Metropolitan Planning Authority

Whole of Water Cycle Assessment: PSP 1067 Donnybrook and PSP 1096 Woodstock

Summary Report

Final

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Executive Summary

Arup Pty Ltd (Arup) was engaged by the MPA to prepare a Whole of Water Cycle Assessment (WoWCA) to inform the development of the two PSPs which will guide future urban development in the area. Arup's benefit focussed Design with Water partnership approach to WoWCA has been utilised in the development of this project.

The purpose of this study was to identify a high-level strategy and schematic design for integrated water management to assist in the establishment of the future urban structure for the new communities of Donnybrook and Woodstock. The study identified issues and considerations for the future urban development of the study area and provided options and recommendations for a schematic urban structure to facilitate whole-of-water-cycle management. The assessment will enable MPA to plan the future urban structure for the Donnybrook and Woodstock PSPs with greater consideration of the whole-of-water-cycle opportunities available.

This Summary Report brings together work undertaken to date, stakeholder feedback through the stakeholder workshop conducted in February, comments received after the workshop and consultation with key stakeholders along with other background information available regarding the Woodstock and Donnybrook PSPs.

The development of a WoWCA for the two PSP's involved a number of key steps which include:

1. Development of a base case report to document key site characteristics and the business as usual scenario (completed in February 2014)
2. Consultation with stakeholders to explore if there are other more innovative and efficient options which meet the required criteria (completed during February and March 2014)
3. Assessment of alternative options and comparison with the base case (the subject of this report)

Organisations consulted in the development of the WoWC Report include:

- MPA
- Yarra Valley Water
- Whittlesea City
- Melbourne Water
- Office of Living Victoria
- Mitchell Shire
- Department of Health

WoWCA process and Precinct Structure Planning

According to MPA in the context of Precinct Structure Planning, whole-of-water-cycle management seeks to make effective use of all sources of water by tailoring them to different locations and circumstances and thereby delivering multiple benefits.

Whole-of-water-cycle management at the PSP scale helps deliver on the objectives of the Victorian Government's Living Victoria strategy 'Melbourne's Water Future' (Office of Living Victoria, July 2013) to plan and manage an integrated and resilient water system.

MPA WoWCA Objectives:

Objectives of the whole-of-water-cycle assessment include:

- Diversification of supply thereby reducing the cost of future large scale centralised water/wastewater systems
- Waterway health improvement, consisting of less volume and higher quality
- Management of potential flooding and decreasing flood risk
- Improved liveability and urban landscapes
- Engagement of the community via key stakeholders.
- Identification of opportunities within the planning and building process that will also help to deliver on the above objectives.
- To deliver on these objectives, whole-of-water management opportunities could include:
    - Minimising potable water usage by use of alternative water supplies
    - Roof rainwater harvesting
    - Stormwater harvesting
    - Stormwater quality measures
    - Flood management including the minimisation of flood extents
    - Sewer mining
    - Groundwater including aquifer storage and recovery
    - Sewage treatment and discharge
    - Improving environmental, landscape and liveability outcomes through water management.

Site Details

The Donnybrook PSP is located in the Cities of Whittlesea and Mitchell and to the east of the recently approved Lockerbie PSP. The precinct is bounded by the Outer Metropolitan Ring Road (OMR) E6 reservation to the north, the Sydney-Melbourne train line to the west, Donnybrook Road to the south, and the Woodstock PSP to the east.

The Donnybrook PSP is 1,067 hectares (gross) with a proposed primary land use of residential. The PSP is expected to accommodate over 10,000 residential lots. The Woodstock PSP is 759 hectares (gross) with a proposed primary land use of residential and is expected to accommodate over 7,500 residential lots.

Option Description and assumptions

The first stage of the WoWCA process was to define and develop a base case for consideration by the wider stakeholder group. In defining the base case, Arup, in collaboration with and drawing on previous work by Melbourne Water, Yarra Valley Water and the Office of Living Victoria developed in the document “An Integrated Water Future for Melbourne’s North,” considered a number of options presented in this document in order to provide water services to theses growth areas. The base case was further refined in consultation with key stakeholders and was presented to the stakeholders for comment and discussion at a subsequent stakeholder workshop and was updated accordingly.

A key component of this phase of work was to also collaborate with the project stakeholders to develop two alternative whole of water cycle options for the PSP areas and document the assumptions on which analysis of these are based. This was done via face-to-face meetings, a stakeholder workshop and a formal feedback process on the alternatives developed.

There were two alternatives that were then developed: Alternative 1 option is considered a ‘Base Case Plus’ and has been developed to build on the elements identified in the Base Case in order to achieve improved WoWCA outcomes and Alternative 2, the ‘Future Stretch Alternative’, was developed to introduce large scale interventions to supply part of the residential water demand, explore the benefits of a distributed approach to runoff water quality treatment and encourage innovation.

A summary of the options are below:

Base Case	**Alternative 1 Base Case +**	**Alternative 2 – Future Stretch**
Wastewater is collected and treated to recycled water standard at a regional treatment facility and is then returned to residential houses via a 'third pipe' system for non-drinking purposes. Approximately 30% of the water demand is met by the recycled water system, reducing the water demand for piped drinking water supply and downsizing drinking water pipes. Retail and employment, education and public and open space land uses are supplied with potable water only. Active open space is irrigated to the minimum extent required to maintain coverage but lush conditions are not always achieved. Rainwater and stormwater are collected in pipes and treated through a series of settling ponds and wetlands prior to discharge into the receiving waterway.	Base Case + sets an efficiency target to reduce water usage in households by 10% off baseline figures. Wastewater is collected and treated to recycled water standard at a regional treatment facility and is then returned to residential houses and to non-potable uses in retail and employment, educational and community facilities via a 'third pipe' system for non-drinking purposes. Approximately 30% of the water demand is met by the recycled water system, reducing the water demand for piped drinking water supply and downsizing drinking water pipes. Rainwater and stormwater are collected in pipes and treated through a series of settling ponds and wetlands and are then used as supply for irrigation of active open space to achieve lush conditions.	Future Stretch sets an efficiency target to reduce water usage in households by 20% off baseline figures. Wastewater is collected and treated to recycled water standard at a regional treatment facility and is then returned to residential houses and to non-potable uses in retail and employment, educational and community facilities via a 'third pipe' system for non-drinking purposes. Approximately 30% of the water demand is met by the recycled water system, reducing the water demand for piped drinking water supply and downsizing drinking water pipes. Rainwater is collected by household rainwater tanks to supply hot water to residential buildings and as an additional opportunity to achieve beyond best practice. A distributed approach to surface water runoff management incorporating streetscape elements along major road reserves and drainage lines to reduce size and extent of end of line detention and treatment is adopted. Stormwater is harvested as supply for irrigation of open space to achieve lush conditions.

All options incorporate water efficiency measures including Water Efficiency Labelling Scheme (WELS) star rated appliances, fittings and fixtures.

Precinct Demands and Sewer Discharge

This section outlines the anticipated precinct wide demands and sewer discharges for the various land uses under each of the options. A summary of all cases is provided below.

Case	Location	Total Anticipated Water Demand (per annum)	Total Anticipated Water Demand able to be provided by recycled water (per annum)	Sewer Discharge (per annum)	Demand to provide lush active open space (per annum)	Rainwater Capture at the household scale (per annum)
Base Case	Donnybrook	1.7 GL	440 ML	1.2 GL	N/A	N/A
	Woodstock	1.4 GL	330 ML	920 ML	N/A	N/A
Alternative 1 – Base Case +	Donnybrook	1.6 GL	500 ML	1.1 GL	160 ML	N/A
	Woodstock	1.4 GL	420 ML	850 ML	180 ML	N/A
Alternative 2 – Future Stretch	Donnybrook	1.5 GL	300 ML	950 ML	160 ML	350 ML
	Woodstock	1.25 ML	280 ML	750 ML	180 ML	230 ML

Schematic Design

High level schematic designs have been prepared for each of the options including the revision of the scheme design for the base case demand figures and feedback from stakeholders regarding site constraints. The schematic designs developed have been assessed based on the required runoff and water quality targets, the appropriate whole of water cycle assets for the site conditions and opportunities and the results of the constraints assessment. The schematic designs have also attempted to take into account other design considerations appropriate at the PSP scale and to fit with the proposed urban structure. It is noted that there are further requirements to re-visit these layouts as additional site information comes to hand.

Water Sensitive Urban Design

WSUD integrates urban water cycle management with urban planning and design, with the aim of mimicking natural systems to minimise negative impacts on the natural water cycle and receiving waterways and bays. It offers an alternative to the traditional conveyance approach by acting at the development scale, reducing the size of the required stormwater system.

All options incorporate some form of Water Sensitive Urban Design (WSUD) to help achieve BPEM requirements; however the Alternative 1 and 2 options apply alternative configurations of these elements to increase the reuse of stormwater and rainwater and to explore high level opportunities to take a more distributed rather than end of line approach to surface water management.

The Alternative Options developed for this project require the potential use of rainwater tanks, vegetated swales and the colocation of wetlands within a retarding basin. Innovative stormwater management, such as WSUD, can contribute greatly to sustainability and liveability, but ongoing costs and management responsibilities are a key consideration.

Land take requirements for the surface area of such wetlands/retarding basins range according to the figures below. These areas only consider the flows from within the site boundary and will require revision as the site layout is further developed:

	Base Case	Alternative 1	Alternative 2
Donnybrook	11.3 ha	11.3 ha	10.2 ha
Woodstock	8 ha	8 ha	7.1 ha

For Alternatives 1 and 2 the retarding basins and wetlands were broken down to smaller retarding basins and wetlands where considered feasible after taking into consideration the topography and location of proposed open spaces. The purpose of this iterative exercise was to provide distributed wetland locations and maximise reuse opportunities by locating wetlands as close as possible to open space areas requiring irrigation.

Alternative 2 has small reductions in pervious area and there are also minor benefits in reduction in water requiring treatment with the installation of rain water tanks at the household scale.

Options assessment – Quantitative

Based on high level capital and operational costs a high level assessment of options is produced to quantitatively compare the alternatives. Further detailed costing data would be required in the next stage of work and detailed information on ground conditions would also be required.

A brief overview is seen below:

Donnybrook

	Base Case	Base Case +	Future Stretch
Total Demand (ML/a)	1707	1630	1531
Total Capex	$8.5m	$8.5m	$45.3m
Total Opex	$57 k	$57k	$635k
Savings off water bill (consumption) ($/a)	0	0	$910k
Savings off water bill (council) ($/a)	0	$425k	$425k

Woodstock

	Base Case	Base Case +	Future Stretch
Total Demand (ML/a)	1394	1353	1242.1
Total Capex	$6m	$6m	$34m
Total Opex	$40k	$40k	$467k
Savings off water bill (consumption) ($/a)	0	0	$590k
Savings off water bill (council) ($/a)	0	$470k	$470k

Options assessment – Qualitative

A qualitative assessment was also undertaken to determine the benefits for a variety of factors including water supply, wastewater, economy & innovation, place & community, food & agriculture, climate change, energy & carbon and health & wellbeing. Alternative 2, Future Stretch, was found to be the most beneficial.

Recommendations and key findings

It was found that although Alternative 2, Future Stretch, scored the highest qualitative assessment; it is unclear at this stage if the overall benefits of rainwater tanks outweigh the costs associated with them. There is potential to explore alternative sizing options for rainwater tanks however Melbourne Water are generally not in favour of the use of tanks to perform a retarding function and there is negligible savings at the household level when comparing water bill savings to operational costs.

It is recommended the adoption of the Alterative 1 - Base Case Plus in terms of the required land take areas and indicative locations, perceived benefits and minor additional expenditure over the baseline. This approach seeks to collocate stormwater detention and treatment adjacent to active open space to allow for increased stormwater harvesting opportunities and place making opportunities associated with these features by distributing them more widely throughout the landscape.

Cost savings related to water expenditure will also be experienced by Council’s responsible for maintaining open space assets and a reduction in flows to nearby waterways although relatively minor will be experienced. Optimised locations of stormwater treatment assets will need to be undertaken in future stages to account for ground conditions, land status, land acquisition and any changes to the urban structure, while also reducing costs associated with drainage infrastructure.

It is also noted that there has been initial support from DEPI, Melbourne Water, OLV and councils for investigating the use of grassy woodland conservation areas for evaporation basins and to provide water to existing red gum areas. However, it is noted that a large amount of work still required to detail how this could be implemented particularly in terms of water delivery regimes, funding and ongoing maintenance. Implementation of a successful scheme could have a number of beneficial impacts including revegetation of conservation areas, significant reductions in stormwater flows to creeks, recharge of ground water, while also reducing retarding requirements.

1 Introduction

The Metropolitan Planning Authority (MPA), formerly the Growth Areas Authority (GAA), in partnership with the City of Whittlesea and Mitchell Shire Council has commenced preparation of the Donnybrook and Woodstock Precinct Structure Plans (PSPs) which will establish the future urban structure for a new community. Donnybrook and Woodstock PSPs are located in Melbourne's Northern Growth Corridor (see Figure 1 for the location of Donnybrook PSP 1067 (cells D1, D2 and D3) and Woodstock PSP 1096 (cells WS1, WS2 and WS3)).

As part of the PSP development Arup Pty Ltd (Arup) has been engaged by the MPA to prepare a Whole of Water Cycle Assessment (WoWCA) to inform the development of the two PSPs which will guide future urban development in the area. The incorporation of water management requirements at this stage in the planning process allows for the future urban developments to take into account the best available opportunities for the provision of water services along with opportunities to improve the local environment and increase amenity and liveability outcomes for residents.

A WoWCA planning approach recognises that water can enhance social infrastructure and open space making it more attractive and sustainable. It also recognises that open space and other areas can be used to treat and store water for later reuse, prevent flooding, and reduce environmental impacts from development on waterways. Understanding the interface between water infrastructure and space requirements is the key to creating a truly multi-functional landscape that delivers multiple social, economic and environmental benefits while minimising unnecessary and costly land take. This in turn creates attractive communities, while ensuring that developer contributions for shared infrastructure are as low as possible to ensure affordability for home buyers. Arup's benefit focussed Design with Water partnership approach to WoWCA has been utilised in the development of this project and is depicted in Figure 2.

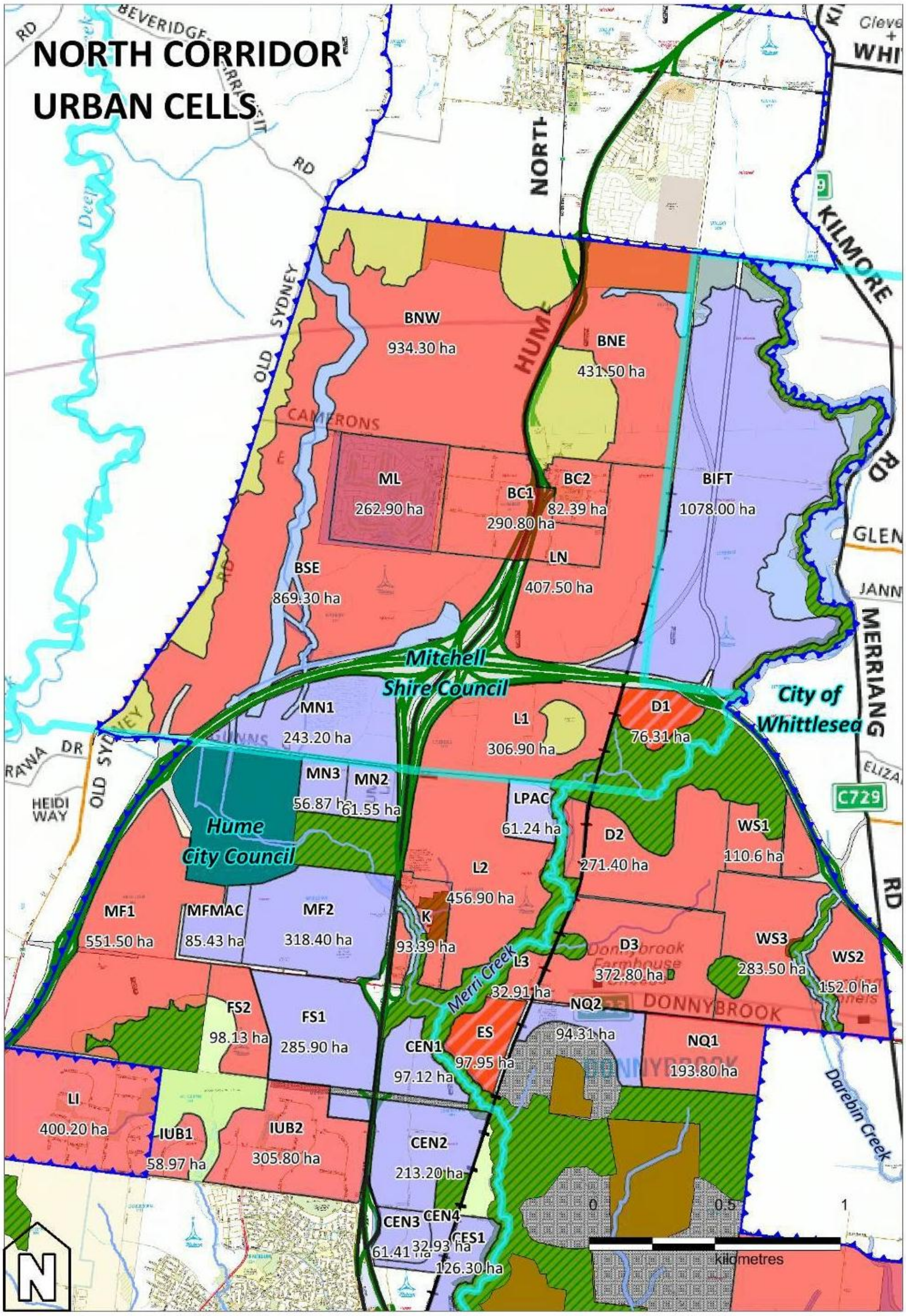


Figure 1 Northern Corridor Urban Cells (source: MPA)

Placing an integrated water cycle at the centre of design can deliver multiple wider benefits.

Water Supply

Reduction in demand for potable water supply and treatment, through use of water efficient fixtures and fittings and alternative decentralised water supplies, including rainwater, greywater and groundwater. Capital investment and whole-life cost savings.

Wastewater

Reduction of surface water volume to sewers, extending network asset life, improving water quality (fewer spills to rivers from combined sewer overflows), and reducing treatment. Opportunity to recycle and re-use water through decentralised treatment.

Flooding

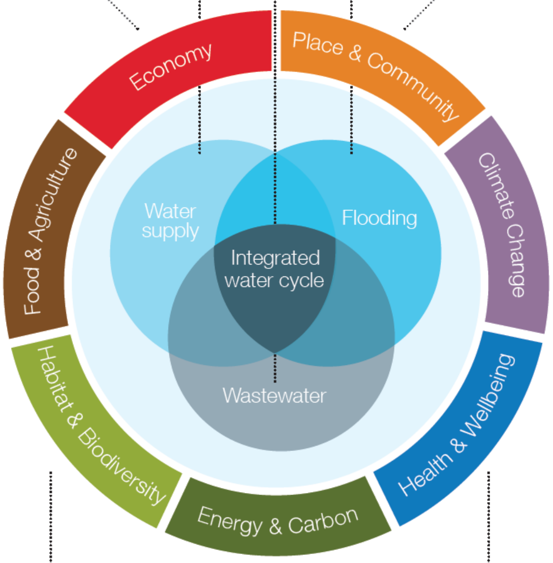
Reducing risk and increasing resilience by integrated catchment management and improved management of surface water within cities. Design and planning of infrastructure, buildings and landscapes to be more adaptable to flooding.

Economy

Potential direct contribution through water-related investment in infrastructure, associated new technologies, partnership with small enterprise, etc. Indirect impact on land and property values, attracting inward investment and improved labour productivity.

Place & Community

Access to and engagement with water can play a significant role in creating better places with a strong sense of identity. Making space for water can open up and reconnect people and places. Water is an integrator which can facilitate partnership and collaboration.



Food & Agriculture

Local food production can be a key driver to retrofitting landscapes, including breaking up of hard surfaces, flood-compatible use of open space, edible planting, water harvesting and treatment, localised nutrient recycling and improved agricultural practice.

Climate Change

Design for water helps to mitigate and adapt to climate change. Large tree planting, greening of urban areas, and open water bodies directly contribute to improved microclimate. Locally managed water can increase resilience to water scarcity and drought.

Habitat & Biodiversity

New and improved habitats through making space for water within green infrastructure networks, provision for natural treatment of water and wastewater, improving water quality, river/wetland and coastal restoration, woodland, green roofs and walls.

Energy & Carbon

Removal and sequestration of greenhouse gases as a result of urban greening. Reduction in energy demand due to shading/insulation, reduced pumping and treatment of water and wastewater. Potential for renewable energy generation from hydro and waste.

Health & Wellbeing

Water-related green infrastructure can absorb air pollutants and improve microclimate, provide opportunities for recreation, exercise and education. Water can help to improve overall living environments and provide opportunities for community engagement.

Figure 2 The benefits of WoWCA approach © Arup

The development of a WoWCA for the two PSP's involves a number of key steps which include:

1. Development of a base case report to document key site characteristics and the business as usual scenario (completed in February 2014)
2. Consultation with stakeholders to explore if there are other more innovative and efficient options which meet the required criteria (completed during February and March 2014)
3. Assessment of alternative options and comparison with the base case (the subject of this report)

The purpose of this study is to identify a high-level strategy and schematic design for integrated water management within the study area and to identify any issues or considerations for the future urban development of the study area.

Required outputs include the provision of supporting documentation which considers options for an urban structure to facilitate whole-of-water-cycle management and which recommends a preferred option for inclusion into the PSP.

The assessment will enable MPA to plan the future urban structure for the Donnybrook and Woodstock PSPs with greater certainty by identifying issues relating to land capability early in the planning process.

1.1 Report contents

This Summary Report brings together work undertaken to date, stakeholder feedback through the stakeholder workshop conducted in February, comments received after the workshop and consultation with key stakeholders along with other background information available regarding the Woodstock and Donnybrook PSPs such as heritage and biodiversity constraints, roads and utilities placement, commercial and community facilities, and open space.

This Summary Report is a high level strategy and schematic design responding to MPA instructions and issues arising from stakeholder workshops and makes recommendations on the draft future urban structure for the two PSPs including:

- Details of drainage, stormwater, constructed waterways, open space, waterways corridors, conservation areas that are required to support delivery of the options
- A comparison of how the draft urban structure may be amended to accommodate each of the whole-of-water-cycle options investigated
- A strategy and schematic design identifying the alignment of drainage lines/waterways and location and size of retarding basins and water quality treatment wetlands (or other water retardation or treatment facilities)
- High level opinion of cost to implement and maintain the short-listed options.
- High level comparative analysis that provides relative statements of advantages and disadvantages of each whole-of-water-cycle management option against relevant criteria (environmental impact, infrastructure requirements, etc) to assist in establishing a preferred outcome.
- Schematic plans and figures to visually demonstrate the mapping of the land take and infrastructure (required water, sewerage, alternative water, and

drainage services) for each whole-of-water-cycle management option to be assessed in its relationship to the other precinct networks, including open space, community facilities and transport.

This Summary Report will also make a recommendation as to whether further detailed analysis of whole-of-water-cycle management options is appropriate in the development of the PSPs.

1.2 WoWCA process and Precinct Structure Planning

According to MPA in the context of Precinct Structure Planning, whole-of-water-cycle management seeks to make effective use of all sources of water by tailoring them to different locations and circumstances and thereby delivering multiple benefits.

Sources of water could include recycled water, rainwater, stormwater, wastewater, groundwater, potable water and waterways. Whole-of-water-cycle management at the PSP scale helps deliver on the objectives of the Victorian Government's Living Victoria strategy 'Melbourne's Water Future' (Office of Living Victoria, July 2013) to plan and manage an integrated and resilient water system which:

- supports liveable and sustainable communities;
- protects the environmental health of urban waterways and bays;
- provides secure water supplies efficiently;
- protects public health; and
- delivers affordable, essential water services.

The Government's Living Victoria policy identifies a number of reform priorities including the need to improve the integration of urban and water planning. It has a guiding vision of:

"A smart, resilient water system for a liveable, sustainable and productive Melbourne."

The MPA Integrated Water Management PSP Note requires that each PSP include WoWCA. The PSP Note outlines the following key WoWCA concepts:

"The aim of the integrated water management plan is to identify and bring together relevant water strategies and plans to consider land use impacts and opportunities as part of an overall approach. The objective is to consider how to manage water as a strategic resource within a sustainable development framework."

"Opportunities need to be considered for combining land uses such as drainage infrastructure, recreational facilities, open space and walking and cycling trails. This approach can lead to significant cost savings while promoting efficient use of land, which ultimately assists housing affordability."

Figure 3 shows the scale and applicability of water options and at which planning scales they should be considered.

