TOTAL WATERMARK

CITY AS A CATCHMENT

City of Melbourne

FOREWORD

Relying on a single centralised water supply for urban areas is no longer a sustainable option.

Cities must reduce their water consumption and source water in different ways. Greater investment is needed in rain and stormwater harvesting, water recycling and accessing groundwater to ensure cities a water supply at an efficient cost that also leaves sufficient water for rural communities and environmental needs. It is also important for cities to treat stormwater to minimise the impact of pollution and protect the health of their waterways.

To integrate these ideas into how the City of Melbourne operates, we have approved this landmark water management strategy, *Total Watermark – City as a Catchment.*

Total Watermark – City as a Catchment is based on the vision of a 'water sensitive city' where water sensitive urban design (WSUD) techniques conserve, re-use and recycle water, and manage the quality of stormwater runoff.

The City of Melbourne has made significant progress to date in this by improving the water-efficiency of Council-owned buildings as well as our irrigation systems, and by better landscaping parks and gardens we manage.

Other sites throughout the city showcase how stormwater can be improved for harvesting, recycling and discharging to waterways. Examples include the Royal Park wetlands, the Queen Victoria Market rainwater harvesting project and numerous rain gardens throughout the city's streetscapes, car parks and public open spaces.

This document provides a new framework to build on these initiatives and a platform for a 'water sensitive city' approach.

It establishes water conservation and water quality targets, including a commitment to eliminating the use of drinking-quality water for open spaces managed by the City of Melbourne.

It sets a water balance which quantifies all 'sinks' and 'sources' for the city, as well as a pollutant balance that quantifies loads from impermeable surfaces. These demonstrate that when combined with reducing our water consumption, stormwater harvesting can substantially meet municipal water demands while removing pollutants from runoff.

The City of Melbourne is leading the way in sustainable water management and we commend T*otal Watermark – City as a Catchment* to other local governments and water management authorities across Australia.

Robert Doyle
Lord Mayor

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This strategy has been developed based on a report issued to Council entitled 'City as a Catchment: a strategy for adaptation', by EDAW's Ecological Engineering Practice Area.

EXECUTIVE SUMMARY

LEADING THE WAY IN SUSTAINABLE WATER MANAGEMENT

The City of Melbourne has practised total water-cycle management since 2002, supported by its adoption of the *Total Watermark* policy in 2004 and the *Water Sensitive Urban Design (WSUD)* Guidelines in 2005.

This new policy revises *Total Watermark* to place it within a 'city as a catchment' context and outlines the City of Melbourne's goal to become a water sensitive city. A water sensitive city aims to protect our waterways, respond to climate change and sustainable manage the total water cycle.

This document focuses on conserving and improving water quality in the City of Melbourne. It promotes a localised water management model to reduce reliance on systems that impact other regions and provides a framework that contributes to adapting to climate change.

Relying on a single centralised water supply for Melbourne is not a sustainable option. Reduced rainfall in southern and eastern Australia has meant less surface water availability in centralised water catchments. Without new alternative sources of supply, these reductions in water storage pose a threat to the water security of the City of Melbourne.

Understanding how water flows through our municipality as well as the resulting pollutants is essential to the 'city as a catchment' approach. The City of Melbourne is home to three important waterways: the Yarra River, Maribyrnong River and Moonee Ponds Creek. These waterways provide important habitat, aesthetic, recreational, and economic value to industry and the broader community.

The health of these waterways is strongly influenced by the pollutants contained in stormwater that flows into them. Major forms of stormwater pollution include suspended solids, an excess of nutrients (such as nitrogen and phosphorus), and toxins (such as pesticides and herbicides and heavy metals).

SUSTAINABLE WATER MANAGEMENT GUIDELINES

Total Watermark – City as Catchment adopts a sustainable water management hierarchy incorporating water supply within and beyond the local catchment. This hierarchy is supported by the Model WSUD Guidelines developed by the City of Melbourne in conjunction with the cities of Port Phillip, Stonnington, and Yarra.

The management considerations within the hierarchy are set out as flows:

Within the local catchment:

- Reduce water demand to conserve water and minimise the generation of wastewater, across all new building and infrastructure works, as well as refurbishments and extensions.
- Consider rainwater harvesting as a simple and low impact alternative water source requiring little, if any treatment.
- Consider stormwater harvesting providing the dual benefits of water savings, and improving water quality (by preventing polluted water going down the drain).
- Consider water recycling with a focus on low-energy, low maintenance systems.

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Beyond the local catchment:

- Consider wastewater carried along the Melbourne Water Sewerage Transfer Network. Use low energy technology, and ensure that demand is great enough to maximise the system.
- Consider stormwater in the Yarra River, Maribyrnong River and Moonee Ponds Creek. At the 'bottom of the catchment' the City of Melbourne is not generally limited by environmental flow requirement, but it is necessary to assess other environmental factors.
- Consider potable water use from the centralised mains system if none of the above water management approaches are suitable for a particular site.
- Consider groundwater. This is a low priority for the City of Melbourne as the groundwater in the municipality is shallow and saline.

OUR TARGETS

Total Watermark – City as a Catchment commits the City of Melbourne to achieve targets for saving water, increasing water sourced from alternative supplies, improving stormwater quality, reducing wastewater and supporting groundwater.

Water saving targets

- 50 per cent reduction in potable water consumption per employee by 2020
- 40 per cent reduction in potable water consumption per resident by 2020
- 90 per cent reduction in potable water consumption by Council by 2020
- 25 per cent 'absolute' water saving target by 2020.

Alternative water use targets

- Council will source 30 per cent of its water needs from alternative water sources by 2020
- Non-Council land managers will source nine per cent of their water needs from alternative water sources by 2020.

Stormwater quality targets

- 20 per cent reduction in total suspended solids (soil, tyre/car residue etc.) on Council and non-Council land by 2020
- 30 per cent reduction in litter on Council and non-Council land by 2020
- 15 per cent reduction in total phosphorus (fertilisers, detergent etc.) on Council land by 2020
- 25 per cent reduction in total phosphorus (fertilisers, detergent etc.) on non-Council land by 2020
- 30 per cent reduction in total nitrogen (airborne pollutants, fertilisers etc.) on Council land by 2020
- 40 per cent reduction in total nitrogen (airborne pollutants, fertilisers etc) on non-Council land by 2020.

Wastewater reduction target

- 30 per cent reduction in wastewater across the municipality by 2020.

Groundwater quality target

- Where groundwater needs to be re-injected to prevent land subsidence, it needs to be of equal or better quality to the water in the aquifer.

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ACHIEVING OUR TARGETS

To achieve its 2020 targets, the City of Melbourne aims to undertake a range of on-ground works across the public and private sectors. These include:

Projects for Council-managed assets:

- Further reduce potable water use in parks (dependent on impending research into the horticultural assessment of different water needs) through:
  - irrigation efficiencies (subsurface, soil moisture sensitive, technological improvements, limited time)
  - understanding of soil types and subsequent soil moisture needs
  - mulching to prevent evaporation
  - planting drought tolerant species
  - staff training programs and contract provisions.
- Reduce water use in Council-owned buildings through:
  - efficient fittings – flow restrictors on taps, showerheads
  - efficient toilets – dual flush, reduced header tank flow
  - fire-sprinkler testing (reduced from weekly to monthly, or recirculating)
  - cooling tower efficiencies
  - staff training, contract provisions, education and behaviour change programs.
- Rainwater harvesting – starting with the Public Record Office rainwater tanks.
- Stormwater harvesting – starting with the Grant Street and Shrine of Remembrance stormwater harvesting projects. The scheduled 5 ML expansion of the Royal Park wetland storage capacity will further assist with irrigation in Royal Park. Stormwater harvesting being established at Flagstaff Bowls Club will be used to water the bowling green.
- Sewer mining – starting with the CH_2 sewer mining plant for watering street trees, with endeavours to establish sewer mining plants within parks to reduce the reliance on trucking.
- Investigate offsets to assist and/or fund water reductions outside the responsibilities of Council to cover the water used by Council. To achieve 100 per cent reduction in potable water use in parks and gardens, Council aims to:
  - reduce demand for water (40 per cent)
  - source alternative water (50 per cent)
  - offset remaining potable water (10 per cent).
- Stormwater treatment for streetscapes and parks – program of WSUD works includes:
  - laneway improvements – starting with Bullens Lane sand filters
  - raingarden implementation – starting with Bellair St, Grant St, Royal Park Zoo Northern Entrance, and Flagstaff Bowls Club
  - swales and small wetlands – to be implemented in the City of Melbourne
  - porous and permeable paving – to be implemented in the City of Melbourne.

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- Program of alternative water source projects for Council buildings through:
  - rainwater harvesting – starting with Queen Victoria Market capturing rainwater for flushing public toilets
  - water recycling – where appropriate, starting with Fawkner South Pavilion
  - sewer mining – starting with activation of the CH_2 sewer mining plant.

Projects for the commercial buildings

- Commercial business – demand reduction:
  - fire sprinkler testing (reduced from weekly to monthly, or recirculating).
  - cooling tower efficiencies.
  - appliances (efficient washing machines and dishwashers)
  - efficient fittings (flow restrictors on taps, showerheads).
  - gardens (efficient species, layout and irrigation)
  - property management and tenant behaviour change programs.
- Commercial business on large sites – alternative water sources and WSUD treatment:
  - proceed with proposed water harvesting and treatment schemes at Royal Botanic Gardens, Southern Cross Station, Public Record Office, Melbourne Museum, MCG, Melbourne Convention Centre and Flemington Racecourse
  - facilitate new WSUD schemes – perhaps ports, Melbourne Exhibition Centre, universities, hospitals and schools.
- Commercial business on smaller sites – alternative water sources
  - encourage uptake rate of rainwater tanks on private commercial properties to 50 times the current uptake/ installation rate a year (increase to 300 tanks per year).

Projects for residential buildings

- Low-rise residential:
  - efficient fittings (flow restrictors on taps, showerheads)
  - appliances (efficient washing machines and dishwashers)
  - gardens (efficient species, layout and irrigation)
  - swimming pools (pool covers, re-use of backwash)
  - householder behaviour change through education.
- High-rise residential:
  - balance ring mains, fire sprinkler and cooling tower efficiencies
  - efficient fittings and appliances
  - householder behaviour change through education.
- Residential – alternative water sources
  - rainwater tanks for toilet flushing on private residential properties
  - consider water recycling for toilet flushing in high-rise residential apartments.

Total Watermark – City as a Catchment as a will be fully reviewed in 2012 to align with any changes in policy, design, technology, behaviour and other factors. Action plans will be undertaken annually and yearly progress towards achieving the targets will be reported in the City of Melbourne annual report.

1. INTRODUCTION

Total water-cycle management in the City of Melbourne

The City of Melbourne has practised total water-cycle management since 2002, supported by its adoption of the *Total Watermark* policy in 2004 and the *Water Sensitive Urban Design (WSUD) Guidelines* in 2005. Total water-cycle management is the integrated management of all components of the hydrological cycle within urban areas and landscapes – including water consumption, stormwater, wastewater and groundwater – to secure a range of benefits for the wider catchment.

This new strategy revises *Total Watermark* to place it within a 'city as a catchment' context.

What is 'city as a catchment'?

'City as a catchment' is a fundamental principle and approach supporting the creation of a 'water sensitive city'[1]. It recognises the important role of the natural catchment but works primarily with the artificial city catchment (including its roads, roofs and impermeable surfaces) to minimise mains water consumption, reduce wastewater generation and lessen the impact of stormwater discharges on receiving waters.

This approach seeks local solutions to achieve sustainable water management, including the adoption of demand-management practices and harvesting alternative water supplies.

These solutions aim to reduce the reliance on one centralised water supply source – potable mains water. They also aim to minimise the environmental and social impacts associated with upstream sources supplementing the centralised water system (such as the Thompson and Goulburn rivers and potential desalination plant).

Understanding the quantity and location of water flowing through a municipality, and the pollutants being carried with these flows, will help local governments like the City of Melbourne to initiate and assess sustainable water management projects.

The 'city as a catchment' approach explores interactions between supply, the quality and quantity of stormwater and wastewater, land use, climate, social capital and the receiving waterways (rivers and bays). Furthermore, it is an adaptation strategy in response to climate change.

It provides the basis for moving towards an informed 'city as an ecosystem' approach that encompasses greenhouse mitigation and habitat protection and stretches beyond single municipal boundaries.

1 A concept developed by Wong and Brown (2008), a 'water sensitive city' recognises the links within and between the urban water cycle, built form and landscape, and organisational and community values. It has access to a diversity of centralised and decentralised water sources, providing cities with the flexibility to access a 'portfolio' of water sources at least cost and with least impact on rural and environmental water needs. See chapters 3 and 4 for more information.

1. INTRODUCTION

Where to from here?

The City of Melbourne is applying the 'city as a catchment' approach in the following ways:

- **implementing WSUD** through the revised *WSUD Guidelines* (see the Council's map of water initiatives)
- **helping other metropolitan municipalities** to apply the 'city as a catchment' approach (a regional strategy will enable wider and increased implementation)
- working to achieve **zero potable water use in Council-managed parks**
- introducing changes to **roads maintenance, building and construction practices** to better provide for water saving, water harvesting and improving water quality and the health of our waterways
- assisting large **non-Council sites** to implement WSUD, such as the Shrine of Remembrance, Public Record Office, Flemington Racecourse and the MCG
- undertaking climate adaptation analysis and works to feed into stormwater harvesting and microclimates
- continuing the sustainable building program with the private sector to reduce water, energy and waste
- supporting continued **research** into urban advancement towards 'water sensitive cities' using the City of Melbourne as a pilot.

2. BACKGROUND

What has the City of Melbourne already achieved in sustainable water management?

Total Watermark 2004 introduced the City of Melbourne's commitment to sustainable urban water management covering the total water cycle, including water supply, stormwater, wastewater and groundwater.

This was followed in 2005 with the release of the *WSUD Guidelines*, which provides Council staff and the broader industry with guiding principles, case studies and fact sheets to demonstrate how sustainable water management practices can be integrated into a range of urban landscapes.

Additional policy and guideline commitments for sustainable water management include:

- *Construction Management Plan Guidelines*: setting out Council's best-practice requirements for stormwater management procedures on development sites. It also provides requirements that can be transferred into contracts for city development, including parks.
- *Greening Your Building Toolkit:* helping building managers to save water, energy and waste.
- *Corporate reports:* reporting on efforts to reduce water consumption and improve stormwater quality (reduction in total suspended solids reaching our waterways).
- *Environment Local Law:* addressing waste, stormwater and noise management.

Since 2002, the City of Melbourne has been saving water while meeting additional sustainable water objectives, including:

- finding ways to save mains water through efficiency, design and behavioural changes
- minimising wastewater disposal to the sewer through demand management, and some recycling
- treating stormwater to improve water quality for harvesting and re-use and/or discharge to waterways
- protecting groundwater from contaminants and disruption
- managing catchment hydrology, particularly for aquatic habitats.

In addition to this, the City of Melbourne is committed to advocating for logging to cease in Melbourne's water catchments. Logging can reduce water yields and quality significantly, because young regrowth trees require more water, thus reducing stream flow to water catchments. The loss of water through logging activities also undermines water saving efforts elsewhere in the catchment.

Sustainable water management progress to date includes:

- 28 per cent reduction in Council water use since 2000
- 39 per cent reduction in water use per resident living in the municipality since 2000
- 48 per cent reduction per employee working in the municipality since 2000
- 4 per cent reduction in water pollution entering our waterways since 2005 (total suspended solids).

2. BACKGROUND

Why is the City of Melbourne improving its water management approach?

Total Watermark 2004 outlines the City of Melbourne's water policy and will be superseded by this strategy, *Total Watermark – City as a Catchment*, which goes further in terms of integrating the different parts of sustainable water management – water conservation, stormwater, wastewater and groundwater.

The City of Melbourne's traditional approach to water management has come a long way, as shown in Appendix A on page 48.

To date, water conservation and stormwater quality improvements have been driven by separate water management programs at both the state and local government levels. Better accounting is needed of the multiple benefits that are achieved across programs and across the urban water cycle.

With rapid progress in the WSUD field, the City of Melbourne's *WSUD Guidelines* have been updated to include new examples of design, technology, and environmental and risk management that incorporate the 'city as a catchment' approach.

The WSUD Guidelines are being implemented through the Inner Melbourne Action Plan (IMAP), which incorporates the cities of Melbourne, Port Phillip, Yarra and Stonnington.

What wider catchment area does the City of Melbourne sit within?

The City of Melbourne is located at the junction of the Yarra and Maribyrnong rivers. It is the business centre of a broader catchment region consisting of rural landscapes, agricultural industry, industrial and commercial premises, parks and reserves, indigenous vegetation, water storages, thousands of kilometres of waterways and Port Phillip Bay where the catchment meets the sea[2].

The Port Phillip and Westernport catchment is now wholly under the responsibility of Melbourne Water for delivery of regional drainage, floodplain and waterway services.

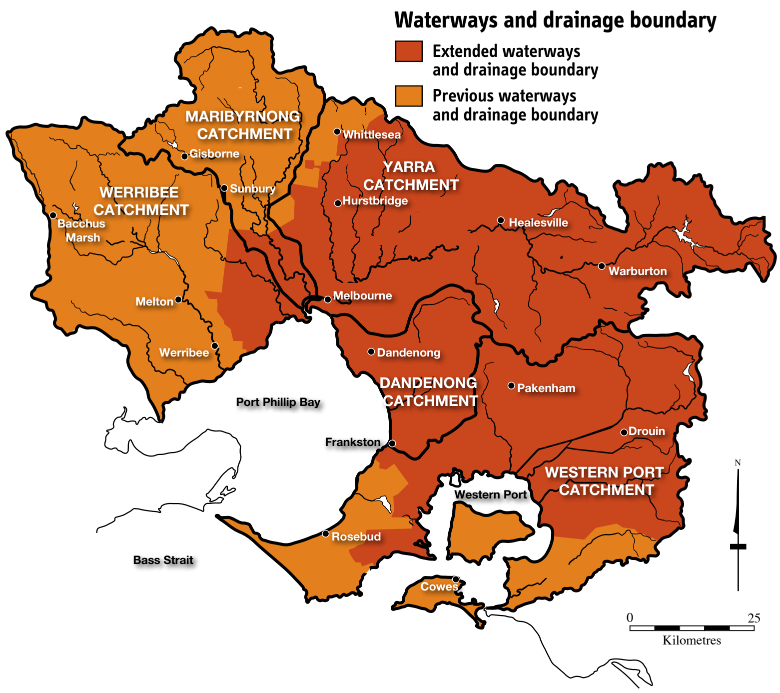


Figure 1: Melbourne Water's drainage boundary and the major catchments, including Yarra and Maribyrnong (Melbournw Water)

2 Port Phillip and Westernport Catchment Management Authority (2003)

2. BACKGROUND

There are three major waterways within the City of Melbourne:

- The Yarra River is the most prominent waterway within the City of Melbourne. The Yarra rises in the Yarra Ranges to the east of Melbourne and runs through the Yarra Valley and Melbourne's eastern suburbs before discharging into Port Phillip Bay. The Yarra drains much of eastern and northern Melbourne with the City of Melbourne constituting less than one per cent of the entire catchment area of the Yarra River.
- The Maribyrnong River enters the City of Melbourne along its western boundary. Its catchment rises to the north-west of Melbourne and drains into the Yarra River. The Maribyrnong River catchment covers 1430 km^2.
- The Moonee Ponds Creek flows from Melbourne's northern suburbs and enters the Yarra River upstream of Appleton Dock in a realigned channel beside the Bolte Bridge. The Moonee Ponds Creek catchment covers a total area of 145 km^2.

