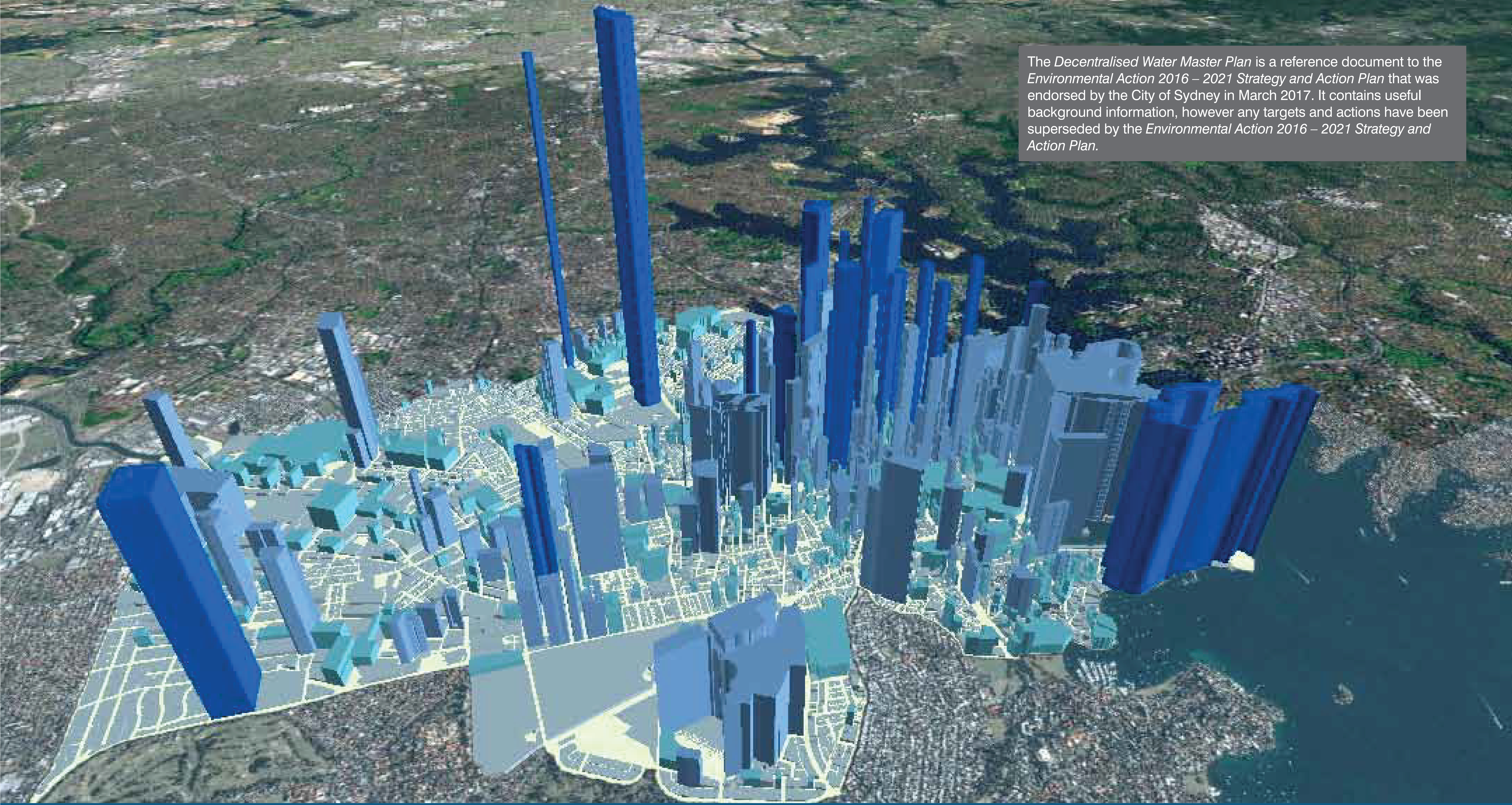

The *Decentralised Water Master Plan* is a reference document to the *Environmental Action 2016 – 2021 Strategy and Action Plan* that was endorsed by the City of Sydney in March 2017. It contains useful background information, however any targets and actions have been superseded by the *Environmental Action 2016 – 2021 Strategy and Action Plan.*

Decentralised Water Master Plan 2012–2030

Acknowledgements

City wishes to acknowledge and thank

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- **Sydney Water** for providing the metered water consumption data that underpins this master plan.
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- **Members of the Stakeholder Reference Group** for participating in the meetings held during the development of the master plan and providing their input to the master plan.
- **Agencies represented in the Stakeholder Reference Group included:**
  - Sydney Water
  - Independent Pricing and Regulatory Tribunal (IPART)
  - Metropolitan Water Directorate
  - NSW Office of Water
  - NSW Office of Environment & Heritage
  - NSW Department of Planning & Infrastructure
  - Marrickville Council
  - Woollahra Council
  - Leichhardt Council

This master plan has been prepared by City of Sydney

July 2012

Contents

Foreword

In 2008 the City of Sydney launched Sustainable Sydney 2030 and committed Sydney to becoming a green, global and connected city.

Drought-proofing an entire city, reducing its stormwater pollutants and adapting the city to climate change requires more than a building scale solution; we need a city-wide strategy which address the sustainability of the existing infrastructure and assets

The 2003–10 drought brought home the impacts of taking water for granted. The recent floods have also reminded us that Australia's historic drought and flood cycles are predicted to become more intense with climate change. The drought led to water restrictions and a growth in individual recycled water systems as Sydney tried to adapt to unpredictable and dramatic weather cycles. However, there was no integrated city wide strategy to mitigate or adapt to these events.

Currently, our water strategy is to build remote large holes in the ground (dams), hope that it rains, treat all water to drinking-water standards, pump it long distances into the city and then only drink 2 per cent of the water received. Even if we take other water demand uses into account where we may ingest that water, such as catering, showering and bathing, drinking water requirements amounts to no more than half of our water consumption. The other 50 per cent of water demand is for non-drinking water uses such as toilet flushing, air conditioning cooling towers and irrigation of our parks and gardens.

Similar to centralised energy, centralised water solutions are inefficient, unsustainable and highly vulnerable to climate change. Similarly, the amount of pollutants entering our waterways is not acceptable. We cannot allow such outdated solutions to compromise the social, economic and environmental wellbeing of the city.

The City of Sydney local government area is the most significant urban economy in Australia. As Australia's only global city, Sydney is the heart of the Australian economy. Economic activity within the City's local government area comprises 25 per cent of NSW's GDP and 8 per cent of Australia's GDP – about $100 billion a year and up there with the mining industry. It's imperative the city's water supply is sustainable, drought-proofed and utilised to adapt to climate change.

The city has the oldest water supply and sewage infrastructure in Australia, and now is the time to rethink how we deliver the city's drinking and non-drinking water supplies for the 21st century.

Providing a decentralised water network derived from local recycled and alternative water resources not only makes the city more self sufficient and able to address climate change issues such as the urban heat island effect, it also frees up drinking water supply capacity, particularly in times of drought.

What this master plan has established is there is more than enough recycled and alternative water resources to make the city more self-sufficient in water resources, adapt to climate change and to free up additional drinking water.

In fact, we have a choice – so we have looked at the economics and carbon abatement of 10 different ways of providing recycled or alternative water sources.

Sewer mining and thermal desalination appear to be the most economic and provide the greatest amount of carbon abatement. Thermal desalination is the most innovative of these technologies and would be an Australian first; a technology that would never have been looked at with conventional approaches to infrastructure.

However, we have the Green Infrastructure Plan, which enables us to look at green infrastructure holistically by combining the Master Plans for Decentralised Energy and Decentralised Water into a single Green Infrastructure Plan.

Unlike conventional desalination such as the Sydney desalination plant at Kurnell, which consumes huge amounts of electricity a year, , thermal desalination uses the zero-carbon waste heat from local low-carbon electricity generation, i.e., trigeneration, with the electricity supplying the city's buildings and street lighting turning this part of the city's trigeneration network into a quadgeneration system providing four useful outputs from one input.

In time, even low-carbon electricity will become zero carbon with the replacement of natural gas from renewable gases which will be covered in our Renewable Energy Master Plan.

Sewer mining, also, not only reduces the drinking water demand on the Warragamba Dam, it reduces the demand on remote sewage treatment stations.

Located in parks and open spaces, stormwater harvesting provides economic means of producing recycled water at precinct scale while also providing several environmental benefits.

Finally, our commitment to reduce stormwater pollutants will also improve the environmental health of our waterways.

Allan Jones MBE
Chief Development Officer,
Energy & Climate Change
City of Sydney

Lord Mayor Clover Moore MP
City of Sydney

Unlocking the Master Plan

The Decentralised Water Master Plan provides a blueprint for Council to:

1. Reduce mains water consumption across the City of Sydney local government area by 10per cent of 2006 levels by 2030 through water efficiency programs.
2. Reduce mains water consumption in Council's own buildings and operations to 10per cent below 2006 levels by 2030 through water efficiency and connection of Council facilities to park-based or precinct scale recycled or alternative non-potable water supplies.
3. Replace 30per cent of mains water demand across the City of Sydney local government area with recycled or alternative non-potable water generated from local water resources by 2030.
4. Reduce sediments and suspended solids by 50per cent and nutrients by 15per cent discharged into the waterways from stormwater run-off generated across the City of Sydney local government area by 2030.

