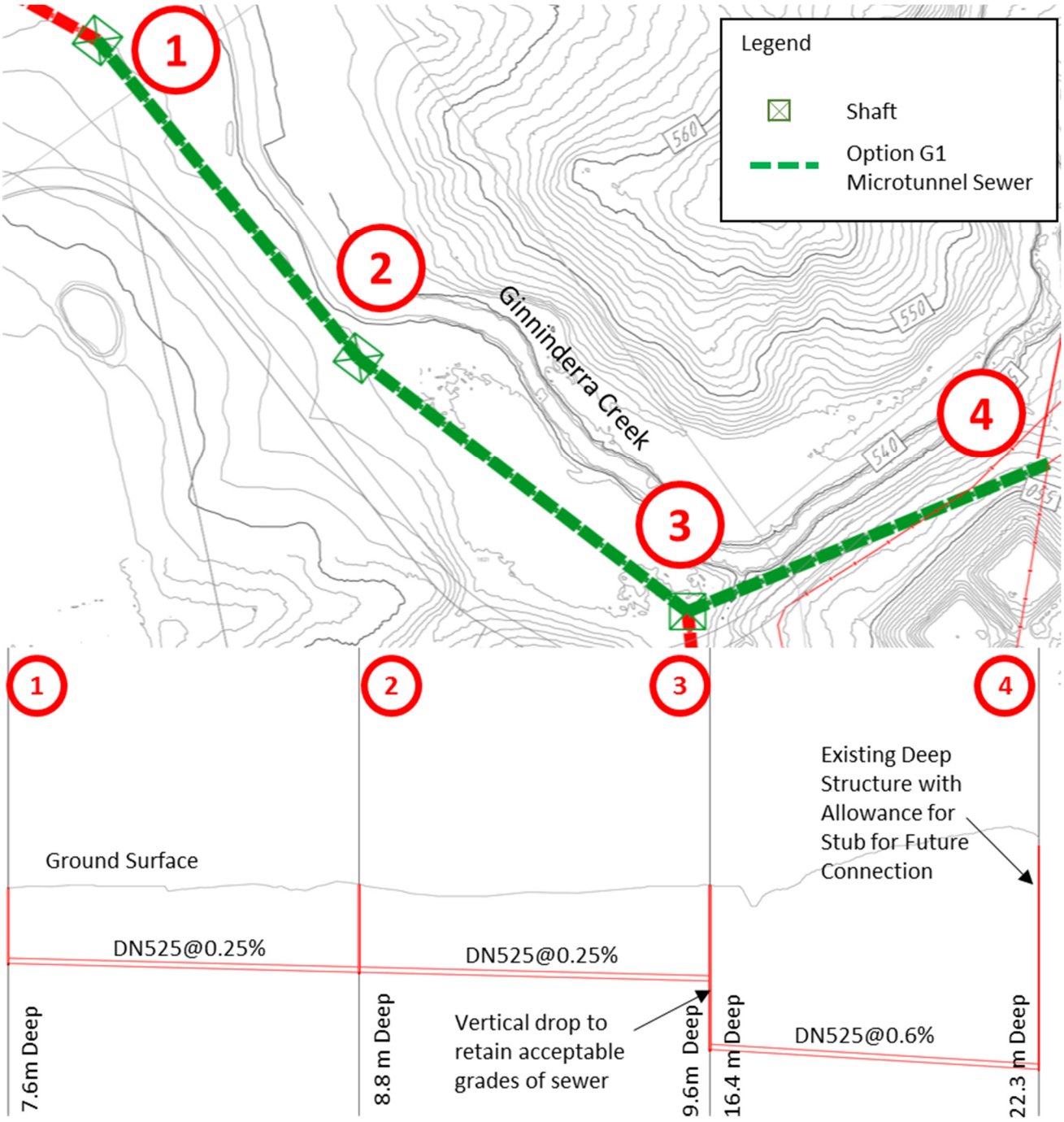


Figure 7 Long Section for G1 Microtunnel Sewer

Impact on Environmental Habitat

There is no existing PTWL and BGWL habitat adjacent the proposed sewer alignment.

The minimum distance between the proposed microtunnel sewer alignment and the GSM offset areas is 7.8m. Construction of the proposed trunk sewer using microtunneling technology will avoid impact on the existing GSM offset areas.

Impact on Trees

A tree assessment was undertaken by Kevin Mills for the West Belconnen development. A total of twelve trees will need to be removed during construction. The tree classification status for each tree that needs to be removed is shown in the table below.

Table 3 Tree Removal for Option G1

Tree Classification Status	Tree ID	No. of Trees
High Quality	2113 to 2121	9*
Poor	2278, 2274, 2277,	3
Total		**12**

*these trees are along the driveway to the Ginninderry Homestead. The pipe size at this location is 375mm diameter. The pipe could either be bored under the trees or alternative construction methodology be adopted to minimise impact on the high quality trees.

Option G2 – Pump Station + Gravity Sewer

This option aims to provide a gravity sewer main that can be constructed by standard trenching operation without specialist tunnelling works. This requires the new main to be connected into the existing GST at the West Macgregor sewer connection at approximately 8m deep. This main can then extend along Ginninderra Creek for approximately 3km at minimum of 0.2% self-cleansing grade and an extra of 1km further upstream at minimum of 0.26% self-cleansing grade (refer to sketch plans in **APPENDIX C**). This gravity pipe then daylights and cannot be extended further. The gravity trunk sewer is approximately 4.5km long, with size ranges from 375mm to 600mm diameter. The depth of the trunk sewer ranges from 1m to 8m deep.

Two catchments cannot be serviced by gravity into this trunk sewer. Therefore, this option requires two pump stations with peak wet weather flow greater than 10 L/s. Sewage will be pumped to the new gravity trunk sewer.

The proposed pump stations will be located at low points on Lot 61/DP801234. Details of the pump station are summarised in the table below:

Table 4 Summary of Option G2 Pump Stations

G2 Pump Station	NSA (ha)	PWWF (L/s)	Rising Main Size (mm)	Rising Main Length (m)	Pump (kW)	Emergency Storage (kL)
G2.1 (5N-1)	12.8	20.0	150	820	9.0	144
G2.2 (5N-2.1)	38.6	56.2	225	748	22.8	404

Sewage from Pump Station G2.2 will be pumped to the new gravity trunk sewer, which starts from Lot 7 / DP771051 then runs along Ginninderra Creek prior to discharging to the GST.

Impact on Environmental Habitat

There is no existing PTWL and BGWL habitat adjacent the proposed sewer alignment. The minimum distance between the proposed sewer construction corridor and the GSM offset areas is 12m.

Impact on Trees

No tree needs to be removed for Option G2.

2.7.3 Murrumbidgee River Trunk Sewer

A total of five (5) trunk sewer options were investigated to service the Murrumbidgee River Catchment.

Option M1 – Trench Gravity Sewer

This option aims to service the entire southern catchment via a trenched gravity main. The gravity sewer catchment will be maximised by using a minimum grade of 0.20% for pipe size 450mm diameter and above. This grade does not achieve slim control, however, ACTEW Water have accepted a flatter grade in order to maximise the area that can be drained by gravity sewer. Two catchments in NSW with flows greater than 10L/s will require pump stations. Other smaller areas below the gravity sewer would require small pump stations or not be developed. Refer drawing C13080-CP010+ in **APPENDIX D** for areas that cannot be drained by gravity.

Under this option, the Murrumbidgee River catchment will be serviced by a new 12.2km long trenched gravity main, which starts from Lot 5 / DP771051 in NSW then follows the river corridor boundary prior to discharging to the GST overflow structure at IL 518.7 (invert to obvert connection). The sewer alignment generally follows the natural contours. However, within the development area, some deeper sections of the trunk sewer require microtunneling and boring through ridges to keep works out of the river corridor and avoid impact on the PTWL habitat. The last section of the trunk sewer will run through the existing PTWL habitat within the river corridor. Refer **Figure 9** for location of this alignment.

Impact on Environmental Habitat

An 18m wide construction reservation/corridor is proposed for the proposed open trench trunk sewer alignment. The construction reservation includes silt fence, 5m wide access track zone, sewer trench and trench spoil area. Similar arrangement was adopted for the construction of the Molonglo Trunk Sewer and Sewer 3 Central projects, which has similar requirements on protection of PTWL and BGW habitat and similar size sewer mains.

The impact area for the sensitive habitat is calculated for the trunk sewer construction corridor, which includes the access track and trench spoil area. The impact area on the PTWL habitat will be approximately 5.3ha or 4% of the total PTWL habitat to be protected within the West Belconnen Conservation Corridor (over 2km long of trunk sewer). Will Osborne inspected the alignment through the PTWL habitat and did not support this option due to its impact on the habitat (refer Will Osborne's letter dated 12 December 2013 in **APPENDIX G**).