Groundwater is a significant resource for Melbourne's wider catchment, not only for irrigation, commercial, urban and residential uses, but most significantly as a natural body that forms an essential part of the water cycle and geological structure.

Groundwater contributes to base flows in our rivers and water depths in our wetlands. The interrelationship between groundwater and surface water should not be underestimated.

Groundwater aquifers underlie most of the Port Phillip region. They are mostly interconnected and range in depth from several hundred metres to less than one metre. The groundwater supplies in the City of Melbourne are generally not a mineable resource, as in most areas they are too saline. No clear information exists about the balance of water extraction and recharge.

The City of Melbourne is one of the most urbanised municipalities in metropolitan Melbourne, which has meant a great loss of indigenous vegetation within its boundaries. However, local community groups are undertaking revegetation schemes along the Maribyrnong River and Moonee Ponds Creek.

2. BACKGROUND

How does the City of Melbourne work with its stakeholders?

The City of Melbourne works with a range of stakeholders to deliver its sustainable water management program. This includes, but is not limited to, the partnerships set out in Table 1.

Table 1: List of the City of Melbourne's water partnership programs 2008

No.	Partner/s	Program	Description
1	Melbourne Water	Living Rivers Stormwater Program	Assistance and funding to deliver a WSUD project on the ground.
2	Inner Melbourne Action Plan (IMAP): Yarra, Port Phillip and Stonnington councils	Action 9.1 Environmental Targets Action 9.3 Water Sensitive Urban Design Action 9.6 Water in Parks	Action 9.1 addresses consistency of environmental targets across the IMAP councils. Action 9.3 addresses consistent guidelines and local policies for implementing WSUD. Action 9.6 addresses water management in parks including irrigation efficiency and alternative water solutions.
3	Environment Protection Authority (EPA) Victoria	Yarra River Investigations and Response Program	Assistance and funding to deliver stormwater pollution improvement projects.
4	Melbourne Water, Sustainability Victoria, EPA and Yarra, Stonnington and Boroondara councils	Lower Yarra Litter Strategy	Partnership program to deliver litter reduction projects to protect our waterways.
5	International Council for Local Environmental Initiatives (ICLEI)	ICLEI Water Campaign	To date we have achieved Milestone 4 in Community Water Use and Milestone 3 in Corporate Water Use.
6	Clinton Climate Initiative	Building Retrofit Program	To deliver building retrofit works for Council buildings to save water and energy.
7	Sustainable Water Use Reference Group	Council-run partnership	This reference group was established by the City of Melbourne to pursue sustainable water management projects in parks, business and across the community. Partners include City West Water, South East Water and the Plumbing Industry Commission.

The City of Melbourne welcomes continued and new partnerships to deliver sustainable water management.

3. THE BASIS FOR CITY AS A CATCHMENT

In a time of drought, climate change and population growth, it is necessary for urban communities to incorporate design strategies for water management that provide resilience to future uncertainty.

In the past it was an urban challenge to provide piped water, sewerage services and flood mitigation.

These remain challenges today, but they can be managed in ways to ensure water is re-used where possible, and waterways are protected from runoff pollution.

Moving towards a 'water sensitive city' (Figure 2) can provide solutions for water management.

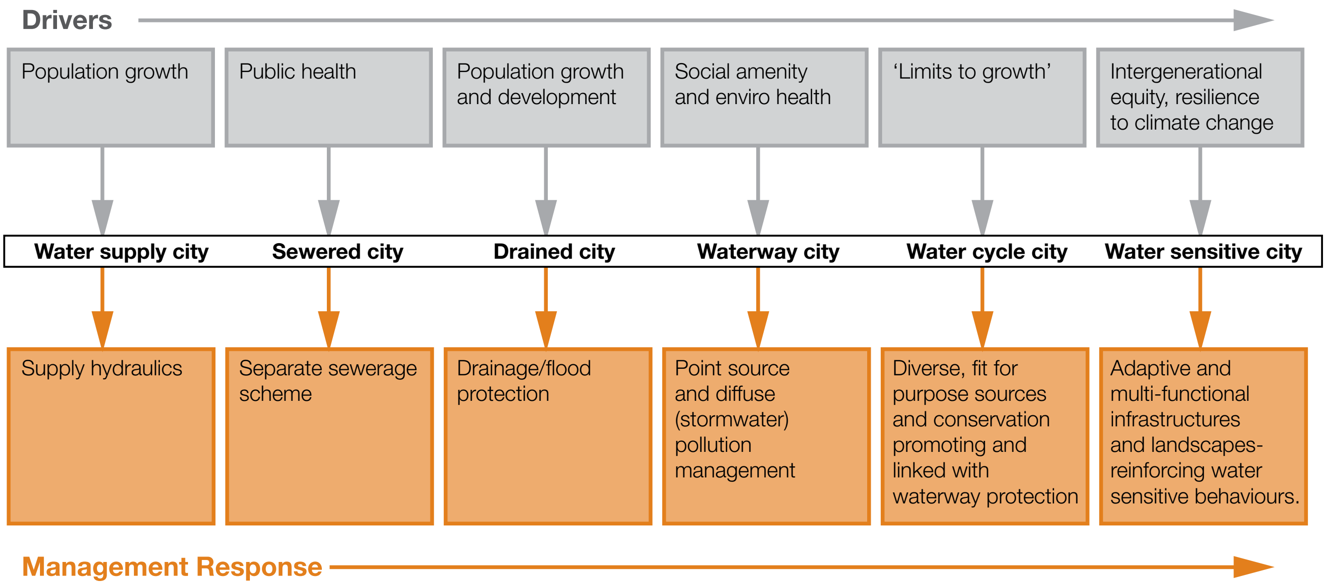


Figure 2: Urban water management transition framework: 'water supply city' to 'water sensitive city' (Brown et al. 2008)

A traditional 'water supply city' is based on a single, centralised infrastructure, which provides limited flexibility for water management and re-use in times of changing climate.

The framework for a 'water sensitive city' focuses on the links within and between the urban water cycle, built form and landscape, and organisational and community values. It uses diverse infrastructure associated with the harvesting, treatment, storage and delivery of the water from both centralised and decentralised water supply schemes. Any stormwater or wastewater not harvested is treated before discharge to the environment.

The 'water-sensitive city' considers natural waterways alongside traditional water infrastructure to create a more integrated approach to water management. As this approach effectively changes the urban landscape, new forms of urban design and architecture will be required within the built environment.

For local governments this means demonstrating full commitment to sustainable water management by implementing WSUD across all of their assets (including parks and gardens, buildings and roads).

3. THE BASIS FOR CITY AS A CATCHMENT

Local government influence must extend beyond adoption within the public domain, through to education, incentives, partnerships with industry and regulation to facilitate the uptake of WSUD in the private sector (including commercial and residential sites).

The City of Melbourne is a recognised leader in the application of WSUD but has relied to date on one-off demonstration projects. Committing to the 'city as a catchment' approach is a more strategic way to apply sustainable water management practices in the urban landscape. *Total Watermark – City as a Catchment* will strengthen the Council's commitment to rollout these practices across its land and buildings, as well as the residential and commercial/industrial sectors of the community.

How is climate change likely to impact on water management in the City of Melbourne?

Victoria is expected to become drier with annual average rainfall decreasing by about four per cent by 2030, with most of the decrease expected in winter and spring. The projected decrease in rainfall and more evaporation, along with warmer temperatures, is likely to increase drought risk and severity[3].

By 2030, the decline in annual rainfall and higher evaporation is expected to cause less runoff into rivers. For Melbourne, average stream flow is likely to drop 3–11 per cent by 2020 and 7–35 per cent by 2050[4].

One of the major impacts of the rainfall decline in southern and eastern Australia has already been a reduction in surface water available in our centralised water catchments. Victoria has experienced a 20 per cent rainfall decrease since the mid 1990s, translating into an inflow reduction of about 40 per cent[5]. Without new alternative sources of supply, these reductions in water storage pose a large threat to the water security of the City.

3 CSIRO (2008a)
4 CSIRO (2007b)
5 CSIRO (2007b)

3. THE BASIS FOR CITY AS A CATCHMENT

Table 2: Projected seasonal changes (%) in Melbourne rainfall

	2030 Low	2030 High	2070 Low	2070 High
Summer	0 to -5%	-5 to -10%	-5 to -10%	-20 to -30%
Autumn	0 to -5%	0 to -5%	0 to -5%	-5 to -10%
Winter	0 to -5%	0 to -5%	0 to -5%	-10 to -20%
Spring	-5 to -10%	-10 to -20%	-10 to -20%	-30 to -40%

Average seasonal changes (per cent) in Melbourne rainfall for 2030 and 2070 relative to 1990, for the CCAM (Conformal Cubic Atmospheric Model) Mark 2 (CSIRO 2007).

Even though the overall rainfall for Victoria is expected to decrease, extreme rainfall events are projected to increase. The future precipitation regime will have longer dry spells interrupted by heavier precipitation events[6].

Table 3: Percent change in average intensity of 1-in-40-year rainfall in South Central Victoria

DJF		MAM		JJA		SON		ANN	
2030	2070	2030	2070	2030	2070	2030	2070	2030	2070
+12%	+11%	=	+28%	-4%	=	-4%	-18%	-10%	-1%

CCAM (Mark 2) percentage changes in average intensity of 1-in-40-year rainfall in South Central Victoria, relative to the average simulated for 1961–2000. (ANN = Annual; DJF = December, January, February; MAM = March, April, May; JJA = June, July, August; SON = September, October, November) (CSIRO 2007).

By 2050, higher sea levels and more intense storms, coupled with increased storm surge heights of approximately 20 per cent, will greatly expand the area likely to be inundated by storm events. Modelling indicates that most of this height increase will be due to sea-level rise, with a small fraction due to wind speed increase[7].

Increased storm intensity and longer dry spells need to be considered as part of the City of Melbourne's ongoing commitment to sustainable water management. It is important that WSUD works that are used to meet sustainable water management goals take into account the impact of climate change.

The City of Melbourne's draft *Climate change adaptation strategy – Risk assessment and action plan discussion paper* (July 2008) identified two key high-value adaptation measures that have potential to provide benefits across many risks. The first is 'stormwater harvesting which can assist in flash flooding events and limited water supply'. This *Total Watermark – City as a Catchment* strategy is central in responding to this climate adaptation need.

6 CSIRO (2007b)
7 CSIRO (2007b)

4. FRAMEWORK FOR A 'WATER SENSITIVE CITY': A STRATEGY FOR RESILIENCE

The purpose of a 'water sensitive city' approach is to implement best-practice water sensitive urban design (WSUD) techniques to conserve, re-use and recycle water, and manage the quality of stormwater runoff. Such an approach provides a framework for adaptation to climate change by responding to various water supply opportunities. Risks and opportunities for water management are considered on the basis of infrastructure renewal, climate change impacts, urban consolidation and population growth.

See Appendix B on page 51 for the national, state and regulatory context for implementing a 'water sensitive city'.

What are the main steps to implementing a 'water sensitive city'?

There are three fundamental attributes for implementing a 'water sensitive city'[8]. These are described in detail below, and include:

1. access to a diversity of water sources (both centralised and decentralised)
2. provision of ecosystem services for the built and natural environment
3. community engagement (socio-political capital for sustainability).

1. Access to a diversity of water sources

Melbourne's drinking water is of a very high quality. This service is reliant on catchment runoff and is vulnerable to drought and climate change.

To reduce their vulnerability, cities like Melbourne need to lessen demand on their mains water supply, and source their water in various ways[9], including water harvesting, water recycling and groundwater.

Not all of these solutions are suitable for sites in the City of Melbourne because of the municipality's geography, geology, topography and wider environmental concerns. A hierarchy of sustainable water management solutions best suited to the City of Melbourne is set out in Section 5.1 of this report on page 29.

8 Wong and Brown (2008)
9 PMSEIC (2007)

4. FRAMEWORK FOR A 'WATER SENSITIVE CITY': A STRATEGY FOR RESILIENCE

What is 'fit-for-purpose' water use?

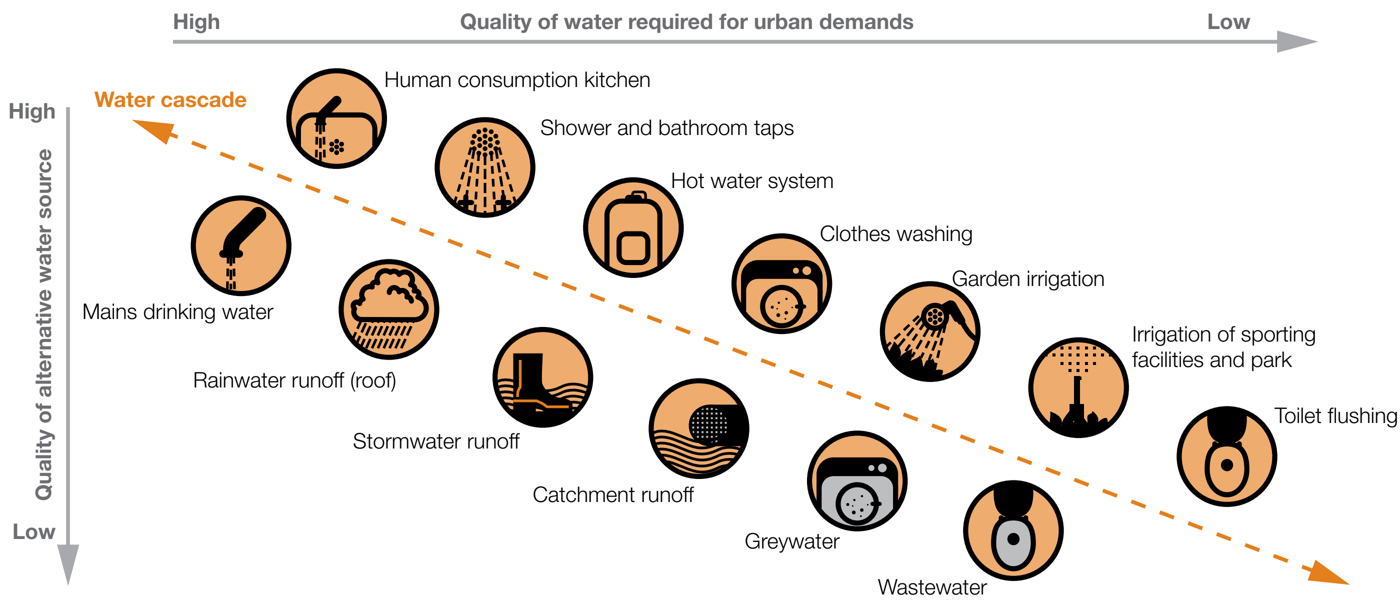


Figure 3: Cascading consideration and uses of alternative water sources (modified after Holt, 2003)

The concept of 'fit-for-purpose' water use helps to priorities alternative water sources to different water demands – based on a cascading range in quality (as shown in Figure 2). With the exception of wastewater, the closer the match in quality of the source and demand, the less treatment required (and generally the less energy intensive and most cost efficient). If the preferred source-demand arrangement is not viable then other combinations in the context of local site conditions need to be considered.

2. Provision of ecosystem services for the built and natural environment

Landscapes are the product of natural (ecological landscapes) or built forms. The 'water sensitive city' recognises that ecological landscapes are bound by built landscapes including roads, roofs and impermeable surfaces. Ecological and built landscapes are not static but shaped by local microclimates interacting within a regional and global ecosystem.

At the local scale, landscapes can be categorised as a 'source' (e.g. sites that can harvest stormwater such as a road, or harvest rainwater such as a building with a large roof) or a 'sink' (e.g. a park, sports field or large water-using business). Water-cycle links can be made between these landscapes.

4. FRAMEWORK FOR A 'WATER SENSITIVE CITY': A STRATEGY FOR RESILIENCE

The design of these landscapes may encompass the perspectives of nature conservancy through to creating urban ecologies, all of which are dependant on sustainable water management practices to ensure their longevity. Three broad functioning themes are defined by Wong (2007) to help characterise design objectives, distinguished by the degree of urban density and complexity. They are:

- *Nature conservancy* – conserving and protecting biodiversity in flora and fauna across terrestrial and aquatic environments.
- *Natural/urban interface* – managing the urban/natural environment interface, protecting areas of significant conservation value, and mitigation and rehabilitation of environmental impacts associated with catchment urbanisation. The focus is the transitioning of natural environments into a more complex and balanced landscape of natural and created features that provide enhanced physical, biological and social outcomes.
- *Urban ecology* – urban design where the role of bio-mimicry[10] in promoting ecosystem services is actively integrated into the urban landscape. Natural features, built landscapes, art and science all influence the design of the urban landscape.

The City of Melbourne recognises the biodiversity value of WSUD features in the urban environment. To further enhance this, WSUD works will involve diverse planting to support local biodiversity.

3. Community engagement for sustainability

Organisational commitment and community acceptance for WSUD is fundamental to the City of Melbourne's capacity to deliver the *Total Watermark – City as a Catchment* strategy.

Local governments and communities will play an important role in bringing sustainable urban water management practices into the mainstream.

Projects led by local government should involve community participatory action models, including workshops to jointly envisage sustainable water futures and action-based forums to develop local strategies and WSUD plans. These models provide the greatest chance of gaining community ownership of local WSUD initiatives.

Projects proposed independently by the community should be supported as much as possible. This includes finding opportunities to link beneficial community projects into the City of Melbourne's operations.

Mainstream adoption of WSUD requires behavioural change and the uptake of sustainable urban water management practices across the private domain. For this to occur, the City of Melbourne must empower the community to get involved and contribute to reducing demand on potable water supplies and protect downstream environments through minimising wastewater and stormwater generation.