The City of Sydney has prepared this master plan based on a study undertaken by GHD, University of Technology, Sydney and P3iC as set out in the Technical Appendix. The combination of this master plan and other master plans will position the city to deliver 30 per cent of the city's water demand from recycled water by 2030.

The targets in *Sustainable Sydney 2030* were to deliver 10 per cent of water supply by local water capture and reduce stormwater pollutants by 50 per cent. However, this master plan reviews these targets to determine what is actually needed to meet the city's water demand and stormwater pollutants reduction targets by 2030.

The analysis that has been undertaken in the preparation of this master plan has been itself transformative. It has drawn upon a unique combination of metered water utility data, detailed floor space analysis and comprehensive water supply and demand as well as water pollutant load balance modelling that has allowed us to understand the city in a way that has never before been attempted.

By doing so, we are able to present a master plan that sets out the most appropriate path for the City to achieve *Sustainable Sydney 2030* based on water efficiency, recycled water and stormwater pollution reduction performance and cost. It demonstrates how best to configure the decentralised water solutions, where they should be located, how they will perform and how they can be enabled.

This master plan is limited in its scope. It is neither a development application, nor is it a business plan. Yet its implications are profound.

In developing this master plan, our challenge was twofold:

- To establish the targets that would be needed to meet the city's water demand and reduction in stormwater pollutants requirements by 2030.
- To show that there are more than enough non-drinking water resources that could be tapped into to deliver the targets in an affordable and effective timeframe.

We believe that this master plan has met these challenges by showing that by implementing the Decentralised Water Master Plan, Council would:

1. Reduce mains water consumption across the City of Sydney local government area by 10 per cent of 2006 levels by 2030 through water efficiency programs. The programs would specifically target air conditioning cooling towers, office buildings, multi-residential and single dwellings, hotels and restaurants.
2. Reduce mains water consumption in Council's own buildings and operations to 10 per cent below 2006 levels by 2030 through water efficiency and connection of Council facilities to park-based or precinct scale recycled or alternative not potable water supplies. With the growth in Council buildings and operations portfolio the City anticipates that its water consumption will increase by 30 per cent by 2030 on a 'business as usual basis'. Therefore, reducing 2006 mains water use by 10 per cent will provide an effective target of a 40 per cent reduction in mains water consumption by 2030 in practical terms.
3. Replace 30 per cent of 2030 mains water demand across the City of Sydney local government area by recycled or alternative non-potable water generated from local water resources, including stormwater, black water, wastewater, rainwater harvesting, greywater recycling and sea water via thermal desalination and trigeneration. The 30 per cent target will be delivered in partnership with NSW and Federal governments to help deliver the City's local government area's contribution towards the national target of 30 per cent of Australia's wastewater being recycled, with 10 per cent by the City of Sydney implementing measures and 20 per cent by NSW and Federal governments funding and/or implementing measures.
4. Reduce sediments and suspended solids by 50 per cent and nutrients by 15 per cent discharged into the waterways from stormwater run-off generated across the City of Sydney local government area.

1. Decentralised water

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Decentralised water

This master plan proposes to utilise local water resources in a way that represents a radical departure from current practice.

The proposed decentralised water system can provide immediate and significant reductions in mains water consumption by using recycled water to cool and green the city contributing towards climate change adaptation.

Sustainable Sydney 2030 called for the city to have capacity to meet 10 per cent of water supply by local water capture and reduction in pollution discharged by stormwater run-off into waterways by 50 per cent.

Why a decentralised water master plan?

Rising population and growth in development is going to increase demand of water in the future. Climate change is predicted to bring about increased rainfall intensity and sea level rise which are going to be a strain on our stormwater infrastructure. Climate change is also predicted to bring more hot days in the future which means more demand for water used for cooling. In addition, Sydney's climate is characterised with long spells of drought creating uncertainty about water security.

The Decentralised Water Master Plan is a road map to equip the City of Sydney with a reliable supply and local network of recycled water that can be accessed and used for keeping the City green and cool under changing climatic conditions.

Ageing water infrastructure in the City is yet another driver for the Decentralised Water Master Plan. More than 50 per cent of the water infrastructure (water mains, pipes discharging sewage and pipes carrying the stormwater) in the City of Sydney is more than 70 years old and is reaching its capacity to serve the needs to cope with future growth in population and urban development and is difficult and expensive to upgrade. Before we lock away new infrastructure for another century, with old ways of thinking, the Decentralised Water Master Plan offers the opportunity to re-think the water in the city and develop innovative solutions.

The focus of the Decentralised Water Master Plan is the integrated and localised management of water, wastewater (sewage) and stormwater – the three key elements of the urban water cycle within the City of Sydney. This means planning and developing projects that achieve multiple service objectives and working on the synergies of the three water cycle elements. Hence, decentralised water is about improving water efficiency of the buildings and operations within the city, providing recycled water by treating sewage, stormwater and other locally available water resources for non-potable or non drinking purposes and reducing the stormwater pollution discharged to improve the quality of the waterways.

What is decentralised water?

Decentralised water is about finding local solutions for water management, rather than relying solely on large-scale remote solutions.

These may include solutions such as:

- Finding ways to reduce the demand through water efficiency.
- Developing local water supply alternatives.
- Capturing and recycling locally generated wastewater and stormwater by looking upon them as local water resources.
- Integrating more vegetation into the urban forms and designs to slow down and filter pollutants from stormwater and protect the waterways.

These solutions enable large reserves of previously unused water to be utilised for non-potable water purposes such as toilet flushing, air conditioning cooling towers and irrigation of parks and gardens. Keeping green spaces green during droughts and hot summers mitigates the urban heat island effect, helping the city to adapt to climate change.

Current water system

Current water management

The City of Sydney uses approximately 33.7 billion litres of water a year. The demand for water is expected to grow by 30 per cent to 44 billion litres a year due to increased population and urban growth by 2030. Being Australia's first colonial settlement, Sydney has the oldest and most intricate networks of water mains, sewage pipes and drainage pipes and pits in Australia. This ageing water infrastructure has coped well with population and development growth since the time they were laid underground.

However, a significant proportion of them are reaching their structural life and/or hydraulic capacity to deal with increased water demand and volumes of sewage and stormwater run-off anticipated by 2030. In addition, infiltration of groundwater in the cracks in the old and ageing wastewater pipes (sewer pipes) also contributes to reduced capacity. In some cases sewage leaks out of the pipes and contaminates the stormwater run off with faecal matter making its way to the waterways and adversely impacting their environmental and recreational value.

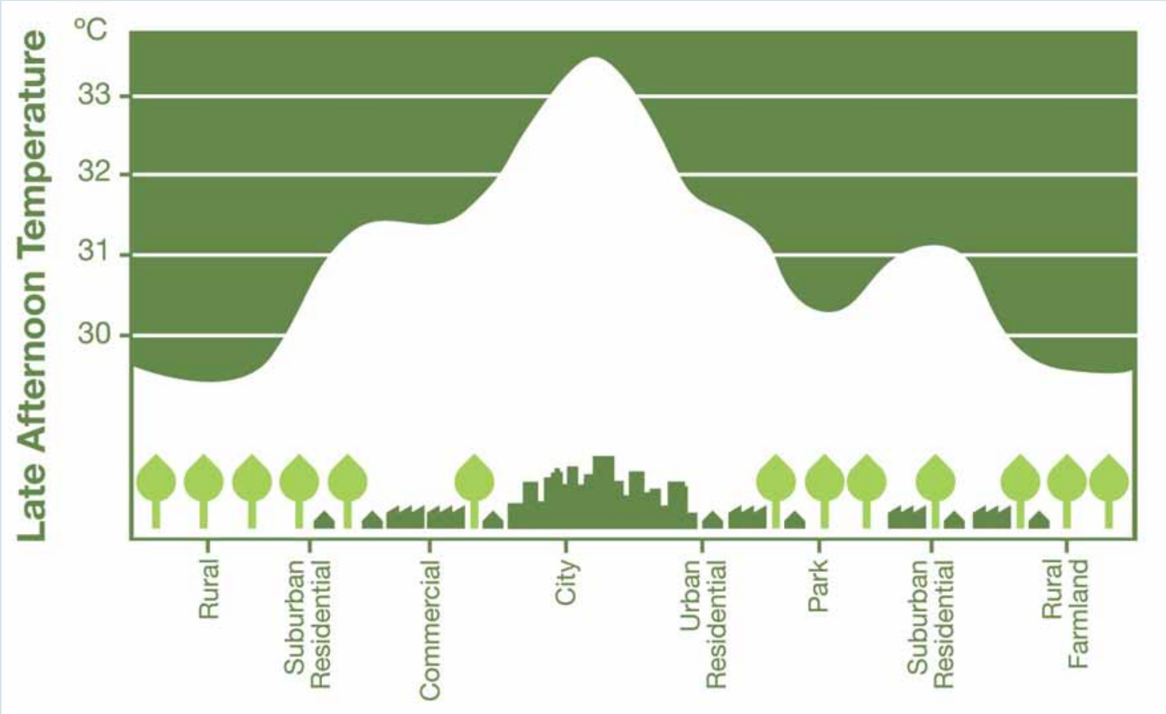
Water in the City of Sydney is supplied by Sydney Water through a centralised network that imports and distributes drinking quality water from Nepean, Warragamba and Shoalhaven dams located more than 70 kilometres from the city. Since 2011, the mains water is also sourced from the desalination plant in Kurnell, located 40 kilometres from the city.

Wastewater in the city is also managed by Sydney Water. Wastewater currently undergoes primary treatment which gets rid of suspended solids in the wastewater. Following this it is discharged into the sea through deep ocean outfalls.

