Yass Valley Water Source Strategy

Options Assessment and Strategy Report

Yass Valley Council

18 October 2022

→ The Power of Commitment

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Executive summary

This report is subject to, and must be read in conjunction with, the limitations set out in section 1.4 and the assumptions and qualifications contained throughout the Report.

Yass Valley Council (Council) are seeking to identify a water source strategy across the Local Government Area (LGA) of Yass Valley to service identified growth areas of Yass and Murrumbateman. Development is also projected to occur in Parkwood (adjacent the ACT border), but this area will be serviced from the ACT as the development occurs. This report identifies the parameters for the water source strategy including population and supply demographics as well as the range of water source options that can be considered for this strategy.

This water source strategy document is being prepared separately to the IWCM process. This document is a targeted water source strategy inclusive of source options assessment and identification of a preferred water source option to address specific security of supply risks including the impact of cross border development, extraction licencing, governance, and legal requirements.

Water for the main townships in the Yass Valley Local Government Area (LGA) is currently supplied from the Yass Dam on Yass River (or via Groundwater for emergency purposes in Yass and Murrumbateman). While the Yass Dam was raised in 2013, lifting capacity to 2,464 ML, the additional yield will be exhausted in the near future and, with potential climate change impacts, the time to exhaustion of additional yield may be shortened further. Climate projections do show increasing rainfall in the region, but increased temperatures are likely to lead to increased demands during dry periods.

The Yass Valley Settlement Strategy provides population projections up to 2036 with growth projected between 1.6% to 2.33% over the period 2011-2036 and growth to around 43,900 by 2056, with 12,400 additional people living in the town of Yass. Parkwood is the NSW component of the residential development that will extend from west of Belconnen in the ACT, into Yass Valley in NSW. The development will ultimately see 5,000 new dwellings in NSW commencing with 300 dwellings per year from 2032-2047, resulting in a total forecast population of approximately 13,000 people.

Based on the analysis done by Public Works Advisory (Draft Issues Paper, 2021), assuming no additional irrigation allowance is attributed upstream of Yass Dam, and a high growth scenario, the future water demand would likely be approximately 817 ML/year (Average Year unrestricted future demand (PWA, 2021)) by 2031 and 1,140 ML/year by 2051 for Yass, Murrumbateman, Bowning and Binalong. Similarly, the Dry year extraction will be 1,409 ML/year (2031) and 1,892 ML/year (2051). Considering a secure yield for Yass Dam of 482 ML/year (1 °C warming scenario), the proposed additional water source would need to supply approximately 1,410 ML/y considering the forecast Dry Year extraction.

The approach for this project is to develop assessment criteria covering a broad range of priorities and drivers that will enable Council to compare identified suitable water source options and determine a preferred option for each growth area. The preferred options will then be combined into an overall water source strategy.

The following principles have been applied to the development of the criteria used on this project:

– Impact and benefit focused – captures the characteristic impacts of the options being assessed both positively and negatively
– Discrete – avoids double counting on measure
– Discernible – highlights the difference across options, not similarities
– Non-redundant – allows differentiation between decision options (criteria will be eliminated where they do not provide discernment between options)
– Measurable – allows comparison either by quantity or by judgement of Yass Valley Council and other stakeholders.
– Universally applied – all criteria are applied consistently across the options.

The selected criteria for the project are:

1. Availability – Based on the volume, reliability of supply and ability to meet growth scenarios up to a 30-year horizon. If this criterion cannot be met by any single option, it would need to be considered in conjunction with other source options.
2. Environmental Impact – To consider the environmental and biodiversity benefit and/or impact.
3. Energy use and emissions – Direct energy use mainly in relation to treatment options and pumping.
4. Flexibility and adaptiveness – Considers the agility of the option to be modified to suit the emerging context as measured by two dimensions: Time and Scale.
5. Circular economy principles – Measure the overall circular economy benefits of the options as a general philosophy that compensates for the ability to be able to quantify them as measured by the three principles: Design out waste and pollution, keep products and material in use, regenerate natural systems.
6. Ability to meet community expectations – Customer expectations, cultural heritage, and community affordability.
7. Minimal Impact on Traditional Owners – Impact on First Nations heritage assets.
8. System resilience contribution – Incorporates the contribution the option provides to the overall system resilience including in the light of climate change as measured by the three dimensions which are: extreme drought, major water quality event and major asset failure.
9. Minimise complexity – Complexity of treatment process. With complexity increasing with higher levels of treatment and adoption of simplistic/known technology and comfort of operators with technology.
10. Minimise Regulatory challenges – Complexity and effort required and likelihood of approval.
11. Indicative CAPEX costs – CAPEX high level comparison estimate (qualitative).
12. Indicative OPEX costs – OPEX high level comparison estimate (qualitative).

The source options considered to meet the required demand included:

– Surface water
  - Off-river storage
  - Lake Burrinjuck
  - Supply from ACT
– Groundwater
– Recycled water
  - Non-potable
  - Purified recycled water
– Alternative water sources
  - Rainwater tanks
  - Stormwater harvesting
  - Managed aquifer recharge
  - Water carting
  - Atmospheric water generation

For the Parkwood development, water supply will be through the ACT and developed as the development progresses due to logistical reasons. Technical (e.g. metering of water use for Parkwood) and regulatory (e.g. legislation to supply Parkwood, similar to Queanbeyan LGA) aspects of the arrangement will need to be considered separately as part of the Parkwood Project Working Groups.

For Yass and Murrumbateman, a workshop was held on 10 December 2021 to identify the preferred source option. The workshop was attended by DPE Water, Council staff and GHD. At this workshop, a pairwise comparison of the above criteria was undertaken to determine weightings and each feasible source option scored against the criteria. This process gave a weighted score to each source option and the preferred water source strategy was identified to be supply from the ACT.

The pipeline is proposed to connect to the existing Icon Water supply system east of Canberra in the vicinity of Hall/Nicholls. It is proposed that the pipeline will generally follow the Electrical Transmission easement and Barton Highway through to the existing pipeline between Murrumbateman and Yass. Indicative alignment and an overview of constraints such as heritage areas and creek crossings are presented in this report. Threatened flora and fauna will need to be examined at a finer scale as the water supply project progresses. It is understood that the existing section of pipeline between Murrumbateman and Yass was constructed with 18 km of DN250 DICL/PVC transfer main and 0.5 km of DN300 PVC trunk distribution mains within Murrumbateman.

The water demand data from Yass, and Murrumbateman is 1,140 ML/year for an Average Year Demand and 1,892 ML/year for Dry Year Extraction. This equates to approximately 3.1 ML/day and 5.2 ML/day for the average and dry extraction year, respectively. The existing pipeline between Yass and Murrumbateman is documented to be able to reverse the water transfer to supply Yass up to 5 ML/day with booster pumping (Feasibility Study for Yass to Murrumbateman, PWA October 2015).

A review to determine the most suitable pipe diameter for the new section from the ACT to Murrumbateman was undertaken with an allowance of minimum head of 3 m along the pipeline. The pipeline between ACT and Murrumbateman is proposed as approximately 30km of DN300 DICL. Indicative costing of the pipeline between ACT to Murrumbateman is $15.5M, based on the NSW reference rates but are likely to be closer to $25m based on construction rates experienced in the local area during 2022. This cost excludes land acquisition and contingency.

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1. Introduction

1.1 Purpose of this report

Yass Valley Council (Council) are seeking to identify a water source strategy for the Yass Valley across three growth areas: Yass, Murrumbateman, and the future cross border development at Parkwood (known as Ginninderry in the ACT). This report is to document the process and decision making undertaken in determining the preferred water source strategy.

1.2 IWCM linkage

Public Works Advisory (PWA) are currently preparing an Integrated Water Cycle Management Strategy (IWCM) Issues Paper on a separate timeframe. This is a critical document to foster discussions with regulatory authorities.

This water source strategy document is being prepared separately to the IWCM process. This document is a targeted water source strategy inclusive of source options assessment and identification of a preferred source option to address specific security of supply risks including the impact of cross border development, extraction licencing, governance, and legal requirements.

This document will only address water source options and will not determine options for stormwater or sewage.

The approach for this project is to develop assessment criteria covering a broad range of priorities and drivers that will enable Council to compare identified suitable water supply options and determine a preferred option for each growth area. The preferred source options will then be combined into an overall water source strategy.

1.3 Scope and limitations

This report: has been prepared by GHD for Yass Valley Council and may only be used and relied on by Yass Valley Council for the purpose agreed between GHD and Yass Valley Council as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than Yass Valley Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring after the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section 1.4 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

1.4 Assumptions

GHD has made the following assumptions in preparing this report.

1. The water supply scenarios are only developed for the identified growth areas of Yass, Murrumbateman and Parkwood.
2. Parkwood water supply will be from the ACT and extended as the development progresses.

2. Project overview

2.1 Yass Valley Local Government Area

The Yass Valley Council is a Local Government Area (LGA) in the Southern Tablelands region of NSW. The LGA covers an area of 3,999 km^2 and shares its southern border with the ACT. Most of the population resides in the towns of Yass, Murrumbateman, Bowning and Binalong. Other smaller communities in Yass Valley include Gundaroo, Sutton Village, Wee Jasper and Bookham. The nearest major city is Goulburn to the east and Canberra to the Southeast. The LGA boundary is shown in Figure 2-1.

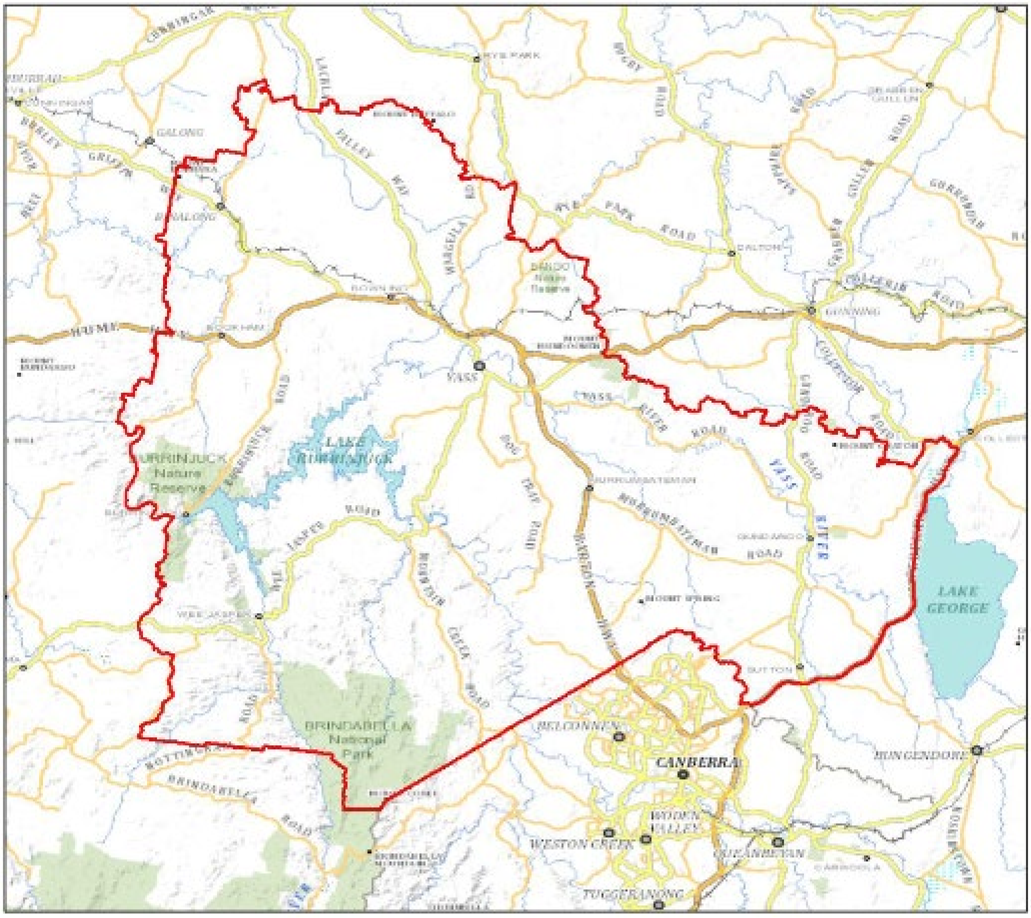


Figure 2-1 Yass Valley LGA

2.2 Geography

According to Saha et. al. (2014), the Yass River is a tributary of the Murrumbidgee River in the Murray-Darling Basin (MDB) of Australia. Around two-thirds of the annual flow of the Murrumbidgee River system comes from the Burrinjuck and Blowering dams of the upper Murrumbidgee catchment. The Yass River is a major tributary of this area which drains directly into the Burrinjuck dam. The Yass River originates near the south of Bungendore and flows 120 km in the north and northwest direction and ends in the Burrinjuck dam. Being in the higher elevation part of the Murrumbidgee catchment with relatively high amount of rainfall, the Yass River contributes significant amount of flow to the Burrinjuck dam. The Yass catchment covers an area of 1,597 km^2 upstream of Burrinjuck dam. The elevation of the catchment varies from 373 to 934 m Australian Height Datum (AHD). The average annual rainfall of the catchment is 675 mm. The dominant land use of the catchment is grassland/pasture. The Yass River catchment is often affected by drought and flood conditions.

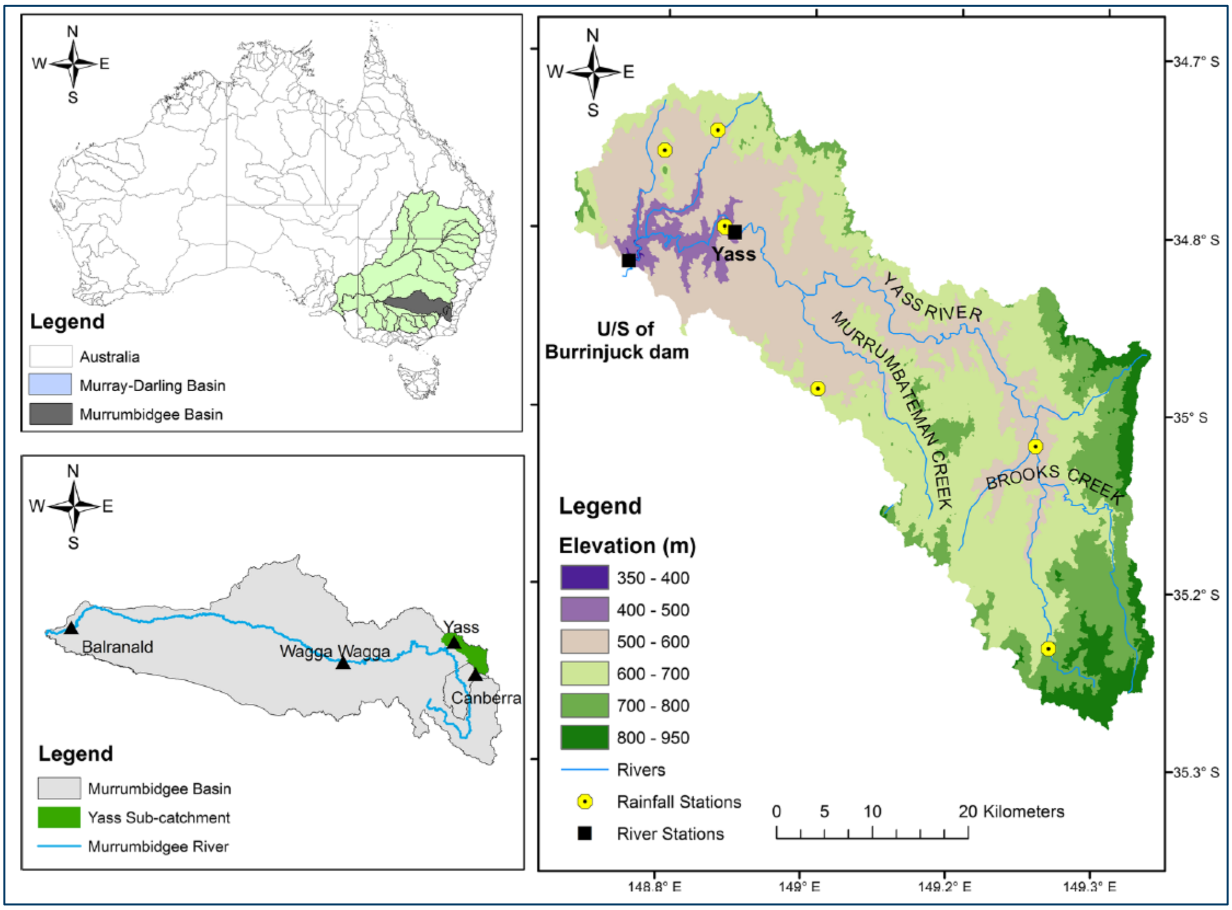


Figure 2-2 *Yass River Catchment (Saha PP, Zeleke K, Hafeez M (2014) Streamflow modelling in a fluctuant climate using SWAT: Yass River catchment in south-eastern Australia)*

2.2.1 Climate Projections

By 2070 annual rainfall is projected to increase across most of the state. The exception is a decrease in the Snowy Mountains. There are large seasonal changes forecast, as well as varying rainfall across the Southeast and Tablelands region. The greatest increases are seen across most of the region during summer and autumn. There are large decreases in rainfall predicted across most of the region during spring and winter in the Snowy Mountains and far south coast (Office of Environment and Heritage, 2015).

Mean temperatures are projected to rise by 2 °C by 2070. The greatest increases are seen in the north and west of the region during summer and spring. All models show there are no declines in mean temperatures across the South East and Tablelands (Office of Environment and Heritage, 2015).

Across much of NSW, surface runoff is projected to increase in both the near and far future. Largest increases are evident in the central west through to the northern tablelands. Large reductions in surface runoff are projected in both the near and far future for alpine areas in the south of the state (Office of Environment and Heritage, 2015).

