

Our Local Water Ways



NOVEMBER 2022

KINGSTON'S INTEGRATED WATER STORY THE FULL PICTURE



City of
KINGSTON

Acknowledgement of Country

The City of Kingston proudly acknowledges the Bunurong People of the Kulin Nation as the Traditional Owners and Custodians of this land, and we pay our respect to their Elders, past and present and emerging.

Council acknowledges the Bunurong's continuing relationship to the land and waterways and respects that their connection and spiritual identity is maintained through ancient ceremonies, songlines, dance, art and living culture. Council pays tribute to the invaluable contributions of the Bunurong and other Aboriginal and Torres Strait Island elders who have guided and continue to guide the work we do.

The City of Kingston's Innovate Reconciliation Action Plan (April 2022 – April 2024) aims to raise awareness and promote reconciliation. This document is available on our website.

Cover image:
View of Patterson River beside Bonbeach.





Inset: Indigenous Elders educating local students about Bunurong history with Edithvale-Seafood wetlands pictured.



Glossary

Alternative water

Alternative water sources include rainwater from your roof, stormwater, recycled water or greywater.

CSIWM Plan

'Catchment Scale Integrated Water Management', refers to the regional catchment that flows into Port Phillip Bay, and how the water runoff is managed in a holistic, integrated way. Kingston is located within the Dandenong catchment.

Environmental water

Water managed to improve or maintain the health of rivers and wetlands – including the plants and animals that depend on them. The Victorian Environmental Water Holder (VEWH) uses the term to mean water available under environmental entitlements actively managed to benefit the environment.

Environmentally Sustainable Design (ESD)

An aspect of design, applying to buildings as well as civil works, that seeks to improve performance; reduce environmental impacts, resource use and waste; and create healthy environments for occupants/users

Green wedge land

Green wedge land is defined in Section 46AC of the *Planning and Environment Act 1987* as "land that is described in a metropolitan fringe planning scheme as being outside an urban growth boundary."

Impervious surfaces

Hard surfaces that do not allow water to infiltrate to the underlying soil, such as roads, roof tops, paving and car parks.

Permeability

A surface that allows water to be absorbed into the soil. It then either infiltrates into groundwater, or evaporates, or absorbed via plant transpiration.

Nuisance flooding

Low levels of inundation that do not pose significant threats to public safety or cause major property damage, but can disrupt routine day-to-day activities, put added strain on infrastructure systems, such as roadways and can cause minor property damage.

Potable water

Potable water is also known as drinking water and comes from surface water and groundwater sources. This water is treated to levels that meet state and federal standards for consumption.

Rainwater

Rain that has fallen onto a roof and has traditionally been directed into rainwater tanks.

Recycled water

Wastewater from kitchen, laundry and toilets that has been treated to a Class A standard for non-potable reuse such as irrigation.

Rain garden

A depressed garden area that treats stormwater runoff from roofs, driveways and other hard surfaces by filtering through sandy soil before it drains to our waterways.

Stormwater

The net increase in runoff from urban development due to water not being able to seep into the ground because of impervious surfaces, such as roofs and roads.

Urban heating

An increase in localised temperature due to the urban built environment, primarily due to high amounts of concrete and asphalt, and a reduction in vegetation. Increasing tree canopy cover is a key method to reducing these effects.

Water Sensitive City

A Water Sensitive City is a place where built and natural environments are in harmony. It is a liveable city that reflects community values and has healthy waterways running through it.

Water Sensitive Urban Design

A holistic approach to water management that integrates urban design and planning to protect aquatic environments, enhance urban ecology and achieve multiple beneficial outcomes.

TSS, TP, TN

Stormwater pollutant loads categorised as Total Suspended Solids (TSS), Total Phosphorous (TP) and Total Nitrogen (TN).

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Our Plan

Integrated Water recognises that all parts of the water cycle are linked, including water security (for now and the future), stormwater pollution, flooding, groundwater impacts and waterway health.

The following set of documents explain our approach to integrated water moving forward and replace our previous Integrated Water Cycle Strategy (City of Kingston, 2012):

1.
“Our Local Water Ways”
– *Kingston’s Integrated Water Strategy:*
A community focussed summary of Kingston’s future direction.

Kingston’s Integrated Water Implementation Plan – Towards 2030 (attachment 1):
A description of our actions with 2030 and 2050 aspirational targets.

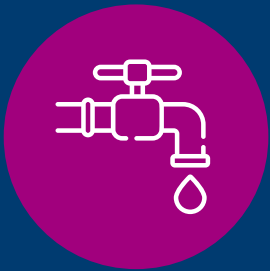
2.
“Our Local Water Ways”
– *Kingston’s Integrated Water Story, The Full Picture* (this document):
A more detailed discussion about our journey, challenges, and opportunities. This focuses on Kingston’s current and future water projections and summarises our water modelling data. It is aimed at people with an understanding of integrated water, or those who are interested in learning more about Kingston’s strategic approach.

Our Vision and Objectives

Our vision is to become a 'Water Sensitive City'. This is a place where healthy waterways are valued, and our community is engaged in making wise choices about water. A place where our built and natural environments are in harmony.

The broad objectives of Kingston's Integrated Water Strategy are:

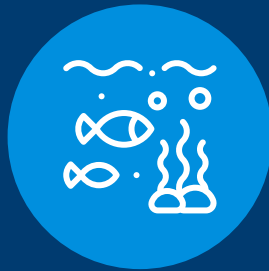
Strategic Objective 1:



Use our Water Wisely

To use water throughout the City of Kingston wisely, including less drinking water (potable water) and more use of alternative water such as rainwater tanks, harvested stormwater and recycled water from Melbourne Water's treatment plant.

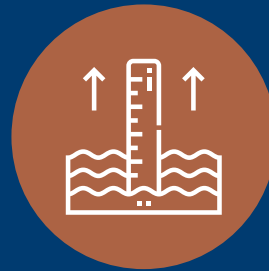
Strategic Objective 2:



Protect our Waterways and Bay from Pollution

To improve the quality of stormwater runoff from local areas flowing into water courses and Port Phillip Bay, with a focus on reducing litter and all forms of pollution.

Strategic Objective 3:



Improve our Flood Management

Improve resilience to floods in the way we prevent, manage and respond to them.

Strategic Objective 4:



Enhance our Education, Engagement and Partnerships

Work with our community and regional partners for the benefit of managing our water resources.

This Strategy includes tips on how our local community can take simple steps to support our objectives.

1. Introduction

The City of Kingston has a proud history of being pioneers in Integrated Water Management (IWM) and has played an important role in the advancement of these principles and stormwater quality initiatives since the late 1990s.

In partnership with the community and key stakeholders, we have implemented many ground-breaking strategies and projects that seek to address the immense pressures that changes to our climate and increased urbanisation places on every part of the water cycle.

The strategic objectives primarily focus on achieving the following outcomes:

- Using less potable water and increasing the use of alternative water, such as recycled water pipelines and stormwater harvesting. Water will play a critical role in supporting Council's cooling, greening, urban forest and climate change adaptation objectives.
- Improving the quality of stormwater runoff from local areas flowing into waterways and Port Phillip Bay.
- Improving resilience to flood events, in alignment with Kingston's approach to flood management.

1.1

What is Integrated Water Management?

Integrated Water Management (IWM) is a collaborative approach to planning and managing all elements of the water cycle, including stormwater, wastewater, water supplies (surface water and groundwater) and waterways.

IWM provides a mechanism to respond to the adverse impacts of climate change on biodiversity, habitat and the health of ecosystems and waterways (as documented in Kingston's Climate & Ecological Emergency Response Plan). These include anticipated impacts, such as declining rainfall, increased intensity of rainfall events, an increase in hot days and heatwave events, and a coastline increasingly vulnerable to sea level rise and storm surge.

Through good design, green spaces coupled with water-sensitive assets, such as wetland and raingardens, provide valuable habitat, protect waterways, and provide opportunities to use captured water as an important resource.

An integrated approach to water planning and management can provide multiple benefits to the health and wellbeing of the local communities, including the ability to:

- Build resilience to climate change effects by ensuring water security and reducing flood risk
- Enhance liveability by creating open green spaces and reducing heat island effects by supporting tree canopies
- Protect the environment by reducing stormwater pollution
- Increase community water literacy and connection with water.

1.2 How is IWM different to historical water management approaches?

Traditionally, the following three 'areas' of the water cycle have been managed separately: water supply, wastewater and stormwater.

IWM recognises the interrelationships between different sources of water and views water cycle management within a more holistic social, cultural, and economic context.

Unless appropriately considered, urban consolidation can increase hard surfaces which increase stormwater volumes, pollutant loads and can exacerbate flooding issues. IWM responds to these impacts by considering ways to reduce, retain and reuse stormwater in the landscape while simultaneously maximising urban greening, cooling and biodiversity opportunities.

For an IWM approach to be successful, it requires collaboration across multiple organisations that influence all elements of the water cycle. This includes, but is not limited to, local governments, residents and community, water corporations, catchment management authorities, the Department of Environment, Land, Water, Planning (DELWP), and the Traditional Owners.

2.

City of Kingston's Journey (2000 to 2022)

2.1 Overview

The City of Kingston's ongoing aims to protect Port Phillip Bay and highly valued waterways from the impacts of stormwater pollution commenced in 1999 when Kingston Council was one of the pioneer Melbourne municipal Councils to support a joint Stormwater Quality Plan in partnership with Melbourne Water.

Since then, our organisation has embraced the importance of taking a holistic approach to integrated water management and has contributed towards continuous improvement. A brief overview of some of Council's achievements are outlined below.

- Forging strong relationships with key stakeholders South East Water, Melbourne Water, and the Department of Environment, Land, Water and Planning (DELWP), which facilitate cross-jurisdictional projects.
- Constructing many innovative rain gardens as part of Council's streetscape improvement projects.
- Kingston teamed up with Clearwater (a leading capacity-building program aligned with by Melbourne Water and DELWP) to regularly host educational tours to showcase local stormwater treatment projects.
- Kingston Council has received more than 10 industry awards, including state and national recognition, for projects and programs in the area of environmental stormwater management.

Industry-leading research and water modelling was undertaken in 2011 to develop a deeper understanding of the City of Kingston's holistic water balance. This was a 'groundbreaking' approach.

Aspirational targets and actions in the 2012 Strategy were a key driver in delivering the following between 2012 to 2022:

- Water Sensitive Urban Design (WSUD) was introduced into Kingston's Local Planning Policy.
- Numerous foreshore drainage outlets were treated by installing innovating natural swales.
- The award-winning stormwater harvesting project at Edithvale Recreation Reserve was completed in 2018, providing more than 8 million litres per year of treated water to irrigate sport fields.
- Most of Kingston's sports ovals were upgraded with the latest technology and turf management practices to reduce irrigation and save potable drinking water.
- Kingston's use of stormwater to irrigate our sports fields has steadily increased as a percentage of total water use.
- Comprehensive IWM guidelines were developed for developers to meet best-practice requirements.
- Kingston's innovative Stormwater Quality in-lieu developer contributions scheme was launched in 2017.
- A green roof was constructed as part of the new Edithvale lifesaving club building in 2018 (pictured).
- Over \$30 million was invested in upgrading local drainage systems in flood-prone suburbs.



Figure 1. Edithvale Life saving club, incorporating a green roof

2. City of Kingston's Journey (2000 to 2022)

2.2 Relationship with Other Council Plans

The City of Kingston Council Plan 2021 – 2025 sets out our Community vision as:

Kingston is a resilient, inclusive and diverse community. We are building the most liveable and sustainable city in Victoria. We champion and nurture our green and open spaces, creating a safe, healthy environment. Our shared legacy connects our community, embracing innovation, making Kingston the place to live.

The Council Plan 2021–25 is “Our Roadmap” and features the following six strategic directions:

Liveable:

Our city will be a vibrant, enjoyable, and easy place to live.

Sustainable:

We prioritise our environment and reduce our impact on the earth.

Prosperous:

We will embrace the concept of a 20-minute neighbourhood, support the ongoing process of decentralisation and support people to live and work locally.

Healthy & Inclusive:

We are progressive, inclusive and prioritise the wellbeing of all members of our community.

Safe:

Our community will feel safe, and be safe, in all aspects of their lives.

Well-governed:

Council will be collaborative, accountable, transparent, responsive, well-informed and efficient.

Other important Council strategies or plans, that have a strong alignment with water management, are discussed below.

Strategy/Plan	Relevance to Integrated Water Management
Climate & Ecological Emergency Response Plan	Kingston Council declared a Climate & Ecological Emergency in 2021. The Response Plan articulates Council’s priorities that include supporting low-carbon living, adapting to the impacts of climate change and transforming Council operations. It describes the environmental, health and wellbeing problems, including significant changes to our waterways. It references Council’s Cooling Strategy due to the heat impacts of climate change.
Urban Cooling Strategy	The Urban Cooling Strategy describes Council’s approach to reducing the impacts of heat islands in areas that have a greater proportion of bitumen, dark roofs, dry grass and bare ground. In contrast, cool islands feature irrigated grass, wetlands, water bodies and trees in the landscape, noting that large areas of bare ground or dry grass can be much hotter than average regional temperatures. Using alternative water to irrigate reserves and sports fields is a key link between these strategies.
Open Space Strategy	The Open Space Strategy guides local policy and decision making regarding open space provision, acquisition and management. Many open spaces can contribute to cooling, especially where they are irrigated and green. The planning and implementation of recycled water pipelines and harvested water will allow larger areas of parkland to be irrigated.
Tree Management Policy	The Tree Management Policy describes Council’s approach in managing the Council land component of the urban forest, which consists of approximately 90,000 trees within reserves, streets and Council managed facilities. The street tree watering program will require the planning of rainwater tank refill locations to ensure a sustainable outcome.
Draft Urban Forest Strategy	The Urban Forest Strategy describes the areas of Kingston with low tree canopy coverage, highlighting a lack of shade and increased risk for more vulnerable members of our community. It identifies opportunities and actions for increasing tree planting that will need to be supported by additional sources of alternative water.