Impact on Heritage

Aboriginal heritage sites are known to occur in the River Conservation Corridor. These are not shown on the drawings or figures due to legislation requirements. Reference should be made to the ACT Heritage Unit and NSW Department of Environment and Heritage at detailed design stages.

The existing heritage sites are outside the proposed 18m wide construction corridor.

Impact on Trees

A total of sixteen trees will need to be removed during construction. The tree classification status for each tree that needs to be removed is shown in the table below.

Table 5 Tree Removal for Option M1

Tree Classification Status	Tree ID	No. of Trees
Medium	834, 833, 652	3
Poor	1959, 668, 669, 824, 1891, 1892, 1917, 1918, 1919, 1920, 1890, 1915	12
Dead	3384	1
Total		**16**

The peak wet weather flow (PWWF) contributing to the Murrumbidgee River Trunk Sewer is approximately 253.5 L/s. This sewer flow is common to all options investigated. The trunk sewer size ranges from 225mm diameter to 600mm diameter. The minimum depth of the trunk sewer is approximately 1m.

The alignment within the developable area upstream of the Sewer Node 5W-15 is similar for all subsequent options and is shown on Drawing C13080-CP010, 013, 014 in **APPENDIX D**. The following options only discuss alternative ways to transfer sewage from Node 5W-15 to the GST (refer to **Figure 9**).

Impact on Development Area

The length of the gravity sewer downstream/south of node 5W-15 is approximately 3.3km for Option M1 compared to 1.6km for Option M2. This has the effect of being approximate 4m higher at the River Conservation Corridor, which corresponds to less developable areas (refer **Figure 8**). This will need to be considered against the development areas identified in the masterplan.

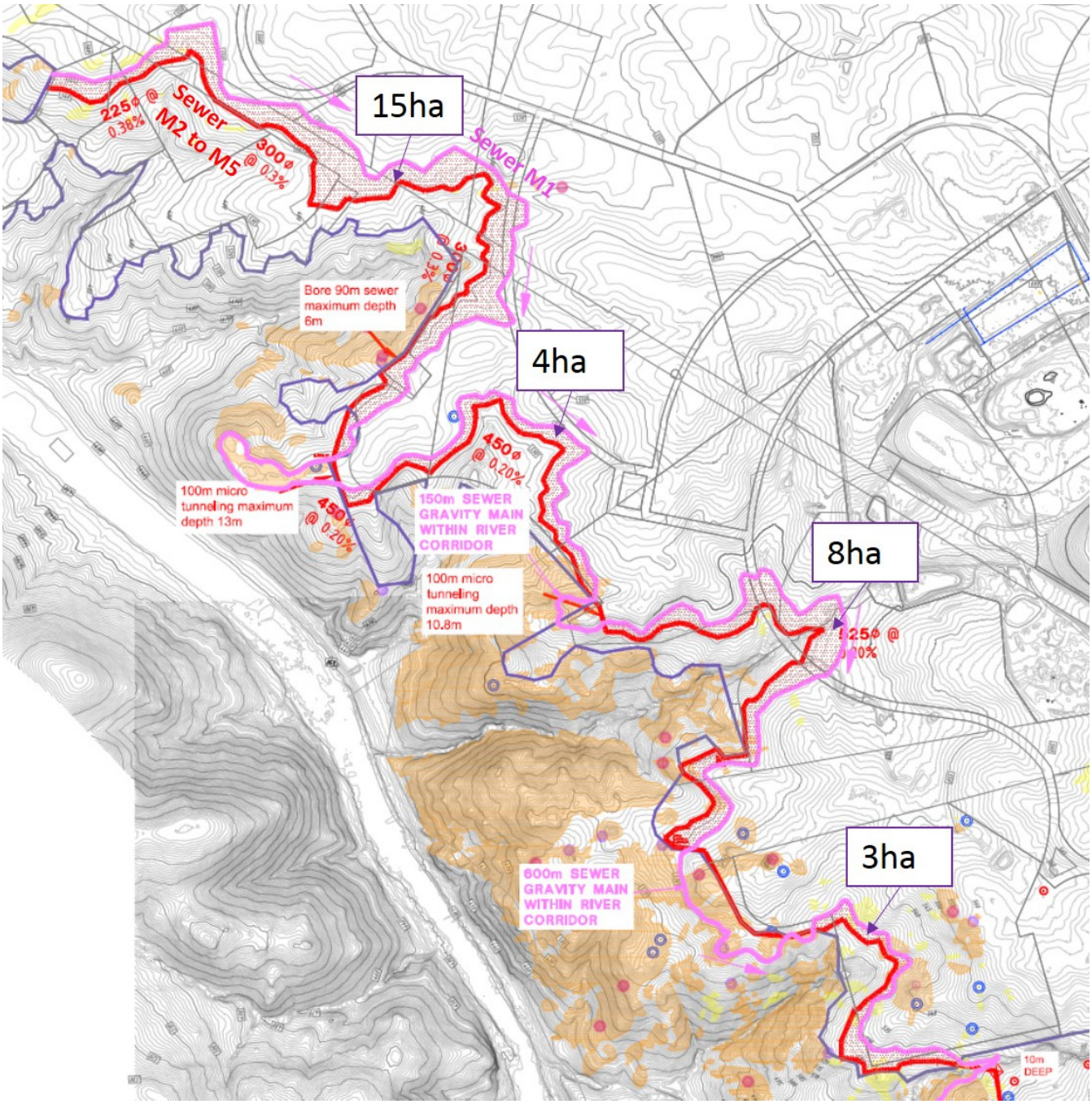


Figure 8 Comparison of Options M1 and M2 south of Node 5W-15

Option M2 – Microtunnel (Trenchless) Gravity Sewer

Compared with Option M1, this option aims to use the microtunneling (trenchless) technology to achieve the following:

- Construct deep sewer in rock by microtunneling under ridges, which reduce trunk sewer length and increase the gravity sewer catchment. It is noted that the steep undulating nature of this area is suited to microtunneling due to its topography.
- Reduce surface disruption and thus avoid or minimise construction impact on the existing PTWL habitat within the river corridor.

Under this option, the Murrumbidgee River catchment can be serviced by a new 9.1km long gravity main, which starts from Lot 5 / DP771051 in NSW then runs along the river corridor boundary prior to discharging to the GST overflow structure at IL 518.7 (invert to obvert connection). Refer to **APPENDIX C** and Drawings C13080-010, 013 to 015 in **APPENDIX D** for details of this option.

The trunk sewer size ranges from 225mm diameter to 600mm diameter. The depth of the trunk sewer ranges from 1m to 40m.

Brown Consulting has liaised with Pezzimenti, who advised that the maximum microtunnel length they can achieve in hard rock between two shafts is approximately 350m. This appears to be close to the limit of the current microtunneling technology and is achieved by two 175m long tunnels joining together. Based on this advice, a total of seven shafts will be required to microtunnel the trunk sewer from Node 5W-15 to connection to the GST. The depth of the shaft ranges from 9m to 25m deep. The shafts have been strategically positioned to be minimum of 20m away from the environmentally sensitive PTWL habitat areas. It is assumed that each one of these shafts would become a manhole for operation and maintenance purposes.

Impact on Environmental Habitat

The existing PTWL habitat is outside the proposed 18m wide construction corridor. One of the microtunnel shaft (approximately 20m^2) may impact on the existing BGW habitat. The impact area is approximately 0.05ha, which can be reduced during detailed design stage.

Impact on Heritage

The existing heritage sites are outside the proposed 18m wide construction corridor.

Impact on Trees

A total of sixteen trees will need to be removed during construction. The tree classification status for each tree that needs to be removed is shown in the table below.

Table 6 Tree Removal for Option M2

Tree Classification Status	Tree ID	No. of Trees
Medium	3452, 3453, 3457, 3458, 1902, 1903, 1911	7
Poor	3393, 3391, 1954, 1955, 1956, 1906, 1907, 1910	8
Dead	1908	1
Total		**16**

Option M3 – Gravity Sewer + Large Pump Station

This option aims to provide a gravity sewer main through the development and a sewer pump station to minimise construction through the river corridor.

This option differs from Option M2 downstream of Sewer Node 5W-15 (refer **Figure 9**), requiring the following:

- A new pump station at Node 5W-15 and 2.4km long rising main 128m pump head
  Sewage from the development will be pumped to a high point near Stockdill Drive (RL 609) via a new 375mm diameter rising main.
- A 1.0km long gravity sewer
  The pumped flows will be discharged to a new gravity sewer, which runs along Stockdill Drive and connect to the overflow structure on the GST.

The existing PTWL and BGW habitat is outside the proposed 18m wide construction corridor. A total of sixteen trees will need to be removed during construction.