Investment must be directed at translating scientific water-cycle management insights into information that helps raise community awareness of the issues and WSUD solutions. This will help create community confidence that decentralisation of water infrastructure will provide safe, reliable and cost-effective solutions with positive environmental and social outcomes.

10 A discipline that studies and imitates nature's best designs and processes to solve human problems.

4. FRAMEWORK FOR A 'WATER SENSITIVE CITY': A STRATEGY FOR RESILIENCE

Supporting behavioural change in the community

Water studies have shown that household water consumption is influenced by three variables: household size, appliance ownership and attitudes to water use.[11]

It is understood that simply providing information will rarely result in behaviour change. Despite rational economic theory suggesting that people will change practices when it is in their financial interests to do so, it appears that people need additional convincing that the change is warranted.[12] The threat of resource depletion quite often seems to have little influence on behaviour towards better environmental practices.

Behaviour change is most effectively achieved through initiatives delivered at the community level[13] and includes the following:

- making the change as easy, attractive and normal as possible
- acknowledging the role that self-interest plays in the adoption of new practices and technology[14]
- using regulatory controls as the most effective means to create change (although this is not applicable in all instances)
- gaining commitment by involving the community, setting goals, or intervening in such a way as to involve personal contact.[15]

Community involvement and participation is a powerful way to achieve behavioural change[16], and local action groups have demonstrated they can help improve environmental outcomes.[17]

A long-term management approach is the most effective way to encourage behavioural change. The City of Melbourne will continue to invest in an ongoing education program and community participation campaign to expose the public to the issues, ideas and solutions associated with water management.

Ongoing research is needed to ensure that *Total Watermark – City as a Catchment* continues to be relevant and takes into account the rapidly changing knowledge base. Relevant research from the water industry and other sources will be incorporated into the strategy through the annual revision of its action plans.

How people think about water

Water users have been shown to think about water in different ways, including:

- *lifestylers* – water is important in all aspects of the lives of these people
- *conservationists* – water conservation is important to these people and they do not see it as a consumer item
- *utilitarians* – to these people, water is purely a consumer item or service similar to electricity and transport, and they should not be limited in their use
- *indifferent* – water is not significant in any way to these people.

Interestingly, the ways people think about water is not reflected in their water-using behaviour. This reflects the gap between intentions and behaviour.[18]

11 Nancarrow and Syme (2003)
12 Kurz (2002)
13 McKenzie-Mohr and Smith (1999)
14 Taylor and Wong (2002)
15 Kurz, Donaghue and Walker (2006)
16 McKenzie-Mohr and Smith (1999)
17 Breen and Lawrence (2003)
18 Nancarrow and Syme (2003)

5. CITY OF MELBOURNE: A 'WATER SENSITIVE CITY'

The City of Melbourne is located at the bottom of the Port Phillip Bay catchment and is home to three important waterways: the Yarra River, Maribyrnong River and Moonee Ponds Creek. They all provide important habitat, aesthetic, recreational, tourism and economic value to industry and the broader community. The area of land within the municipality is 3766 ha.

By identifying the movement of water (expressed as a water balance) through the municipality, it is possible to better implement sustainable urban water management. Council can act immediately on the land and buildings it owns and this can have a profound influence on practices in the private domain (commercial and residential) through education, policy reform, financial incentives and enforcement.

The remainder of this section presents the City of Melbourne's water balance and pollutant budget. Information on water demands, mains water supply, wastewater, groundwater, water conservation and stormwater treatment has been sourced from a variety of documents and databases, as listed in Appendix C on page 55.

What is a water balance?

A water balance assesses the movement and transformation of water (including potable water) to sewer, how much water is used as irrigation and lost as evapotranspiration or to groundwater, and wastewater generation.

It helps determine the amount of water needed on a site, and the alternative water sources that are available to help meet this need.

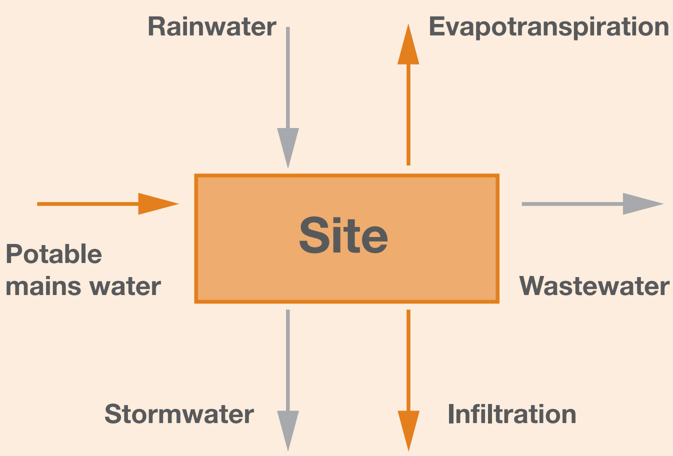


Figure 4: Water balance schematic for a site

A water balance can be considered in the context of identifying opportunities to minimise mains water use through demand management while still meeting the water needs of the site.

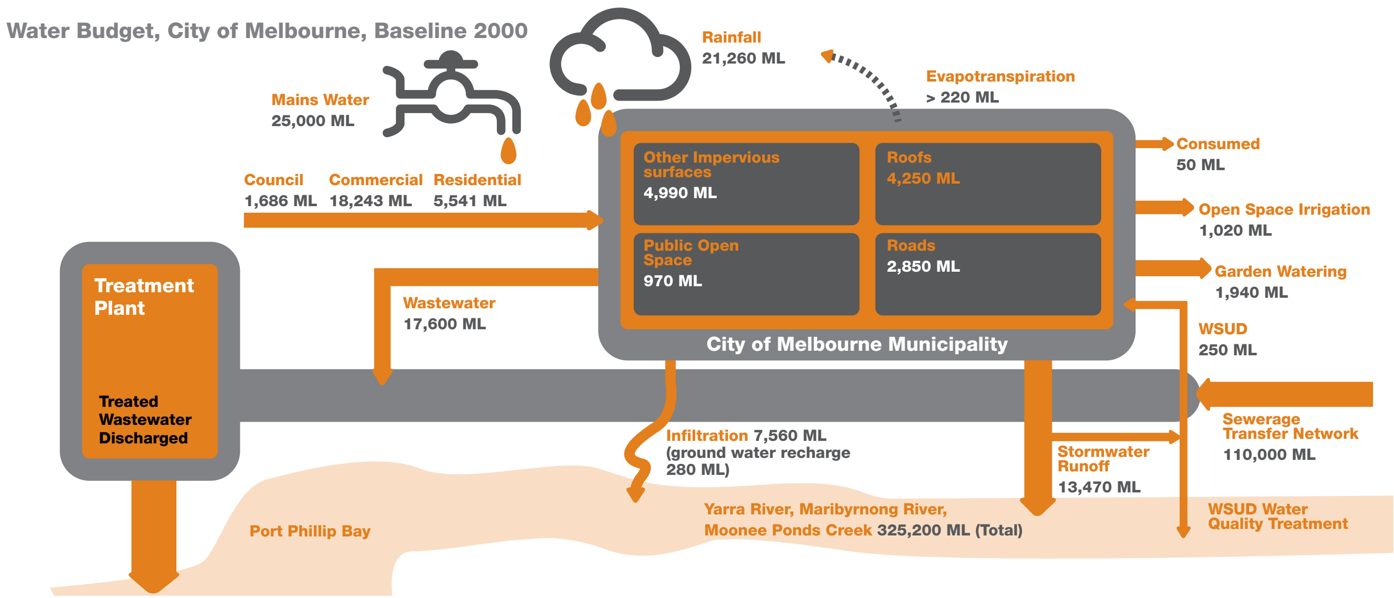
A water balance can assist design 'fit-for-purpose' water sensitive urban design (WSUD) solutions that achieve desired water conservation and water quality improvement outcomes. The minimisation of wastewater should also be considered as part of a water balance.

Under the 'city as a catchment' approach, a stormwater pollution budget can also be developed by assessing the type of surface that rainwater is likely to fall on, and calculating the pollutants that the stormwater would pick up as a result of different land-use practices. By calculating the amount of rain falling on roads, footpaths, open space, roofs or other impervious areas, we can estimate the amount of total suspended solids (e.g. soil, tyre and car residue), total phosphorus (detergent and fertilisers) and total nitrogen (air-borne pollutants and fertilisers) that will need to be managed in the municipality.

5. CITY OF MELBOURNE: A 'WATER SENSITIVE CITY'

5.1 THE CITY OF MELBOURNE'S WATER BALANCE

The City of Melbourne's water balance shows potable water, wastewater and rainfall flows. The stormwater runoff is substantial, highlighting the potential for harvesting to help meet local water demand. Increased stormwater treatment and harvesting, water saving and climate change are reflected in the Target 2020 water budget.



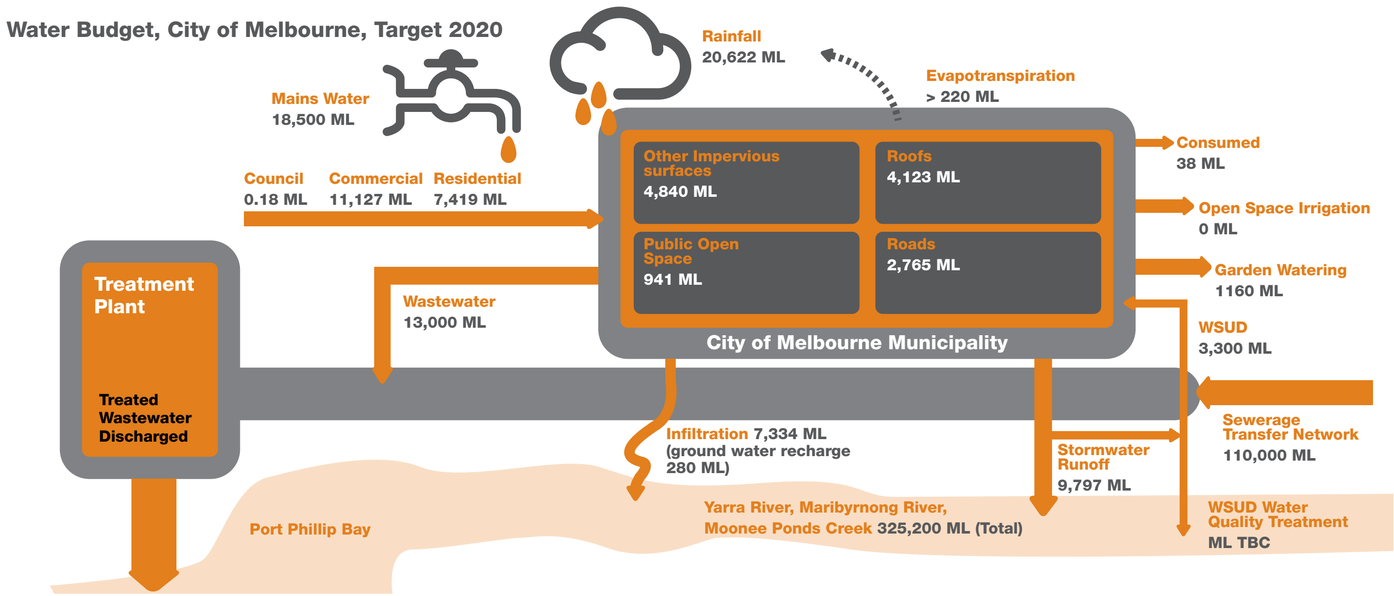


Figure 5: Water balance for the City of Melbourne – showing baseline and targets

5. CITY OF MELBOURNE: A 'WATER SENSITIVE CITY'

Where is water being used in the City of Melbourne?

Figure 6 shows that in the base year of 2000, commercial practices placed the greatest demand on mains water supply (18,243 ML/yr), followed by residential (5541 ML/yr) and Council (1585 ML/yr) demands.

Even though Council's demand represents a relatively small proportion of the total, it has an important role to provide leadership in the community. The implementation plan, detailed in Section 7 on page 42, discusses how Council can directly contribute to achieving sustainable water management targets.

Approximately 88 per cent of potable water is used and then discharged to the sewer as wastewater (22,510 ML/yr) from the municipality.

Stimulating demand-management practices across the commercial sector is critical to conserving mains water and reducing wastewater flows across the municipality.

Approximately 11 per cent of mains water (2959 ML/yr) is used for outdoor purposes in the municipality, including residential garden watering and irrigation of public open spaces. Irrigation of the City of Melbourne's public open spaces represents 65 per cent of its potable water use. Ample stormwater is available to meet the municipality's mains water demands, such as irrigation requirements, by tapping into catchment drainage that flows adjacent to parks and gardens.

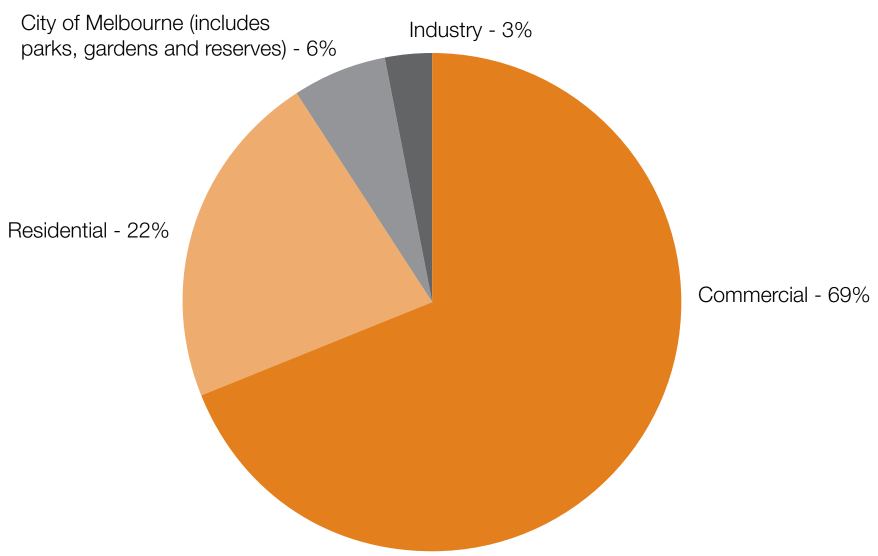


Figure 6: Total water consumption in the City of Melbourne in base year 1999–2000

5. CITY OF MELBOURNE: A 'WATER SENSITIVE CITY'

What water saving efforts are underway and continue to be promoted?

See below for Council and community water saving efforts that are underway and continue to be promoted.

Sector	Demand reduction measures
Council	**Parks:** reduce potable water use in parks through: • irrigation efficiencies (subsurface, soil moisture sensitive, technological improvements, limited time) • understanding of soil types and subsequent soil moisture levels • mulching to prevent evaporation • planting climate responsive, drought-tolerant species • recirculating and recycled water in fountains • staff training programs and contract provisions.
	Buildings: reduce water use in Council-owned buildings through: • efficient fittings – flow restrictors on taps, showerheads • efficient toilets – dual flush, reduced header tank flow • fire sprinkler testing (reduced from weekly to monthly, or recirculating) • cooling tower efficiencies • staff training, contract provisions, education and behaviour change programs.
Residential	**Residential:** reduce water use in households through: • efficient fittings – flow restrictors on taps, showerheads • appliances – efficient washing machines and dishwashers • gardens – efficient species, layout and irrigation (to be maintained when water restrictions are not in place) • swimming pools – pool covers, reuse of backwash • householder behaviour change through education • high-rise residential – balance ring mains, fire sprinkler and cooling tower efficiencies.
Commercial, including industrial	**Commercial:** reduce water use in commercial/industrial settings through: • fire sprinkler testing (reduced from weekly to monthly, or recirculating) • cooling tower efficiencies • appliances – efficient washing machines and dishwashers • efficient fittings – flow restrictors on taps, showerheads • gardens – efficient species, layout and irrigation (to be maintained when water restrictions are not in place) • property management and tenant behaviour change programs.

Table 4: Demand reduction measures for Council, residential and commercial sectors

Once the above demand-management measures are in place, alternative water can be sourced to meet as much remaining demand as possible.

5. CITY OF MELBOURNE: A 'WATER SENSITIVE CITY'

Where and how much rain is falling in the City of Melbourne?

The mean annual rainfall volume across the municipality is 21,260 ML, of which approximately 63 per cent (13,470 ML) is discharged as surface runoff, 1 per cent (220 ML) is returned to the atmosphere through evapotranspiration processes and 35 per cent (7560 ML) infiltrates into the underlying soils. Approximately 1 per cent (280 ML) of the infiltrated runoff contributes to groundwater recharge across the municipality.

A total of 4230 ML/yr of roof runoff is generated across residential and commercial sites, providing an abundance of water with the potential to be harvested and used for garden irrigation, toilet flushing, hot water and laundry purposes. Private impervious areas and roads are other sources of runoff that could be harvested to provide a valuable supply.

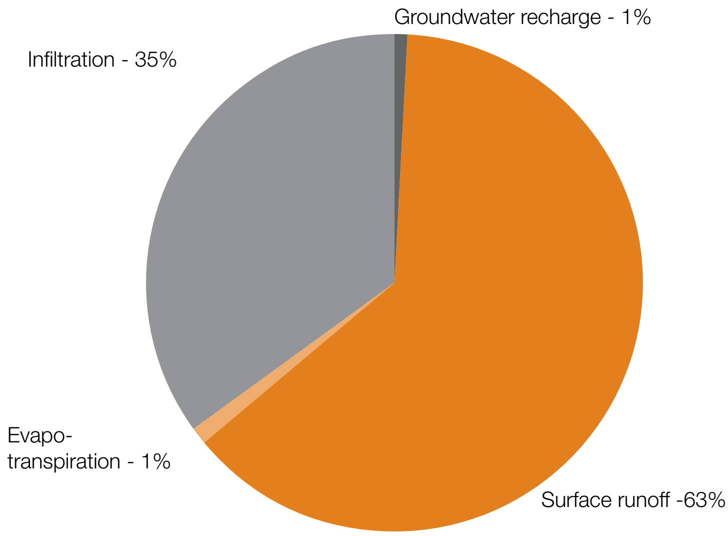


Figure 7: Rainfall end point in the City of Melbourne 2005

How is climate change factored into *Total Watermark – City as a Catchment*?

The rainfall data used across the Victorian water industry is based on historical rainfall patterns. It is acknowledged that these patterns show higher rainfall than has been experienced in the past 10 years and that future rainfall is forecast to be less than that shown in historical rainfall patterns.

The *Total Watermark – City as Catchment* targets for water saving have factored in reduced rainfall of 3 per cent by 2020, which is an average figure used by the City of Melbourne and guided by the CSIRO findings set out on page 17 of this report.

The City of Melbourne strongly advocates that rainfall data be modified in the industry's water modelling tools to reflect the growing understanding of climate change impacts on rainfall and storm events.