2. City of Kingston's Journey (2000 to 2022)

Strategy/Plan	Relevance to Integrated Water Management
Biodiversity Strategy 2018–2023	The Biodiversity Strategy sets out goals and strategic objectives for protecting, preserving and improving biodiversity within Council's Natural Resource Areas (NRA). The way in which NRAs are managed in the future will have an impact on water management.
Draft Housing Strategy & Neighbourhood Character Study	The draft Housing Strategy and Neighbourhood Character Study provides a framework to guide the growth and change of residential areas in the City of Kingston. The way in which residential areas grow and change will need to be designed to achieve the objectives of a water-sensitive city, including minimising potable water consumption, minimising stormwater runoff and pollution, managing flood risks, and maximising open space benefits.
Activity Centre Structure Plans	A structure plan is a long-term guide for changes to land use, building and public spaces in activity centres (e.g. Moorabbin, Highett, Cheltenham, Mentone, Carrum, Chelsea). As these areas transform and densify, they provide opportunities to incorporate water-sensitive urban design elements to treat stormwater and develop green streetscapes.
Public Health & Wellbeing Plan 2021–2025	This Plan sets out Council's priorities and objectives to improve the health and wellbeing of the community. Key objectives of this Plan include improving the amenity of open spaces and the natural environment, plus increasing community resilience for health impacts of climate change. Water can contribute towards achieving both objectives.
Stormwater Management	<p>Melbourne Water and the City of Kingston prepared joint Flood Management Plans in 2011 and 2016 that describe the stormwater drainage network, flood hotspots and improvement strategies. An updated Flood Management Plan is listed within Kingston's Integrated Water Strategy (see action K3d within the Implementation Plan) to review emerging flood risks.</p> <p>Council has supported the need to reduce the volume of stormwater runoff, via increased storage and infiltration, and was an early leader of implementing stormwater quality treatment systems since 1999.</p>

A young girl with her hair in a bun, wearing a yellow dress with small blue polka dots, stands barefoot on a dark grey concrete block in a shallow pond. The water is calm and reflects the girl and the block. In the background, there are green trees and a blurred structure, possibly a playground or park area. A dark blue text box is overlaid on the right side of the image.

Water is vital to cooling the municipality, particularly through irrigation of green spaces.

3.

Meeting challenges now and into the future

The City of Kingston is experiencing an ongoing change in climate, steady growth in population and urban development.

3.1 Mitigating and Adapting to Climate Change

Recognising that the Earth's current warming trajectory threatens most life on this planet, the City of Kingston declared a climate and ecological emergency in 2020. One year later, the Council adopted our Climate and Ecological Emergency Response Plan. This signals a move away from 'business as usual' towards reversing carbon output and moving towards a 'net zero' future.

The Greater Melbourne Climate Projections 2019 report states that climate change impacts are already being felt now, and will increase in the future. The City of Kingston is already experiencing increasing temperatures, shifting rainfall patterns, decreased rainfall, coastal inundation, extreme weather events and biodiversity loss.

Increased rainfall events will exacerbate flooding, whilst elevated temperatures will increase the impacts on our community's health and wellbeing. Reductions in average annual rainfall mean prolonged periods of drought that will place pressure on our water supplies and the natural environment.

We need to prepare for climate change impacts on the water cycle, such as:

- Increase in temperature
- Reduction in cool season rainfall (April to October)
- Large decreases in streamflow
- Increase in extreme rainfall events
- Increase in flash flooding
- Sea level rise.

“We need to plan for climate change because the change is happening already and it's going to keep happening and it's going to make life a lot more challenging for a lot of people.”

– Community member





Climate Change Modelling

Planning for Kingston’s future water needs will be significantly influenced by the impacts of climate change, particularly around the forecasts for future rain fall intensity and seasonal volumes.

Council plans will need to be flexible and able to adapt to suit a range of possible future climatic scenarios, including drier or wetter periods with varying implications for different aspects of the water cycle and integrated water management.

Kingston Council engaged E2Designlab to undertake climate change modelling during 2021, with a more detailed description provided in their technical report. As part of this work, modelling was undertaken to understand the impacts of climate change and development on the future of Kingston’s water cycle, including rainfall, evapotranspiration, infiltration, stormwater volumes and pollutant loads generated across the municipality.

There are a range of potential future climatic scenarios with differential impacts on Kingston’s water cycle. The modelling focussed on two climate change scenarios, discussed in Appendix 2.

These are recognised as representative of the bookends to a range of possible future climatic conditions and have been used to inform the predicted 2030 and 2050 stormwater volumes.

Increases in population growth and development have also been considered in the modelling.



Figure 2. Greening of Mentone Shopping Precinct, built in 2019

Urban Heat

Extreme heat and heat waves have a major impact on the health and wellbeing of the community and more broadly the productivity of the economy. They are likely to occur more frequently and impact larger areas because of climate change and increased urbanisation. Increasing temperatures and a potentially drying climate are likely to lead to reduced water availability in soils, vegetation and water bodies in the landscape which provide crucial local cooling benefits. Simultaneously, an increase in hot asphalt, concrete and roof surfaces that absorb, trap and accumulate heat can cause temperatures in urban centres to rise above regional averages. This is known as the “urban heat island” effect.

As cities grow and populations increase, the amount of green space compared with hard impervious surfaces can increase. Where surfaces are replaced with materials that accumulate heat (e.g. bitumen, dark roofs, dry grass and bare ground), the landscape can become hotter. However, where vegetation is maintained during development and “cooling” materials are used (e.g., light-coloured roof surfaces), temperatures can be maintained. In particular, retaining water in the urban environment through irrigated green spaces is important to provide shade and natural cooling benefits.

The vision to integrate ‘cooling’ into decision making, as outlined in Kingston’s Urban Cooling Strategy, aligns with Council’s strategic objectives to plan for alternative water sources to allow larger areas of parklands to be irrigated to maintain lush green areas.

For example:

- Under a hot, dry future, reduced rainfall will mean more water is required for the greening of open spaces, but less water would be available for harvesting stormwater.
- Under a warm, wet future, comparatively less water is needed, but the increased stormwater from increased rainfall would create more pollution.
- It is generally expected that under all future climate scenarios, higher intensity storm events will likely occur, which is likely to increase the frequency of flash flooding events.

Given the range of potential modelling scenarios, it is important to remain flexible and take a conservative approach to planning that considers the least favourable possible outcome.

3.

Meeting challenges now and into the future

3.2 Impacts of Population Growth and Urbanisation

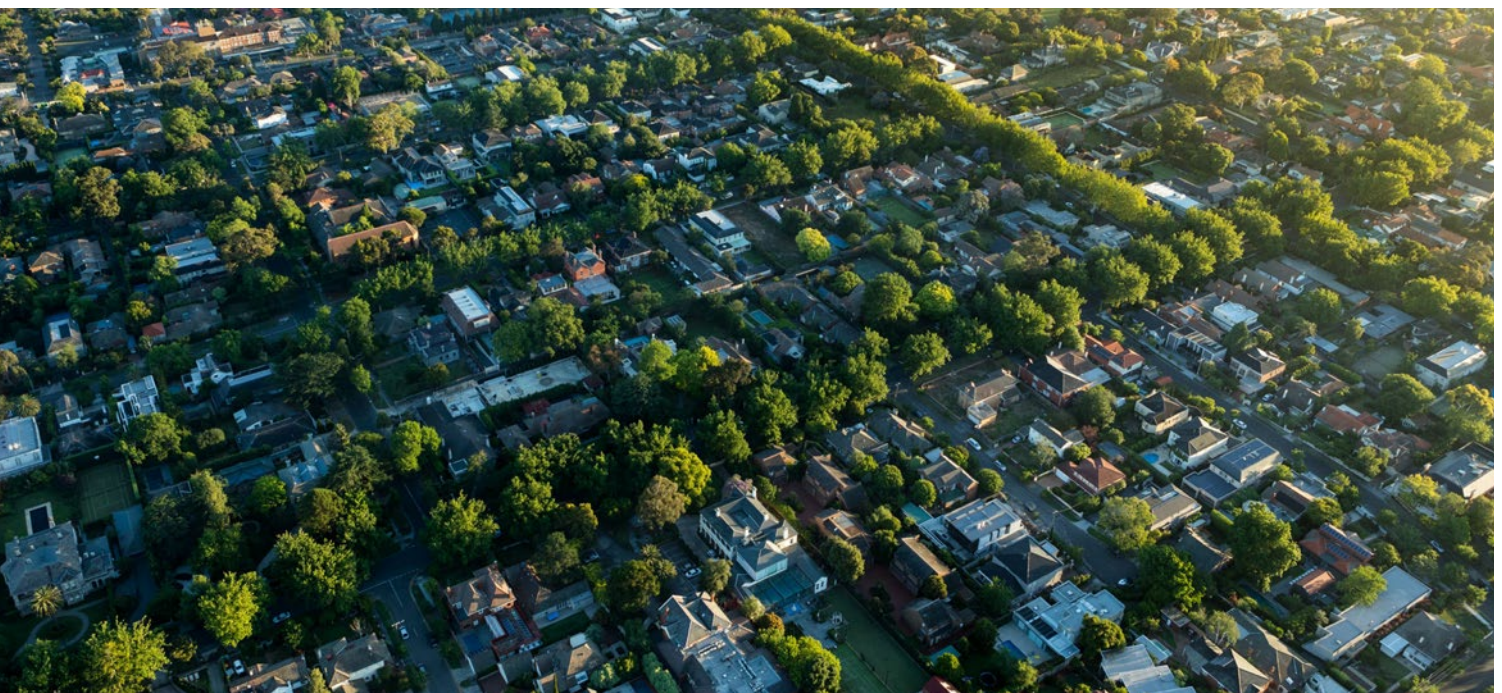
Demand for water is expected to increase with projected population growth, as discussed under Section 6.1, and can provide challenges for water and liveability.

More houses to support population growth could mean an increase in hard surfaces and less green space, likely resulting in elevated urban heat stress and increased stormwater runoff. Increased volumes of stormwater are likely to increase flooding risks, and deliver more nutrients, sediments and other pollutants of ecological and public health concern into our waterways and flowing into Port Phillip Bay.

Future Development Scenario

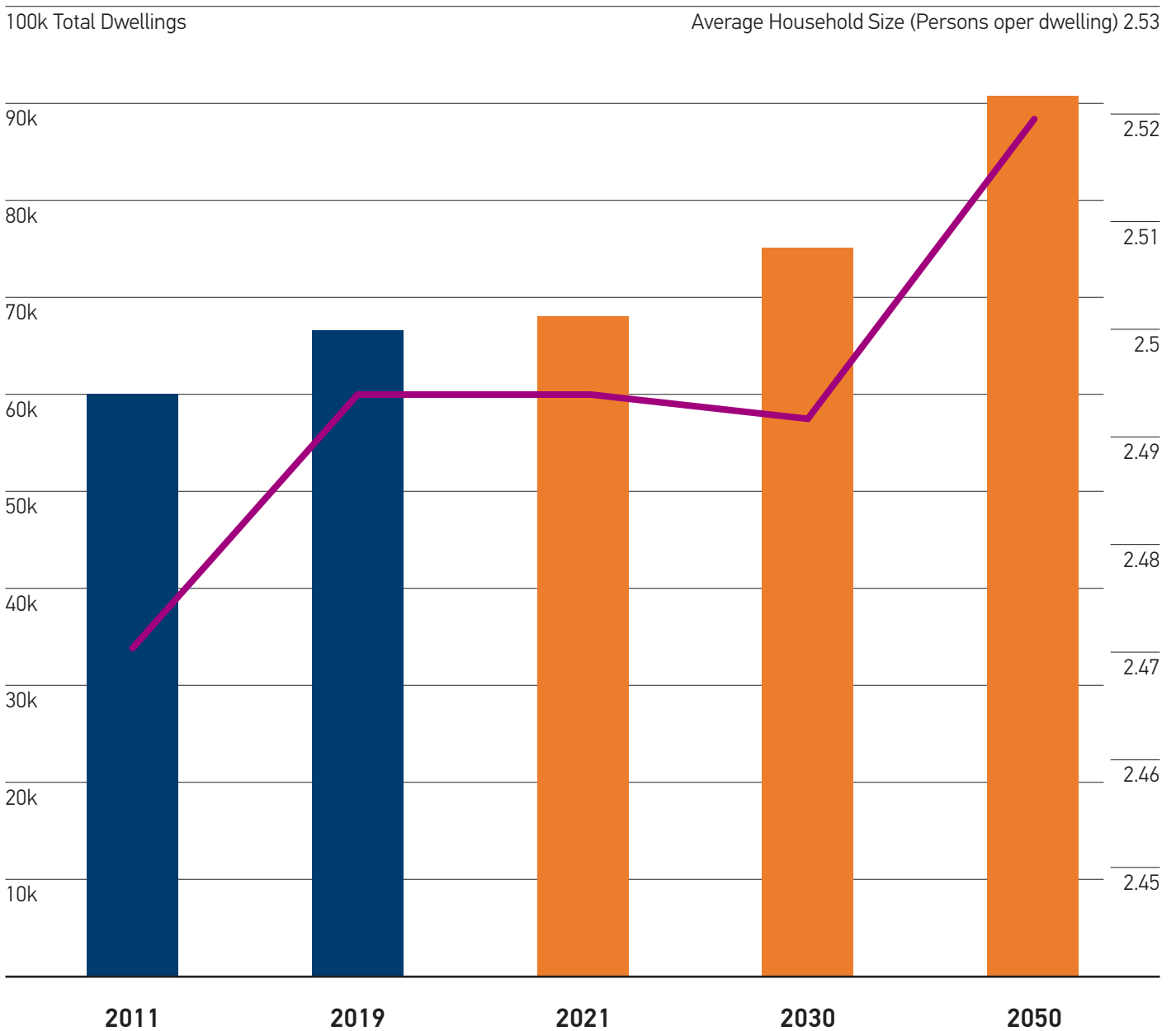
Kingston's potential future development scenarios were used to model the impacts on Kingston's water cycle. An estimated average increase of around 800 new dwellings constructed each year was used to predict the number of rainwater tanks, stormwater runoff volumes and the volume of pollutants generated in 2021, 2030 and 2050.

Further details on the number of new dwellings forecast is discussed in Appendix A2.



Potential Future Developments Scenario

■ Total Dwellings – Historical
 ■ Total Dwellings – Projected
 ■ Average Household Size (Persons per dwelling)



3.