Option M4 - Gravity Sewer + Large Pump Station

This option differs from Option M3 downstream Sewer Node 5W-15 (refer **Figure 9**) by utilising a 400m long 375mm diameter rising main with 44m pump head and a new 1.4km long 600mm diameter gravity sewer. The gravity sewer will be connected to the existing GST via a new 19m deep drop structure to be constructed over the GST. This option has the benefit of reduced pumping costs from a shorter rising main with less pressure head.

The rising main and trunk sewer alignments downstream of Node 5W-15 have been designed to avoid the heritage sites and impact on the exiting PTWL habitat.

Impact on Environmental Habitat

The existing PTWL habitat is outside the proposed 18m wide construction corridor. The existing BGW habitat will be affected by the proposed works. The impact area is approximately 1.4ha.

Impact on Heritage

The existing heritage sites are outside the proposed 18m wide construction corridor.

Impact on Trees

Impact on the existing trees for Option M4 is similar to Option M2. A total of sixteen trees will need to be removed during construction.

Option M5 - Gravity Sewer + Large Pump Station

This option aims to pump the sewer flows to the proposed Ginninderra Creek Trunk Sewer with no construction within the river corridor.

Sewage will be pumped from Node 5W-15 to a high point at RL 578 near Block U via a 1.1km long rising main with 83m pump head into the Ginninderra Creek catchment. From this high point, sewage will be carried by a new 2.3km long 600mm diameter gravity sewer along the 330kV easement to the Ginninderra Creek catchment sewer discharge point.

The existing heritage sites, PTWL and BGW habitat are outside the proposed 18m wide construction corridors. A total of sixteen trees will need to be removed during construction.

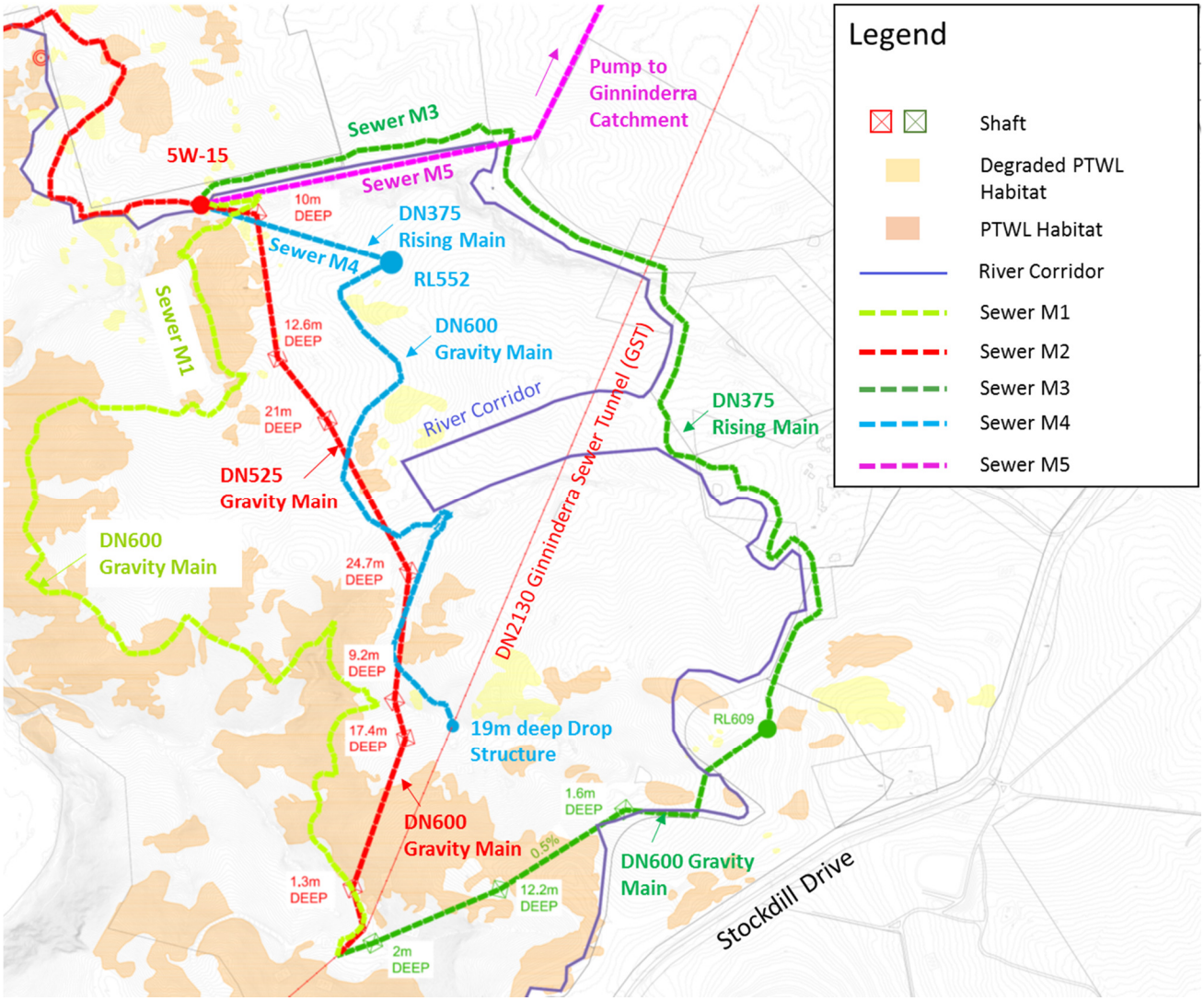


Figure 9 Comparison of Options M1, M2, M3, M4 and M5 Downstream of Node 5W-15

2.8 Cost Estimates

Brown Consulting's opinion of cost for the proposed sewerage infrastructure was estimated based on similar recent local projects.

The opinion of cost includes:

- Direct costs, with an adopted 10% preliminaries inclusive of site preparation, mobilisation and demobilisation; materials, construction and installation, commissioning and testing;
- Contingency of 40% for trunk sewers, including cost risks on site conditions, engineering design issues, accuracy of data, impact from natural events, change of technology or new technology, change of

standard/redesign, community/stakeholders, political issues, environmental and heritage issues, land and property issues; and

- The applicable GST rate (10%).

The opinion of cost excludes:

- Approvals and licence fee;
- Concept design, development application, detailed design and documentation;
- Project management and coordination with other consultants and contactors; and
- Community Consultation;
- Supervision or works by Services Authorities (e.g. ACTEW and ActewAGL).

Rates are based on assumed consistent and good ground conditions. Groundwater management has not been include in cost estimates. All rates are subject to review following geotechnical investigation and interpretation and further engineering feasibility investigations.

A net present value analysis has been undertaken for each option based on the following assumptions:

- Expense or costs over 50 years (Year 2015 – 2065);
- Discount rate of 5%; and
- Replacement of pumps and fittings for the pump stations is scheduled every 25 years, as advised by ACTEW Water.
- Due to the likelihood of power costs increasing higher than inflation, NPV analysis was also undertaken for a higher energy cost.

A summary of the cost estimate for each trunk sewer option is shown in **Table 7** below. Details of the costs estimates are shown in **APPENDIX E**.

Table 7 Comparison of Cost Estimates for Each Trunk Sewer Option

Trunk Sewer	Option No.	Total Sewer Length (km)	Capital Costs ($M)[1]	O&M Costs $0.2/kwh ($M/yr)[2]	O&M Costs $0.4/kwh ($M/yr)[3]	NPV for $0.2/kwh ($M Year2015)	NPV for $0.4/kwh ($M Year2015)	Comments
Ginninderra Creek	G1	6.5	12.7	-	-	$3.6	$3.6	6.2km long gravity sewer including 5.2km open trench and 1km microtunnel sewer Removal of 12 poor to high quality trees
	G2	6.0	8.6	$0.04	$0.04	$3.1	$3.2	Two pump stations 4.5km long open trench gravity sewer No trees removal
Murrumbidgee River	M1	12.2	10.6	-	-	$4.8	$4.8	12.2km open trench gravity sewer Affects 5.3ha PTWL habitat[4] or 4% of the total PTWL habitat Removal of 16 trees No pump station Less developable area
	M2	9.1	34.9	-	-	$18.2	$18.2	7.5km open trench and 1.6km microtunnel sewer through river corridor Affects 0.05ha BGW habitat or less than 0.01% of the total BGW habitat Removal of 16 poor to medium quality trees No pump station