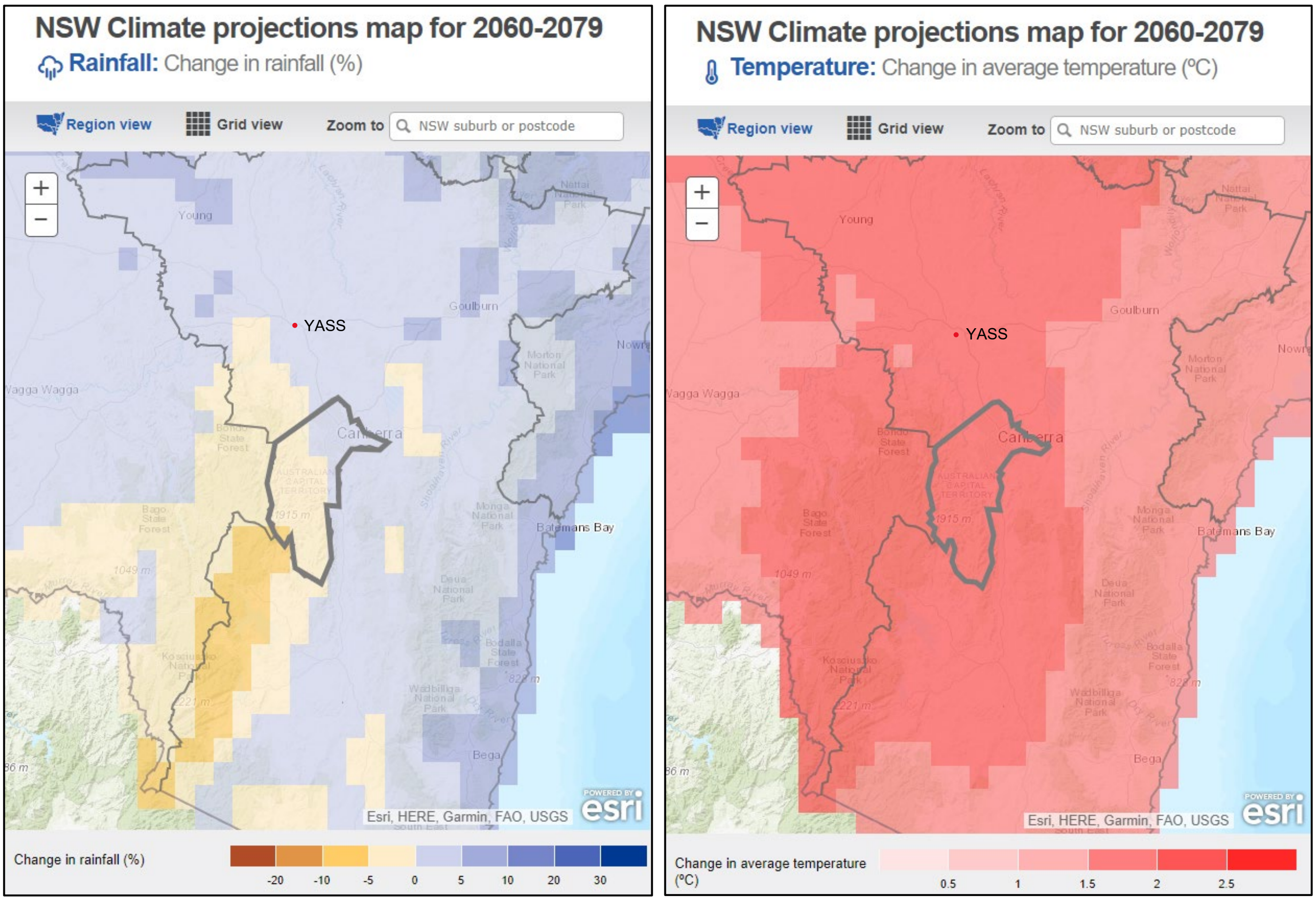


Figure 2-3 Rainfall and temperature projections (Office of Environment and Heritage, 2015).

2.3 Current supply sources

Council currently supplies water to the LGA utilising its annual license to extract up to 1,700 ML/year from Yass River via Yass Dam under its current Water Access Licence (WAL) entitlement (refer Table 2.1).

Yass Dam is located on the Yass River just East of the main township of Yass and is fed from a catchment area of 1,230 km^2. Yass Dam wall was raised by 3 m in 2013, increasing the dam's storage capacity to 2,464 ML maximum capacity with a secure yield of around 1300 to 1600 ML/a (NSW Department of Commerce, 2003), securing water for Yass, Binalong, Bowning and Murrumbateman (with completion of the pipeline) for a population up to 15,500. No further raising of the dam is considered feasible by Council.

The dam's highest yearly extraction was 915 ML in 2015/16 according to the most recent IWCM Issues Paper (PWA, 2021). Yass Water Treatment Plant (WTP) treats water from Yass Dam and has a capacity to treat 13 ML/day with typical production approximately 3 ML/day in winter and 7 ML/day in summer. Of this, approximately 40 ML/year and 20 ML/year is supplied to townships of Binalong and Bowning respectively via pipeline. The rest is supplied to Yass and Murrumbateman.

Table 2.1 Yass Valley Council water access licences (Public Works Advisory Yass Valley Council IWCM Draft Issues paper, 2021)

WAL	Category	Water source (description)	Entitlement (ML/annum)	Water Sharing Plan (WSP)
33531	Town Water Supply	Yass lower water source (Yass Dam)	1700	Murrumbidgee unregulated river water sources
32979	Town Water Supply	Jugiong water source – Illalong Dam – silted/railway	30	
33522	Unregulated River	Yass lower water source – Irrigation of parks in Yass	14	

WAL	Category	Water source (description)	Entitlement (ML/annum)	Water Sharing Plan (WSP)
33529	Unregulated River	Yass lower water source – not used – Laidlaw sub-division	15	
28536	Local Water Utility	Yass Catchment Groundwater Source – Emergency bore – Yass Willow Creek	70	NSW Murray Darling Basin Fractured Rock Groundwater Sources
28240	Local Water Utility	Yass Catchment Groundwater Source – Yass Old Quarry	100	
28312	Local Water Utility	Yass Catchment Groundwater Source – Irrigation of Parks – Sutton	1	
28359	Local Water Utility	Murrumbateman Bore (recreation ground)	56	

2.4 Supply demographics

The Yass Valley LGA has experienced sustained population growth since it was formed. In 2005 (post-amalgamation) the estimated residential population of Yass Valley was 13,247. In the ten years following, the population grew by 3,171 people i.e. an increase in total population of over 24% or approximately 2.4% per annum. This increase occurred despite growth being constrained by available water for much of this period. By June 2015, the estimated residential population (ERP) had increased to 16,418 people (Yass Valley Settlement Strategy, YVC, 2019).

Council has nominated a non-residential demand growth rate to be a proportion of the residential demand growth rate. The non-residential demand has been nominated to grow at 25% of the residential demand for both water supply and sewerage systems (IWCM Issues Paper Draft, PWA, 2021).

2.4.1 Covid-19

The social, economic and technological impacts of COVID-19 have had major implications around the globe. In Australia, the impact of the pandemic has seen a shift in the migration patterns between capital cities and regional areas in the short term at least. The longer-term implications on this topic are still very uncertain.

In a presentation by the Australian Centre for Population the key findings were:

- Central projection scenario sees a net shift in migration away from capital cities in favour of regional areas in 2020-21, before gradually returning towards the long-run average.
- Underscoring the uncertainty surrounding this topic, surveyed experts were split on the impact of COVID-19. Approximately half expect it to have no impact on migration patterns between cities and regions, with the other half expecting a slight shift in favour of migration from capital cities to regional areas.
- Early PRIME data indicates there has been a net shift in migration towards regional areas. The impact of the lockdown in Melbourne and Victoria is also evident in the data, with Melbourne experiencing its largest net migration loss on record.

2.4.2 Yass and Murrumbateman

According to the Yass Valley Settlement Strategy 2036, areas of Binalong, Bookham, Bowning are not forecasted to grow over the next 30 years. Yass and Murrumbateman have, on the other hand, experienced sustained growth and are forecast to provide most of the future growth in development in the Council local government area (LGA) to 2036.

The Yass Valley Settlement Strategy provides population projections up to 2036, providing projections estimated by NSW Department of Planning and Environment (DPE) and .id (refer Figure 2-4). The two provide slightly different outlooks for projections with .id projecting a slightly higher growth rate of 2.33% vs 1.6% from DPIE over the period 2011-2036. It further predicts the total population of Yass Valley could be projected to grow to around 43,900 by 2056.

	DPE	.id
Total Population		
2011	15,600	15,603
2016	17,150	16,764
2021	18,750	18,436
2026	20,300	20,268
2031	21,900	22,166
2036	23,400	27,726

Figure 2-4 ***Yass Valley Council area population forecast summary (Yass Valley Settlement Strategy, 2019)***

2.4.3 Parkwood

Parkwood (known as Ginninderry in the ACT) is the NSW component of the residential development that will extend from west of Belconnen in the ACT, into Yass Valley in NSW. The development will ultimately see 6,500 new dwellings in ACT, and 5,000 new dwellings in NSW. The total estimated population over the next 30 years is expected to be 30,000 new residents.

Development into the NSW side, however, is not expected to start until after 2032 with 300 dwellings proposed to be released per annum in Parkwood between 2032-2047 resulting in a total forecast population of approximately 13,000 people.

Figure 2-5 (Ginninderry, 2021) outlines the sequential stages of the development plan up to 2055.

As noted at section 1.4, it is assumed that Parkwood will be supplied from the ACT's water supply and that the servicing of this area will be undertaken in line with the development. As such Parkwood has not been considered further in this options study. Further discussion on the challenges and issues faced in this development will be addressed separately as part of the Parkwood Project Working Groups.

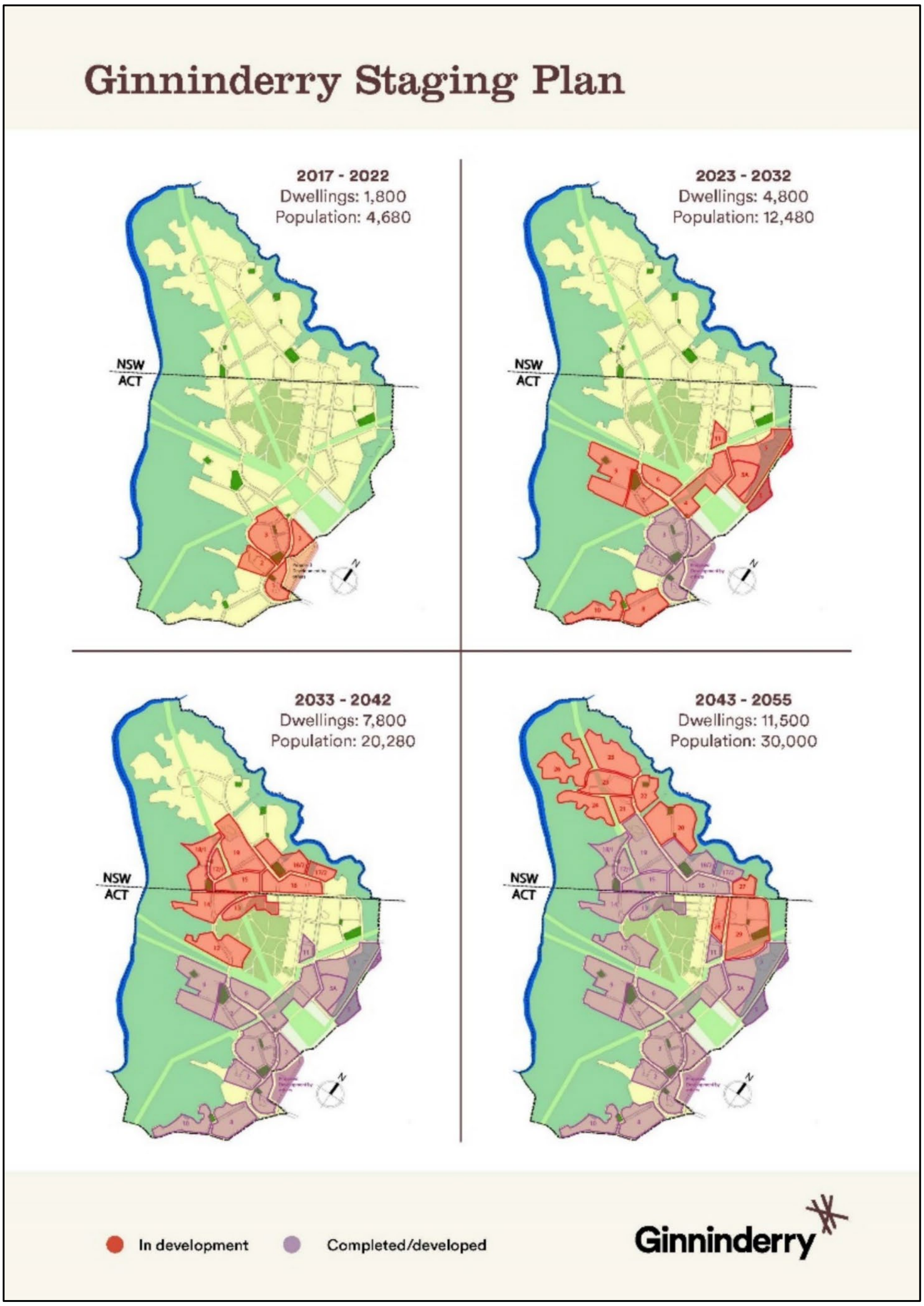


*Figure 2-5 Ginninderry Staging Plan (**https://ginninderry.com/our-vision/masterplan/**)*

2.5 Water demand

Under the NSW Security of Supply basis 'Secure Yield' is defined as the highest annual water demand that can be supplied from a water supply headworks system while meeting the above '5/10/10' rule. The key aspects of the 5/10/10 rule is:

1. Water restrictions are in place for no more than 5% of the time of available records
2. Water restrictions occur on average once every 10 years
3. During water restrictions, demand is reduced by 10%

Based on the analysis done by Public Works Advisory (Draft Issues Paper, June 2021), assuming no additional irrigation allowance upstream of Yass Dam, and a high growth scenario, the preferred water source scenario would likely need to provide approximately 817 ML/year by 2031 and 1,140 ML/y by 2051 (average year demand). Higher demand is expected during dry periods.

Council's current water access licence (WAL) entitlement for Yass Dam is 1,700 ML/year. Public Works Advisory undertook a secure yield analysis in its most recent Council IWCM issues paper using DPE Water's draft guidelines. The analysis projected unrestricted future extraction using two scenarios – historical climate data and data based on 1ºC warming (refer Figure 2-6).

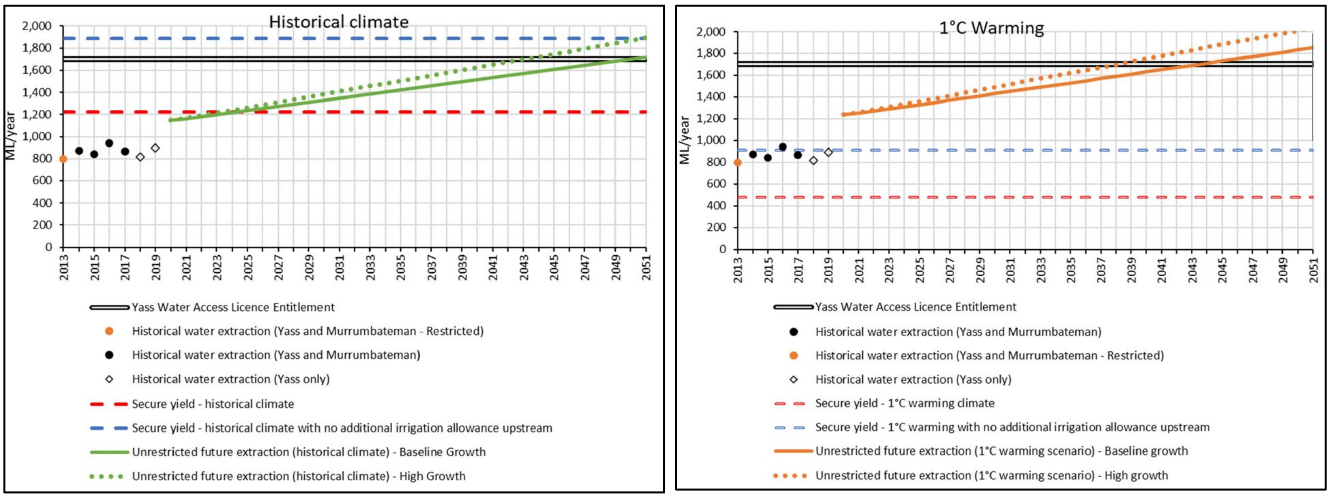


Figure 2-6 ***Projected unrestricted future extractions (Yass Valley Council IWCM Draft Issues Paper, Public Works Advisory, 2021)***

Under the future 1 °C warming scenario, the WAL entitlement will be exceeded by 2038/39 for the high growth scenario and 2043/44 for the baseline growth scenario (IWCM Issues Paper, June 2021). The analysis, based on historical data, indicates that the secure yield of the Yass Dam will not be exceeded if no additional irrigation licences are provided upstream of the Yass Dam. Under the 1 °C Warming, secure yield of the current headworks would be insufficient to service the expected growth under any irrigation scenario.

As a result of the above, this work is seeking to find a water source that can supply 1,410 ML/y in addition to the supply from Yass Dam (based on unrestricted future development and 1 °C warming, Dry Year Extraction).

2.6 Legislative framework for water access

The growth areas are situated within NSW but close to the border of the ACT. Given this, the primary focus of the legislative framework for surface water supply relates to NSW, but consideration may need to be given to ACT water policy if supply is to be drawn from the Canberra water system.

2.6.1 Murray Darling Basin Plan Murrumbidgee Surface Water Resource Plan (NSW)

To implement the Basin Plan 2012 (Commonwealth), Water Resource Plans are put in place across the Murray-Darling Basin (MDB), which must comply with the requirements of Chapter 10 of the Basin Plan for accreditation under Division 2 of Part 2 of the Commonwealth Water Act 2007. Under the Basin Plan, a draft Surface Water Resource Plan (SWRP) has been prepared for the Murrumbidgee basin (NSW DoI, 2019), which includes the townships of Yass and Murrumbateman.

The primary objectives of the Murrumbidgee SWRP are:

- To set out how NSW will incorporate and apply the long term annual diversion limit for the Sustainable Diversion Limit (SDL) resource unit in the Murrumbidgee SWRP Area (shown in Figure 2-7).
- Manage interception activities with a significant impact on water resources
- Plan for environmental watering
- Define water quality objectives

– Measure and monitor water extraction and water resources
– Define aboriginal values and uses.