Meeting challenges now and into the future

The forecast water and pollutant balance, due to climate change and increased urbanisation, shows that:

- We are using potable water faster than nature can replace it.
- There will be an increased output of wastewater and urban stormwater.
- Urban development, commercial and industrial activities will increase the pollution in our waterways.

There is a need to:

- Reduce our reliance on potable water by harnessing alternative water sources (e.g. rainwater, stormwater and recycled water).
- Prevent and manage stormwater pollution from agricultural activities, urban development and commercial/industrial activities to protect the health of our waterways and bays.
- Move towards sustainable groundwater and surface water management.

3.3 Permeability & Impervious Surfaces

Increasing urban density has led to a dramatic reduction in permeable surfaces, such as soil, grass and vegetated landscapes, through the construction of impervious roads, buildings, and car parks, with more dwellings adding to this situation.

As the percentage of permeable areas decreases, less water infiltrates into the soil and the volume of stormwater runoff increases. This has implications for the capacity of Council's drainage infrastructure, which was not originally designed to accommodate the additional runoff volumes expected with increasing urban consolidation and storm intensities.

This is predicted to contribute to more frequent flooding in addition to exacerbated pollution and degradation of Kingston's waterways and Port Phillip Bay.

Where possible, Council will retain areas of permeable surfaces. Options include installing or retaining where practical:

- Green landscaped areas
- Garden beds or swales to infiltrate stormwater runoff
- Rain gardens or green roofs
- Permeable surfaces e.g. gravel, porous paving or permeable pavements.

A high-level assessment of permeability across the municipality identified that building footprints are the most dominant landform contributing to impermeability. A more detailed assessment will inform future decision-making.



Figure 3. Award-winning stormwater treatment system in Edithvale

4.

Federal, State and Local Context

4.1 Collaborative Approach

Water is integral to the liveability of our local suburbs, the health of our environment and the prosperity of our community. Collaborative and integrated water cycle management is needed. Our state water plan, Water for Victoria (DELWP, 2016) is a framework to guide smarter water management, bolster the water grid and support more liveable Victorian communities, both now and in the future. To help deliver this objective, Integrated Water Management Forums (DELWP, 2017) were established across the state to identify, prioritise and oversee the implementation of collaborative water opportunities.

Across greater Melbourne there are five Integrated Water Management forums, comprised of Yarra, Maribyrnong, Werribee, Dandenong and Western Port, that align with the existing five major waterway catchments shown below.

The City of Kingston is located within the Dandenong catchment as described in Section 5. The strategic objectives and goals within Kingston's Integrated Water Strategy have been developed to align with the Dandenong Strategic Directions Statement, and contribute towards the Dandenong key measures and targets, to ensure that we are all working towards a consistent regional approach.

Another important strategic document is the draft Greater Melbourne Urban Water & System Strategy (2021): 'Water for Life'. This Strategy is updated by the water corporations every 5 years to plan for Melbourne's water security, with a summary provided in section 6.1.2.

4.2 Policy Framework

Kingston's Strategy also supports and aligns with the Commonwealth Government, state government and other local government plans and considers existing and future challenges and opportunities.

Below is a list of the various legislation and policies that relate to Kingston's Integrated Water Strategy and initiatives.

Commonwealth

- National Water Initiative
- *Environment Protection and Biodiversity Conservation Act 1999*

State of Victoria

- Water for Victoria 2016
- Integrated Water Management Framework for Victoria 2017
- *Planning and Environmental Act 1987*
- Victorian Planning Provisions (Amendment VC154)
- *Environment Protection Act 2017* (2021 Amendment)
- State Environment Protection Policy (Waters for Victoria)
- Urban Stormwater Best Practice Environmental Management Guidelines
- Healthy Waterway Strategy 2018
- Urban Water Strategy Provisions
- Melbourne Water Flood Strategy Regional Catchments

- Dandenong Strategic Direction Statements
- Dandenong Catchment Scale Integrated Water Management Plan (IWMP)
- Flood Management Strategy for Port Phillip and Westernport 2021 – 2031
- *Marine and Coastal Act (2018)*
- *Environment Protection Act (2017)*

More information about each stakeholder’s involvement is outlined in Appendix 1 (Stakeholders) and Appendix 4 (Flood History & Emergency Management).

The *Environment Protection Act (2017)* includes a “duty of care” for environmental protection that came into force in September 2022. This requires individuals, companies and agencies to be accountable for the prevention of pollution.

City of Kingston

- Council Plan 2021
- Kingston’s Integrated Water Strategy
- Joint Kingston and Melbourne Water Flood management Plan (2016)

Managing water and drainage systems within the City of Kingston also requires the involvement and co-ordination of a significant number of stakeholders, including Melbourne Water, Kingston Council, Environmental Protection Authority, water retailers, emergency services agencies, Commonwealth agencies, communities, businesses, and individuals.

The local boating community are keen for Mordialloc Creek to be dredged to improve access. The planning and funding for dredging of waterways requires state government intervention and would require collaboration to safely dispose of contaminants within the removed sediments.

5. Dandenong Catchment Forum

The City of Kingston is located within the Dandenong catchment and has been an active participant in the Dandenong Integrated Water Management Forum (Dandenong IWM Forum) that includes twelve municipal Councils, agencies, and representatives.

A large portion of stormwater runoff from the upper reaches of the Dandenong Catchment flows south into Mordialloc Creek and Patterson River, before eventually draining into Port Phillip Bay.

As the City of Kingston is located at the downstream end, the planning and coordination of activities throughout the Dandenong catchment will significantly influence flow volumes, water quality and liveability for the Kingston community.

A map of the Dandenong catchment, shown in Figure 10, highlights the main waterways, wetlands and the eight sub-catchments, with those of key importance that flow into Mordialloc Creek and Patterson River being:

- Lower Dandenong Creek catchment that extends from Carrum to Huntingdale
- Middle Dandenong Creek catchment that extends as far north as Kilsyth
- Eumemmerring Creek that extends into the outer eastern suburbs, including Narre Warren.

The Dandenong IWM Forum's Strategic Directions Statement (SDS) includes several priority projects and higher-level institutional policy changes required to enable reform in the sector.

An action from the SDS was the development of a Dandenong Catchment Integrated Water Management Plan. This Plan provides scientific evidence to guide decision-making and prioritise investment in sustainable water strategies.

The intent of the Dandenong Catchment IWM Plan is to guide coordinated planning and to assist each local Council to embed the strategies and actions within their municipal plans and activities.

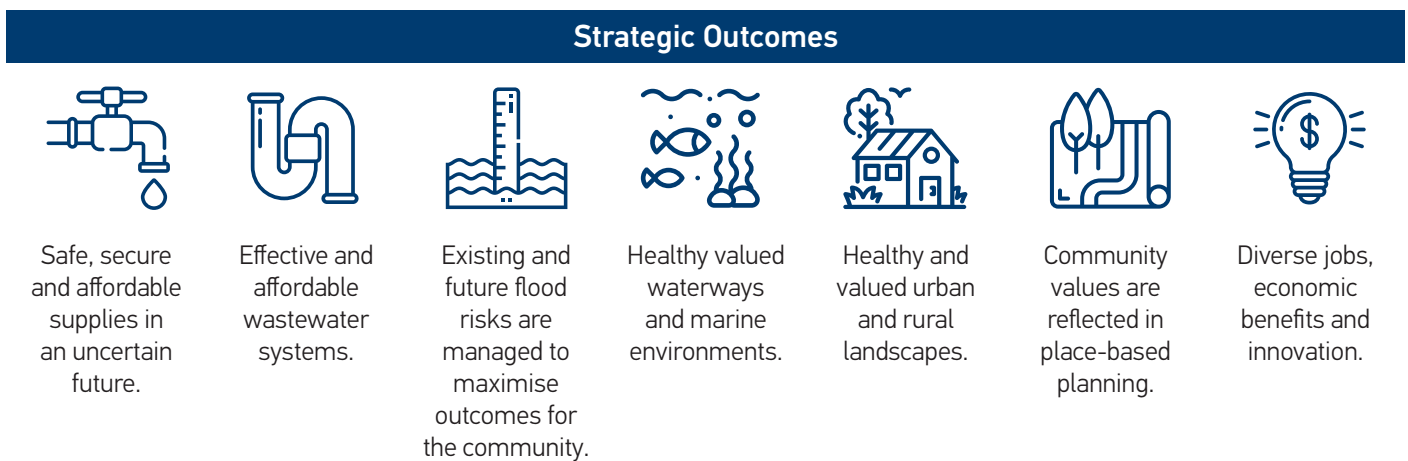


Dandenong Catchment – Key Facts

- Urban areas cover 60% of the catchment
- Large industrial precincts in Kingston and Dandenong provide 44 per cent of Victoria’s total manufactured product.
- Edithvale-Seaford Wetlands is internationally protected.
- Population is modelled to increase from 1.4 million (2019) to over 1.7 million by 2040, requiring an additional 7000 dwellings per year.

The Dandenong IWM Forum is driven by a vision for the Dandenong catchment together with the following 7 strategic outcomes:

Figure 4. IWM Strategic Outcomes



Dandenong Integrated Water Management Targets

The Dandenong Catchment Integrated Water Management Plan (Dandenong CSIWM Plan) includes 28 quantifiable IWM measures and regional targets to monitor progress towards the strategic outcomes. These are discussed in Appendix 3.

The Dandenong IWM Forum’s Strategic Directions Statement outlines 35 priority projects within the Dandenong catchment, with the City of Kingston listed as a collaborative partner in 9 integrated water projects.

Of these, Kingston is a key partner in projects to install stormwater harvesting in Moorabbin and working with South East Water to provide recycled water pipelines to irrigate open spaces, including sports fields, parks and golf courses.

The regional measures, targets and priority actions that are most applicable to the City of Kingston are included in Appendix 3.

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Kingston's Strategic Objectives

The Strategy supports the Dandenong CSIWM Plan and focuses on the aspirations that Kingston Council is best positioned to play an important local leadership role or have a positive influence. Those aspirations are listed below:

- Safe, secure and affordable water supplies in an uncertain future
- Healthy and valued waterways and marine environments
- Healthy and valued urban and rural landscapes
- Community values and town planning incorporate IWM
- Existing and future flood risks are managed to maximise outcomes for the community
- Organisational commitment, collaboration, and capacity to implement IWM.

The goals and actions that have been identified to support progress towards achieving these objectives are documented in Kingston's Integrated Water Implementation Plan that will be reviewed and updated as new information becomes available.

The Implementation Plan also summarises IWM targets for years 2030 and 2050 that represent the City of Kingston's planned contribution towards the regional targets.

Extensive modelling work informed the Strategy undertaken by E2Design Lab, which is widely recognised in the integrated water industry as a leading specialist consultancy firm. Their findings are summarised in a supporting document titled 'City of Kingston IWCS Background Research and Technical Report' (E2Designlab, June 2022).

A range of water cycle values were modelled to establish current values (2021), including water consumption, stormwater pollution removal, and stormwater flows generated within the City of Kingston.

Modelling of likely activities and works programs helped to forecast future values and set targets. Kingston's 2030 targets are outlined with the implementation plan and are based on practical assessments of the likely changes to:

- The number of new dwellings built each year, including more rainwater tanks
- Council's proposed works program, including flood management projects and stormwater harvesting projects
- State government projects, including the planning for a new wetland in Mordialloc
- South East Water's plans to install recycled water pipelines.

The implementation plan also set aspirational targets for 2050 that are based on likely projections, plus an allowance for further improvements. Future goals will depend on the rate of support for new initiatives, requiring everyone to play their part in becoming increasingly more water wise and environmentally aware.

The following sections summarise the information supporting each of Council's objectives and goals, with further details on the modelling work described in E2Design Lab's Technical Report.

6.1 Water Usage

Council’s strategic objective is to use water throughout the City of Kingston wisely, including less drinking water (potable water) and more use of alternative water, such as rainwater tanks, harvested stormwater and recycled water from Melbourne Water’s treatment plant.

The supporting key goals, actions and targets are documents within Kingston’s Integrated Water Strategy.

6.1.1 Potable water demands are increasing

As Kingston population grows, so does demand for water, with an estimated increase of 20% between 2020 and 2050.

The regional Dandenong IWM Plan indicates that under a medium population growth scenario, potable water demand will exceed supply by 2043.

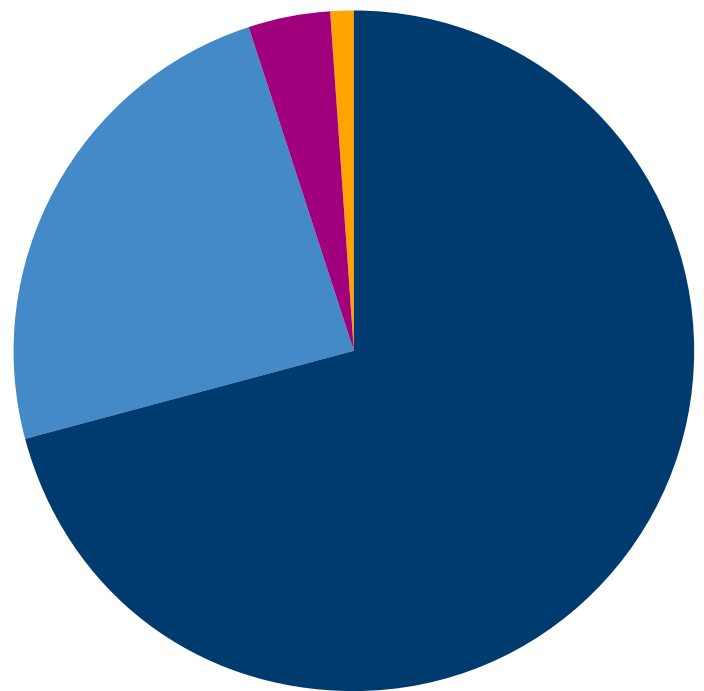
This timeline is reduced to 2028 under a high growth scenario. To meet this demand there will be an increasing need to substitute potable water with alternatives, such as rainwater tanks, harvested stormwater and recycled waste water for non-drinking purposes. These types of alternative water sources are discussed further under Section 6.1.2.