Trunk Sewer	Option No.	Total Sewer Length (km)	Capital Costs ($M)[1]	O&M Costs $0.2/kwh ($M/yr)[2]	O&M Costs $0.4/kwh ($M/yr)[3]	NPV for $0.2/kwh ($M Year2015)	NPV for $0.4/kwh ($M Year2015)	Comments
	M3	10.9	29.5	$0.5	$0.9	$24.5	$32.1	Largest pump station in ACT 7.5km open trench and 0.6km microtunnel sewer through river corridor Pipe works in river corridor Removal of 16 poor to medium quality trees
	M4	9.2	26.5	$0.2	$0.3	$17.3	$19.8	Large Pump Station 7.5km open trench gravity sewer Trenched pipes in river corridor Affects 1.4ha BGW habitat or 1.8% of the total BGW habitat Removal of 16 poor to medium quality trees
	M5	11.1	25.4	$0.2	$0.3	$16.3	$18.6	Large Pump Station Gravity Sewer discharges to Ginninderra Creek catchment Additional trunk sewer main in Ginninderra Creek catchment No pipe works in river corridor Removal of 16 poor to medium quality trees

1. Costs in Year 2014 $
2. Assumed the maintenance costs is 1.5% of the capital costs of the proposed pump station and the operational costs (energy costs) is $0.20/kwh (ActewAG's ACT standard retail electricity supply schedule of charges from 1 July 2014).
3. Sensitivity analysis for each option if energy costs increases to $0.4/kwh (200% increase)

Discussion of Sewer Options

Ginninderra Creek Catchment

- The capital costs for Option G1 (microtunnel) is approximately 48% more expensive than Option G2 (pump station).
- The NPV costs over 50 years for Option G1 (microtunnel) is approximately 16% more expensive than Option G2 (pump station).
- Both Options G1 and G2 have no impact on the existing Golden Sun Moth habitat.
- Option G1 needs to remove approximately 12 trees, 9 of which are high quality trees. The pipe could either be bored under these trees or alternative construction methodology be adopted to minimise impact on the high quality trees. No tree removal is required for Option G2.

Murrumbidgee River Catchment

- Option M1 (trench) has the cheapest capital and NPV costs yet more impact on the existing sensitive habitat within the river corridor. Should this option be adopted, the proposed trunk sewer will affect approximately 5.3 ha of PTWL habitat or 4% of the total PTWL habitat to be protected within the West Belconnen Conservation Corridor.
- Option M2 (microtunnel) has the highest capital costs, which is approximately 2.3 times more than Option M1 and 37% more than the cheapest pump station option M5. Compared with Option M1, M2 has insignificant impact on the existing sensitive environmental habitat.
- Option M5 is the cheapest pump station option, which is approximately 1.4 times more than the capital costs of Option M1.
- The net present value for Options M2 and M5 is comparable over 50 years. Should the energy costs be increased significantly (i.e. 50% or more), Option M5 will be more expensive than M2.

2.9 Sewerage Infrastructure Staging

The indicative staging of the development is shown in **APPENDIX B**. The development will commence from Stockdill Drive and Parkwood Road and progress towards the border. The microtunnelled options and pump station options require large capital expenditure at the commencement of the project. Schemes to stage the trunk sewer expenditure have been considered and described below.

2.9.1 Ginninderra Creek Catchment

The proposed trunk sewerage infrastructure servicing the initial stages of the development in the Ginninderra Creek catchment is shown on **Figure 10**. This will service Stages 2, 3, 4, 5 and 5A of the development. These stages do not need to be serviced by the trunk sewer but require a local sewer pipe proposed through these stages and connect to the GST at a shallower level.

The first stage of the sewerage infrastructure can service approximately 95ha catchment (i.e. Sewer Node 5N-8), which has a PWWF of 83L/s from approximately 2,104 dwellings in 7 years. The proposed first stage sewerage infrastructure includes:

- 0.7km long 225mm diameter sewer at minimum of 0.62% grade.
- 1.4km long 300mm diameter sewer at minimum of 0.68% grade.

- 0.44km long 375mm diameter sewer at minimum of 0.6% grade.
- Connection to the existing 450mm diameter stub (West Macgregor Trunk Sewer) at RL536.8.

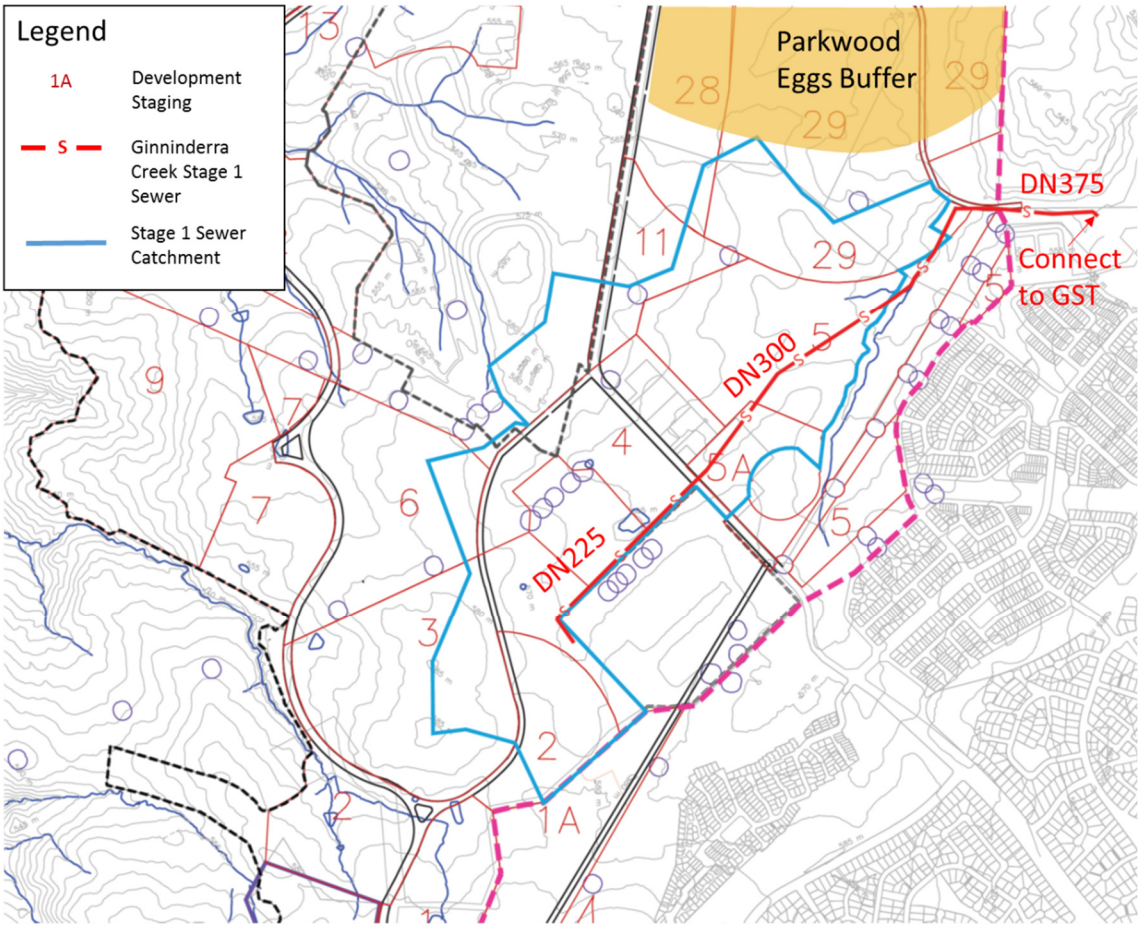


Figure 10 Stage 1 Trunk Sewer Infrastructure for Ginninderra Creek Catchment

The opinion of cost to construct the first stage of the sewerage infrastructure for the Ginninderra Creek catchment is **$1.1million** GST inclusive as shown in **Table 10**.

Table 8 Stage 1 Sewerage Infrastructure Cost Estimates for Ginninderra Creek Catchment

Item	Unit	Qty	Rate ($)	Amount ($ GST Incl.)
Preliminaries			10%	$70,890.50
Open Trench				
150mm sewer pipe	m	715	$190.00	$135,850.00
300mm sewer pipe	m	1365	$307.00	$419,055.00
375mm sewer pipe	m	440	$350.00	$154,000.00
Subtotal				*$779,795.50*
Contingency			40%	$311,918.20
Stage 1 Sewerage Infrastructure TOTAL				**$1,091,713.70**

2.9.2 Murrumbidgee River Catchment – Open Trench Sewer

The Staged trunk sewerage infrastructure for the Murrumbidgee River catchment tunnelled sewer option M1 can service approximately 92.8ha catchment (i.e. Sewer Node 5W-16), which has a PWWF of 63L/s from approximately 1,262 dwellings in 4 years. This will service Stages 1, 1A, 3 and 8 of the development. The proposed first stage sewerage infrastructure includes:

- 1.1km long 300mm diameter sewer at minimum of 0.42% grade;
- 3.3km long 600mm diameter trunk sewer to be constructed via open trench, including a 18m wide construction corridor;
- Connection to existing overflow structure at GST; and
- The propose works will affect 3.5ha of PTWL habitat.