Stormwater management is the responsibility of the City of Sydney. Stormwater in the city is collected through an intricate network of drainage pipes and pits with about half of them owned by Sydney Water and the remaining half owned by the City of Sydney.

Sydney's rainfall is variable. The recent drought has highlighted the importance of improving our understanding of the implications of climate variability and climate change for the water supply/demand balance of Australia's largest city.

What is urban heat island effect?



(Reference: http://healthyurbanhabitat.com.au)

The urban heat island effect refers to the tendency for a city or urban area to remain warmer than its surroundings, by as much as 3°C or more. This effect is caused mostly by the lack of vegetation and soil moisture, which would normally use the absorbed sunlight to evaporate as part of photosynthesis (a process called evapo-transpiration).

Instead, the sunlight is absorbed by built structures such as roads, car parks, and buildings. With little or no water to evaporate, the sunlight's energy goes into raising the temperature of those surfaces and the air in contact with them. As the day progresses, a dome of warm air forms over the city, convection transports heat from the surface to higher in the atmosphere. After the sun sets, temperatures remain elevated above the vegetated areas around the city or town, and so the heat island effect persists during the night as well.

Proposed water solutions for the future

Decentralised water solutions for the future

To cope with the anticipated rise in population, growth in urban development, ageing infrastructure and drought associated with climate variability, it is critical that the city reduces its reliance on mains water supply and builds its resilience to cope with more frequent droughts through diversity of water supply.

Improving water efficiency within buildings and irrigated green spaces and amenities reduces the need or demand for water and is therefore the first and most cost-effective way to prepare for adapting to climate change.

The mains water supplied by Sydney Water is of drinking quality. However, only about 50 per cent of demand (such as bathroom, shower, kitchen and water use in hospitals and restaurants) within the city requires such high-quality water. The remaining 50 per cent of the demand (such as cooling towers, toilet flushing, irrigation and washing bays) can do with water of lower quality. This provides the opportunity for capturing locally available water such as stormwater, sewage, and sea water, treating it to a level that is fit for non-drinking purposes.

Recycling sewage and stormwater not only provides an alternative water supply source but, also prevents the pollutants carried by them from discharging into our waterways. Having a local supply of recycled water that is independent of the centralised water supply also improves the security of supply for irrigating and maintaining more green space areas, which in turn, helps to mitigate the urban heat island effect as well as reducing stress on drinking water supplies.

Taking advantage of the proximity to the sea and the zero carbon waste heat generated by trigeneration plants, producing recycled water from distilled sea water by thermal desalination is also amongst the mix of recycled water solutions.

Harvesting stormwater and sewage on a city wide scale for producing recycled water has the potential to relieve the capacity of these pipes thus providing more capacity for the pipes to cope with frequent nuisance flooding predicted with climate change.

Sustainable Sydney 2030 called for reducing the pollutants being discharged into the waterways, by 50%. The Decentralised Water Master Plan has identified key pollutants in the stormwater run off that are within City of Sydney's influence of control, and set targets for reducing them.

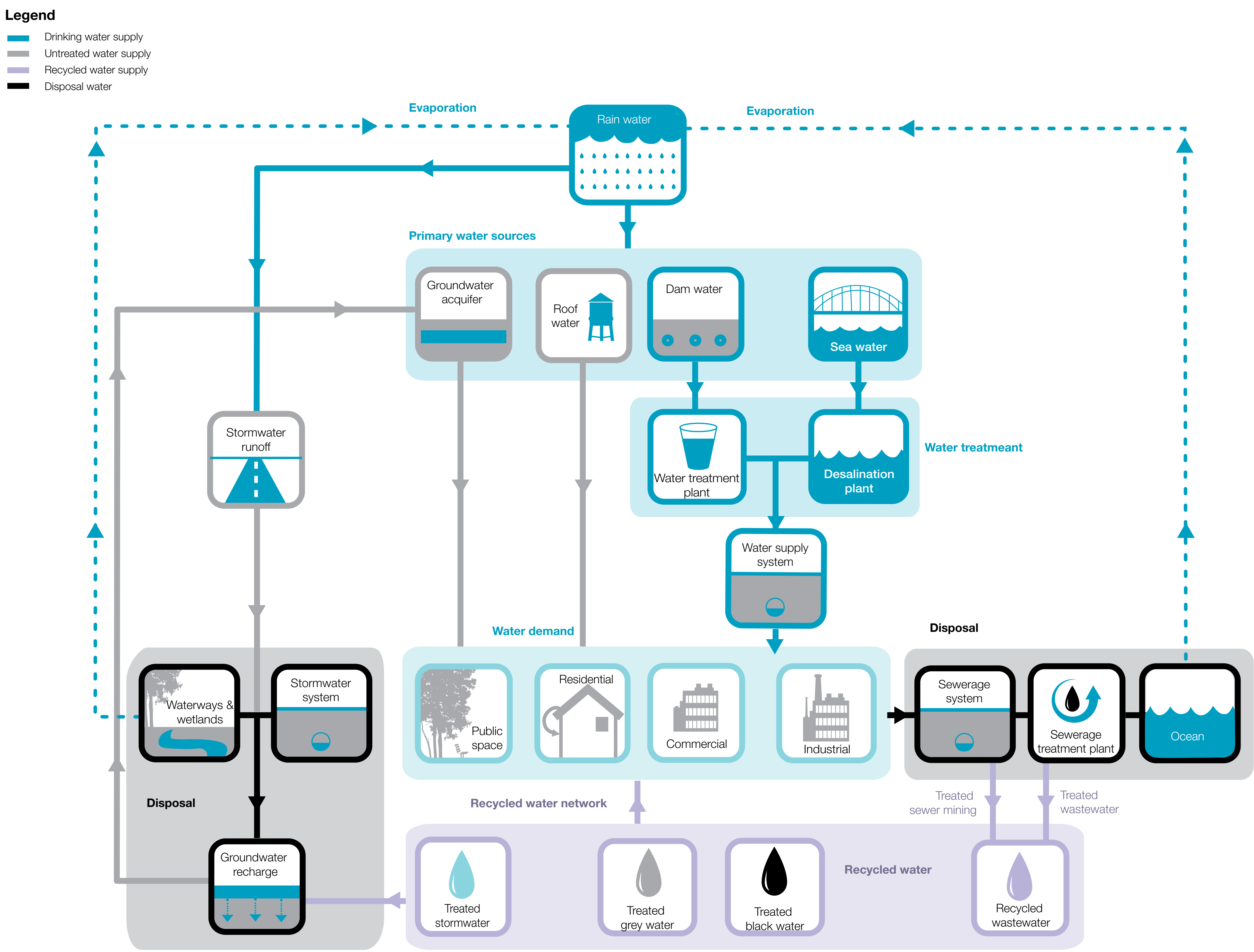
Australian best practice for reducing the pollutants in stormwater requires water sensitive urban design (WSUD) approach to managing stormwater. WSUD is about strategically integrating rain gardens and similar vegetated systems into the urban forms which help in slowing down the stormwater run-off and filtering the pollutants from roads and hardstands. The WSUD solutions have multiple benefits in the form of improved biodiversity (as the vegetated systems are largely made up of native plants and have potential to provide habitats for local fauna), cool microclimate and improved amenities. These multiple benefits achieved being cumulative at the city scale also contribute to mitigating the urban heat island effect. WSUDs require a larger footprint. Therefore, for space constrained developed areas, to make the most of the WSUDs in the cities, it is best to combine them with cost-effective end-of-the-catchment solutions that tend to occupy smaller areas per unit of pollutant removed.

This Master Plan has identified locations where it would be most cost-effective to integrate rain gardens and gross pollutant traps within the City of Sydney to help reduce the total suspended solids (TSS) as well as invisible pollutants of total nitrogen (TN) discharging into the waterways.

The content of the Decentralised Water Master Plan offers a different approach to managing and moving water in the city. Founded on the principles of integrated water cycle management and water sensitive urban design, it differs from traditional management of water in three key ways:

- sewage and stormwater treated as a water resource rather than waste to be discharged.
- recycled water used many times locally – a less wasteful way of using water.
- stormwater retained, slowed down and treated with vegetated systems, rather than disposed off swiftly through concrete pipes and channels into the receiving waters.

Figure 1.1: Urban water cycle and resources in the City of Sydney context



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2. Rethinking water in the city

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Foundations of the master plan

Moving to a decentralised water solution cannot be achieved through a conventional view of cities and city planning.

This chapter outlines the data that forms the foundations of the master plan. In order to ensure that the master plan is evidence based and robust, best available data from various sources were mapped. Different layers of mapped data provided the basis for models that were built for finding decentralised water solutions.

Water consumption in the city is not the only water use that the City of Sydney is responsible for. Centralised energy power stations supplying grid electricity to the city use and consume significant quantities of water, some 17GL of water a year for a typical 1000MW coal fired power station. The City's Decentralised Energy Master Plan – Trigeneration will displace a net 9.5GL of water a year form centralised energy power stations, equivalent to a 22% reduction in the City of Sydney's overall 2030 water demand (see inbox on this page).

Although this is a significant reduction in the City of Sydney's water demand from another Master Plan in the City's Green Infrastructure Plan, for the avoidance of doubt the targets in the City's Decentralised Water Master Plan are in addition to, and not part of the Decentralised Energy Master Plan – Trigeneration. Further reductions in the City of Sydney's centralised energy water demand will also be delivered by the Decentralised Energy Master Plan – Renewable Energy due to be published in 2013.