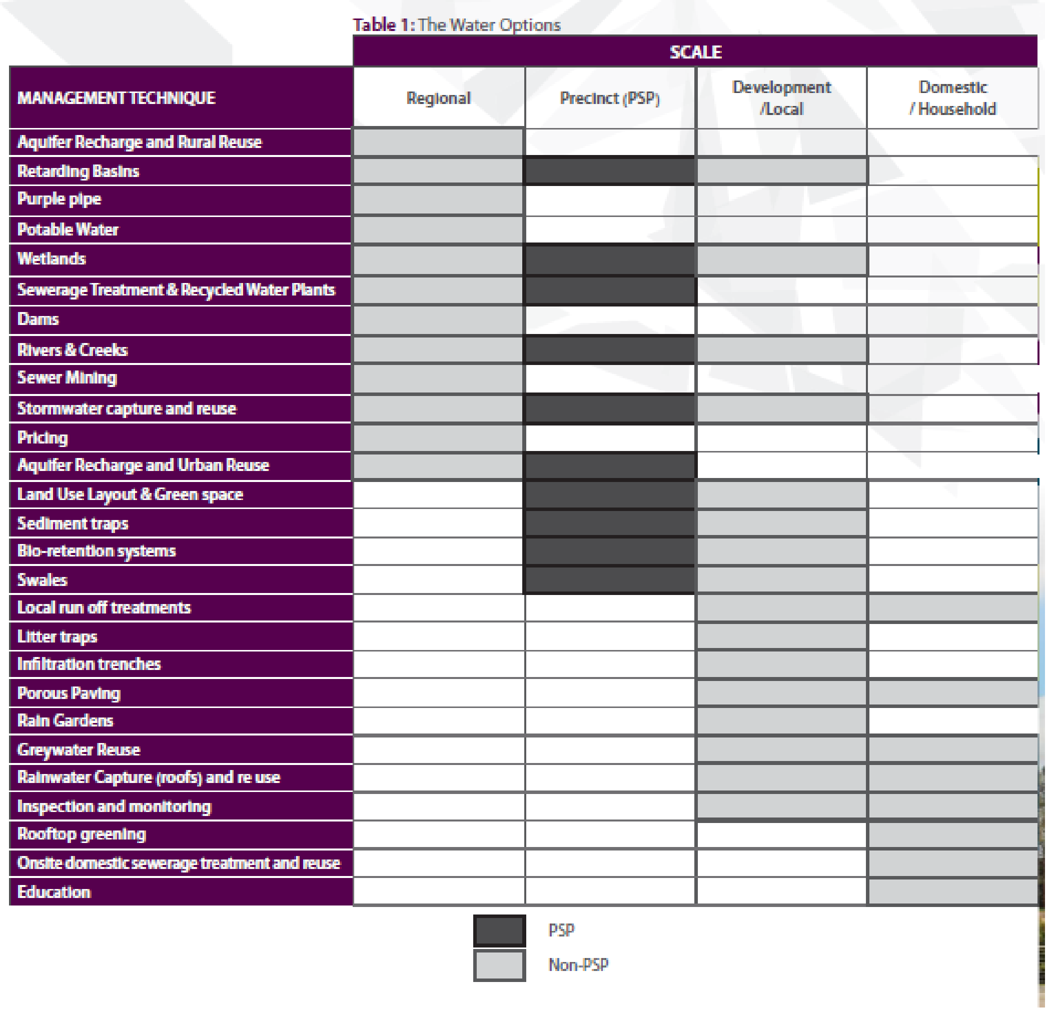


Table 1: The Water Options

MANAGEMENT TECHNIQUE	SCALE			
	Regional	Precinct (PSP)	Development /Local	Domestic / Household
Aquifer Recharge and Rural Reuse	▨			
Retarding Basins	▨	■	▨	
Purple pipe	▨			
Potable Water	▨			
Wetlands	▨	■	▨	
Sewerage Treatment & Recycled Water Plants	▨	■		
Dams	▨			
Rivers & Creeks	▨	■	▨	
Sewer Mining	▨			
Stormwater capture and reuse	▨	■	▨	
Pricing	▨			
Aquifer Recharge and Urban Reuse	▨	■		
Land Use Layout & Green space		■	▨	
Sediment traps		■	▨	
Bio-retention systems		■	▨	
Swales		■	▨	
Local run off treatments			▨	▨
Litter traps			▨	
Infiltration trenches			▨	
Porous Paving			▨	▨
Rain Gardens			▨	
Greywater Reuse			▨	▨
Rainwater Capture (roofs) and re use			▨	▨
Inspection and monitoring			▨	▨
Rooftop greening				▨
Onsite domestic sewerage treatment and reuse				▨
Education				▨

■ PSP
▨ Non-PSP

Figure 3 Scale and Applicability of Water Options (source: MPA (GAA) PSP Notes Integrated Water Management)

This ultimate WoWCA developed is required to consider Melbourne's Water Future and the nominated whole-of-water-cycle performance outcomes and urban planning outcomes relevant to the PSP area in accordance with the IWM PSP Note. The plan also needs to consider An Integrated Water Future for Melbourne's North produced by Yarra Valley Water, Melbourne Water and Office of Living Victoria and has been expanded to take into account further work being undertaken as part of the Water Future North project. Arup's approach in the development of the WoWCA base case and the two alternative options has been to utilise the water scenarios developed as part of the Regional IWMP for the North as a basis to ensure regional alignment.

MPA WoWCA objectives

Objectives of the whole-of-water-cycle assessment include:

- Diversification of supply thereby reducing the cost of future large scale centralised water/wastewater systems
- Waterway health improvement, consisting of less volume and higher quality
- Management of potential flooding and decreasing flood risk
- Improved liveability and urban landscapes
- Engagement of the community via key stakeholders.
- It is likely that there are other opportunities within the planning and building process that will also help to deliver on the above objectives.
- To deliver on these objectives, whole-of-water management opportunities could include:
    - Minimising potable water usage by use of alternative water supplies
    - Roof rainwater harvesting
    - Stormwater harvesting
    - Stormwater quality measures
    - Flood management including the minimisation of flood extents
    - Sewer mining
    - Groundwater including aquifer storage and recovery
    - Sewage treatment and discharge
    - Improving environmental, landscape and liveability outcomes through water management.

1.3 Acknowledgments

In developing this base case report Arup have consulted with the organisations and persons noted below. The purpose of the consultation has been to understand each organisations position with respect to a proposed water strategy for the Donnybrook and Woodstock PSP areas, thereby ensuring that the proposed strategy developed as part of this work is congruent with the intentions of each organisation. Arup wishes to acknowledge the following people and organisations who have provided input into the preparation of the Summary Report.

Table 1: Organisations and persons consulted in development of base case

Organisation	Name
MPA	Bruce Hunter Chris Braddock Fiona McDougall
Yarra Valley Water	Paul Curtis Simon Newberry Alicia Carr Kein Gan
Whittlesea City	Niall McGovern Ben Harris Ross Guastalegname Molly Wilson Edmond Lascaris Paul Bellis
Melbourne Water	Stephen Miller Carolina Balagtas Nino Polon Andrew Mellor James Hodgens Digby Richardson
Office of Living Victoria	Bridgett Weatherall Lisa Ehrenfried Kanchana Karunaratna
Mitchell Shire	Amy Reynolds Gregory Harris
Department of Health	Vanora Mulvenna

2 Site details

PSP boundaries and the location of the site in relation to Melbourne are illustrated in Figure 4.

The Donnybrook PSP is located in the Cities of Whittlesea and Mitchell and to the east of the recently approved Lockerbie PSP. The precinct is bounded by the Outer Metropolitan Ring Road (OMR) E6 reservation to the north, the Sydney-Melbourne train line to the west, Donnybrook Road to the south, and the Woodstock PSP to the east.

The Donnybrook PSP is 1,067 hectares (gross) with a proposed primary land use of residential. The PSP is expected to accommodate over 10,000 residential lots. Land to the north of Merri Creek, in the Mitchell Shire Council, is identified as “potential urban” in the North Growth Corridor Plan (see Figure 1). The PSP for Donnybrook will need to confirm a specific land use designation for this land.

The Woodstock PSP is bounded by the OMR E6 reservation to the north-east, Merriang Road in the east, Donnybrook Road to the south, with the boundary of the Donnybrook PSP defining the western boundary of the PSP. The Woodstock PSP is 759 hectares (gross) with a proposed primary land use of residential and is expected to accommodate over 7,500 residential lots.

These precincts form part of larger-scale development in the North Growth Corridor and will contribute to a projected population increase in the North to between 260,000 to 330,000 residents by 2031. The two precincts will be serviced by the Donnybrook Principal Town Centre (in the Lockerbie PSP, immediately abutting the west of the precinct), and are expected to accommodate local town centres, community facility hubs, local active recreation and passive reserves and conservation areas (see Figure 5 for the current draft land use budget).

A description of existing site conditions in contained in Appendix A.

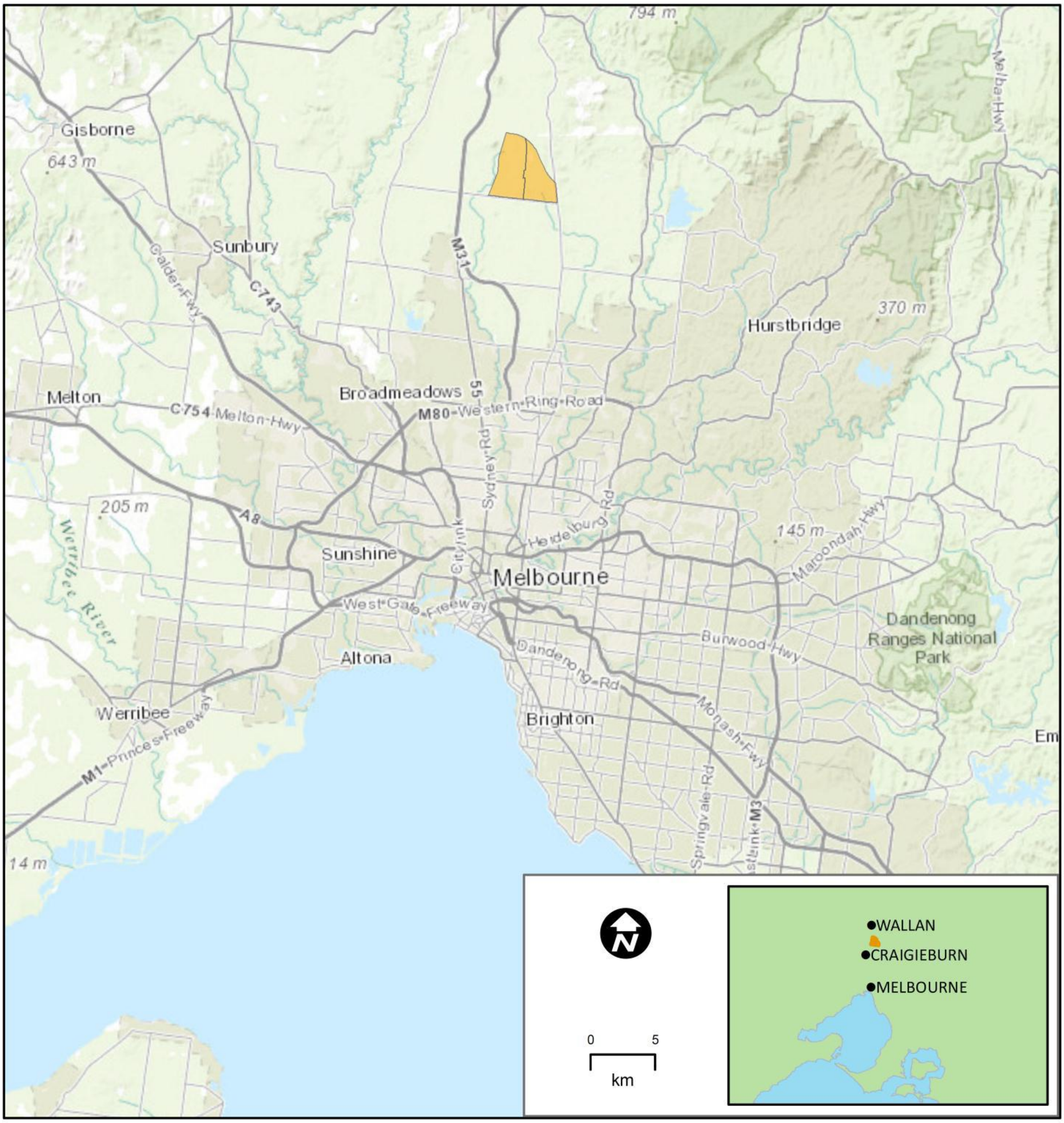


Figure 4 Locality map

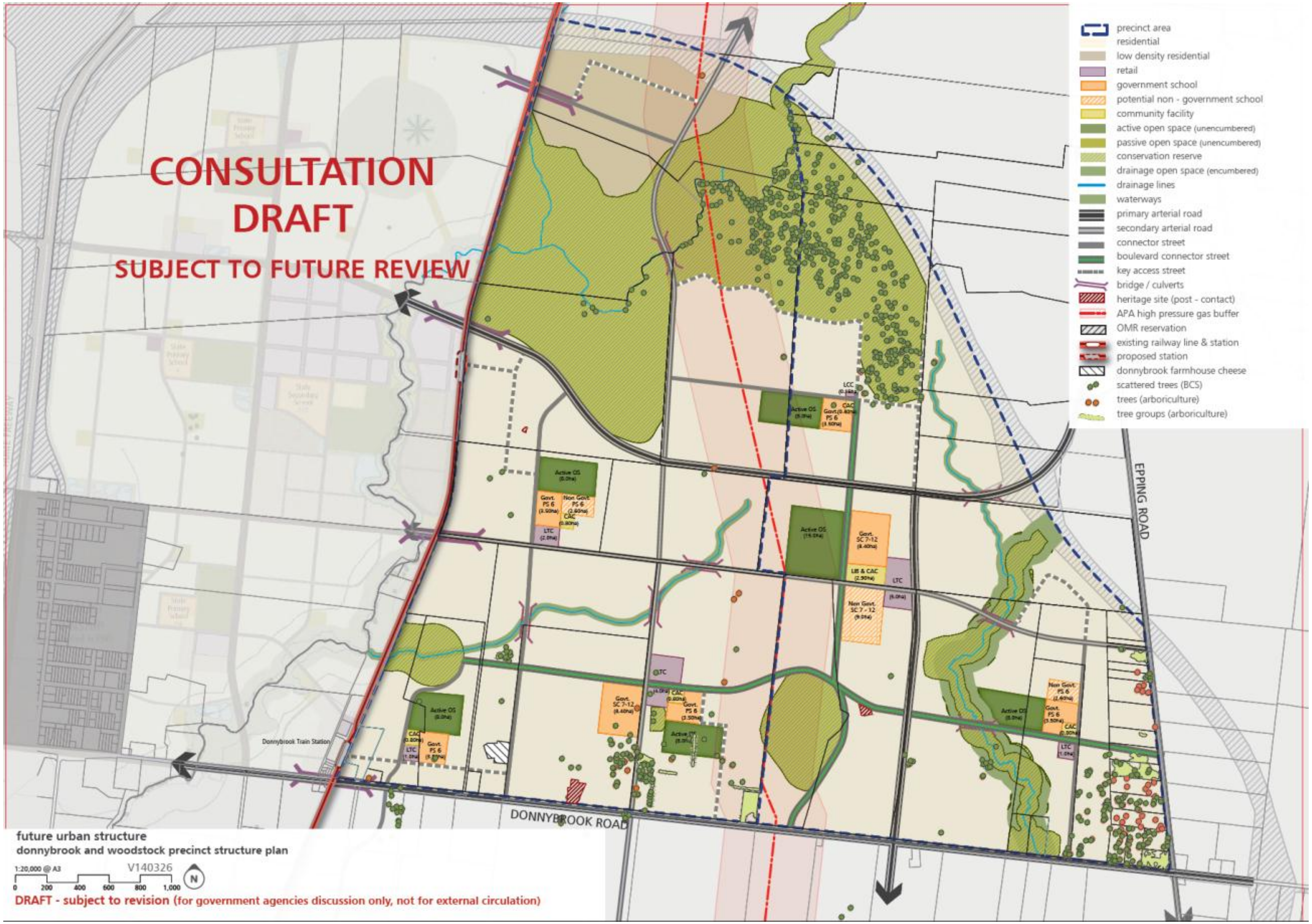


Figure 5 Draft Future Urban Structure (source: MPA)

3 Option description and assumptions

A key component of this phase of work was to collaborate with the project stakeholders (organisations listed in Table 1) to develop two alternative whole of water cycle options for the PSP areas and the assumptions on which analysis of these are based. This was done via face-to-face meetings, a stakeholder workshop and a formal feedback process on the alternatives developed.

3.1 Alternative option development

Stakeholders were asked to assist in the development of Alternative WOWCA servicing options that better aligned with overarching WOWCA objectives and helped leverage regional and city scale objectives as the local scale as outlined in Figure 6.

Figure 6 The hierarchy of whole of water cycle management as defined by OLV

These alternative options were developed at a highly interactive Stakeholder Workshop held in Arup’s offices on 13 February 2014. Stakeholders were asked to consider site specific objectives and the mechanisms to achieve these objectives via the alternative options developed.

The workshop was attended by representatives of:

- Office of Living Victoria
- City of Whittlesea
- Mitchell Shire Council
- Yarra Valley Water
- Metropolitan Planning Authority

- Melbourne Water

Detailed workshop notes are contained in Appendix B.

Key objectives identified for the site included:

- Align with wider regional water planning initiatives
- Maximise the use of recycled water
- Utilise rainwater/stormwater where possible
- Enhance waterway health
- Maintain amenity of open space and urban areas through the provision of irrigation water for green space and tree watering and the use of water conveyance areas as a means of connecting the community (e.g. through installation of bike tracks and walking paths)

Potential means to achieve the above objectives were identified through:

- Improved water use efficiency in households
- Connectivity along drainage lines
- Export of excess water
- Use of household rainwater tanks which could include ‘leaky’ tanks for the management of flow events and provision of household hot water
- Distributed WSUD systems for surface water management
- Extension of recycled water beyond mandated residential areas to as many uses/users as possible
- Placement of park areas in low points of catchments to allow for irrigation via gravity fed stormwater harvesting – stormwater for open space

Post workshop the information was collated to develop two alternative WOWCA options. These were then circulated to stakeholders for comment

Comments were received by the following organisations:

- Office of Living Victoria – regarding updated demand figures for Water Future North and alignment with government water policy
- Melbourne Water – regarding risks associated with the use of rainwater tanks at the lot scale for detention of high flow events and difficulties associated with the use of retarding/basins wetlands for frog habitat. This advice noted that both of these options should be considered secondary benefits rather than primary functions of this WoWCA infrastructure
- City of Whittlesea – regarding aquifer storage and recovery potential

These comments were considered and the Alternative options were re-drafted to account for this stakeholder feedback.

3.2 Options description

3.2.1 Base case

The first stage of the WoWCA was to define and develop a base case for consideration by the wider stakeholder group. Arup's approach in defining the base case was to align with the existing planning work undertaken collaboratively between Melbourne Water, Yarra Valley Water and the Office of Living Victoria in developing the document "An Integrated Water Future for Melbourne's North." This document considers a number of options to provide water services to the growth areas of Melbourne north.

Accordingly the baseline option recognises that the PSP areas are within a mandated third pipe zone and residential lots will be supplied with recycled water via a regional treatment facility.

The base case was further defined and was presented to the stakeholders for comment and discussion at a subsequent stakeholder workshop. The base case was updated following comments from stakeholders regarding the supply and use of water, new demand figures and more locally specific MUSIC inputs developed as part of the Water Future North Project.

Base Case Option (source: Integrated Water Future for Melbourne's North)

Wastewater is collected and treated to recycled water standard at a regional treatment facility. The recycled water is then returned to residential houses via a 'third pipe' system for non-drinking purposes such as flushing toilets, washing clothes and watering the garden.

Piped drinking water supply and sanitation services are provided; however, drinking water pipes can be downsized as approximately 30 per cent of the water demand will be met by the recycled water system.

Retail and employment, education and public and open space land uses are supplied with potable water only. Active open space is irrigated to the minimum extent required to maintain coverage, but lush growth is not always achieved.

Rainwater and stormwater are collected in pipes and treated through a series of settling ponds and wetlands prior to discharge into the receiving waterway.

This option incorporates water efficiency measures including Water Efficiency Labelling Scheme (WELS) star rated appliances, fittings and fixtures.

Figure 7 provides a graphical representation of the flow of water under the agreed Base Case. The Base Case has been updated and modelled based on the following assumptions which have largely been drawn from the current work being undertaken by stakeholders in the preparation of Water Future North – WWCM options and data collection and information provided by MPA regarding expected densities.

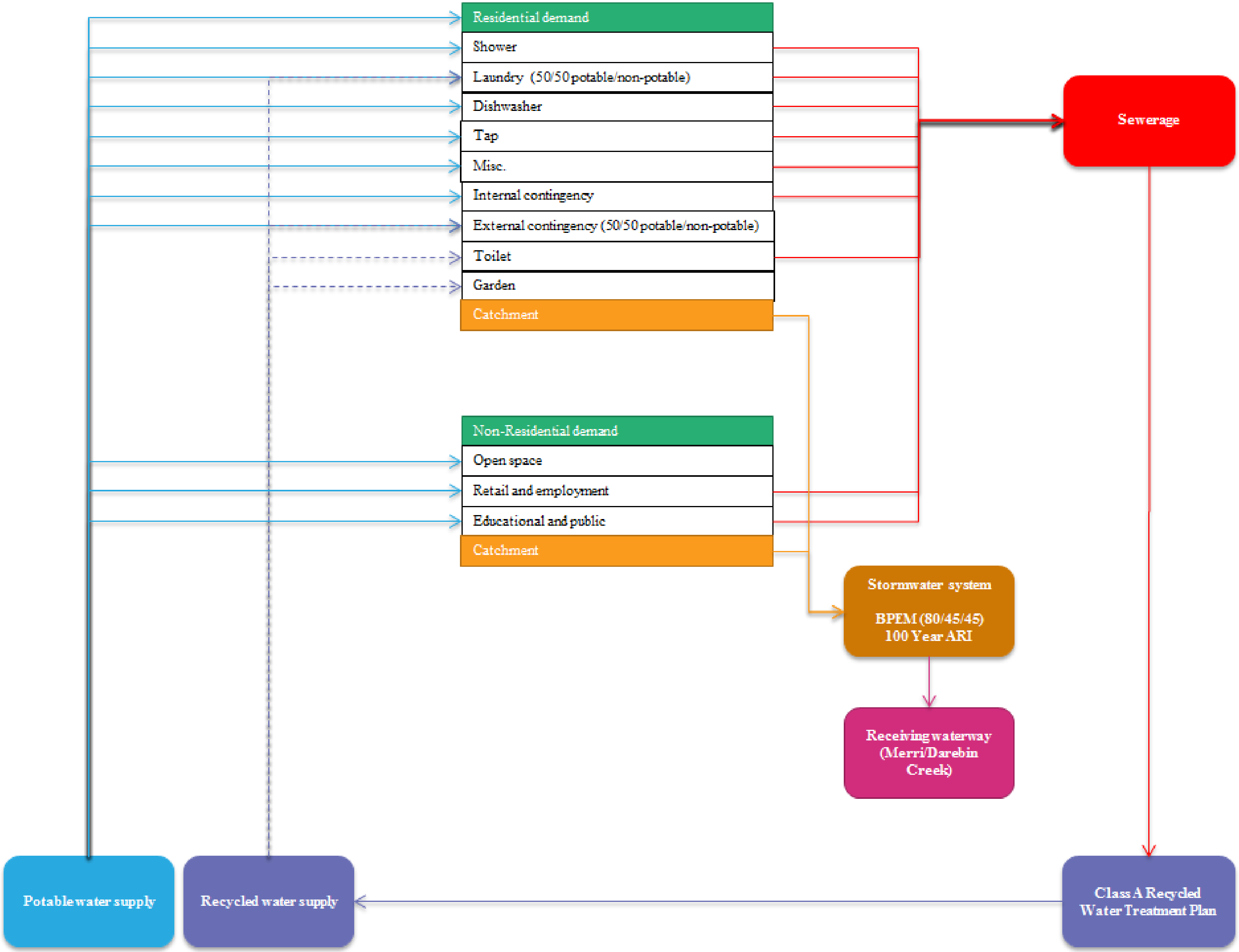


Figure 7 Base Case Water Flows

3.2.2 Alternative 1 – Base Case +

The Alternative 1 option is considered a Base Case Plus and has been developed to build on the elements identified in the Base Case and to reimagine/leverage these for improved WoWCA outcomes. A schematic flow diagram of water flows in this option are provided in Figure 8.

Description – Base Case +

An efficiency target is set which reduces water usage in households by 10% off baseline figures.

Wastewater is collected and treated to recycled water standard at a regional treatment facility. The recycled water is then returned to residential houses via a ‘third pipe’ system for non-drinking purposes such as flushing toilets, washing clothes and watering the garden. Recycled water is also supplied to non-potable uses in retail and employment, educational and community facilities to the maximum extent possible.

Piped drinking water supply and sanitation services are provided; however, drinking water pipes can be downsized as approximately 30 per cent of the water demand will be met by the recycled water system.

Rainwater and stormwater are collected in pipes and treated through a series of settling ponds and wetlands. Passively treated stormwater is used for irrigation of active open space to’ lush’ conditions all year round where feasible. Recycled water is provided to open space areas as a backup supply for irrigation.

This option incorporates water efficiency measures including Water Efficiency Labelling Scheme (WELS) star rated appliances, fittings and fixtures.

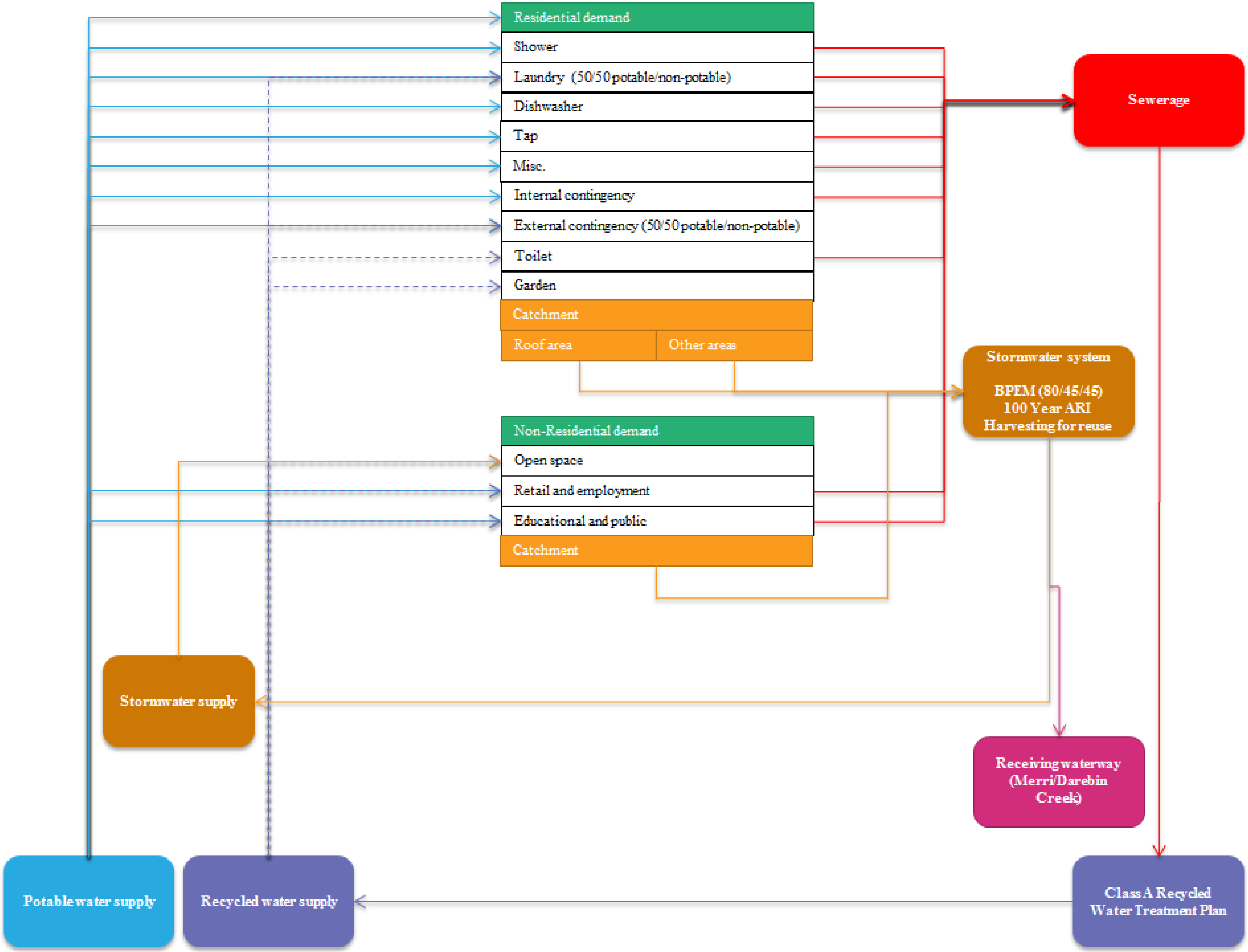


Figure 8 Alternative 1 – Base case plus water flows

3.2.3 Alternative 2 – Future stretch

The future stretch scenario was developed to introduce lot scale interventions to supply part of the residential water demand and also attempts to explore the benefits of a distributed approach to runoff water quality treatment and encourage innovation. A schematic flow diagram of water flows is provided in Figure 9.