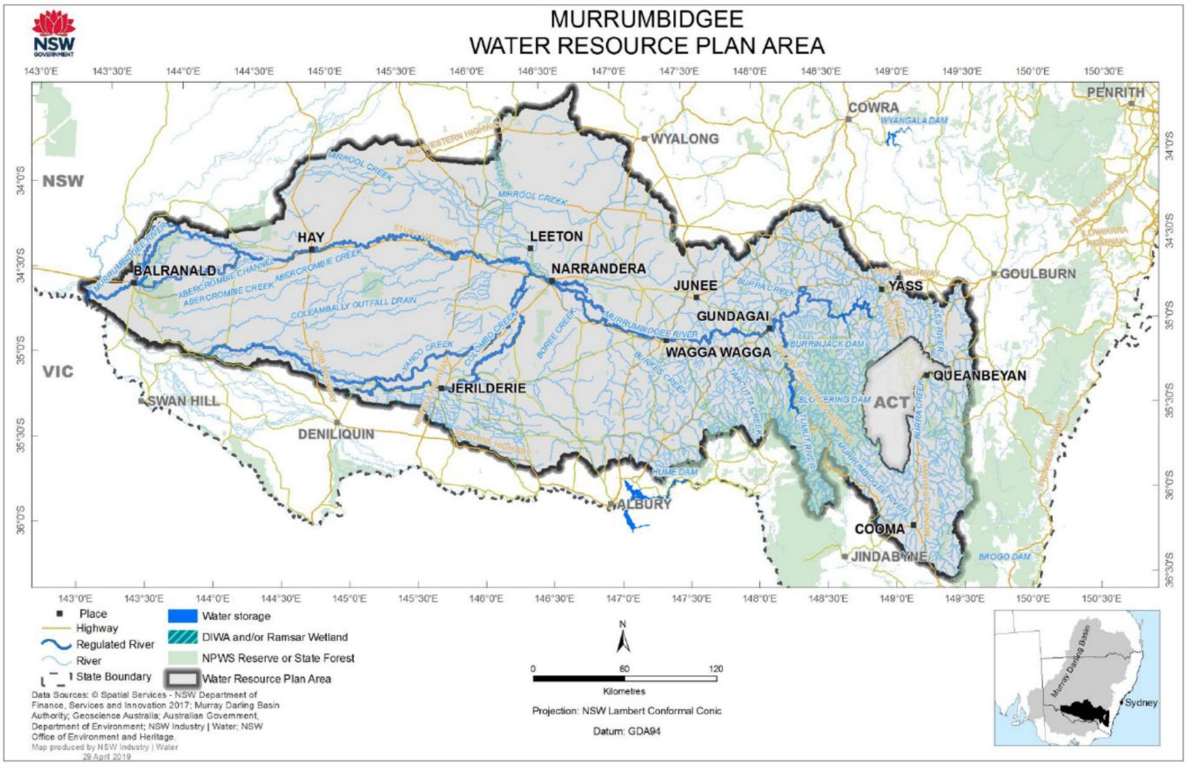


Figure 2-7 Murrumbidgee Surface Water Resource Plan Area (NSW Dept of Industry, 2019)

A key component of the Murrumbidgee SWRP was an assessment of risks to water resources, including:

– insufficient water being available for the environment
– water being of a quality unsuitable for use, and
– poor health of water-dependent ecosystems.

A number of strategies were defined to address the risks, the first being to limit consumptive water extractions in the WRP area to the predefined share of available water.

Another key component of the Murrumbidgee SWRP was an assessment of take for consumptive use, which identified water access rights and other take in the Murrumbidgee SWRP. In the Murrumbidgee unregulated river water sources, local water utility access licences and stock and domestic access licences have a higher priority than unregulated river access licences.

2.6.2 Water Sharing Plan (NSW)

Two Water Sharing Plans sit within the Murrumbidgee SWRP, the *Water Sharing Plan for the Murrumbidgee Regulated River Water Sources 2016*, and the *Water Sharing Plan for the Murrumbidgee Unregulated River Water Sources 2012*. The growth area is located in an upstream part of the Murrumbidgee basin that is not regulated by major storages. As such, water sharing in the region is managed under the *Water Sharing Plan for the Murrumbidgee Unregulated River Water Sources 2012* (NSW Office of Water, 2012, also referred to here as 'The Water Sharing Plan'), as indicated in Figure 2-8.

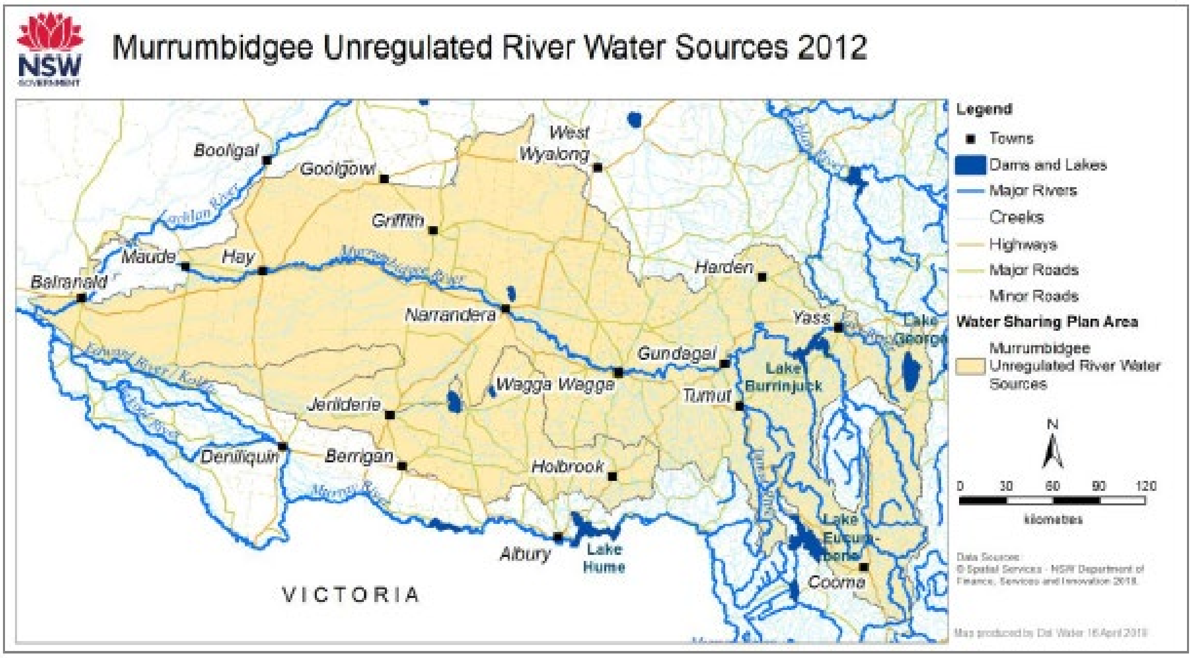


Figure 2-8 Water Sharing Plan Area: Murrumbidgee Unregulated River Water Sources 2012

2.6.3 Water entitlements

Importantly, there are no unallocated water resources in the Murrumbidgee basin, so any water supply for the growth areas would need to be traded from an existing licence. There are four surface water extraction management units in the Murrumbidgee Unregulated Plan which are divided into 39 surface water sources, as well as 6 groundwater sources.

The Water Sharing Plan defines the various water source areas into ‘Extraction Management Units’. The ‘Unregulated Murrumbidgee Above Burrinjuck Dam Extraction Management Unit’ is further sub-divided into water source zones, as shown in Figure 2-9. The growth areas include the Yass Lower zone (Yass township), the Yass Upper zone (Murrumbateman township), and the Murrumbidgee III zone (the northern extent of the Ginninderry development).

The long-term average annual extraction limit for the Mid Murrumbidgee Zone 3 Alluvial Groundwater Source is 30,176 ML/year (Groundwater Sharing Plan).

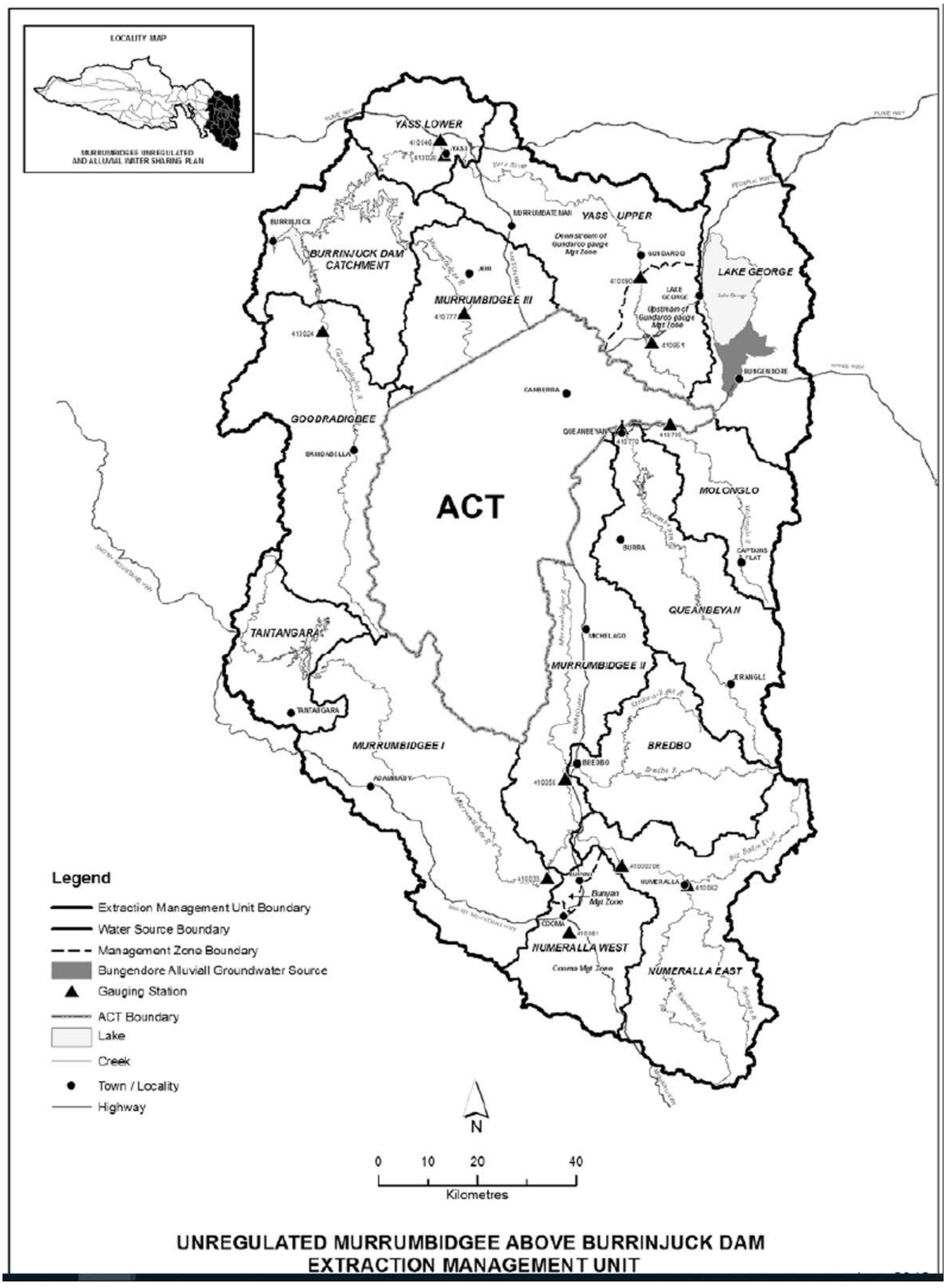


Figure 2-9 Water source zones in Unregulated Murrumbidgee Above Burrinjuck Dam Extraction Management Unit

The share components of access rights and licences in the three noted water source zones are summarised in Table 2.2.

Table 2.2 Water rights and licence allocations in Yass Lower, Yass Upper and Murrumbidgee III zones

Water right/licence	Yass Lower zone	Yass Upper zone	Murrumbidgee III zone
Domestic and stock rights	87 ML/year	338 ML/year	116 ML/year
Domestic and stock access licences	31 ML/year	115 ML/year	45 ML/year
Native title rights	No determination made	No determination made	No determination made
Local water utility access licences	1,700 ML/year	None authorised	None authorised
Unregulated river access licences	427 unit shares	1,651 unit shares	1,881.2 unit shares

2.6.4 Town supply (NSW)

Towns in the upper catchment above Burrinjuck Dam are mostly supplied from storages and direct river extractions. Under the Water Resource Plan, for unregulated river water sources, towns have a higher priority than other users, in that water utilities can access low flows while other users cannot. Towns also have a higher priority for access to water than commercial licences. Water Sharing Plans recognise this priority by ensuring that a full share of water is allocated for annual town water supplies except where exceptional drought conditions prevent this. The annual share for every town water supply will be specified on the town's licence. Towns may be able to sell part of their annual account water to other towns but, unlike commercial users, cannot sell the licence permanently.

Any development of new water storages in the Plan area must be undertaken within the bounds of the Plan. The Plan is not prescriptive in endorsing any option since economic considerations vary over time. Instead, the Plan sets a framework within which development of future water supplies can occur in a sustainable manner.

In unregulated surface water sources, towns will not need to change their existing water access arrangements unless their infrastructure is upgraded. In this case, when a major augmentation of the works occurs, town water utilities will need to meet conditions specified in the Plan to ensure that there is enough water flowing to protect the environment and consider any potential impacts on other consumptive users.

2.6.5 Trading (NSW)

Trading rules for the NSW Murrumbidgee are guided by the following principles:

- Where instream values are considered high, trades are either not permitted or only allowed into high flows.
- Where a water source is under high hydrologic stress no trades are permitted into the water source.
- Trades into downstream water sources are permitted regardless of stress or instream value, if the water sources have a direct hydrologic connection.
- Trades through a regulated river are not permitted, for example a licence cannot be traded from an unregulated water source upstream of the regulated reach to a water source downstream of the regulated reach.
- Trading within water sources is generally permitted, however in some areas trading may be restricted to protect high value areas or to limit demand in areas where competition for water is already high.

As a result of these principles, trades are not permitted into many unregulated water sources across the plan area. High instream value water sources are protected by the Plan by prohibiting trades or limiting trades into only higher volume flows. Trades are allowed into some water sources with lower value to encourage the movement of extraction from high to lower environmental value areas.

Trades between water sources have been permitted in some circumstances where there is a connection but only within individual extraction management units.

3. Assessment Criteria

The assessment criteria will be the basis on which options identified for water supply will be compared. It is important therefore that the developed criteria capture the priorities and align to the requirements of Council and the communities served by this strategy.

3.1 Criteria principles

The aim of this assessment process is to identify options that will form the basis of the future water source strategy. As decisions made now will impact future operations, it is important that the framework for decision making is consistent and defensible.

To this end, the following principles have been applied to the development of these criteria:

– Impact and benefit focused – captures the characteristic impacts of the options being assessed both positively and negatively
– Discrete – avoids double counting on measure
– Discernible – highlights the difference across options, not similarities
– Non-redundant – allows differentiation between decision options (criteria will be eliminated where they do not provide discernment between options)
– Measurable – allows comparison either by quantity or by judgement of Yass Valley Council and other stakeholders
– Universally applied – all criteria are applied consistently across the options.

3.2 Criteria type

Mandatory or minimum performance criteria – these criteria were identified to eliminate any water supply options that would not be feasible. Every option considered must meet these criteria.

Broader objectives – these criteria capture the drivers and priorities for Council and the community.

3.3 Criteria developed

3.3.1 Mandatory criteria

#	Criteria	Definition
1	Availability	Based on the volume, reliability of supply and ability to meet growth scenarios up to a 30-year horizon.

To meet the future water source strategy and projected demand, any option proposed must be able to supply 1,410 ML/year based on the Unrestricted Future Demand and 1 °C warming, Dry Year Extraction presented in the IWCM Issues Paper (PWA, 2021). Any option that cannot meet this supply volume is removed from further consideration.

3.3.2 Broader objective criteria

#	Criteria	Definition
2	Environmental Impact	To consider the environmental and biodiversity benefit and/or impact.
3	Energy use and Emissions	Direct energy use mainly in relation to treatment options and pumping.
4	Flexibility and adaptiveness	Incorporates the agility of the option to be modified to suit the emerging context as measured by two dimensions: Time and Scale.

#	Criteria	Definition
5	Circular Economy Principles	Measure the overall circular economy benefits of the options as a general philosophy that compensates for the ability to be able to quantify them as measured by the three principles: - Design out waste and pollution - Keep products and material in use - Regenerate natural systems
6	Ability to Meet community expectations	Customer expectations, cultural heritage, and community affordability.
7	Minimal Impact on Traditional Owners	Impact on First Nations heritage assets
8	System resilience contribution	Incorporates the contribution the option provides to the overall system resilience including in the light of climate change as measured by the three dimensions which are: - Extreme drought - Major water quality event - Major asset failure
9	Minimise complexity	Complexity of treatment process. With complexity increasing with higher levels of treatment and adoption of simplistic/known technology and comfort of operators with technology.
10	Minimise Regulatory challenges	Complexity and effort required and likelihood of approval.
11	Indicative CAPEX Costs	CAPEX high level comparison estimate (qualitative)
12	Indicative OPEX costs	OPEX high level comparison estimate (qualitative)

3.4 Application of criteria

Screening was undertaken as a preliminary assessment to indicate whether the option rated for each criterion was:

"HIGH" suitable with minimal trade-offs

"MEDIUM" may be suitable, subject to a more detailed assessment

"LOW" where an option is not suitable

A list of the criteria is shown in Table 3.1. The results of the assessment for options are provided in a table under each option.

Table 3.1 Criteria scaling

	Criterion	Low	Medium	High
1	Availability	Water source has low supply volume compared to demand and / or large variability of supply.	Water source can supply a moderate amount of water and / or periodically has issues with reliability.	Water source can meet demand and has no issues with variability of supply.
2	Environmental Impact	Large negative impact on environment	Moderate impact on the environment with some possible benefits	Many positive benefits on the environment
3	Energy use & Emissions	High energy demand with high greenhouse emissions	Moderate energy demand and emissions	Low energy demand and emissions
4	Flexibility and adaptiveness	Inflexible / unlikely to be modified or scaled up quickly	Some flexibility to be modified or scaled up quickly	Flexible and adaptive, can be modified and scaled up quickly

	Criterion	Low	Medium	High
5	Circular Economy Principles	Highly wasteful and degenerates valuable natural systems	Moderately wasteful and unlikely to always regenerate natural systems	Highly efficient and regenerates natural systems
6	Ability to Meet community expectations	Low expectations and likely to face significant pushback from community	Mixed expectations, some pushback likely but can be addressed through effective education and engagement.	High expectations and strong community support.
7	Minimal Impact on Traditional Owners	High impact very likely of important sites and impacts access to ancestral lands.	Moderate impact on important sites likely but can be managed with considerable planning.	Low to minimal impact on Aboriginal cultural heritage.
8	System resilience contribution	Highly dependent on rainfall, susceptible to poor water quality and / or asset failure	Somewhat dependant on rainfall, can be prone to poor water quality and / or asset failure	Independent / detached from rainfall, reliable water quality and low rate of asset failure
9	Minimise complexity	Highly complex systems or processes using complex or unfamiliar technology	Moderately complex systems or processes using some complex / unfamiliar technology	Simple systems or processes using familiar and established technology
10	Minimise Regulatory challenges	Complex/Unlikely to be approved	Some complexity, approval possible but may be difficult	Clear method for approval
11	Indicative CAPEX Costs	Very expensive to construct	Moderately expensive to construct	Low cost to construct
12	Indicative OPEX costs	Very expensive to operate	Moderately to expensive operate	Low cost to operate

4. Water source options

To achieve forecast growth in the Yass Valley LGA, new water supplies will need to be secured as current supply sources will not match future growth figures. This section identifies the long list options with short descriptions of each that could be used within the identified growth areas of Yass and Murrumbateman. These sources were selected based on discussions with Yass Valley Council. No design was undertaken but instead information has been obtained from supplied reports, studies and guidelines available to articulate the option to then allow for comparison between options to determine feasibility.