5. CITY OF MELBOURNE: A 'WATER SENSITIVE CITY'

How much of local water needs can be met by the rain falling in the City of Melbourne?

The water budget shows that combining stormwater and roof-water runoff could, on paper, meet 70 per cent of the potable water needs of residents and businesses in the City of Melbourne.

This offers great potential, however, in reality all 70 per cent is not available for use – as it is unfeasible to build the large storage capacity needed to capture all of this rainfall. A preliminary feasibility study looking at seven parks and one boulevard in the City of Melbourne shows that the stormwater harvesting potential for these sites will, on average, meet 43 per cent of the water needed for the sites. This gives a general idea of the stormwater harvesting capacity that is available for the municipality, which together with demand management practices, could provide well over half the water needs of the City of Melbourne.

Stormwater harvesting will not provide all of the municipality's water needs, but forms an important component of integrated urban water management. The benefits of stormwater harvesting reach beyond mains water conservation in that it reduces stormwater pollutant loads discharged to receiving waters, reduces excessive runoff flows (higher than natural volumes when it rains) to waterways and thereby protects the health of our water bodies at the same time. It is important that stormwater flow volumes are not reduced to such a level that the lack of flow negatively affects the waterways. For the City of Melbourne, being at the bottom of the catchment means that such stormwater flows are not as essential as they are for upstream areas.

Capturing stormwater requires water sensitive urban design

Water sensitive urban design (WSUD) embraces a range of measures that are designed to avoid, or at least minimise, the environmental impacts of urbanisation by reducing the demand for water and the potential pollution of natural waterways.

WSUD is able to treat stormwater before it enters the waterway or before it is re-used for another purpose. It benefits the environment by saving water and improving stormwater quality, and also has the following advantages:

- replacement of pipes with natural elements for drainage, such as wetlands;
- enhanced aesthetics through increased vegetation, aquatic elements and landscaping;
- 'visible infrastructure' combining functionality and natural elements; and
- linked urban and natural environments.

WSUD treatments can include:

- porous and permeable pavement to allow water to seep into the water table, rather than rushing into the stormwater system; and
- street trees in roadways designed to ensure the tree is watered from stormwater flowing into its base from the road, and then filtering the pollutants from the excess stormwater before it enters the drain and ultimately the waterway.

5. CITY OF MELBOURNE: A 'WATER SENSITIVE CITY'

- raingardens which enable rainwater and stormwater to be used for a garden while filtering stormwater before it enters our waterways
- swales which slow water down and divert its flow so that treatment can occur
- rainwater tanks which save water and reduce the amount of pollutants entering the waterways
- water recycling and sewer mining technologies that save potable water use.

Where else should water be sourced in the 'city as a catchment'?

Reducing demand, harvesting rainwater from roofs and harvesting stormwater from the ground can provide for a significant proportion of local water needs (and at the same time improve water quality).

Beyond this, site managers can consider a range of other alternative water sources and assess their suitability for each site, as set out in the alternative water source hierarchy discussed on the next page. Council's *WSUD Guidelines* are available for assessing the suitability of different alternative water sources, thereby reducing the vulnerability associated with relying on one centralised water supply (and its upstream sources from other catchments).

Water recycling is a localised water source available to site managers. Water recycling can encompass simple greywater diversions or treatment of toilet, kitchen or industrial blackwater for re-use – through to water mining from the sewer trunks running by the site. The range of technologies is progressing rapidly and can be assessed by site managers to cover risk, carbon, ecology, maintenance and community issues using the WSUD Guidelines.

It is not recommended that surface water or groundwater be used in the City of Melbourne. Even though our waterways are at the 'bottom of the catchment' and hence not limited by environmental flow needs, any surface water would likely be saline and require intensive treatment before use. Similarly, local groundwater would require desalination, which would not be viable until desalination can be undertaken with a smaller environmental footprint. Further information on groundwater in the City of Melbourne is available in Appendix D on page 56.

In response to the range of alternative water sources available in the municipality, the City of Melbourne has set a target of zero potable water use on its parks by 2020.

Model WSUD Guidelines

Model Melbourne WSUD Guidelines have been developed[19] to assist Council staff, developers, industry and the community to implement water sensitive urban design. The guidelines help site managers and assessors to find the best sustainable water solution for their site, taking into account:

- WSUD principles
- energy and climate impacts
- community considerations
- life cycle costs
- technology selection
- risk management
- maintenance considerations.

19 Inner Melbourne Action Plan initiative supported by Melbourne Water

5. CITY OF MELBOURNE: A 'WATER SENSITIVE CITY'

ALTERNATIVE WATER SOURCE HIERARCHY

Which alternative water sources provide the best environmental solutions for the City of Melbourne?

A fundamental principle of *Total Watermark – City as a Catchment* is to emphasise decentralised water supply options that reduce reliance on potable water brought in from outside the catchment. The following general hierarchy for considering sustainable water management solutions in the City of Melbourne is recommended.

Alternative water sources from within the local catchment

1. **Undertake water demand reductions**
   Save water in buildings through efficient fittings, appliances, good design and good behaviour. Save water in open spaces through good design and planting along with moisture-sensitive irrigation if needed at all.
2. **Consider rainwater harvesting**
   Smaller rainfall volumes are easy to harvest because the equipment required (e.g. tanks, storage pond, lakes) to hold this volume of runoff can be relatively small, yet are able to contribute to reducing some of the residential and Council demands on mains water supply. Typically, 90 per cent of rainfall is attributed to frequent events smaller than the one-in-three-month annual recurrence interval (ARI).

   Rainwater harvesting also helps to reduce stormwater pollutants, most particularly nitrogen loads from atmospheric pollutants.
3. **Consider stormwater harvesting**
   Stormwater harvesting allows for a much greater amount of rainfall to be harvested once it has landed on roads, footpaths, open space and other impermeable areas. Stormwater needs treatment, therefore requiring more management, financing and energy than rainwater harvesting. Stormwater harvesting generally requires planning for large storage areas once the water has been captured and treated.

   Stormwater harvesting provides the greatest reductions in stormwater pollutants compared with other alternative water sources. In particular, it reduces total suspended solids (soil, car and tyre residue).
4. **Consider water recycling**
   This hierarchy is shaped by the City of Melbourne's carbon neutral commitment and the energy and lifecycle implications of water recycling (greywater and blackwater). Treatment standards for recycled water must protect public health and the environment and can be managed through Council's risk management provisions for WSUD.

   Each of the alternative water sources has unique reliability, energy cost, environmental risk and economic profiles. It is necessary to consider the circumstances of every site to determine the best option for saving water, sourcing alternative water and reducing stormwater pollution.

5. CITY OF MELBOURNE: A 'WATER SENSITIVE CITY'

ALTERNATIVE WATER SOURCE HIERARCHY CONTINUED

Alternative water sources from beyond the local catchment

If the above hierarchy of sustainable water management solutions is not able to meet water conservation and water quality targets, then it is recommended that water sources generated from outside the municipality, and which transverse the City of Melbourne, be considered to supplement supply. Alternative sources include:

5. **Wastewater conveyed along the Melbourne Water sewerage transfer network**
   Sewer mining is an option for alternative water sourcing on sites that have limited space or other constraints. It does have significant energy implications that need to be managed, but has the benefit of certainty of supply (unlike rain-dependent options) and fewer storage requirements.

6. **Stormwater in the Yarra River, Maribyrnong River and Moonee Ponds Creek**
   Drawing water from waterways requires full consideration of environmental flow requirements of that waterway. The City of Melbourne is at the bottom of the catchment and as a result, is able to draw water with less environmental and habitat implications than upstream areas. The drawback of being downstream, however, is that the water in these lower reaches is saline and requires significant treatment and desalination.

7. **Mains water**
   Inexpensive supply with existing infrastructure and low greenhouse emissions. The limitation is the reliance on a single source that is vulnerable to drought. Population growth, waterway health, rural water needs and climate change are limiting this option, and the above alternative sources should be considered before relying on full mains water sourcing.

8. **Groundwater**
   Groundwater is unlikely to be a significant resource across the municipality because of the shallow, saline water table across the Yarra Delta region[20]. If extracted, groundwater would need to be desalinated. There is some potential for aquifer storage and recovery in the lower reaches of the City of Melbourne that can be further explored.

Appendix E on page 59 summarises the advantages, challenges and recommendations of mains water and alternative water sources across the City of Melbourne. Council's *WSUD Guidelines* advise on how to implement these alternative water options on different sites within the municipality.

20 Broad scale potential mapping exercise undertaken by Dudding et al. (2006)

5. CITY OF MELBOURNE: A 'WATER SENSITIVE CITY'

5.2 POLLUTANT BUDGET FOR THE CITY OF MELBOURNE

The health of the Lower Yarra River, Maribyrnong River and Moonee Ponds Creek estuarine environments and the open water features of the City of Melbourne are strongly influenced by the pollutants found in stormwater entering these waterways. In many urban environments this is compounded by physical changes to waterways, such as channelisation, concrete lining and sheltered harbours.

What are the main pollutants entering water bodies in the City of Melbourne?

Stormwater pollution loads have a major impact through:

- *Increased loads of suspended solids* – suspended solids are soil and organic particles transported by stormwater to the receiving waterways during runoff events. Suspended solids increase the turbidity of the water, decreasing the penetration of light into the water, and consequently reducing or sometimes completely inhibiting photosynthesis by aquatic organisms. Nutrients, heavy metals, hydrocarbons and organic chemicals may also be transported with suspended solids, by adsorbing onto the particle surfaces. This also negatively affects aquatic benthic[21] communities in water bodies.
- *Increased nutrient inputs* – an excess of nutrients (especially nitrogen and phosphorus) can lead to eutrophication, resulting in the growth of undesirable algae and aquatic weeds, shortages of dissolved oxygen, and blooms of cyanobacteria (which pose a serious health hazard to humans and animals). This reduces the ability of water bodies to support aquatic habitat and recreation.
- *Increased loads of toxicants and anthropogenic chemicals (such as pesticides and herbicides, and heavy metals)* – chemical organic compounds are often associated with organic solids in stormwater or sorbed onto sediment.[22] These compounds can be toxic to some aquatic organisms and can be bio-accumulated through the food chain, creating long-lasting impacts.
- *Increased salinity disturbances* – estuarine environments are essentially characterised by variations in salinity. However, the efficiency of conventional urban drainage systems causes a significant increase in the rate and volume of runoff. As a consequence, urban estuarine ecosystems have to cope with an increased salinity gradient. This factor alone has ecosystem health impacts (i.e. reduced ecosystem diversity).

21 The ecological region at the lowest level of a body of water.
22 Ferguson (1994)

5. CITY OF MELBOURNE: A 'WATER SENSITIVE CITY'

What activities and conditions cause stormwater pollution?

- Accidental or deliberate spills or waste streams from commercial and industrial premises.
- Contaminated stormwater runoff from industrial and commercial premises.
- Faecal matter from dogs, cats and birds create microbial contamination.
- Oil and other chemicals from vehicles on roads contaminate stormwater and can contain dangerous additives that are difficult to remove. Oil can also result from illegal backyard servicing or workshop discharges, spillage associated with fuelling at service stations, storage leaks from service stations and/or bulk fuel distributors, and spillage from fuel tankers involved in accidents.[23]
- Dust on roofs and the ground can contain natural and human-made contaminants.
- Litter such as plastic bags and cigarette butts contribute to gross pollution.
- Food scraps can increase organic loading and excessive algal growth.
- High-speed runoff from large rain events can erode exposed earth, particularly along natural waterways that have lost most of their natural streamside vegetation.
- Runoff from agricultural land located in the upper catchments can add pesticides, herbicides, sediments and nutrients to waterways in the City of Melbourne.
- Runoff from construction sites can add sediment and other chemical contamination.
- Pesticides and herbicides and other chemicals on parks and home gardens.
- Food oils leaking from outside retail premises that do not dispose of it correctly.
- Car washing and similar activities.
- Washing of paintbrushes and other chemical disposal outside homes.
- Sewer overflows and incorrect plumbing and cross connections.

What are the main stormwater pollutant loads in the City of Melbourne?

The stormwater pollution budget for the City of Melbourne shows that non-Council impervious surfaces (e.g. driveways, carparks, forecourts and hardstand areas), roof areas and roads generate the greatest volume of runoff across the municipality.

Land uses responsible for the greatest loads of pollutants in the City of Melbourne are:

- Roads and other impervious surfaces for total suspended solids[24] – The generation of total suspended solids (TSS) is very high in the City of Melbourne for both Council land and non-Council land. TSS is primarily generated from roads, and is therefore very high in the municipality because of its highly urbanised nature and road coverage.
- Roof areas for nitrogen loads – Like TSS, nitrogen in stormwater is generated from roads, footpaths and driveways, however, one of the other primary generators is roofs (as roof water picks up atmospheric pollutants which largely includes nitrogen). Nitrogen is particularly relevant for non-Council land because of the large amount of roof space.

23 Phillips and Lawrence (2003)
24 Based on updated stormwater flow concentration parameters used by Coomes (2007) using Fletcher (2005) recommendations

5. CITY OF MELBOURNE: A 'WATER SENSITIVE CITY'

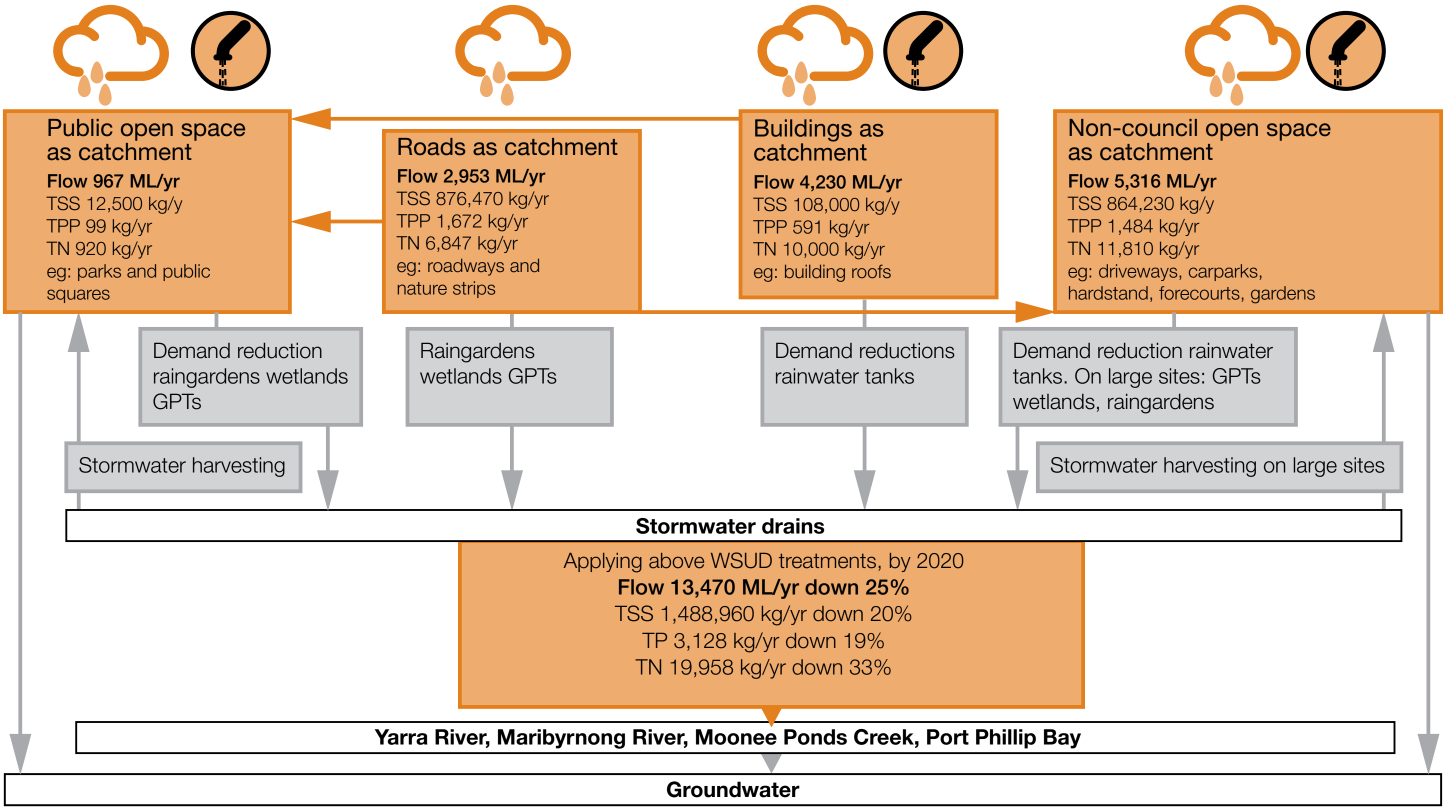


Figure 8: Stormwater pollutant load for the City of Melbourne

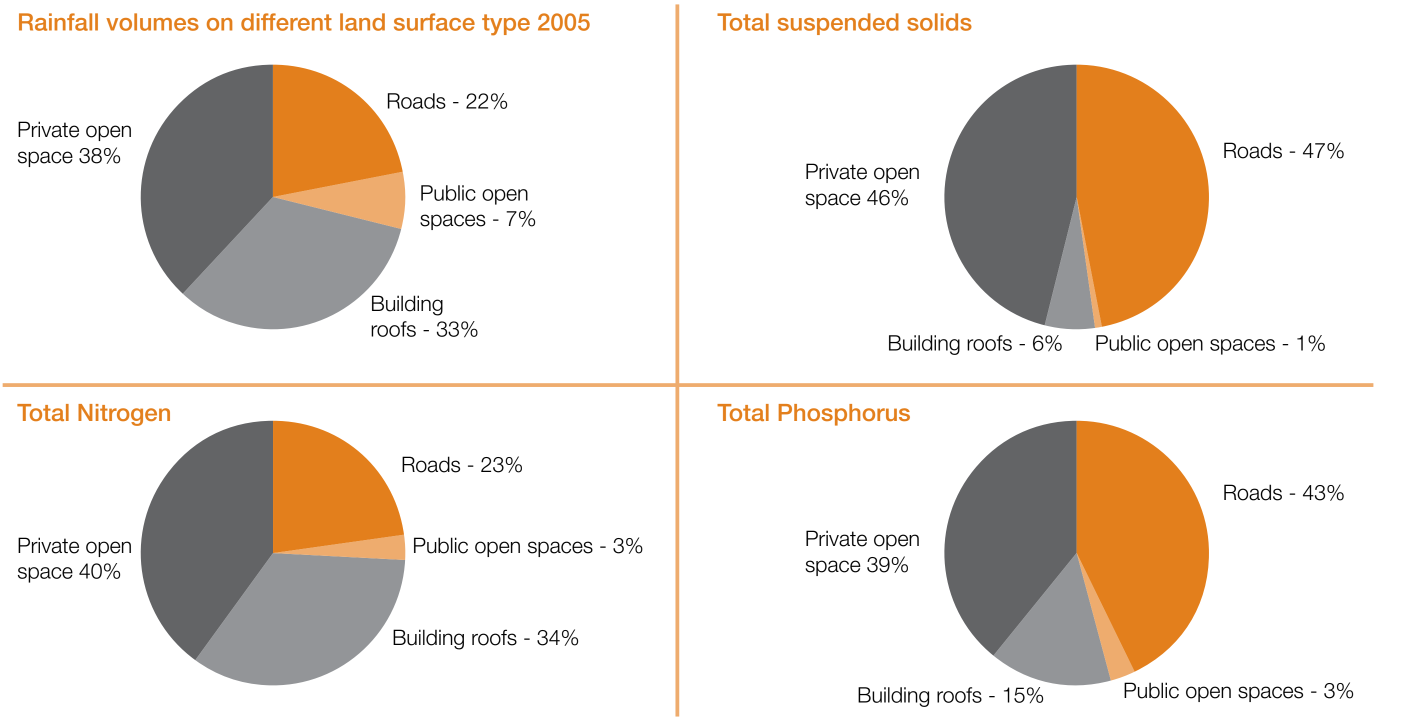


Figure 9: Comparison showing flow volumes, TSS, TP and TN loads on different surfaces in the City of Melbourne (see Appendix F on page 61)

5. CITY OF MELBOURNE: A 'WATER SENSITIVE CITY'

5.3 WATER CYCLE MANAGEMENT TARGETS FOR THE CITY OF MELBOURNE

What are the total water cycle targets for the City of Melbourne?