Description – Future Stretch

An efficiency target is set which reduces water usage in households by 20% off the baseline.

Wastewater is collected and treated to recycled water standard at a regional treatment facility. The recycled water is then returned to residential houses via a ‘third pipe’ system for non-drinking purposes such as flushing toilets, washing clothes and watering the garden. Recycled water is also supplied to non-potable uses in retail and employment, educational and community facilities to the maximum extent possible.

Piped drinking water supply and sanitation services are provided; however, drinking water pipes can be downsized as approximately 30 per cent of the water demand will be met by the recycled water system.

Household rainwater tanks supply hot water usage in residential buildings and provide some additional detention and slow release of rainfall events from household roof areas incorporated as an additional opportunity to achieve beyond best practice.

A distributed approach to surface water runoff management incorporating streetscape elements along major road reserves and drainage lines to reduce size and extent of end of line detention and treatment is adopted. Stormwater is harvested for irrigation of open space to’ lush’ conditions all year round where feasible. The potential for Aquifer Storage and Recovery of treated stormwater is considered where feasible.

This option incorporates water efficiency measures including Water Efficiency Labelling Scheme (WELS) star rated appliances, fittings and fixtures.

It is also noted that there has been initial support from DEPI, Melbourne Water, OLV and councils for investigating the use of grassy woodland conservation areas for evaporation basins and to provide water to existing red gum areas. However, it is noted that a large amount of work still required to detail how this could be implemented particularly in terms of water delivery regimes, funding and ongoing maintenance.

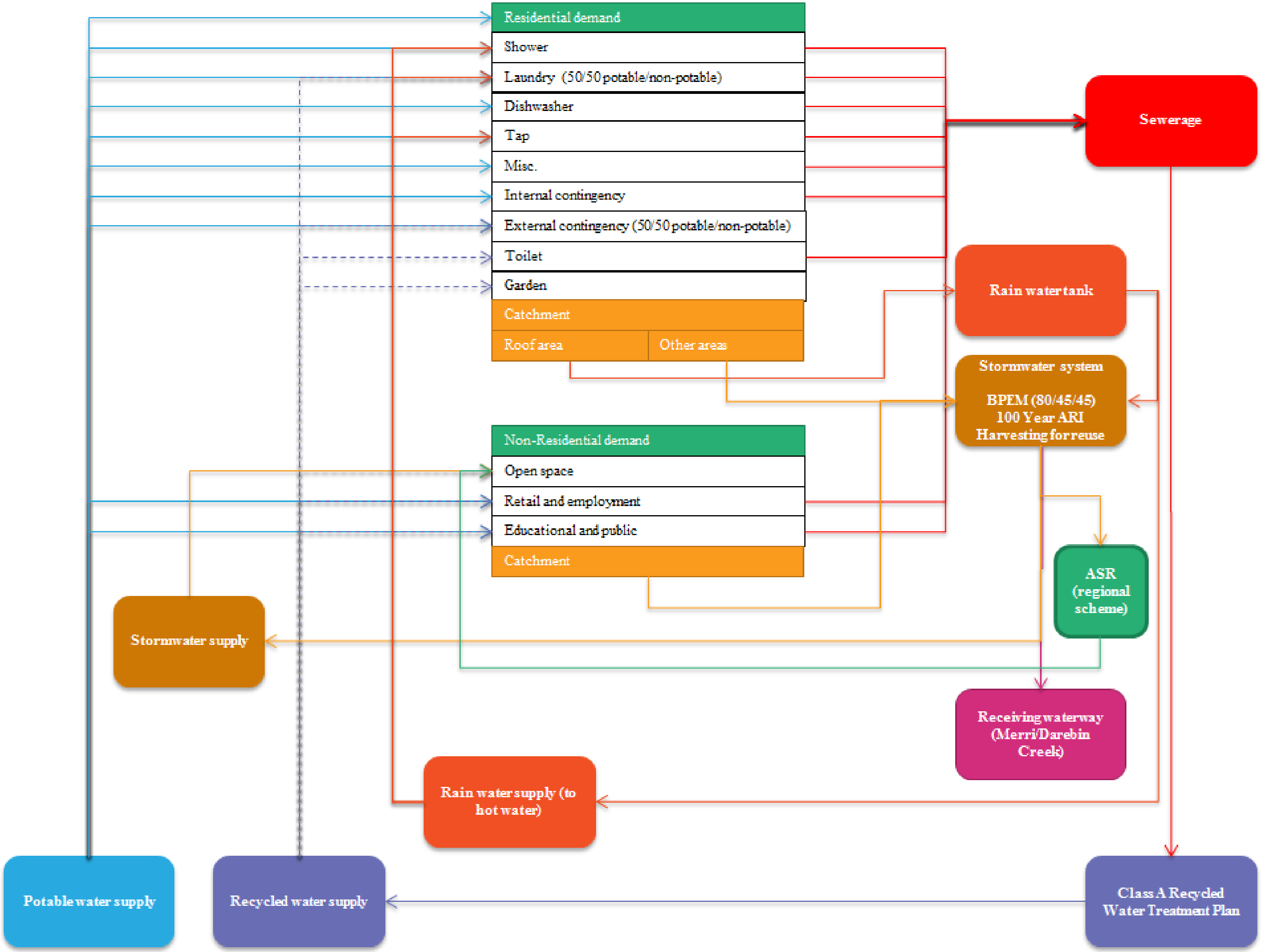


Figure 9 Alternative 2 – Future stretch water flows

3.3 Key assumptions

3.3.1 Land use types requiring water

The following land uses have been identified within the PSP areas as requiring some form of water servicing.

- Residential
- Active open space
- Retail and employment
- Educational and public

3.3.2 Land use extents

Donnybrook

Table 2 Donnybrook land use budget

Development Block	Dwellings	Active Open Space (ha)	Retail and Employment (ha)	Education and Public (ha)
D1 (high density)	960	4	0	0
D1* (low density)	132	0	0	0
D2	3420	8	2	6.9
D3	4700	16	5	17
Total Donnybrook (high density)	9080	24	7	23.9

Woodstock

Table 3 Woodstock land use budget

Development block	Dwellings	Open Space (ha)	Retail/Employment (ha)	Education and Public (ha)
WS1	1390	8	0.15	3.9
WS2	3570	15	1	6.9
WS3	1920	8	5	20.3
Total Woodstock	6880	31	6.15	31.1

*Alternative low density scenario for the northern Donnybrook area in Mitchell Shire assumes 1 acre blocks of 132 blocks of 2.47 blocks per hectare of Net Developable Area. All other household water usage assumptions remain the same. Low density also removes the 4ha of active open space.

An assumed average number of household inhabitants of 3 has been used based on advice received from Yarra Valley Water and OLV.

3.3.3 Residential Development Assumptions

Based on Yarra Valley Water's Water Use Calculator

Lot area (m2)	Persons per house	Garden size	Number of Cars	Roof area (m2)*
450	3	Small	1	270

* modelled as 100% impervious

3.3.4 Water supply

3.3.4.1 Potable

Potable water supply is provided by Yarra Valley Water from Yan Yean reservoir (see Figure 12 for YVW's Preliminary Servicing Strategy).

3.3.4.2 Recycled

Under the Base Case recycled water is provided by Yarra Valley Water for mandated residential use only.

Under Alternatives 1 and 2, recycled water is provided to all other land uses to the maximum extent possible (see Figure 12 for YVW's Preliminary Servicing Strategy).

3.3.4.3 Treated stormwater

Under Alternative 1 and 2 passively treated stormwater from wetlands is provided for open space irrigation where feasible to lush conditions and any shortfall is met by recycled water.

3.3.4.4 Rainwater

Under Alternative 2, rainwater from household roofs is provided to the hot water system and additional minimal storage is provided within rainwater tanks for part detention of rainfall events to achieve beyond best practice surface water management outcomes.

Tankulator.com.au has sized a tank of 1,500 L as capable of providing 100% of demands of 90.4 L/day of household hot water demand based on an average roof area of 270m^2. This totals 32,850 L of tank water used per household (or water from the mains supply saved).

Under this scenario the tank overflows on 92 days for a total of 164,341 L/hh/a.

In the absence of more detailed data it is assumed that daily potable water usage and recycled water usage in reduced by 45.2 L for each category of demand (i.e. 50% showers and 50% laundry.).

3.3.5 Surface water management

For the base case “end of line” treatment and detention systems for stormwater management incorporating retarding basins and wetlands prior to discharge to local waterways.

For Alternative 1 and 2, contributing catchments have been broken down in order to collocate retarding basins/wetlands in areas proximate to active open space to allow for these areas to be provided with treated stormwater for irrigation and to increase amenity outcomes.

Quantity to retard: 1 in 100 ARI year flow events.

Quality of discharge to meet current Best Practice Environmental Management Guidelines:

- 80 % reduction in Total Suspended Solids (TSS)
- 45% reduction in Total Phosphorous (TP)
- 45% reduction in Total Nitrogen (TN).

3.3.5.1 Water quantity/runoff

Arup developed a RORB model for both Donnybrook and Woodstock PSP areas to determine the retardation volume required to reduce the flows from proposed development back to the existing i.e. pre-development condition in line with the Business as Usual (BaU) scenario where “rainwater and stormwater are collected in pipes and treated through a series of settling ponds and wetlands prior to discharge into the receiving wetlands”.

RORB is a general runoff and streamflow routing program used to calculate flood hydrographs from rainfall and other channel inputs. It subtracts losses from rainfall to produce rainfall-excess and routes this through catchment storage to produce runoff hydrographs at any location. It can also be used to design retarding basins and to route floods through channel networks.

The results of the RORB model in terms of the indicative location of retarding basins are shown in the Baseline PSP layout in Figure 16.

3.3.5.2 MUSIC modelling inputs

MUSIC (Model for Urban Stormwater Conceptualisation) modelling was undertaken to assess the changes to water quality in the receiving environments following the development of the upstream catchment. MUSIC is decision support tool, developed by eWater and is used to assess different stormwater management measures.

A MUSIC model was constructed for the Donnybrook and Woodstock catchments to simulate the discharge loads and concentrations of TN, TP, TSS and Gross Pollutants (GP) generated by the catchment. The pollutant load reductions predicted by the model were compared with the Best Practice Environmental Management Guidelines (BPEMG) specified targets and the effectiveness of the proposed treatment measures was determined.

The model was developed in accordance with Melbourne Water’s MUSIC Guidelines (Melbourne Water, 2010) and recent regional updates recommended by E2 (2014) in the development of an IWCM for Melbourne’s North. This guideline provides guidance on the recommended input parameters and modelling approaches for developing MUISC models for the Northern Melbourne region. The following assumptions apply to development of the conceptual model:

- The recommended rainfall station for the project is Melbourne Airport Station which has a mean annual rainfall of 550-650mm. The reference year is 1996. A rainfall template with the rainfall data for the reference year (1996) recorded at 6 minute interval was utilised in the model. Monthly evapotranspiration values for the same period were adopted in the model.
- The proposed developments PSP 67 and PSP 96 were treated as independent catchments receiving no stormwater runoff from external areas.
- For the model development, the rainfall run-off characteristics recommended for the Merri Creek Catchment have been adopted. The soil properties were based on current work being undertaken by E2 (2014) in the Northern Growth Areas and are discussed further in Section 3.3.5.4.
- Similarly, the default values for TSS, TN and TP were used as per the Melbourne Water guidelines.
- The catchments of PSP67 and PSP96 were each sub-divided with wetlands treating the run-off generated in the smaller sub-catchments.
- The findings and recommendations from this assessment would need to be revisited following any significant change to the design of the development.
- For Alternatives 1 and 2, opportunities to break catchments up into smaller areas to allow for colocation of wetlands adjacent to proposed open space areas were undertaken.
- For Alternative 2 rainwater tanks at the household level sized at 1,500 L supplying hot water demands were included in the analysis with the subsequent decrease in overall retarding basin/wetlands determined. Analysis was also undertaken to include swales within the streetscape of major roads.

3.3.5.3 Expected pollutant concentrations

Table 4 Summary of pollutant concentrations for Donnybrook and Woodstock

Catchment Land Use Type	Parameter	Total Suspended Solids (TSS) (Log $_{10}$ mg/L)		Total Phosphorus (TP) (Log $_{10}$ mg/L)		Total Nitrogen (TN) (Log $_{10}$ mg/L)	
		Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow	Storm Flow
Commercial	Mean	1.1	2.2	-0.82	-0.45	0.32	0.42
	Std. Deviation	0.17	0.32	0.19	0.25	0.12	0.19

3.3.5.4 MUSIC Model Runoff Generation Parameters

Work currently being conducted by E2 (2014) has produced a calibration of the model for the Merri (and Darebin) Creek catchments (in the Northern Growth Corridor) which has resulted in soil parameters that are different to the MUSIC default parameters and different to those adopted in the Melbourne Water MUSIC modelling guidelines, as shown in the table below.

The calibrated soil parameters were determined by E2 based on an analysis of gauged flow data from Merri Creek. The adopted soil parameters result in flow data from MUSIC which corresponds to the gauged flow data for Merri Creek. The calibrated soil parameters have been used for modelling of stormwater runoff in the PSP areas.

Table 5 Calibrated soil parameters for Merri Creek (from 'Case study of development standards for beneficial waterway outcomes – Northern Growth Corridor', E2Designlab 2014')

Parameter	**Melbourne Water**	**MUSIC default**	**Merri Creek Calibrated**	
			97% (deep soil)	3 % (riparian zone)
Rainfall threshold (mm/day)	1	1	1	
Soil storage capacity (mm)	30	120	115	30
Initial storage (% of capacity)	25	25	25	
Field capacity (mm)	20	80	100	20
Infiltration capacity coefficient – a	200	200	200	
Infiltration capacity coefficient – b	1	1	1	
Initial groundwater depth (%)	10	10	10	
Daily recharge rate (%)	25	25	4	
Daily base flow rate (%)	5	5	3	
Daily deep seepage rate (%)	0	0	0	
Music Link Routing (day) **Muskingum-Cunge, Theta 0.25**	-	-	0.5	0.5
Imperious proportion (%)			1	0

3.3.5.5 Treatment elements

The recommended MUSIC modelling parameters for the treatment elements are from 'Case study of development standards for beneficial waterway outcomes – Northern Growth Corridor', E2Designlab 2014':

- Wetlands with extended detention of 0.35m and permanent pool depth of 0.35m. When included as part of the treatment train for a regional harvesting scheme, the treatment performance of the wetland itself must attain a minimum reduction of 80% TSS, 45% TN and 45% TP. This will ensure the longevity of the harvesting and storage infrastructure. The additional pollutant and flow reductions required to meet the new development standards can be attained through the benefits delivered by the harvesting scheme and/or evapotranspiration field.
- Vegetated swales - Assumed average depth of 0.5m, batter slope of 1 on 3 and base width of 1m.
- Rainwater tanks – sized at 1,500 L per household

3.3.6 Potable and non-potable water demands

3.3.6.1 Household

The following alternative water demand rates were used in the testing of options as derived from Yarra Valley Water (2013).

Table 6 Alternative water demand rates for 450m^2 allotments (based on Yarra Valley Water's Water Use Calculator for New Homes – Version Jan 13)

Use	Source	Demand (L/hh/day)
Toilet flushing	NP	50
Shower	P	113
Laundry (assumed 50/50 split)	NP/P	56
Dishwasher	P	9
Taps	P	79
Misc	P	9
Garden**	NP	43*
Car Washing	NP	-
Internal contingency	P	64
External contingency (assumed 50/50 split)	P/NP	22
Total Demand	**P/NP**	**455**

** Garden irrigation demand is based on 73L/hh/day rate between October to April and no irrigation between May and September. Note: Hot water is assumed to equate to 36% of the total internal demand which is calculated as 113 L/hh/day.

For household garden irrigation an average rate has been determined for calculations of annual demand. This rate is based on an average summer irrigation demand of 73 L/hh/day (between October and April) and no irrigation between May and September. This is based on Yarra Valley Water's Water Use Calculator which assumes an average of 2.1 garden watering sessions per week between October and April using a 16 L/min hose and an average of 15 minutes of watering.

3.3.6.2 Active open space

The following assumptions are for irrigation of active public open spaces (mm/m^2):

Table 7 Irrigation rates for active open space areas

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg Yr
Lush growth*	121.2	103.9	82.2	0	0	0	0	0	0	74	91.4	110.9	583.6
Maintenance**	95	74	44	0	0	0	0	0	0	17	46	70	346

* University of SA tank sizing tool adapted from Connellan (2002)

** Smartgardenwatering.org.au

3.3.6.3 Retail/Employment

- An average water demand of 6,450L/ha/day is identified for employment lands by Yarra Valley Water.
- Under Alternatives 1 and 2 it has been assumed that 61% of water usage is potable and 39% is non-potable (source: Sydney Water: Water use benchmarks for shopping centres).

3.3.6.4 Education and public

- Education and public building water usage of 1 kL/m^2/annum of Gross Floor Area (GFA) (source: Monash Sustainability Institute 2012 Australian Tertiary Education Sector Sustainability Report 2011).
- It has been assumed that the GFA is 50% of the total land area.
- Under Alternatives 1 and 2 it has been assumed that 77% of water use in educational facilities is non-potable and 23% is potable (source: www.epa.gov/watersense).

3.3.7 Sewer discharge

3.3.7.1 Residential

- Yarra Valley Water’s Water Use Calculator identifies 338 L/house/day of residential flows to sewer each day. This assumes 50% of tap and miscellaneous use is for human consumption and does not flow to sewer.

3.3.7.2 Open space

- No sewer discharge from open space

3.3.7.3 Retail and employment

- Yarra Valley Water identifies an average daily flow of 5,625 L/ha/day to sewer for employment land.

3.3.7.4 Education and Public

- The discharge rate for retail and employment land has been adopted of 5,625 L/ha/day

3.3.8 ASR Potential

Advice issued from MPA regarding ASR investigations noted that unless there is an established project that will be implemented by an authority/agency, investigations at the PSP should only consider if the outcome will allow an ASR scheme to be implemented in future within the PSP area or alternatively will feed into an adjoining ASR scheme.

Work by Jacbos and Melbourne Water (2014) assessing ground water resources in the Merri and Darebin Creek areas has recently commenced particularly in relation to the presence and extent of ground water dependent ecosystems. Information provided in relation to the above work does not make mention of the specific potential for an ASR scheme within the boundaries of the Donnybrook or Woodstock PSPs however it is noted that “although the Donnybrook Mineral Spring’s recharge zone is not in the zone of influence of the PSP zone (is further north), it is still a very fragile ecosystem in the area and has significant social value.” Accordingly any future ASR scheme and related investigations would need to balance the risk of affecting this mineral spring resource.

High level mapping conducted by CSIRO in 2006 notes that ASR potential in the area of Donnybrook and Woodstock is very low to low. Accordingly in the context of PSP planning further investigation of the potential for ASR is not warranted at this stage and should be led by a more appropriate agency such as s Water Authority and target a regional scale due to the significant expense involved in conducting on ground investigations to determine the potential and associated risk factors of ASR.

If a smaller scale ASR scheme was developed the most logical place would be in the location of wetlands/retarding basins assuming geological conditions allow and there is sufficient demand for recovered water.

3.3.9 Climate Change Scenarios

Consistent with most recent climate data, the following three climate scenarios have been utilised in modelling of potential impacts of future climate change. This data is sourced from DSE (2008). Climate change in the Port Phillip and Westernport region. Department of Sustainability and Environment. http://www.climatechange.vic.gov.au/__data/assets/pdf_file/0008/73196/PPWP_WEB.pdf

These scenarios have been used to sensitivity test the WOWCA options in MUSIC by altering climatic conditions such as rainfall, evaporation and temperature accordingly.

Table 8 Climate change criteria utilised in the modelling of scenarios

Criteria	2030	2070	
		Low emissions	High emissions

Change in average temperature (C)	0.6 to 1.1	0.9 to 1.9	1.8 to 3.7
Change in annual rainfall (%)	-8 to 0	-13 to 0	-24 to 0
Change in potential evaporation (%)	+1 to +5	+1 to +9	+2 to +17

4 Precinct demands and sewer discharge

The follow section depicts the anticipated precinct wide demands and sewer discharges for the various land uses under each of the options. A summary graph is provided in Figure 10.

4.1 Base Case

Demands

Table 9 Base case demands for Donnybrook and Woodstock

Land use	Supply	Donnybrook	Woodstock
Residential	Potable	1037 ML	786 ML
	Non-potable	437 ML	331 ML
Open space	Potable	97 ML	107 ML
Retail and employment	Potable	16.5 ML	14.5 ML
Education and public	Potable	120 ML	156 ML
Total	**Potable**	**1270 ML**	**1063 ML**
	Non-potable	**437 ML**	**331 ML**

Sewer discharge

Table 10 Calculated sewer discharge volumes for Donnybrook and Woodstock

	Donnybrook	Woodstock
Residential	1120 ML	848 ML
Retail and employment	14 ML	12 ML
Education and public	49 ML	64 ML
Total (discharge)	**1183 ML**	**924 ML**

Base Case Summary

Donnybrook

Under the Base Case total anticipated water demands for Donnybrook are 1.7 GL per annum with 440 ML of this demand anticipated to be able to be provided by recycled water for household usage in the laundry, toilet and garden.

Sewer discharges total 1.2 GL per annum.

NB - The demands and discharges presented above currently assume a high density development scenario for the D1 block. If a low density approach is taken the anticipated 132 dwellings in this block (as opposed to 960 dwellings) would result in slightly lower overall consumption for the precinct of 1.34 GL/a and a sewer discharge volume of 1 GL/a

Woodstock

Under the Base Case total anticipated water demands for Woodstock are 1.4 GL per annum with 330 ML of this demand anticipated to be able to be provided by recycled water for household usage in the laundry, toilet and garden.

Sewer discharges total 920 ML per annum.

4.1.1 Alternative 1 – Base Case +

Demands

Table 11 Summary of water demands for Donnybrook and Woodstock under Alternative 1 – Base Case +

Land use	Supply	Donnybrook	Woodstock
Residential	Potable	934 ML	707 ML
	Non-potable, recycled	394 ML	298 ML
Open space	Non-potable, stormwater	163 ML	180 ML
Retail and employment	Potable	10 ML	9 ML
	Non-potable	6.5 ML	5.5ML
Education and public	Potable	27.5 ML	36 ML
	Non-potable	92 ML	120 ML
Total	**Potable**	**971.5 ML**	**749.5 ML**
	Non-potable, recycled	**495 ML**	**423.6 ML**
	Non-potable, stormwater	**163 ML**	**180 ML**

Sewer discharge

Table 12 Calculated sewer discharge volumes for Donnybrook and Woodstock under Alternative 1 - Base Case +

	Donnybrook	Woodstock
Residential	1000 ML	764 ML
Retail and employment	14 ML	13 ML
Education and public	49 ML	64 ML
Total (discharge)	**1063 ML**	**841 ML**

Alternative 1 – Base Case +

Donnybrook

Under the Base Case + total anticipated water demands for Donnybrook are 1.6 GL per annum with 500 ML of this demand anticipated to be able to be provided by recycled water for household usage in the laundry, toilet and garden and anticipated non-potable demands associated with retail and employment and education and public land uses.

Demands to provide lush active open space are anticipated to be 160 ML which can be provided by stormwater harvesting if feasible or via recycled water.

Sewer discharges total 1.1 GL per annum.

Woodstock

Under the Base Case + total anticipated water demands for Woodstock are 1.4 GL per annum with 420 ML of this demand anticipated to be able to be provided by recycled water for household usage in the laundry, toilet and garden and anticipated non-potable demands associated with retail and employment and education and public land uses.

Demands to provide lush active open space are anticipated to be 180 ML which can be provided by stormwater harvesting if feasible or via recycled water.

Sewer discharges total 850 ML per annum.

4.2 Alternative 2 – Future stretch

Demands

Table 13 Summary of water demands for Donnybrook and Woodstock under Alternative 2 - Future stretch

Land use	Supply	Donnybrook	Woodstock
Residential	Potable	680 ML	515 ML
	Non-potable, recycled water	200 ML	152 ML
	Non-potable, rainwater	350 ML	227 ML
Open space	Non-potable, stormwater	163 ML	180 ML
Retail and employment	Potable	10 ML	9 ML
	Non-potable	6.5 ML	5.5 ML
Education and public	Potable	27.5 ML	36 ML
	Non-potable	92 ML	120 ML
Total	**Potable**	**717.5 ML**	**557.5 ML**
	Non-potable – recycled)	**301 ML**	**277.6 ML**
	Non-potable – rainwater)	**350 ML**	**227 ML**
	Non-potable – stormwater)	**163 ML**	**180 ML**

Sewer discharge

Table 14 Calculated sewer discharge volumes for Donnybrook and Woodstock under Alternative 2 - Future stretch

	Donnybrook	Woodstock
Residential	896 ML	679 ML
Retail and employment	14 ML	13 ML
Education and public	49 ML	64 ML
Total (discharge)	**956 ML**	**756 ML**

Alternative 2 – Future stretch

Donnybrook

Under the Future Stretch total anticipated water demands for Donnybrook are 1.5 GL per annum with 300 ML of this demand anticipated to be able to be provided by recycled water for household usage in the laundry, toilet and garden and anticipated non-potable demands associated with retail and employment and education and public land uses.

Demands to provide lush active open space are anticipated to be 160 ML which can be provided by stormwater harvesting if feasible or via recycled water.

Rainwater capture at the household scale for use to supply domestic hot water supplies are estimated at 350 ML/a

Sewer discharges total 950 ML per annum.

Woodstock

Under the Base Case + total anticipated water demands for Woodstock are 1.25 GL per annum with 280 ML of this demand anticipated to be able to be provided by recycled water for household usage in the laundry, toilet and garden and anticipated non-potable demands associated with retail and employment and education and public land uses.

Demands to provide lush active open space are anticipated to be 180 ML which can be provided by stormwater harvesting if feasible or via recycled water.

Sewer discharges total 750 ML per annum.