Within this section we have provided a summary table against the nominated assessment criteria as discussed above (Section 3.4). In these summary tables Y = Yass and M = Murrumbateman development areas.

4.1 Surface water

Surface water options include construction of dams, weirs, upgrading existing dams and construction of off-river storages to add capacity to drinking water systems. More than 80% of Australia's current water supply is sourced from surface water and surface water options currently provide the bulk of Council's water supply.

4.1.1 Off-river storage

Raw water from Yass River or Yass Dam could be pumped to fill an off-river storage dam during periods of high rainfall. Off-river storage dams could also be supplemented with flows from bore water in times of high yield (high precipitation). A large off-stream raw water storage (say, 500 to 3,000 ML) would enable lower flows in the river to be passed and higher flows to be diverted. Finding a suitable location for an off-stream storage and WTP will require careful assessment.

Two examples of off-river storage used in NSW include:

– The Bowraville Off-River Water Storage Project in Nambucca Valley Council on the Northeast coast of NSW is a 4,650 ML off-river storage dam built in 2014. The dam is supplied by a system of bore fields located approximately 1.5km away that feed into the dam via a transfer pump station and pipeline. The project cost $53 million with $10 million coming from the Federal Government, $14.8 million from State Government and $30 million from Nambucca Valley Council.

– Mardi Dam (maximum capacity, 7,400 ML) is an off-river storage dam on the Central Coast and is fed by pumping water from Wyong River and Ourimbah Creek before it reaches the Ocean.

Dams have large upfront costs and consideration would also need to be made for the likely environmental and social impacts on the surrounding land that may be inundated, which in recent years have made dams less popular.

An off-river dam option for Council would require investigation for potential catchments sites with sufficient off-field storage capacity and within sufficient distance to the water source (Yass River/Dam or bore fields) to avoid costly long transfer pipelines. Council has already considered a 500 ML off-river storage during investigations to Yass Dam wall raising. Council opted for the dam wall raising as it provided three times the yield (1,590 ML).

Results from the Yass Dam Second Yield Study (2009) suggested the secure yield of the proposed raised dam was somewhat sensitive to irrigation demand and which flows are used. It found secure yields varied from 1,300 to 1,660 ML/year.

Off-river storage is only a potential option for Yass. Murrumbateman can then be supplied from this option, much like the current situation.

Type of solution		Surface Water – Off-River Storage		
	Description	Further expansion of Yass dam through off-river storage.		
#	Criteria		Suitability	Comment
1	Availability	Y	Medium	Land availability for an off-stream storage is limited. More severe and longer lasting droughts due to climate change makes this option less reliable. A 500 ML off-stream dam (as was looked at previously) does not provide significant storage capacity. Required storage would be over 1,000 ML and this would have too large a footprint to be viable.
		M	Medium	It is proposed that the Off-river storage would be constructed at Yass and the existing pipeline between Yass and Murrumbateman used for supply.
2	Environmental Impact	Y	Low	Large footprint of storage area impacts landscape.
		M	Low	Utilise existing pipeline for supply.
3	Energy use & Emissions	Y	Medium	Pump to Yass WTP as per now from Yass Dam and utilise pipeline to transfer to Murrumbateman.
		M	Medium	
4	Flexibility and adaptiveness	Y	Low	Structure would be sized at construction with limited ability to alter in future.
		M	Low	
5	Circular Economy Principles	Y	Medium	Implementing additional capacity for cascading water use. Retains water that otherwise directly flows into Burrinjuck with less energy requirements for pumping. Potential impact on environmental flow and evaporation loss
		M	Low	Currently no treatment infrastructure at scale, smaller catchment with challenge to collect sufficient amounts. Connected via Murrumbateman Creek to Yass River to feed into Yass storage
6	Ability to meet community expectations	Y	Medium	Supply quality would be equivalent to current but loss of land use impacts.
		M	Medium	
7	Minimal Impact on Traditional Owners	Y	Medium	Higher likelihood on impact due to size of infrastructure.
		M	Medium	
8	System resilience contribution	Y	Low	Reliance on surface water and capture of high flows.
		M	Low	
9	Minimise complexity	Y	High	Dams and pumped pipeline are common infrastructure.
		M	High	
10	Minimise Regulatory challenges	Y	High	Utilise existing WAL 1,700 ML/year.
		M	High	
11	Indicative CAPEX Costs	Y	High	In the order of $6 million plus.
		M	High	
12	Indicative OPEX costs	Y	High	Like existing arrangement.
		M	High	

4.1.2 Lake Burrinjuck

Approximately 30 km Southwest of Yass Dam is Lake Burrinjuck with a 1,026 GL capacity. Lake Burrinjuck is predominantly used for agricultural irrigation and supplies water to a small number of rural dwellings, however other than these there are no other significant withdrawals. Lake Burrinjuck is a significant potential water source for Yass, however, the distance and cost for pumping water is likely to be significant.

The 2007 Council IWCM report by JWP cites an assessment in the Yass Water Supply Emergency Drought Strategy (Department of Commerce) which considered a pipeline connection to Murrumbidgee River through bore extraction at the Burrinjuck Dam above the full supply level. Water would be lifted by submersible pumps to a settling tank and transported by the raw water pump station to a balance tank to gravitate to Yass WTP. The option considered three volumetric scenarios:

1. 2 ML/day via DN200 at $5.43 m (2007) – approx. $7.3 m today, $1.66 m operating cost over 20 years
2. 4 ML/day via DN200 at $6.06 m (2007) – approx. $8.2 m today, $2.45 m operating cost over 20 years
3. 10 ML/day via DN200 at $9.14 m (2007) – approx. $12.3 m today, $2.95 m operating cost over 20 years

To achieve water demand to 2051, scenario 2 would be the minimum requirement.

The other options mentioned in the 2008 Council IWCM report included:

- Pipeline connection to Goldenfields Water with a proposed route from Jugiong via trunk mains at Galong. Initial discussions between Council and Goldenfields Water back then indicated only a limited supply is possible.
- Pipeline connection to Murrumbidgee River at Childowla via the Hume Highway.
- Pipeline connection to Murrumbidgee River at Childowla via Black Range Road.

Type of solution			Surface Water – Lake Burrinjuck	
Description			Pipeline from Lake Burrinjuck to Yass then on to ACT via Hall.	
#	Criteria		Suitability	Comment
1	Availability	Y	High	Lake Burrinjuck has a capacity of 1,026 GL and only irrigation and small rural supply demands.
		M	High	
2	Environmental Impact	Y	Medium	Pipeline construction
		M	High	Utilise existing pipeline
3	Energy use & Emissions	Y	Medium	Pumped supply from Lake Burrinjuck and treatment at Yass WTP
		M	Medium	Same as existing
4	Flexibility and adaptiveness	Y	Medium	Pipeline sized at design/construction. Potential for duplication but no significant adaption available. Pump sizing could be made flexible.
		M	Medium	
5	Circular Economy Principles	Y	Low	Using existing storage but no infrastructure. Large percentage of water will be returned to storage after use. At this stage lack of renewable energy to pump water back to Yass WTP.
		M	Low	Return flow to Burrinjuck diverted due to sewage treatment in Murrumbateman. But options to regenerate natural system through recycled water and return flow via Murrumbateman Creek
6	Ability to Meet community expectations	Y	High	Supply quality would be equivalent to current with additional pipelines Community concerns raised during Yass Water Supply Emergency Drought Strategy (Department of Commerce) over water quality – Council advice on this sought.
		M	High	
7	Minimal Impact on Traditional Owners	Y	Low	Additional pumping and pipeline required.
		M	Medium	No change from current.
8	System resilience contribution	Y	Low	Reliant on surface water supplies as per current.
		M	Low	
9	Minimise complexity	Y	High	Pumped pipeline is common infrastructure.
		M	High	
10	Minimise Regulatory challenges	Y	High	Approval of licence water take but similar to existing arrangement
		M	High	
11		Y	High	In the order of $8 million plus.

	Indicative CAPEX Costs	M	High	
12	Indicative OPEX costs	Y	Medium	Like current with higher pumping costs
		M	High	

4.1.3 Cross border supply from ACT

The option for a cross border pipeline tapping into Icon Water's supply has been extensively investigated in previous studies and discussed between Council and Icon Water, with Icon Water supportive of the scheme. Icon Water has a well-connected network with significant capacity for future demand which could easily sustain Council's growth demands well into the foreseeable future. Such a scheme would see Icon Water Billing Council for bulk supply and Council responsible for managing the pipeline.

Noting that a pipeline between Murrumbateman and Yass water supply was recently completed, future options would include extending the pipeline from Murrumbateman village to the ACT, likely connecting to Icon Water's system east of Canberra in the vicinity of Gungahlin.

Several likely possible corridors for the pipeline route have already been investigated and include a combination of the existing electrical transmission easement and Barton Highway, the Barton Highway (currently undergoing duplication) and a route following rural roads connected with Dog Trap Road, with the most preferred option at this stage being a combination of the Electrical Transmission easement and Barton Highway (refer Figure 4-1).

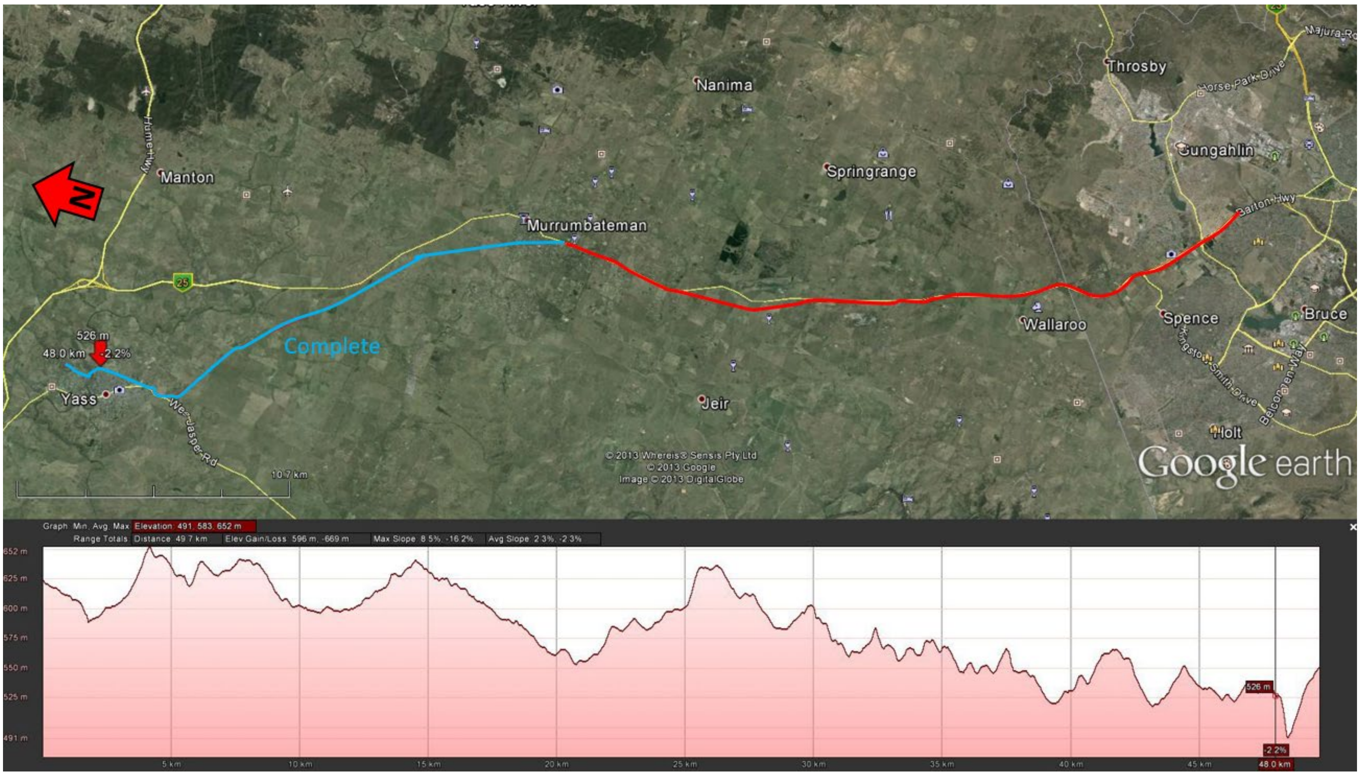


Figure 4-1 Indicative pipeline route

Type of solution			Surface Water – Cross border pipeline with ACT	
Description			Pipeline from ACT to Yass via Murrumbateman and Hall.	
#	Criteria		Suitability	Comment
1	Availability	Y	High	Icon Water has excess capacity to supply development. Water access licencing would need to be reviewed.
		M		
2		Y	High	Pipeline already constructed. Re-chlorination may be required.

	Environmental Impact	M	Medium	Pipeline corridor required between ACT and Murrumbateman.
3	Energy use & Emissions	Y	High	Gravity feed possible between Murrumbateman and Yass
		M	High	Gravity Feed from ACT via Hall.
4	Flexibility and adaptiveness	Y	Medium	Pipeline sized at design/construction. Potential for duplication but no significant adaption available.
		M	Medium	
5	Circular Economy Principles	Y	High	No/low level of additional drinking water treatment required; gravity fed – low energy use. Treated return flow to Murrumbidgee (i.e. Burrinjuck)
		M	High	No/low level of additional drinking water treatment required; gravity fed – low energy use, low evaporative loss. Treated return flow through Murrumbateman Creek and Yass River to Murrumbidgee?
6	Ability to Meet community expectations	Y	High	Like current supply arrangements
		M	High	
7	Minimal Impact on Traditional Owners	Y	High	No change from present
		M	Medium	Pipeline construction corridor between Gungahlin and Murrumbateman
8	System resilience contribution	Y	High	Reliance on surface water source, however the ACT has diversity of supply across their networks and across multiple catchment areas.
		M	High	
9	Minimise complexity	Y	High	No change from current
		M	High	Pipeline connection is common infrastructure
10	Minimise Regulatory challenges	Y	Low	Negotiation and cooperation with Icon Water will be required, Icon Water open to the idea. Agreement required under the Googong Dam Act. Water pricing issues will need to be considered.
		M	Low	
11	Indicative CAPEX Costs	Y	High	No construction required.
		M	Medium	High upfront costs for new pipeline ($18m, ActewAGL Water Division, 2006) – Approx. $14m when only looking at ACT to Murrumbateman connection and adjustments due to inflation.
12	Indicative OPEX costs	Y	High	Re-chlorination and cost of bulk water will also need to be considered
		M	High	

4.2 Groundwater

Groundwater is a major source of water for urban and rural communities via bores, spear-points and wells. Groundwater's potential for use is dependent on aquifer productivity and water quality. Licensed groundwater extraction is typically used for agriculture, industrial, mining and commercial uses.

The Yass Catchment Groundwater Source covers an area of 195,000 hectares. It is dominated by fractured rock aquifers on Cambrian metasedimentary, Silurian volcanic and Silurian to Devonian sedimentary rocks of the Lachlan Fold Belt. Shallow unconsolidated sediments occur along the major drainage lines including the Yass and Murrumbidgee Rivers. The eastern margin of the catchment is defined by the Lake George Fault, which has an impressive topographic expression and has been associated with Tertiary faulting and is associated with the development of Lake George (NSW Office of Water, 2012).

Groundwater harvesting can have relatively low environmental impacts provided it is carefully managed and sustainable extraction is less than the annual recharge rate. Groundwater options generally require more energy than surface water options due to the need to lift the water from its source and in some cases infrastructure to transfer the water over long distances for treatment. Groundwater may be used to compliment surface water supplies and support town water source resilience by diversifying existing water supply options.

Local water utility extractions for town water supplies account for a small proportion of total entitlements within the catchment with Yass Catchment entitlement consisting of 279 ML/year (slightly higher than stated in the Yass

Valley Council IWCM Draft Issues Paper (PWA, June 2021)), as shown in Figure 4-2 and Figure 4-3. The long term annual average extraction limit (LTAAEL) is shown in Figure 4-4.

Groundwater Source	Estimated requirements (ML/year)
Adelaide Fold Belt MDB	2,143
Inverell Basalt	1,073
Kanmantoo Fold Belt MDB	8,154
Lachlan Fold Belt MDB	74,311
Liverpool Ranges Basalt MDB	1,828
New England Fold Belt MDB	14,520
Orange Basalt	1,158
Warrumbungle Basalt	540
Yass Catchment	1,153
Young Granite	759
Total	**105,639**

Figure 4-2 Total Estimated requirements of domestic & stock rights of each groundwater source. Source: NSW Office of Water, 2012

Groundwater Source	Entitlement (ML/year)
Adelaide Fold Belt MDB	0
Inverell Basalt	56
Kanmantoo Fold Belt MDB	0
Lachlan Fold Belt MDB	5,101
Liverpool Ranges Basalt MDB	0
New England Fold Belt MDB	667
Orange Basalt	160
Warrumbungle Basalt	0
Yass Catchment	279
Young Granite	38
Total	**6,301**

Figure 4-3 Licensed town water supplies from groundwater for each groundwater sources. Source: NSW Office of Water 2012

Water source	High environmental value areas Average annual rainfall recharge (ML/yr)	% of average annual rainfall recharge from high environmental value areas made available for possible extraction	Non-high environmental value areas Average annual rainfall recharge (ML/yr)	Sustainability factor (% of average annual rainfall recharge non-high environmental value areas made available for possible extraction)	LTAAEL (ML/year)
Fold Belt MDB					
Orange Basalt	715.01	0%	32,415.01	50%	16,207.50
Warrumbungle Basalt	5,788.69	0%	22,841.17	25%	5,710.29
Yass Catchment	587,36	0%	52,326.45	50%	26,163.23
Young Granite	4.79	0%	19,057.58	50%	9,528.79
Total	**269,625.45**		**4,706,802.03**		**1,337,392.93**

Figure 4-4 Long-term average annual extraction limit (LTAAEL) for the MDB Fractured Rock Groundwater Sources. Sources: NSW Office of Water, 2012

There are three bores at Murrumbateman tapping into fractured rock aquifers below. The highest extraction was 51.4 ML/year in 2019/20 and the licence limit is 56 ML/year. It is understood these bores are at capacity and suffer variable water quality. There is an embargo on issuing of new groundwater licences for the Yass Valley Groundwater Catchment due to over extraction and groundwater quality in Murrumbateman is poor in relation to nitrates, hardness and total dissolved salts. (YVC, 2008 and YVC, 2019).