In order to determine the scope (where) and potential (how much) for water efficiency and water recycling, the City of Sydney's rich land use and floor space data, together with metered water consumption data from Sydney Water were mapped.

Water (stormwater, water and wastewater) infrastructure maps from the City of Sydney and Sydney Water were helpful in mapping:

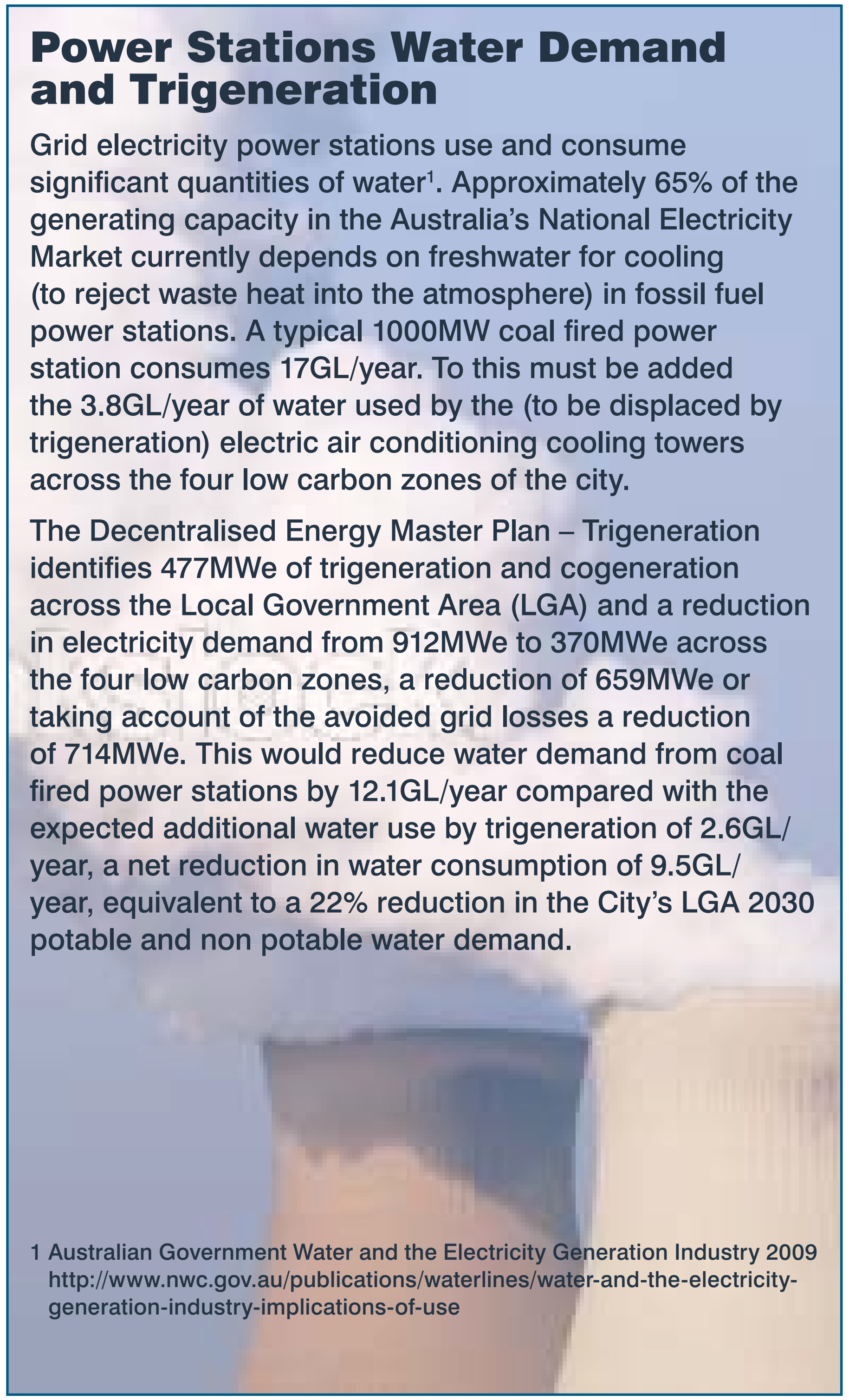
- the infrastructure capacity constraints
- sewer overflows
- flooding hotspots.

The infrastructure maps were also useful in estimating and mapping the potential fraction of wastewater and stormwater that can be harvested for producing recycled water for non drinking purposes.

Power Stations Water Demand and Trigeneration

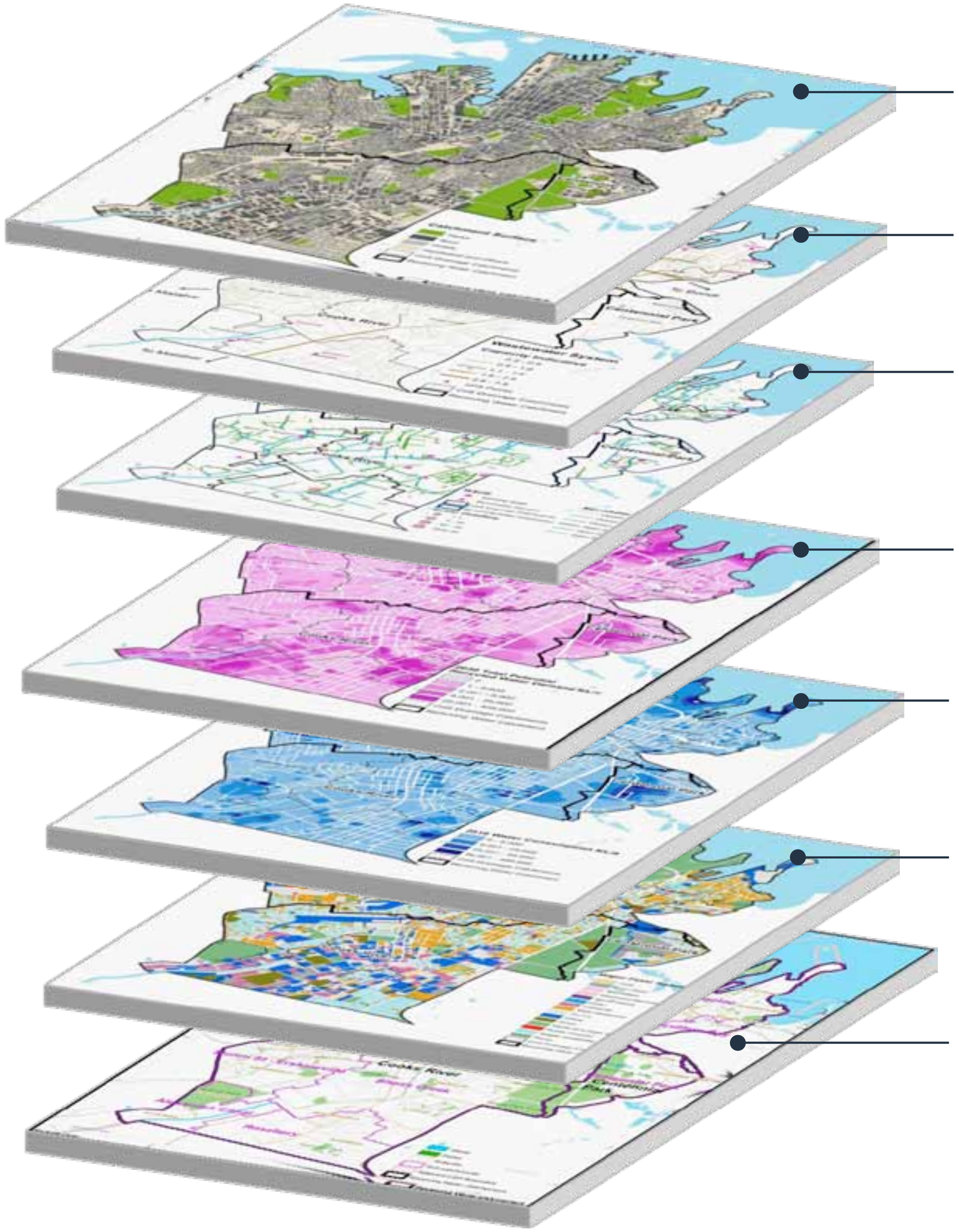
Grid electricity power stations use and consume significant quantities of water[1]. Approximately 65% of the generating capacity in the Australia's National Electricity Market currently depends on freshwater for cooling (to reject waste heat into the atmosphere) in fossil fuel power stations. A typical 1000MW coal fired power station consumes 17GL/year. To this must be added the 3.8GL/year of water used by the (to be displaced by trigeneration) electric air conditioning cooling towers across the four low carbon zones of the city.

The Decentralised Energy Master Plan – Trigeneration identifies 477MWe of trigeneration and cogeneration across the Local Government Area (LGA) and a reduction in electricity demand from 912MWe to 370MWe across the four low carbon zones, a reduction of 659MWe or taking account of the avoided grid losses a reduction of 714MWe. This would reduce water demand from coal fired power stations by 12.1GL/year compared with the expected additional water use by trigeneration of 2.6GL/year, a net reduction in water consumption of 9.5GL/year, equivalent to a 22% reduction in the City's LGA 2030 potable and non potable water demand.



1 Australian Government Water and the Electricity Generation Industry 2009 http://www.nwc.gov.au/publications/waterlines/water-and-the-electricity-generation-industry-implications-of-use

Figure 2.1: Spatial layers that assisted in determining decentralised water solutions



Layer F: Land use and surface type

Based on aerial photographs and zoning map of the City of Sydney, each sub-catchment was broken down into different land use and surface types in order to estimate the pollution load generated in each sub-catchment.