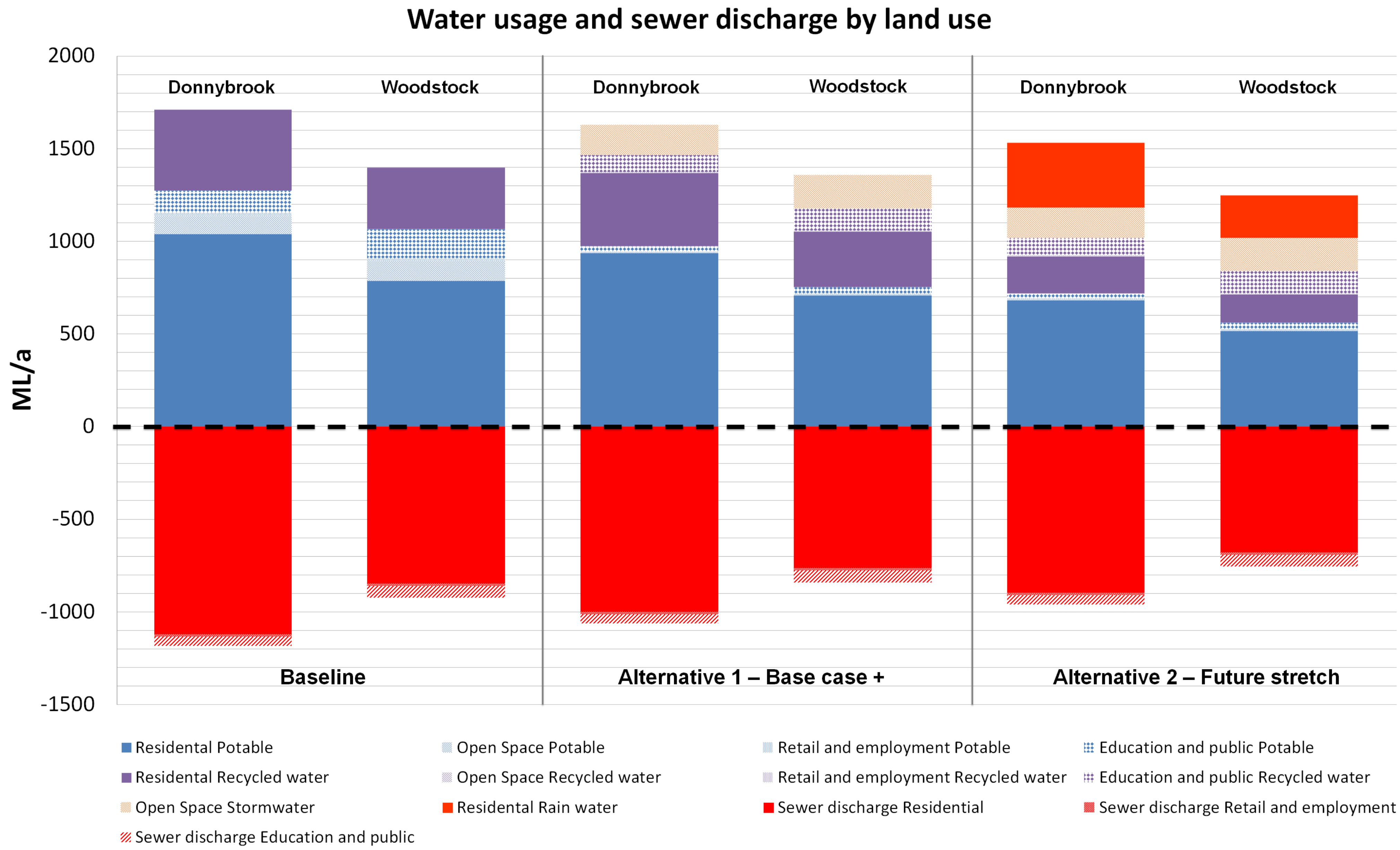


Figure 10 Water usage and sewer discharge by land use and water source

5 Schematic design

High level schematic designs have been prepared for each of the options including the revision of the scheme design for the base case demand figures and feedback from stakeholders regarding site constraints which are mapped in the Figure 11 below. These constraints have been mapped based on GIS layers provided by MPA and relate to:

- High value conservation areas
- Scattered trees
- High pressure gas pipeline easement
- Aboriginal cultural heritage sites
- Post-settlement cultural heritage sites
- Waterways
- Existing houses and facilities

The schematic designs developed have been assessed based on the required runoff and water quality targets, the appropriate whole of water cycle assets for the site conditions and opportunities and the results of the constraints assessment. The schematic designs have also attempted to take into account other design considerations appropriate at the PSP scale, such as:

- Multiple WoWCA benefits – design of surface water management systems to achieve multiple stormwater benefits, such as stormwater treatment, stormwater retention as well as water conservation and demand management.
- Consideration if other benefits can also be achieved through the stormwater design, such as high quality open space for communities along drainage lines and around wetlands and detention basins.
- Flooding – development of designs to minimise local inundation.
- Environment – consideration of surface water management measures can protect and enhance the environment.
- Climate change – consideration of the impacts that climate change may have on a system, and if these need to be accounted for in the design.
- Community – consideration of opportunities for community engagement and education, such as signage and ensuring opportunities for designing WSUD systems to be a community feature
- Opportunities to enhance proposed servicing strategies for the area from Melbourne Water and Yarra Valley Water (see Figure 12)
- Working with the current site topography to avoid major cut and fill requirements for stormwater infrastructure (see Figure 13)
- Preliminary construction and maintenance considerations

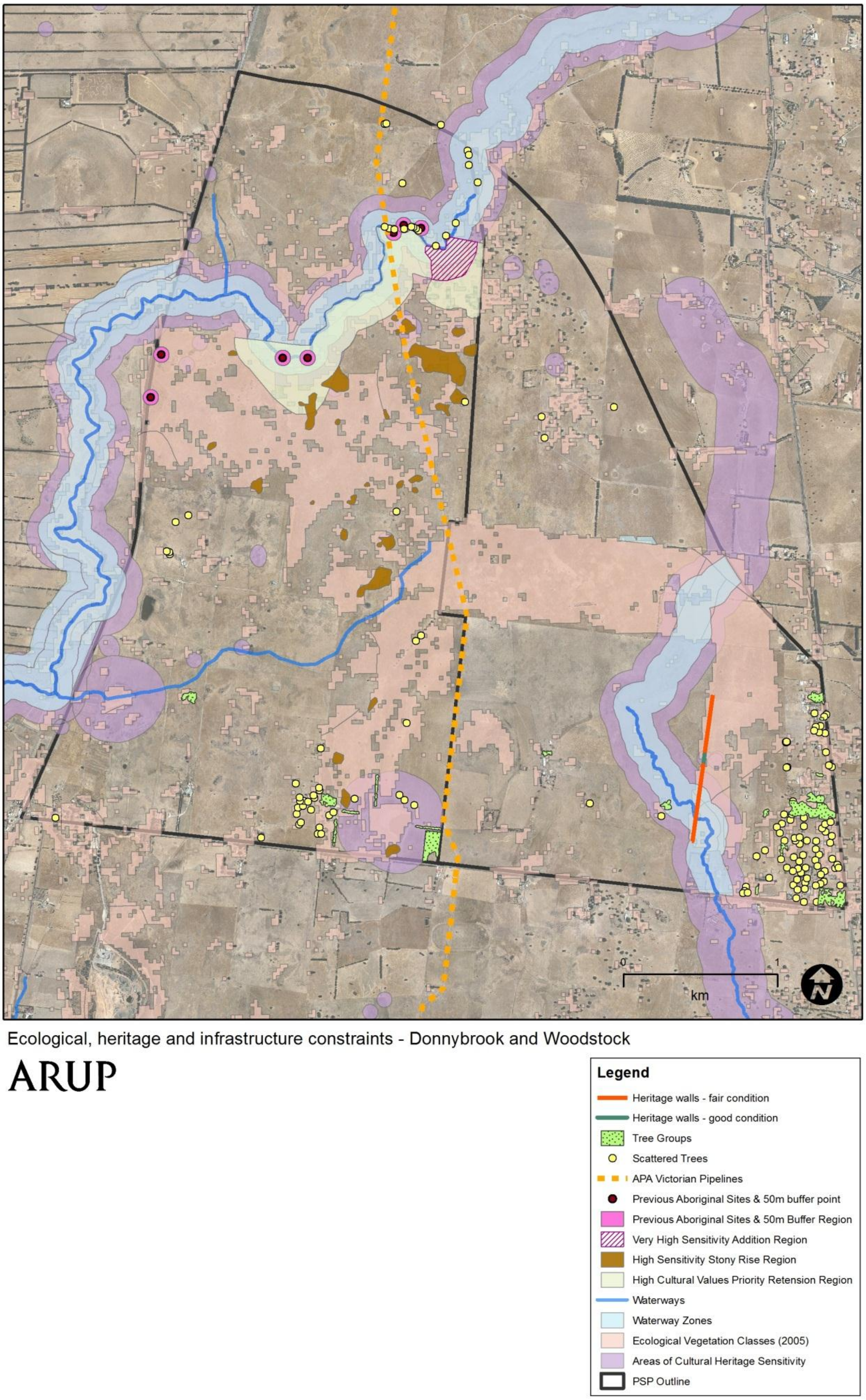


Figure 11 Site constraints

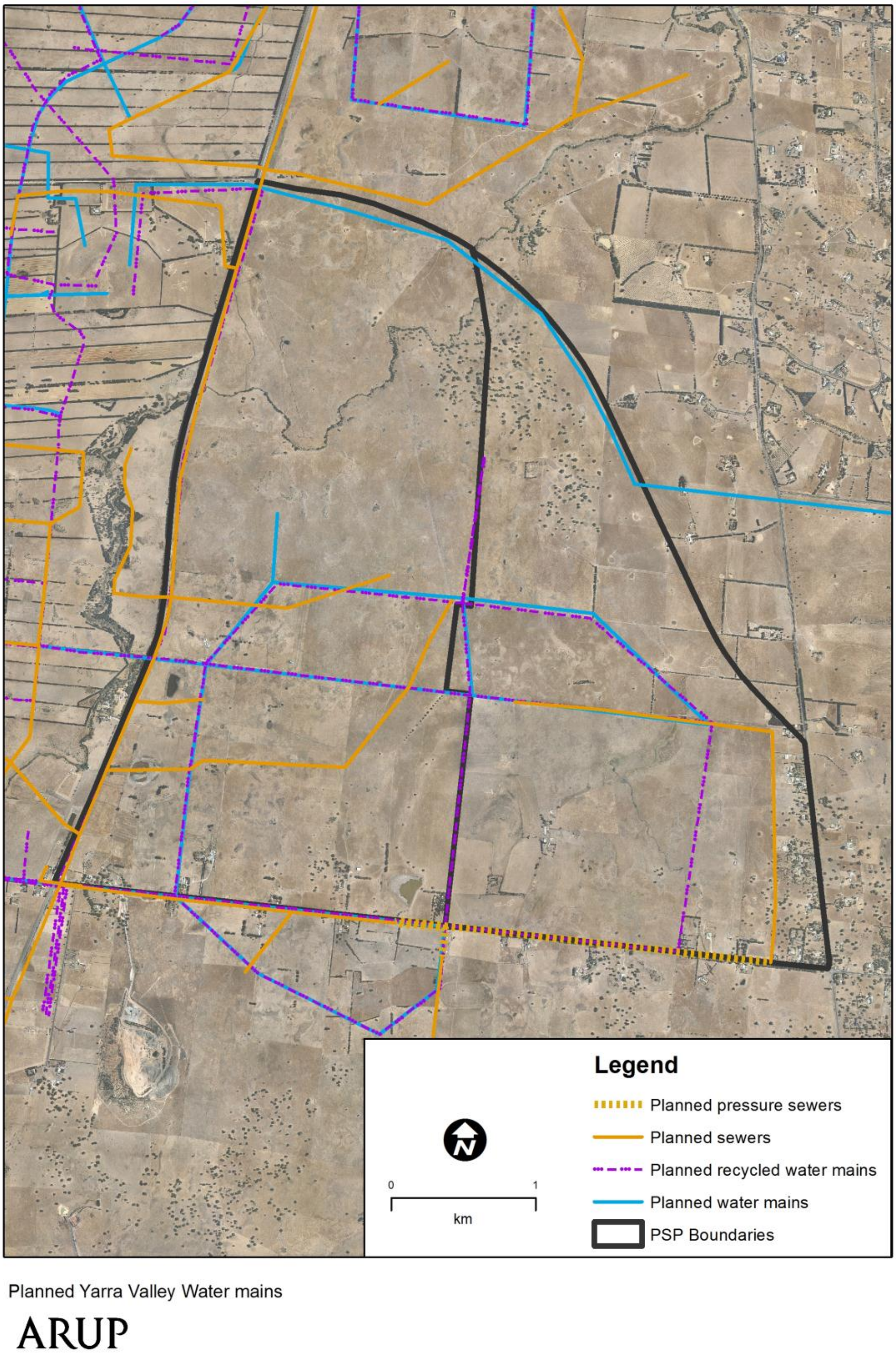


Figure 12 Yarra Valley Water Preliminary Servicing Strategy

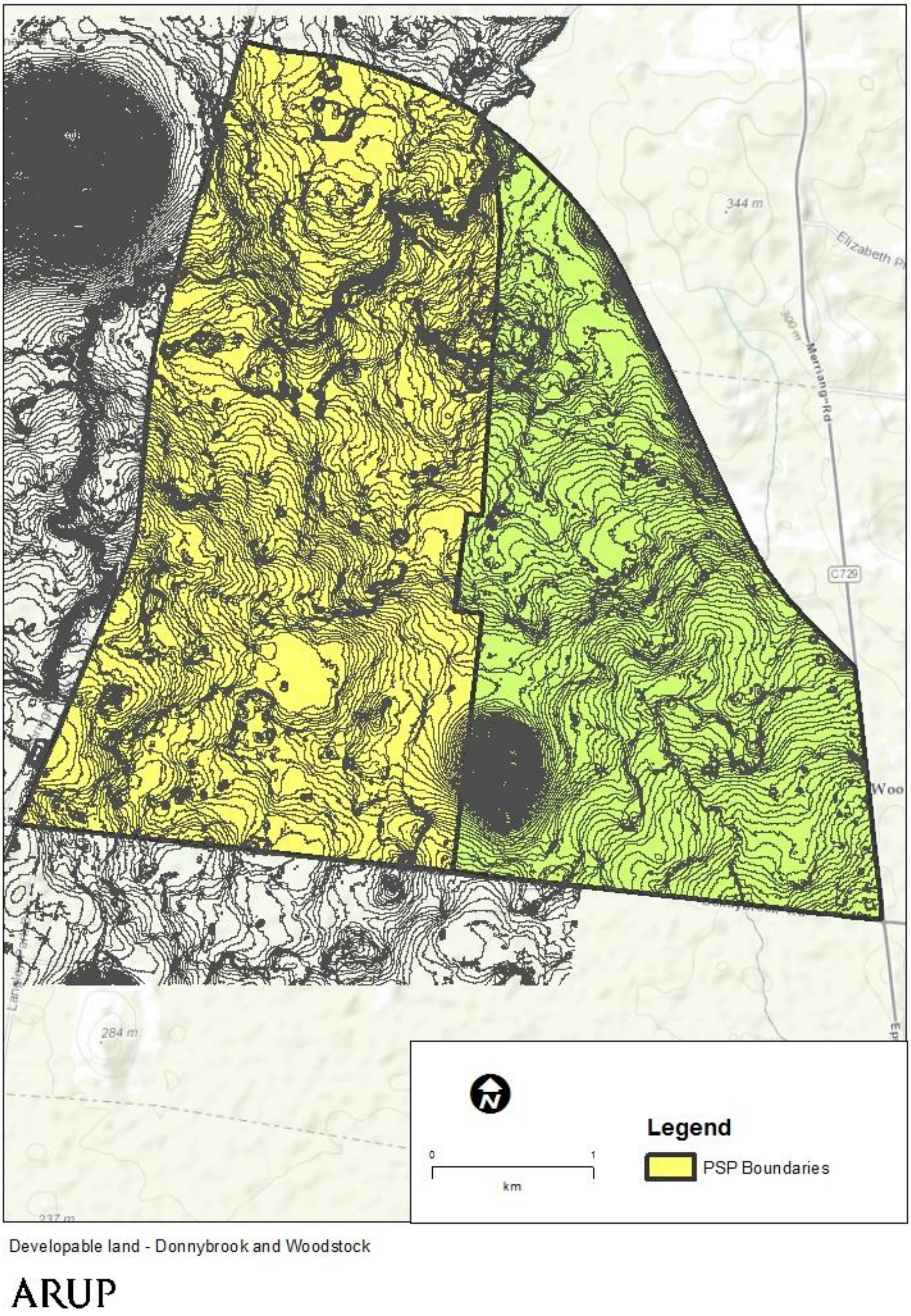


Figure 13 Site contours

5.1 Water Sensitive Urban Design

All options incorporate some form of Water Sensitive Urban Design (WSUD) to help achieve BPEM requirements; however the Alternative 1 and 2 options apply alternative configurations of these elements to increase the reuse of stormwater and rainwater and to explore high level opportunities to take a distributed rather than end of line approach to surface water management.

As noted by Melbourne Water innovative stormwater management, such as WSUD, can contribute greatly to sustainability and liveability, particularly when considered as part of an overall urban strategy. WSUD integrates urban water cycle management with urban planning and design, with the aim of mimicking natural systems to minimise negative impacts on the natural water cycle and receiving waterways and bays. It offers an alternative to the traditional conveyance approach to stormwater management by acting at the development scale (at the source), and thereby reducing the required size of the structural stormwater system. It seeks to minimise impervious surfaces, reuse water on site, incorporate retention basins to reduce peak flows, and incorporate treatment systems to remove pollutants. WSUD also provides the opportunity to achieve multiple benefits though sustainable urban water management.

WSUD applications can include a range of applications, including:

- grassed or landscaped swales
- infiltration trenches and bio-retention systems
- gross pollutant traps, wetlands and sediment ponds
- rainwater tanks – stormwater harvesting and reuse
- grey water harvesting and reuse
- rain gardens, rooftop greening and urban forests
- porous pavements
- aquifer recharge and reuse

A summary of WSUD features, treatment function applicability and cost is provided below (see Figure 14). The Alternative Options developed for this project require the potential use or rainwater tanks, vegetated swales and the co-location of wetlands within retarding basins. A description of these features is proved below along with maintenance considerations and cost assumptions (adapted from Melbourne Water and E2 (2014)).

Table 15 Cost functions for WSUD features

	Capex	Opex
Wetland	$75/m^2$	$0.50/m^2/a
Vegetated swale	$150//m^2$	$5/m^2/a
Rainwater tanks (includes tank, pumping and plumbing for 1,500L)	$4,000 per unit	$60 per unit/a

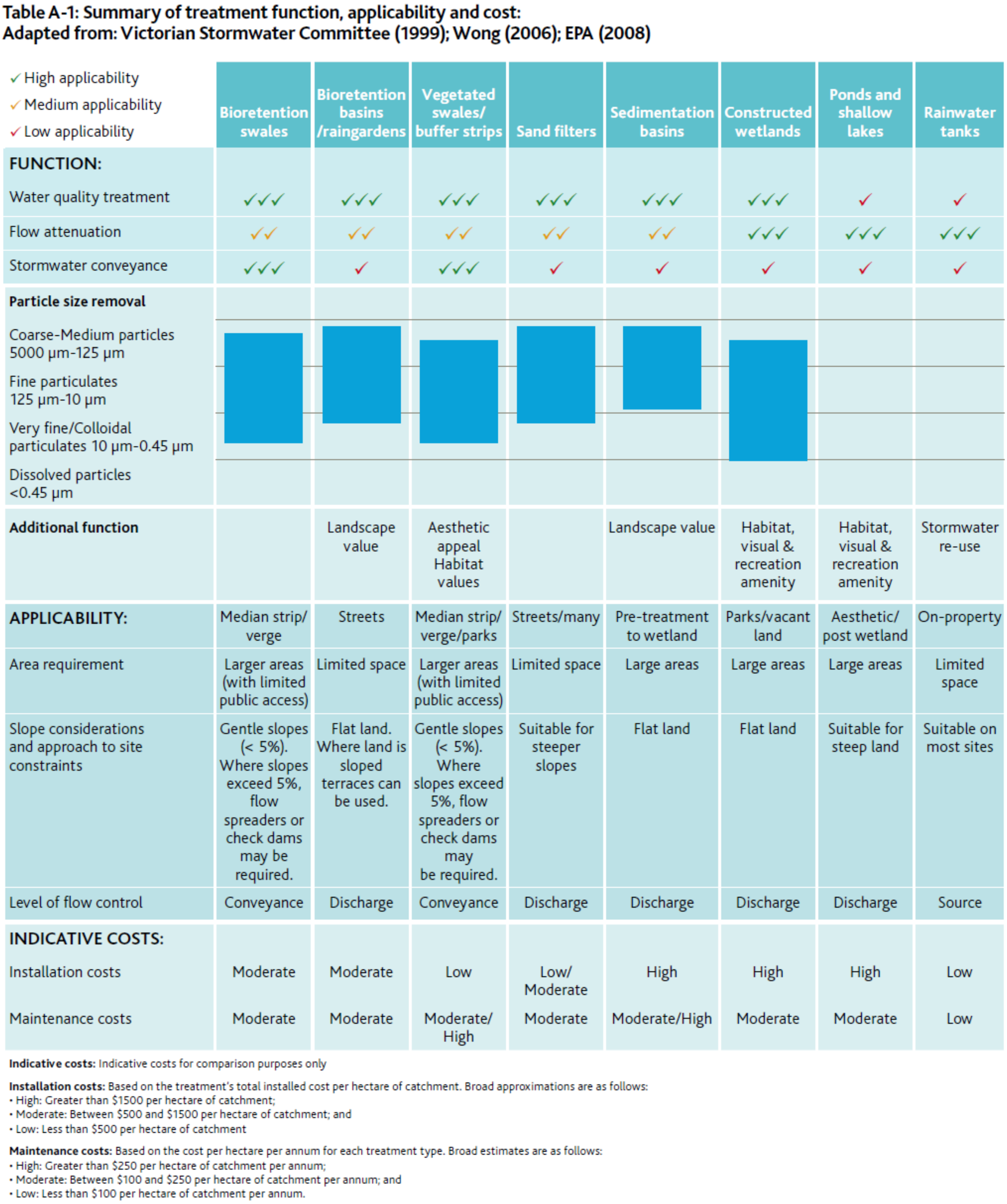


Table A-1: Summary of treatment function, applicability and cost:
Adapted from: Victorian Stormwater Committee (1999); Wong (2006); EPA (2008)

✓ High applicability ✓ Medium applicability ✓ Low applicability	Bioretention swales	Bioretention basins /raingardens	Vegetated swales/ buffer strips	Sand filters	Sedimentation basins	Constructed wetlands	Ponds and shallow lakes	Rainwater tanks
FUNCTION:								
Water quality treatment	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓	✓
Flow attenuation	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓✓	✓✓✓	✓✓✓
Stormwater conveyance	✓✓✓	✓	✓✓✓	✓	✓	✓	✓	✓
Particle size removal								
Coarse-Medium particles 5000 µm-125 µm	■	■	■	■	■	■		
Fine particulates 125 µm-10 µm	■	■	■	■	■	■		
Very fine/Colloidal particulates 10 µm-0.45 µm	■	■	■	■		■		
Dissolved particles <0.45 µm								
Additional function		Landscape value	Aesthetic appeal Habitat values		Landscape value	Habitat, visual & recreation amenity	Habitat, visual & recreation amenity	Stormwater re-use
APPLICABILITY:	Median strip/ verge	Streets	Median strip/ verge/parks	Streets/many	Pre-treatment to wetland	Parks/vacant land	Aesthetic/ post wetland	On-property
Area requirement	Larger areas (with limited public access)	Limited space	Larger areas (with limited public access)	Limited space	Large areas	Large areas	Large areas	Limited space
Slope considerations and approach to site constraints	Gentle slopes (< 5%). Where slopes exceed 5%, flow spreaders or check dams may be required.	Flat land. Where land is sloped terraces can be used.	Gentle slopes (< 5%). Where slopes exceed 5%, flow spreaders or check dams may be required.	Suitable for steeper slopes	Flat land	Flat land	Suitable for steep land	Suitable on most sites
Level of flow control	Conveyance	Discharge	Conveyance	Discharge	Discharge	Discharge	Discharge	Source
INDICATIVE COSTS:								
Installation costs	Moderate	Moderate	Low	Low/ Moderate	High	High	High	Low
Maintenance costs	Moderate	Moderate	Moderate/ High	Moderate	Moderate/High	Moderate	Moderate	Low

Indicative costs: Indicative costs for comparison purposes only

Installation costs: Based on the treatment's total installed cost per hectare of catchment. Broad approximations are as follows:
- High: Greater than $1500 per hectare of catchment;
- Moderate: Between $500 and $1500 per hectare of catchment; and
- Low: Less than $500 per hectare of catchment

Maintenance costs: Based on the cost per hectare per annum for each treatment type. Broad estimates are as follows:
- High: Greater than $250 per hectare of catchment per annum;
- Moderate: Between $100 and $250 per hectare of catchment per annum; and
- Low: Less than $100 per hectare of catchment per annum.

Figure 14 WSUD features, treatment function applicability (source: Melbourne Water)

5.1.1 Vegetated swales/Buffer strips

Vegetated swales convey stormwater and provide removal of coarse and medium sediment. They are commonly used in conjunction with areas of vegetation through which runoff passes, known as buffer strips. Vegetated swales are similar to bioretention swales, but are less effective in removing nitrogen from the stormwater, as they do not feature the filtering component and convey water on the surface only.

Vegetated swales can provide an aesthetically pleasing landscape feature and are relatively inexpensive to construct and maintain. They can be used median strips, verges, car park runoff areas, parks and recreation areas.

Design and maintenance considerations

- The longitudinal slope of a swale is the most important consideration. Swales are most efficient with slopes of 1% to 4%. Lower than this, swales can become waterlogged and/or have stagnant pooling, while steeper slopes may have high flow velocities (with potential erosion and vegetation damage risks).
- Check banks (small porous rock walls) may be constructed to distribute flows evenly across the swale if they are identified as the most suitable treatment option in such areas.
- Where swales are publicly accessible, flow depths and velocities must be acceptable from a public risk perspective.
- Traffic and deliveries should be kept off swales as they may damage vegetation and create preferential flow paths that do not offer filtration. Appropriate mitigation measures should be implemented.
- Swale side slopes depend on Council regulations, traffic access and the provision of crossings. Typically 1 in 9 side slopes are suitable. For maintenance requirements, grassed swales requiring mowing must not have side slopes exceeding 1 in 4.

5.1.2 Wetlands

Wetland systems are shallow, extensively vegetated water bodies that remove pollutants through enhanced sedimentation, fine filtration and pollutant uptake processes. Stormwater runoff is passed slowly through the vegetated areas, which filter sediments and pollutants, and biofilms establish on the plants, which absorb nutrients and other contaminants.

Wetlands are well suited to treat large volumes of stormwater runoff and have the advantage of improving local amenity and providing habitat diversity.

Key design issues to consider include:

- verifying the size and configuration for treatment;
- determining design flows;
- designing the inlet zone;
- layout of the macrophyte zone;
- hydraulic structures;

- selecting plant species; and
- planting densities and providing maintenance.

Design and maintenance considerations

- The constructed wetland should treat at least 90% of Mean Annual Runoff (MAR) through the use of a stored event volume above the normal standing water level of the wetland.
- A high flow bypass should be capable of taking flows in excess of design flows (typically a 1 in 1 year event).
- The wetland design must meet safety requirements and implement reasonable safety measures. This includes fencing, safety batters, signage and benching.
- Health and Safety considerations for maintenance staff should also be addressed. It is recommended that an independent safety audit be conducted for each design.
- Approach batter slopes should be no steeper than 1:5 Vertical to Horizontal (V:H). All edges should have safety benches of at least 1.5m to 3.0m wide from the edge of the normal top water level.
- Safety benches should have a maximum grade of 1:8 (V:H) for the first 1.5m – 3.0m before changing to a 1:5 (V:H) grade for at least the next 0.5m. Beyond this, may be up to a maximum of 1:3 (V:H). The safety bench should be densely planted with emergent macrophytes such that casual entry will be difficult.
- Hard stand areas should be provided adjacent to the inlet zone to allow for the maintenance and cleanout of this zone.
- Measures to reduce the prevalence of mosquitoes should be taken
- Where possible, wetlands should be constructed in the base of retarding basins to reduce land requirement.
- The wetland should be divided into four macrophyte zones, an open water zone and a littoral zone and the percentage allocation of each zone in line with Melbourne Water guidance.
- Suitable vegetation should be adopted as per Melbourne Water guidelines
- Wetlands require large areas of land for construction and are unsuited to steeply sloping land.
- A geotechnical investigation is required prior to design to determine soil profiles and infiltration rates.
- Hydrogeological investigations may also be required in areas where there is a likelihood of groundwater discharge or high seasonal water tables.