The opinion of cost to construct the following sewerage infrastructure is **$4.4 million** GST inclusive:

Table 9 Stage 1 Sewerage Infrastructure Cost Estimates for Murrumbidgee River Catchment (Open Trenchl)

Item	Unit	Qty	Rate ($)	Amount ($ GST Incl.)
Preliminaries			10%	$283,286.40
Open Trench				
300mm sewer pipe	m	1057	$307.00	$324,499.00
600mm sewer pipe	m	3253	$705.00	$2,293,365.00
Connection to existing overflow structure	No.	1	$215,000.00	$215,000.00
Subtotal				*$3,116,150.40*
Contingency			40%	$1,246,460.16
Stage 1 Sewerage Infrastructure TOTAL				**$4,362,610.56**

2.9.3 Murrumbidgee River Catchment – Microtunnel Sewer

The proposed trunk sewerage infrastructure to service the initial stages of the development in the Murrumbidgee River catchment is shown on **Figure 11**. This will service Stages 1, 1A, 3 and 8 of the development.

The Stage 1 trunk sewerage infrastructure can service approximately 92.8ha catchment (i.e. Sewer Node 5W-16), which has a PWWF of 63L/s from approximately 1,262 dwellings in 4 years. The proposed first stage sewerage infrastructure includes:

- 1.1km long DN225 sewer at minimum of 0.4% grade;
- 1.6km long trenched DN375 sewer at minimum of 0.28% grade;
- 405m long DN600 trunk sewer to be constructed via microtunneling technology, including 3 shafts ranges from 1.3m deep to 17.4m deep for microtunneling the DN600 trunk sewer; and

» 155m long DN600 trunk sewer to be constructed via open trench and connection to the existing overflow structure on GST.

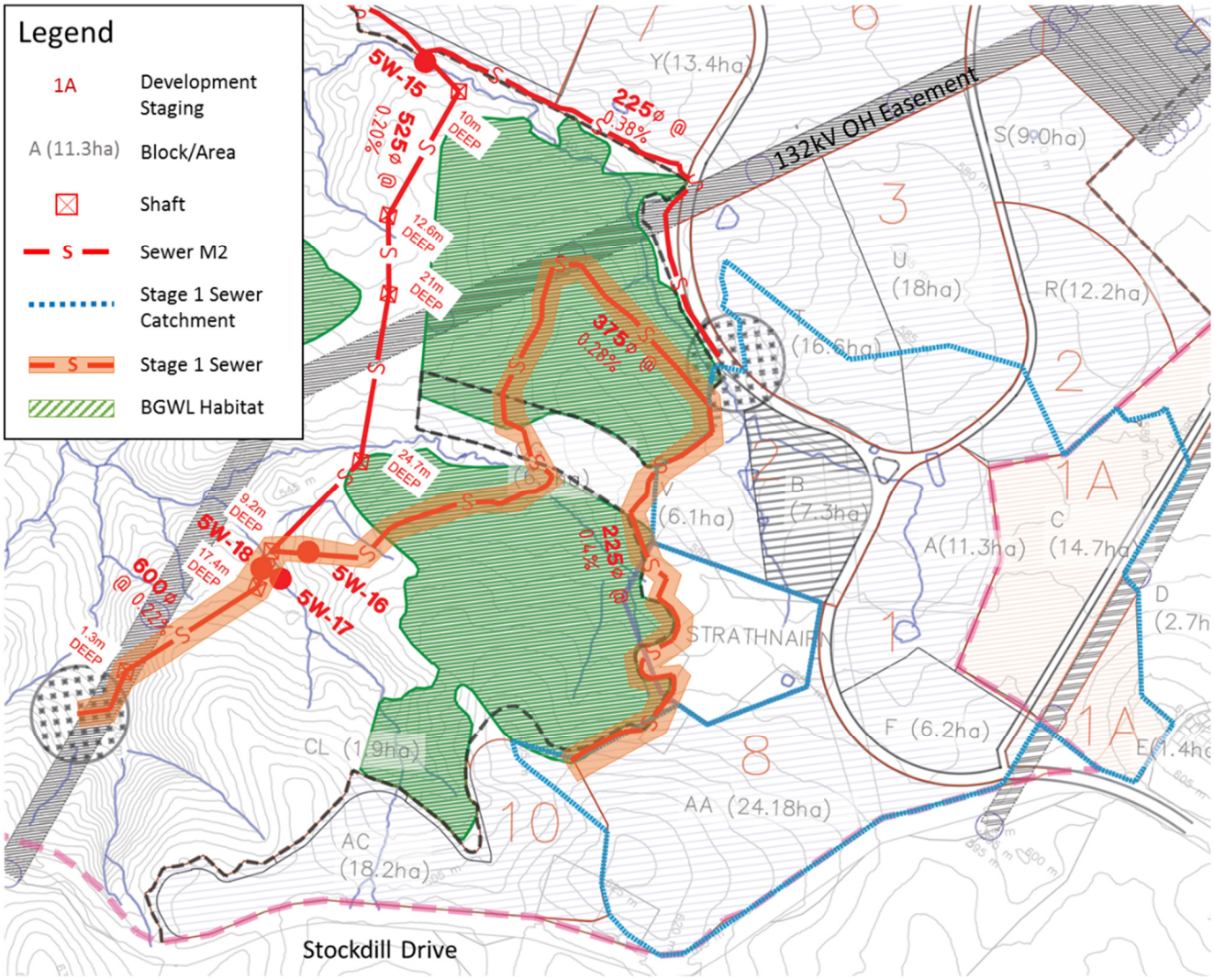


Figure 11 Stage 1 Trunk Sewer Infrastructure for Murrumbidgee River Catchment

The opinion of cost to construct the Stage 1 sewerage infrastructure for the Murrumbidgee River catchment is **$7.7 million** GST inclusive as shown in **Table 10**. None of this infrastructure is abortive work.

Table 10 Stage 1 Sewerage Infrastructure Cost Estimates for Murrumbidgee River Catchment (Microtunnel)

Item	Unit	Qty	Rate ($)	Amount ($ GST Incl.)
Preliminaries			10%	$500,270.00
Open Trench				
225mm sewer pipe	m	1085	$295.00	$320,075.00
375mm sewer pipe	m	1600	$350.00	$560,000.00

Item	Unit	Qty	Rate ($)	Amount ($ GST Incl.)
600mm sewer pipe	m	155	$705.00	$109,275.00
Microtunnel				
Shaft well, <3m deep[1]	No.	1	$150,000.00	$150,000.00
Shaft well, <11m deep[1]	No.	1	$500,000.00	$500,000.00
Shaft well, 15-20m deep[1]	No.	1	$1,500,000.00	$1,500,000.00
600mm sewer pipe[2]	m	405	$550.00	$222,750.00
Sewer pipe construction[3]	m	405	$3,520.00	$1,425,600.00
Connection to existing overflow structure	No.	1	$215,000.00	$215,000.00
Subtotal				*$5,502,970.00*
Contingency			40%	$2,201,188.00
Stage 1 Sewerage Infrastructure TOTAL				**$7,704,158.00**

1. Costs of shaft well are estimated based on the quote provided by UEA on 29 November 2013.
2. Cost of Jacking Pipe was provided by Global Pipe on 6 February 2014.
3. Cost of microtunneling was provided by Pezzimenti on 30 January 2014.

2.9.4 Ginninderra and Murrumbidgee River Catchment – Packaged Pump Station

A packaged pump station could be installed as temporary infrastructure to service the 92.8ha catchment within the Murrumbidgee River Catchment, which has a PWWF of 63L/s from approximately 1,262 dwellings in 4 years. The packaged pump station will pump flows to a high point then discharge to Ginninderra Creek Trunk Sewer via gravity, which follows Option M5's trunk sewer alignment. The proposed gravity sewer can then service Stages 2, 3, 4, 5 & 5A and 1, 1A, 3, 8 of the development in Ginninderra Creek and Murrumbidgee River Catchment.

The proposed first stage sewerage infrastructure includes:

- A packaged pump station with duty of 62L/s at 31m head;
- 446kL emergency storage;
- 0.5km long 375mm diameter rising main north to the ridge;
- 0.4km long 225mm diameter gravity sewer at minimum grade of 0.38% north to the GST at the West Macgregor connection; and
- 2.6km long 375mm diameter gravity sewer at minimum grade of 0.48%.

The temporary pump station would be demolished once the main pump station is constructed and become operational. The rising main and gravity mains could possibly be reused.

The opinion of cost to construct the Stage 1 sewerage infrastructure for the Murrumbidgee River catchment is **$3.4 million** GST inclusive as shown in **Table 11**. This infrastructure will be redundant work and removed when the new large pump station is constructed.