Layer E: Wastewater volume and sewer pipe network

Sydney Water provided the maps of sewerage network for the entire City of Sydney area along with the location and frequency of wastewater overflows. Together this layer provided an estimate of the yield of wastewater.

Layer D: D1=Stormwater D2=Groundwater and seepage water

Stormwater, groundwater and water that seep into tunnels are interconnected and are a useful local water resource. To help map the location and yield of this resource, maps of drainage networks owned by the City of Sydney and Sydney Water were used, along with the City's flood studies map of groundwater, seepage water and flooding hotspots. Yield of this water resource is affected by rainfall intensity.

Layer C: Growth in water demand by 2030

Growth in water demand by 2030 was mapped and estimated based on projected increase in water demand arising from growth in population and urban development. Mapping of projected urban development to accommodate the 2030 growth in population was based on the City's Capacity Study (2010).

Layer B: Water consumption data

Metered water consumption data of properties across the local government area was provided by Sydney Water and matched with the City's FES data. Specific end uses such as cooling towers and irrigation that could be supplied by recycled water were estimated and mapped.

Layer A: Land use and floor space

The City of Sydney's Floor Space and Employment Survey (FES) and land use zoning data measures and captures the entire built form of the city providing an understanding of every space and use across every building in the local government area.

Base layer: Boundaries and context

Topographically, the City of Sydney is made up of 11 sub-catchments that drain to three receiving waters – Sydney Harbour, Cooks River and Centennial Park Ponds.

Base layer
Boundaries and context

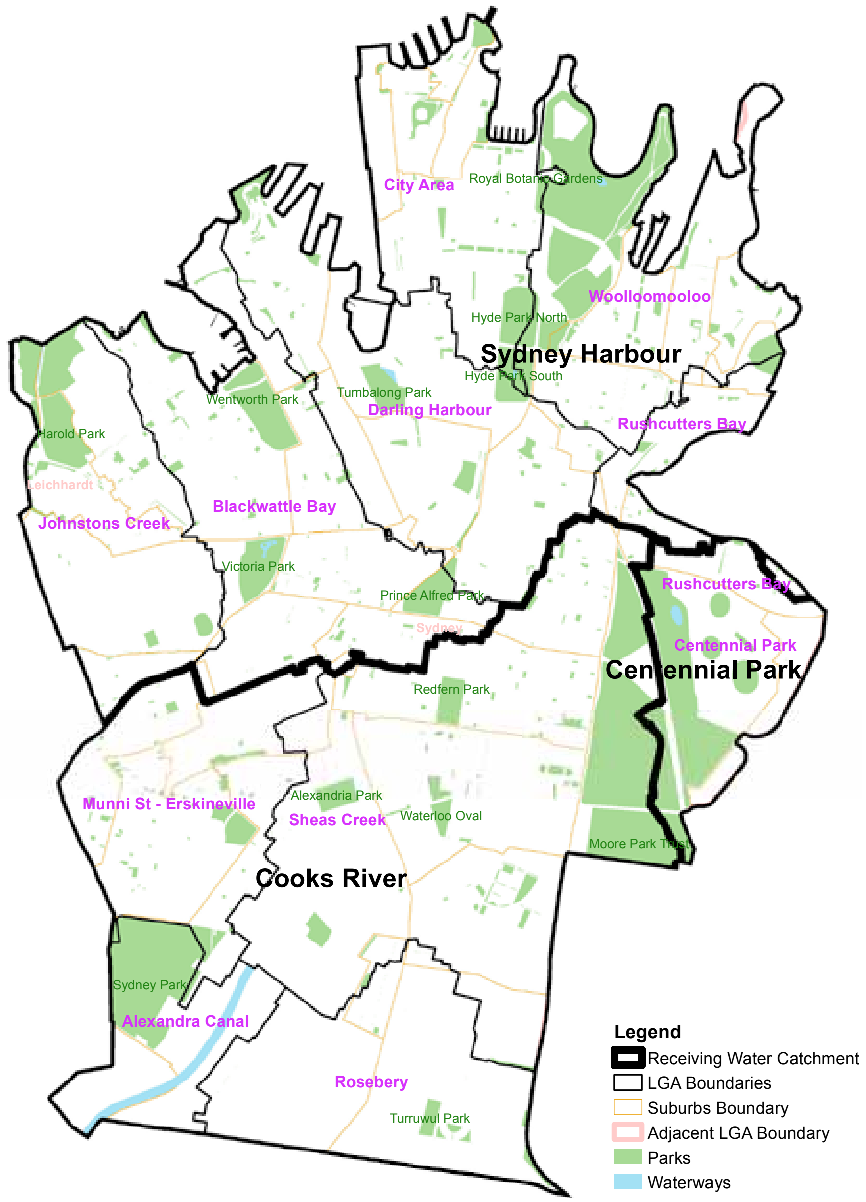
Figure 2.2 shows the City of Sydney's boundary, catchment and sub-catchment boundaries as well as the location of suburbs, parks and public open spaces.

The City of Sydney is made up of 11 sub-catchments that drain to three receiving waters – Sydney Harbour, the Cooks River and Centennial Park Ponds. The three receiving water catchments are defined by natural topography.

The 11 sub-catchments are defined by the drainage network laid to collect the stormwater run-off and divert to the receiving water body. This master plan has used the stormwater sub-catchments and receiving water catchments as a basis when identifying and mapping the opportunities for water efficiency, stormwater pollution reduction and water recycling.

A catchment based approach helps to contextualise the problems and the opportunities that can help develop decentralised water solutions that are tailored to the local situation and can achieve multiple objectives.

Figure 2.2: Catchment and sub catchment boundaries of the City of Sydney Local Government Area (LGA)



Layer A
Floor space and employment survey

The City of Sydney Floor Space and Employment Survey (FES) provides an unprecedented detailed understanding of the city's buildings and land use. The FES measures and captures the entire built form of the city providing an understanding of the breakdown of floor space and its use across every building in the local government area.

This layer of information identifies the scale of different uses across the city and provides the foundation for analysing the city's current water consumption and potential recycled water demand at both building and precinct scales.

Each building use is characterised by a different water demand profile. While commercial office buildings require water for cooling towers to provide air-conditioning during weekday working hours, residential buildings have morning and evening peak water demands. The floor space sector map (Figure 2.3) highlights the commercial, residential and industrial zones in the city and represents where the water demands are distributed across the city. The Gross Floor Area map (Figure 2.4) was helpful in mapping the water intensity across the city.