5.1.3 Rainwater tanks

Rainwater tanks collect roof runoff for subsequent reuse, conserving potable mains supplies and reducing stormwater runoff volumes and pollutants from reaching downstream waterways.

Rainwater tanks are applicable to areas of high roof area to occupancy ratio, while they are less applicable in regions of low roof area to occupancy ratio, such as medium and high density residential dwellings.

Design and maintenance considerations

- Rainwater tanks should be installed in accordance with the Plumbing and Drainage Standards (AS/NZS 3500:2003).
- Rainwater tanks may not provide the optimal strategy for stormwater runoff from a sustainability perspective compared to a centralised stormwater harvesting scheme. This issue should be investigated thoroughly during the concept design stage of a project.
- Continual water balance assessments using MUSIC should be performed to determine how much runoff rainwater tanks are removing from the catchment in terms of runoff volumes and associated pollutant loads.
- Rainwater tanks should be sized using the appropriate reference curves for the region

Advice was sought from the Department of Health (DoH) related to the use of rainwater for hot water systems. A summary of this advice is provided below

- Use of roofwater is not regulated by the Victorian DoH.
- DoH has provided guidance on the use of roofwater and rainwater tanks in urban communities, *Rainwater use in urban communities - Guidelines for non-drinking applications in multi-residential, commercial and community facilities*, April 2013.
- Research was undertaken in 2012 on the microbial risk for the use of roofwater in hot water systems. A Quantitative Microbial Risk Assessment was performed and the research looked at different hot water systems (electric, solar, gas). One of the main outcomes was, *"Hot water services should not be relied on to inactivate enteric pathogens (pathogens found in the gut) as they may not heat water to a high enough temperature for long enough to act as appropriate treatment (Deere et al 2012)."*
- The research indicated that the use of roofwater in hot water systems poses a higher risk to users than the normal health standards that the DoH has for potable water.
- The DoH cannot reject the use of roofwater in hot water systems, but this poses a risk to end users which they need to made aware of.

5.2 Anticipated layout

Figure 15, Figure 16 and Figure 17 show the anticipated schematic layouts for each of the options including major drainage paths and the location of wetlands, retarding basins and vegetated swales.

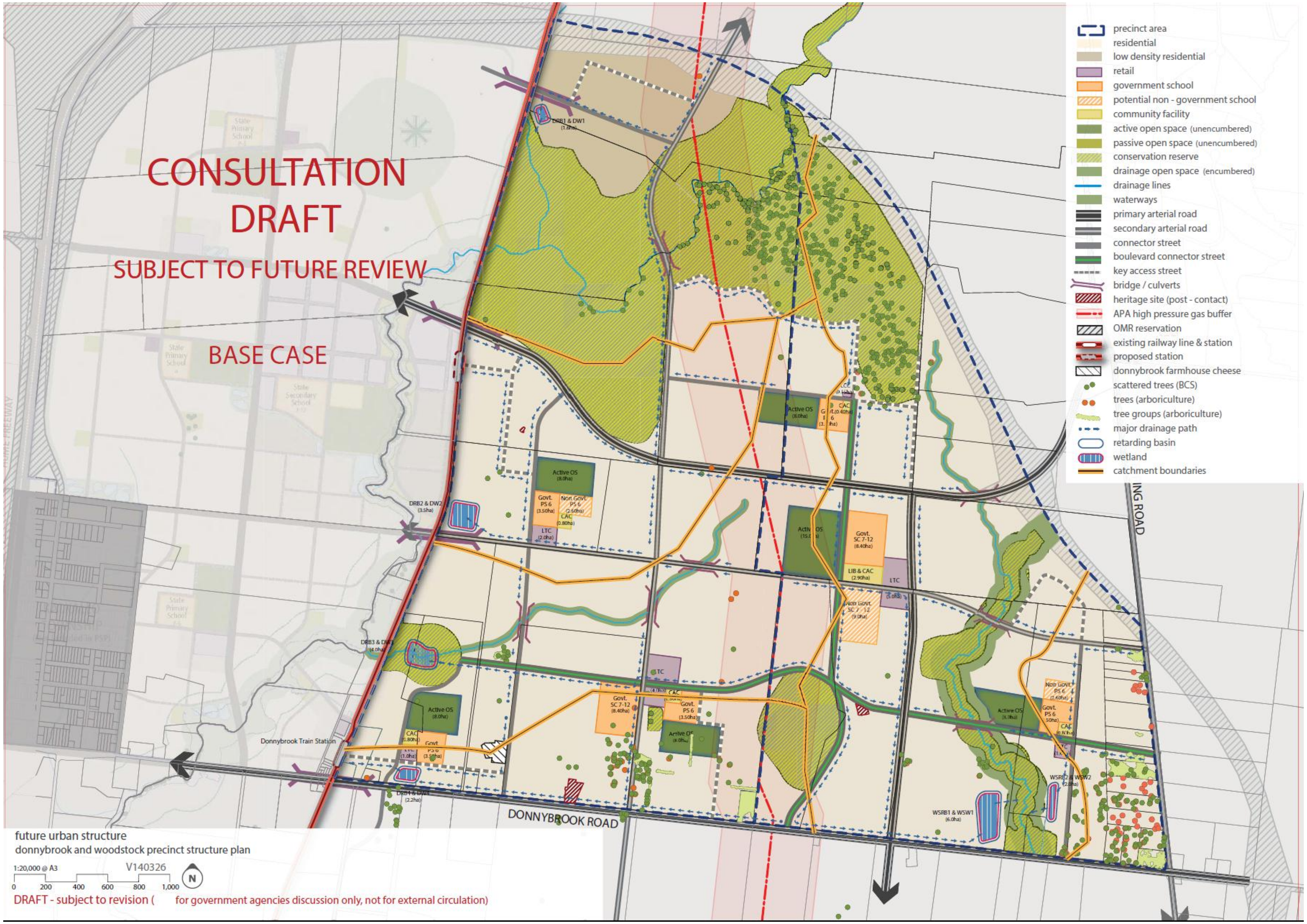


Figure 15 Base case schematic design

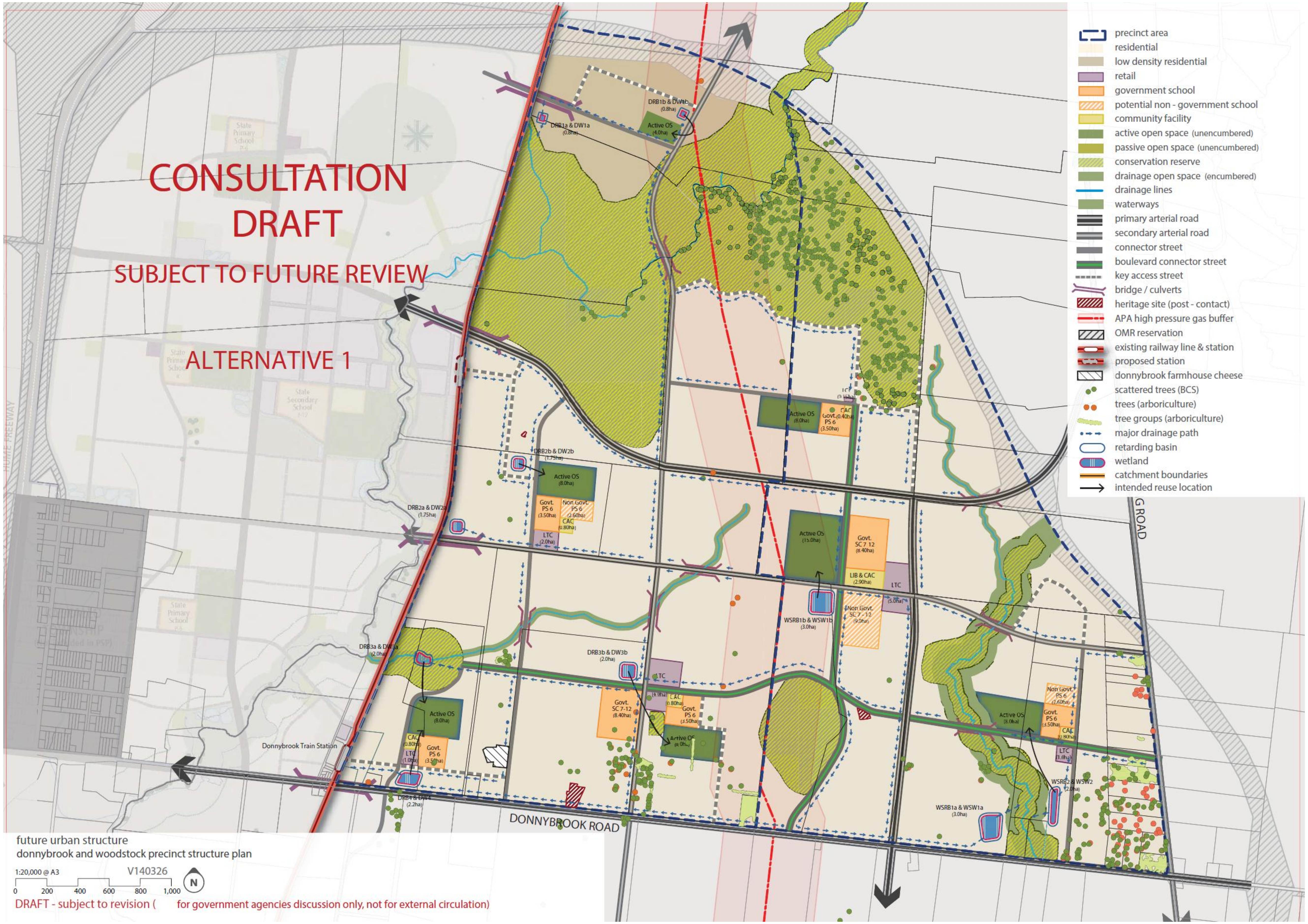


Figure 16 Alternative 1 – Base Case Plus – Schematic Design

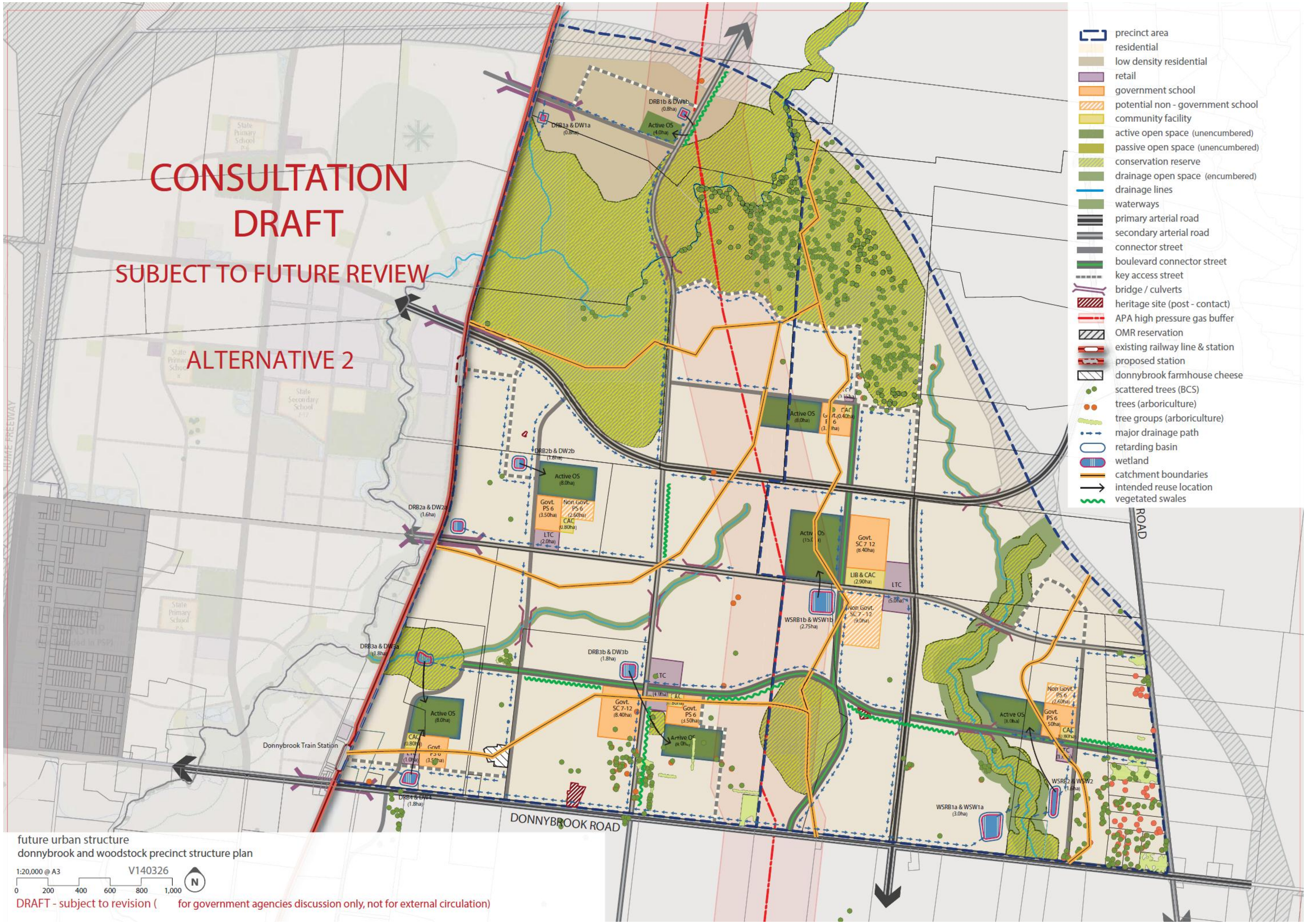


Figure 17 Alternative 2 – Future Stretch – Schematic Design

5.3 Land take requirements

5.3.1 Base case

Four of the retarding basins (DRB 1, 2, 3 and 4) are located in Donnybrook within PSP 67 which discharges to Merri Creek. WSRB 1 and 2 are located in the Woodstock area, within the southern extent of PSP 1096 located within the Darebin Creek catchment.

Table 16 Properties for Proposed Retarding Basins for Base Case

Name of RB	Inflow (m^3/s)	Outflow (m^3/s)	Volume (m^3)
DRB 1	34.99	21.03	38,300
DRB 2	80.78	14.92	54,200
DRB 3	35.27	17.95	28,800
DRB 4	42.23	24.26	84,500
WSRB 1	51.00	15.06	25,000
WSRB 2	37.94	9.37	18,000

Refer to Donnybrook and Woodstock Precinct Structure Plan for location of proposed retarding basins.

The design of wetlands to treat stormwater and meet BPEM water quality requirements are discussed in the water quality section of this report. The wetlands for all the sub-catchments have been located inside the retarding basins to minimise land take by combining water retardation and treatment functions while still meeting 1 in 100 year flood detention and meeting best practice water quality discharge requirements.

Generally the design of retarding basins can be varied to suit the available land area, to an extent. However, in this case as the wetlands are located within the retarding basin, the surface area requirement of the wetlands have dictated the footprint of the retarding basins as shown in the precinct structure plan.

Table 17 Retarding basin areas for Donnybrook PSP

Name of Retarding Basin	**Name of Wetland**	**Base Case Footprint (ha)**
DRB 1	DW 1	1.6
DRB 2	DW 2	3.5
DRB 3	DW 3	4.0
DRB 4	DW 4	2.2
Total	4 wetlands	11.3

Table 18 Retarding basin areas for Woodstock PSP

Name of Retarding Basin	Name of Wetland	Base Case Footprint (ha)
WSRB 1	WSW 1	6.0
WSRB 2	WSW 2	2.0
Total	2 wetlands	8.0

5.3.1.1 Donnybrook

Four tributaries of the Merri Creek are located within PSP 67. As these four tributaries each have different outlet locations to the existing downstream environment four separate retention elements are needed to retain the extra volume of stormwater to prevent flooding during a 1 in 100 year event.

- DRB 1 is proposed to be located at the northern tributary of the Merri Creek with the retardation volume of 38,300m^3 in order to retard flows from urban cell D1.
- DRB 2 is located on the overland flow path which is located in the middle of the PSP 67 and has an anticipated volume of 54,200m^3.
- DRB 3 is located adjacent to the tributary that runs through the middle of PSP 67 and has a volume of 28,800m^3.
- DRB 4 is proposed at the southern end of the PSP. The volume of this retarding basin will be 84,500m^3.

5.3.1.2 Woodstock

Two tributaries of the Darebin Creek exist within PSP 96. These two tributaries have different outlet locations and therefore two separate drainage system are needed to retain the additional post-development volumes of stormwater to prevent flooding.

- Retarding basin WSRB 1 is proposed to be located at the tributary which flows from north to south through the middle of the development with a retardation volume of 25,000m^3.
- WSRB 2's proposed location is on the eastern tributary with a volume of 18,000m^3.

5.3.2 Alternative 1 and 2

For Alternatives 1 and 2, the above retarding basins and wetlands have been broken down to two smaller retarding basins and wetlands where considered feasible after taking into consideration the topography and location of proposed open spaces. The purpose of this iterative exercise was to provide distributed wetland locations and maximise reuse opportunities by locating wetlands as close as possible to open space areas requiring irrigation.

For the purpose of sizing and designing the retardation basins, total inflow, outflow and retardation volume for base case, Alternative 1 and 2 are all assumed to be same although for Alternative 2 there is likely to be small but negligible reduction in pervious area and therefore overflow due to inclusion on vegetated swales which reduces the required wetland area. There are also minor associated benefits in reduction in water requiring treatment with the installation of rain water tanks at the household scale.

The name and surface area (i.e. footprint) of each of the retarding basin and wetlands for Alternative 1 and 2 are summarised below:

Table 19 Retarding basin and wetland areas required for the Donnybrook PSP for Alternatives 1 and 2

Name of Retarding Basin	Name of Wetland	Alternative 1 Footprint (ha)	Alternative 2 Footprint (ha)
DRB 1a	DW 1a	0.8	0.8
DRB1b	DW1b	0.8	0.8
DRB 2a	DW 2a	1.75	1.6
DRB 2b	DW 2b	1.75	1.6
DRB 3a	DW 3a	2.0	1.8
DRB 3b	DW 3b	2.0	1.8
DRB 4	DW 4	2.2	1.8
Total Land Take	**7 wetlands**	**11.3**	**10.2**

Table 20 Retarding basin and wetland areas required for the Woodstock PSP for Alternatives 1 and 2

Name of Retarding Basin	Name of Wetland	Alternative 1 Footprint (ha)	Alternative 2 Footprint (ha)
WSRB 1a	WSW 1a	3.0	2.75
WSRB 1b	WSW 1b	3.0	2.75
WSRB 2	WSW 2	2.0	1.6
Total Land Take	**3 wetlands**	**8**	**7.1**

Land take

- For Donnybrook land take for wetlands/retarding basins ranges from 11.3 hectares to 10.2 hectares
- For Woodstock land take for wetlands/retarding basins ranges from 8 hectares to 7.1 hectares
- The overall land take required for the wetlands Alternative 2 reduces by 2 ha due to treatment and minor detention provided by rainwater tanks and swale installation.

6 Options assessment

A high level assessment of options has been presented below based on capital and operational costs above those incurred under the base case and qualitative assessment of potential benefits based on Arup's Design with Water framework which includes a high level climate resilience assessment.

For the climate change scenarios, MUSIC models have been re-run amending the predicted evaporation increases this result in minor changes in the run-off volumes generated annually under each case with the table below depicting the % change in mean annual flows.

Table 21 Climate change criteria and mean flow reduction for each scenario

Criteria	2030	2070	
		Low emissions	High emissions
Change in average temperature (C)	0.6 to 1.1	0.9 to 1.9	1.8 to 3.7
Change in annual rainfall (%)	-8 to 0	-13 to 0	-24 to 0
Change in potential evaporation (%)	+1 to +5	+1 to +9	+2 to +17
Changes in mean annual flow (%)	No change	0.23% reduction	0.94% reduction

6.1 Donnybrook

Table 22 Summary of WoWCA for Donnybrook PSP

		Base Case	Base Case +	Future Stretch
Demands (ML/a)	Potable	1270	971	717
	Recycled water	437	495	301
	Stormwater	0	163	163
	Rainwater	0	0	350
	Total	1707	1630	1531
	Potable : Non-potable split	**86% : 14%**	**60% : 40%**	**47% : 53%**
Stormwater runoff (ML/a)		**2460**	**2460**	**2460**
Sewer discharge (ML/a)		**1183**	**1063**	**956**
Excess (recycled water vs sewer discharge) (ML/a)		**746**	**568**	**655**
Number of retarding basins/wetlands		4	7	7
Extent of retarding basins/wetlands (ha)		**11.3**	**11.3**	**10.2**
Capex ($)		$8.5 m	$8.5 m	$7.7 m
Opex ($/a)		$57 k	$57 k	$51 k
Extent of swales (m^2)		0	0	6,750
Capex ($)		0	0	$1.1 m
Opex ($/a)		0	0	$34 k
Number of rainwater tanks		0	0	9,080
Capex ($)		0	0	$36.5 m
Opex ($/a)		0	0	$550 k
% pollutant reduction	TSS	83	82	84
	TP	74	73	74
	TN	53	52	49
	Gross pollutants	100	100	100
Total Capex		**$8.5 m**	**$8.5 m**	**$45.3 m**
Total Opex		**$57 k**	**$57 k**	**$635 k**
Savings off water bill for tank water (consumption only) ($/a)		0	0	$910k
Savings off water bill (council irrigation) ($/a)		0	$425k	$425k
Additional saleable lots compared with Base Case		0	0	24

6.2 Woodstock

Table 23 Summary of WoWCA for Woodstock PSP

		Base Case	**Base Case +**	**Future Stretch**
Demands (ML/a)	Potable	1063	749.5	557.5
	Recycled water	331	423.6	277.6
	Stormwater	0	180	180
	Rainwater	0	0	227
	Total	1394	1353	1242.1
	Potable : Non-potable split	**76% : 24%**	**55% : 45%**	**45% : 55%**
Stormwater runoff (ML/a)		**2000**	**2000**	**2000**
Sewer discharge (ML/a)		**924**	**841**	**756**
Excess **(recycled water vs sewer discharge) (ML/a)**		**593**	**417.4**	**478.4**
Number of retarding basins/wetlands		2	3	3
Extent of retarding basins/wetlands (ha)		**8**	**8**	**7.1**
Capex ($)		$6 m	$6 m	$5.4 m
Opex ($/a)		$40 k	$40 k	$36 k
Extent of swales		0	0	3125
Capex ($)		0	0	$470 k
Opex ($/a)		0	0	$16 k
Number of rainwater tanks		0	0	6,880
Capex ($)		0	0	$28 m
Opex ($/a)		0	0	$415 k
% pollutant reduction	TSS	81	82	81
	TP	72	73	70
	TN	52	52	46
	Gross pollutants	100	100	100
Total Capex ($)		**$6 m**	**$6 m**	**$34 m**
Total Opex ($/a)		**$40 k**	**$40 k**	**$467 k**
Savings off water bill for tank water (consumption only)		$0	$0	$590 k
Savings off water bill (Council irrigation)		$0	$470 k	$470 k
Additional saleable lots compared with Base Case				20

6.3 Qualitative assessment

Under the qualitative framework a 1 to 5 scale has been used based on the following in terms of the potential benefits achieved.