Table 11 Stage 1 Sewerage Infrastructure Cost Estimates for Murrumbidgee River Catchment – Pump Option

Item	Unit	Qty	Rate ($)	Amount ($ GST Incl.)
Preliminaries			10%	$219,705.00
Open Trench				
225mm sewer pipe	m	1085	$295.00	$320,075.00
375mm sewer pipe	m	2593	$350.00	$907,550.00
Pump Station				
Pump Station, 62 L/s[1]	No.	1	$1,000,000.00	$1,000,000.00
375mm rising main	m	490	$350.00	$171,500.00
Subtotal				*$2,416,755.00*
Contingency			40%	$966,702.00
Stage 1 Sewerage Infrastructure TOTAL				**$3,383,457.00**

1. Costs of packaged pump station are provided by QMAX on 20 June 2014. The costs include supply and installation of well, pumps, controls, pipework and emergency storage with interconnecting pipework.

2.10 Conclusion

The open trench options are the cheapest in both capital costs and net present value. However, additional costs for potential remediation of the affected environmental habitat areas should also be considered against the expensive microtunnel options.

The microtunneling sewer options are considered in the design due to the following reasons:

- Compared with open trench gravity sewer options in the Murrumbidgee River catchment, microtunneling technology minimises impact to the existing sensitive environmental habitat and maximise size of the catchment serviced by gravity sewer. A site walk was conducted along the M2 microtunnel alignment on 12 March 2014 with ACTEW Water, Riverview, Will Osborne and David Shorthouse. During the site inspection, the proposed alignment and the shaft locations were deemed in principle to be suitable to minimise impact on the PTWL habitat and worthy of further investigation.
- Whilst the initial capital costs associated with the microtunneling options far exceed the costs of the alternative open trench (M1) and pump station options (G2 and M2 to M5), the ongoing maintenance and operation costs are minimal.
- Reduced impact on the sensitive environmental habitat areas from both construction and potential sewer overflow from a sewer pump station.
- Ability to stage construction and delay costly infrastructure capital expenses.

- No requirements for noise and odour buffers as required for a pump station.

The net present value for the pump station options are comparable to the microtunnel options. However, the potential increase in energy costs will make the pump station options less viable then the gravity sewer options.

The trunk sewer options and staging for both the Ginninderra Creek and Murrumbidgee River catchments require further detailed analysis and consultation with the relevant government agencies and authorities.

3. POTABLE WATER CONCEPT PLAN

3.1 Background

An Existing Services Investigation Report was prepared by Sellick Consultants on February 2009. The study undertook a preliminary investigation of the proposed water supply infrastructure required to service the proposed West Belconnen development within the ACT land only. ACTEW Water provided the following advice as part of the investigation:

- The proposed demand from the development is estimated to be 10ML per day.
- The Higgins reservoir has sufficient capacity to service the development.
- The development needs to be serviced by three pressure zones, low zone, extra low zone and ultra-low zone.
- Two new reservoirs will be required on site.

The study area in this report includes the development in both ACT (including Parkwood) and NSW land. The scope of work for preparing the Water Concept Plan include the following:

- Review the previous Existing Services Investigation Report prepared by Sellick Consultants.
- Liaise with ACTEW Water to update the site servicing advice for the proposed West Belconnen Masterplan including a staged delivery model of the trunk water infrastructure to service the site.
- Update the water pressure zones based on the latest land budget and Masterplan.
- Undertake preliminary water network modelling based on the site boundary conditions provided by ACTEW Water.
- Liaise with ACTEW Water to identify the location of the proposed reservoirs or pressure reduction valves.
- Liaise with ACTEW Water to identify potential upgrades required on the existing water supply infrastructure.
- Identify water supply services staging to ensure the delivery of the land release program and management of infrastructure expenditure and delivery; and
- Prepare preliminary opinions of cost for the proposed water supply infrastructure for the purpose of the Riverview and LDA's budgeting for the corresponding upcoming Capital Works program for West Belconnen.

3.2 Design Standards

Preparation of the water concept plan is based on the ACTEW Corporation- Water Supply and Sewerage Standard (AWSSS). Subject to development and finalisation of the development sustainability objectives related to Water Sensitive Urban Design (WSUD) and water recycling, this report and concept plans for water are based on meeting the current AWSSS to provide a based case workable concept for servicing the site.

ACTEW Water is investigating the Water Supply Strategy and proposed bulk water supply infrastructure for servicing the proposed West Belconnen development. To date, ACTEW Water have not provided conclusive advice nor any written advice on the Water Supply Strategy. The substance of the water concept plan provided are based on the information discussed in a number of meetings with ACTEW Water and EDD and is provided in this report only to inform potential masterplan consideration.

The design criteria used in preparing the Water Supply Concept Plan are described below:

- Peak hour demand (PHD) = maximum hourly rates times block/site area. The maximum hourly rate for different land use types is obtained from Table 2-1 in AWSSS. For the West Belconnen development, the PHD will range from 1.1 L/s/ha for the town or city centres to 1.9 L/s/ha for the education facilities/school.
- Fire flow demand (FD) – based on a minimum flow rate for various fire risk categories specified in Table 2-2 in AWSSS. For the West Belconnen development, the fire category will range from F4 at the group centre (60L/s), F5 for medium and high density residential areas (45L/s) and F6 for low density residential areas (25L/s).

The proposed water reticulation system design is based on providing minimum pressures of 20 metres head (30 metres head at commercial properties) during peak hour and a minimum of 10 metres of head during fire flow conditions, concurrently with peak hour demand. AWSSS requires that the maximum static pressure at any point of the development should be 75m head.

Design for ACT & NSW together with all servicing to come from ACTEW Water network.

3.3 Existing Water Services

Figure 12 and Drawings C13080 – 020 to 022+ shows the existing trunk water mains within and adjacent the study area.

There is an existing Higgins Reservoir is located approximately 3.2km southeast of the site at the intersection of Kingsford Smith Drive and Drake Brockman Drive. ACTEW Water advised that the top water level (TWL) of the reservoir is RL638.6 and that this reservoir has capacity to service the entire West Belconnen development. The reservoir has a 900mm diameter trunk water main outlet, which runs along Kingsford Smith Drive, east of the site and a 600mm diameter water main that runs west along Drake Brockman Drive.

There is an existing water main located within the verges of Parkwood Road. The water main is:

- 100mm diameter east of Block 1586 Belconnen, servicing the West Belconnen Resource Management Centre within the study area.
- 150mm diameter north of the Canberra Substation. Part of the water main is located within the study area.
- 225mm diameter between Britten-Jones Drive and Kingsford Smith Drive. The water main connects to a 900mm diameter trunk water main in Kingsford Smith Drive.

There is an existing water main located within the verges of Stockdill Drive and Drake Brockman Drive. The water main is:

- 225mm diameter west of Trickett Street. The main provides a service tie to Block 1420 south of the site and provides potable water supply to LMWQCC. A 100mm diameter reticulation main, which connects to this main, runs along Studio Road and provides water services to Block 1332 Belconnen (Strathnairn) within the site.
- 375mm diameter from Trickett Street to Macnaughton Street.
- 600mm diameter from Macnaughton Street to Kingsford Smith Drive. The water main connects to the 900mm diameter trunk water main in Kingsford Smith Drive.