Figure 2.3: Floor space sector

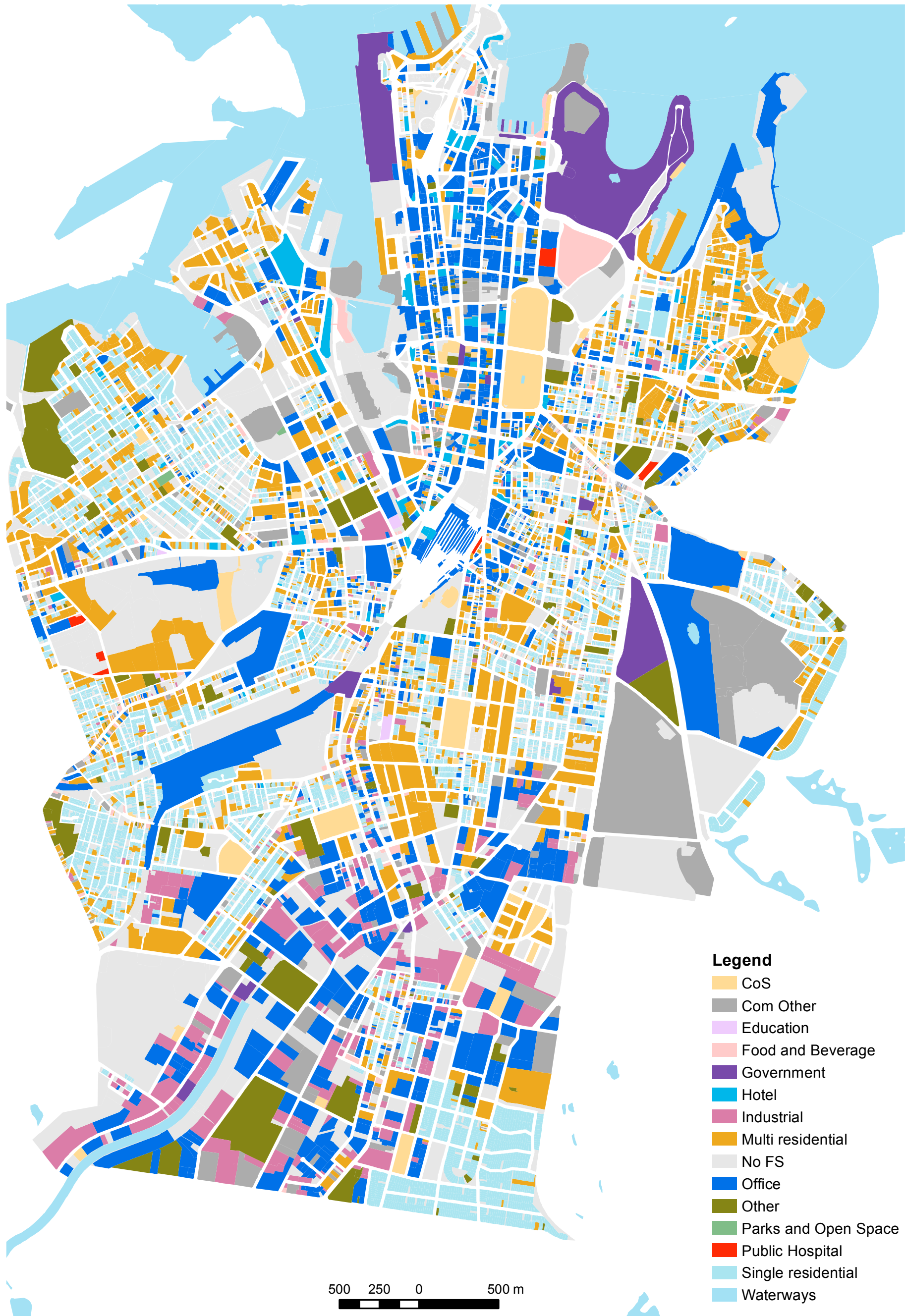
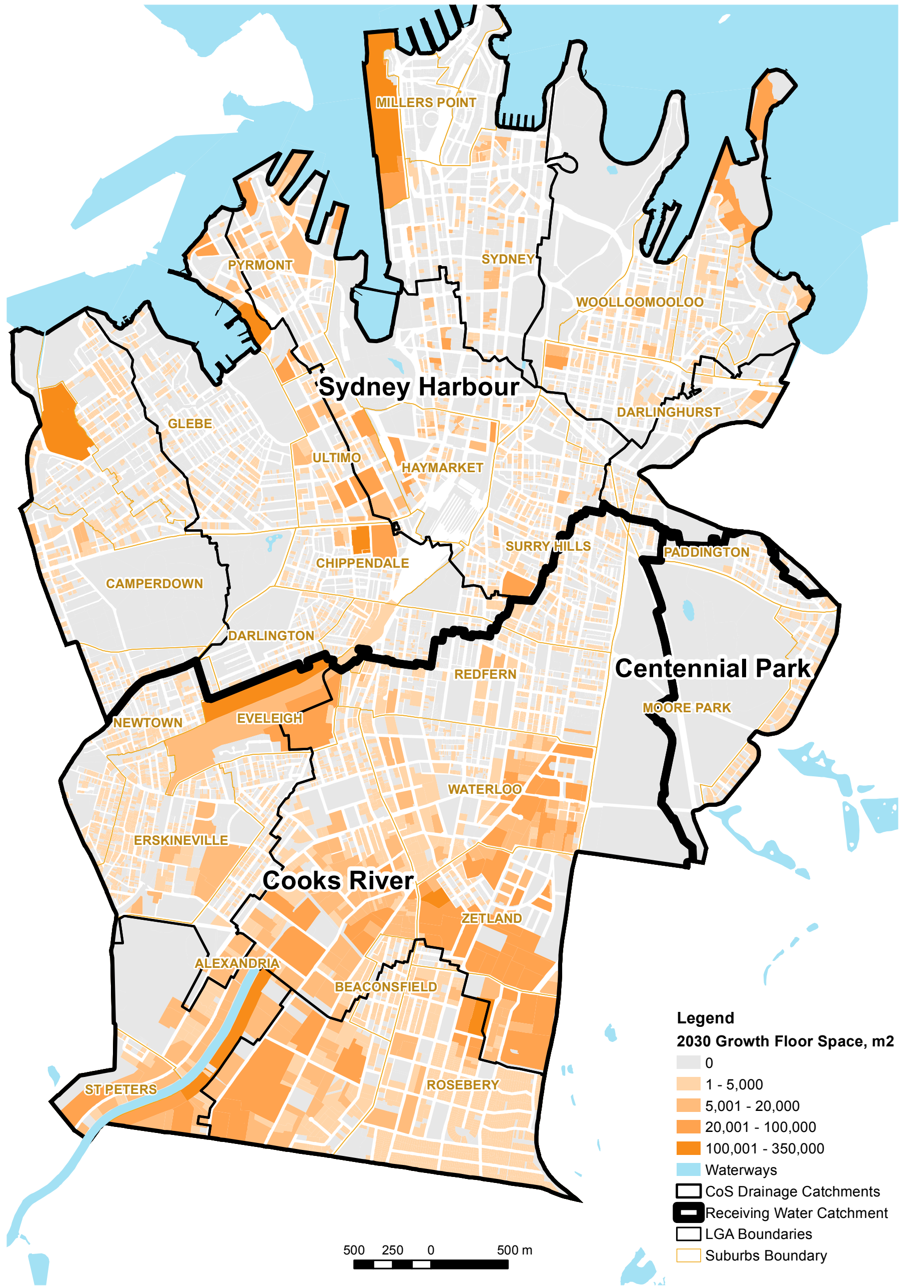


Figure 2.4: Gross floor area



Layer B
Water consumption data

Sydney Water provided 10 years of historical metered water consumption data. This combined with the City's FES data was used to estimate and map water consumption (Figure 2.5) and sector-wise breakdown of water demand (Figure 2.6) profiles for properties within each sector.

In 2010, properties in the City of Sydney used 33.7 billion litres of drinking water, which is 7 per cent of water demand in Greater Sydney. A sector-wise breakdown of water demand (Figure 6) shows that multi-residential and office buildings consume the greatest amount of water in the city.

As shown in Figure 2.7, almost 50 per cent of water demand in the city has the potential for using non-drinking quality water compared to the remaining half that needs to be supplied with drinking quality water.

This analysis has helped in identifying the scope for water efficiency and water recycling solutions.