Based on current information collated so far, there is potential to provide a supplemental water source, however, there is uncertainty around licencing.

Type of solution			Groundwater	
Description			Includes associated infrastructure to treat and transport the water.	
#	Criteria		Suitability	Comment
1	Availability	Y	High	High potential yield (Approximately 26,000 ML/year) however current embargo due to over extraction in certain areas and poor water quality.
		M	High	
2	Environmental Impact	Y	Medium	Can have low impact if properly managed to maintain a yield below the annual recharge rate.
		M	Medium	
3	Energy use & Emissions	Y	Medium	Potential for higher energy use depending on distance pumps, location of wells and topography. Generally, require more energy than surface water options.
		M	Medium	
4	Flexibility and adaptiveness	Y	High	Infrastructure sized at design/construction. Pump sizing could be made flexible. Additional bore sites added to increase capacity.
		M	High	
5	Circular Economy Principles	Y	Low	Groundwater availability low, lack of knowledge of system knowledge (groundwater-surface water interaction and potential impact on natural systems)
		M	Low	Groundwater availability would only allow for supplementary use, lack of knowledge for aquifer recharge
6	Ability to Meet community expectations	Y	High	Can be achieve with good community consultation
		M	Medium	Similar to current arrangements.
7	Minimal Impact on Traditional Owners	Y	Medium	Construction of bore fields and pipeline corridor has the potential to impact
		M	Medium	
8	System resilience contribution	Y	Low	Connected to surface water and dependent on rainfall and therefore is not climate resilient. Deep aquifers more resilient to rainfall changes but refilling can take years.
		M	Medium	
9	Minimise complexity	Y	Low	Construction of groundwater extraction scheme
		M	Low	
10	Minimise Regulatory challenges	Y	Low	Complicated by need to obtain licence for extraction and no licence volumes available.
		M	Low	
11	Indicative CAPEX Costs	Y	High	Cost to construct reasonable.
		M	High	
12	Indicative OPEX costs	Y	High	Cost to operate reasonable.
		M	High	

4.3 Recycled water

4.3.1 Non-Potable

Reclaimed wastewater treated to non-potable levels and used in non-potable applications such as irrigation, industrial uses and via ‘purple pipe’ systems. The regulatory process for non-potable use is clear unlike for potable use, which is significantly more difficult.

The township of Googong in the inland area of Queanbeyan, south west of Canberra is currently being developed and includes a system to reduce potable water consumption by up to 60% and recycle over half its Wastewater with the construction of a new $133m treatment system. Recycled water is now supplied to its current residents through it’s ‘purple pipe’ network. To date Googong is a town of over 2,000 people and preliminary flow monitoring suggests the town with a proposed population of 18,000 is on its way to achieving 60% water efficiency – equivalent to a normal town of 6,500.

Installing a new 'purple pipe' system into an existing development would pose significant challenges and would require extensive upgrades to the existing treatment plants at Yass and Murrumbateman.

Yass STP currently discharges into a creek that flows into Yass River downstream of the dam.

Murrumbateman Sewage Treatment Plant was constructed in 2016 and currently utilises a 70 ML storage pond for treated effluent servicing three irrigation areas onsite locally around the STP.

With the new development of Parkwood and its vicinity to ACT, connection to ACT's existing sewer system would likely be the most logical solution which would then be treated at LMWQCC and discharged into the Molonglo River or recycled on-site and used for cooling, scrubbing and irrigation off-site to a local golf course. Alternatively, a recycled water plant similar to that constructed at Googong could service this development but would require the development of a similar treatment system to Googong in the order of $133m. This is unrealistic with the existing treatment plant in such close proximity. This is therefore not considered an option for Parkwood.

Type of solution			Recycled – Non-potable	
Description			Reclaimed wastewater treated to non-potable levels and used in non-potable applications	
#	Criteria		Suitability	Comment
1	Availability	Y	Low	Individual recycled water plant at each growth area site yield is based on recycling water from each growth area for that growth area. If we take a best-case scenario at 40% reduction in water consumption, it would equate to approx. 690 ML/year for baseline growth and 760 ML/year for high growth (Both at Dry year extraction) by 2051.
		M	Low	
2	Environmental Impact	Y	High	New treatment plant required
		M	High	
3	Energy use & Emissions	Y	Low	Treatment plant high energy use and emissions
		M	Low	
4	Flexibility and adaptiveness	Y	High	Modular design can provide flexibility into future.
		M	High	
5	Circular Economy Principles	Y	High	Direct recycling of water for non-potable use.
		M	High	
6	Ability to Meet community expectations	Y	Low	Substantial education required around non-potable use.
		M	Low	
7	Minimal Impact on Traditional Owners	Y	Medium	Site considerations.
		M	Medium	
8	System resilience contribution	Y	High	Source is recycled water so not as impacted by climate change as surface water options.
		M	High	
9	Minimise complexity	Y	Low	More complex to operate than current plants.
		M	Low	
10	Minimise Regulatory challenges	Y	High	The regulatory process for non-potable use is clear
		M	High	
11	Indicative CAPEX Costs	Y	Low	High capital cost plant to build.
		M	Low	
12	Indicative OPEX costs	Y	Low	High capital cost plant to operate.
		M	Low	

4.3.2 Purified Recycled Water

Reclamation of wastewater into potable drinking water is known as purified recycled water (PRW). PRW can be introduced for direct potable reuse (DPR), where reclaimed water is introduced directly into the potable distribution network, or indirect potable reuse (IPR) where reclaimed wastewater is introduced into the natural watershed (e.g. groundwater or dam) for subsequent withdrawal and treatment to potable standards. The regulatory process for direct potable reuse is significantly difficult and the costs are similar to desalination (WSAA, 2020). Councils pursuing this option may encounter pushback from the community due to the 'yuck' factor, however, through open and transparent engagement this can be overcome over time.

In South East Queensland, one of the world's largest potable reuse scheme has been constructed to augment surface water supplies for the area, including Brisbane. Treated wastewater is collected from six WWTPs and delivered to three Advanced Wastewater Treatment Plants (AWWTPs) Bundamba (60 ML/day), Luggage Point (70 ML/day) and Gibson Island (100 ML/day) producing a total of 230 ML/day. Currently, however, the potable schemes have sat unused since the end of the 2008 drought and will continue to do so as long as South East Queensland Water storages remain above 40%. Water for non-potable reuse has continued to be produced for industrial use.

Type of solution			Recycled – Potable	
Description			Reclamation of wastewater into potable drinking water known as Purified Recycled Water	
#	Criteria		Suitability	Comment
1	Availability	Y	Low	Individual recycled water plant at each growth area site yield is based on recycling water from each growth area for that growth area. A potable reuse scheme could potentially have the capacity to augment future supply demands as the amount of effluent available for reuse would increase with population.
		M	Low	
2	Environmental Impact	Y	High	New treatment plant required, however significantly reduced reliance on surface water sources.
		M	High	
3	Energy use & Emissions	Y	Low	Treatment plant high energy use and emissions
		M	Low	
4	Flexibility and adaptiveness	Y	High	Modular design can provide flexibility into future.
		M	High	
5	Circular Economy Principles	Y	High	Recycling of water embraces circular economy principles balanced with renewable energy use.
		M	High	
6	Ability to Meet community expectations	Y	Medium	May encounter pushback from the community due to the 'yuck' factor and may take a number of years
		M	Medium	
7	Minimal Impact on Traditional Owners	Y	High	Site considerations.
		M	High	
8	System resilience contribution	Y	High	Source is recycled water so not as impacted as surface water.
		M	High	
9	Minimise complexity	Y	Low	More complex to operate than current plants.
		M	Low	
10	Minimise Regulatory challenges	Y	Low	Regulatory challenges depending on direct or indirect.
		M	Low	
11	Indicative CAPEX Costs	Y	Medium	High capital cost plant to build.
		M	Medium	
12		Y	Low	High cost plant to operate.

	Indicative OPEX costs	M	Low	

4.4 Alternate Water Sources

4.4.1 Rainwater Tanks

Opportunities exist for harvesting/maximising rainwater using rainwater tanks installed at individual dwellings and larger buildings such as community halls, schools and commercial premises. Rainwater can be used for non-potable applications including toilet flushing, washing machines and garden irrigation, contributing to significant reticulated water savings and alleviate stress on primary water sources.

A simple spreadsheet model prepared by JWP in their IWCM report for Council in 2008 showed for roof sizes of 150 m^2, up to 45% of total outdoor and toilet flushing water needs (currently supplied from reticulation) could be supplied by a 5,000 L rainwater tank, resulting in 52 kL/y of stormwater prevented from flowing from each dwelling.

An estimate for Canberra shows that for a 150 m^2 roof and a house of three occupants, a 10 kL rainwater tank can save 82 kL per year (The Department of Health, 2020).

Yass Valley Council's *Water Supply for Rural Areas & Villages* Policy dictates a minimum tank size of 45,000 L for a roof size of 150 m^2 without reticulated bore water supply. This policy also notes that if bore water supply is available this tank size can reduce to 22,500 L.

Rainwater tanks have their limitations and are reliant on regular rainfall. Roof sizes also have an impact on tank sizes. During droughts rainwater tanks can sit empty for long periods of time making them a redundant water source when needed most. Other issues include maintenance requirements with upkeep largely resting on the individual owners (i.e. not replacing pump when it breaks then permanently switching to potable).

There are no licence requirements for installation for private use, however, tanks are required to be installed according to relevant codes, i.e. BASIX.

Rainwater tanks are a reliable and robust technology. They are widely used for non-potable residential demand.

Type of solution			Rainwater Tanks	
Description			Collection and storage of rainwater tanks at individual dwellings for non-potable reuse.	
#	Criteria		Suitability	Comment
1	Availability	Y	Medium	Dependant on rainfall with potential for fluctuations in supply.
		M	Medium	
2	Environmental Impact	Y	Medium	Positive effect on environment.
		M	Medium	
3	Energy use & Emissions	Y	Medium	Requires small pumps and minimal simple filtration treatment (non-potable).
		M	Medium	
4	Flexibility and adaptiveness	Y	High	Suitable for individual property needs
		M	High	
5	Circular Economy Principles	Y	Medium	Support cascading water use before release into catchment after treatment, evaporation is restricted. Requires infrastructure, materials, space
		M	Medium	Support cascading water use before release into catchment after treatment, evaporation is restricted. Requires infrastructure, materials, space
6	Ability to Meet community expectations	Y	Low	Community likely to support non-potable scheme only.
		M	Low	
7	Minimal Impact on Traditional Owners	Y	High	None as they are installed at the property.
		M	High	

8	System resilience contribution	Y	Low	Highly dependent on rainfall and therefore is not climate resilient.
		M	Low	
9	Minimise complexity	Y	Low	Non-potable schemes are commonplace these days and fairly self-sufficient. Issue lies with management and operation reliant on individual owners for upkeep.
		M	Low	
10	Minimise Regulatory challenges	Y	High	Clear process in place. BASIX encourages the use of rainwater tanks.
		M	High	
11	Indicative CAPEX Costs	Y	Low	Capital costs are moderate and are paid by the landholder. However overall, this requires installation at each property. An advantage of rainwater tanks is they can be installed as development progresses.
		M	Low	
12	Indicative OPEX costs	Y	Low	Rainwater tanks are a mature, well understood technology. However, on a lot-scale, supply and quality are dependent on the homeowner and on a community scale, CAPEX and OPEX would be high.
		M	Low	

4.4.2 Stormwater Harvesting

Stormwater is runoff from urban areas that has not infiltrated into the ground or entered a waterway. It differs from rainwater harvesting as runoff is collected from drains or creeks rather than roofs. Storage can be held on-line (constructed on a creek or drain - in the form of dams or weirs) or off-line (constructed some distance from a creek or drain, for example stored in tanks). Due to their nature, urban areas generate a lot more run-off compared to the equivalent natural state (before vegetation was cleared). This additional stormwater is known as ‘urban excess’ which can be seen as available for harvesting.

Stormwater harvesting is dependent on rainfall and catchment characteristics and are licenced in a similar way to wastewater treatment; Section 60 Approval from the DPIE if the scheme is developed by Council or Section 68 approval from Council for a private scheme.

Harvested stormwater is typically treated as non-potable and used in non-potable applications including irrigation of public parks, sport grounds and gardens, industrial wash applications such as car parks, dust suppression, concrete batching etc. Stormwater harvesting also has added benefits in reducing impact of urban development on water quality and river systems. Further treatment options in a stormwater harvesting scheme for domestic uses for hot water or a ‘third pipe’ to residential dwellings will require development of appropriate water quality monitoring and control measures and approval from relevant health authorities.

Orange City Council (population approximately 40,300) has an award-winning storm water harvesting system which can supply up to 1,300 ML of additional water (25% of the cities’ total water needs) into Orange’s raw water supply dam each year, all from the city’s stormwater system. During the millennial drought it was observed that despite periodic rainfall events, the catchments feeding the dams did not generate enough flow to raise levels, while urban catchments would feed into the river systems below the dams. The scheme consists of two catchments, Blackmans Swamp Creek (34 km^2) and Ploughman’s Creek (23 km^2) harvesting schemes. The infrastructure required included several dams, pump stations, constructed swamps and harvesting weirs costing approximately $9.1 million.

4.4.2.1 Yass

Yass Valley LGA has a drainage network that services urban areas consisting of kerb and guttering, pipes, surface flows, grass swales and natural drainage lines which currently discharges into the natural watercourses of Chinamans Creek, O’Briens Creek and the Yass River downstream of Yass Dam. A quick desktop catchment assessment of the Yass urban centre reveals up to 4km^2 of stormwater catchment yield potential however unlike Orange the catchment opportunities for Yass do not appear to be as favourable as the catchment is more fragmented and constrained by the Yass River (refer Figure 4-5).

Using the yield figures from Orange and considering average annual rainfall for Yass is less than Orange, the maximum potential yield for a stormwater harvesting scheme at Yass would supply an approximate maximum of around 66 ML/year.

Figure 4-5 Topographic map of Yass. Source: topographic-map.com

4.4.2.2 Murrumbateman

Murrumbateman has a smaller stormwater drainage system that drains into Murrumbateman Creek which is a tributary of Yass River and upstream of Yass Dam. Efforts to harvest stormwater in Murrumbateman is unlikely to be seen as viable given the stormwater already feeds indirectly into the water supply of Yass Dam.

Type of solution			Stormwater Harvesting	
Description			Collection, storage, treatment and re-use of stormwater for non-potable use.	
#	Criteria		Suitability	Comment
1	Availability	Y	Medium	Limited data on catchment but initial desktop studies suggest Yass storm water catchment is relatively small and fractured with a harvesting potential of approximately 66 ML/year.
		M	Medium	Catchment already part of wider Yass Dam catchment.
2	Environmental Impact	Y	Medium	Positive effect on environment in managing impact of excess urban flows.
		M	Medium	
3	Energy use & Emissions	Y	Medium	Requires pumps and minimal treatment (non-potable).
		M	Medium	
4	Flexibility and adaptiveness	Y	Medium	Each site has some ability to modify after commencement
		M	Medium	
5		Y	High	Applies. Underlines cascading water for reuse or recycling as well as redirecting for environmental use. In Murrumbateman this includes

	Circular Economy Principles	M	High	harvesting and feeding back into Yass River via Murrumbateman Creek. Treatment requirements (energy/material use) to be discussed.
6	Ability to Meet community expectations	Y	Medium	Community likely to support non-potable scheme.
		M	Medium	Murrumbateman's existing stormwater runoff drains into Yass River catchment which flows into Yass Dam
7	Minimal Impact on Traditional Owners	Y	High	Unlikely to impact if developed along with development areas.
		M	High	
8	System resilience contribution	Y	Low	Totally reliant on rainfall.
		M	Low	
9	Minimise complexity	Y	Low	Non-potable schemes are common and familiar but would need to be developed across a large scale to meet these requirements
		M	Low	
10	Minimise Regulatory challenges	Y	High	Clear process in place.
		M	High	
11	Indicative CAPEX Costs	Y	Low	Capital costs are moderate to high. Potential significant capital associated with construction of weirs, ponds, pump stations and pre-treatment. Particularly if multiple catchments.
		M	Low	
12	Indicative OPEX costs	Y	Low	Maintenance requirements around additional infrastructure. $1.3 - $33 per kL (WSAA)
		M	Low	

4.4.3 Managed Aquifer Recharge (MAR)

Managed aquifer recharge is the process of adding stormwater, river, or recycled water to aquifers under controlled conditions for withdrawal later. Water typically needs to be treated to remove solids to prevent clogging before injection/infiltration and ground conditions near urban areas need to be assessed for suitability.

Managed Aquifer Recharge is currently used in Perth's Beenyup Advanced Water Recycling Plant (refer Figure 4-6), recharging up to 14 GL/year into two aquifers where it is expected to reach the first abstraction bores in ten to twenty years (WSAA, 2021).

Figure 4-6 Perth's Beenyup Advanced Water Recycling Plant. Source: Water Corporation

MAR does come with challenges including capacity for available water for diversion, diverted water quality and existing groundwater quality need to be compatible, a suitable aquifer is required with enough storage and any environmental impacts need to be understood. MAR is an uncommon technology in Australia however is being successfully used in Beenyup, Perth and Alice Springs, NT.

Type of solution			Managed Aquifer Recharge (MAR)	
Description			Injection / infiltration of stormwater, river, or recycled water to aquifers under controlled conditions for withdrawal later.	
#	Criteria		Suitability	Comment
1	Availability	Y	Low	Further investigation would be required for this option.
		M	Low	
2	Environmental Impact	Y	Medium	Minimal impact on environment. Positive effect of contributing to recharging of groundwater.
		M	Medium	
3	Energy use & Emissions	Y	Low	Requires new infrastructure or upgrade of existing infrastructure which have higher energy requirements.
		M	Low	
4	Flexibility and adaptiveness	Y	Medium	Injection and extraction rates can be used to manage volumes.
		M	Medium	
5	Circular Economy Principles	Y	High	Replenishment of groundwater for reuse but challenges might apply regarding required level of treatment and related energy use and emissions. Renewable energy source needed.
		M	High	
6	Ability to Meet community expectations	Y	Medium	Community support can be a particular challenge due to “Yuck” factor. Council may need to build trust.
		M	Medium	
7	Minimal Impact on Traditional Owners	Y	Low	Possible with infrastructure such as pipelines, treatment facilities and recharge sites.
		M	Low	
8	System resilience contribution	Y	High	Ability to build a buffer for use during overabundance of water but depending on treatment needs
		M	High	
9	Minimise complexity	Y	Medium	New systems and technology that is not widely used.
		M	Medium	
10	Minimise Regulatory challenges	Y	Medium	New licence agreements required for increase in water entitlements.
		M	Medium	
11	Indicative CAPEX Costs	Y	Low	Capital costs for pump stations, filtering and treatment system, pipelines and bore fields.
		M	Low	
12	Indicative OPEX costs	Y	Low	Maintenance requirements around additional infrastructure. $0.9 - $6.0 per kL, Median $2.34 per kL (WSAA)
		M	Low	

4.4.4 Water Carting

Includes carting small volumes of water to areas in short supply within a catchment or between catchments and usually utilised as a short-term option, typically during extreme drought where no other option is possible. Water carting options include delivery of treated water directly to a town’s reservoir or raw water to a local dam or weir for local treatment and distribution. Typically, viability for water carting will need to consider size of the community, distance, impacts on community and financial costs.