Community potable water use

Around 13,470 million litres of potable water per year are used throughout Kingston (in 2021), divided across the following categories:

Total Water Use

- 71% Residential properties
- 24% Industrial & other
- 4% Non-rateable properties
- 1% Council



Residential properties within Kingston use around 71% of the total, with an average use of 165 litres per person per day. This is a bit higher than the Melbourne wide aim of 155 litres per person. Industrial and other non-domestic properties use around 25%, whilst non-rateable properties, such as charities and religious bodies, use less than 4%.

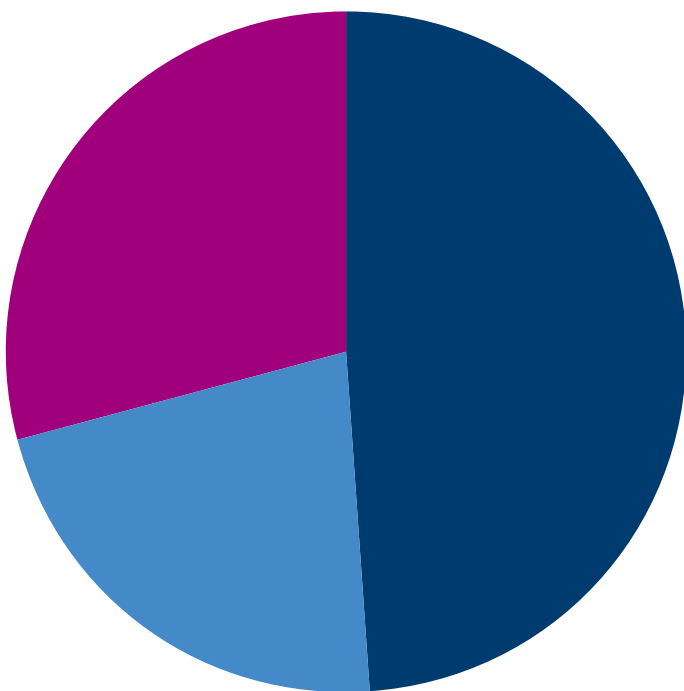
6. Kingston's Strategic Objectives

Council potable water use

The Kingston Council's consumption of potable water is around 175 million litres per year (in 2020) which is around 1.3% of the total volume of water consumed throughout Kingston. Council's water use is divided across the following services:

Council Water Use

- 49% Irrigating sports fields & open spaces
- 13% Waves public pool
- 38% Council buildings & other



Parks and Open Spaces represent Council's largest consumers of potable water using 85 million litres per year in 2020 (49%). The largest individual consumer of potable water was Waves Leisure Centre (public swimming pool), using 22 million litres per year in 2020 (13%).

Encouragingly, Council has reduced potable water use by around 8%, between 2011 and 2020. This reduction was due to Council gradually implementing water efficiency measures, such as:

- The conversion of sports ground to warm season grass that requires less water
- Installing high-tech irrigation systems that are better aligned to watering needs
- Constructing stormwater harvesting projects to irrigate sports fields
- Installing rainwater tanks as part of new Council building projects
- Incorporating water-efficient fixtures and appliances in Council buildings.

The programmed roll out of similar water saving projects are planned to continue and are factored into our 2030 and 2050 targets. Best-practice water efficiencies will also be designed into our new aquatic centre to be constructed along Governor Road in Mordialloc.

6.1.2 Alternative Water Sources

Melbourne's water corporations (comprised of Greater Western Water, Melbourne Water, South East Water and Yarra Valley Water) are planning to manage the use of water and increase alternative supplies.

Their draft 'Water for Life' Strategy (2021), also referred to as the Greater Melbourne Urban

Water and System Strategy (GMUWSS), is a comprehensive assessment of the options required to address of our future water needs.

This includes increasing:

- The supply of manufactured water, such as desalinated water, recycled water and stormwater solutions
- The use of alternative water, such as stormwater, rainwater, and fit-for-purpose recycled water
- Water conservation and efficiency programs.

This approach is supported by Kingston Council and will require an increased focus on using more:

- Rainwater as new residential properties install more tanks
- Harvested stormwater as Council projects are constructed
- Recycled water as State Government pipelines are constructed.

Kingston Council aims to provide its community with cool green parks and streetscapes, along with high-quality playing fields. Using alternative water to do this is the most sustainable option.

Opportunities and future projections for increasing the use of alternative sources of non-potable water are discussed below. Further details on the modelling work are described in the Technical Report.

Rainwater Tanks

Rainwater tanks collect fresh rainwater from roofs and provide substantial benefits, including water savings, reduce flows in street drains, and reducing stormwater pollutant loads from draining into waterways.

Currently, Kingston residents use around 58 million litres per year of rain water (in 2021), which represents around 0.5% of all residential water usage. The City of Kingston requires all new dwellings that require a planning permit to install a 2,000 litre rainwater tank. These are mostly being used for watering gardens, with a smaller percentage connected for toilet flushing.

For the longer-term benefits and targets to be realised, it will require a change in community acceptance, including increased awareness around:

- Using rainwater tanks to supplement mains water indoors for non-drinking purposes. This includes connections to toilets and washing machines.
- How to operate and maintain rain water tanks effectively over several decades.

Rainwater tanks offer an important alternative water supply and provide many other benefits, including those discussed under Section 6.2 to reduce the volume of polluted stormwater flowing into waterways.

Stormwater Harvesting

Stormwater harvesting involves collecting, treating, storing and using stormwater runoff from urban areas as an important alternative water source. It differs from rainwater harvesting as the runoff is collected from drains rather than roofs.

The area of runoff is generally large, such as a part of a suburb including roads and properties, providing opportunities to collect large volumes of water. This usually presents a challenge as the untreated water is generally more polluted and requires space to treat, such as a vegetated filter system known as bio-retention, a wetland, or a mechanical filtration system.

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Kingston's Strategic Objectives

Currently, Kingston uses around 99 million litres per year of all types of water (in 2021) to irrigate Council open spaces. This is divided across the following categories:

- Sport ovals are the largest user at around 93%, with the watering of trees and horticultural areas making up the remaining 6%.
- Potable water usage represents 72%, with a goal to substitute with alternative water.
- Harvested stormwater represents 13%, with a goal to significantly increase.
- Bore water represents 8%, with a goal to substitute with alternative water.

The use of harvested stormwater has grown from 6% to 13% of total Council water use over the 5 years since 2016, primarily due to the construction of the Edithvale Recreation Reserve harvesting project that was constructed in stages between 2015 and 2018.

The Kingston Stormwater Treatment and Reuse Prioritisation Program (Design Flow Consulting, 2013) provides a ranked list of projects together with preliminary conceptual layouts to treat and reuse stormwater.

Modelling of the future projected use of harvested stormwater to irrigate around 20 Council reserves across Kingston shows the highest priority reserves, based on a range of cost, feasibility, and sustainability benefits. The majority of these projects incorporate measures to treat the stormwater to best practice prior to reuse, with the priority locations discussed under Section 6.2.4 – Council treatment Measures.

Recycled Water Pipelines

Greywater from residential kitchens, laundries and showers (in addition to toilets) flows from the property through wastewater pipes. It is then treated to the highest-Class A standard (for non-drinking water) at water recycling plants to make sure it meets the Australian Recycled Water Guidelines. The supply pipes are commonly called 'purple pipelines' as they are required to be installed using purple-coloured pipes, so that they are easily recognised as supplying Class A water.



Melbourne Water operates two wastewater treatment plants so that the retail water companies (Greater Western Water and South East Water) can distribute the treated water through their dedicated recycled water pipelines to homes and businesses. In 2019–20 around 8% of the waste water generated was treated and piped to customers as recycled water, with the largest volumes supplied to parts of Werribee and Cranbourne.

The only location within Kingston (as of 2021) that is supplied with recycled water is the Patterson River Golf Club due to its proximity to Melbourne Water's Eastern Treatment Plant, located beside Thompson Road in Bangholme.

South East Water is planning to deliver Class A recycled water to customers across the South East Green Wedge.

The key projects that will deliver recycled water within the City of Kingston include:

- **The Patterson River Recycled Water Scheme**
The project will require government funding and will potentially involve the installation of 13 km of pipeline along the alignment of the Long Beach Trail, extending from the Eastern Treatment Plant to Aspendale. This scheme has the potential to deliver 221 million litres per year of Class A recycled water to approximately 133 hectares of parkland, golf courses and playing fields.

The first stage would be a 6 km pipeline delivering up to 120 million litres per year of Class A recycled water to irrigate approximately 78 hectares, including Bonbeach Sports Reserve and the Bicentennial Park cluster of reserves and open space.

- **The Dingley Recycled Water Scheme**
This project could eventually involve the installation of 42 km of recycled water pipes from the Eastern Treatment Plant to customers in Dingley Village, Oakleigh South, Sandringham and Cheltenham to use this water in agriculture, nurseries, and for irrigating parks and golf courses.

The first stage would be a 12 km transfer main from Perry Road in Dandenong South, extending along the east side of the Mordialloc Freeway reserve, and finishing near Capital Golf Course, off Old Dandenong Road in Heatherton.

Financial co-contributions from the Victorian State Government and South East Water were announced in 2022 to implement the staged installation of the Dingley recycled water scheme.

Groundwater

The surface aquifer occurs at a depth of 1m to 5 m for much of the municipality, increasing to 5m to 10m in the north. Generally, there are some good aquifer resources in the northern part of Kingston as a potential source of water, with some or limited potential in other areas.

Salinity levels are generally acceptable for irrigation use, although it can potentially result in long-term salinity build up.

Groundwater is managed and licenced to users by Southern Rural Water in the Greater Metropolitan Melbourne Region. There are approximately 300 groundwater bores in the City of Kingston registered with Southern Rural Water (SRW). These bores are registered for a variety of different uses (domestic, stock, irrigation, etc) but no data exists on the demands from any of these bores. Groundwater reserves across Melbourne are intrinsically linked to the health of local ecosystems and are experiencing challenges due to a changing climate and over-extraction. Council's plan is to gradually phase out all use of ground water for municipal purposes by 2030. Council only has one groundwater bore in use at Kingston Heath Recreation Reserve that used around 8 million litres per year for irrigating the sports fields in 2021.

6. Kingston's Strategic Objectives

6.2 Protecting Our Waterways & Bay

Council's strategic objective is to improve the quality of stormwater runoff from local areas flowing into water courses and Port Phillip Bay, with a focus on reducing litter and all forms of pollution.

Stormwater pollutants that flow into waterways, wetlands and the Bay are a major threat to aquatic biodiversity, public health, recreation and tourism. Pollutants range from larger litter and silt through to oil, heavy metals and nutrients. Melbourne Water Healthy Waterways Strategy (2018) has assessed the water quality of wetlands, rivers and estuaries within Kingston. Water quality is currently rated as 'low' and it is likely to become worse unless substantial action is taken.

Further information on Port Phillip Bay, Kingston's 13 km of foreshore and contributing waterways are detailed in the draft Kingston Coastal & Marine Management Plan, 2020 (CMMP).

Kingston Council is committed to taking action to mitigate the impact of stormwater pollutants on local water quality and has undertaken modelling to understand the current status (2020) and future projections to 2030 and 2050. This information, with details shown within the technical report, will inform Kingston's ongoing contribution towards the Dandenong IWM measures and targets.

Examples of the type of treatment systems that Council have successfully installed include:

- Rain gardens constructed with streetscapes and parks
- Bio-retention (filter) systems constructed within reserves and within the foreshore sand dunes
- Porous pavements and vegetated swales
- Various types of litter and gross pollutant traps.

Details on modelled pollutants load outcomes, using total nitrogen (TN) reductions as an indicator, are described under the following sections.

6.2.1 Best-Practice Pollution Reduction Levels

The State Environment Protection Policies (SEPPs) require stormwater quality treatment to be undertaken. The SEPPs are binding for all government agencies, private individuals and businesses conducting activities on private and public land.

Under the Victorian Planning Provisions (VPP) many developments must design urban stormwater systems to meet the objectives of the Urban Stormwater Best-Practice Environmental Guidelines (BPEM, 1999). This means that new residential, commercial and industrial developments must be designed and constructed to reduce the levels of certain pollutants, compared to the typical urban annual load, by the following amounts:

Type of Pollutant	% Reduction
Suspended Solids	80%
Litter	70%
Total Phosphorus (TP)	45%
Total Nitrogen (TN)	45%

Kingston Council’s long-standing aim has been to treat 100% of stormwater runoff, from the combination of all land uses within the City of Kingston (both pre-existing and new), to a level that meets or exceeds the above BPEM requirements.

Modelling estimates that approximately 57,100 kg per year (2021) of total nitrogen is generated via stormwater runoff from all land uses across the City of Kingston.

There is an opportunity to cost-effectively reduce pollutant loads via ongoing auditing, improvement and maintenance of Water Sensitive Urban Design (WSUD) assets, such as rainwater tanks, gross pollutant traps and devices, porous paving, rain gardens, swales, bioretention systems and wetlands.

Summary of Nitrogen Removal

While it is important to aim towards achieving all of the BPEM pollution reduction requirements, the percentage of total nitrogen (TN) removed is commonly used as an effective indicator, as treating for this pollutant will also generally remove the other types of pollutants.

Nitrogen removal is also a key Melbourne Water objective for the health of Port Phillip Bay, as high levels of nitrogen can lead to problems with algal blooms. In urbanised areas, nitrogen pollution is often caused by a combination of organic substances such as grass clippings, garden waste, tree leaves, fertilizer used on lawns, animal droppings and soil erosion.

To achieve the BPEM best practice reduction, a total of 25,700 kg per year (2021) would need to be removed by a combination of treatment measures, either located:

- Within private properties
 - e.g. rainwater tank to harvest roof runoff
- Along local streets – e.g. rain gardens or swales within nature strips
- At the end of the drainage system, to treat an entire suburb or regional areas. e.g large wetlands or stormwater harvesting projects.

Based on the predicted rate of installing treatment measures across both private and public land, detailed modeling was undertaken to estimate the volume of TN removed. The improvements are shown in the following table, with the proposed Mordialloc wetland contributing a significant increase, based on an assumed completion date of 2032:

Year	Volume of TN removed	% Towards BPEM Requirement
2021	Existing measures remove 17,000 kg per year	67%
2030	Existing & projected measures remove 17,800 kg per year	68%
2050	Existing & projected measures remove 23,000 kg per year	85%

Approaching this level of best practice would be an outstanding result, given that improvement projects need to overcome the legacy of pre-2000 developments not being required to treat runoff, and the impacts of increasing urbanisation.