Total Watermark – City as a Catchment sets the following targets for total water management in the City of Melbourne:

Water saving targets:

- 50 per cent reduction in potable water consumption per employee by 2020
- 40 per cent reduction in potable water per resident by 2020
- 90 per cent reduction in potable water consumption by Council by 2020
- 25 per cent 'absolute' water saving target by 2020.

Alternative water use targets:

- Council to source 30 per cent of its water needs from alternative water sources by 2020 (1999–2000 base year)
- non-Council land managers to source 9 per cent of their water needs from alternative water sources by 2020 (1999–2000 base year).

Stormwater quality targets:

- 20 per cent reduction in total suspended solids (soil, tyre/car residue etc.) on Council and non-Council land by 2020
- 30 per cent reduction in litter on Council and non-Council land by 2020
- 15 per cent reduction in total phosphorus (fertilisers, detergent etc.) on Council land by 2020
- 25 per cent reduction in total phosphorus (fertilisers, detergent etc.) on non-Council land by 2020
- 30 per cent reduction in total nitrogen (airborne pollutants, fertilisers etc.) on Council land by 2020
- 40 per cent reduction in total nitrogen (airborne pollutants, fertilisers etc) on non-Council land by 2020.

Wastewater reduction target:

- 30 per cent reduction in wastewater across the municipality by 2020.

Groundwater quality target:

- where groundwater needs to be re-injected to prevent land subsidence, it needs to be of equal or better quality to the water in the aquifer.

Read on for an explanation of targets and progress achieved to date.

Water saving targets

The City of Melbourne seeks to save water to help reduce the reliance on drawing water from the Port Phillip, Westernport and neighbouring catchments. Saving water encompasses reducing the demand for water, and finding alternative water sources. Figure 10 shows the significant progress of Council towards meeting its water saving targets.

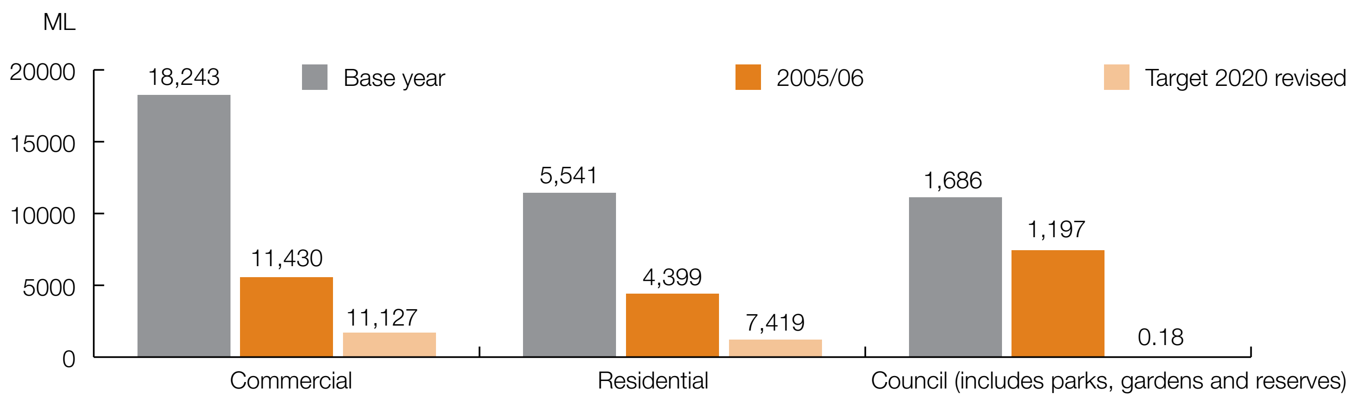


Figure 10: City of Melbourne progress towards meeting water saving targets

5. CITY OF MELBOURNE: A 'WATER SENSITIVE CITY'

Table 5 below sets out the Council's revised targets based on progress to date.

Water saving targets				
Base year	**Previous targets established in *Total Watermark 2004***	**Progress**	**Comments**	**Revised targets**
99–00	40% reduction in potable water consumption per employee by 2020	48% reduction per employee. Water use down from 181 litres/person/day to 95 l/p/d (target is 109 l/p/d). 38% reduction in total commercial water use from 18,243 ML/yr to 11,430 ML/yr. The target is 13,327 ML/yr factoring employee growth.	Remarkable progress by the commercial sector and well exceeding target already. Includes offices, retail, food businesses, manufacturing, events venues etc. Recommend increasing target to 50% reduction per employee (91 l/p/d) as exhibited in July/Aug 2008. The revised total commercial water consumption target is 11,127 ML/yr factoring employee growth (from 323,000 in 1999–2000 to 335,000 in 2020).	50% reduction in potable water consumption per employee by 2020.
99–00	40% reduction in potable water consumption per resident by 2020	39% reduction per resident. Water use down from 296 l/p/d to 179 l/p/d (target is 178 l/p/d). To date, 21% reduction in total residential water use from 5541 ML/yr to 4399 ML/yr. The target is 7461 ML/yr factoring residential growth.	Great progress by residents. Much of the savings due to water restrictions – water use likely to increase once these restrictions are lifted and as such, water saving target retained at 40%. Refined resident population forecast of 120% increase (not 141% used in Total Watermark 2004) totals 112,000 residents. This is combined with the increased target to give revised residential water consumption target of 7419 ML/yr.	40% reduction in potable water consumption per resident by 2020
99–00	40% reduction in potable water consumption by Council by 2020	29% reduction in Council use. Water use down from 1686 ML/yr to 1197 ML/yr. The target is 1012 ML/yr.	Very good progress by Council. Parks section is now committed to 100% reduction in potable water use by 2020 through demand reduction and alternative water sourcing. Council buildings are seeking 40% reduction in water use. This incorporates retention of some potable water for drinking and high exposure uses. Combined this equates to a 90% reduction in Council water use (water consumption will be 183,693 KL or 0.18 ML)	90% reduction in potable water consumption by Council by 2020
99–00	12% 'absolute' water saving target by 2020	Currently 34% absolute saving.	Absolute saving already exceeds the target and the challenge remains to keep an absolute saving while the population grows by 120%. With the above increase in commercial and Council water saving, along with a revised population forecast, the expected absolute water saving will nearly double to 25%.	25% 'absolute' water saving target by 2020

Table 5: Review of City of Melbourne water saving progress and proposed revised water saving targets

5. CITY OF MELBOURNE: A 'WATER SENSITIVE CITY'

Alternative water use targets

Using the 'city as a catchment' approach, the alternative water use target is a stepping stone to achieve:

- the water saving target (reduced reliance on potable water)
- the stormwater quality target (reduced amount of stormwater pollutants entering the waterways)
- the wastewater reduction target (reduced amount of wastewater entering the sewer).

To date, no targets have been set for the municipality for alternative water use. This is analysed in Table 6 with alternative water use targets recommended.

Alternative sources of water are one way to save potable water, however, it should be considered only after – or in conjunction with – all efforts to reduce demand, such as efficient fittings and appliances. Treatment standards need to match the proposed re-use standards.

Alternative water use targets				
Base year	**Previous targets**	**Progress**	**Comments**	**New targets**
N/A	None in place	Total amount of alternative water sourced by Council is 4% or 74 ML in 2006–07	Alternative water sourcing began in 2007 with the operation of the Royal Park wetlands and the temporary watering of trees by trucks and water-filled barriers with recycled water. Council is committed to alternative water sourcing that does not rely on water-filled barriers and trucking.	Council to source 30% (480 ML) of its water needs from alternative water sources by 2020
N/A	None in place	Total amount of alternative water sourced by non-Council land managers is 1% or 238 ML in 2006–07	Alternative water sourcing has begun. This is the best data available to date.	Non-Council land managers to source 9% (2800 ML) of its water needs from alternative water sources by 2020.

Table 6: Review of City of Melbourne alternative water use progress and recommended alternative water use targets

5. CITY OF MELBOURNE: A 'WATER SENSITIVE CITY'

Stormwater quality improvement targets

Meeting best-practice stormwater quality targets will help protect the ecological quality and health (along with recreational and tourism value) of the Yarra River, Maribyrnong River, Moonee Ponds Creek and Port Phillip Bay. Meeting these targets also ensures that litter is prevented from entering water bodies.

Flood management remains the primary objective for stormwater solutions to ensure the protection of lives, property and the local environment. Stormwater quality targets have recently been set and these have been enhanced through further analysis, as shown in Table 7. Pollutant loads are specified in Appendix G (page 62).

Stormwater quality improvement targets				
Base year	**Previous targets adopted May 2008**	**Progress**	**Comments**	**Revised and new targets**
2005	20% reduction in total suspended solids (TSS) by 2020	4% TSS reduction for Council land 3% TSS reduction for non-Council land 3% average across municipality	Target consistent with best-practice standard of 80% reduction in TSS	20% reduction in total suspended solids on Council and non-Council land by 2020
2005	Total phosphorus (TP) – none in place	6% TP reduction for Council land 3% TP reduction for non-Council land 4% average across municipality	Target consistent with best-practice standard of 45% reduction in TP	15% reduction in total phosphorus on Council land by 2020 25% reduction in total phosphorus on non-Council land by 2020
2005	Total nitrogen (TN) – none in place	11% TN reduction for Council land 2% TN reduction for non-Council land 4% average across municipality	Target consistent with best-practice standard of 45% reduction in TN	30% reduction in total nitrogen on Council land by 2020 40% reduction in total nitrogen on non-Council land by 2020
2005	Litter – none in place	Analysis shows that a 15% reduction in litter has been achieved across the municipality since 2005 (base year 435,000 kg). See Appendix J. Reduction in litter can be achieved by: • behaviour change (less litter) • WSUD infrastructure treatments • street cleaning practices • end-of-pipe litter traps.	Target consistent with best-practice standard of 70% reduction in litter.	30% reduction in litter on Council and non-Council land by 2020

Table 7: Review of City of Melbourne stormwater quality progress and recommended stormwater quality targets

5. CITY OF MELBOURNE: A 'WATER SENSITIVE CITY'

Wastewater reduction target

Reducing the amount of wastewater will reduce the energy requirements and ecological pressures at metropolitan treatment centres, while allowing for expected additional demand from forecast population growth.

Wastewater reduction targets				
Base year	**Previous targets established in *WSUD Guidelines 2005***	**Progress**	**Comments**	**Revised targets**
99–00	20% reduction of wastewater by 2020	29% reduction of wastewater entering the sewerage system. Flow reduction from 22,510 ML/yr down by 6424 ML/yr.	Wastewater reductions arise from using less mains water, and capturing it for re-use. The target will need to be met despite continued population growth.	30% reduction of wastewater by 2020

Table 8: Review of City of Melbourne wastewater reduction progress and recommended wastewater reduction targets

Groundwater target

Protecting groundwater is an important part of protecting the City of Melbourne's catchment. Progress in this area is analysed in Table 9.

Groundwater management targets				
Base year	**Previous target established in *WSUD Guidelines 2005***	**Progress**	**Comments**	**Retained targets**
N/A	Where groundwater needs to be re-injected to prevent land subsidence, its quality needs to be equal to or better than the water in the aquifer.	Council has not yet introduced protocols for considering groundwater management and is not able to report on this target. Council has determined that it is generally not appropriate to source groundwater for alternative water use because of the shallow aquifers and saline water.	Research into local groundwater has not progressed significantly during recent years. There is no baseline data for quality, and therefore no target of optimal quality. In light of this, Council cannot set a quantitative target but will seek to do this as part of its on-going sustainable water management program. The existing target is to be retained. Council needs to establish partnerships and processes to better manage and analyse groundwater use.	Where groundwater needs to be re-injected to prevent land subsidence, it needs to be of equal or better quality to the water in the aquifer.

Table 9: Review of City of Melbourne groundwater management and recommended groundwater management targets

6. CURRENT STATUS OF SUSTAINABLE URBAN WATER MANAGEMENT PRACTICES

The City of Melbourne is a recognised leader in the application of water sensitive urban design (WSUD).

The ‘city as a catchment’ approach forms the nexus between the drivers for improved water management and the goal of ecologically sustainable development. It encompasses all elements of the urban water cycle and draws on WSUD tools and resources to manage each element in a way that is integrated with the other elements of the water cycle and with urban design and built form.

The following list summarises the City of Melbourne’s key strengths and its approach to sustainable water management practices. They include:

- significant water saving achievements already made since base year of 1999–2000
- water quality achievements underway with a system implemented to track progress
- senior staff support and commitment
- high-level policy on sustainability, commitment to water cycle management targets and WSUD
- *WSUD Guidelines* and a widespread appreciation of tools and resources available to Council
- dedicated WSUD officer and a water reference group that meets with key industry stakeholders on a bimonthly basis
- demonstration sites showcasing:
  - best-practice demand-management strategies that provide mains water savings through efficiency and design for Council-owned buildings (e.g. the CH2 office) and across Council-managed assets (e.g. landscaping and water efficient irrigation systems installed across parks and gardens)
  - best-practice application in stormwater quality improvements to meet water quality objectives for harvesting and re-use and/or discharge to waterways (e.g. Royal Park wetlands, Docklands and numerous raingardens located in streetscapes, car parks and public open spaces)
  - wastewater recycling projects.

Introducing the ‘city as a catchment’ approach across the municipality will further inform the strategic, planning and implementation stages of the water management process.

6. CURRENT STATUS OF SUSTAINABLE URBAN WATER MANAGEMENT PRACTICES

Water Sensitive Urban Design	Water management process	Programs and reports
City as a catchment strategy	STRATEGIC	• Total Watermark – City as a Catchment • WSUD Guidelines • Growing Green – Environmental Management Plan for Parks
	PLANNING	• Water Conservation Plan • Stormwater Management Plan • Melbourne Planning Scheme
	FUNDING	• City of Melbourne capital and operational budgets • Living Rivers Stormwater Program • Smart Water Fund • Urban Stormwater Fund • Sustainability Fund • Others
	IMPLEMENTATION PLANS	• Parks and planning city as a catchment action plan (underway) • Capital works programs, roads and drainage
	MONITORING AND REPORTING	• Annual corporate reporting on water saving and water quality • waterMAPS for sites over 10 ML • Lower Yarra Stormwater Quality Improvement Program • ICLEI Water Campaign

Figure 11: Existing water management activities in Council

6. CURRENT STATUS OF SUSTAINABLE URBAN WATER MANAGEMENT PRACTICES

Linking stormwater quality and water conservation

Total Watermark – City as a Catchment shows the greatest improvements in stormwater quality for the City of Melbourne can be attributed to stormwater harvesting schemes – schemes that also provide significant water saving benefits. For example, a storage tank will not only save water but also reduce pollutant loads (see Figure 12). To date, these water saving projects are rarely considered in retrofit situations for their contribution to improving stormwater quality.

Rainwater harvesting	Stormwater harvesting
Over the course of a year, a 100 KL water tank, treating a roof catchment **area of 2500 sqm with a daily re-use demand of 3500 litres can save:**	**Over the course of a year, 100 KL water tank, treating a** road catchment **area of 2500 sqm through a GPT and 80 m^2 of raingardens with a daily re-use demand of 3500 litres can save:**
1.12 ML of water being drawn from our drinking water supplies (using 82% of the captured rainfall)	**1.06 ML** of water being drawn from our drinking water supplies (catching 85% of the runoff)
and will prevent our waterways from receiving:	**and will prevent our waterways from receiving:**
30.4 kg of total suspended solids (0.4% of annual target of 8000 kg)	**394 kg** of total suspended solids (4.9% of annual target of 8000 kg)
2.56 kg of total nitrogen (1.3% of annual target of 194 kg)	**2.8 kg** of total nitrogen (1.4% of annual target of 194 kg)
0.16 kg of total phosphorus (0.7% of annual target of 22 kg)	**0.7 kg** of total phosphorus (3.2% of annual target of 22 kg)
0 kg of litter (0% of annual target of 8700 kg)	**46.3 kg** of litter (0.5% of annual target of 8700 kg)
Cost approx $1.00 per litre	Cost approx $3.50 per litre

Figure 12: Comparison of water saving and water pollutant reductions achieved between stormwater and rainwater tank

7. DEVELOPING A STRATEGY FOR RESILIENCE

7.1 IMPLEMENTATION HIERARCHY

Total Watermark – City as a Catchment provides the policy platform for integrated water management. Implementation will then take place using a range of tools and resources designed by the City of Melbourne including:

- *Water Sensitive Urban Design (WSUD) Guidelines* incorporating the following tools:
  - risk management framework
  - WSUD carbon sensitive framework
  - decision-making checklist
  - WSUD maintenance templates
  - fact sheets and case studies.
- stormwater quality points progress system and ready reckoner
- *Construction Management Plan* guidelines
- partnership projects.