1 = very low

2 = low

3 = medium

4 = high

5 = very high

Option	**Key 'design with water' features**	**Assessment criteria**										
		Water supply **Reduction in demand for potable water supply and treatment, through use of water efficient fixtures and fittings and alternative decentralised water supplies, including rainwater, greywater and groundwater. Capital investment and whole-life cost savings.**	**Wastewater** **Reduction of water volume to sewers, extending network asset life, improving water quality and reducing treatment. Opportunity to recycle and re-use water through decentralised treatment.**	**Flooding** **Reducing risk and increasing resilience by integrated catchment management and improved management of surface water within cities. Design and planning of infrastructure, buildings and landscapes to be more adaptable to flooding.**	**Economy & Innovation** **Potential direct contribution through water-related investment in infrastructure associated new technologies, partnership with small enterprise, etc. Indirect impact on land and property values, attracting inward investment and improved labour productivity.**	**Place & Community** **Access to and engagement with water can play a significant role in creating better places with a strong sense of identity. Making space for water can open up and reconnect people and places. Water is an integrator which can facilitate partnership and collaboration.**	**Food & Agriculture** **Local food production can be a key driver to retrofitting landscapes, including breaking up of hard surfaces, flood-compatible use of open space, edible planting, water harvesting and treatment, localised nutrient recycling and improved agricultural practice.**	**Climate Change** **Design for water helps to mitigate and adapt to climate change. Large tree planting, greening of urban areas, and open water bodies directly contribute to improved microclimate. Locally managed water can increase resilience to water scarcity and drought.**	**Habitat & Biodiversity** **New and improved habitats through making space for water within green infrastructure networks, provision for natural treatment of water and wastewater, improving water quality, river/wetland and coastal restoration, woodland, green roofs and walls.**	**Energy & Carbon** **Removal and sequestration of greenhouse gases as a result of urban greening. Reduction in energy demand due to shading/insulation, reduced pumping and treatment of water and wastewater.** **Potential for renewable energy generation from hydro and waste.**	**Health & Wellbeing** **Water-related green infrastructure can absorb air pollutants and improve microclimate, provide opportunities for recreation, exercise and education. Water can help to improve overall living environments and provide opportunities for community engagement.**	**Total**
Base Case	Local STP providing recycled water for mandated residential uses Surface water management to meet BPEM and 1 in 100 year ARI through end of line system before discharge to local water bodies Green space maintained to a 'survival' level	3 WELS standard fittings and fixtures Recycled water supply	3 Local STP provides recycled water	3 Meets 1 in 100 ARI requirements	3 Local STP provides regional employment Availability of recycled water may allow for industries requiring secure supplied of water during restrictions to locate to the area	2 Parks are supplied with potable water and subject to future water restrictions. Wetlands combined with retarding basin reduces land take and provides amenity	2 Availability of recycled water means opportunities for local food production and community gardens can be explored at alter stages	3 Localised provision of recycled water provides increased resilience for water supply in times of low rainfall	3 Placement of wetlands and surface water features avoids existing high quality vegetation areas. Potential indirect creation of new habitats in wetlands	3 Localised treatment of sewage reduces pumping costs	3 Bike paths walking trails can be collocated along major drainage lines Visual access to water bodies improves mental and physical health Further opportunities can be explored at alter stages	28
Base Case +	10% reduction in water usage in residential houses Local STP providing recycled water for mandated residential uses along with recycled water demands in all other land use types Surface water management to meet BPEM and 1 in 100 year ARI through distributed system which seeks to collocate wetlands and retarding basins close to open space areas to maximise reuse opportunities for irrigation reuse Green space maintained to a 'lush' level	4 Higher rated WELS standard fittings and fixtures leading to a 10% reduction in householder water reuse Recycled water supply extended to other land uses Stormwater supplied for open space irrigation	4 Local STP provides recycled water 10 %r reduction in household water usage reduce flows to sewer	5 Meets 1 in 100 ARI requirements. Increased number of retarding basins improves resilience	4 Local STP provides regional employment Availability of recycled water may allow for industries requiring secure supplied of water during restrictions to locate to the area Reuse of stormwater reduces water bills for councils maintaining open space assets	4 Parks are supplied with stormwater where feasible due to colocation of wetlands adjacent to these areas. Recycled water is provided as a backup meaning open space is resilient to water restrictions and low rainfall Wetlands combined with retarding basin reduces land take and provides amenity. Increased number of wetlands adjacent to planned open space improves	2 Availability of recycled water means opportunities for local food production and community gardens can be explored at alter stages.	4 Localised provision of recycled water provides increased resilience for water supply in times of low rainfall. Climate independent source of water allows for maintenance of green space and tree canopy. Distribution of water bodies improves microclimate	4 Placement of wetlands and surface water features avoids existing high quality vegetation areas. Distributed wetlands provide potential indirect creation of new habitats in wetlands Reuse of stormwater reduces flows to adjacent waterways Opportunities to increase/maintain habitat connectivity along drainage lines can be explored	4 Localised treatment of sewage reduces pumping costs Local use of stormwater gathered and treated using gravity systems to the maximum extent possible reduced water travel distances and associated pumping.	4 Bike paths walking trails can be collocated along major drainage lines Visual access to water bodies improves mental and physical health Further opportunities can be explored at alter stages	35

Option	**Key 'design with water' features**	**Assessment criteria**										
		Water supply **Reduction in demand for potable water supply and treatment, through use of water efficient fixtures and fittings and alternative decentralised water supplies, including rainwater, greywater and groundwater. Capital investment and whole-life cost savings.**	**Wastewater** **Reduction of water volume to sewers, extending network asset life, improving water quality and reducing treatment. Opportunity to recycle and re-use water through decentralised treatment.**	**Flooding** **Reducing risk and increasing resilience by integrated catchment management and improved management of surface water within cities. Design and planning of infrastructure, buildings and landscapes to be more adaptable to flooding.**	**Economy & Innovation** **Potential direct contribution through water-related investment in infrastructure associated new technologies, partnership with small enterprise, etc. Indirect impact on land and property values, attracting inward investment and improved labour productivity.**	**Place & Community** **Access to and engagement with water can play a significant role in creating better places with a strong sense of identity. Making space for water can open up and reconnect people and places. Water is an integrator which can facilitate partnership and collaboration.**	**Food & Agriculture** **Local food production can be a key driver to retrofitting landscapes, including breaking up of hard surfaces, flood-compatible use of open space, edible planting, water harvesting and treatment, localised nutrient recycling and improved agricultural practice.**	**Climate Change** **Design for water helps to mitigate and adapt to climate change. Large tree planting, greening of urban areas, and open water bodies directly contribute to improved microclimate. Locally managed water can increase resilience to water scarcity and drought.**	**Habitat & Biodiversity** **New and improved habitats through making space for water within green infrastructure networks, provision for natural treatment of water and wastewater, improving water quality, river/wetland and coastal restoration, woodland, green roofs and walls.**	**Energy & Carbon** **Removal and sequestration of greenhouse gases as a result of urban greening. Reduction in energy demand due to shading/insulation, reduced pumping and treatment of water and wastewater.** **Potential for renewable energy generation from hydro and waste.**	**Health & Wellbeing** **Water-related green infrastructure can absorb air pollutants and improve microclimate, provide opportunities for recreation, exercise and education. Water can help to improve overall living environments and provide opportunities for community engagement.**	**Total**
Future stretch	20% reduction in water usage in residential houses Local STP providing recycled water for mandated residential uses along with recycled water demands in all other land use types Surface water management to meet BPEM and 1 in 100 year ARI through distributed system which seeks to collocate wetlands and retarding basins close to open space areas to maximise reuse opportunities for irrigation reuse Installation of swales within some major road reserves to achieve increased treatment of surface water runoff Household rainwater tanks installed to provide hot water Green space maintained to a 'lush' level	5 Higher rated WELS standard fittings and fixtures leading to a 20% reduction in householder water reuse Recycled water supply extended to other land uses Stormwater supplied for open space irrigation Rainwater provided for household hot water usage	5 Local STP provides recycled water 10 %r reduction in household water usage reduce flows to sewer	4 Meets 1 in 100 ARI requirements. Increased number of retarding basins improves resilience Swales provide minor infiltration during large events reducing runoff volumes Rainwater tanks provide minor retarding function during some events	5 Local STP provides regional employment Availability of recycled water may allow for industries requiring secure supplied of water during restrictions to locate to the area Installation of rainwater tanks for hot water provides opportunities for local manufactures and tradesmen Reuse of stormwater reduces water bills for councils maintaining open space assets Supply of rainwater for hot water in urban environments is an innovative approach	4 Parks are supplied with stormwater where feasible due to colocation of wetlands adjacent to these areas. Recycled water is provided as a backup meaning open space is resilient to water restrictions and low rainfall Wetlands combined with retarding basin reduces land take and provides amenity. Increased number of wetlands adjacent to planned open space improves Placement of swales within planned Boulevards connector streets allows for passive watering of trees and improved tree canopy coverage	2 Availability of recycled water means opportunities for local food production and community gardens can be explored at alter stages	5 Localised provision of recycled water provides increased resilience for water supply in times of low rainfall. Climate independent source of water allows for maintenance of green space and tree canopy. Distribution of water bodies improves microclimate	5 Placement of wetlands and surface water features avoids existing high quality vegetation areas. Distributed wetlands provide potential indirect creation of new habitats in wetlands Opportunities to increase/maintain habitat connectivity along drainage lines can be explored. Reuse of stormwater and diversion of rainwater for hot water usage reduces flows to adjacent waterways Vegetated swales allow for creation of more resilient tree related habitats.	4 Localised treatment of sewage reduces pumping costs Local use of stormwater gathered and treated using gravity systems to the maximum extent possible reduced water travel distances and associated pumping Use of rainwater reduces bulk water pumping and treatment costs and emissions	4 Bike paths walking trails can be collocated along major drainage lines Visual access to water bodies improves mental and physical health Further opportunities can be explored at alter stages	48

7 Recommendation and key findings

Key recommendations and findings from this study are provided below:

- Alternative 2 Future stretch scores highest in terms of qualitative assessment, and has the highest potable water replacement ratio of approximately 45% potable water usage and 55% non-potable water usage.
    - In terms of Capex and Opex the expected costs for Alternative 2 are almost 6 times those of the base case and base case + options due to the costs associated with the installation and operation of rainwater tanks at the household scale.
- Under all options there is an excess of wastewater generated against recycled water demands. This is most profound under the base case where almost 1,400 ML of treated waste water will require discharge to either local waterways or into the Melbourne sewer system.
    - Opportunities to extend the supply of recycled water to other land uses and at the household level should be undertaken to reduce discharges of treated water to the environment.
    - The water balance for the Future Stretch option indicates that from a quantity perspective the installation of rainwater tanks at the lot scale where recycled water is also available will further exacerbate the excess of treated water requiring disposal or direction to alternative uses outside of the PSP areas.
- Cost savings or otherwise related to the installation of rainwater tanks at the household level need to be subjected to a more rigorous cost: benefit analysis to determine the benefit flow and who should fund the installation and operation of these measures. However benefits to households appear to be marginal given the expected Opex vs the savings in water bills.
    - It is also noted that the diversion of rainwater into the sewer system under the future stretch option may not be able to be recognised as billable for treatment under Yarra Valley Water's current billing arrangements which do not measure water flows leaving the house, but rather account for flows by applying a factor to metered potable water usage.
- Under the Alternative 1 option, Base Case plus, there is the potential for council's to be able to offset around $900k across both PSPs off their irrigation water bills by harvesting stormwater. This involves minimal expense in reconfiguring the placement of wetlands and applying reuse to these facilities. These costs and benefits should be explored in further detail.
    - The distribution of wetlands throughout the development and adjacent to open space requiring irrigation water also allows for a more staged approach to infrastructure delivery.
- Consultation with developers to understand their appetite for the installation of WSUD features beyond the baseline should be undertaken.
- Consultation with Council's and Melbourne Water regarding arrangements for the ongoing management of wetlands and other WSUD features should be undertaken. This relates to large wetlands, vegetated swales and any infrastructure associated with treatment, storage or distribution for reuse.
- Further refinement of costs, benefits, responsibilities and risk management procedures is required to better inform a preferred option at the PSP scale.

  - Risk management and treatment requirements for stormwater and risk management arrangement for hot water supply via rainwater need to be further considered to reduce risks to public health.
- It is also recommended that if a beyond best practice approach to stormwater quality is sought and opportunities for the passive watering of boulevard and major arterial street trees is sought that land is configured within these road reserves to allow for the installation of vegetated swales where slopes allow.
- It is also noted that there has been initial support from DEPI, Melbourne Water, OLV and councils for investigating the use of grassy woodland conservation areas for evaporation basins and to provide water to existing red gum areas. However, it is noted that a large amount of work still required to detail how this could be implemented particularly in terms of water delivery regimes, funding and ongoing maintenance.
- Future PSP planning layouts should take a ‘water first’ approach and seek to locate areas where stormwater could be harvested and provided to open space irrigation place in low contour points to maximise harvest volumes, reduce pumping, provide increased flood resilience, maximise opportunities to connect communities to green open space along drainage lines and enhance amenity of open space areas through the inclusion of water features.

Recommended urban structure to facilitate whole-of-water-cycle management and which recommends a preferred option for inclusion into the PSP

While Alternative 2 – Future Stretch scores higher in terms of qualitative assessment it is unclear at this stage if the overall benefits or rainwater tanks outweigh the costs associated with them. Alternative sizing options for rainwater tanks could be explored to provide for runoff detention benefits, however at this stage Melbourne Water are unsupportive of the use of rainwater tanks as a primary means to detain surface water flows and thus there are limited associated savings with regard to reductions in the required sizes of detention basins. At the household level water bill savings vs operational costs of rainwater tanks appear negligible.

It is recommended the adoption of the Alterative 1 - Base Case Plus in terms of the required land take areas and indicative locations, perceived benefits and minor additional expenditure over the baseline.

This approach seeks to collocate water bodies adjacent to active open space to allow for increased stormwater harvesting opportunities and place making opportunities associated with these features by distributing them more widely throughout the landscape. It also ensures there is sufficient space available which can be reduced if rainwater tanks are adopted at the lot scale.

Cost savings related to water expenditure will also be experienced by Council’s responsible for maintaining open space assets and a reduction in flows to nearby waterways although relatively minor will be experienced.

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Appendix A

Description of site details

A1 Climate and rainfall

The PSP areas have a temperate climate with cold to mild winters and hot summers. Average annual rainfall is approximately 660 mm/a falling relatively evenly throughout the year. Records from the nearby Yan Yean Reservoir indicate that lowest annual rainfall recorded was in 1945 when just 371.1 mm fell. Maximum annual rainfall was recorded in 1972 when 1048.6 mm fell.

Summer temperatures average between 24 to 27°C with winter temperatures averaging 9 to 12°C with the lowest winter minimums in July and August.

A1.1 Flora and Fauna

DEPI mapping shows that Ecological Vegetation Classes (EVCs) in the PSP area largely comprised Plains Grassland, with Plains Grassy Woodland in the northern extent, Riparian Scrub along the Merri Creek corridor and Swampy Woodland extending through the middle section from the west.

The 2005 EVC's show that the native flora and fauna of the Donnybrook region have been substantially reduced and modified since European settlement. Some remnant vegetation remains within the subject land, especially along the Merri Creek corridor mostly in the form of Plains Grassy Wetland, Plain Grassland and Plains Grassy Woodland.

The North Growth Corridor Plan (GCP) identifies a large area of woodland to the east of Merri Creek as woodland, zoned as Rural Conservation Zone (RCZ). Within the Woodstock PSP a small volcanic cone is located in the south of the precinct it is also zoned as RCZ and has the potential to provide a vantage point in the corridor. Previous site investigations conducted for MPA have noted that aside from some small groups of trees and isolated examples, and plantings around individual properties, tree cover in the Precinct is restricted to an area of Red Gums in the north western corner of the Precinct.

Growling Grass Frog corridors have been mapped by DEPI (see Figure 18) within both precincts. These are generally focussed on establishing conservation buffers around the Merri and Darebin Creeks and in areas of potential growling grass frog habitat. Ecology Australia is currently preparing a conservation concept plan for the conservation areas within the Donnybrook-Woodstock PSPs

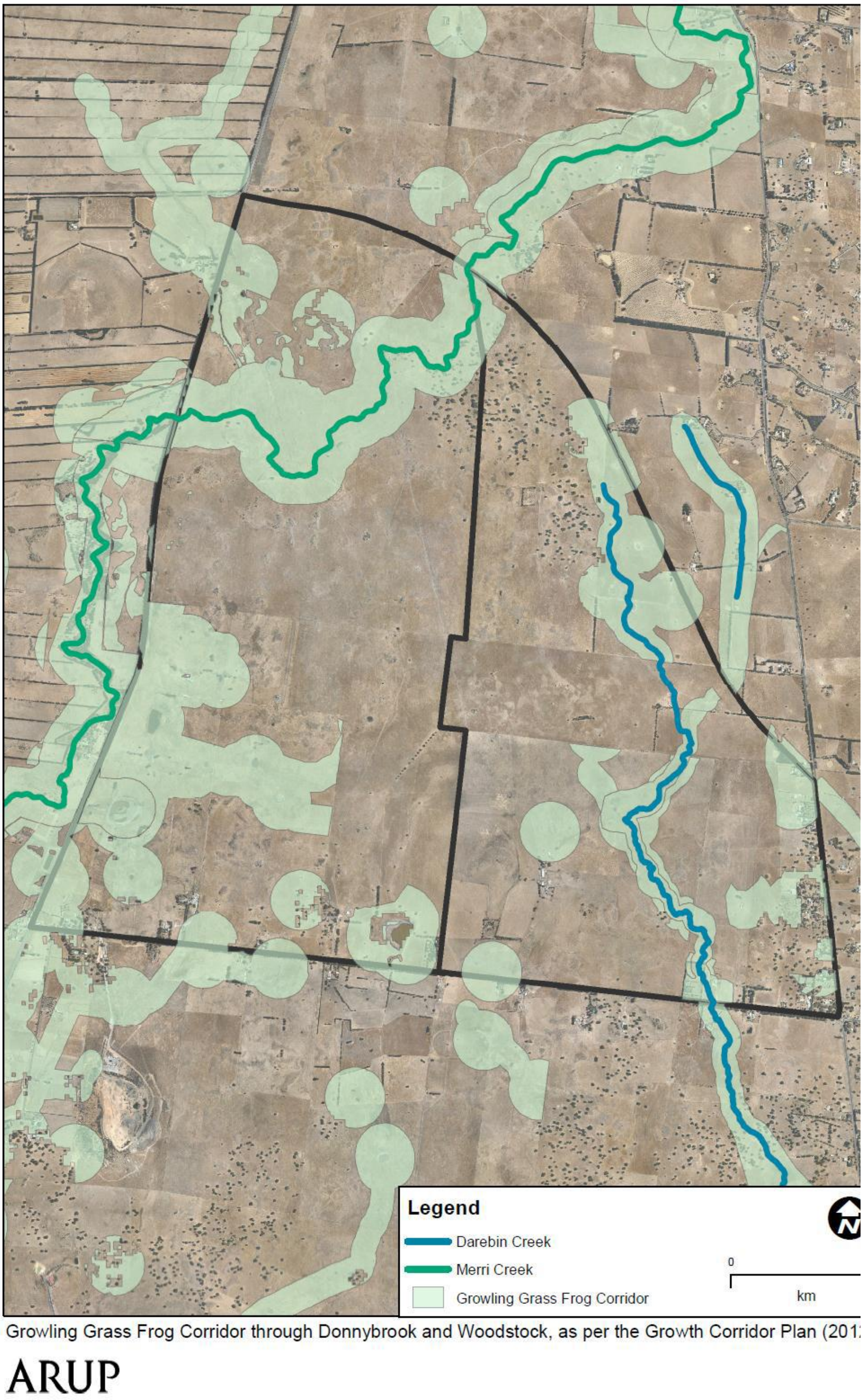


Figure 18 Growling Grass Frog Corridor through Donnybrook and Woodstock, as per the Growth Corridor Plan (2012)

A1.2 Geology

The Precinct is located within the Western Volcanic Plains geographic region which stretches from Victoria's south west border with South Australia across to Melbourne's north and north western suburbs. The site area is characterised by basalt plains which vary in their elevation, escarpments and valleys formed by drainage lines, stony rises and ephemeral lakes or soaks.

The overall precinct is generally flat, at between 200 and 250m above sea level but generally rising to the north, before it is interrupted by the line of the Merri Creek. A small part of a volcanic hill is located in the south east corner of the Precinct. Soils of the volcanic plains generally consist of sodic duplex soils, shallow gradational soils and grey and black clays and are predominantly shallow and more suited to pastoral agriculture than arable planting.

The post contact heritage assessment conducted by Context (2013) notes that Rocky knolls dot the Victorian Volcanic Plains bioregion, and a number are present in the Precinct. These were formed about 4.5 million years ago when lava flowing from the many active volcanos that were part of western Victoria's landscape cooled. Today, the knolls that remain are considered significant land forms, recognised as places of high value for both Indigenous and post-contact settlers, and as places of high ecological and natural significance containing significant grasslands and grassy vegetation, as well as small patches of woodland.

Terra Culture (2013) note that deposits of Quaternary alluvium occur along the banks of the Merri Creek and its tributaries. This alluvium consists of gravels, sands and silts. It is likely that the local alluvial deposits have become more extensive since European settlement, following the clearing of native vegetation and the subsequent increased erosion of top soils.

The local hills and ridges including Mount Ridley (289m asl) immediately west of the Hume Freeway and Summer Hill (239m) and Woody Hill (280m) east of the Merri Creek consist of Silurian aged siltstone and thin-bedded sandstones dating to between 440 and 420 million years ago. Collectively this is known as the Dargile Formation and underlies these foothills and ranges.

A1.3 Hydrology

Merri Creek crosses the northern extent of the Donny Brook PSP area and is the largest watercourse in the area. The creek's headwaters are in the central highlands of Victoria where it then flows in a southerly direction through the north of the Donnybrook PSP area and south to its confluence with the Yarra River at Clifton Hill. Similarly to Merri Creek, Darebin Creek flows in a southerly direction and is a major tributary of the Yarra River, which it meets at Alphington after passing through the eastern extents of the Woodstock PSP.

Tributaries of Merri Creek include Malcolm and Aitken creeks, which flow from the east and meet the Merri Creek at Craigieburn. A number of smaller tributaries run into Merri Creek, including an unnamed tributary which runs through the south of the PSP area. Other local ephemeral creeks also include Kalkallo Creek which runs through the township of Kalkallo, meeting Merri Creek south of Donnybrook Road.

Terra Culture (2013) note that at the time of European settlement, Merri Creek had good quality water and its environs were abundant with plant and animal life. John Batman was reported to have said that the Merri Creek was “a creek of good water in a most beautiful valley...altogether a most enduring spot” (cited in Wigney no date 14). The fertile land around the creek was suitable for crop, market gardening and dairying and as reported by Wigney (no date 14) the intensification of these landuse practices contributed to erosion, alteration in the water course and changes arising from the effects of flooding.

Downstream of Donnybrooks more substantial changes to the quality of the water occurred through industrial activities that were established near the Merri Creek. Tanneries, wool washers and abattoirs all discharged into the creek. Further impacts are also evident due to extensive residential subdivision and intensification of occupation in the Melbourne region.

In the Donnybrook region the Merri Creek remains fairly rural in its setting and use which is in contrast to the alignment closer to Melbourne.

The IWCM (2012) for the north notes the following with regard to landscape features and management priorities in the area: “other significant landscape features include floodplains associated with Merri Creek, natural wetlands, and Melbourne Water’s Greenvale Reservoir and Kalkallo Retarding Basin. Melbourne Water’s Healthy Waterways Strategy indicates that protection and enhancement of frog habitat in the headwaters of the Merri Creek catchment is a priority, as is the protection and enhancement of riparian vegetation. The Strategy also highlights the importance of catchment-wide stormwater management for waterway protection as the new urban areas are planned and developed across the upper and middle portions of the catchment. In the middle and lower (existing urban) portions of the catchment, social values such as amenity are considered a priority for management.”

The Merri and Darebin Creeks form part of the lower Yarra catchment. Melbourne Water’s Our Yarra website notes that “large amounts of stormwater enter these waterways, reducing water quality and changing water flow rates. Together with waterway diversions upstream, this can cause low flows and low dissolved oxygen, which harms plants and animals in the waterway.

Recent research by Walsh (2013) and colleagues at the Waterway Ecosystem Research Group, University of Melbourne noted the following with regard to the in-stream ecological future of Merri and Darebin Creeks as the middle and upper catchment urbanises:

- Use of current ‘best practice’ urban stormwater management practices will result in loss of existing ecological values in upper Merri Creek.
- The risk of loss of values under Melbourne Water's preliminary Integrated Water Cycle Management Plan is very high
- Much better and stronger strategies for management of urban stormwater are needed to reduce the risk of loss of values.
- Harvesting and use of stormwater is the most straightforward way to do better than we do currently.
- If stormwater is not harvested, very large areas of open space will be needed, ideally along drainage lines, to allow adequate losses of stormwater though infiltration and evapotranspiration.

- If we fail to stem a decline in upstream values, the likelihood of restoring the degraded condition of Merri Creek downstream decreases even further.

The objectives in the Regional River Health Strategy for the Merri are:

- For rural sections:
- Prevent further damage in the condition of rural sections, i.e. maintain at current overall condition of poor. IRC ratings for sub-indices are:
- Water quality - poor
- Aquatic life - moderate
- Habitat & stability - moderate
- Vegetation - poor
- Flow - excellent

Condition of key values

Key value	Condition	Details
	Current: very low	Urban developed has significantly altered **platypus** habitat. Populations have declined since the 1990s possibly due to reduced river flows and platypus are now rare, though medium-size populations exist in some urban sections of the Yarra River and tributaries.
	20-year: very low	
	Long-term: moderate	
	Current: moderate	The variety and proportion of native **fish** species has declined since the 1990s. There is a moderate variety of species, and introduced species are relatively abundant. A large range of works aims to improve this over the next 20 years.
	20-year: high	
	Long-term: very high	
	Current: very high	**Frog** population diversity is very high and stable, and works aim to maintain this.
	20-year: very high	
	Long-term: very high	
	Current: low	Substantial urban development means **bird** populations are in low condition. Vegetation improvements aim to stabilise bird diversity and abundance and allow for future improvements, though the long-term potential is limited as land is not available for large-scale connectivity.
	20-year: low	
	Long-term: moderate	

	Current: very low* 20-year: moderate Long-term: high	Extensive **vegetation** clearing for urban development has occurred over the past 200 years, so the condition is very low. Continued investment in vegetation will improve this.
	Current: low 20-year: moderate Long-term: high	**Macroinvertebrate** communities have been affected by urban development and poor water quality. Improvements to stormwater treatment and vegetation aim to improve this condition.
	Current: moderate 20-year: high Long-term: very high	**Amenity** enjoyed from waterways is moderate, with specific areas important for relaxation and rejuvenation. Vegetation and litter management works aim to improve amenity to high over the next 20 years.

* Limited data used to determine this rating

A1.3.1 Donnybrook

PSP 1067 is located within the Port Phillip and Western Port Catchment. Surface water runoff from within PSP 1067 will generally move in a westerly and south-westerly direction towards Merri Creek. Meinhardt (2013) note that Merri Creek transects the northern sector of the PSP area, flowing through properties 45, 44, 43 and 31 and then flows along the western boundary of PSP 1067.

A number of ephemeral watercourses also flow across the site and discharge into Merri Creek at the western boundary of the site. These water courses flow in a westerly and south-westerly direction. The water courses are most likely to flow during significant rainfall events.

A number of large dams are located in the PSP area. The dams are located on properties 35, 32 and 31. The dam located on property 35 is approximately 2 ha in area. The dam and area surrounding it is currently not allocated for development. Additionally a number of smaller dams are located across the site on majority of the larger properties within the PSP.

Inundation map from VWRM depicts land subject to inundation areas which were recorded along the flow path of Merri Creek at properties 45, 44, 43 and 31. A search of the Victorian Water Resources Data Warehouse (VWRDW) was undertaken by Meinhardt (2013) for floodways and 1 in 100yr flood information. No floodways or 1 in 100yr floods were identified within PSP 1067 boundaries. However inundation areas were identified along the flow path of Merri Creek, indicating potential flood zones.

A1.3.2 Woodstock

PSP 1096 is located within the Port Phillip and Western Port Catchment area. Surface water runoff from within PSP 1096 will generally move in a westerly and south-easterly direction towards Darebin Creek. Darebin Creek transects the south-eastern sector of the PSP area, flowing through Properties 20, 21, 22 and 23 and then flows in a southerly direction, where it eventually discharges into the Yarra River. Previous work by Meinhardt (2013) has noted that in the Woodstock area Darebin Creek appears to be an ephemeral feature.

A number of smaller dams are located across the site on generally located on the larger agricultural properties within the PSP.

Meinhardt (2013) noted that a search of the Victorian Water Resources Data Warehouse (VWRDW) was undertaken for floodways and 1 in 100yr flood information. No floodways or 1 in 100yr floods were identified within PSP 1096 boundaries.

A1.4 Groundwater

A1.4.1 Donnybrook

With reference to the DNRE Groundwater Beneficial Uses Map for South Western Victoria (1994) and the Melbourne Groundwater Directory, the groundwater beneath the site is present in two main aquifers, the upper Newer Volcanics aquifer, a fractured rock basalt aquifer, and a deeper regional bedrock aquifer within the Silurian aged formation.

Groundwater within the upper aquifer is expected to have salinity in the range of 1,000 - 13,000 mg/L TDS, which classifies the groundwater as Segments B and C under the Groundwater SEPP (1994). The Victorian Water Resources Map identified 19 registered boreholes within the site boundary of PSP 1067. Eight of the bores are registered for private use, where they are most likely used for domestic and/or stock watering capacity. The remaining 11 bores are used for monitoring and observation purposes (see Figure 19). No bores were registered for industrial groundwater extraction.

A1.4.2 Woodstock

A preliminary assessment of groundwater resources within the area by Meinhardt (2013) notes that with reference to the DNRE Groundwater Beneficial Uses Map for South Western Victoria (1994) and the Melbourne Groundwater Directory the groundwater beneath the site is present in two main aquifers, the upper Newer Volcanics aquifer, a fractured rock basalt aquifer, and a deeper regional bedrock aquifer within the Silurian aged formation. In the north-eastern portion of PSP 1096 the Newer Volcanics aquifer is not present and the bedrock aquifer is main aquifer beneath the site.

Groundwater within the upper aquifer is expected to have salinity in the range of 1,000 - 13,000 mg/L TDS, which classifies the groundwater as Segments B and C under the Groundwater SEPP (1994).

The Newer Volcanics aquifer system is complex and generally consists of several superimposed basalt flows, often separated by clay and silt aquitards (Leonard, 1992). The aquifer ranges from approximately 150m to 210m AHD in thickness, and is generally unconfined to semi-confined. Due to the varying characteristics of different basalt flows, salinity and yield in the Newer Volcanics aquifer can be highly variable over short distances.