The table below sourced from the Department of Regional Development, Manufacturing and Water QLD, provides a range of scenarios that might be considered physically viable, based on the assumption that all the issues described above can be met.

Connected population	Demand*		Distance to supply (km)	Tanker volume (kL)	Number of tankers	Operating time (hrs/d/tanker)
	(L/p/d)	(ML/month)				
500	200	3	100	10	2	15
2000	150	9	150	30	5	12
4000	165	20	150	30	8	14
5000	200	30	100	30	7	16
10 000	140	42	50	30	6	16

Notes: * Raw or treated volume

Figure 4-7 ***Scenarios for understanding water carting options.***
Source: Department of Regional Development, Manufacturing and Water, QLD

Water carting can supply small volumes of water and usually a short-term 'last resort' option. As such it is not considered suitable as a water source strategy for the Yass Valley and hasn't been considered further.

4.4.5 Atmospheric Water Generation (AWG)

Atmospheric Water Generation (AWG) also known as air water harvesting, extracts water vapour directly from the atmosphere using condensation of cooling surfaces, desiccant capture or gas separating using membrane technologies. Extraction rates are dependent on climate conditions of the area.

AWGAustralia is an example of an Australian producer that makes units that are capable of up to 10,000 L a day, however the units consume significant amounts of energy.

Rainmaker, based in Canada and Netherlands, produce a modular and portable wind powered turbine and atmospheric generator-in-one where the wind turbine drives a ventilation system, with claims up to 20 kL water generation per day.

There are no known large-scale examples in Australia and current potential for economies of scale appear limited. As such this option is not suitable and is not considered further.

4.5 Levelised costs

A major decision-making factor in typical business cases is the potential cost to build and operate the system. In its report, *Urban Water Supply Options for Australia 2020*, WSAA provides a chart summarising the indicative costs for each option (Figure 4-8).

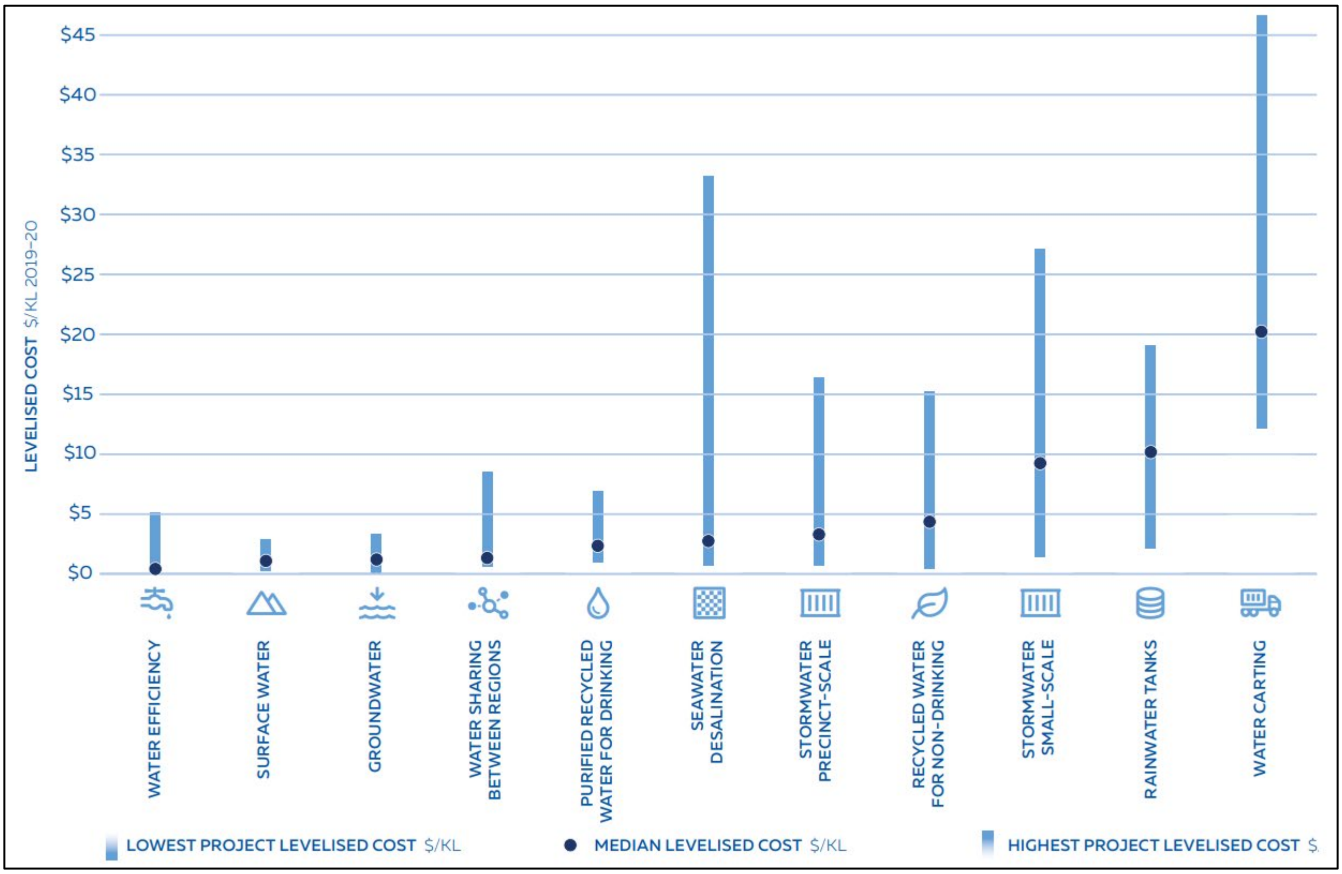


Figure 4-8 *Indicative costs of water supply options (All Options on the Table, WSAA 2020)*

While capital and operating costs continue to be a major contributing factor in decision making today, the value and benefits/impacts on other aspects of supply are becoming increasingly more important.

4.6 Efficiency & Conservation

The following measures are noted and should be considered by Council under any strategy. These are measures that can reduce overall demand and therefore improve water availability. As such, these are not considered as a source of water for the purpose of this study.

4.6.1 Network improvements

Reduction of water losses and improve water security through replacement and upgrade of distribution pipelines. Depending on current known losses (economic level of leakage) investment in pressure management and mains renewals can eliminate/reduce background leakage to as close to unavoidable annual real losses.

4.6.2 Smart Metering

Installing smart metering devices enabling wireless communication provides better visibility and optimisation of water use including early detection of potential leaks.

5. Assessment process

A workshop was held on 24 November 2021 with the participation of DPE, Council staff and GHD to develop the assessment methodology.

5.1 Weighting criteria

Pairwise comparison of each criterion was undertaken. This process considers each criterion against each other in turn. For each pair a score is given to the criterion felt more important and by how much on a scale of one to three. For example, if A is a lot more important than B that comparison would score 3A. If B were a little more important than A, the comparison would instead score 2B. If A is only slightly more important that B score 1A. The criteria can’t be considered equal under this weighting method.

5.1.1 Assessed criteria

A	Environmental/biodiversity benefit/impact
B	Energy use / greenhouse gas emission
C	Flexibility / adaptiveness
D	Circular Economy principles
E	Ability to meet community expectations
F	Traditional Owners
G	System resilience contribution
H	Minimisation complexity (construction and operations & maintenance)
I	Minimisation of regulatory challenges
J	Indicative cost - CAPEX
K	Indicative cost - OPEX

5.1.2 Pairwise comparison result

The resultant comparison is shown in the graphic below.

	B	C	D	E	F	G	H	I	J	K
A	2B	1A	1D	2E	1A	3G	3H	2A	1J	2K
B		1B	2B	2E	3B	2G	1H	2B	3J	3K
C			3C	2C	3C	1G	1H	1C	3J	3K
D				2E	2F	3G	3H	2I	3J	2K
E					1F	1E	1H	1E	1J	1K
F						3G	2H	2I	2J	2K
G							1G	1G	1J	1K
H								2H	1H	1K
I									2J	1K
J										1K
K										

5.1.3 Resultant weighting

The scores from the above pairwise comparison were then tallied to give a weighting as shown below.

Table 5.1 Resultant weighting from pairwise comparison

Criteria	Score	Weighted Score
A - Environmental/biodiversity benefit/impact	4	0.408

Criteria	Score	Weighted Score
B - Energy use / greenhouse gas emission	10	1.02
C - Flexibility / adaptiveness	9	0.918
D - Circular Economy principles	1	0.102
E - Ability to meet community expectations	6	0.612
F - Traditional Owners	3	0.306
G - System resilience contribution	14	1.429
H - Minimisation complexity (construction and operations & maintenance)	14	1.429
I - Minimisation of regulatory challenges	4	0.408
J - Indicative cost - CAPEX	16	1.633
K - Indicative cost - OPEX	17	1.735
Total	98	10

Based on this assessment, the criteria with the highest weighting were indicative cost (operational and capital), system resilience and minimising complexity in construction, operations and maintenance.

5.2 Assessment of options

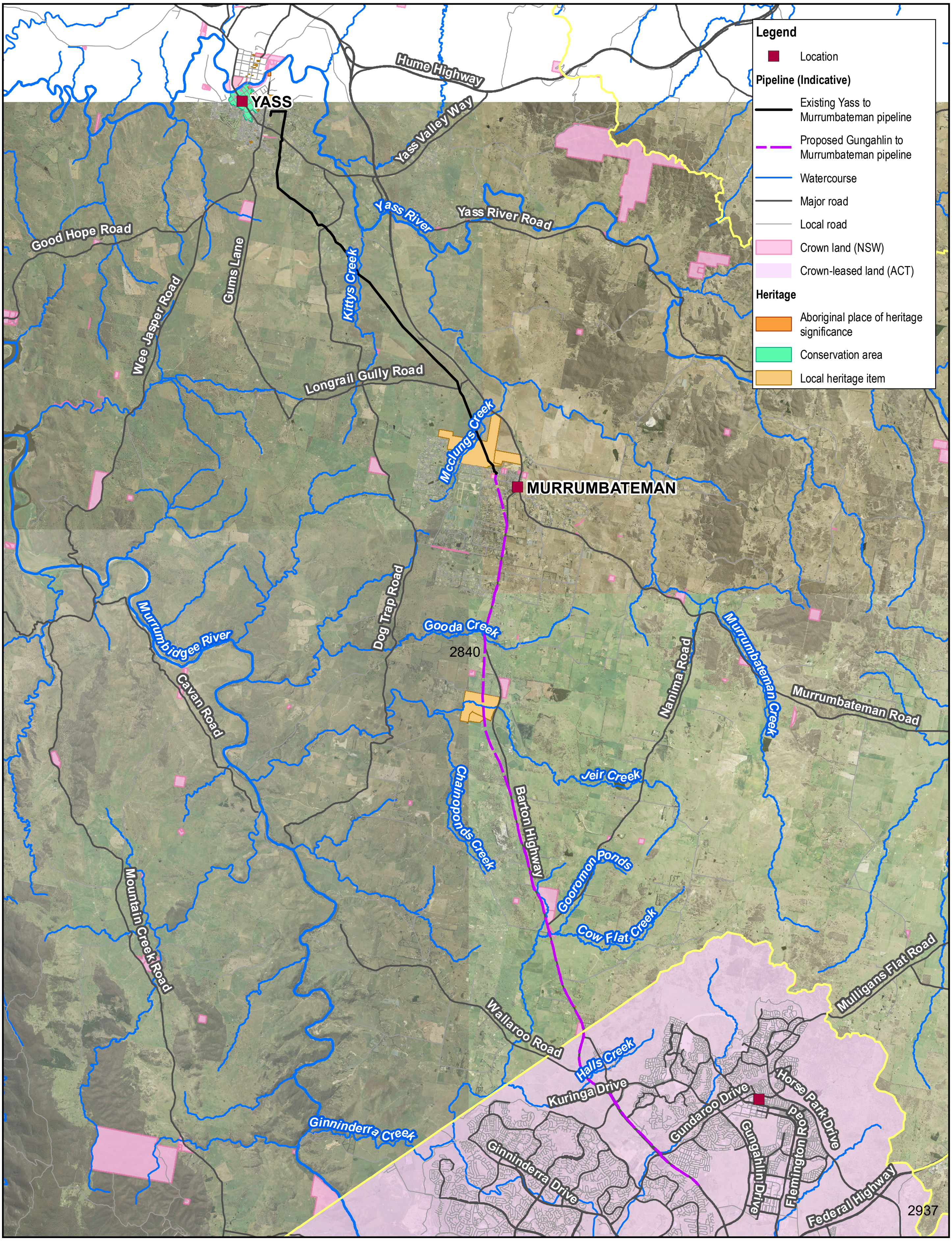
An assessment against each criterion was undertaken. Options were scored 1 (poor) to 5 (excellent). These scores were then tallied and the agreed weightings above applied. The assessment is shown in Appendix A. This produced a weighted score for each option.

The highest scoring option was identified as supply from the ACT. This was followed by rainwater tanks, however it was noted that rainwater tanks scored poor in one of the key criteria, system resilience, due to its reliance on rainfall, which could be impacted by climate change. The next preferred option was for supply from Lake Burrinjuck. This scored slightly lower in most criteria than the ACT supply due to slightly higher complexity and construction challenges.

7. Preferred strategy

7.1 Cross border supply from ACT

As a result of the MCA, the cross border supply from ACT was selected as the preferred strategy. The following details a high level assessment of the preferred option. The pipeline is proposed to connect to the existing Icon Water supply system east of Canberra in the vicinity of Hall/Nicholls (shown on alignment figure to end in Gungahlin to be conservative given that there are existing supply reservoirs there). It is proposed that the pipeline will generally follow the Electrical Transmission easement and Barton Highway through to the existing pipeline between Murrumbateman and Yass. Figure 7-1 shows the indicative alignment and provides an overview of constraints such as heritage areas and creek crossings. Threatened flora and fauna will need to be examined at a finer scale as the project progresses. Figure 7-2 shows in plan the topography over which the proposed pipeline link will traverse. From the broad scale elevation data, a ground profile along the pipeline alignment has been developed along with a review of the hydraulic grade line (HGL) shown as Figure 7-3.



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Yass Valley Council
Yass Valley Water Supply Strategy

Pipeline alignment

Project No. **12548725**
Revision No. **0**
Date **16/02/2022**

FIGURE 7-1

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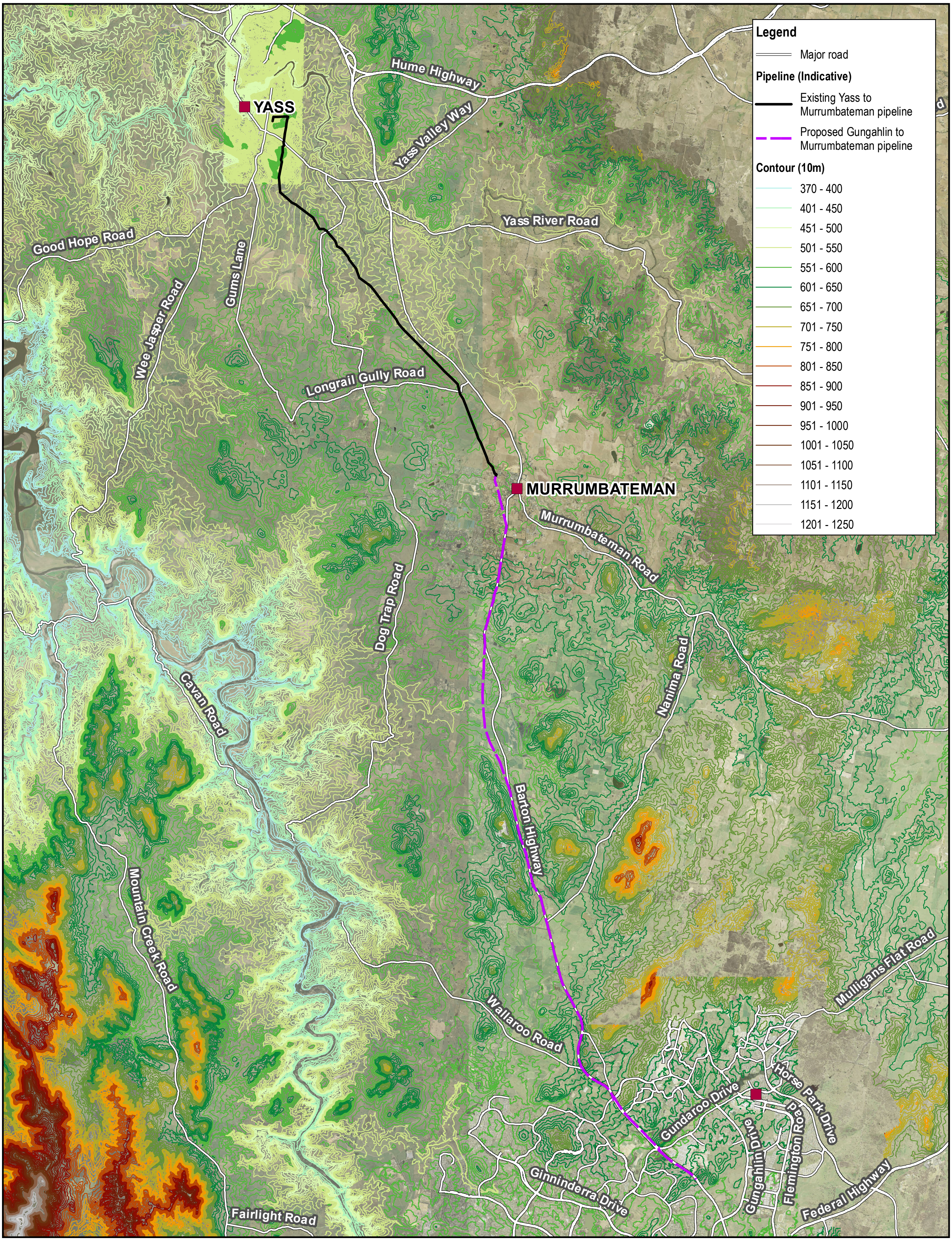
Print date: 18 Oct 2022 - 13:22

Data source: General topography - LPI 2015; Non-aboriginal heritage - OEH 2022; Aerial imagery - © Department of Finance, Services & Innovation 2018. Created by: tmorton



Paper Size ISO A4

0 1 2 3 4

Kilometres

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

GHD

Yass Valley Council
Yass Valley Water Supply Strategy

Elevation

Project No. **12548725**
Revision No. **0**
Date **16/02/2022**

FIGURE 7-2

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Print date: 18 Oct 2022 - 13:33

Data source: General topography - LPI 2015, Contours, 2022; ; Aerial imagery - © Department of Customer Service 2020. Created by: tmorton

The existing section of pipeline between Murrumbateman and Yass was constructed with 18 km of DN250 DICL/PVC transfer main.