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Kingston's Strategic Objectives

The majority of the existing (2021) reductions are achieved via the very large older Melbourne Water wetlands located in the Edithvale and Braeside.

Due to a lack of suitable open space remaining within the City of Kingston, it is difficult to construct large scale regional improvements in the same way. Progress is more reliant on implementing a greater number of small to medium scale treatment measures, discussed in Section 6.2.4.

The details of the projected treatment measures, and the actions required to achieve them, are discussed under the following headings.

6.2.2 Reducing Stormwater Flows

Recent Melbourne-wide forecasts (footnote: Municipal Association of Victoria, submission on the draft EPA Urban Stormwater Management Guidance Submission, December 2020) are that the total area of impervious surfaces will almost double over the next 30 years, and that urban growth is likely to generate 80 GL of stormwater every year.

Increased stormwater runoff will result in a corresponding increase in stormwater pollution. The following CSIWM modelling data provide a good indication of the total volumes of runoff generated across the City of Kingston:

- Annual flows are estimated to be 7,148 million litres per year in 2021.
- Annual flows are forecast to increase to 7,329 million litres per year in 2030, and 7,732 million litres per year in 2050.

The Dandenong CSIWM has a focus on setting flow reduction targets that will also help to reduce pollutant volumes, reduce the stress on drainage system capacities and improve waterway health.

Kingston Council has identified existing and proposed IWM treatment measures, both private and public, as documented in the technical report and summarised under the following. These measures have been modelled to demonstrate the following flow reduction outcomes:

- Annual flows are estimated to have been reduced by around 1,700 million litres per year in 2021 through WSUD interventions, representing 24% of total flows generated in Kingston.
- Annual flows are predicted to be offset by a further ~100 million litres per year by 2030 through new WSUD interventions, representing a combined flow reduction of ~1,800 million litres per year i.e. ~25% of the predicted volume of stormwater generated by 2030 across Kingston.
- Annual flows are predicted to be reduced by a further 620 million litres per year by 2050 due to new WSUD interventions, making a combined flow reduction of ~2,400 million litres per year i.e. ~31% of the predicted volume of stormwater generated by 2030 across Kingston.

The IWM assets that make the largest contribution towards the above flow reductions are:

- Existing large wetlands managed by State Government bodies (predominantly Melbourne Water), accounting for 18% of the 2021 reduction.
- Council's existing medium-scale bioretention basins that account for 3% of the 2021 reduction.
- Private rainwater tanks that account for 1% of the 2021 reduction but are predicted to increase to 7% by 2050, with further reasoning discussed under the next heading.

6.2.3 Private Treatment Measures

To improve water quality outcomes from private property, Kingston will work with other stakeholders and developers, builders and property owners to implement long-term sustainable management of privately owned WSUD assets: rainwater tanks and onsite treatment measures.

Predicted population growth will drive the need to build more dwellings, with future development growth projections discussed under Section 3.2.

It will be vitally important for Kingston Council and other stakeholders to work closely with developers, design consultants, builders, property owners and our local community to maximise the best outcomes across planning, design, construction and the long-term sustainable management of privately owned WSUD assets.

Key contributions from private assets, which play an important role to reduce pollutant loads, and planning considerations are outlined below.

Rainwater Tanks

Rainwater tanks provide an alternative source of water, as discussed under Section 6.1.2, but also play an important role in helping new developments to achieve:

- Best-practice pollution reduction requirements, in combination with other treatment measures; and
- Detention storage requirements to restrict flow rates being discharged from properties, thereby assisting with mitigating the impacts of localised flooding.

The modelling of rainwater tanks throughout the City of Kingston has been based on the way that rainwater tanks are currently being used and how this could change in the future to inform 2030 and 2050 predictions.

Based on the number of rainwater tanks across the City of Kingston, current and future potential performance in removing total nitrogen (TN) can be summarised as follows:

Year	Volume of TN removed by Rainwater Tanks	% Towards BPEM Requirement
2021	Existing tanks remove around 385 kg per year.	1.5%
2030	Existing & projected measures would remove around 720 kg per year.	2.8%
2050	Existing & projected measures would remove around 1,500 kg per year, based on current water re-use practices.	5%
2050	Existing & projected measures could remove around 2,100 kg per year, based on a potential increase in water re-use practices.	8%

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By partnering with South East Water and Melbourne Water, Kingston Council can help to increase our local community's understanding and acceptance of using rainwater for more than garden watering, including increased uptake and maintenance of tanks connected to toilets, laundries, and bathrooms for non-drinking purposes.

Changing the way that rainwater tanks are used, in combination with monitoring of development compliance and maintenance practices, could result in increasing the volume of total nitrogen removed from Kingston's drainage system from 5% to 8% by 2050.

Treatment Measures

Around 2004, Kingston was one of the first Councils in Victoria to require new development to achieve stormwater quality requirements as a planning permit condition.

Improving stormwater quality, by meeting or exceeding BPEM pollution reduction requirements, can be achieved via various environmentally sustainable design (ESD) measures. Common water sensitive urban design (WSUD) treatments include:

- Reducing roof and impervious surface areas
- Increasing infiltration via porous surfaces and passive watering of landscaped areas.
- Installing rain gardens and swales to treat stormwater runoff.

The design requirements for vegetated treatments have been refined to suit local conditions. Kingston Council routinely provides advice and guidance to developers and design consultants; however, more needs to be done to audit the condition of privately owned WSUD assets to gain a better understanding of compliance and maintenance practices to ensure their long-term sustainability and effectiveness.

Kingston Council's strategic approach to provide further support towards this objective, plus all inter-related IWM educational objectives, is outlined under Section 6.4.

Figure 5. A residential subdivision in Heatherton where the front yards have vegetated swales that treat stormwater runoff.





6.2.4 Council Treatment Measures

Local Litter Management

A common method of managing litter that has already entered the drainage system is by installing a gross pollutant trap (GPT) to trap coarse pollutants larger than 5 mm. Since gross pollutant traps tend not to be effective in removing nutrient or fine pollutants, they are most often used in combination with other stormwater treatment measures, such as wetlands or bio-retention systems.

Kingston Council has around 20 large GPTs (2022) to capture litter from locations that generate more litter, such as local shopping strips, and to protect the foreshore and waterways. As part of implementing measures to reduce litter flowing into waterway, Kingston Council will investigate and implement a prioritised GPT installation program between 2022 and 2030, recognising the protection of Patterson River and Mordialloc Creek as important objectives.

This program will be coordinated to be consistent with the broader regional actions under the Lower Dandenong Catchment plan discussed under Section 6.2.5.

Foreshore Swales

Kingston Council has been an industry leader in installing innovative vegetable swales along the foreshore (including Aspendale, Edithvale and Bonbeach) to treat stormwater pipes that previously directed road runoff directly on the beach sand.

These types of treatments, installed between 2006 and 2022, are an effective way to:

- Capture gross pollutants such as litter, and filter soluble pollutant into the sand dunes
- Significantly reduce beach scouring caused by concentrated flows from stormwater pipes
- Remove unattractive stormwater pipe outlets.

Council has a prioritised works program to investigate opportunities to upgrade foreshore drainage outlets, and gradually implement improvement measures between 2022 and 2030.

Streetscape Rain Gardens

Kingston Council has installed around 250 rain gardens, between 2001 and 2017, within the nature strips of residential streets to treat stormwater runoff from roads and properties. A very good example is the 19 rain gardens installed along Collins Street Mentone, pictured in the Strategy.

Council's existing rain gardens remove around 400 kg per year (2021) of total nitrogen, contributing 1.6% towards BPEM best practice requirements.

Council's future priority is focused on the construction of medium-scale systems, due to comparatively more attractive cost-benefit outcome for treating stormwater, with additional reuse benefits.

Medium-scale Filtration Systems

Bio-retention systems are larger and more sophisticated versions of rain gardens that are designed to treat stormwater runoff from larger catchment areas. Stormwater flows are treated by filtering through a vegetated soil media layer. The treated stormwater is then collected in perforated pipes and, where practical, stored in large above

Figure 6. Rain gardens installed along a Mentone street to treat stormwater runoff from the road and houses.

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or below ground tanks for irrigating sports fields, or other uses such as filling trucks to water street trees.

The City of Kingston's largest project is located in Edithvale Recreation Reserve and treats stormwater runoff from a 60 Hectare residential catchment. The stormwater harvesting benefits are discussed in Section 6.1.2, with an example photograph shown on the back page.

Based on the modelling of Council's bio-retention systems across the City of Kingston, their current and future performance in removing total nitrogen (TN) can be summarised as follows:

Year	Volume of TN removed by Bio-retention Systems	% Towards BPEM Requirement
2021	Existing systems remove around 1,800 kg per year.	7%
2030	Existing & planned projects would remove around 2,200 kg per year.	8%
2050	Existing & planned projects would remove around 3,700 kg per year.	14%

Plans to construct 7 additional bio-retention systems, between 2022 and 2050, are factored into the above table and would represent Council's highest contributing asset towards reducing stormwater pollution. The priority locations are Moorabbin Reserve, Bricker Reserve (Moorabbin), LePage Park (Cheltenham), Roy Dore Reserve (Carrum), Highett Reserve, Bonbeach Reserve and Chelsea Recreation Reserve.

Council's future program was guided by the Kingston Stormwater Treatment and Reuse Prioritisation Program (Design Flow Consulting, 2013), plus recent modelling (E2DesignLab, 2022) that reviewed the existing treatment models to inform an updated prioritised list of projects.

The locations were prioritised based on a range of IWM assessment criteria. These project options are subject to further feasibility assessments, and will be influenced by the timing of recycled water pipelines and community consultation outcomes.

6.2.5 Future Regional Treatment Measures

Regional Litter Management

Melbourne Water is coordinating a project to identify actions to prevent litter from upstream catchments flowing into waterways, including Patterson River and Mordialloc Creek. This project is known as the Lower Dandenong Creek Catchment Litter Collaboration and has representation from the Cities of Kingston, Greater Dandenong, Casey, plus Melbourne Water, Parks Victoria and the EPA.

The working group recognises that litter within the Lower Dandenong Creek catchment is having an ongoing and widespread negative effect on

both community and environmental values. For many years, Councils and other agencies with litter management responsibilities have independently taken action to address the litter issue, but individual organisations tackling litter within the boundaries of the land and creek-line they manage does not match with the systemic and interconnected nature of the problem.

Considering litter management at a catchment scale as a shared responsibility across land and waterway managers, and coordinating information and interventions between those managers, can better leverage existing resources, target new interventions more effectively, coordinate community involvement more successfully, and improve overall outcomes.

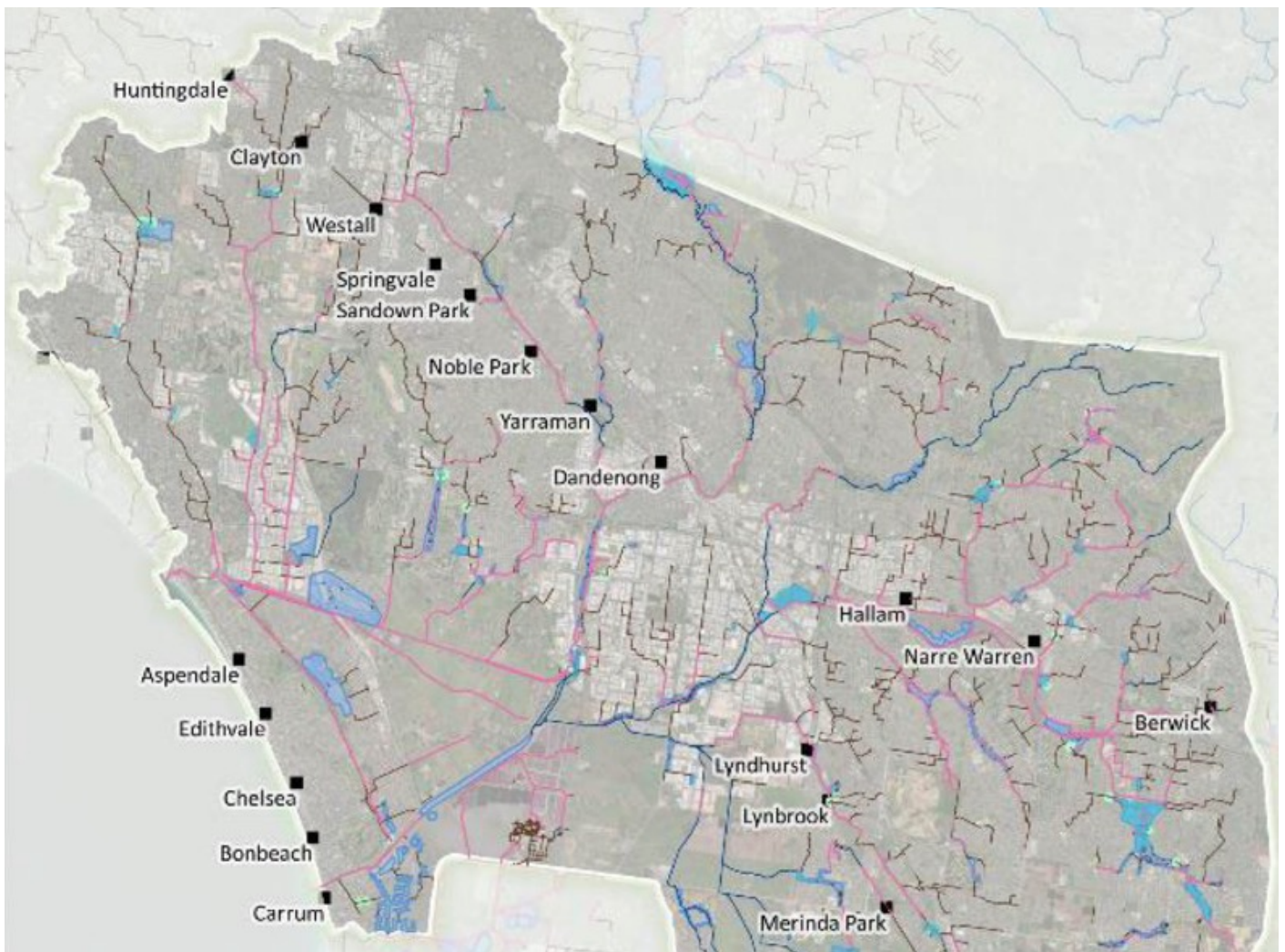


Figure 7. Map of Lower Dandenong Creek Catchment that flows into Patterson River & Mordialloc Creek

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Regional Wetland

Melbourne Water has commenced planning on the design of the Mordialloc Creek wetland. The project will involve a \$10 million State Government investment to construct approximately 1,300 metres of wetland ecosystem extending along the creek.