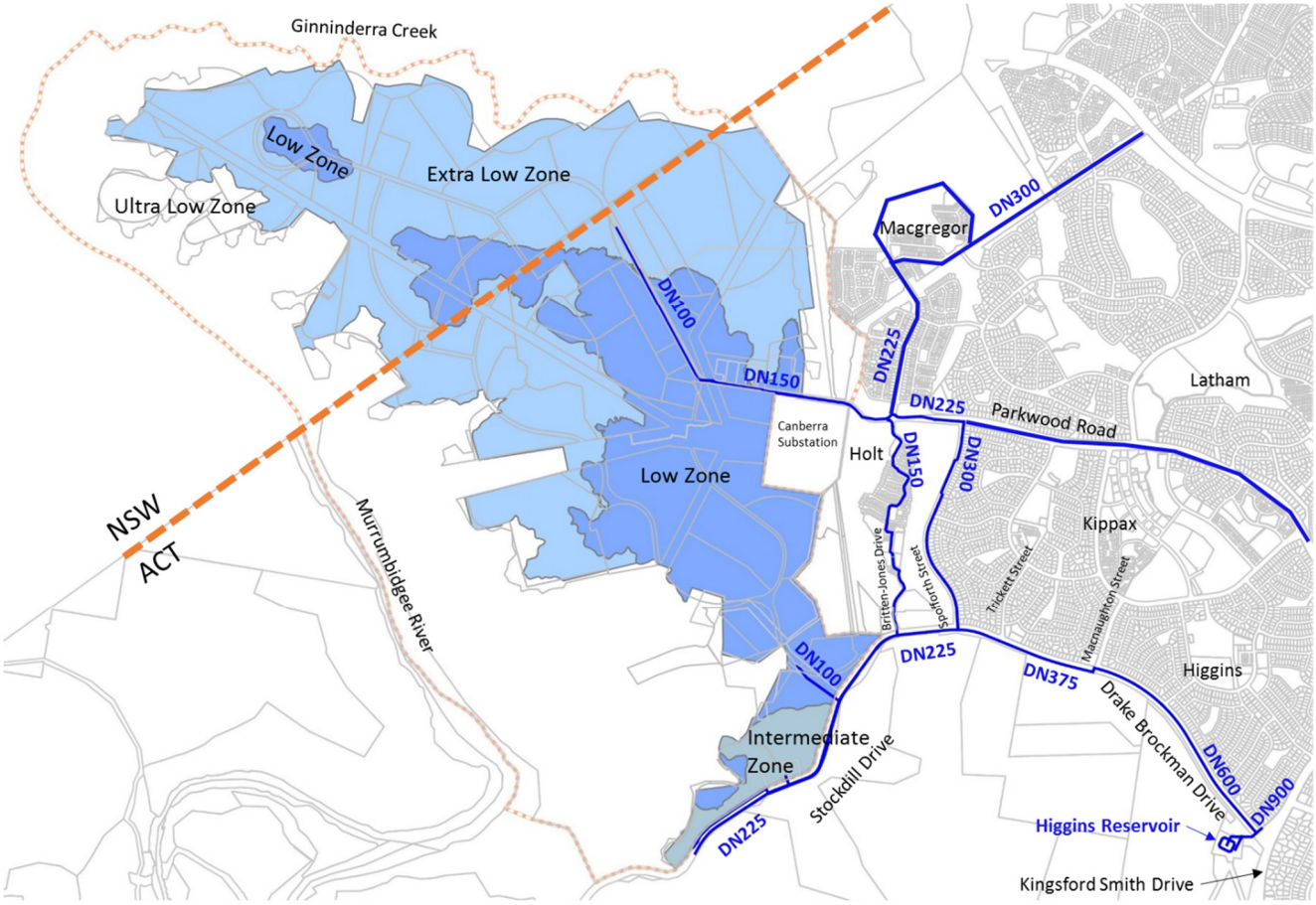


Figure 12 Existing Water Services and Water Zones for West Belconnen Development

3.4 Water Pressure Zones

ACTEW Water advised that there are four water pressure zones within the proposed West Belconnen development as shown in **Figure 12**, which match to the existing zones in adjacent Belconnen suburbs. Details of each water zone are shown in **Table 12**.

Table 12 West Belconnen Water Pressure Zones

Water Zone	Lowest Served Area (RL)	Highest Served Area (RL)
Intermediate	600	625
Low	560	600
Extra Low	530	565
Ultra Low	500	530

Majority of the West Belconnen development is located in the 'Low' and 'Extra Low' pressure areas. A small area near Stockdill Drive south of the site is located within the Intermediate Pressure Zone. There are also some low lying areas in the north-western side of the NSW development near the river corridor located within the Ultra Low Pressure Zone.

3.5 Proposed Water Supply Infrastructure

The total peak hourly demand for the proposed development is approximately 674 L/s based on the current in peak demand rate in AWSSS. ACTEW Water undertook preliminary network analysis and proposed two options to service the development.

3.5.1 Option 1 – Trunk Main + Reservoirs within Development

This option includes the following infrastructure:

- A 3.2km long trunk water main (indicative size 1050mm diameter) running along Drake Brockman Drive, from Higgins Reservoir to the site boundary for servicing the Low Zone areas and filling the Extra Low Zone reservoir (refer drawing C13080 – CP022 in **APPENDIX D**).
- A 10ML to 15ML reservoir within the site to service the Extra Low Zone. The reservoir can be constructed at ground level at RL585 with 10m head or as an elevated reservoir at RL568 with approximately height of 20m head. Refer to Drawing C13080 – CP020 in **APPENDIX D** for possible tank locations within the development.
- A smaller trunk main (indicative size 300mm diameter) from the Intermediate Zone in Hawker or connected to the Stromlo Bulk Supply Main, both of which are located near the Higgins Reservoir, extending to the West Belconnen Intermediate Zone.
- A 0.5ML reservoir south of the site to service the Intermediate Zone. The reservoir could be constructed at RL648 on a nearby hill.
- Pressure Reduction Valves (PRVs) to service the Ultra Low Zone.

ACTEW Water will confirm the trunk water main sizes and reservoir sizes and locations after completing the water network modelling and strategy for the West Belconnen Development.

3.5.2 Option 2 – Trunk Mains Only with PRVs within Development

Compared with Option 1, this option aims to service the extra low zone using Pressure Reduction Valves off the low zone mains within the site, with no new reservoirs. This option includes the following infrastructure:

- Two 3.2km long trunk water main (indicative size 1050mm diameter each) running along Drake Brockman Drive, from Higgins Reservoir to the site boundary for servicing the Low Zone areas (refer drawing C13080 – CP022 in **APPENDIX D**).
- Pressure reduction valves off the low zone water mains within the site to supply extra low zone areas (refer to Drawing C13080 – CP020).
- Two smaller mains (indicative size 300mm diameter each) off the Stromlo Bulk Main to Intermediate Zone.

ACTEW Water will confirm the trunk water main sizes after completing the water network modelling and strategy for the West Belconnen Development.

3.6 Water Supply Infrastructure Staging

ACTEW Water advised that the initial stages of the development can be serviced by extending the existing 600mm diameter trunk water main from Macnaughton Street to the site boundary as shown in **Figure 13**. The new DN600 trunk water main is approximately 1.6km long and can service up to 1,000 dwellings within Low Zone.

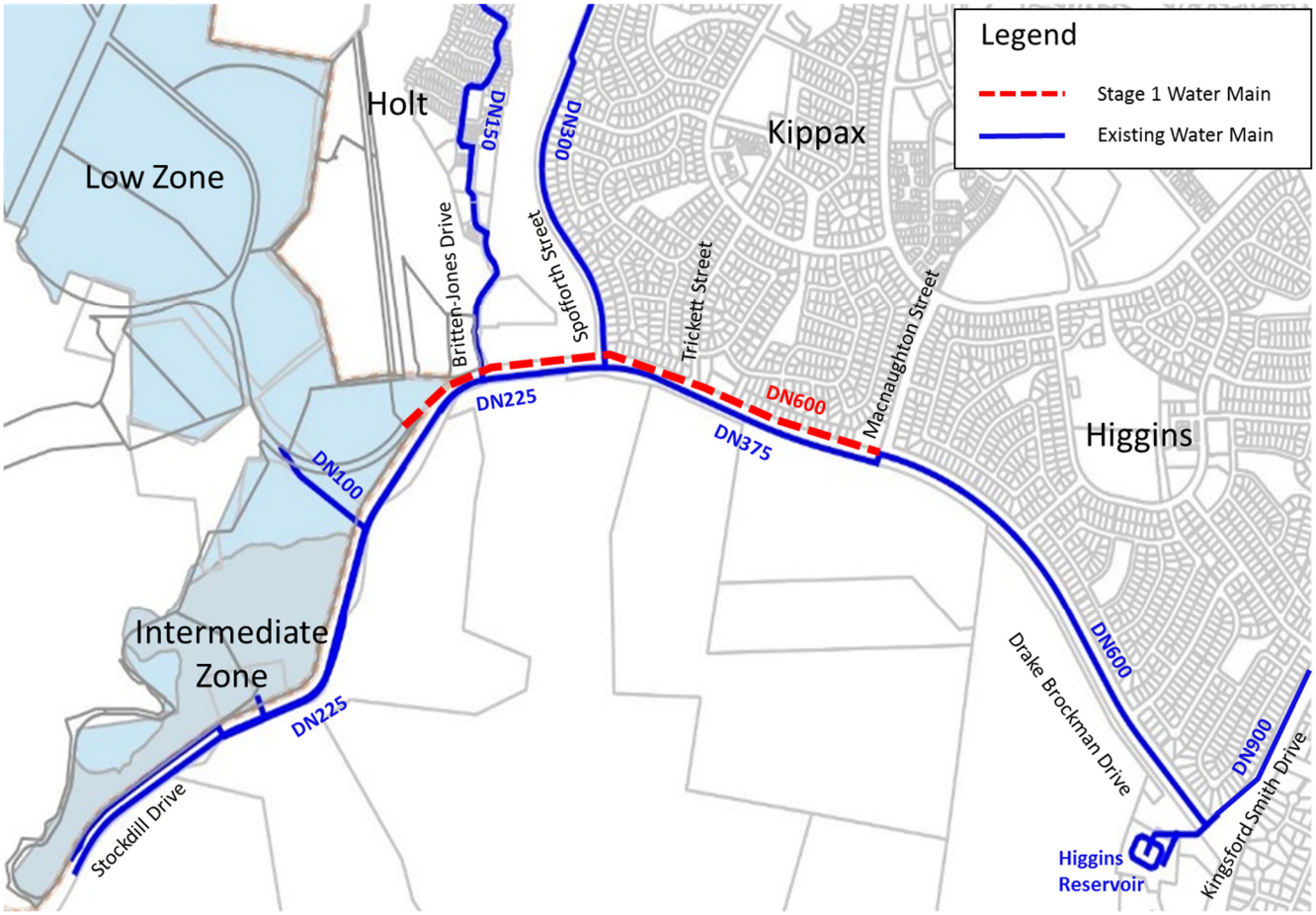


Figure 13 Stage 1 Water Supply Infrastructure for West Belconnen Development

3.7 Conclusion

Options 1 and 2 will be subject to more detailed analysis and consultation with the relevant government agencies and service authorities. It is noted that the capital costs associated with Option 2 (PRV) are likely to be significantly less than Option 1 (Reservoir) and less land take is required for Option 2 by not requiring a large reservoir. However, Option 1 may be considered as a more appropriate servicing solution, providing higher water supply security and reliability to the development.