The City of Melbourne will prioritise the following actions:

- Firstly, saving water and preventing stormwater pollution at *source by using non-structural techniques* including demand-management strategies that engage, communicate and educate to bring about behavioural change. Other strategies include regulation, planning controls and financial incentives.
- Secondly, saving water and preventing stormwater pollution at *source by structural techniques* to treat and/or harvest alternative water supplies.
- Thirdly, saving water and preventing stormwater pollution in *system by structural techniques*. Such infrastructure, for example gross pollutant traps, is installed within drainage/stormwater systems to manage stormwater quality and quantity before it is discharged to receiving waters.

These measures are preferable to treating and/or harvesting stormwater at the *end of pipe* where the quality of water and high flow volumes make sustainable water projects less efficient and effective.

How will *Total Watermark – City as a Catchment* apply at a site-by-site level?

The following decision-making guidelines have been set out to assist sustainable water management on a site-by-site basis. These inform policy decisions, *WSUD Guidelines*, design, contracts, communication and projects on the ground.

1. All city sites are catchments

All city sites (buildings, roads, open space) are to be considered holistically to contribute to sustainable water management across the municipality. Over time this will build resilience to the ongoing pressures of urban consolidation and climate change on water resources and aquatic environments.

2. Community engagement

Community engagement is an integral component of all projects and needs to include:

a) information sharing and feedback from relevant stakeholders and the community about water options and potential issues

b) community consultation to direct the scale of the project.

7. DEVELOPING A STRATEGY FOR RESILIENCE

3. Decentralised water solutions

Fundamental to achieving the 'city as a catchment' approach is the incorporation of local decentralised solutions. To achieve this, all city sites, planning or building proposals, and Council-managed projects need to:

a) identify a site as a water source or sink (that is, a site water budget) and identify opportunities on the site itself and on adjacent/nearby sites that could use surplus water from the site or supply a source of water if a site deficiency exists

b) account for the costs and benefits of decentralised water options in terms of water, energy, building materials/infrastructure/technology, and risks

c) consider habitat enhancement for biodiversity, bird life and microclimate benefits.

4. Hierarchy of sustainable water solutions

A hierarchy of guiding rules have been set out to promote the adoption of sustainable water management practices across Council-managed assets, residential and commercial/industrial land uses.

The hierarchy establishes a general approach based on least cost, least energy-intensive options in the first instance through to more complex solutions in which the water-cycle benefits need to be considered in the context of the project's effect on broader sustainability sectors (such as energy).

Water hierarchy decision guidelines are:

(1) **Protection of receiving waters** including waterways, harbours, bays or groundwater. Recreational, tourism and economic uses of waterways must not negatively affect their social or ecological values. To protect receiving waters:

  a) all planning or building proposals need to demonstrate no net negative effect on receiving waters in terms of quality and/or quantity

  b) all road-renewal projects and street-tree replacement to promote passive irrigation where possible, and meet best-practice stormwater quality standards by applying WSUD (e.g. raingardens)

  c) all new building and other infrastructure in the municipality must treat catchment runoff to meet best-practice stormwater quality standards by applying WSUD (this generally requires the one-in-three-month annual recurrence interval (ARI) peak flows to be treated)

  d) infiltration into the water table is encouraged when treatment ensures water quality meets best-practice stormwater quality standards through integration with WSUD (e.g. raingardens).

7. DEVELOPING A STRATEGY FOR RESILIENCE

(2) **Demand management** conserves water and minimises the generation of wastewater:

a) all new building, other infrastructure and private open space works need to minimise water consumption through the installation of demand-management fixtures, fittings, appliances and educational signage

b) all refurbishments, upgrades and extensions need to minimise water consumption through the installation of demand-management fixtures, fittings, appliances and educational signage

c) all Council-managed assets (including buildings, parks, gardens and sporting facilities) need to consider opportunities to retrofit demand-management landscaping, fixtures, fittings and appliances.

(3 **Stormwater quality improvement** to protect receiving waters to be considered in all urban design works:

a) treatment is to reduce total suspended solids, total nitrogen, total phosphorus and litter to best-practice standards

b) WSUD treatments to be integrated in various stages of the water cycle, where appropriate, and recognising where existing water quality treatment is already occurring or planned upstream

c) WSUD treatments are to be modelled to demonstrate achievement of best-practice water quality – models for private land are requested to be provided to Council so that it can acknowledge the contribution of private land to improving waterway quality.

(4) **Stormwater harvesting** to conserve water and protect receiving waters is encouraged and must:

a) quantify stormwater quality benefits in addition to the water saving benefits

b) all stormwater harvesting projects must incorporate a 'fit-for-purpose' approach to water use; for example, re-used water is more suitable for gardens and toilet flushing than potable water

c) explore opportunities for harvesting stormwater for future linkages between alternative schemes to further diversify and expand decentralised supply options.

(5) **Greywater/wastewater harvesting** to conserve water and protect receiving waters is encouraged following implementation of water saving measures. Such schemes need to address:

a) risk management to ensure protection of public health, receiving water and the environment

b) greenhouse reduction measures.

(6) **Groundwater** as a water source is generally not considered viable within the municipality due to its shallow and saline nature, however, if opportunities are identified then the user has a responsibility to ensure:

a) over the long term, there is no net change in the water quantity

b) water injected should be of a quality greater than or equivalent to the receiving groundwater.

7. DEVELOPING A STRATEGY FOR RESILIENCE

7.2 ACHIEVING 2020 INTERIM TARGETS ACROSS THE MUNICIPALITY

The City of Melbourne has committed to a range of integrated water-cycle management targets directed at water conservation, stormwater quality and wastewater minimisation.

To achieve the 2020 targets, it is necessary to undertake the following on-ground works across the public and private sectors:

	Action	Desciption	Outcome
WSUD projects for Council-managed assets:			
1	**Parks – demand reductions**	Further reduce potable water use in parks through: • irrigation efficiencies (subsurface, soil moisture sensitive, technological improvements, limited time) • understanding of soil types and subsequent soil moisture needs • mulching to prevent evaporation • planting climate responsive, drought tolerant species • staff training programs and contract provisions. Demand reduction in parks is dependent on impending research into the horticultural assessment of different water needs	Achieve 40% reduction in potable water use in parks through demand reductions.
2	**Buildings – demand reductions**	Reduce water use in Council-owned buildings through: • efficient fittings – flow restrictors on taps, showerheads • efficient toilets – dual flush, reduced header tank flow • fire-sprinkler testing (reduced from weekly to monthly, or recirculating) • cooling tower efficiencies • staff training, contract provisions, education and behaviour change programs.	Achieve 40% reduction in water use in buildings through demand reductions and alternative water sourcing.
3	**Parks – alternative water sources**	Program of alternative water source projects for parks and gardens via: • *Rainwater harvesting* – starting with the Public Record Office rainwater tanks. • *Stormwater harvesting* – starting with the Grant Street and Shrine of Remembrance stormwater harvesting projects. The scheduled 5 ML expansion of the Royal Park wetland storage capacity will further assist with irrigation in Royal Park. Stormwater harvesting being set up at Flagstaff Bowls Club will be used to water the bowling green. • *Sewer mining* – commencing with the CH2 sewer mining plant for watering street trees, with endeavours to establish sewer mining plants within parks to reduce the reliance on trucking.	Achieve 50% reduction in potable water use in parks by 2020 through alternative water sources This action also contributes towards the following water quality goal: 20% reduction in water pollution by 2020 (total suspended solids) requires an annual reduction of 8000 kg TSS

7. DEVELOPING A STRATEGY FOR RESILIENCE

	Action	Desciption	Outcome
WSUD projects for Council-managed assets: continued			
4	**Parks – water saving offsets**	Offsets will consist of assisting and/or funding for water reductions outside of parks' responsibilities to cover the remaining water use from Council. To achieve 100% reduction in potable water use in parks and gardens, Council will: • reduce demand for water (40%) • source alternative water (50%) • offset remaining potable water (10%). Offsets are not developed or operational at the time of writing, and an increasing knowledge of these opportunities may adjust the mix of targets in achieving a 100% reduction in potable water for parks and gardens.	10% reduction in potable water will be achieved through funding water reductions outside of parks responsibilities.
5	**Streetscapes and parks– stormwater treatment**	Program of WSUD works includes: • *laneway improvements* – starting with Bullens Lane sand filters • *raingarden implementation* – starting with Bellair St, Grant St, Royal Park Zoo Northern Entrance, and Flagstaff Bowls Club • *swales and small wetlands* – to be implemented in the City of Melbourne • *porous and permeable paving* – to be implemented in the City of Melbourne. Council will deliver a mix of the above WSUD treatments to meet the annual target of reducing 8000 kg of TSS each year. Additional WSUD treatments are likely to evolve in coming years which can also be delivered to help meet the target.	20% reduction in water pollution by 2020 (total suspended solids) requires an annual reduction of 8000 kg TSS
6	**Buildings – alternative water sourcing**	Program of alternative water source projects for Council buildings through: • *rainwater harvesting* – starting with Queen Victoria Market capturing rainwater for public toilet use • *water recycling* – where appropriate, starting with Fawkner South Pavilion • *sewer mining* – starting with activation of the CH2 sewer mining plant.	Achieve 40% reduction in water use in buildings through demand reductions and alternative water sourcing. This action also contributes towards the following water quality goal: 20% reduction in water pollution by 2020 (total suspended solids) requires an annual reduction of 8000 kg TSS.

Total Watermark – City as a Catchment will be fully reviewed in 2012 in accordance with changes in policy, design, technology, behaviour and other factors. Partial reviews may occur before this time. Action plans will be undertaken annually and yearly progress towards achieving the targets will be reported in the City of Melbourne's annual report.

7. DEVELOPING A STRATEGY FOR RESILIENCE

	Action	Desciption	Outcome
WSUD projects for the commercial sector:			
7	**Commercial business – demand reduction**	• Fire sprinkler testing (reduced from weekly to monthly, or recirculating). • Cooling tower efficiencies. • Appliances – efficient washing machines and dishwashers. • Efficient fittings – flow restrictors on taps, showerheads. • Gardens – efficient species, layout and irrigation (to be maintained when water restrictions are not in place). • Property management and tenant behaviour change programs. Proceed with the rollout of water conservation projects currently being trialled including installation of waterless woks, cooling tower program, fire sprinkler testing program, green hotels and sustainable office building program.	50% reduction in water use per employee achieved through demand reduction and alternate water sourcing.
8	**Commercial business on large sites – alternative water sources and WSUD treatment**	• Proceed with proposed water harvesting and treatment schemes at Royal Botanic Gardens, Southern Cross Station, Public Record Office, Melbourne Museum, MCG, Melbourne Convention Centre and Flemington Racecourse. • Facilitate new WSUD schemes – perhaps ports, Melbourne Exhibition Centre, universities, hospitals and schools.	
9	**Commercial business on smaller sites – alternative water sources**	• Increase uptake rate of rainwater tanks on private commercial properties to 50 times the current uptake/installation rate a year (increase to 300 tanks per year). This will be done through a combination of education, incentive and regulatory measures.	
WSUD projects for the residential sector:			
10	**Residential – demand reduction**	Low-rise residential: • efficient fittings – flow restrictors on taps, showerheads • appliances – efficient washing machines and dishwashers • gardens – efficient species, layout and irrigation (to be maintained when water restrictions are not in place) • swimming pools – pool covers, re-use of backwash • householder behaviour change through education. High-rise residential: • balance ring mains, fire sprinkler and cooling tower efficiencies • efficient fittings and appliances • householder behaviour change through education.	40% reduction in water use per resident achieved by 2020 through demand reduction and alternate water sourcing.
11	**Residential – alternative water sources**	• Rainwater tanks for toilet flushing on private residential properties. • Consider water recycling for toilet flushing in high-rise residential apartments.	

Table 10: Action plan to achieve sustainable water management targets

APPENDIX A – TRADITIONAL WATER MANAGEMENT

HOW HAVE WE TRADITIONALLY MANAGED WATER IN OUR CITIES?

Water supply, stormwater, wastewater and groundwater management have traditionally been managed as entirely separate infrastructure issues with goals different to the current ones of water conservation and water quality.

Water consumption

Across the world, early water strategies were generally shaped around the supply of water. Authorities would forecast the amount of water needed based on 'business as usual' water consumption, and then take action to provide a greater volume of water supply from a central source.

The main problem with traditional water management practices is that water has not been recognised as a limited resource in its regional, national or international context. Given the scarcity of fresh water in the world today, water supply has to be based on rational consumption. That is, water should not be supplied so easily that users are wasteful in their practices.

In addition, there are significant ecological and social impacts of providing centralised water service infrastructure in the form of dams, weirs and connecting pipes. By disrupting and modifying the natural and existing environment, the new infrastructure will cause detrimental effects to local flora and fauna habitats, which leads to a loss of biodiversity.

Water conservation needs to be part of our daily lives through design, technology and behaviour. Drawing on alternative water sources will also take the pressure off our centralised potable water supply.

Stormwater management

The historical view of stormwater in cities has been to see it as a problem, potentially causing floods that pose safety and nuisance threats. In response to this, infrastructure has been developed to dispose of the rainwater as soon as possible, so that the risk of flooding and associated damage is reduced.

It is now recognised that there are a number of issues associated with traditional stormwater management practices.

The rapid flow of rainwater down our stormwater system can result in environmental degradation as contaminants are carried into our rivers and bay. Erosion and channelling also have a negative impact on our waterways.

The current stormwater system is also wasteful because it doesn't offer the opportunity to store and re-use water, and doesn't reduce our dependence on drinking-quality water.

There are substantial pressures on stormwater infrastructure arising from the volume and velocity of rainwater that passes through the existing pipes. Much of this infrastructure requires on-going replacement. It is possible to take advantage of this infrastructure renewal by putting structural source controls in place that will have a more sustainable long-term outcome.

The traditional stormwater management system is not designed to make the urban community aware or responsible for water flow management. Water flows are removed quickly from view, taking litter and contaminants with them, leaving residents with little understanding of the movement, volume, and value of water.

APPENDIX A – TRADITIONAL WATER MANAGEMENT

Community groups, such as the WaterWatch, have found a role for themselves in protecting local waterways; however, there are many more opportunities for community members and groups to become more aware of water and environmental management. This is important if we are to move away from the traditional approaches to stormwater management.

Future stormwater management should minimise flows, capture the resource and minimise potential impacts on receiving waters. This can be done by using innovative design and implementation, educating the community and getting the people of Melbourne involved.

Wastewater management

Wastewater management is an integral part of a total water management strategy. Wastewater from all sources is collected in sewers and is transported to a wastewater treatment facility for treatment before discharge into the environment. This has been a progressive system in treating our water, but is also considered a lost opportunity to have the treated sewerage disposed to the ocean rather than captured for re-use.

Some companies treat wastewater to specific standards as set out in waste discharge licences issued by the EPA. Licence holders are required to progressively improve wastewater quality to avoid any potential impact on the environment.

Underground sewerage pipes can become broken over time due to tree roots, disturbance or age. This can lead to sewage leaking out and polluting the surrounding soil and groundwater. Stormwater and rainwater can also infiltrate the sewer pipes, causing them to become too full and overflow.

An integrated alternative is to re-use greywater and blackwater at a local level. For example, re-using laundry water for toilet flushing, or re-using industrial water for another industrial process (applying treatment where necessary).

Re-use of treated wastewater can positively alter the urban water balance and provide significant benefits for the whole water cycle. The volume of demand for water from rain and ground sources is reduced and, at the same time, the volume of wastewater discharged into waterways is also reduced. As a result, environmental flows in surrounding catchments can be increased and the quality of receiving waters improved.[25]

Groundwater management

The traditional approach to managing groundwater in urban environments has been to disregard its value in its natural, untouched form, and to remove its flow where it could cause risk to the built environment. Large subsurface constructions like multi-storey buildings, tunnels and foundations for bridges, all contribute to disrupting and dissecting ancient groundwater aquifers.

Developers normally seek to remove groundwater from construction sites to eliminate its corrosive effect on concrete and metals. However, its elimination can have long-term effects on the ground surface, as water removed from previously saturated soils can cause the subsoil to settle or compact. This sometimes results in the soil sinking and disturbing the foundations of old and smaller buildings.

25 Coombes, Mitchell and Breen (2003)

APPENDIX A – TRADITIONAL WATER MANAGEMENT

Groundwater moves very slowly, which means the impacts of changing the permeability of surfaces or disrupting pre-existing aquifers can take a long time to appear.

Preventing the pollution of groundwater has not traditionally been addressed by land owners and land/property managers. In the past, the dumping of rubbish and pollutants in landfill and soil has been a significant threat to groundwater because of pollutants leaking from decomposing materials. Today there are much better provisions for managing landfills.[26]

The negative effects of the growing presence of salt in water are well understood by land managers, particularly farmers. While it does not affect highly urbanised areas, there is still a responsibility to care for groundwater at a larger catchment scale. Actions in one local area can lead to problems much further downstream. By reducing the amount of fresh water that is naturally infiltrating and recharging the groundwater, saline water can seep into the aquifer from Port Phillip Bay to fill the void, resulting in the contamination and loss of a freshwater resource.

26 EPA Victoria (2001)

APPENDIX B – NATIONAL AND STATE CONTEXT

What is the national context for implementing a 'water sensitive city'?

The National Water Initiative (NWI), which is the national water reform framework for Australia, commits all states and territories to innovation and capacity building to create 'water sensitive Australian cities'.[27] While the attributes of a 'water sensitive city' are not stipulated in the NWI, leading thinking and research in the area of best-practice urban water management sets out the following fundamental principles that would underpin a 'water sensitive city'. They are:

1. **Intergenerational equity** – communities and their governments to understand and agree that current development must not compromise the ability of future generations to enjoy secure water supplies and healthy natural water environments.
2. **Triple bottom line approach** – government and urban water managers to measure the 'value' of water and water services in social, environmental and economic terms rather than financial 'cost'.
3. **Integrated approach** – water resources including water supply, sewerage and stormwater services to be managed as part of a total water cycle. Government and urban water managers to choose to invest in water supply and sewerage options that are beneficial to waterway and ecological health, and community wellbeing. Outcomes also understood to be part of a larger nutrient and energy cycle and urban water managers will choose water sources that do not produce excessive greenhouse gases or nutrient discharges.
4. **Diverse water sources** – government and urban water managers to invest in a diversity of water sources underpinned by a range of centralised and decentralised infrastructure providing cities with the flexibility to access a 'portfolio' of water sources at least cost and with least impact on rural and environmental water needs.
5. **'City as a catchment'** – government and urban water managers to minimise importing potable water, and exporting of wastewater, from and to areas outside of the boundaries of the city, and will instead optimise the use of water resources within a city in a 'fit-for-purpose' capacity. A 'water sensitive city' to be viewed as a catchment where stormwater and treated wastewater are important water sources.
6. **Ecosystem services** – waterways to be valued as an integral part of the city, and ecological health will be actively protected. Water managers to recognise that healthy ecosystems and waterways provide important ecosystem services that make the city more liveable and mitigate the impact of a city on the environmental values of aquatic systems within and downstream of the city.
7. **Resilience to climate change and variability** – diverse water sources to ensure that the city can adapt to both water-scarce and water-abundant conditions. Because waterways will be protected, these will also be resilient, helping to provide amenity for the community. WSUD to also provide microclimate benefits and act as heat sinks, which will be particularly important under projected global warming conditions and the extreme variability of Australia's climate and stream flows.
8. **Social capital** – a smart, sophisticated and engaged community, living and engaging in a sustainable lifestyle that is sensitive to the inter-dependent nature of the built and natural environments. Social capital to extend to the professionals and practitioners in the water sector.
9. **Business case** – governments, businesses and the private sector to have the institutional and economic incentives to invest in sustainable solutions.