As documented in Section 2.5 the water demand data from Yass, Murrumbateman is 1,140 ML/year for an Average Year Demand and 1,892 ML/year for Dry Year Extraction. This equates to approximately 3.1 ML/day and 5.2 ML/day for the average and dry extraction year, respectively.

The existing DN250 pipeline that transfers water from Yass to Murrumbateman is documented to be able to reverse the flow from Murrumbateman to Yass up to 5 ML/d with booster pumping (Feasibility Study for Water Supply Transfer System from Yass to Murrumbateman, October 2015).

A review to determine the most suitable pipe diameter for the new section from the ACT to Murrumbateman is detailed in Table 7.1 and Table 7.2 for the flow cases respectively. A minimum head of 3 m along the pipeline was allowed for in the calculations. DN250 sized pipe was assumed for the entirety of the completed section from Murrumbateman to Yass (to be conservative). Based on the review the proposed pipeline between ACT and Murrumbateman is proposed as a DN300 DICL. Alternate materials may be possible for some sections, however the section around chainage 20 km, has approximately 100 m pressure and, allowing for surge, may be pushing the limits of PN16 pipe materials, hence, to provide a conservative estimate, DICL PN35 has been adopted. It is noted that the velocity through a DN300 is lower than the desired 0.7 m/s, which is similarly the case for the DN250. This will need to be reviewed in future stages of the project to determine if there are likely to be any impacts on the system’s performance longer term or the water quality.

At a daily flow of 3.1 ML, gravity feed is possible between Hall and Murrumbateman assuming 40 m pressure is available at Hall, refer Table 7.1 and Figure 7-3. It is noted that a pressure reducing valve or similar may be needed to reduce the pressures entering the Yass system. Pumping is not required and no significant difference in the head required at Hall is made by the addition of a pump station.

However, the 5.2 ML/day flow case requires either 65 m pressure (for DN300 option) at the point of connection (refer Table 7.2) or the construction of a booster station in the vicinity of Murrumbateman as shown in Figure 7-4. With pumping, the pressure of 65 m can be reduced to 50 m by the addition of 15 m of pressure at CH25000, as shown in Figure 7-4.

Table 7.1 Preferred pipeline alignment ACT to Murrumbateman new section diameter (3.1 ML/d)

Diameter (DN)	Internal diameter (mm)	Velocity (m/s)	Headloss in new section of pipeline (m)	Headloss (m/m)	Required pressure at connection in Hall (m)	Pressure at Yass (m)
250	264	0.62	43	0.00143	60	75
300	322	0.42	15	0.00053	40	80
375	401	0.27	5	0.00018	35	85

*Headloss assumes Colebrook-White k value of 0.15, section of DN250 from Murrumbateman to Yass contributes to 25m of headloss.

Table 7.2 Preferred pipeline alignment ACT to Murrumbateman new section diameter (5.2 ML/d)

Diameter (DN)	Internal diameter (mm)	Velocity (m/s)	Headloss in new section of pipeline (m)	Headloss (m/m)	Required pressure at connection (m)	Pressure at Yass (m)
300	322	0.74	47	0.00015	65	30
375	401	0.48	15	0.00052	40	34
450	480	0.33	6	0.00021	35	52

*Headloss assumes Colebrook-White k value of 0.15, section of DN250 from Murrumbateman to Yass contributes to 76m of headloss.

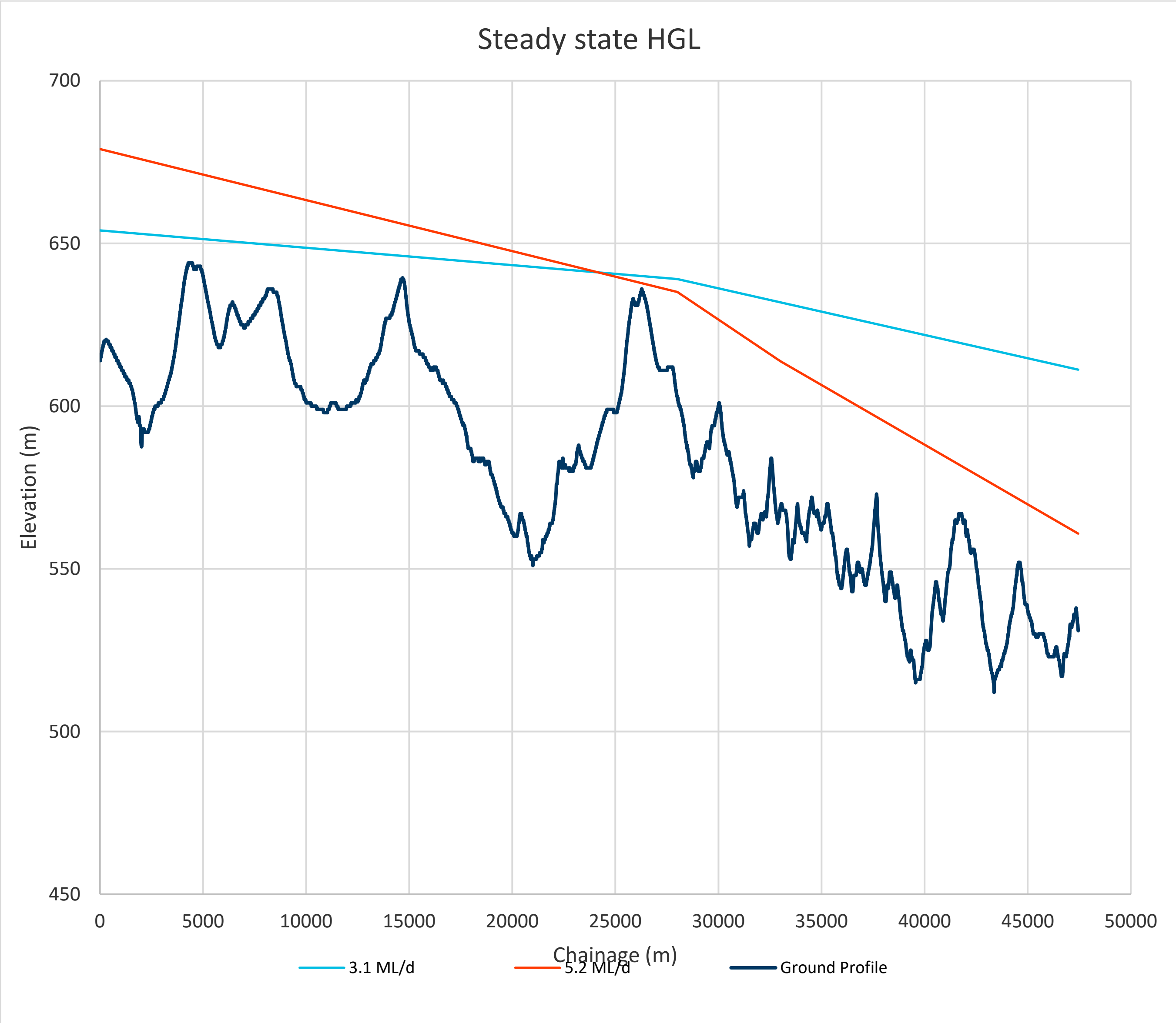


Figure 7-3 ***Hydraulic Grade Lines – gravity option***

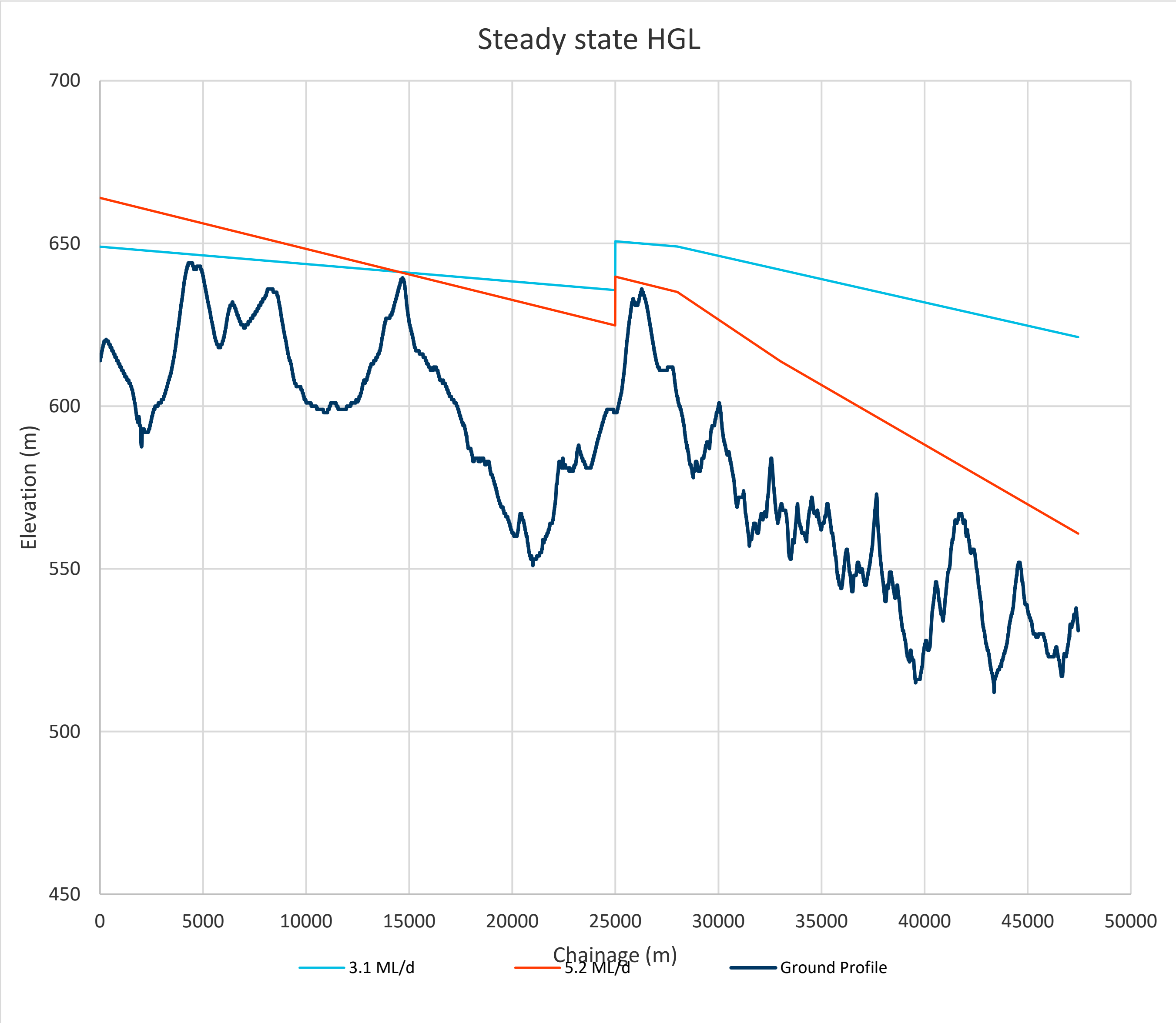


Figure 7-4 ***Hydraulic Grade Lines with pump station***

Indicative costing of the pipeline between ACT to Murrumbateman is $15.5M for the recommended DN300 DICL piping based on the NSW reference rates but are likely to be closer to $25m based on construction rates experienced in the local area. This cost does not include land acquisition or contingency.

8. References

Campbell, R., & Nurul, N. (2008). *Yass Valley Council - Integrated Water Cycle Management.* Ballina NSW 2478: WorleyParsons (incorporating JWP).

Department of Primary Industries. (2012). *Water Sharing Plan for the Murrumbidgee Unregulated and Alluvial Water Sources.* NSW Department of Primary Industries, Office of Water.

Department of Primary Industries. (2014, June). NSW REference Rates Manual - Valuation of Water Supply, Sewerage and Stormwater Assets.

Ginninderry. (2021, November 16). *Masterplan*. Retrieved from Ginninderry: https://ginninderry.com/our-vision/masterplan/

NSW Department of Commerce. (2009). *Yass Water Supply Second Yield Study.* NSW Water Solutions.

NSW Department of Industry. (2019). *Murrumbidgee Surface Water Resource Plan.* NSW Department of Industry.

Public Works Advisory. (2021). *Yass Valley Council IWCM Issues Paper.* PWA.

Yass Valley Council. (2019). *Settlement Strategy.* Yass: YVC.

9. Project team

The project team for the development of this strategy was

Yass Council – Kuga Kugaprasatham, James Dugdell, Chris Berry, Jim Collins

GHD – Christina West, Nathan Malcolm, Oliver Maennicke

DPE – Andrew Sloane, Peter Ledwos, Roshan Iyadurai

PWA – Glenn Fernandes

Appendices

Appendix A

MCA assessment outcomes

Minutes

10 December 2021

Project name	Yass Valley Water Supply Strategy	From	Christina West
Subject	MCA Workshop	Tel	02 6113 3397
Date / Time	10 December 2021 / 9:30am to 2pm	Project no.	12548725
Attendees	Chris Berry (CB), YVC James Dugdell (JD), YVC Jim Collins (JC), currently between YVC and DPIE jobs (virtual) Kuga Kugaprasatham (KK), YVC Liz Makin (LM), YVC Andrew Sloan (AS), DPIE Glenn Fernandes (GF), PWA (virtual) Christina West (CW), GHD Oliver Maennicke (OM), GHD	Apologies	Nathan Malcolm (NM), GHD Tad (Peter) Ledows (TL), DPIE Roshan Iyadurai (RI), DPIE
Objective	Complete the MCA for long listed options	Copy to	All invitees

Minutes	To be actioned by
Welcome – An Acknowledgement of Country was given by CW – Participants introduced themselves	
Project Overview – Background to and overview of the project was given by JC. – Overview form YVC perspective by JD: through settlement strategy and IWCM process it was clear that additional water supply was needed. Near term growth requires additional water. No formal study exists to date to look at additional sources. Approximately 2000 new lots in the next 3-4 years. – Historically it was said that once Yass Dam is exhausted ACT supply should be thought after as part of rapid settlement strategy. – JC states Secure Yield is a real issue. Challenges with access licences and actual availability, and involving ACT Government is very timely.	
MCA process overview – GHD (CW) provided introduction of step-wise approach through the MCA	
Pairwise comparison – All attendees considered criteria pairwise to discuss and agree to which degree a criterion can be considered more important the following observations discussions are highlighted to enable sensitivity analysis. GHD had proposed initial results for the group to challenge and discuss considering additional insights – Environment/biodiversity benefit/impact (A) vs Energy use/ greenhouse gas emission (B)	

The Power of Commitment

Minutes	To be actioned by
• While Environmental impact is important, councillors understand greenhouse gas emission better than biodiversity. The attraction of Yass Valley is also its environmental asset / biodiversity – Environment/biodiversity benefit/impact (A) vs Flexibility /adaptiveness (C) • Hard to split as dealing with infrastructure this important. E.g. pipeline Y2M should have more capacity. Due to options (perception: such as a pipeline there is not much flexibility – Environment/biodiversity benefit/impact (A) vs Circular Economy principles (D) • New concept test sensitivity – Environment/biodiversity benefit/impact (A) vs Ability to meet community expectations (E) • Community is always important – Environment/biodiversity benefit/impact (A) vs System resilience contribution (G) • System resilience what is it where does it come from: Diversification of sources, treatment plants, very important in IWCM process. Resilience and reliability sides of the same coin. – Environment/biodiversity benefit/impact (A) vs Minimisation complexity (H) • Notion that generally less complexity has less impact. Minimising complexity very important – Environment/biodiversity benefit/impact (A) vs Minimisation of regulatory challenges (I) • Regulatory issues at the beginning. Long term regulation often dependent on A. Also pricing models and demand management are well established tools. – Environment/biodiversity benefit/impact (A) vs CAPEX (J) • Traditionally J heavily weighted (ca. 30%). Really depends on where ethe funding comes from. If from National or State funding A will dominate if out of council pocket the J. This could swing depending on funding and sensitivities have to be identifies in the weighting – Environment/biodiversity benefit/impact (A) vs OPEX (K) • High bill. Due to building dam on own cost. OPEX is important in case of more maintenance of due to poor engineering, old assets, depreciation etc. – Energy use / greenhouse gas emission (B) vs Minimising complexity (H) • Balancing act, both important – Energy use / greenhouse gas emission (B) vs Minimisation of regulation • Regulation set in stone therefore B more important – Energy use / greenhouse gas emission (B) vs CAPEX (J) and OPEX (K) • Check sensitivity between low to high J and K. High CAPEX can has high OPEX regarding long term loan. Energy cost highest cost beside staff cost. Thinking of depreciation of expensive solutions. – Highlighting by GF that net present value, a common metric, has not been used here, considering life cycle cost. Sanity check required if this has a place in this assessment – Circular Economy principles (D) vs. Traditional Owners (F) • Regarding traditional owners, values are well identified in YWC. Part of community expectations. Really depends on actual project location. Look at regulations in NT and WA with themes related to environmental flows groundwater. Indigenous assets are well regulated and of strong general community interest. Aboriginal community in YWC well engagement and good positioned. LM highlighted that there Parkwood has to be differentiated form Yass and Murrumbateman are. – Minimisation of complexity (H) vs. Minimisation of regulatory challenges • Regulatory upfront, complexity relevant later during asset life. A Environmental/biodiversity benefit/impact B Energy use / greenhouse gas emission C Flexibility / adaptiveness D Circular Economy principles E Ability to meet community expectations F Traditional Owners G System resilience contribution H Minimisation complexity (construction and operations & maintenance) I Minimisation of regulatory challenges	

Minutes	To be actioned by
J Indicative cost - CAPEX K Indicative cost - OPEX	

Pairwise comparison

1. Compare two criteria.
2. Which is more important and by how much?

E.g. A v B
- If A is a lot more important than B score 3A.
- If A is a little more important than B score 2A.
- If A is slightly more important than B score 1A.
- The criteria can't be equal.