The Mordialloc Wetland, should it go ahead, is anticipated to be a significant regional project contributing to stormwater quality improvement. Council's implementation plan has assumed that this important asset will be constructed by 2032, for the purpose of modelling the pollution removal targets for 2030 and 2050.

The project, to be located near Boundary Rd, will involve the construction of a naturalised wetland system of approximately 4.5 ha. It will extend approximately 1,300 metres along the creek upstream of the Mordialloc Settlement Drain and will improve the current narrow, straight-cut channel to a naturalised wetland system.

The wetland system is expected to remove approximately 1.9 tonnes of nitrogen annually entering Mordialloc Creek, which ultimately outfalls

into Port Phillip Bay. The source of this load comes from Dunlop's Drain, from the upstream existing industrial/mixed use catchment, and from water entering the site from the east.

The wetlands present an opportunity to achieve multiple community benefits. These include facilitating development, improvement existing waterway condition and health, and providing additional stormwater treatment capacity.

The project is expected to improve Mordialloc Creek's narrow, straight-cut channel to achieve a more naturalised waterway, enhancing the stream condition and biodiversity of the creek to deliver key objectives of Melbourne Water's Healthy Waterways Strategy (Melbourne Water, 2018).

Simultaneously, the wetland system is expected to provide local flood calming and pollutant removal benefits. At present, significant pollutant loads enter the Mordialloc Creek via Dunlop's Drain, which services a large industrial/mixed use catchment on the northern side of the creek.

Figure 8. Location of the proposed Mordialloc Creek wetland



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Kingston's Strategic Objectives

6.3 Flood Management

Council's strategic objective is to improve resilience to flood events.

Flooding may arise for many different reasons, including blocked drains, intense rainfall and runoff that exceeds the capacity of the local or regional drainage system.

Small-to-medium storm events can cause flooding along roads and within properties, whilst extreme rainfall can cause more widespread flooding. Removing frequent nuisance flooding is challenging, due to the age of the pipes and flat terrain, but fortunately the number of dwellings that have experienced significant flooding above floor level is relatively low.

Adding to these challenges are long-term future pressures on the drainage system associated with urban consolidation, increase in rainfall intensity and forecasts for rising sea levels.

Council's approach to managing the locations that have a higher risk of frequent flooding are summarised under the following headings.

Flood Emergency Management

Melbourne Water, Council and the Victoria State Emergency Service are working together to reduce the severity and impacts they cause to people, places and communities. This will be managed through a range of strategies and works programs that are discussed below.

Further information about the history of flooding throughout the City of Kingston and emergency management arrangements are included in Appendix 4.

Flood Management Plan

Kingston's overall drainage strategy and approach to flood management is discussed with Melbourne Water, including annual coordination meetings.

Council has previously undertaken significant flood planning work across a range of technical studies and reports. However, these documents do not explain our current and future approach to managing flood risks to our community in a clear way.

In recognition of this gap, our 'Implementation Plan' includes an action item to prepare an updated Flood Management Plan (see reference no. K3d within attachment 1 of the Strategy). This Plan will review a broad range of topics related to managing flood risks, including:

- Clarifying the responsibilities that are shared between Kingston and Melbourne Water
- Climate change risks around the impacts of rainfall intensities, sea level rise and storm surges
- Planning for changes to Special Building Overlays' and 'Land Subject to Inundation Overlays'
- Processes for prioritising improvement works.
- Asset management planning
- Opportunities to improve community engagement and strengthen partnerships.

Programs and projects that are jointly coordinated between Kingston and Melbourne Water include: emergency management, maintenance programs, improvement projects, flood mapping and investigation to prioritise future improvement projects, and updating flood overlays into the Planning Scheme.

Climate Change risks

Kingston has a unique set of flood-related risks, including 13 km of foreshore and low-lying areas. Our older suburbs have historically experienced a mix of flash flooding, with drainage systems that are influenced by tidal water levels in Port Phillip Bay and along major waterways, such as Mordialloc creek and Patterson River.

The Kingston Flood Management Plan identifies several localised flood risks and impacts arising from climate change. These include increased risk of flooding within the Mordialloc activity centre because of storm surge from Port Phillip Bay, and increased wave action within the Mordialloc creek from sea level rise. There are additional concerns around the impacts of climate change-induced sea-level rise on flooding around low-lying coastal areas and tidally influenced water bodies in Kingston. Higher sea-levels may make it harder to achieve adequate drainage outfall for stormwater to effectively discharge from the drainage system.).

Flood Overlays

There is a need to update flood overlays to incorporate the impacts of sea-level rise and increased rainfall storm intensities predicted with climate change, in addition to changes modelled within the new version of Australian Rainfall and Runoff (ARR, 2019).

Preliminary modelling indicates that around 20% of properties within the City of Kingston could be affected by inundation during extreme rainfall events, under future climate scenarios.

This will be confirmed by further modelling led by Melbourne Water during 2023 to 2025.

Two types of overlays exist in the Kingston planning scheme to the location and extent of land that may be subject to flooding. They are the Special Building Overlay (SBO) and the Land Subject to Inundation Overlay (LSIO). Their main purpose is to minimise the effects of overland flows and flooding on new buildings and surrounding properties.

Overlays are based on the extent of flooding resulting from a rainfall event that has a one per cent chance of occurring in any given year. Having this information means drainage issues can be addressed at the start of the development process and proposals are properly designed to protect future property owners as well as the broader community.

Drainage Performance

Kingston Council manages around 800 km of local stormwater drains assets, such as pipes, pits, swales and pumps. Ideally, all flooding caused by either minor or extreme storm events would be eliminated. This is impossible for extreme events in older suburbs and Council's aim is to manage the drainage system to limit regular flooding.

Improving the performance of the drainage system will reduce the level of inconvenience and stress that is experienced by a significant number of our residents, business operators and visitors.

6.

Kingston's Strategic Objectives

Figure 9. Stormwater Pumping Station constructed in Edithvale (2017) that reduces flooding and uses harvested water to irrigate sports fields.



Drainage Improvement Program

Following a major joint study with Melbourne Water in 2011, a unique design solution was developed to drain the low-lying areas between Bonbeach and Aspendale that were developed in the 1960s. Large parts of these suburbs have older stormwater pipes, that are below sea level, requiring the construction of large pipes that act as temporary detention storage systems that are slowly emptied by large pumping stations.

Kingston Council has constructed three of these systems (in Carrum and Edithvale over the previous 5 years) gradually making significant improvements to areas that, for many decades,

were previously considered too difficult to address due to a range of complex constraints. More large-scale drainage improvement projects are planned for construction from 2022 to 2030.

Kingston's approach to prioritising drainage improvement projects is directly linked to the available budget and the limitations of Melbourne Water's main drainage system at various locations.

Kingston's drainage renewal investment strategy is part of Council's Long-Term Financial Plan (LTFP). Further funding will be required in future years to replace aging drainage infrastructure that is approaching the end of the functional asset life.



High Priority

Flooding of a house/habitable building/ garage/shed above floor level, flooding of a main road that could cause a serious accident

Drainage Maintenance

We are working towards a more proactive pipe monitoring and cleaning approach, based on available resources. To this end, we are investigating the cost of expanding the pipe cleaning and CCTV inspection program.

This will provide a better understanding of the condition of older pipes that can be used to inform future asset management and resourcing strategies. Council engineers regularly assess the priority of drainage issues according to their severity and frequency. Descriptions of low, medium and high priority flooding incidents are shown below.



Medium Priority

Significant flooding of private property, flooding of a main road (not dangerous)



Low Priority

Flooding of local roads

6.

Kingston's Strategic Objectives

6.4 Education, Engagement & Partnerships

The actions will support strategic objectives 1, 2 and 3 by working with our community and regional partners to manage our water resources. This includes raising awareness of all aspects of integrated water with all stakeholders, including the local community, local business, local developers, Council operations and coordination with external government agencies.

Our goal is to increase community and local business water literacy, so that we all have a common understanding of our current situation, our future water challenges, and how we can work together to achieve a shared vision for Kingston. This will involve continued discussions, education campaigns and surveys to gauge our collective progress and future programs.

6.4.1 Community Awareness

Kingston Council appreciates the work undertaken by many community groups and individuals who actively work to preserve and enhance the unique natural values of Kingston's waterways and coastal environments for future generations. We also recognise the need to engage more broadly with our local community and discuss ways that we can all help to progress towards becoming a water sensitive city.

We plan to have conversations about our vision, increase local knowledge and provide practical advice about how we can all work together to:

- Improve the quality of our waterways and the bay. This will include promoting ways to reduce street litter and raising awareness about water sensitive urban design (WSUD) principles, such as rain gardens to reduce stormwater pollution.

- Increase our understanding about why we need to use less potable drinking water and how to increase the use of private rainwater tanks. We will need to appreciate the benefits of using more manufactured water, particularly within public spaces, such as fit-for-purpose recycled water, harvested stormwater and desalinated water.
- Improve our knowledge about flooding and how we can all be better prepared. This includes improving public and private drainage systems, and improving the level of support both before, during and after heavy rainfall events.

Feedback was sought from a range of community group representatives of the most effective way to increase awareness and make positive change in community behaviour. Suggestions included the need to increase education for students; however they are unlikely to be aware that the City of Kingston has supported the Dolphin Research Institute to run an ambassador program for local primary and secondary schools since 2011. Their "i sea, i care" healthy waterways field day was delivered to more than 15 Kingston schools during 2022.

Other suggestions were to spread information via sports clubs and groups with large memberships using their newsletters. The implementation plan (see attachment 1 of the Strategy) includes an action to develop a communication plan that will consider the feedback suggestions, plus websites, signage and other mechanisms.

The communication plan will aim to prioritise our investment and available resources to maximise how Council can most effectively influence community behaviour, across the full spectrum of integrated water objectives.

Kingston Council will work with the state government to identify and promote public information to ensure that the information provided to our local community is readily available, helpful, consistent, and effective.

6.4.2 Local Development

All building projects that require a planning permit, must meet stormwater management requirements. This includes complying with:

- All Commonwealth and Victorian State Government legislation
- Melbourne Water flood overlay requirements at applicable locations
- Kingston Council's 'Civil Design Requirements for Developers - Part A: Integrated Stormwater Management' that are readily available on our website.

Feedback received on the draft Strategy highlighted the need for an increased focus on field inspections and enforcement of building sites to reduce litter, including small plastics and polystyrene.

To enable private developments to achieve better construction and maintenance outcomes, Kingston Council will continue to review and improve:

- Council's requirements during the planning approval and compliance process to ensure that they are clear and effective
- The installation of integrated water assets on private property and how well they comply with the planned requirements
- The effectiveness of longer-term maintenance of integrated water assets on private property.

This includes ongoing activities by larger companies and owners' corporations, as well as increasing awareness for individual owners who have moved into a new property.

Developer Contributions

Kingston Council offers flexible options for developers to meet their stormwater quality obligations.

The following approach was introduced in 2017 where developers can apply to either:

- Continue to install stormwater quality treatment measures on-site, or
- Pay a fixed in-leu contribution towards a Kingston Council fund that is used to construct larger and more cost-effective stormwater treatment and reuse projects, such as the Edithvale project described in section 6.2.4 with a photo shown on the last page.

These projects will be installed at prioritised locations throughout the municipality.

This approach provides a range of benefits including:

- Linking the contribution amount directly to the size of the development's impervious surfaces (e.g. roof, carpark and paths) as an effective indicator of stormwater pollution generated.

Figure 10. Dandenong Catchment Map
 Courtesy of Melbourne Water

SUB-CATCHMENTS	
1 Bayside	4 Dandenong Creek Lower
2 Blind Creek	5 Dandenong Creek Middle
3 Corhanwarrabul, Monbulk and Ferny Creeks	6 Dandenong Creek Upper
	7 Eumemmerring Creek
	8 Kananook Creek

ESTUARIES
1 Elwood Canal
2 Kananook Creek
3 Mordialloc Creek
4 Patterson River

RIVERS – Jells Park, Dandenong Creek



Over 900,000 visitors a year enjoy Jells Park's 127 hectares of wide open space and in excess of nine kilometres of paths and trails.

WETLANDS – Edithvale Wetlands




Edithvale-Seaford Wetland Education Centre is a valuable educational resource for school groups and a popular spot for birdwatchers to enjoy this Ramsar listed wetland.

WETLANDS	
1 Banyan Waterhole	7 Eastern Treatment Plant Wetlands
2 Barnbam Swamp, Lynbrook	8 Edithvale Wetlands
3 Braeside Park Wetlands	9 Hallam Valley Floodplain Wetlands
4 Dandenong Catchment stormwater treatment wetlands	10 Seaford Wetlands
5 Dwarf Galaxias Conservation Wetlands, Narre Warren	11 Tamarisk Waterway Reserve Wetlands
6 Dwarf Galaxias habitat ponds, Dandenong Creek	12 Tirhatuan Wetlands
	13 Wannarkladdin Wetlands
	14 Winton Wetlands



ESTUARY – Patterson Lakes, Patterson River



Patterson River precinct is highly valued by boaters, fishermen, canoeists and other paddlers, as well as local residents.

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Kingston's Strategic Objectives

This means that each property pays an appropriate offset, and it encourages developers to consider environmental alternatives, such as porous paving.

The stormwater quality in-leu developer contribution scheme provides a range of benefits, such as:

- Accelerating the construction of Council projects, that have a comparatively better cost-benefit ratio, with better environmental outcomes.
- Transferring the cost and responsible for maintaining stormwater treatment measures from future property owners to Council. This ensures that treatment systems are regularly inspected as part of a robust asset management program to ensure their long-term sustainability.
- Avoiding a situation where developers need to install treatment measures in tight spaces or implement solutions that may be less effective.
- Simplifying the process for developers, as it by-passes the design and approval requirements for on-site measures.