27 Clause 92 Inter-Governmental Agreement on a National Water Initiative

APPENDIX B – NATIONAL AND STATE CONTEXT

What is the State context for implementing a 'water sensitive city'?

Melbourne 2030 – Metropolitan Strategy:

Melbourne 2030 sets objectives for water management to ensure 'water consumption efficiency will be managed so that existing storages can reliably meet water demand beyond 2030'. It sets out broad objectives to achieve this, including the promotion of water efficiency practices and adopting guidelines to encourage the use of alternative water sources such as rainwater tanks and water recycling.

Targets include 15 per cent per capita reduction in water consumption by 2010 and 20 per cent of wastewater at the treatment plants being recycled by 2010. Best-practice targets are also set for water quality including a 45 per cent reduction in nitrogen load, 45 per cent reduction in phosphorus load and an 80 per cent reduction in suspended solid loads. Water sensitive urban design and groundwater management are promoted.

Our Water Our Future:

In 2004 the Victorian Government put in place a long-term plan for water – *Our Water Our Future*.

Our Water Our Future sets out 110 initiatives for water conservation aimed at every sector of the community, seeking to provide water to sustain growth over the next 50 years. Its 110 actions aim to:

- repair rivers and groundwater systems – the natural source of all our fresh water – by giving them legal water rights and conducting restoration works
- price water to encourage people to use it more wisely
- permanently save water in our towns and cities, through water saving and recycling measures
- secure water for farms through pioneering water allocation and trading systems
- manage the water allocation to balance economic, environmental and social values.

Central Region Sustainable Water Strategy:

The Victorian Government's strategy to secure water supplies for homes, business, industry, agriculture and the environment for the next 50 years. The Central Region Sustainable Water Strategy is focused on balancing the water needs of urban and rural customers and the environment across the whole region. It also addresses any conflicts arising from sharing water between urban areas, irrigators and rivers in the Central Region.

Victorian River Health Strategy:

The Victorian River Health Strategy (VRHS) outlines the Victorian Government's long-term direction for the management of the state's rivers. It provides a vision for the management of rivers in Victoria, and policy direction on issues affecting river health to ensure the most effective river health benefits are obtained for the effort and resources invested.

The VRHS provides the framework for regional communities to make decisions on river protection and restoration and to find the balance between using the rivers and maintaining their ecological condition.

Yarra River Action Plan:

The Yarra River Action Plan: Securing water quality for a healthy future sets priorities for managing water quality in the Yarra, from its source to the sea. The plan supports the Victorian Government's *Our Water Our Future* plan, outlining projects that will meet the challenge of managing water quality in the Yarra River over the long-term.

APPENDIX B – NATIONAL AND STATE CONTEXT

Flood Management and Drainage Strategy:

Defines five flood management objectives and outlines actions to achieve these and guide priorities and expenditure by Melbourne Water. The Port Phillip and Westernport Region faces significant flood management and drainage challenges that require a coordinated and collaborative approach by flood managers and the community. In the region:

- more than 100,000 properties are known to be at risk from flooding
- 82,000 of these properties are at risk of flooding from overland flows
- more than 40,000 of these properties contain buildings or dwellings that are at risk of flooding above floor level
- on average, the annual damage caused by flooding has been estimated to be $245 million.

Victoria's legislative framework provides a number of tools for local government, ranging from state-wide policy, such as Victorian legislation, to more localised policy, such as Municipal Strategic Statements and planning permit conditions.

The following is a list of the legislative framework that exists to manage water quality.

- *Environment Protection Act 1970* (Vic). Administered by the Environment Protection Authority, the Act aims to protect the environment from pollutants by limiting the activities of industry and business to an environmentally acceptable level. This is done through primary mechanisms such as licensing, works approvals, inspections, pollution abatement notices and land-use planning referrals. The Act enables policies to be developed (e.g. State Environment Protection Policies). Specific requirements have been developed by EPA including *Best Practice Environmental Guidelines for Major Construction Sites Publication No. 480*, and *Construction Techniques for Sediment Pollution Control – Publication No. 275.*
- *State Environment Protection Policies (SEPPs)* set out the beneficial uses and values of the environment, define environmental quality objectives and describe the attainment and management programs that will ensure the necessary environmental quality is maintained. *SEPP Schedule F6 (Waters of the Port Phillip Bay)* and *SEPP (Waters of the Yarra Catchment)* are of most relevance to the City of Melbourne and the management of its stormwater. Schedule F6 defines requirements for nutrient management within Port Phillip Bay, with an annual nitrogen load reduction of 1000 tonnes. Schedule F7 'provides further protection to the beneficial uses of the Yarra River and its tributaries'. *SEPP (Groundwaters of Victoria)* also sets out requirements for protecting groundwater.

SEPP (Waters of Victoria) requires that runoff from urban areas must not compromise the beneficial uses of the receiving waters. Several provisions of *SEPP (Waters of Victoria)* specifically refer to stormwater pollution and require that measures be implemented to control its environmental impact.

Targets for best-practice stormwater quality improvements were introduced in 1999 for the mean annual load reduction in litter, sediment and nutrients. During the past decade there has been progressive industry-wide adoption of WSUD to achieve these targets for the protection of receiving water from urban stormwater discharges. In October 2006 these targets were mandated targets for residential subdivisions under Clause 56-07.04 of the State Planning Provisions.

These targets are:

- 80 per cent reduction in total suspended solids
- 45 per cent reduction in total nitrogen
- 45 per cent reduction in total phosphorus
- 70 per cent reduction in litter.

APPENDIX B – NATIONAL AND STATE CONTEXT

- *Local Government Act 1989* (Vic) gives Victorian councils the power to create local laws to assist in delivering democratic, efficient and effective local government. Particular reference to the protection of stormwater is contained within the *Environment Local Law 1999* (Vic) and the *Activities Local Law 1999* (Vic).
- The Environment Local Law adopts a Municipal Environment Management Plan to control wastes and emissions and protect stormwater drains. Under the Activities Local Law, Council has the power to request a construction management plan including stormwater management considerations.
- The *Building Act 1993* (Vic) controls the safety and quality of building works. Under Part 2 Section 8 of the Act, the building regulations empower Council to make local laws with respect to requirements for building work and the preparation of land for building works. However, the Act does not make any specific reference to environmental matters and thus Council has no obligations under the Act to consider stormwater management.
- *Planning and Environment Act 1987* (Vic) provides a 'framework for planning the use, development and protection of land in Victoria in the present and long-term interests of all Victorians'. The framework requires planning to encompass and integrate relevant environmental, social and economic factors. The City of Melbourne has an obligation (as a planning authority and responsible authority) for administering the Act, and to consider the potential impacts of land uses and developments on stormwater discharges.
- A Municipal Strategic Statement (MSS) is a statement of the key strategic planning, land use and development objectives for municipalities. It provides the strategic basis for the application of the zones, overlays and particular provisions in the planning scheme and for decision-making by the responsible authority. Objectives of the MSS relate to improving water quality and enhancing the environmental values of the Yarra and Maribyrnong rivers and Moonee Ponds Creek.

The City of Melbourne also manages the regulatory water commitments set out in Table 1.

No.	Regulatory requirement	Description
1.	Water Management Plan	With the introduction of water restrictions in 2006, the City of Melbourne was required to submit a Water Management Plan for each of its sporting fields.
2.	WaterMAP	In mid 2007, the Victorian Government introduced a mandatory requirement that all sites using more than 10 ML/yr of water needed to submit a water action plan (known as a WaterMap) to their water retailer. The City of Melbourne submitted WaterMaps for its large gardens and for the Town Hall.
3.	Environment Resource Efficiency Plan	At the end of 2007, the Victorian Government introduced mandatory requirements for organisations to undertake an Environment Resource Efficiency Plan (EREP) covering water, waste and energy management for any site that exceeds either 120 ML of water or 100 TJ of energy. No sites in the City of Melbourne trigger the requirement for an EREP.

Table 1: List of the City of Melbourne's current regulatory water commitments 2008

APPENDIX C – SOURCE OF INFORMATION TO CALCULATE WATER BALANCE AND POLLUTANT LOADS

Information details	Sourced
Water demand figures COM	COM (2007a), COM (2007b), Stark data spreadsheet (COM) for 2006–07
Water demand figures private and commercial	COM (2007a)
Uptake rates of demand-management strategies	Smartwater rebates data, City West Water and South East Water
Uptake rate of rainwater tanks for residential properties	Smartwater rebates data, City West Water and South East Water
Stormwater pollutant generation and flow volumes	MUSIC V3
Rainfall and evaporation data	Bureau of Meteorology, Melbourne Regional Office (#086071)
Implementation of stormwater treatment measures	Lower Yarra Stormwater Quality Program database (Melbourne Water)
Royal Park wetland data	Stark data spreadsheet (COM) for 2006–07
Mean annual flow in Yarra River	Mean daily flow data for Yarra River at Fairfield, Merri Creek at Northcote and Gardiners Creek at Gardiner (Melbourne Water data)
Wastewater generation figures for the City of Melbourne	Mains water minus human consumption (UTS 2002) minus outdoor demands for irrigation
Wastewater flow volumes conveyed in the transfer network	Melbourne Water data
Groundwater/infiltration losses	MUSIC, Dudding et al. (2006) & Dahlhaus et al. (2004)

APPENDIX D – GROUNDWATER

Groundwater is stored in, and moves slowly through, layers of soil, sand and rock called aquifers. Surface waterways and water bodies are connected to the groundwater system, making it necessary to manage groundwater to help protect surface aquatic ecosystems. Rising and falling groundwater levels will influence environmental flows in rivers and streams, the hydrology of wetlands, lakes and springs, and change salinity concentrations in these aquatic systems.[28] The groundwater in the Port Phillip Region contributes water to wetlands and lowland native vegetation in the catchment.[29]

The City of Melbourne is one of the most built-up municipalities in Australia, so it has limited areas where water can infiltrate the soil and recharge groundwater.

In areas where material above the aquifer is permeable, pollutants can sink into the groundwater. Groundwater can become polluted from leaking underground storage tanks, leaking sewerage pipes and infiltration by rainwater which has passed through contaminated soil and fill material. If groundwater becomes polluted it is no longer safe to drink.[30] Once groundwater has been polluted, it is costly and difficult to rectify. Groundwater flow rates are slow so the time required to 'flush' contaminants from an aquifer can be many years. Groundwater contamination can also contribute to the corrosion of subsurface engineering structures.

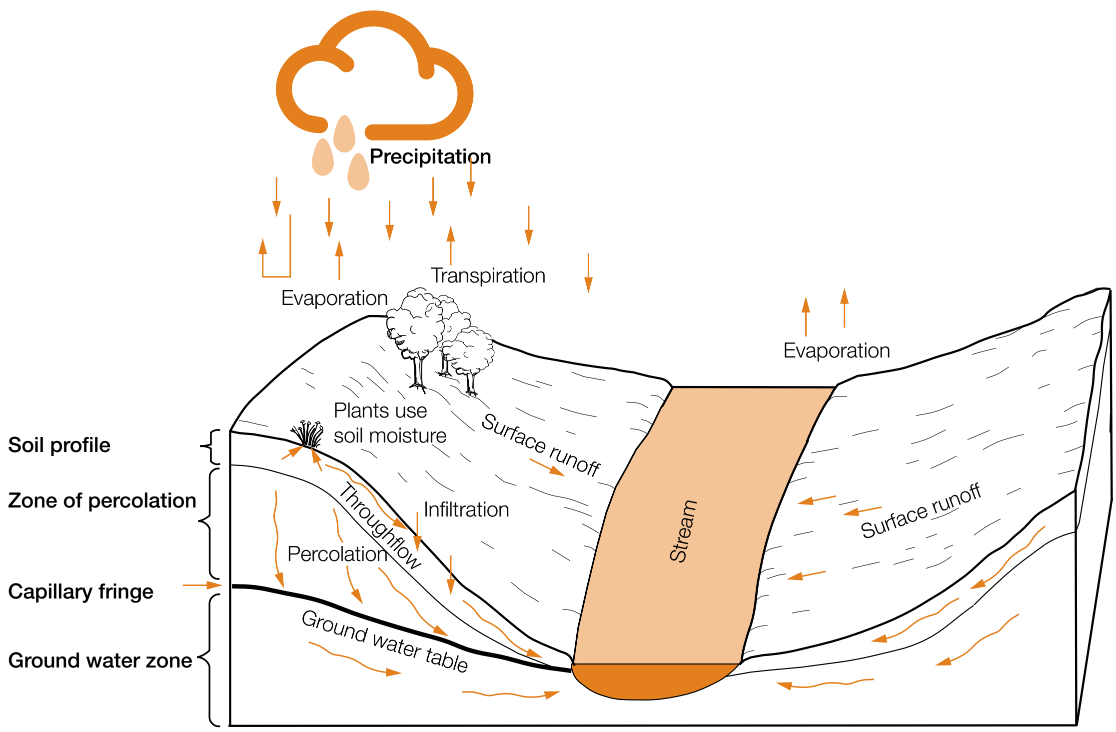


Figure 13: Groundwater movement

28 Commissioner for the Environment (1992)
29 Leonard (1992)
30 The Groundwater Foundation (2003)

APPENDIX D – GROUNDWATER

The Environment Protection Authority is the main government agency with responsibility for groundwater quality management in Victoria.

Southern Rural Water protects groundwater by licensing private bore construction and groundwater use. Domestic groundwater extraction is not metered as the consumption is extremely low compared with irrigation or industrial uses. The bore license system aims, among other things, to ensure that bores are appropriately designed and constructed to prevent saline surface waters and inter-aquifer flows entering and polluting the groundwater.

The City of Melbourne is a 'protection agency'[31] with shared responsibility for the management of contamination.

Groundwater as a water supply source

Worldwide, groundwater is recognised as a major water resource. Many cities are dependent on groundwater for reliability of water supplies, including Paris, Los Angeles, London, Bangkok and Perth.[32]

Melbourne is not reliant on groundwater for its water supply. Instead the city relies on surface water from its forested catchment areas. There are only a handful of licensed groundwater bores in the City of Melbourne and no licences to extract groundwater. Given that the municipality is located on Port Phillip Bay and much of its waterways are estuarine, it is natural that the groundwater is salty and would require desalinating if it were to be used. This limits the use of groundwater, however, it is important to safeguard possible future use.

The Victorian Government, through the EPA, regulates that catchment activities should not affect the quality of groundwater to such an extent that the groundwater can no longer be used for other purposes (or beneficial uses) such as ecology, drinking water, agricultural, industrial and recreational uses. Furthermore, groundwater is not to be used or extracted to the extent that it reduces the volume and quality of waterway flows.

An additional requirement is that saline wastewater discharged from groundwater pumping does not pollute other water bodies. The discharge is to be avoided, re-used and recycled, or discharged to artificial drains or evaporation basins. Alternatively the water can be treated through mechanisms including dilution.[33]

Southern Rural Water manages groundwater data, yet there are significant gaps in the recorded information. It is not possible to determine the total amount of water that is extracted in the municipality, nor is it possible to determine the amount of recharge water. This limits the potential for establishing sustainable groundwater management targets.

Modifications to the groundwater system

The natural groundwater system in the City of Melbourne area has been substantially modified during the past century. Groundwater has been contaminated, there is intrusion into the aquifers through bores and the construction of building basements and tunnels, and groundwater has been extracted and recharged elsewhere.

31 EPA (2002)
32 Conference Paper (30– 31 August 2000)
33 EPA (2003)

APPENDIX D – GROUNDWATER

Groundwater pollution can occur through intentional contamination caused by direct disposal of liquid wastes into aquifers or unintentional contamination caused by the leaching of contaminants from landfills or leaky septic tanks, and accidental spills.[34] Due to the 'invisibility' of groundwater, there is a very poor understanding of the impact that polluting activities can have on our groundwater, and ultimately on our waterways.

The City of Melbourne is home to a vast number of high-rise buildings with deep basement car parks that obstruct the underground aquifers. This modifies the natural groundwater processes, with water diversions put in place by engineers to ensure the groundwater does not contact the building structure and result in rusting, corrosion and other such damage.

The most significant groundwater impact in recent years has been the construction of the Burnley and Domain CityLink tunnels which dissect the municipality and the groundwater aquifers as they burrow beneath the Yarra River. To prevent the structural pressure on the Burnley and Domain tunnels, existing groundwater needs to be drained away from the tunnel lining. However, this water is then replaced to prevent a lowering of the water table which could in turn impact on the stability of the soil around the tunnels and at the surface.

34 Leonard (1992)

APPENDIX E – ADVANTAGES AND CHALLENGES OF WATER SOURCES

Water source	Advantages	Challenges	Recommendations
Water management from within the local catchment			
Rainwater harvesting – roof runoff	• Multiple water-cycle benefits (mains water conservation and reducing stormwater volumes and pollutant loads discharged to environment). • Minimal treatment required as roof runoff is considerably cleaner than other alternative sources of supply. • Resilience to climate change.	• Volume of supply to meet competing demands. • Reliability of supply. • Potentially higher pollutant concentrations conveyed to receiving waters from other land-use practices across catchment, because runoff is not diluted with cleaner roof runoff (treatment of stormwater quality from sources, such as roads, is important to counteract this potential issue).	• Decentralised system requiring minimal maintenance. • Greatest water conservation and ecosystem protection benefits achieved when used for indoor demands such as toilet flushing. • Also viable for other purposes such as garden irrigation when other sources are not a practicable supply option.
Stormwater harvesting – ground runoff	• Multiple water-cycle benefits (drinking-water conservation and minimising stormwater pollutant discharge to waterways). • Provides local aesthetic and landscape improvements – passive irrigation of landscape can also reduce costs. • Potential to minimise drainage infrastructure size and cost. • Resilience to climate change.	• Reliability of supply. • Land uptake for treatment and storage requirements in confined spaces. • Treatment must be adequate to prevent pollutant/nutrient loading of irrigated land • Dependent on committed on-site management.	• Decentralised system – preference is to supplement open space irrigation. • Water not harvested should be treated to improve water quality and manage flows prior to discharge to receiving waters. • Provides landscaping values.
Water recycling	• Multiple water-cycle benefits (water conservation and minimising wastewater discharges to receiving waters). • Provides resilience to climate change. • Constant supply.	• High energy expenditure for treatment to meet end-use water quality requirements. • Health risks need to be managed to limit ingestion. • Storage requirements if supply–demand do not match. • Possible increase in salt and nutrient levels in supply, irrigation rates to be managed to ensure excess runoff does not enter waterways and affect ecological health. • Least greenhouse efficient approach.	• Broader sustainability impacts should be considered (such as energy and sodicity), especially if treatment facility is not currently available.