Cells highlighted in Yellow will undergo sensitivity analysis. Text marked in red describes change of score (in relation to GHDs initial score) by 2 or more/ change of criteria relevance. Text marked in orange describes change of score (in relation to GHDs initial score) by 1 in the same category

Pairwise Comparison of Criteria

	B	C	D	E	F	G	H	I	J	K
A	2B	1A	1D	2E	1A	3G	3H	2A	1J	2K
B		1B	2B	2E	3B	2G	1H	2B	3J	3K
C			3C	2C	3C	1G	1H	1C	3J	3K
D				2E	2F	3G	3H	2I	3J	2K
E					1F	1E	1H	1E	1J	1K
F						3G	2H	2I	2J	2K
G							1G	1G	1J	1K
H								2H	1H	1K
I									2J	1K
J										1K
K										

Aligning on options and background

- Going through options to align the groups understanding
- Off river storage: very high cost $60M -$100M for land, planning and pumping etc.
- Lake Burrinjuck: more rock. 7-8 river crossing, $1M per km pipeline in easy country. $25-30M for pipeline alone, also pumping and treatment requirements. Examples from Orange. Also, would need to consider duplication of Y2M pipeline, Water Treatment currently only considers Yass dam treatment capacity
- ACT supply: Perception that NSW Transport more flexible and collaborative than before to use road corridor as utilities corridor. Pipeline across agricultural land can be easily regenerated. Implications for potential upgrade for M2Y pipeline e.g., for emergency supply current capacity no problem but upgrade needed for ongoing supply form ACT. Booster chlorination required. Ca. $25-50M for pipeline. What would be the arrangements, e.g., supply reservoir at the border (Queanbeyan model)? Implications if there is water there would be request for expanding reticulated systems in existing developments. Developer contributions or connection feed?
- Groundwater: Considered because it had been in use. But groundwater is not available and no comprehensive evidence base. To be reflected upon.
- Recycled – non potable: Real challenge with water balance. Only when non-drought conditions prevail. Option for new developments as potable substitution. What are requirements to upgrade treatment such as activated sludge due to human contact)? Regulatory issues where water can be used for irrigation with time bound exclusion zones. Seen as regulatory complex/staff intensive. Many councils back away.

To be actioned by: GHD

Minutes	To be actioned by
– Purified recycled water: Feasible when higher population as it is not economically viable for low volumes; Could be standalone option but issues with effluent concentrated and community acceptance – Rainwater tanks: Not full when you need them – Stormwater Harvesting: needs separate system and the dam is usually full when there is a storm. Deemed not suitable – Management Aquifer Recharge. See ground water and even less suitable as water also has to be treated and places have to be found to recharge KK highlights we are looking at standalone options. How quickly can we do these options, timing and what needs to be done to get there: qualifying commentary required in report: expertise, water agreements negotiation, planning timelines.	
Assessment options assessment Discussion to be had what a mandatory indicator is. It might be more suitable for some options to talk about feasibility to support existing water supply. Also reconsider, options that score poor suitability at any one criterion. If so, discuss why option is still considered for this strategic assessment. – Circular economy Criteria. Not yet well understood but relevant – Low perception of flexibility of purified recycled water – Community expectations. Groundwater – challenge between neighbouring consumers; acceptance with recycled potable water, also operational issues (e.g. output water in Towoomba not suitable for fish; rainwater tanks well established – Systems resilience: Burrinjuck not very resilient due to downstream water needs. ACT supply requires more date in relation to resilience – Minimisation of complexity. Difficulty to design for varying water quality. Technologies are not cheap to build and replace – Minimise regulatory challenges: E.g. Take Parkwood and Give pipeline. Technical solution that just needs a political solution (cost, funding, jurisdictional trading). NSW government perceived as most difficult stakeholder (also change of government). Precedent with Queanbeyan already exists.; issues with licencing regarding storm water harvesting, also rainwater not a a source water option as non-potable. – CAPEX: for Off-storage high. Rainwater tanks not CAPEX and OPEX to council but issues comes when there is not rain and tanks are empty	GHD/ALL
Next steps	
– Consider inclusion of ACT water supply as part of IWCM. More evidence is required to run scenario analysis with portfolio of sources.	YVC/PWA
– KK Highlighted the need for a stand-alone option with an option to be supplemented where required.	GHD
– JD highlights that IWCM should look at drought proofing options for growth: ACT, Burrinjuck and Reuse	YVC/PWA
– IWMC to address timelines of when new/additional sources are required	YVC/PWA
– A meeting has been arranged to discuss this preferred option with ACT Government/Icon Water.	GHD/YVC
Close	
– GHD to prepare minutes and provide workshop results to participants to review to finalise	GHD

Attachment – Presentation slides, MCA EXCEL file

→ **Christina West & Oliver Maennicke**
Senior Project Managers

Yass Valley Water Supply Strategy – MCA Workshop

Welcome

MCA Workshop

→ Agenda

Agenda item	Who	Time
Acknowledgement and Welcome	GHD	9:30
Introductions	All	9:35
Project overview	YVC	9:40
MCA process	GHD	9:50
Pairwise comparison	All	10:00
Break		11:00
Options	GHD	11:10
Assessment	All	11:40
Next steps	GHD	12:40
Close	GHD	13:00

I'd like to take a moment to acknowledge the traditional owners of the lands on which we are meeting today, the Ngunnawal and Wiradjuri people. I extend that acknowledgement to the lands from which others are joining from today.

I pay my respects to their Elders – past, present and emerging and celebrate the diversity of Aboriginal peoples and their ongoing cultures and connections to the lands, waters and communities around us.

Project Overview

→ Background and scope

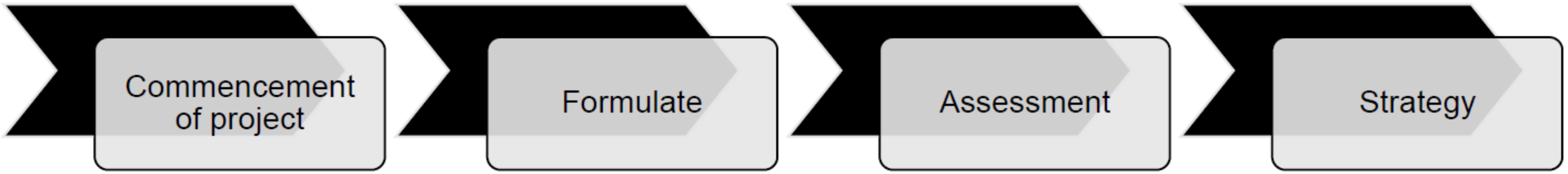
Where are we at in the project?

Commence & Formulate

- Task 1 – Commencement of project
  - Background briefing meeting
  - IWCM Issues Paper Presentation
  - Scope Conformation Workshop
  - Review of Information
- Task 2 – Formulate
  - Criteria Development
  - Criteria confirmation workshop

Assess & Strategise

- **Task 3 – Assessment**
  - Long list of options
  - Draft Assessment
  - MCA Workshop
- **Task 4 – Strategy**
  - Scenario development
  - Preferred Scenario
  - Water Supply Strategy



Multi-criteria Analysis

→ Process

Overview of MCA

Water Supply Options Assessment

→ Assessment Criteria

Project constraints

- Located within the Murray Darling Basin
- Mean temperatures rising by 2 °C by 2070
- Current water supply from surface and groundwater
- Non-residential demand 25% residential
- COVID-19 has impacted migration patterns, unclear what future trend will be
- Growth in Murrumbateman, Yass and Parkwood development
- 5/10/10 rule for water restrictions
- Current Water Access Licence 1700 ML/year
- Demand estimated at approximately 675ML/year by 2032 and 1,100 ML/year by 2051

Criteria

1. Ability to meet supply-demand volumes (Mandatory)
2. Environmental/biodiversity benefit/impact
3. Energy use / greenhouse gas emission
4. Flexibility / adaptiveness
5. Circular economy principles
6. Ability to meet community expectations
7. Traditional owners
8. System resilience contribution
9. Minimisation complexity (construction and operations and maintenance)
10. Minimisation of regulatory challenges
11. Indicative cost – CAPEX
12. Indicative cost – OPEX

Pairwise comparison

A > B

How does it work?

1. Compare criteria two at a time until each criterion has been compared against all others.
2. Consider which is more important and by how much. For example take Criteria A and B.
   - If A is a lot more important than B, score 3A
   - If A is a little more important than B, score 2A
   - If A is slightly more important than B, score 1A
   - The criteria can't be considered equal.
3. The score given is then used to determine the weighting for each criteria

Refer to the **draft assessment criteria spreadsheet** and review pairwise comparison.

What options are we considering?

1. Off river storage
2. Supply from Lake Burrinjuck
3. Supply from ACT (Icon Water)
4. Groundwater
5. Recycled non-potable
6. Purified recycled water
7. Rainwater tanks
8. Stormwater Harvesting
9. Managed Aquifer recharge

Other options considered but failing the mandatory criteria included water carting and novel technology such as atmospheric water generation

Off-river storage

- Take surface water from Yass River or Yass Dam and fill storage area
- Take is during high flows
- High up front costs – add two examples – Yellow Pinch and Deep Creek
- Site needs to be close to water source
- A 500 ML storage was considered during dam raising
- Secure yield analysis would be required to determine if yield is available
- High land use – high land cost

Lake Burrinjuck

- Take surface water from Lake Burrinjuck (30km SW Yass) and transfer via pipeline
- High up front costs, ~$25-30m (rock, river crossings, pumping)
- Require at least 4 ML/d to meet future demand requirements
- Constraints on pipeline route including environmental, geotechnical
- Utilise existing pipeline between Yass and Murrumbateman as per existing
- Water would come Yass Dam or WTP
- (Orange example)
- Duplication of Y2M pipeline required
- Additional treatment plant capacity may be required

Cross-border ACT

- Utilise existing pipeline between Yass and Murrumbateman in opposite direction than existing
- Route can follow highway easements to connect into ACT at Hall
- Discussions have been held with Icon Water previously
- Regulatory challenges with cross border supply (note discussions required for Parkwood anyway)
- Upgrade of Y2M pipeline required for total supply to come from ACT
- Current pipeline can supply emergency 5ML/d from M2Y
- Booster chlorination only required
- $25m based on previous costs to present value.

Groundwater

- Already utilised to supplement Murrumbateman supply
- Quality issues
- Embargo on groundwater licences
- Availability of fractured rock around Yass unlikely

Recycled non-potable water

- Recycled water plant at Googong, Rouse Hill, Port Macquarie
- Third pipe into existing areas challenging
- Existing surface water supply continues for potable water use
- Community acceptance for non-potable use
- Not climate dependent (drought), note higher rainfall
- Third pipe easier to implement in new developments (potable water substitution)
- Upgrade to STP – need tertiary treatment
- Management of third pipe scheme intensive for Council

Purified recycled water

- Can be direct or indirect
- Direct has higher regulatory challenges
- Community acceptance for potable use is historically low
- Volume available too low due to population
- High rainfall makes not economically viable

Rainwater tanks

- Requirement for installation at individual properties
- Up to 45% non-potable needs from 5,000L tank
- Would capture stormwater run-off that would normally flow back to Yass River
- Rainfall dependent
- Perhaps best suited to demand management strategy

Stormwater harvesting

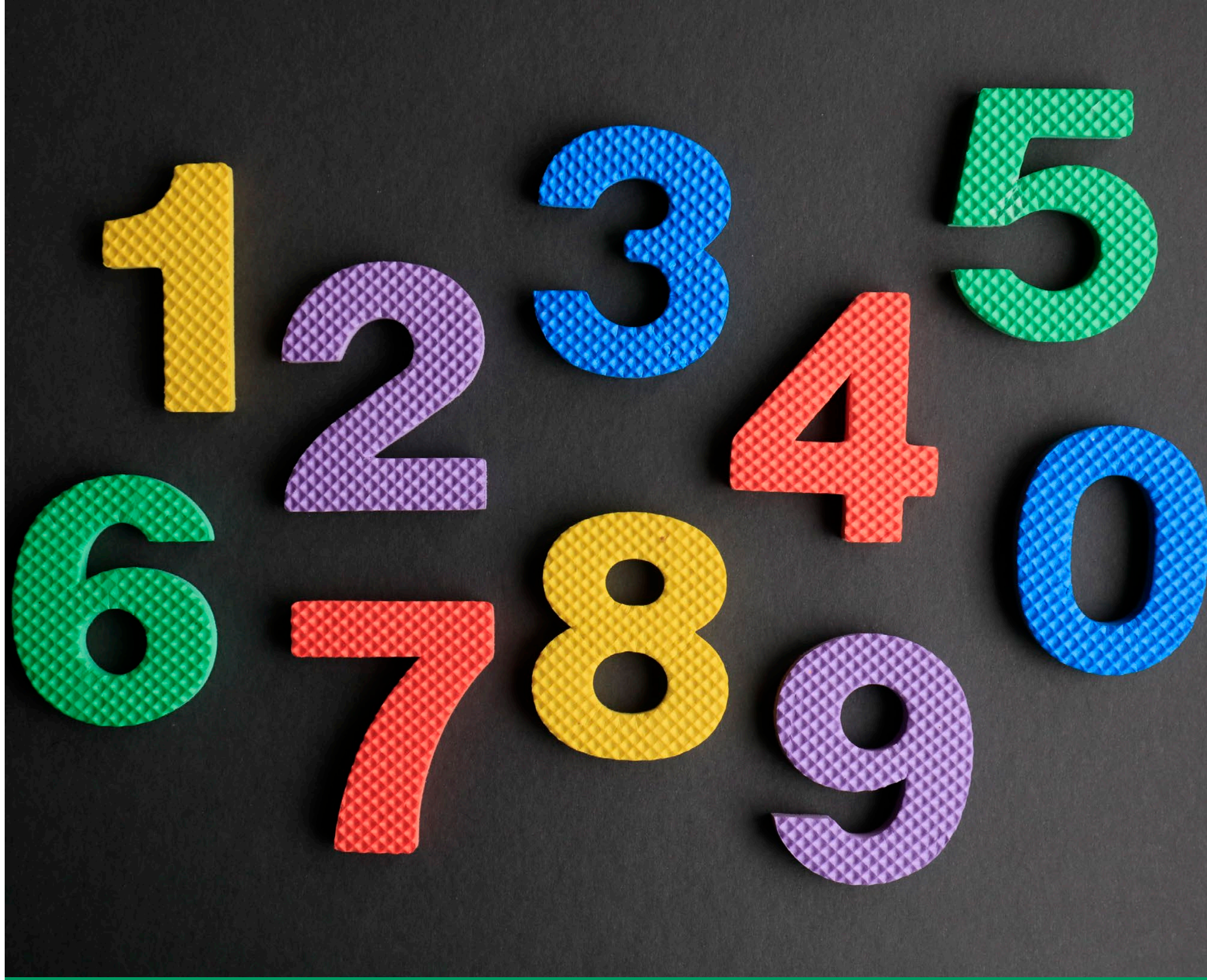
- Would capture stormwater run-off that would normally flow back to Yass River
- Rainfall dependent
- Perhaps best suited to demand management strategy
- Typically non-potable use only

Managed aquifer recharge

- Add water to aquifer for later extraction (e.g. 10-20 years to first abstraction in Perth)
- Location of a suitable aquifer
- Uncommon technology

Option scoring

1. For each identified option give a score for each criterion
   - 5 = Excellent
   - 4 = Very good
   - 3 = Good
   - 2 = Fair
   - 1 = Poor
2. Weighting is then applied and a total score given
3. This will allow us to rank the options and determine a preferred option



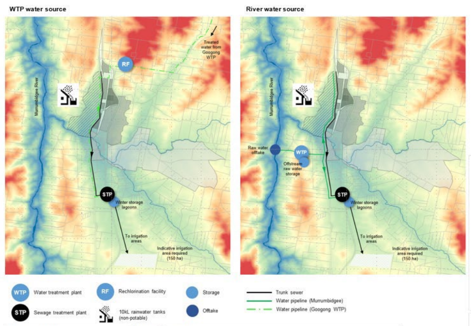
Refer to the **draft assessment criteria spreadsheet** and score the options.

Next Steps

→ Where to from here?

Water Supply Strategy

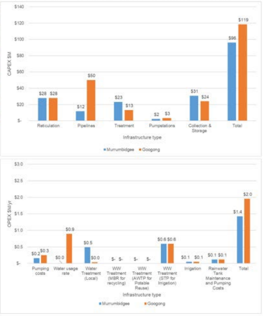
Option 1



Town water connection with 10 kL rainwater tank on each house to supply non potable demand

This option includes:

- 10kL rainwater tank at each household to meet BASIX requirements for all new residential dwellings in NSW for non-potable use only.
- For the Murrumbidgee River option, there will be an offtake where the raw water is pumped to an off-stream storage lagoon or dam, which will then be treated in a WTP. This WTP is sized to provide full potable backup.
- For treated water from Googong, a rechlorination facility is required to add sufficient chlorine to achieve a chlorine residual in the network.
- Potable water reticulation sized for full potable backup.
- Gravity sewer to a STP where it is treated to a quality sufficient for broadacre irrigation.
- Winter storage lagoon.
- Emergency discharge will be via a local creek if required and permitted.



Non-financial criteria	Tick/Cross	Comment
Low operational complexity	✔✔	Least complex of all options
Low energy consumption	✔?	Less WW treatment energy costs, but potentially higher raw water pumping costs
Low raw material usage	✔✔	Options 1 & 2 are the least material resource intensive of all options
High climate change resilience (e.g. drought, bushfire)	✗	Mainly relies on a single water source, with no recycling
Low pollution	✗?	Though water is used for irrigation, some effluent may still be discharged to creeks
High community acceptance	✔✔	Conventional approach
Community affordability	✔	Conventional approach though existing residents may not want to pay for new services
Low construction complexity	✔✔	Conventional approach
Accommodate future increase in capacity	✔	Treatment can be designed to be staged and trunk mains have been assumed to accommodate 12k EP
Flexibility to accommodate uncertain future	✗	Retrofitting a third pipe if required will be expensive
Low level of regulatory approval requirements	✔✔	Conventional approach
Low level of Council resources to manage system	✔✔	Conventional approach

Legend		
Operations	✔✔	Strongly Positive
Sustainability	✔	Positive
Constructability	✔?	Uncertain (Positive)
Resilience / Redundancy	✗✗	Strongly Negative
Regulatory approval	✗	Negative
	✗?	Uncertain (Negative)

1. Document the findings
2. Water Supply Strategy
3. Discussions with regulatory bodies

A tool to facilitate further discussion

* Thank You

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→ The Power of Commitment