6.4.3 Reporting against the Dandenong Catchment Targets

An important feature of the Dandenong CSIWM Plan is the development of 20 indicators with 28 measures for evaluating progress across all aspects of IWM that will be used to track progress across the Dandenong catchment.

Where available, Dandenong catchment scale IWM targets for years 2030 and 2050 have been broken down to apply to the City of Kingston. These are shown in Appendix 4. These are a high-level indication of Council's potential role in contributing towards catchment scale actions into the future. These have been considered when formulating the targets shown in Kingston's Implementation Plan that are based on more detailed local modelling and a more robust assessment of achievable local projects.

Further work is being coordinated by the Department of Environment, Land, Water, Planning (DELWP) to inform all Councils in the region of the ongoing monitoring and reporting arrangements.

Appendix 1

Stakeholders

The responsibilities for implementing, maintaining, and monitoring integrated water assets are shared between the following organisations and stakeholders:

Stakeholder	Key Responsibilities
Federal Government organisations	<ul style="list-style-type: none"> • Set national policies and guidelines for flood and emergency management. • Coordinate national research and data on a range of flooding, weather and climate change issues. • Contribute to delivery of warning services and contribute funding to flood prevention, recovery activities and preparing for the impacts of a changing climate.
Victorian State Government departments and agencies	<ul style="list-style-type: none"> • Set policies, guidelines and standards for floodplain management, urban planning and development, and water resource management. • DELWP contributes to the development and use of integrated water management (IWM) knowledge and tools. This includes climate modelling to assist with future adaptation planning for water assets. • Undertakes technical research and support recovery from floods.
Melbourne Water	<ul style="list-style-type: none"> • Regional drainage and floodplain management authority. • Manage the main drainage network, including large pipes, wetlands and flows along rivers and creeks. This includes the long drainage reserve beside the Long Beach trail that stretches 7km from Mordialloc Creek to Patterson River. • Coordinate planning and delivery of flood management and drainage services across the region. • Undertake catchment and coastal flood modelling and mapping. • Provide flood advice and conditions for new land use and development as a Referral Authority. • Manage waterways and contributes information to warning services.
Department of Transport	<ul style="list-style-type: none"> • Manage the drainage network along major roads, such as Nepean Highway and Mordialloc Freeway.

Stakeholder	Key Responsibilities
Council	<ul style="list-style-type: none"> • Manage local municipal planning schemes and policies. • Coordinate local flood and emergency planning. • Manages the local drainage network along local roads and parks, generally for catchment areas less than 60 hectares. • Support implementation of state policies and regional strategies through local flood management activities. • Develop local water management strategies and plans. This includes working with the broader local community to understand local water cycle elements and impacts
Retail water authorities	<ul style="list-style-type: none"> • Manage urban water supply and sewage services. • Develop and implement IWM infrastructure and tools with other stakeholders. • Implement community water education programs in partnership with the Victorian Government, Melbourne Water and local Councils.
Environmental Planning Authority	<ul style="list-style-type: none"> • Set policies, guidelines, and standards for surface water and ground water pollution management.
Emergency services agencies	<ul style="list-style-type: none"> • Lead emergency preparation and response. • Deliver community awareness and education programs.
Communities, individuals and businesses	<ul style="list-style-type: none"> • Responsible for being aware of personal risks and being prepared for floods. • Property owners and businesses who manage their internal drainage systems, and outlet to street kerbs.

Appendix 2

Modelling the impacts of Climate Change & Development Growth

Kingston Council engaged E2Designlab to model various scenarios during 2021 that were used to inform water runoff volumes, with the findings from their technical report summarised below.

A2.1 Climate Change

Future climate projections were used to model the potential changes to key aspects of the water cycle, including rainfall, evapotranspiration, infiltration, stormwater volumes and pollutant loads generated within Kingston.

The modelling focussed on the following climate change scenarios:

Scenario 1: Future conditions that are more 'warmer-wetter'

This scenario is represented by the NorESM-1M global climate change model where slightly increased rainfall and a reduced rate of evapotranspiration is anticipated compared to existing weather patterns.

This model is appropriate for considering future conditions which are more demanding of stormwater treatment assets as they require the design to cater for higher stormwater pollutant loads. Mindful that exceeding minimum standards can be a positive outcome.

The 2050 'warmer-wetter' scenario forecasts the following outcomes:

- A 0.4% increase in rainfall and 1.5% reduction in losses from evapotranspiration and infiltration across the City of Kingston by 2050.

- An 8% increase in stormwater volumes, a 0.7% increase in the runoff of total suspended solids (TSS) and a 4.7% increase in the runoff of total nitrogen (TN) flowing into receiving waters by 2050. These figures show the net impact after allowing for other future changes, such as population growth, that increase pollution loads compared to existing conditions.

Scenario 2: Future conditions that are more 'hotter-drier'

This scenario is represented by the Hadgem2-CC global climate change model where slightly less rainfall and increased rate of evapotranspiration is anticipated compared to existing weather patterns.

This model provides an indication of how much flows and pollutants may be reduced in future. The 2050 'hotter-drier' scenario forecasts the following outcomes:

- A 27% reduction in rainfall and corresponding 26% reduction in losses from evapotranspiration and infiltration across Kingston by 2050.
- A 29% reduction in stormwater volumes and 31% reduction in runoff pollutants (TSS and TN) delivered to receiving waters.

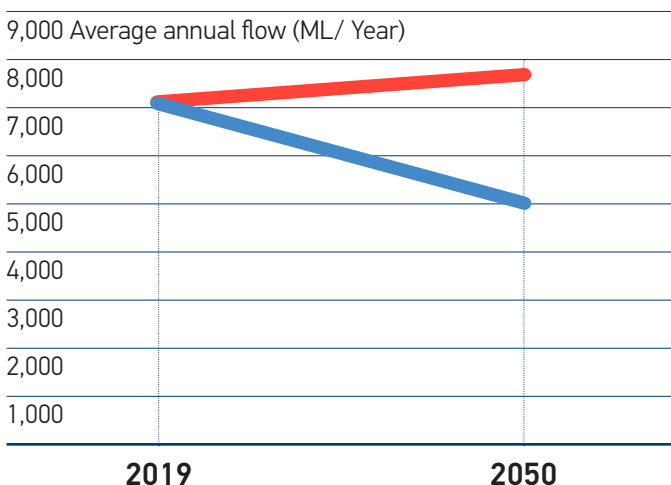
This model is appropriate for considering impacts on our sports reserves and vegetation, and planning for increased watering demand.

The above figures for both scenarios are an indication of the impacts of climate change based on 'business as usual' activities with no increase in IWM investment or interventions. Graphs showing the impacts of each scenario on various IWM measures are included in E2Design lab's the technical report.

The outcomes from these scenarios have been used to inform the stormwater runoff volumes as part of the modelling the status of pollution loads (as of 2021), plus the reductions achieved through implementing a range of improvement projects and activities (for 2030 and 2050 action planning).

The following graph illustrates the difference between the two future scenarios, with the red line representing the 'warmer-wetter' scenario 1 and the blue line representing the 'hotter-drier' scenario 2.

Forecast change in yearly stormwater flows



A2.2 Development Growth

Future population growth and the number of dwellings constructed will have a direct impact on Kingston's water cycle, with figures projected out to 2030 and 2050.

A review of Kingston's current and potential future development scenarios was undertaken to estimate the number of rainwater tanks. This was used to model annual stormwater runoff volumes and the volume of pollutants, such as the kg per year of total nitrogen generated.

The rate of future growth was based on the most likely development assumptions outlined in the City of Kingston's Housing Strategy (Currie & Brown, 2018) assuming a population growth of 5%, over the previous census levels to 2036, resulting in an average of 877 dwellings per year.

Appendix 2

Modelling the impacts of Climate Change & Development Growth

The type of future dwellings assigned were weighted in favour of future medium/high density development. The predicted number of dwellings per year was adjusted to 800 based on updated advice from Kingston City Council; however, ratios of different housing development types (i.e. low, medium and high density dwellings) outlined in the Housing Strategy (Currie & Brown, 2018) were maintained. This resulted in the following estimated annual increase for each category:

- **Low density: 125 (16%)**
Replacing one old dwelling with a new dwelling
- **Medium density: 319 (40%)**
Replacing one old house with two new townhouses
- **High density: 356 (44%)**
Replacing two lots with 3 levels (5 apartments per level)

The average roof areas and impervious areas, used to generate the modelling outputs, are documented in E2Designlab's technical report. The results are summarised in this document under Sections 6.1 (our water use) and 6.2 (protecting our waterways & bay).

Rainwater Tanks

Modelling of the future projected use of rainwater throughout Kingston has been based on an average increase of 800 new dwellings constructed every year, informed by data on local residential growth since 2016 (Currie & Brown, 2018). The runoff generated and captured allows for the proportion of low-density housing, medium-density units, and multi-storey apartments. See Section 3.2 for further discussion on population growth estimates. Taking into account the assumptions for development to accommodate population growth, modelling indicates that the volume of rainwater used throughout Kingston is estimated to increase to around 151 million litres per year by 2030 and 357 million litres per year by 2050.



Appendix 3

Dandenong Catchment

A3.1 Dandenong Catchment Maps

The following map, plus the image shown in figure 10 shows the extents of the Dandenong catchment.

Figure 11. Dandenong catchment map showing urbanised areas



A3.2

Dandenong Catchment Targets

The regional Dandenong Catchment Scale IWM measures and targets have been carefully considered and used as a guide to inform Kingston's Implementation Plan.

The regional targets are recognised as a high-level indication of the City of Kingston's important role in contributing towards the regional catchment scale actions. Some of the local targets adopted within Kingston's Implementation Plan are comparatively more ambitious, based on previous progress, whereas others are considered to be more practical based on local knowledge.

The following table shows the Dandenong CSIWM measures and targets, using the reference numbers within their report. Individual measures and targets have been colour coded based on the following descriptions:

These measures and targets will be primarily driven by activities managed at a regional level by state government agencies. Each of the local Councils within the Dandenong catchment may be able to play a supporting role by promoting and supporting individual initiatives.

These measures and targets will be primarily driven by activities managed by each of the local Councils within the Dandenong catchment.

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Dandenong Catchment

Strategic outcome	Leading measure	Desired 2030 target	Desired 2050 target
1. Safe, secure and affordable water supplies in an uncertain future	1.1a. Residential water use in litres per person per day. 155 l/p/d is a well-recognised campaign supported by Melbourne Water and South East Water but currently under review. Aligns with Kingston Action Ref No. K1a.	State Driven 139 L/p/day	State Driven 129 L/p/day
	1.2b. GL/year of alternative water sources that substitutes potable mains water supply Aligns with Kingston Actions Ref No. K1b & K1c.	State Driven 1007 ML/year in Kingston 11 GL/yr in Region	State Driven 150 GL/y in 2019 estimate of 6 GL/yr in Region
2. Effective and affordable wastewater system	2.1a. ML/year of recycled water delivered to customers Aligns with Kingston Action Ref No. K1b.	85 GL/yr in Region	\$408 million in Region
3. Existing and future flood risks are managed to maximise outcomes for the community	3.1: Dollar (\$) reduction in Annual Average Damage (AAD) delivered by flood management initiatives Aligns with Kingston Action Ref No. K3a.	\$9-64 million in Region	\$408 million in Region
	3.3: Percent of projects that cross-consider IWM and flood mitigation opportunities as part of their design Aligns with Kingston Action Ref No. K4c.	To be confirmed	100%
4. Healthy and valued waterways and marine environments	4.1: ML/year of mean annual runoff volume reduction To be developed.	1547 ML/year in Kingston	2535 ML/year in Kingston
	4.2a. Tonnes/year mean annual Total Suspended Solids (TSS) prevented from discharging to receiving waters Aligns with Kingston Actions Ref No. K2a to K2 for TSS & TN.	Meet the SEPP (waters) targets for pollutants entering Port Phillip Bay which represent a no net increase compared to baseline loads.	As per 2030 2019 estimate is 6602 kg/year in Kingston.
	4.2b. Tonnes/year mean annual Total Nitrogen (TN) prevented from discharging to receiving waters	2019 estimate of	As per 2030

Strategic outcome	Leading measure	Desired 2030 target	Desired 2050 target
5. Healthy urban and rural landscapes	5.1: Percent of street trees that are supported with permanent (active or passive) irrigation from an alternative water supply Aligns with Kingston Action Ref No. K4c for all measures under item 5.	9% in Kingston	22% in Kingston
	5.2a: Percent of the total area of active public open space (sports fields and organised recreation) supported by an alternative water source	23% in Kingston	56% in Kingston
	5.2b: Percent of the total area of passive public open space (parkland and gardens) supported by an alternative water source	5% in Kingston	12% in Kingston
6. Community values are reflected in place-based planning	6.1a. Rating of Traditional Owners' capacity to partner in IWM programs, policy, planning and projects Actions for 6.1a & 6.1b to be progressed at a regional level.	Subject to ongoing discussion with Traditional Owners and the results of a survey.	As per 2030
	6.2b. Rating of other IWM partner organisations' capability to partner with Traditional Owners in IWM programs, policy, planning and projects	Subject to ongoing discussion with Traditional Owners and the results of a survey.	As per 2030
	6.3: Rating of community literacy regarding the water cycle (out of 5) Aligns with Kingston Actions Ref No. K1a & K4a.	4.5 (2019 Data: rated 3)	5
	6.4: Rating of whether water is a key element in city planning and design process (out of 5) Aligns with Kingston Action Ref No. K4c.	4.5 (2019 Data: rated 3.5)	5

Appendix 3

Dandenong Catchment

Strategic outcome	Leading measure	Desired 2030 target	Desired 2050 target
7. Jobs, economic benefits and innovation	7.1a. ML/year of alternative water supplied to agricultural production <i>To be progressed at a regional level.</i>	9 GL/yr in region 2019 estimate of 6 GL/yr	11 GL/yr in Region
Enablers	E1: Rating of vision, leadership and long-term commitment through vision statement and objectives articulated in corporate documents (out of 5) <i>Aligns with Kingston Action Ref No. K4c for all enablers, E1 to E3.</i>	4.5 (2019 Data: rated 4)	5
	E2: Rating of knowledge, skills and organisational capacity (out of 5)	4.5 (2019 Data: rated 3)	5
	E3: Rating of cross-sector institutional arrangements and processes (out of 5)	4.5 (2019 Data: rated 4)	5

The Dandenong Forum includes the following member organisations that will contribute towards achieving the regional Dandenong catchment targets:

- Bunurong Land Council
- Victorian Planning Authority, and the Department of Environment, Land, Water and Planning
- The Cities of Bayside, Casey, Frankston, Glen Eira, Greater Dandenong, Kingston, Knox, Monash, Maroondah, Port Phillip, Whitehorse, Yarra Ranges and the shire of Mornington Peninsula
- Melbourne Water, and Port Phillip & Westernport Catchment Management Authority
- South East Water and Yarra Valley Water.