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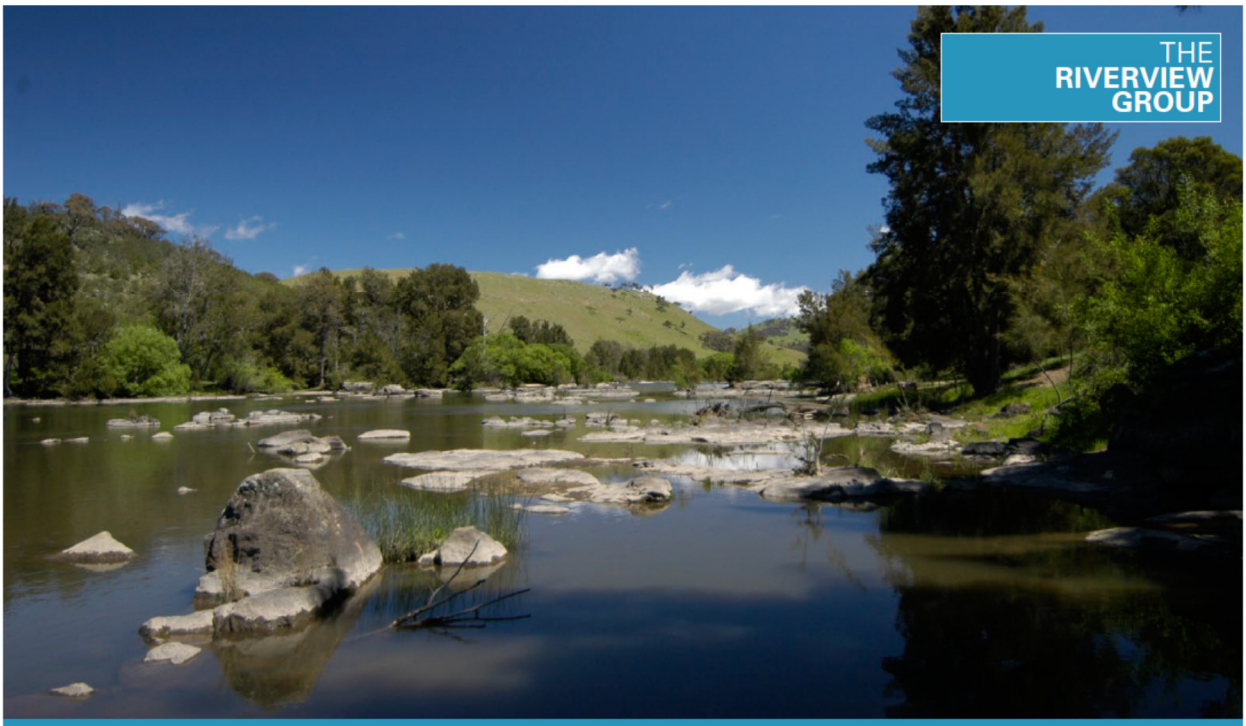
Appendices

APPENDIX A WEST BELCONNEN VISION



The Belconnen Project Sustainability Vision

"Creating a sustainable community of international significance in the Nation's capital."

The Riverview Group, working with the ACT and NSW Governments, will develop the site at Belconnen to achieve a vision of inspiring sustainable living, development practice and awareness. Achieving a high quality of life for the people living at Belconnen is at the heart of our project planning and design.

We will create a community that exemplifies World's Best Practice in its design, construction and long-term liveability. As a model of sustainable community living it will be a place and community that can be showcased throughout Australia and internationally.

Project objectives:

To achieve our Vision we will challenge conventional industry thinking. We will employ practices, processes and systems that embody innovation and design excellence.

This project has been conceived and will be delivered on a fully integrated and audited triple bottom line basis.

Our project will:

- Be sustainable over time, socially, economically and ecologically (with a low and reducing ecological footprint)
- Respond to the local and global environment
- Provide for future beneficial change to occur in design, infrastructure and regulatory mechanisms
- Be cost effective, replicable and measurable
- Act as a new model that others can follow.

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Guiding Principles for Sustainable Results

The principles below will direct decision-making by all project management, sub-consultants and referral agencies in the delivery and development of the Belconnen site. They reflect national priorities and Federal, State and Territory Government policies on housing affordability, climate change and environmental protection.

PARTNERING PRINCIPLES

Ptnr 1. Partnering is essential to this project and the scale and timeframe will allow for positive partnerships to grow and thrive

Ptnr 2. Partnering with public agencies is a cornerstone of our approach

Ptnr 3. Engaging the community in design and governance is fundamental to the delivery of the project.

Ptnr 4. Designing the project for community ownership and ultimate community control

Ptnr 5. Supporting community housing through public and private partnering arrangements

Ptnr 6. Collaborating with research and educational institutions to drive innovation.

EVALUATION PRINCIPLES

Eva 1. Identifying and delivering realistic and costed initiatives

Eva 2. Providing independent peer review of project proposals and project outcomes

Eva 3. Using recognised international and national benchmarks for sustainability performance to publicly report and raise awareness of project outcomes

Eva 4. Empowering resident and community monitoring and management of sustainability performance

Eva 5. Encouraging a culture of continuous improvement.

ECOLOGICAL PRINCIPLES

Eco 1. Acknowledging the intrinsic value of all species and the special role and regional significance of the Murrumbidgee river corridor and Gininnderra Creek

Eco 2. Respecting and supporting the ecosystem functions of air, soil and water, recognising the importance of living and non-living environmental resources

Eco 3. Reducing greenhouse gas emissions through innovative products and place design, material selection and service provision

Eco 4. Recognising our natural ecological limits and minimising our resource, water and energy consumption

Eco 5. Using existing local infrastructure to deliver efficient renewable services and reusable resources

Eco 6. Enhancing local opportunities for food production and production of materials

Eco 7. Fostering a deep sense of respect for and connection to the land, flora and fauna.

SOCIAL AND CULTURAL PRINCIPLES

Soc 1. Respecting and honouring Aboriginal and non-Aboriginal cultural, historical and spiritual values, including integrating with the existing rich, social fabric of Belconnen

Soc 2. Designing for social equity, affordability, diversity and interdependence, honouring differences and catering for the needs of individuals through all stages of life

Soc 3. Maximising health, safety and comfort of the built environment to provide enduring quality of life

Soc 4. Instilling awareness and supporting education of sustainability values, technology and lifestyles

Soc 5. Using creative and robust design solutions to create a continuing sense of place and beauty that inspires, affirms and ennobles

Soc 6. Designing neighbourhoods that support and encourage community interactions through imaginative, functional and enjoyable public spaces

ECONOMIC PRINCIPLES

Econ 1. Delivering a financial return to the ACT Government recognising their sovereign interest in the land

Econ 2. Recognising the opportunities provided by the project's scale and low capital base to achieve high-level sustainability outcomes while delivering profitability to joint venture partners

Econ 3. Building on existing local infrastructure

Econ 4. Ensuring long-term economic viability through design excellence and community building

Econ 5. Minimising obsolescence through design of enduring component life cycle, allowing for disassembly and change

Econ 6. Integrating with the Belconnen commercial, retail and employment networks

Econ 7. Growing a formal and informal green economy that fosters local jobs and builds regional learning around green innovation and technology

APPENDIX B STRUCTURE PLAN AND LAND BUDGET

APPENDIX C SEWER SERVICING OPTIONS AND FLOW CALCULATIONS

APPENDIX D SEWER AND WATER CONCEPT PLAN

APPENDIX E COST ESTIMATES

APPENDIX F SERVICE AUTHORITIES ADVICE

APPENDIX G WILL OSBORNE'S PTWL HABITAT FIELD INSPECTION RESULT