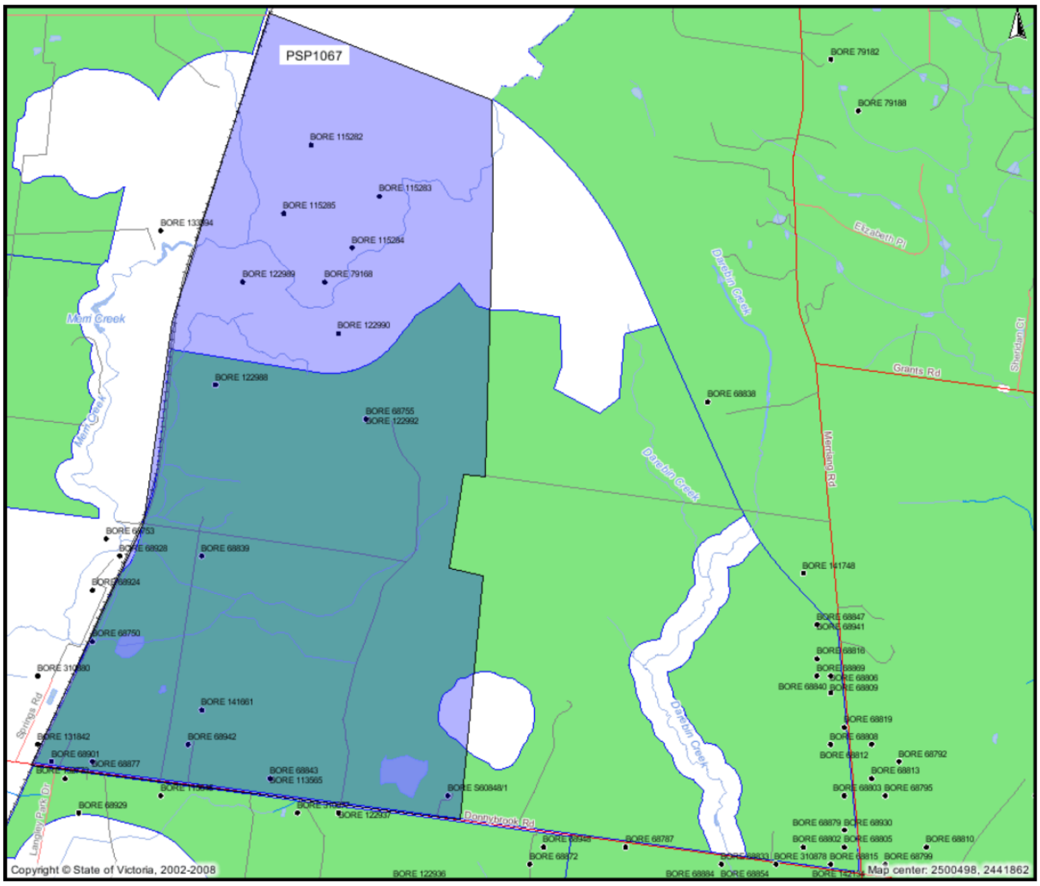


Figure 19 Registered Groundwater Bores within the Donnybrook and Woodstock PSPs (source: Victorian Water Resources Data Warehouse)

A1.5 Wetlands

A1.5.1 Donnybrook

A wetland was identified by Meinhardt (2013) within PSP 1067 belonging to permanent open freshwater category. The open water wetland is located in the south -eastern corner of property 31 and covers an area of 5.63 ha.

An open water wetland is usually more than 1m deep and can be natural or artificial. The wetland (229427) is a permanent wetland as it retains water for longer than 12 months, with periods of drying. The wetland is not listed as a Ramsar Wetland or in the directory of nationally important wetlands in Australia. In addition, the wetland was not identified in the Biodiversity Conservation Strategy (BCS) for retention, so is considered to be offset. Additionally, a dam was identified on the northern section of property 35, with an approximate area of 2ha.

The need to protect native vegetation and animals along creek lines falls under the jurisdiction of DEPI and Melbourne Water, and it is generally understood that the Biodiversity Conservation Strategy (BCS) already considers the wetland as an ‘off set’ area.

A1.6 Woodstock

According to Meinhardt (2013) no wetlands were identified within PSP 1096.

A1.6.1 Water features adjacent to the site

A Heritage Citation Report by the City of Whittlesea (2009) notes the occurrence of mineral springs to the east of the Melbourne-Sydney train line. The citation notes that Donnybrook springs were reportedly used by early settlers in the area. However, it was not until 1912 that the Director of the Geological Survey (E.J. Dunn) formally reported the existence of two springs in the Donnybrook area. An Argus report from 21 February 1912 describes the water coming from the springs as being “a strong flow of excellent water of palatable quality.” By that time various developments had taken place and both springs had pipes driven in to them. The report, prepared by Dunn, recommended further development and that they be made “available to the public.”

Context (2013) notes that over the past century various attempts have been made to develop the springs as a going concern. On 1 November 1912, Donnybrook Mineral Springs Pty Ltd was established, but the business (for reasons that are unclear) failed and was deregistered on 9 May 1917. In 1920 an attempt was made to commercially bottle the spring water by O.T. Pty Ltd. In 1935, the land was bought from the Crown by W. H. Stone and an accommodation resort was developed. In 1953 the property was bought by Mr A. Sattler and the mineral water was being sold under the name of “Donny Spa.” The piping of the spring was reconditioned in 1958, but the accommodation side of the business was discontinued in 1960.

In 1983 the business was sold to Luigi Campeotto, the noted tenor. Campeotto planned to expand the business and build a $1.5 million natural spa complex; however, he struggled to obtain finance and, in the face of the 1990s recession, was ultimately declared bankrupt. In recent times, the complex has been bought by the Macedonian Orthodox Church, which is currently constructing a monastery on the site.

Appendix B

Workshop notes

Notes

Project title	Whole of Water Cycle Assessment: PSP 1067 Donnybrook and PSP 1096 Woodstock	Job number 234383-00
Meeting name and number	Stakeholder Workshop 1/14	File reference Click here to enter text.
Location	Arup Offices, Level 17, 1 Nicholson St, Melbourne	Time and date 11 am - 2pm 13 February 2014

Purpose of meeting

Present the key information, values and objectives of the precinct's development and a review of the Base Case Report. The workshop participants will be asked to: (a) Confirm and/or refine the outcomes of the Base Case Report.(b) Identify two possible WOWCA options .(c) Share respective organisation points of view and key issues, strategies and opportunities which may help to shape the future urban structure.

Present	Bridget Weatherall (OLV)	Lisa Ehrenfried (OLV)
	Ross Guastalegname (Whittlesea)	Niall McGovern (Whittlesea)
	Gregory Harris (Mitchell)	James Hodgens (Melbourne Water)
	Andrew Mellor (Melbourne Water)	Nino Polon (Melbourne Water)
	Paul Curtis (YVW)	Kanchana Karunaratna (YVW)
	Michael O'Neill (Arup)	Rhys Anderson (Arup)
	Shirley Reeder (Arup)	Bruce Hunter (MPA)
	Fiona McDougall (MPA)	Chris Braddock (MPA)
	Carolina Balagtas (Melbourne Water)	Paul Bellis (Whittlesea)
Apologies	Stacy Gardner (Mitchell)	Ragini Prasad (Arup)
Circulation	Those present and apologies	

1.1 Welcome

- Shirley Reeder (Facilitator) welcomed attendees
- Fiona McDougall (MPA) provided an update and context into the Draft Urban Structure of Donnybrook and Woodstock
  - 1800 ha - mainly residential
  - Key features
    - Growling Grass Frog habitat corridors
    - Darebin Creek and Merri Creeks
    - Small bulge in Donnybrook earmarked known as Hayes Hill
    - Donnybrook Rd services corridor
    - Road link into Lockerbie PSP
    - Major gas pipeline
    - 5 centres within the precinct for retail activity of varying extent

Prepared by: Michael O'Neill

Date of circulation: 18 February 2014

Date of next meeting: N/A

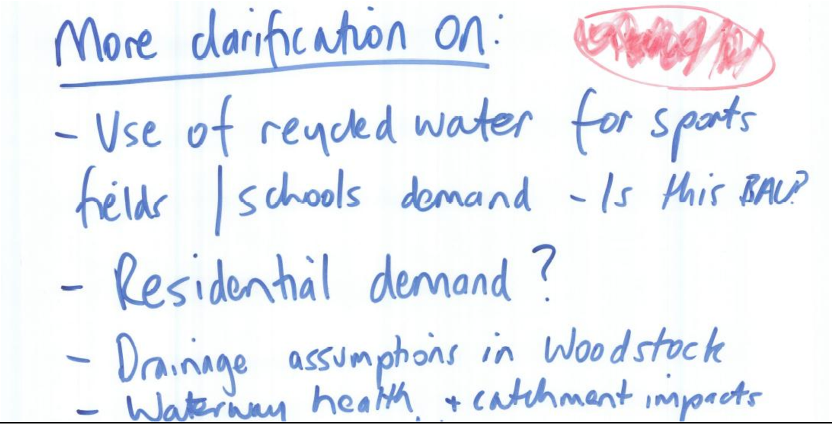
- 15 ha of regional open space
- A number of schools, state and catholic

1.2 Base case presentation

- Rhys Anderson provided a presentation on the findings of the base case
- Chris Braddock (MPA) questioned the relatively high rainfall in the area and what options this might provide particularly around stormwater harvesting.
- Bridget Weatherall (OLV) questioned the urban density and water usage at the lot scale. Bruce Hunter (MPA) noted that Plan Melbourne is aiming for 18 lots per hectare and that Arup should adopt the high scenario figures for future analysis
- Bridget Weatherall (OLV) asked about the role of efficiency in managing water demands. Michael O'Neill (Arup) advised that current 164 L/day figure for per person demand is taken from the IWCM for the North jointly prepared by MWC, YVW and OLV and this assumes 5 star housing. Efficiency objectives are key to capture in the additional options generation.
- General discussion around the role of WoWCA in the context of larger regional actions. Andrew Mellor (MWC) advised that the RORB model for Merri Creek is currently being updated. Michael O'Neill (Arup) advised that Arup's intent is to align as much as possible with regional plans and initiatives including the IWCM for the North.

1.3 Confirm and/or refine the outcomes of the Base Case Report.

- Attendees were separated into three tables and asked to discuss the base case and note down the things they agree with, areas where more clarification is required and potential beneficiaries under this scenario.
- Table 1 noted the following
    - Clarification around the use of recycled water under BaU
    - Drainage assumptions around for Woodstock in the absence of a DSS for the area. Further work with Melbourne Water will be required around how it fits with wider strategy for the area
    - Include waterway values in suggested approaches
    - Benefits – YVW sale of recycled water, Customers – recycled water = resilience of water supply

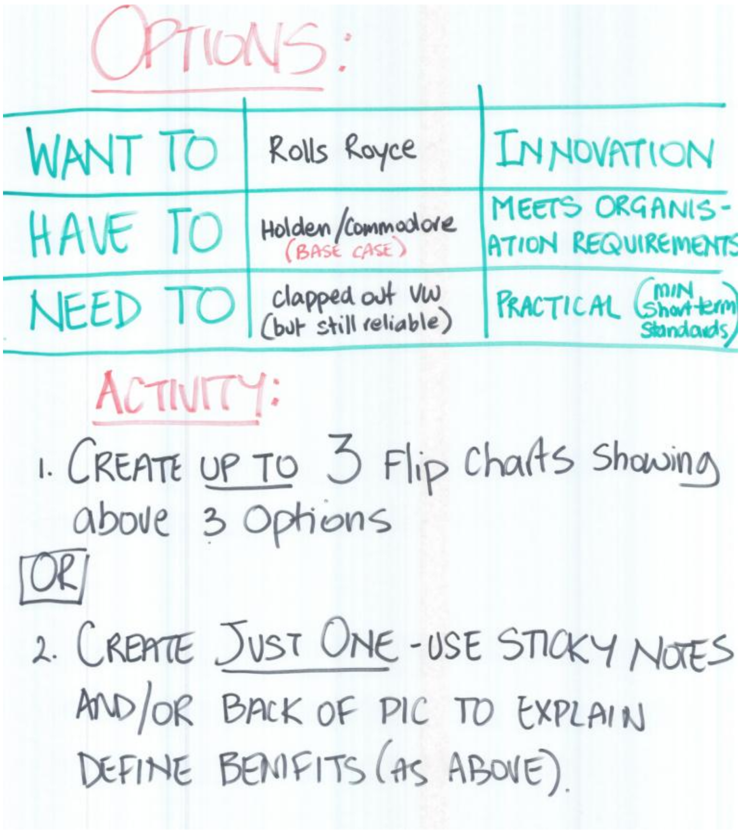


More clarification on:

- Use of recycled water for sports fields | schools demand - Is this BAU?
- Residential demand ?
- Drainage assumptions in Woodstock
- Waterway health + catchment impacts

- Table 2 noted the following:
    - Yarra Valley’s needs - do they require extra stormwater. Paul Curtis (YVW) noted that there is plenty of recycled water to go around
    - Discussion around other stormwater from other catchments
    - Melbourne Water supports the infiltration of water into groundwater and the co-use of frog ponds/wetlands
- Table 3 noted the following:
    - High population scenario is the one presented
    - The BaU should be conservative in terms of water usage figures
    - Some clarification as to the approach to surface water management across Woodstock. Distributed retardation rather than end-of-line in alternative options
    - Whittlesea queried the 134 L per person figure used for wastewater flow and noted they would try and find more specific data
    - The current per person per dwelling density in Whittlesea is 2.8 and 2.9 in Mitchell

1.4 Options development exercise - WoWCA



OPTIONS:

WANT TO	Rolls Royce	INNOVATION
HAVE TO	Holden/Commodore (BASE CASE)	MEETS ORGANISATION REQUIREMENTS
NEED TO	clapped out VW (but still reliable)	PRACTICAL (MIN Short-term Standards)

ACTIVITY:

1. CREATE UP TO 3 Flip Charts Showing above 3 options

OR

2. CREATE JUST ONE - USE STICKY NOTES AND/OR BACK OF PIC TO EXPLAIN DEFINE BENIFITS (AS ABOVE).

- Table 1 – Option development
  - Objectives
    - Maximise use of recycled water
    - Waterway health
  - How do we achieve it?
    - Connectivity along drainage lines
    - Harvesting of stormwater to irrigate open space
    - Export of excess water
    - Rainwater tanks – leaky tanks (management of flow events), provide for hot water
    - Distributed systems for surface water management
  - Problems/opportunities
    - Developers - one not necessarily keen – other might be
    - Affordability is key
    - Demographics – upgrade buyers vs first home owners
    - Opportunities/interface
    - Working with BPEM review

- 2 developers not 11
- Self-sustaining open space (multi-use)
- Over capitalising infrastructure
- Division of public / private responsibilities
- Health – risks and benefits (open and connected), shade and amenity

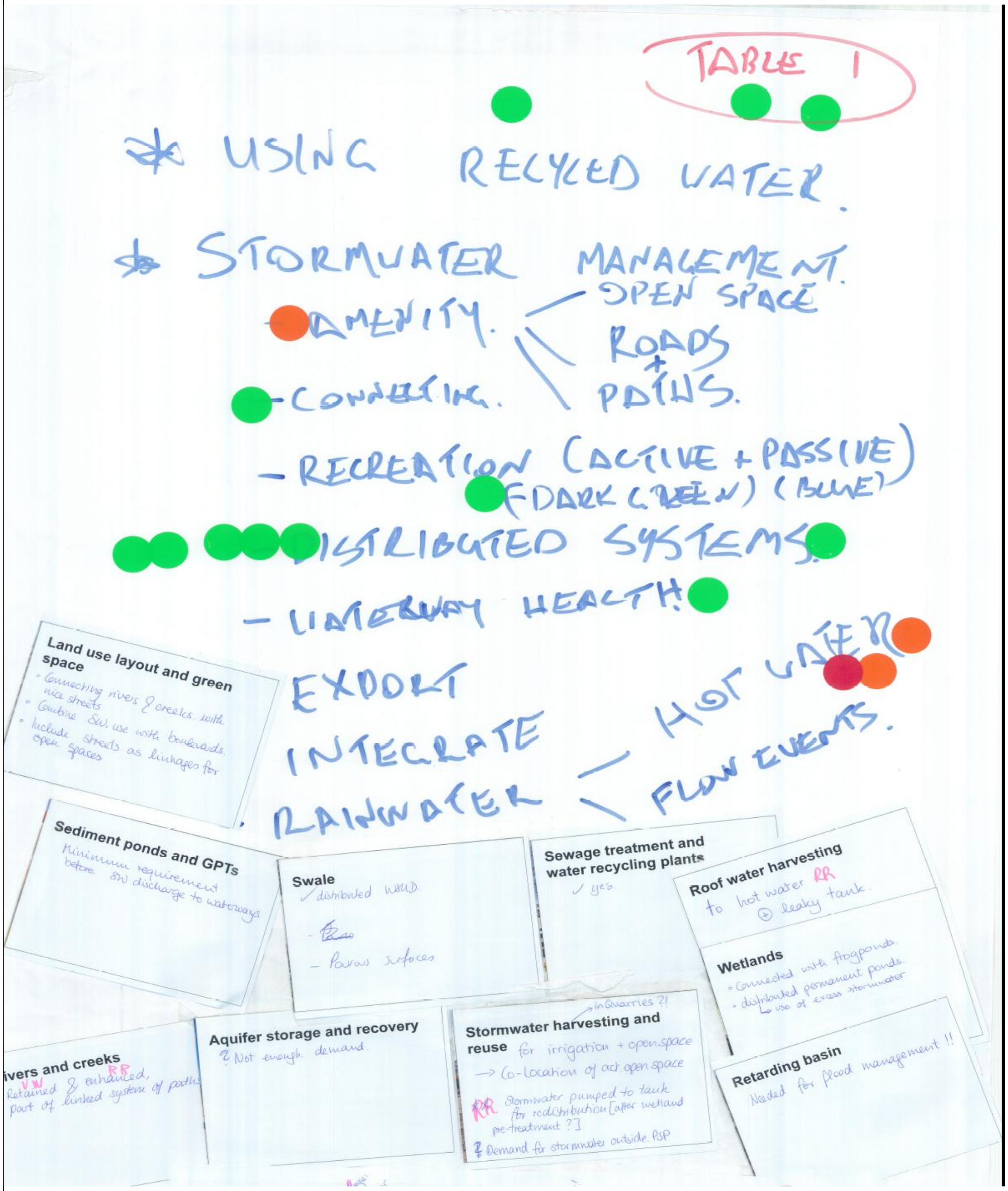


TABLE 1

* USING RECYLED WATER.

* STORMWATER MANAGEMENT.

AMENITY. — OPEN SPACE
ROADS + PATHS.

- CONNECTING.

- RECREATION (ACTIVE + PASSIVE) (DARK GREEN) (BLUE)

DISTRIBUTED SYSTEMS.

- WATERWAY HEALTH

EXPORT

INTEGRATE RAINWATER — HOT WATER
FLOW EVENTS.

Land use layout and green space
- Connecting rivers & creeks with nice streets
- Combine SW. use with boulevards.
- Include streets as linkages for open spaces

Sediment ponds and GPTs
Minimum requirement before SW discharge to waterways

Swale
✓ distributed WSUD.
- ~~Roo~~
- Porous surfaces

Sewage treatment and water recycling plants
✓ yes.

Roof water harvesting RR
to hot water
⊕ leaky tank.

Wetlands
- Connected with frogponds.
- distributed permanent ponds.
  ↳ use of excess stormwater

ivers and creeks VW RR
Retained & enhanced, part of linked system of paths

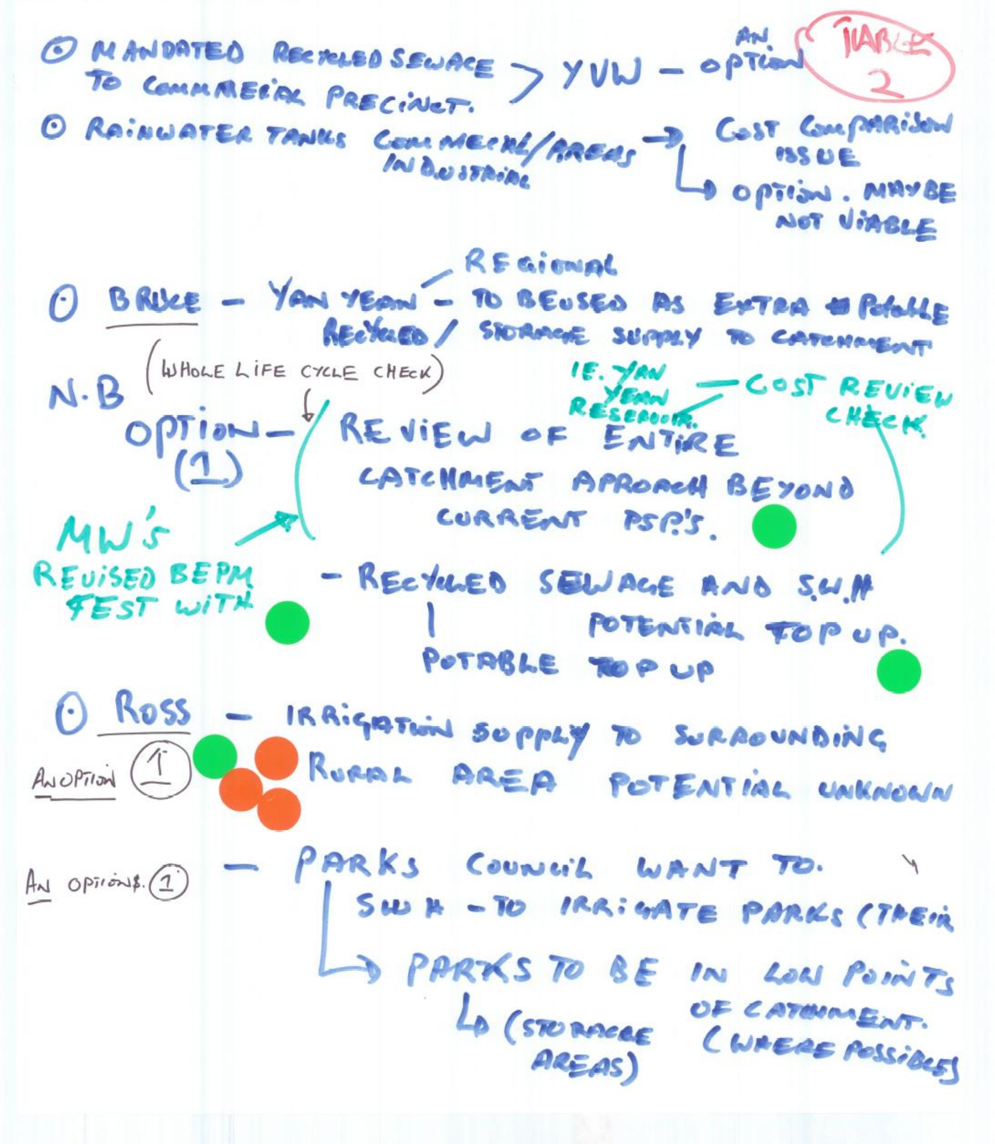
Aquifer storage and recovery
? Not enough demand.

Stormwater harvesting and reuse → in Quarries ?!
for irrigation + open space
→ Co-location of act. open space
RR Stormwater pumped to tank for redistribution [after wetland pre-treatment ?]
? Demand for stormwater outside PSP

Retarding basin
Needed for flood management !!

Table 2

- Extend mandated recycled water usage to commercial precincts
- Rainwater tanks could be used for commercial areas though this may not be viable
- Regional options might be possible such as using Yan Yean to store recycled water
- Irrigation water supply to surrounding rural areas
- Placement of park areas in low points of catchments to allow for irrigation via gravity fed stormwater harvesting – stormwater for open space
- Yarra Valley Water have noted the ample supply of recycled water to the area



⊙ MANDATED RECYCLED SEWAGE TO COMMERCIAL PRECINCT. > YVW – AN OPTION

TABLE 2

⊙ RAINWATER TANKS COMMERCIAL/INDUSTRIAL AREAS → COST COMPARISON ISSUE
↳ OPTION. MAYBE NOT VIABLE

⊙ BRUCE – YAN YEAN – REGIONAL RECYCLED / STORAGE – TO BE USED AS EXTRA POTABLE SUPPLY TO CATCHMENT

N.B (WHOLE LIFE CYCLE CHECK)

OPTION (1) – REVIEW OF ENTIRE CATCHMENT APPROACH BEYOND CURRENT PSP'S. ●

IE. YAN YEAN RESERVOIR. – COST REVIEW CHECK

MW'S REVISED BEPM TEST WITH

– RECYCLED SEWAGE AND S.W.H POTENTIAL TOP UP. ●
| POTABLE TOP UP ●

⊙ ROSS – IRRIGATION SUPPLY TO SURROUNDING RURAL AREA POTENTIAL UNKNOWN ● ● ● ●

AN OPTION (1)

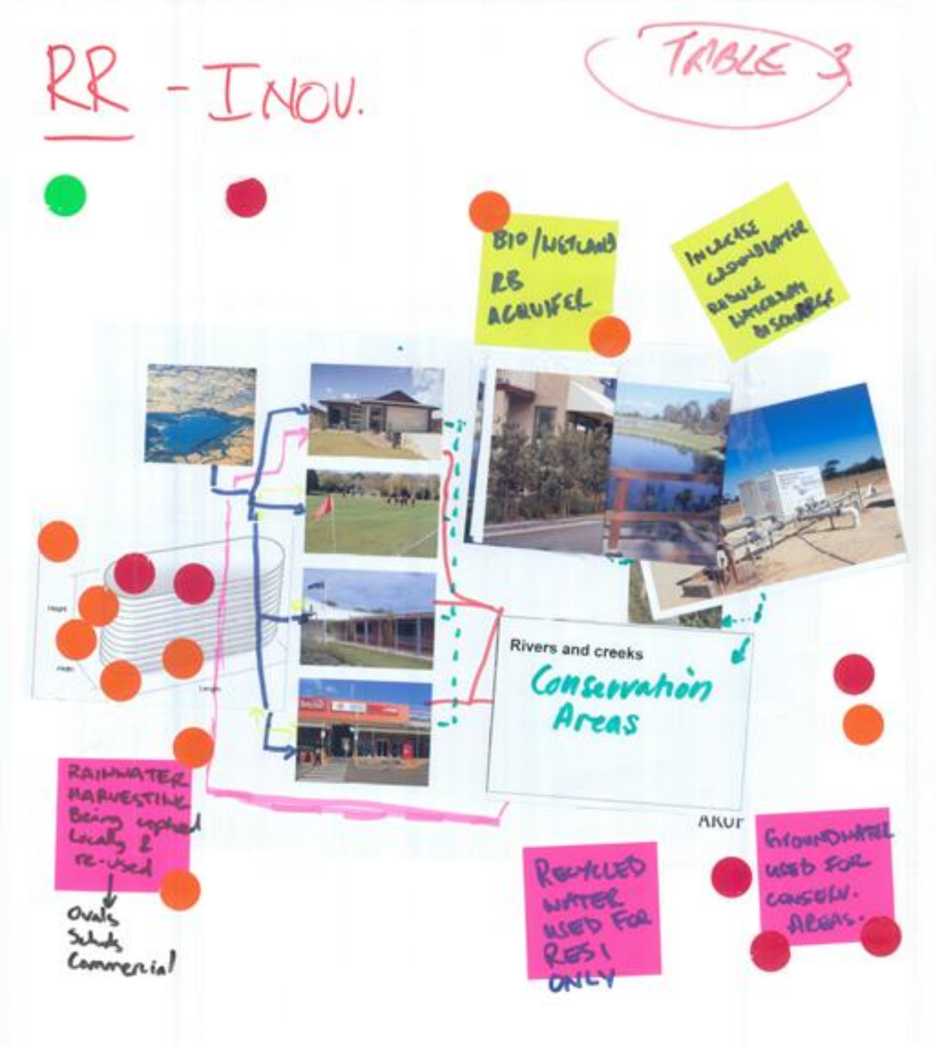
AN OPTIONS. (1) – PARKS COUNCIL WANT TO.
SWH – TO IRRIGATE PARKS (THEIR
↳ PARKS TO BE IN LOW POINTS OF CATCHMENT. (WHERE POSSIBLE)
↳ (STORAGE AREAS)

Table 3

- Option 1 Base Case- Wetlands, retarding basins etc. are needed and incorporated third pipe

- Option 2 - Practical

- Option 3 – Rolls Royce
    - Tanks for non-mandated areas of use (loading bays in retail)
    - Into the aquifer - controlled release (base flows)



1.5 Lunch

1.6 Options discussion

- Risks and concerns, opportunities, benefits, organisational points of view
- Preferred options selection

PRESENT - CHOOSE OURS! BECAUSE ___

DISCUSS RISK:

WHAT	LIKELYHOOD	STRATEGY.
1. Regional vs Current PSPs	* Opportunity.	Entire Catchment Approach. Opportunities
2. BUY IN * (INN) FROM DEVELOPERS	Key RISK.	Realistic Brand. Market Growth Differentiator ? Mandatory req.
3. Value (Commercial) Retailers		? Set higher standard levels.
4 Impact of loss of Open Space	* Opp for Council.	
5. Too Complex? $ Affordability	7. Public vs Private	8. Need for Case Studies.
Resource mngmnt		
6 Health	* Benefits - open/connected spaces. (Shade).	