The regional Dandenong targets will be reviewed, as new information becomes available, such as the outcomes from more detailed localised catchment modelling.



Appendix 3

Dandenong Catchment

A3.3 Priority Regional Actions

Dandenong STRATEGIC DIRECTIONS STATEMENT SEPTEMBER 2018 outlines 35 priority actions, with the City Kingston referenced as a collaborative partner in the following 9 projects:

Project	Description
Moorabbin Reserve Stormwater Harvesting	<p>Action 4: As part of the City of Kingston's Stormwater Master Planning, this reserve was identified as a potential location for a bio-retention system treating a 259 ha catchment and providing more than 4ML/yr of water for sports ground irrigation.</p> <p>This project explores funding opportunities to enable detailed design and implementation.</p>
Recycled Water to the Dingley Green Wedge	<p>Action 6: A unique opportunity exists to lay a recycled water pipeline, or 'purple pipe', along the 6.4 km length of the Mordialloc Freeway works to provide recycled water infrastructure to Kingston's Green Wedge. The area is home to market gardens, golf courses and parklands, with potential for open space in future to host the Hawthorn Football Club.</p> <p>The proposed purple pipe could be extended north into Clayton to meet the needs of the Monash National Employment Cluster and new Clayton Business Park residential development planned by the Victorian Planning Authority.</p> <p>This project investigates the cost-effectiveness of different infrastructure options and the demand for recycled water in the area.</p>
Elster Creek Catchment Flood Management	<p>Action 17: Parts of the Moorabbin and Highett drainage network flows west into the Elster Creek Catchment that is highly prone to significant flooding. Flooding events are disruptive to the local community, particularly beside the Elwood Canal in Elsternwick, and can cause significant infrastructure and property damage.</p> <p>The increased stormwater runoff passing through the catchment can also impact waterway health and the optimal function of the region's water cycle.</p> <p>This project investigates opportunities to respond to flood risk at a catchment-scale, building a shared understanding of flooding and increasing community and water sector stakeholder awareness of flood risks and responses.</p>

Project	Description
<p>Multi-party Solutions to New and Legacy Flooding Issues</p>	<p>Action 18: Parts of the Clayton South drainage network flows east into the older established areas of Dandenong that were designed to cope with low storm intensities. However, infill development in the area is now generating increased stormwater runoffs, leading to a surcharge of existing systems and flooding.</p> <p>It is now imperative that land development proposals incorporate multi-party solutions to accommodate increased runoffs from such developments. This project investigates options for alternatives to flood retarding basins and other traditional approaches, such as large below ground storages for water harvesting.</p> <p>The project will identify major risk areas by taking a total catchment perspective, and in doing so, seeks opportunities to work together to enable catchment-based solutions.</p> <p>This project will also investigate broader catchment-wide benefits of lot-scale rainwater tanks.</p>
<p>Stormwater Outfalls Monitoring and Improvements - Eastern Port Phillip Bay</p>	<p>Action 22: The bayside beach areas of Port Phillip Bay between St. Kilda and Frankston are some of Victoria's most iconic, well-loved and well-used seaside destinations. However, stormwater outfalls discharging directly to the bay can carry litter and pollutants to the water, impacting on water quality, recreation, and the health of this cherished marine environment.</p> <p>This project aims to increase the frequency of water quality monitoring at stormwater discharge points to the bay. It will establish citizen science to monitor water quality. In doing so, this project also aims to raise community awareness of pollution arising from stormwater outfalls.</p>
<p>Seaford Wetlands Environs Planning Study</p>	<p>Action 25: The Edithvale-Seaford Wetlands are internationally significant habitats for a diversity of birdlife, including several rare and endangered migratory water birds from as far afield as Siberia. Melbourne Water has recently completed a management plan for the area, listed as a Wetland of International Importance under the Ramsar Convention.</p> <p>This project undertakes a follow-up investigation into stormwater impacts on the Seaford Wetlands reserve from the surrounding residential area with a view to implement measures to reduce the impact of urban development on this important Ramsar site.</p> <p>Outputs of this project will inform new planning controls on urban developments in the surrounding area and capital improvement measures for the local drainage network.</p>
<p>Elsternwick Park</p>	<p>Action 29: The four Councils in the Elster Creek catchment – Bayside City Council, City of Port Phillip, City of Glen Eira and City of Kingston and Melbourne Water – have agreed to oversee the redevelopment of Elsternwick Park North in the context of the Elster Creek Catchment Action Plan.</p> <p>This Action Plan focusses on providing effective stormwater and flood management of the Elster Creek catchment. Bayside City Council has resolved to close the Elsternwick Golf Course and create a passive recreation/environmentally focused park, with an aim to improve flood mitigation and water quality in the Elster Creek catchment. This site also has the capacity to deliver community and environmental benefits, including passive recreation and revegetation.</p> <p>This project aims to explore water sensitive solutions for Elsternwick Park North by considering their impact of flooding within the Elwood area.</p>

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Dandenong Catchment

Project	Description
Monash National Employment and Innovation Cluster IWM Strategy	Action 31: Can the presence of water in the urban environment attract employment and jobs to an area? This project develops an IWM strategy at the Monash NEIC to determine how water can influence urban renew and infill development (e.g. Clayton Business Park) to improve local liveability and prosperity, as well as environmental and economic outcomes for the precinct.
Kingston Green Wedge Wetlands	Action 53: The construction of a new wetland along the Mordialloc settlement Creek has been listed as one of nineteen additional IWM, in the first phase of the Dandenong IWM Forum cycle, as a potential future project that is subject to further assessment.

A3.4 Regional approaches to the delivery of recycled water

South East Water is currently leading the development of a business case for the delivery of Class A recycled water to customers across the South East Green Wedge, including Kingston City Council.

They will partner with relevant stakeholders and local government to deliver relevant projects, including the identified Dingley recycling scheme and the Patterson River recycling scheme. These projects will require financial co-contributions from Councils, South East Water and State Government in addition to targeted pricing of recycled water.

These projects have been considered as part of technical modelling undertaken to establish the benefits of proposed Council WSUD assets and to determine future stormwater quality targets.

A3.5 Regional approaches to stormwater quality improvement

The Mordialloc Wetland, should it go ahead, is anticipated to be a significant regional project contributing to stormwater quality improvement. This is discussed under Section 6.2.5.

This project has been considered as part of technical modelling undertaken to establish the benefits of proposed future stormwater quality targets. It is estimated that the system will facilitate the removal around 1.8 tonnes of Total Nitrogen from entering Mordialloc Creek annually, ultimately preventing discharge into Port Phillip Bay a further 2 km downstream.

Figure 12. Installation of a recycled water – purple pipeline.



Appendix 4

Flood History & Emergency Management

A4.1 Kington's Drainage History

Most of Kington's older suburbs have areas of flooding and ponding due to road alignments, topography, and limited drainage infrastructure. Kington's northern foreshore suburbs are protected from the Bay by cliffs or primary dunes; however some southern suburbs have historically had flood issues due to tidal influences, high groundwater and/or aging infrastructure. Ongoing urbanisation and development exacerbate the historic flood regimes by increasing runoff, placing increasing pressure on infrastructure.

Much work has been done by the Council to develop and continually update the knowledge base that informs decisions to mitigate flood risk. Continuous drainage improvements protect local suburbs against flooding where possible, whilst building controls have assisted in reducing runoff and mitigating flooding.

A medium climate change scenario is expected to result in 0.8 metre sea level rise and increased storm frequency and intensity by 2100. Increases in storm intensity will challenge existing infrastructure, whilst the expected sea level rise will restrict outflows of stormwater to the bay, leading to more flooding.

Higher intensity and more frequent rain events will mean frequency and severity of flash flooding will increase. Sea level rise will inundate some areas, particularly around the mouth of Mordialloc Creek, and will also result in the backing up of many drainage outlets, limiting their function and thus increasing the risk of flooding.



Figure 13. Comparison of flood levels for the 1934 and 1952 floods Patterson River is labelled as 'Carrum Outfall'

Period	Description
Pre-1950	<ul style="list-style-type: none"> Mordialloc is the oldest town in Kingston that slowly grew around Mordialloc creek from the late 1800s. Most of Kingston was used for farming, except for the swamp areas that extended from Carrum to Braeside. In December 1934, Chelsea and surrounding areas were severely flooded, and an estimated 1,500 people were evacuated from their homes.
1950 to 1960	<ul style="list-style-type: none"> In July 1952, an estimated 1,200 people were evacuated from their homes in the bayside suburbs of Chelsea, Bonbeach, Seaford and Carrum because of severe flooding. During the 1950s and 1960s, the installation of floodgates and pumps on the Patterson River, and the raising of the height of levee banks, increased protection of Chelsea and surrounding areas from severe flooding.
1960 to 1975	<ul style="list-style-type: none"> Kingston's older foreshore suburbs were built along the railway corridor (1960 to 1970). Melbourne suburbs started to expand east of Warrigal Rd with estates constructed in Cheltenham, Dingley Village and Clayton South. Most of the Melbourne Water and Council drainage systems constructed at this time are still functioning; however, they were designed to cater for smaller rainfall events and less impervious surfaces.
1975 to 1995	<ul style="list-style-type: none"> Government planning requirements were introduced to require all new subdivisions to cater for extreme rainfall events (1975). Some subdivisions constructed prior to 1975 remain challenging to protect from extreme flood events. Melbourne water constructed a major drainage upgrade along Nepean Hwy (Cheltenham to Mentone) connecting to Port Phillip Bay (1995).
1995 to 2010	<ul style="list-style-type: none"> In November 2003, thunderstorms resulted in localised flash flooding across the Melbourne metropolitan area, including at Chelsea. In 2004, flood overlays were introduced into the Kingston planning Scheme. Flood mitigation strategies were prepared for higher risk suburbs (1997 to 2010). Council constructed major drainage improvements at the highest priority location, including Dingley Village.
2010 to 2020	<ul style="list-style-type: none"> In February 2011, there was an extreme flood event that affected Kingston and most of greater Melbourne. The worst affected area was a 10 kilometre wide band through Beaconsfield and Dandenong South that received 180mm of rain in one hour. Many local roads were flooded at the low points to a depth of between 100 millimetres to 500 millimetres. Edithvale Road was severely impacted and was closed for a period of 8 days. Kingston's first Integrated Water Cycle Strategy was developed and was recognised in a national award (2012). Kingston was the first Council to prepare a joint Flood Management Plan with Melbourne Water (2010) followed by a new version (2015). Following a major joint study with Melbourne Water, a unique design solution was developed to drain the low lying areas using large-scale pumped storage systems. Major drainage improvements works were constructed in high priority areas, including Carrum, Chelsea, and Edithvale. An ongoing works program is continuing.

Appendix 4

Flood History & Emergency Management

A4.2 Flood Emergency Management

During a flood event within the City of Kingston, the lead agency is the Victoria State Emergency Service (VicSES) and Council's primary role is to provide assistance.

Emergency 'responsibility' is outlined in various legislation, guidelines, and plans. Responsibility is assigned in accordance with the 'phase' of the emergency and in accordance with the jurisdiction namely, Municipal, Regional, State and Commonwealth.

The most relevant documents relating to flooding emergencies occurring within Kingston are:

1. Municipal Emergency Management Plan (MEMP). This document has a focus on readiness, response, relief and recovery.
2. Southern Metro Regional Emergency Management Plan (REMP)
3. State Emergency Management Plan (SEMP)
4. Kingston MEMP Sub Plan: Flood & Storm
5. Protocol for inter-Council resource sharing (MAV)
6. *Emergency Management Act (1986)*; *Emergency Management Plan (2013)*; *Emergency Management Legislation Amendment (2018)*; and *Local Government Act (2020)*.

Community Engagement, Education & Awareness

Kingston Council supports VicSES messaging by emphasising the importance of self-resilience and preparedness and personal responsibility in being 'flood ready'. Council's website, social media and other partners aim to coordinate with the VicSES, Melbourne Water and neighbouring Councils on communication campaigns and joint initiatives.

It's important that the community are aware of flood risks, are prepared and know how to act safely in the event of a flood. Melbourne Water's website includes further information, including:

- A guide for owners of flood-affected homes shows how retrofitting can reduce the impact of future floods
- Checking local flood risk by using the VicSES local flood guides
- Actions you can take to help be prepared
- A link to the Vic Emergency website and app that provides Victorians with information and warnings about incidents – including fires, storms and floods.

More Information

The following websites provide useful additional information on the following topics:

Water Sensitive Cities

www.watersensitivecities.org.au/what-is-a-water-sensitive-city/

Dandenong Catchment Maps

www.water.vic.gov.au

www.melbournewater.com.au/building-and-works/projects/living-links

Preparing for Flood Emergencies

www.melbournewater.com.au/water-data-and-education/water-facts-and-history/flooding/being-prepared-flooding

www.ses.vic.gov.au/plan-and-stay-safe/emergencies/flood

Recycled water pipelines

www.melbournewater.com.au/water-data-and-education/water-facts-and-history/where-your-sewage-goes/producing-recycled-water

Stormwater harvesting

www.melbournewater.com.au/building-and-works/stormwater-management/stormwater-harvesting

www.southeastwater.com.au/residential/learn-about-water/where-does-my-water-come-from/recycled-water/

Rain water tanks

www.yourhome.gov.au/water/rainwater

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Design Flow Consulting. (2013). Stormwater Treatment and Reuse Program Report. City of Kingston.





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Figure 14. Award-winning stormwater harvesting and treatment project constructed beside Edithvale golf course.