APPENDIX E – ADVANTAGES AND CHALLENGES OF WATER SOURCES

Water source	Advantages	Challenges	Recommendations
Water management from beyond the local catchment			
Sewer mining extracted from Melbourne Water sewerage transfer network	• Multiple water-cycle benefits (water conservation and minimising wastewater discharges to receiving waters). • Minimal storage requirements. • Resilience to climate change. • Constant supply.	• High energy expenditure for treatment to meet end-use water quality requirements. • Limit direct pathway for ingestion to minimise risk. • Possible increase in salt and nutrient levels in supply, irrigation rates need to be well managed to ensure excess runoff does not enter waterways and affect ecological health. • Least greenhouse efficient approach.	• Broader sustainability impacts should be considered (such as energy and sodicity), especially if treatment facility is not currently available.
Stormwater from Yarra River, Maribyrnong River and Moonee Ponds Creek	• City of Melbourne is at the 'bottom of the catchment' and is able to draw water with fewer negative environment or habitat implications than upstream sites. • Minimal storage requirements. • Constant supply.	• Surface waters are saline in the City of Melbourne and if extracted, would need to be desalinated before use (high energy use). • License requirements to ensure appropriateness of extraction. • Least greenhouse efficient approach.	• Energy and treatment considerations of desalinating need to be carefully accounted for if this is to be pursued.
Mains water	• Inexpensive supply (because externalities remain unaccounted for and supply was heavily subsidised by government in its establishment phase). • Existing infrastructure is accessible and regulations/ approval process are well understood. • Most greenhouse efficient approach.	• Reliant on single supply source – vulnerable to drought. • Population growth and urban consolidation across Melbourne is placing greater pressure on mains supply. • Climate change will result in less runoff due to higher temperatures and lower soil moisture levels. • No ecological protection • Issues associated with environmental flows downstream of water supply reservoirs. • No means to reduce stormwater or wastewater discharges to the environment. • Likely to be supplemented by desalination water with energy and environmental implications.	• Mains water is an important part of the water supply mix, but where possible, other alternative sources should be sought first. • Demand-management already undertaken in water management hierarchy to reduce water use. • Harvest alternative sources of water to conserve mains water and complement potable water use.

APPENDIX E – ADVANTAGES AND CHALLENGES OF WATER SOURCES

Water source	Advantages	Challenges	Recommendations
Groundwater	• Minimal storage requirement. • Can be sourced close to end-use.	• Groundwater shallow and saline in the City of Melbourne and Yarra Delta region (SKM 2006) • City of Melbourne located on unconsolidated quaternary alluvium deposits and hence very low storage potential for Aquifer Storage and Recovery (ASR). • Groundwater, if extracted, would need to be desalinated (high energy use). • License requirements to ensure appropriate extraction. • Climate change will impact on groundwater flow and quality due to sea level rise.	• Not considered a viable solution for the City of Melbourne due to the shallow and saline nature of the groundwater.

Table 1: Advantages and challenges associated with alternative water sources in the City of Melbourne

APPENDIX F – STORMWATER POLLUTANT BUDGET FOR THE CITY OF MELBOURNE

	City of Melbourne managed assets			Private ownership			Total
	Roads	Public open space	Nature strips	Roof	Other impervious surfaces	Pervious areas	
Flow (ML/yr)	2840	967	113	4230	4990	326	13,466
Total Suspended Solids (kg/yr)	875,000	12,500	1470	108,000	860,000	4230	1,861,200
Total Phosphorus (kg/yr)	1660	99	12	591	1450	34	3845
Total Nitrogen (kg/yr)	6740	920	107	10,000	11,500	310	29,577

Table 1: Stormwater pollutant budget for the City of Melbourne – 2005 base year (1959 rainfall data and Fletcher (2005) storm flow concentration parameters)

APPENDIX G – STORMWATER POLLUTANT LOAD DATA

Pollutant	Land ownership	Pollutant generation baseline year 1999–2000	2020 target load reduction	Percentage removed to date
TSS	Total	1,861,200	372,240	4%
	Council	888,970	177,794	4%
	Private residential	291,669	58,334	1%
	Commercial/industrial	680,561	136,112	4%
TP	Total	3846	423	4%
	Council	1771	195	6%
	Private residential	623	68	1%
	Commercial/industrial	1453	160	4%
TN	Total	29,577	3253	4%
	Council	7767	854	10%
	Private residential	6543	720	1%
	Commercial/industrial	15,267	1679	2%

Table 1: Stormwater pollutant load reduction targets translated to annual loads and implementation points (kg/yr)

APPENDIX H – DETAILED SPREADSHEET OF CURRENT WSUD PROJECT BENEFITS

CURRENT						
Project	Mains demand (baseline 99–00 figures)	Mains water conserved (ML/yr)	Wastewater generation (current 06–07)	Wastewater flow reduction (ML/yr)	Stormwater volume generated (99–00 land use)	Stormwater flow volume reduction (ML/yr)
Council	1686				3,920	
Royal Park wetland and re-use scheme		74				245
Australian Garden native pond		2				2
Demand-management fixture, fitting and restrictions		179		179		
Raintanks (parks and gardens, sporting facilities)		1.06				1
Parks and gardens (metered usage)		253				
Docklands precinct – wetland treatment and re-use		9				9
Docklands street pit trees and raingardens						
WSUD stormwater quality projects (nine MW funded)						
Sub-total	**1,686**	**518**	**0**	**179**	**3,920**	**257**
Private residential	5,541				2,864	
Raintanks rebate data (CWW and SEW) garden irrigation		0.21				0.21
Raintank St Kilda road apartment block – garden irrigation		0.16				0.16
Commonwealth Games village – rain tanks toilet flushing		12		12		12
Demand-management fixture, fitting and restrictions		1,074		859		
Sub-total	**5,541**	**1,086**	**0**	**871**	**2,864**	**12**
Private non-residential	18,243				6,682	
Rainwater tanks (schools, Federation Square, etc)		1				0.56
Demand-management fixture, fitting and restrictions		774		774		
Water retailers conservation figures (beyond project data figures provided for this study)		5,703		4,562		
Flemington Racecourse		60				
Melbourne Zoo		95				95
Melbourne Cricket Ground		32				32
Federation Square		14				1.35
City Baths		0.3				
State Hockey Fields		19				19
Waterless wok program		12		12		
Port of Melbourne Corporation		78				78
60L		1				0.5
Green hotels program		25		25		
Sub-total	**18,243**	**6,813**	**0**	**5,373**	**6,682**	**226**
Municipality total	**25,470**	**8,416**	**22,080**	**6,424**	**13,466**	**495**

APPENDIX H – DETAILED SPREADSHEET OF CURRENT WSUD PROJECT BENEFITS

CURRENT	Stormwater pollutant load reduction (kg/yr)					
Project	TSS load generation	TSS load reduction	TP load generation	TP load reduction	TN load generation	TN load reduction
Council	888,970		1,771		7,767	
Royal Park wetland and re-use scheme		29,123		90		693
Australian Garden native pond		1,824		3		19
Demand-management fixture, fitting and restrictions						
Raintanks (parks and gardens, sporting facilities)		218		0.5		3
Parks and gardens (metered usage)						
Docklands precinct – wetland treatment and re-use		1,854		4		25
Docklands street pit trees and raingardens		796		2		8
WSUD stormwater quality projects (nine MW funded)		3,983		7		30
Sub-total	**888,970**	**37,798**	**1,771**	**105**	**7,767**	**778**
Private residential	291,669		623		6,543	
Raintanks rebate data (CWW and SEW) garden irrigation		124		0.2		0.78
Raintank St Kilda road apartment block – garden irrigation		167		0.3		0.8
Commonwealth Games village – rain tanks toilet flushing		2360		4.7		33.3
Demand-management fixture, fitting and restrictions						
Sub-total	**291,669**	**2,651**	**623**	**5**	**6,543**	**35**
Private non-residential	680,561		1,453		15,267	
Rainwater tanks (schools, Federation Square, etc)		115		0.2		1.6
Demand-management fixture, fitting and restrictions						
Water retailers conservation figures (beyond project data figures provided for this study)						
Flemington Racecourse						
Melbourne Zoo		19,570		40		267
Melbourne Cricket Ground		6,592		13		90
Federation Square		278.1		0.6		3.8
City Baths						
State Hockey Fields						
Waterless wok program						
Port of Melbourne Corporation						
60L		103		0.2		1.4
Green hotels program						
Sub-total	**680,561**	**26,658**	**1,453**	**54**	**15,267**	**364**
Municipality total	**1,861,200**	**67,107**	**3,846**	**165**	**29,577**	**1,177**

APPENDIX H – DETAILED SPREADSHEET OF CURRENT WSUD PROJECT BENEFITS

WSUD project name	System types	Construction completion date	Catchment area	Flow reduction		TSS reduction	
			ha	%	kl/yr	%	kg/yr
Completed to June 2008							
Ryder Pavilion	Rainwater tank	Jun 05					
Parkville Gardens	Swales and raingardens	Sept 05	15	0		92	9470
Berns Pavilion	Underground tank toilets recycling	Nov 05		83	172	93	40
Little Bourke St	Raingarden tree pits	Jun 06	0.083	0		84	57.5
Acland St, South Yarra	Raingarden tree pits	Jul 06	0.077	0		85	73.8
Davidson Place	Raingarden	Nov 06		0		95	54.2
Little Collins St	Raingarden tree pits	Jun 07	0.223	1		81	204
East Melbourne Library	Underground tank internal recycling	Jun 07					
Royal Park wetland	Wetland and pond re-use scheme	Sept 05 Jun 07	170	38	245,000	89.5	118,000
Aust. Native Garden, Royal Park	Swale and wetland	Jul 07				57	1040
Childers St	Raingardens	Dec 07	0.225	0		95.4	132
QVM rainwater recycling	Underground tank	Mar 08	1.43	88.6	5000	92.5	135.1
Totals			**187.0**		**250,172**		**129,207**
Due for completion June 2008 to June 2009							
Bullens Lane	Sand filters	Aug 08		0		72	46.4
Bellair St – Arden St to Ormond St	Raingardens	Sep 08	0.654	0		88.6	597
Fawkner Park South Pavilion	Rainwater tank, internal recycling, greywater recycling	Sep 08					
Flagstaff Bowls Club	Bowls green recycling, underground tank, raingarden, greywater recycling	Oct 08		71	885	94	114
Grant St play space	Raingarden, underground tank	Dec 08	1.1	16.5	1003	76	967
PROV Rainwater Harvesting	Large rainwater harvesting	Dec 08			2735	85.1	59
Royal Park wetland	Addition of 5 ML underground tank	Dec 08	170	47.5	339	92.5	123,020
Royal Park Zoo North Entrance Carpark	Raingardens	Dec 08	0.826	0		86	860
Shrine of Remembrance	Underground tank, GPT	Dec 08	1.615	95.3	6616000	98.2	1150
Totals			**548.3**		**7,121,306**		**267,227**

APPENDIX H – DETAILED SPREADSHEET OF CURRENT WSUD PROJECT BENEFITS

WSUD project name	System types	Construction completion date	TN reduction		TP reduction		Litter reduction		Points
			%	kg/yr	%	kg/yr	%	kg/yr	1/26 kg TSS
Completed to June 2008									
Ryder Pavilion	Rainwater tank	Jun 05							
Parkville Gardens	Swales and raingardens	Sept 05	73	15.1	47	66.6	100	2150	364.2
Berns Pavilion	Underground tank toilets recycling	Nov 05	90	0.078	86	0.52	100		1.5
Little Bourke St	Raingarden tree pits	Jun 06	44	0.43	71	0.098	100	13	2.2
Acland St, South Yarra	Raingarden tree pits	Jul 06	71	0.124	52	0.621	100	15.1	2.8
Davidson Place	Raingarden	Nov 06	81	0.09	59	0.46	100		2.1
Little Collins St	Raingarden tree pits	Jun 07	65	0.33	43	1.51	100	43.8	7.8
East Melbourne Library	Underground tank internal recycling	Jun 07							0.0
Royal Park wetland	Wetland and pond re-use scheme	Sept 05 Jun 07	73.8	197.6	58.7	1085	100	27,900	4538.5
Aust. Native Garden, Royal Park	Swale and wetland	Jul 07	34	6.46	50	1.5			40.0
Childers St	Raingardens	Dec 07	78	0.23	56	1.1	100	28.1	5.1
QVM rainwater recycling	Underground tank	Mar 08	89	0.71	90	11.6	100	221	5.2
Totals				**221**		**1169**		**30,371**	**4969**
Due for completion June 2008 to June 2009									
Bullens Lane	Sand filters	Aug 08	31	0.53	47	0.084			1.8
Bellair St – Arden St to Ormond St	Raingardens	Sep 08	75	1	46.5	4.4	100	122	23.0
Fawkner Park South Pavilion	Rainwater tank, internal recycling, greywater recycling	Sep 08							0.0
Flagstaff Bowls Club	Bowls green recycling, underground tank, raingarden, greywater recycling	Oct 08	82	0.21	78	1.98	100		4.4
Grant St play space	Raingarden, underground tank	Dec 08	58	1.51	36	6.2	100	238	37.2
PROV Rainwater Harvesting	Large rainwater harvesting	Dec 08	78	0.29	79	4.82	100		2.3
Royal Park wetland	Addition of 5 ML underground tank	Dec 08	78.7	209.3	66	1226	100	27,900	4731.5
Royal Park Zoo North Entrance Carpark	Raingardens	Dec 08	52	6.64	71	1.34	100	162	33.1
Shrine of Remembrance	Underground tank, GPT	Dec 08	97.2	2.43	96.1	18.38	100	286	44.2
Totals				**664**		**3601**		**89,450**	**5308**

APPENDIX I – EXAMPLE OF FUTURE WSUD PROJECTS REQUIRED TO ATTAIN 2020 TARGETS

Future 2020		ML/yr	ML/yr	ML/yr	ML/yr
Project		**Mains water used (baseline 06–07 figures)**	**Mains water conserved**	**Wastewater generated (current 06–07)**	**Wastewater flow reduction**
Council		1,168			
	Royal Park wetland and re-use scheme		64.5		
	Raintanks (buildings, sporting facilities)		12.72		
	Parks and gardens 2012 – demand management and stormwater harvesting		202		
	WSUD stormwater quality projects				
	CH2 building		36.4		36.4
	QV		40		
	Fish markets		70		
	Convention centre				
	Museum		7.5		
Sub-total		**1,168**	**433**	**0**	**36**
Private residential		4,455			
	Demand management		1,074		
	Raintanks		2		
Sub-total		**4,455**	**1,076**	**0**	**0**
Private commercial		11,430			
	Rainwater tanks		7		
	Rollout of waterless wok program		350		350
	Royal Botanic Gardens		50		
	Holder car dealership – tanks for car washing		0.01		
	State Netball and Hockey Centre		19		18.5
	Convention centre		4.5		4
	Southern Cross Station		0.6		
	Cooling tower program		330		330
	Fire sprinker testing program		450		450
	Rollout of green hotels program		180		180
Sub-total		**11,430**	**1,391**	**0**	**1,333**
		17,054	**2,900**	**0**	**1,369**

APPENDIX I – EXAMPLE OF FUTURE WSUD PROJECTS REQUIRED TO ATTAIN 2020 TARGETS

Future 2020		ML/yr		Stormwater pollutant load reduction (kg/yr)		
Project		Stormwater volume generated (99–00 land use)	Stormwater flow volume reduction	TSS	TP	TN
Council		3,663				
	Royal Park wetland and re-use scheme		55	1,100	8	90
	Raintanks (buildings, sporting facilities)		13	2,616	5	36
	Parks and gardens 2012 – demand management and stormwater harvesting		202	15,884	38	369
	WSUD stormwater quality projects			15,932	26	119
	CH2 building					
	QV		40	8,240	17	112
	Fish markets		70	14,420	29	197
	Convention centre			312.9	0.509	2.62
	Museum		8	1545	3.15	21.075
Sub-total		**3,663**	**387**	**60,050**	**127**	**946**
Private residential		2,852				
	Demand management					
	Raintanks		2	110	0.3	6
Sub-total		**0**	**2**	**110**	**0.3**	**6**
Private commercial		6,456				
	Rainwater tanks		7	1,380	3	19
	Rollout of waterless wok program					
	Royal Botanic Gardens		50	10300	21	140.5
	Holder car dealership – tanks for car washing		0.01	2	0.004	0.03
	State Netball and Hockey Centre		0.5	103	0.2	1.4
	Convention centre		0.5	103	0.2	1.4
	Southern Cross Station		1	124	0.3	1.7
	Cooling tower program					
	Fire sprinkler testing program					
	Rollout of green hotels program					
Sub-total		**6,456**	**58**	**12,012**	**25**	**164**
		10,119	**448**	**72,172**	**152**	**1,117**

APPENDIX J – GROSS POLLUTANT (LITTER) LOADS AND REDUCTIONS TO DATE

Total load generated from municipality			
Flow (ML/yr)	9.55E+03	3.92E+03	13,470
Total Suspended Solids (kg/yr)	9.10E+05	9.31E+05	1,841,000
Total phosphorus (kg/yr)	2.03E+03	1.87E+03	3,900
Total nitrogen (kg/yr)	2.11E+04	7.82E+03	28,920
Gross pollutants (kg/yr)	3.33E+05	1.02E+05	**435,000**
Load removed from in-ground traps treating 288 ha of catchment across municipality			
Flow (ML/yr)	8.64E+02	864	0
Total Suspended Solids (kg/yr)	1.62E+05	1.62E+05	0
Total phosphorus (kg/yr)	3.44E+02	344	0
Total nitrogen (kg/yr)	2.39E+03	2.39E+03	0
Gross pollutants (kg/yr)	3.83E+04	3.86E+03	**34,440**
Total load removed by other WSUD treatment measures			**30,371**
Total load generated across the municipality			**435,000**
Total load of litter removed			**64,811**
Percentage reduction			**15%**

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