Figure 2.5: 2010 water demand

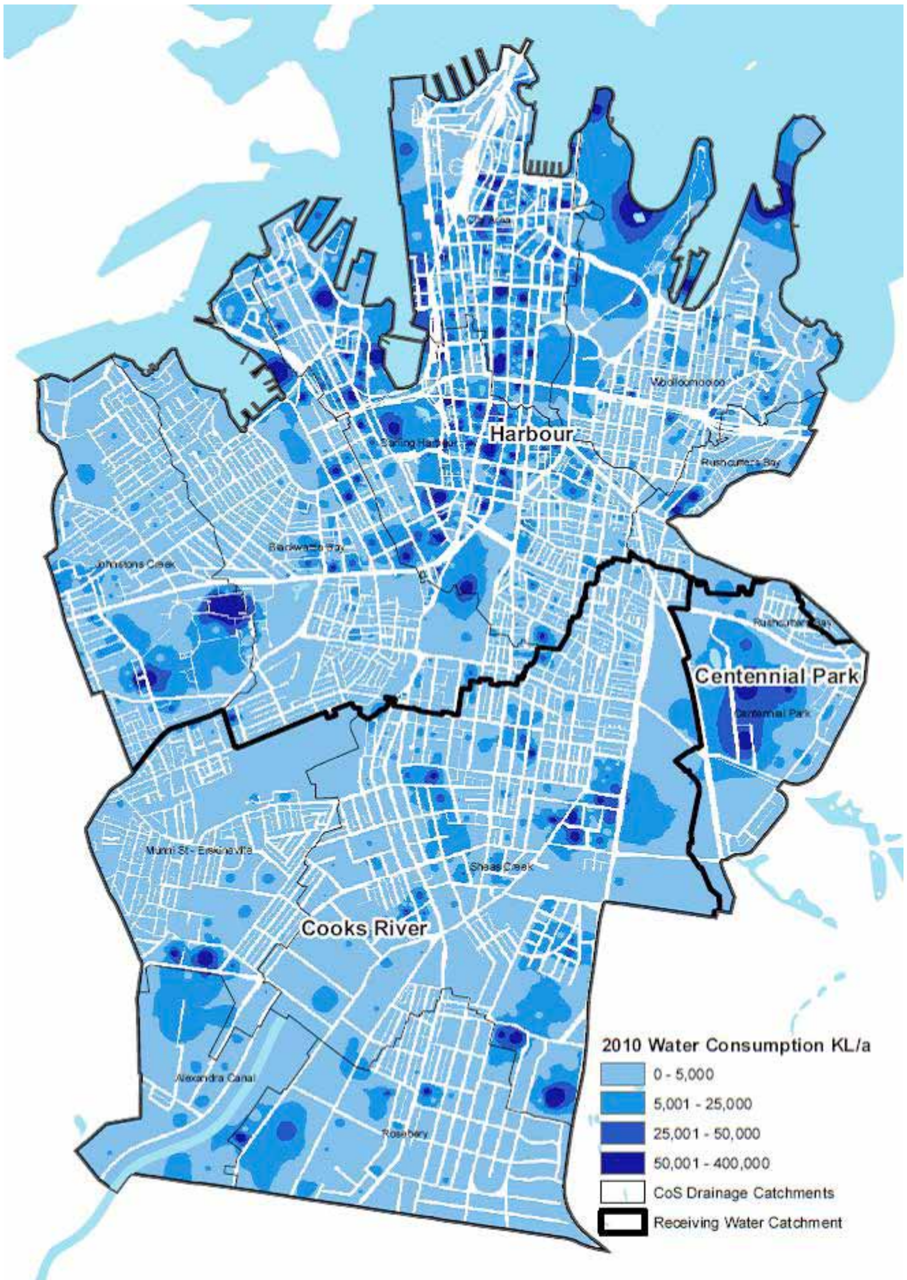


Figure 2.6: Water demand breakdown by sector and by receiving water catchment

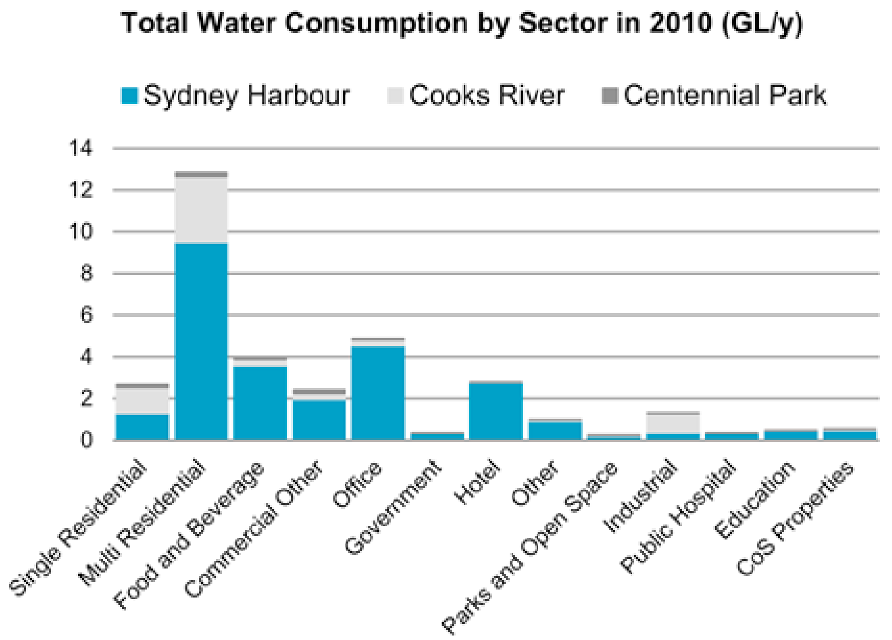
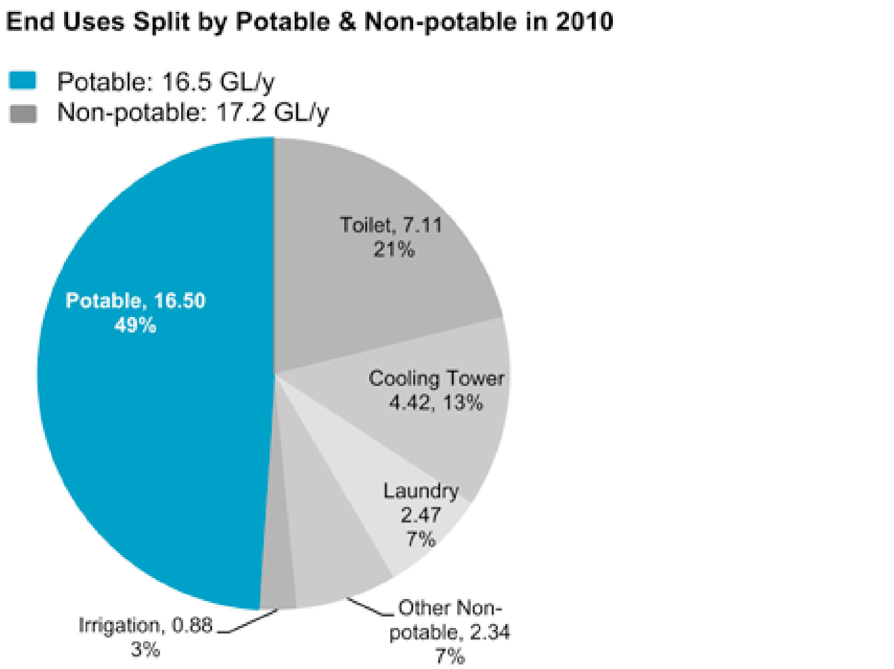


Figure 2.7: Water demand breakdown by water quality requirement



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What is non-potable water demand?

Currently, drinking quality water is used for many uses that do not require such high quality water. For example: toilet flushing, cooling towers, watering of gardens and parks. Water demand of such uses is termed as non potable demand.

The analysis in this Master Plan assumes that taps in kitchens and bathrooms, shower and bath areas would be supplied with drinking quality water. This demand is termed as potable demand. In addition to these specific water uses, some of the water use sectors such as food and beverage and hospitals were also assumed to be supplied with drinking quality water for all uses. The demand by all such water uses and the specific sectors was estimated to be potable demand of the City.

All other water uses were assumed to have the potential for being supplied with non-drinking quality water. Therefore, the scope and potential of non potable water demand was estimated by deducting the potable demand from total demand.

Cooling towers consumed 4.4 gigalitres or 13 per cent of total water demand in 2010. Figure 2.8 reveals the concentration of cooling tower water demand in the Sydney Harbour catchment, which highlights an opportunity to target this demand through water efficiency and recycled water initiatives.

Other non-drinking water demand that currently uses drinking quality water and could use recycled water includes toilet flushing (20 per cent of demand), laundry (7 per cent of demand), irrigation (3 per cent of demand) and other uses such as washing of parking bays and other common areas of buildings.