Dotmocracy results

Green (keep it at all costs)

- 11 – Opportunity for Regional/catchment approach to be adopted vs current PSP limited approach
- 9 – Involve developers in the process
- 6 – Use of distributed systems for stormwater management
- 4 – Using recycled water for the maximum number of uses
- 2 – Use of stormwater for ‘dark green’ open space year round
- 2 - Opportunity to promote health benefits through open connected space, shade and microclimate improvements
- 1 – Connecting the community along stormwater flow lines
- 1 – stormwater management to improve waterway health
- 1 – test against revised BPEM when released
- 1 – Use of recycled water to top-up potable water supply
- 1 - Export of water for adjacent rural uses

Orange (could live without it)

- 7 – Rainwater tanks for residential use, ovals, schools and commercial facilities
- 3 – Export of water for adjacent rural uses
- 2 – Use of rainwater for hot water
- 2 – Bio/wetland/retarding basin to ASR
- 1 – Stormwater usage for amenity in open space and road and shared path reserves

Red (what were you thinking)

- 3 – Groundwater used for conservation areas
- 2 – Rainwater tanks for residential use, ovals, schools and commercial facilities
- 1 – Use of rainwater for hot water

1.7 Wrap up, close, thank you and next steps

- Arup/MPA to review workshop outputs and produce two alternative options for next stage
- MPA to discuss developer involvement/engagement strategy

B1

Appendix C

Stakeholder Commentary

C1 Stakeholder commentary and associated actions

Date Received	Organisation	Report Reference	Comment Text	Action
29/05/2014	City of Whittlesea	3.2.2 Alternative 2 - Base Case + 3.3.4.3 Treated Stormwater	It is considered that the Alternative 1 - Base Case + scenario is achievable; Alternative 1 – Base Case + can be remodelled to include stormwater harvesting; Council's is committed to the irrigation of active open space, in particular to ensure that these areas are available during periods of draught; The stormwater harvesting proposal should also include high flow capture; and if feasible and supported, can stormwater harvesting be included as a DCP item (either in full or in part)?	Note support – optimise location and harvesting volumes in future stages
29/05/2014	City of Whittlesea	3.2.3 Alternative 2 - Future Stretch	Some elements of the Alternative 2 – Future Stretch scenario appear less likely to be realised. In particular the combination of: • Rainwater tank installation at lot level, given MWC risk related comments regarding the detention of flows in high flow events; • Stormwater harvesting (amended as suggested above); • Distributed WSUD assets throughout the precincts; and • Aquifer storage and recovery	Note
29/05/2014	City of Whittlesea	3.2.3 Alternative 2 - Future Stretch	Some refinement of the above mentioned elements for Alternative 2 – Future Stretch, will likely result in this option being more achievable. Suggested tinkering below: • Rainwater tank installation for commercial/retail, education and open space pavilions instead of residential; • Stormwater harvesting as above; • All WSUD assets to treat a minimum size of 5ha and therefore located appropriately within the precinct, to rationalise the number of future assets requiring maintenance and as such minimise the associated financial obligation; and • Aquifer recharge and delivery of water to the river red gum conservation area, as opposed to storage and recovery • The proposed colocation of wetlands and retarding basins in close proximity to active open space is supported; • The amount of retardation required for the Donnybrook catchment falling west towards Merri Creek, could be amended if the existing culverts beneath the Mel-Syd railway line are upgraded. To be confirmed by MWC;	Consider in future stages

			• Nominated wetland figures of extended detention and permanent pool depths of 0.35m are supported; • Grassed batter slopes must be 1:6. The proposed 1:3 is not supported; • Open Space should have some sewer discharge included for public amenity, sporting club pavilions; and • The 'flooding' or watering of the existing River Red Gum/conservation zones should be investigated and included as part of the WoWCA;	
29/05/2014	City of Whittlesea	General - Flood protection	There should be some discussion about the staged delivery of the ultimate flood protection infrastructure i.e. consider that 30% of the residential subdivision has been constructed, but based on locality the need for a retarding basin has not yet been met and therefore not built. During this interim arrangement, an extreme rainfall event occurs (say 100 ARI) and there is no flood protection of properties nor protection of the receiving waterways;	Staging requirements should be considered in future stages
23/05/2014	Melbourne Water	5.3.2 Land Take Requirements Alternative 1 and 2	There are 4 retarding basins that are generally in the same locations in the Donnybrook PSP and the 2 designed DSS's, but the land areas are significantly different. There is insufficient information in the Arup report to assess the methods used to determine these sizes. Further discussions are needed in conjunction with the MPA prior to the drafting of the PSP to agree on suitable land areas.	Further discussions between MPA and Melbourne Water to agree on suitable land areas and locations.
23/05/2014	Melbourne Water	5.3.1.1 Donnybrook (Land Take)	Donnybrook RB 2 location - The WOWCA location is north of the road, whereas the DSS location is south of the road. The DSS location is considered more appropriate as it is adjacent to the existing culvert under the railway line, it is in the lower land and it is closer to the waterway that drains most of the large catchment leading to this basin. It is noted that the PSP does not show the waterway leading to RB 2 and land area will be needed for this waterway.	Reconsider Donnybrook RB2 WOWCA location in future stages based on additional information from Melbourne Water.

23/05/2014	Melbourne Water	5.3.1.1 Donnybrook (Land Take)	Donnybrook RB 2 and WL 2b location - The proposed location in the WOWCA Alternative 1 is in a gully and so could work as a retarding basin and wetland. However, the catchment is quite small and it is unlikely that RB 2a and RB 2b would be large enough together to provide enough retardation for the overall catchment draining to the railway culvert.	Review sizes and locations of RB2a and RB 2b to provide enough retardation for their individual catchments.
23/05/2014	Melbourne Water	5.3.1.1 Donnybrook (Land Take)	Donnybrook RB 2 and WL 3 location - The WOWCA location of the basin and wetland is within the conservation reserve. This would need to be approved by DEPI. Until such approval is received, the DSS does not propose works in the reserve. The DSS proposes a linear retarding basin just upstream of the reserve and another retarding basin in the depression further upstream. In the WOWCA Alternative 1, RB 3 is split into two basins, with RB and WL 3b located away from the waterway. It would require water to be diverted from the waterway to this location. This may be possible for low flows for the wetland and for stormwater reuse, but the retarding basin needs to be where the flood flows are. Therefore, if the wetland is to be co-located in the retarding basin, then a waterway would be needed to direct flood flows to the retarding basin. For this reason, the location of the retarding basin RB 3b is not considered practical.	Note that RB2 and WL3 location require DEPI approval due to being in the conservation reserve. Review RB 3b location in future stages
23/05/2014	Melbourne Water	5.3.1.1 Donnybrook (Land Take)	Donnybrook RB 4 location - The WOWCA location is next to Donnybrook Road, whereas the DSS location is further north adjacent to the railway. The DSS location is considered more appropriate as it is adjacent to the existing culvert under the railway line and it is in the lower land by at least 5 metres.	Note
23/05/2014	Melbourne Water	5.3.1.2 Woodstock (Land Take)	Woodstock RB 1 location - Given the constraints, the WOWCA location RB 1 is reasonable. It would retard flows from a reasonable catchment of future development on the south western side of Darebin Creek.	Note
23/05/2014	Melbourne Water	5.3.1.2 Woodstock (Land Take)	Woodstock RB 1b location - In the WOWCA Alternative 1, RB 1 is split into two basins, with RB and WL 1b located near a reserve. This location is very impractical as it is near the top of the ridgeline. There would be only a very small catchment draining there and so no need for a retarding basin and limited water for a wetland.	Reconsider RB 1b need and location, taking into account the ridgeline in future stages

23/05/2014	Melbourne Water	5.3.1.2 Woodstock (Land Take)	Woodstock RB 2 location - Similar to above, this location has only a small catchment draining to it and so there is limited need for a retarding basin and limited water for a wetland. The flow paths on Figure 15 show water directed from a larger area, but these flows are going uphill, or would require deep pipes. There is another waterway in the southeast corner of the PSP, which is where this area would drain.	Reconsider need/location for RB 2 in future stages
23/05/2014	Melbourne Water	3.3.4.3 Treated Stormwater	Melbourne Water will require best practice treatment of all stormwater before it discharges to Darebin Creek. Treatment would also be required before the significant tributary that runs along the north east edge of the PSP. The WOWCA design only has two wetlands that service the lower parts of the catchment. There is a need for many more stormwater treatment locations adjacent to the waterways that will require significant land take within the PSP. MW does not support that water quality and retardation are only at the bottom of the catchment. So this means that distributed WQ/retardation are required throughout the length of Darebin Creek and its tributaries to protect the waterway and its values.	Further discussions between MPA and Melbourne Water to agree on suitable land areas and locations.
23/05/2014	Melbourne Water	A1.3 Hydrology	There is a tributary on Darebin Creek that is not shown in the WoWCA. MW's first principle is to retain this waterway. Waterway reserves will ultimately need to be determined by MW. These reserves may differ from that shown in the WoWCA plans. Waterway reserves would in any case typically exclude water treatment assets. MW to advise in due course.	Note
23/05/2014	Melbourne Water	General	Drainage assets will help to inform suitable locations of district sports facilities using the 'water first' approach as described in the report	Note
23/05/2014	Melbourne Water	General	Unsure why the report recommends leaving it up to the development industry to determine extent of WSUD beyond the base case. Where does C56 fit in?	Note
23/05/2014	Melbourne Water	General	We'd support approaches that enable passive watering of streetscapes and open spaces	Note
23/05/2014	Melbourne Water	General	Best approach would be to assume BAU land take requirements and any additional features, such as rain tanks, would be a potential added bonus rather than part of base-case	Note

23/05/2014	Melbourne Water	General	Not quite clear why recycled water combined with rain tanks would exacerbate the issue of dealing with excess waste water.	Note
23/05/2014	Melbourne Water	General	How is the future urban structure plan affected by the different options, in terms of land take and location of active open spaces?	Further refinement of land take required in future stages
9/05/2014	Merri Creek Management Committee	5.3 Land Take Requirements	Location of Retarding Basin and stormwater treatment wetland in GGF conservation area - Each of the options shows a retarding basin, DRB3, containing a stormwater treatment wetland, DW3, located within a Growling Grass Frog Conservation Area - This is inappropriate and inconsistent with our understanding of the Biodiversity Conservation Strategy (BCS) where GGF habitat is not be equated with stormwater treatment wetlands.	Reconsider retarding basin location in future stages. Arup understand the DSS location is currently being reviewed by Melbourne Water.
9/05/2014	Merri Creek Management Committee	Appendix A1.1 Flora and Fauna	Lack of general consideration for GGF habitat - the section of Merri Creek which the Donnybrook Precinct drains into is an extremely significant stretch of creek for the Growling Grass Frog. A key conservation objective is to maintain the current populations of GGFs in the Merri Creek. We are thus concerned that: - the habitat needs of this species have not been integrated into the options in the Assessment (and indeed have been over-ridden as per 1) - the water needs of existing and to-be-created GGF habitat have not been included - the hydrological and water quality objectives for urban stormwater runoff, to ensure current GGF in-stream habitat does not suffer a terminal ecological decline, have not been consider and - adequate infiltration to the shallow basalt aquifer to ensure base-flows are maintained in Merri Creek GGF habitat has not been considered	Exhibit a greater consideration for the GGF habitat in future stage assessment by: - Integrating needs of species into options - Include water needs of existing and to be created GGF habitat - Review hydrological and water quality objectives - Explore mechanism to ensure adequate infiltration to the shallow basalt aquifer

9/05/2014	Merri Creek Management Committee	Appendix A1.1 Flora and Fauna and 3.3.4.3 Treated Stormwater	Impact on Merri Creek ecological health - MCMC is deeply concerned at the predictions of Walsh et al (2013) that use of current 'best practice' urban stormwater management practices will result in the loss of existing ecological values in upper Merri Creek. Although Option 2 - Future Stretch - includes features that should help achieve better than 'best practice' these standards don't seem to be specified. We would like to see each of the options assessed against stormwater flow objectives, both the extent to which they reduce the 'flashiness' of typical urban flows and the extent to which they provide infiltration to maintain base-flows. In this way, impact on stream ecological health can be assessed. The only comparison the draft WWC Assessment provides by way of ecological impacts on waterways is water quality (limited to 3 parameters). We are disappointed that impacts on ecological health of Merri Creek are not (yet) an explicit part of the assessment and hope to see this rectified.	Ensure that the ecological health of the Merri Creek is an explicit part of assessments in future stages.
9/05/2014	Merri Creek Management Committee	3.3.2 Land Use extents	Integration of water and biodiversity into open space networks - we note that in each of the options, the proposed retarding basin/wetlands are separated from active public open space by road/s and or/other facilities. Hopefully this is a schematic oversight rather than a lost opportunity to provide high amenity passive open space, containing water and created biodiversity landscapes, linked to other active open space via green space. The mapped representation of retarding basins, with their wetlands, located in isolation from the rest of the green space network, is disappointing.	Optimise locations of wetlands/RBs in future stages to be within open space areas where possible/allowable.
23/05/2014	Mirvac	3.3.4.3 Treated Stormwater	The principle/methodology of using retarding basins for storage of stormwater for use as irrigation on the Active Open space is questioned. To provide effective retardation, retarding basins need to be empty prior to the storm event. As such, if the RBs are to be designed to have storage for irrigation purposes, then they would need to need to be deeper or have a larger area to accommodate this storage. This will come with additional cost – particularly if you consider that they will be constructed in solid basalt. These additional costs should be factored in.	Optimise locations of wetlands/RBs in future stages to account for ground conditions as this information becomes available.
23/05/2014	Mirvac	5.3.2 Land Take Requirements Alternative 1 and 2	It is noted that in Alternative 1 RB3 is split into two smaller Retarding basins (RB3a and RB3b), with R3ba shown on previously identified developable land and RB3b shown to provide stormwater re-use for the Active Open Space. The location for the original (base case) RB3 was identified in the Conservation Reserve which is an effective use of encumbered land. As such the Alternative 1 needs includes additional cost for the land acquisition to construct.	Further discussion required between parties to optimise locations of RB/wetland assets in future stage.

23/05/2014	Mirvac	3.3.4.3 & 5.3.2	Having regard to the above, in comparing the Base case to Alternative 1, costs should be added to Alternative 1 (additional construction costs to allow for stormwater storage, and additional costs for land acquisition - or alternatively loss of yield allowed for in the comparison).	Factor additional construction costs for stormwater storage and additional costs for land acquisition in future stage.
23/05/2014	Mirvac	3.3.4.3 Treated Stormwater	The need for re-use of stormwater is questioned given that there is reticulated recycled water available to the precinct. However If reuse is deemed desirable then it may be better to be harvested and stored in a surface basin or pumped into a large storage tank. Has this been considered?	Note/considers for future stages
23/05/2014	Mirvac	5 Schematic design	Alternative 2 shows bioretention swales along the major arterial roads, and also there is a comment in the report that land should be set aside (to allow for the future installation of swales along arterial roads?). This raises two issues; firstly whether Council/Vicroads would accept swales along the arterial roads and secondly it will result in the loss of more otherwise developable land.	Note – further discussions with responsible authorities required in subsequent stages
13/05/2014	The Office of Living Victoria	General	Overall, the report meets the scope of MPAs WOWCA, but I would argue that the objectives of the stakeholders have not necessarily been met through the options analysis and outcomes.	Note
13/05/2014	The Office of Living Victoria	Appendix A	As per Appendix A, waterway health is identified as a key desired outcome for the precinct, however none of the options can significantly reduce impacts on the waterways. What volume of water would need to be removed from runoff to ensure waterway health is protected?	Note – regional assessments of waterways in understand to inform this answer, but beyond the scope of this WoWCA
13/05/2014	The Office of Living Victoria	General	Can there be a discussion around the difference in urban structure of each option? if any?	Note – for future stages
13/05/2014	The Office of Living Victoria	3.2.3 Alternative 2 - Future Stretch	There is mention of ASR in this option but this is later presented in 3.3.8 and dismissed, so I don't think ASR it is worth including in the option.	Note
13/05/2014	The Office of Living Victoria	3.3.4.2 Water Supply - Recycled	What is the irrigation demand for 'lush conditions'? How does this differ to ‘normal’ irrigation demand?	Irrigation demands are provided within the report
13/05/2014	The Office of Living Victoria	3.3.4.3 Water supply - recycled	What quality of water will is ‘passive treatment’ for irrigation of active open space deliver? Does this meet Class A or B requirements? Usually stormwater is required to be additionally stored and treated through a coarse filter, UV disinfection and then stored in another clear storage before use. This additional storage and treatment will require additional land take and costs which have not been factored into the assessment.	Note – for future stages. There are no Class type requirements for stormwater use for irrigation. A risk based approach is required.

13/05/2014	The Office of Living Victoria	3.3.4.4 Water supply - Rainwater	What if the tank size is increased to 2kL? What hot water savings will be provided as compared to a 1.5kL tank and how much additional water is captured that is then prevented from entering the waterways?	Note – for future stages
13/05/2014	The Office of Living Victoria	3.3.4.4 Water supply - Rainwater	How much land does the tank occupy?	Note – for future stages
13/05/2014	The Office of Living Victoria	3.3.4.4 Water supply - Rainwater	Under what conditions has the tank been sized? Average/wet/dry?	Average year
13/05/2014	The Office of Living Victoria	3.3.4.4 Water supply - Rainwater	How does this option help to achieve 'beyond best practice surface water management outcomes'? Can this be quantified?	Note – for future stages
13/05/2014	The Office of Living Victoria	3.3.5.2 MUSIC modelling inputs	What is the total volume of stormwater predicted to be generated from the site under BAU conditions?	Added to report summary table
13/05/2014	The Office of Living Victoria	5.1.1, 5.1.2 & 5.1.3 Water Sensitive Urban Design	Is all the text which considers design and maintenance considerations really necessary in these sections?	Note
13/05/2014	The Office of Living Victoria	5.3.1 Land Take Requirements	Are the RBs placed in the optimal position to accommodate cut and fill requirements, flood prone land etc? Please discuss.	Optimised locations need to be determined in future stages as more detailed land information is gathered
13/05/2014	The Office of Living Victoria	5.3.2 Alternative 1 and 2	Need to identify the amount of private land required for rainwater tanks at each lot as well public land as the amount of land required for swales and other treatments.	Note – for future stages, land ownership details have not been provided to Arup
13/05/2014	The Office of Living Victoria	5.3.2 Alternative 1 and 2	Will road widths have to be widened to accommodate treatments	Exact layout and widths of road reserves TBD
13/05/2014	The Office of Living Victoria	6.1 and 6.2 Options Assessment	How can the volume of stormwater runoff be the same for all three options if there is additional harvesting treatment in base case+ and future stretch options?	Harvesting does not affect runoff generation. Urban form remains similar thus runoff generation volumes are the same as this granularity of modelling
13/05/2014	The Office of Living Victoria	6.1 and 6.2 Options Assessment	How will stormwater harvesting work? Separate storage and treatment at each site?? other?	Note – to be clarified on a case-by-case basis in future stages
13/05/2014	The Office of Living Victoria	6.1 and 6.2 Options Assessment	Costs for localised stormwater storage, treatment, pumping and transfer have not been considered.	Consider additional costs in future stages

13/05/2014	The Office of Living Victoria	6.1 and 6.2 Options Assessment	What is the associated land take required for the above infrastructure?	Note – to be clarified on a case-by-case basis in future stages.
13/05/2014	The Office of Living Victoria	6.1 and 6.2 Options Assessment	Additional saleable lots compared with base - does it consider the land required to accommodate stormwater treatments? ie road width increase, swales etc?	Note – current calculation only considers the impact of reduced retarding area requirements
13/05/2014	The Office of Living Victoria	6.3 Options Assessment - Qualitative	Can you make a summary comparison of the differences between the options based on the outcomes of the qualitative assessment?	Summary comparison provided in the Conclusion and associated table
13/05/2014	The Office of Living Victoria	6.3 Options Assessment - Qualitative	Why is the base case option, lower in health and wellbeing than the other two options when there is no difference in the urban structure?	Increased access to water features and a more resilient landscape due to additional water sources.
13/05/2014	The Office of Living Victoria	6.3 Options Assessment - Qualitative	It could be readily argued that due to the insignificant volume of rainwater/stormwater that harvested in the base case + and future stretch that there is no difference on habitat and biodiversity	Wetlands distributed through the landscape increase habitat connectivity potential
13/05/2014	The Office of Living Victoria	7 Recommendations and key findings	Cost table is inadequate - need to nominate the source of data used, does not consider all costs, ie land take, stormwater harvesting and transport, etc	Note - Beyond scope of this assessment. Full scale economic and cost analysis should be undertaken in future stages
13/05/2014	The Office of Living Victoria	7 Recommendations and key findings	Second last bullet point of recommendations states that land needs to be set aside in road reserves to accommodate passive watering but there is no consideration of costs for this land take.	Text updated to note that these uses should be ‘accommodated’ within the road reserves where feasible and in a way that minimised additional land take.
13/05/2014	The Office of Living Victoria	7 Recommendations and key findings	Need to consider stakeholder perception of each option and options for governance, O&M, etc	Consider stakeholder perceptions in future stages. CoW have indicated a willingness to manage stormwater harvesting assets
13/05/2014	The Office of Living Victoria	A.1.3	Need to bring the objectives around maintaining waterway health up front into the document.	Included in objectives and contained in executive summary
25/06/2014	Yarra Valley Water	3.2.3 Alternative 2 - Future Stretch	Does comments in future stretch re “slow release of rainfall” mean leaky tanks or is this just referencing the use of the water ?	Initially leaky tanks or talking tanks were envisaged as part of this option however Melbourne Water do not support this

				approach and tank volume was reduced to primarily meet hot water demand.
25/06/2014	Yarra Valley Water	3.3.2 Land use extents	Does an efficiency target of 20% mean building controls on appliances in the houses? I.e. minimum stars for toilets etc?	To be clarified in future stages. 20% target was set by the stakeholder group to explore future efficiency requirements that could be mandated.
25/06/2014	Yarra Valley Water	3.3.4.1 Water Supply - Potable	Water supply may be transferred via the Yan Yean site (balancing storages tanks) but may not actually be from Yan Yean Res as such. Melbourne Water are currently working on bringing the Yan Yean Res on line but at this stage only the clear water tank is in operation.	Note
25/06/2014	Yarra Valley Water	3.3.4.3 Water supply - recycled	Will the treated stormwater be fit for purpose for all intended uses based on wetland treatment?	Noted – additional treatment requirements to be determined in future stages
25/06/2014	Yarra Valley Water	3.3.4.4 Water supply - Rainwater	Please confirm that the 1,500L tank provides 100% reliability. It is 16.6 Days storage based on a 90.4 L/day use. Based on historical rainfall does this really mean 100% reliability?	As modelled by tankulator.com
25/06/2014	Yarra Valley Water	3.3.4.4 Water supply - Rainwater	It needs to be made clearer that the 45L reduction is the hot water substitution with rainwater. This is not clear at this point in the report. i.e 50% laundry and 50% laundry.	Clarified in report
25/06/2014	Yarra Valley Water	3.3.4.4 Water supply - Rainwater	Rainwater tanks feature only in Alternative 2 but the description refers to two volumes (90.4L/d and 113L/d. Can you clarify what the second volume is referring to?	Removed the 113 L/d - this is an error
25/06/2014	Yarra Valley Water	3.3.6.1 Household (Water demand)	It would be useful to split up the per household water use into total potable and total non-potable and show the unit rates on the total water use tables in 4.1?	Note for YVW - Consider splitting per household water use and show unit rates
25/06/2014	Yarra Valley Water	3.3.6.2 Active open space (water demand)	Please show the irrigation rates as ML/ha/yr.	ML/ha/yr is not an appropriate expression to determine scheme reliability

25/06/2014	Yarra Valley Water	6.1 and 6.2 Options Assessment	Is the net present value of the options being considered? For example with the Future stretch option the greatest capital cost is the rainwater tanks. Typically these will be purchased and installed as the development grows. So the total capital is distributed over development life of the PSP. In contrast some of the more centralised assets may need to be built earlier on. So it is important to consider the staging of the assets to get a better comparison of the net present costs.	Detailed economic analysis and staging considerations are not part of this stage of work.
25/06/2014	Yarra Valley Water	6.1 and 6.2 Options Assessment	There is also an additional cost for Alternative 1 and Alternative 2 with respect to the provision of recycled water. The alternatives assumes that recycled water will be provided to residential as well as commercial, retail and industrial customers. So is the additional plumbing for those lots taken into account? Would be good to illustrate the additional cost per lot for the two alternatives.	Noted – to be considered in future stages
25/06/2014	Yarra Valley Water	7 Recommendations and key findings	Please clarify the comment about diverting rainwater into sewer. It is assumed that this refers to the total demand for water that is met by rainwater tanks rather than the centralised potable network. i.e there is no increase in the total sewer flow as a result of rainwater tanks being installed.	There is no increase in sewer flow under this options. Rather the comment notes that due to metering arrangements there will be no mechanism for YVW to recover treatment costs.