Figure 2.8: 2010 Cooling tower demand

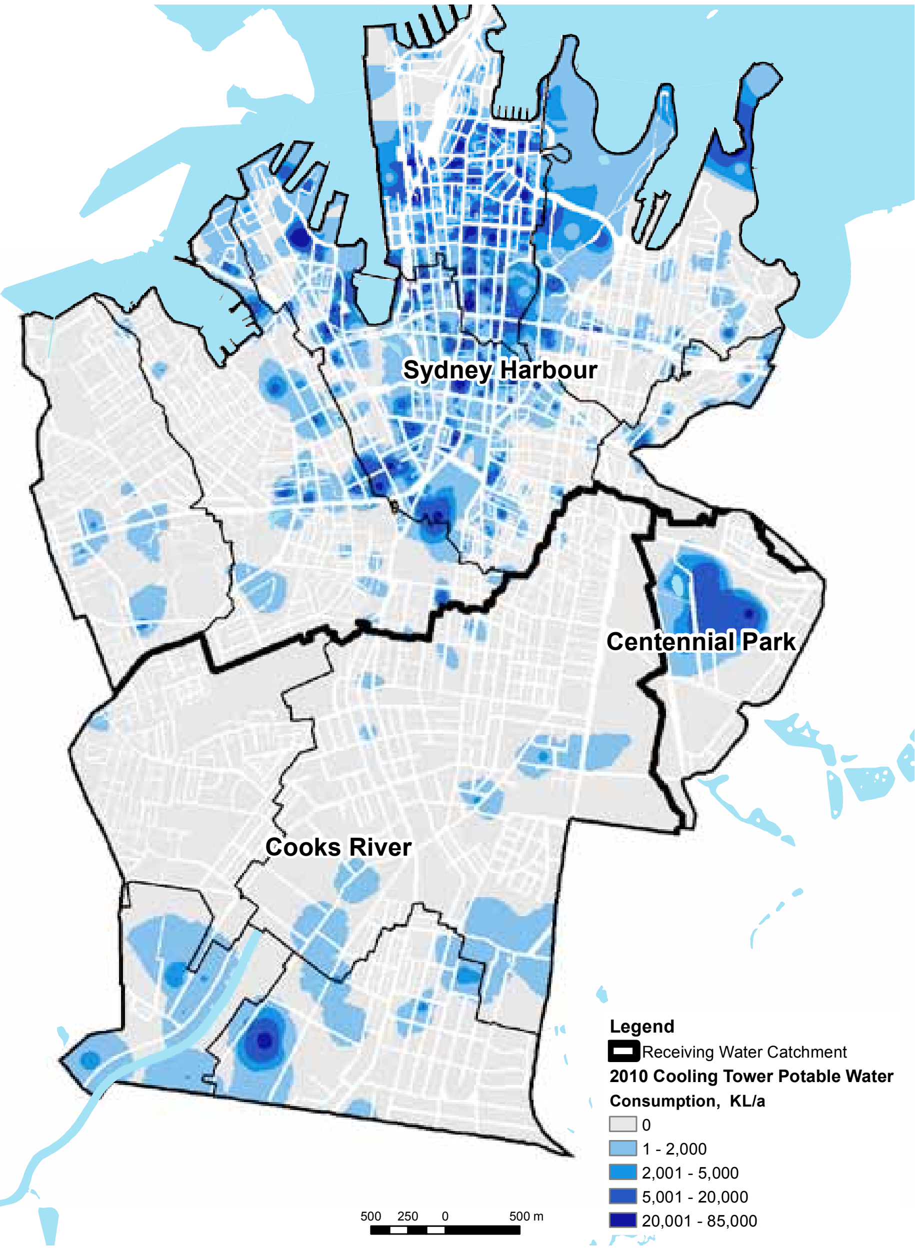


Figure 2.9: 2030 water demand: potable and non-potable water demand

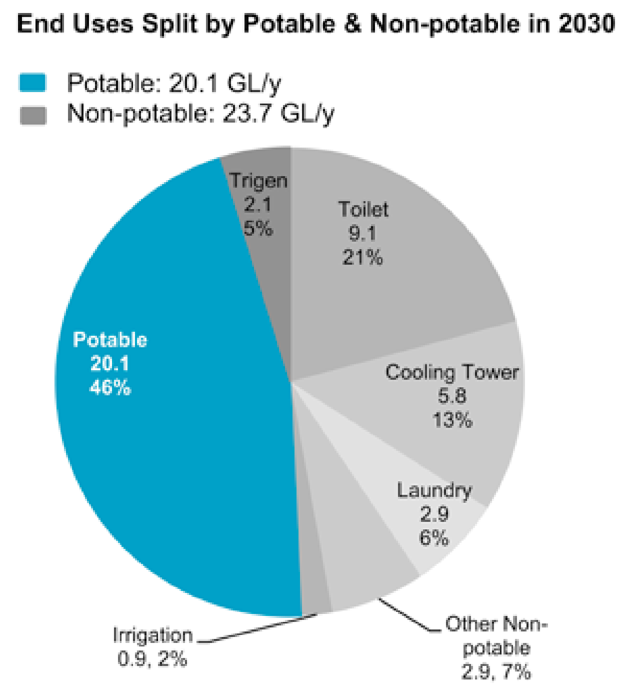
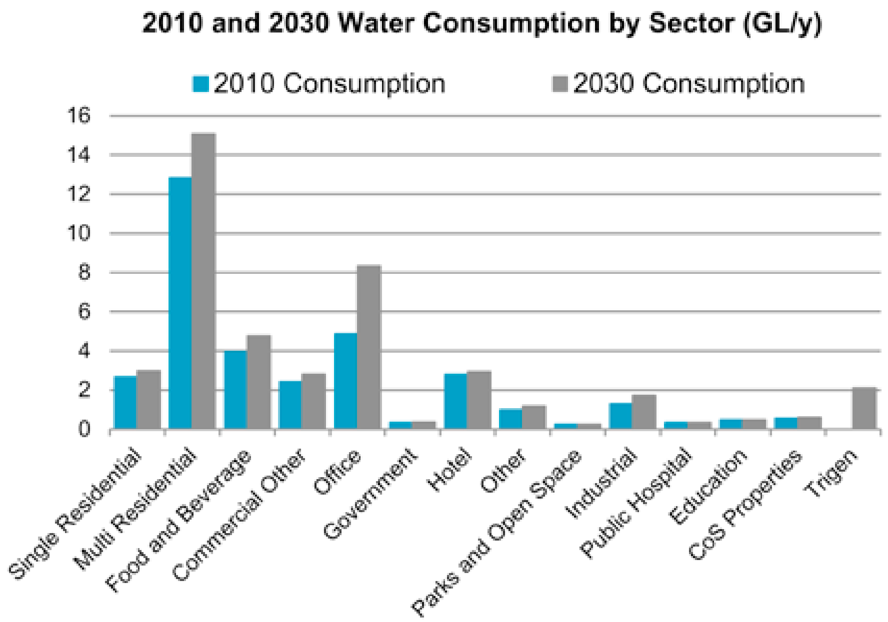


Figure 2.10: Sector-wise water demand: current vs future



Layer C
Growth in demand by 2030

Water demand in re-development areas present the best technical opportunities for incorporating decentralised water solutions. That is because, unlike retrofitting new solutions to old and existing properties, new designs can be integrated while planning new buildings.

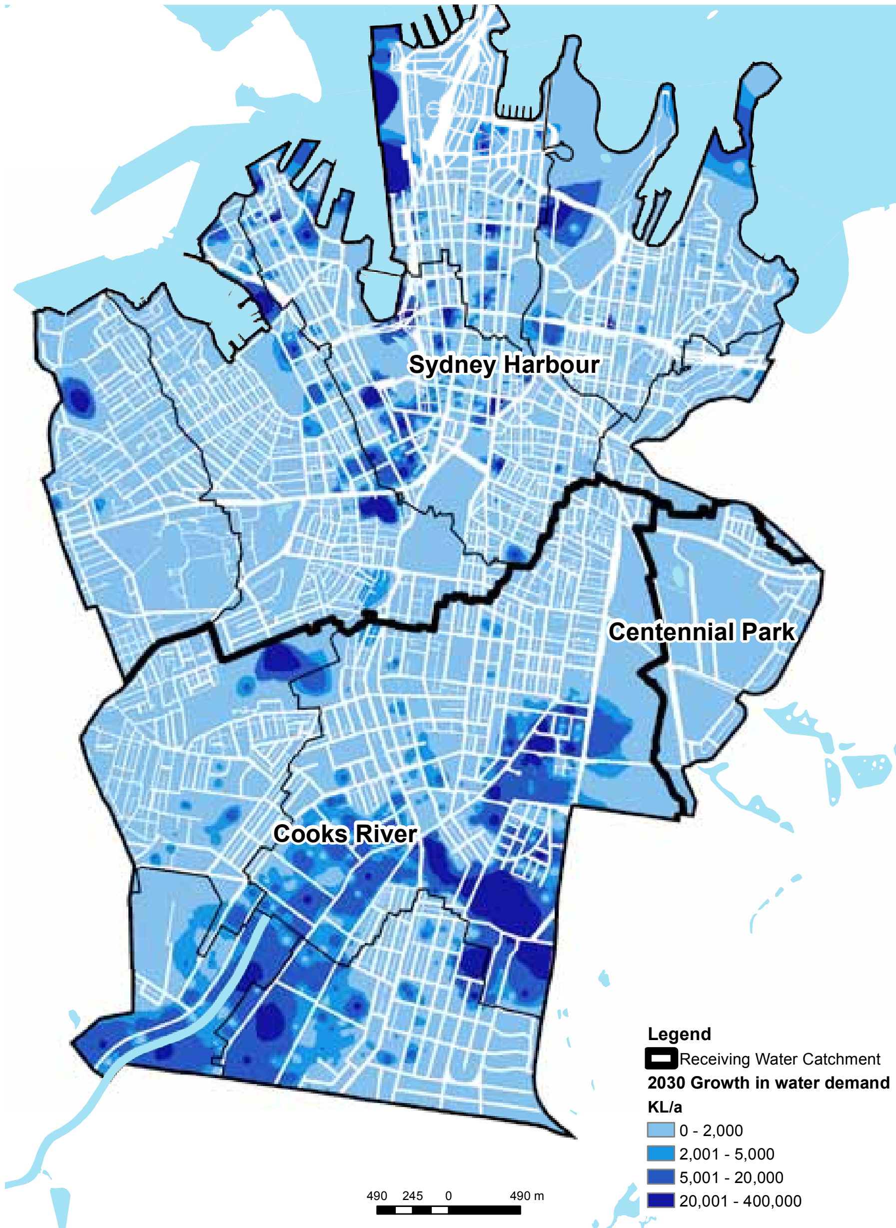
However, existing development can provide better economic opportunities than new development simply because of certainty of water demand against which projects can be financed. Whereas new developments are often built in stages over many years. Hence, financing of projects for early phases is often difficult.

Figure 2.10 shows the change in the sector-wise breakdown between current (2010) and future (2030).

Figure 2.11 maps the growth areas of water demand. This includes those currently under development such as Barangaroo, Central Park and Harold Park in the Sydney Harbour catchment. Significant development and changes in land use are planned in the Cooks River catchment with major developments anticipated in the greater Green Square area and Waterloo. Significant growth is also projected in the area surrounding Alexandra Canal, where the nature of land use is expected to change from industrial to multi-residential.

City wide, approximately 40 per cent of total growth in built form is expected to be infill development. The remaining 60 per cent is expected to be in major brown field redevelopment.

Figure 2.11: 2030 Growth in water demand



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Layer D1
Stormwater

Stormwater, groundwater and seepage water are local water resources and are, by nature, interconnected. Underground structures like railway tunnels are characterised by groundwater seepage, which is traditionally pumped and discharged into stormwater drains.

Figure 2.12 shows the map of the stormwater drainage network overlaid with maps showing location of flooding hot-spots.

Some noteworthy facts about stormwater are:

- Nearly half of the stormwater drainage network (downstream bigger pipes or trunk drains) is owned and managed by Sydney Water and the remaining half (upstream smaller pipes and pits) by the City of Sydney. The divided ownership of the stormwater assets and the management of stormwater resting solely with the City of Sydney adds further complexity to the provision of stormwater management services.
- Major developments will add further pressure on already strained infrastructure.
- Average annual stormwater run-off volume is 20 billion litres.

Mapping the opportunities and issues simultaneously helps in identifying the opportunities that tap into potential synergies between stormwater pollution reduction, stormwater and wastewater recycling and flood mitigation.

Over 20 billion litres of stormwater is discharged annually from the city into the waterways. This is nearly the same volume of water we would need by 2030 for non-drinking purposes.

Urban development typically results in replacing natural impervious soil surface with hard and paved surfaces. This results in more volume of stormwater generated and more pollutants picked up by fast flowing stormwater and dumped into the waterways.

Figure 2.12: Stormwater network system

Layer D2

Groundwater and tunnel seepage

Groundwater

Figure 2.13 shows the extent of the Botany Sands aquifer underlying the Cooks River and Centennial Park catchments as well as the current groundwater management zones. The general zone (green) near Centennial Park is available for domestic use and zone 2 (pink) is currently banned for domestic use. The aquifer in the Cooks River catchment of the city is a potential source of alternative water.

Numerous groundwater bores already exist and groundwater is currently used for irrigation, eg, golf courses and industry, as process water. The aquifer is relevant to this study as a potential water source and storage area for treated stormwater and recycled wastewater.

A separate study may be required to undertake hydro-geological investigations in order to fully understand the potential of the aquifer.

Groundwater Seepage in Tunnels

Figure 2.14 shows the location and volume of groundwater seepage dewatered from railway tunnels. Major sources of the seepage water are the Cross City Tunnel (131 ML), Ausgrid's Campbell Street tunnel (96 ML) and Green Square Railway Tunnel (30 ML).

Figure 2.13: Groundwater

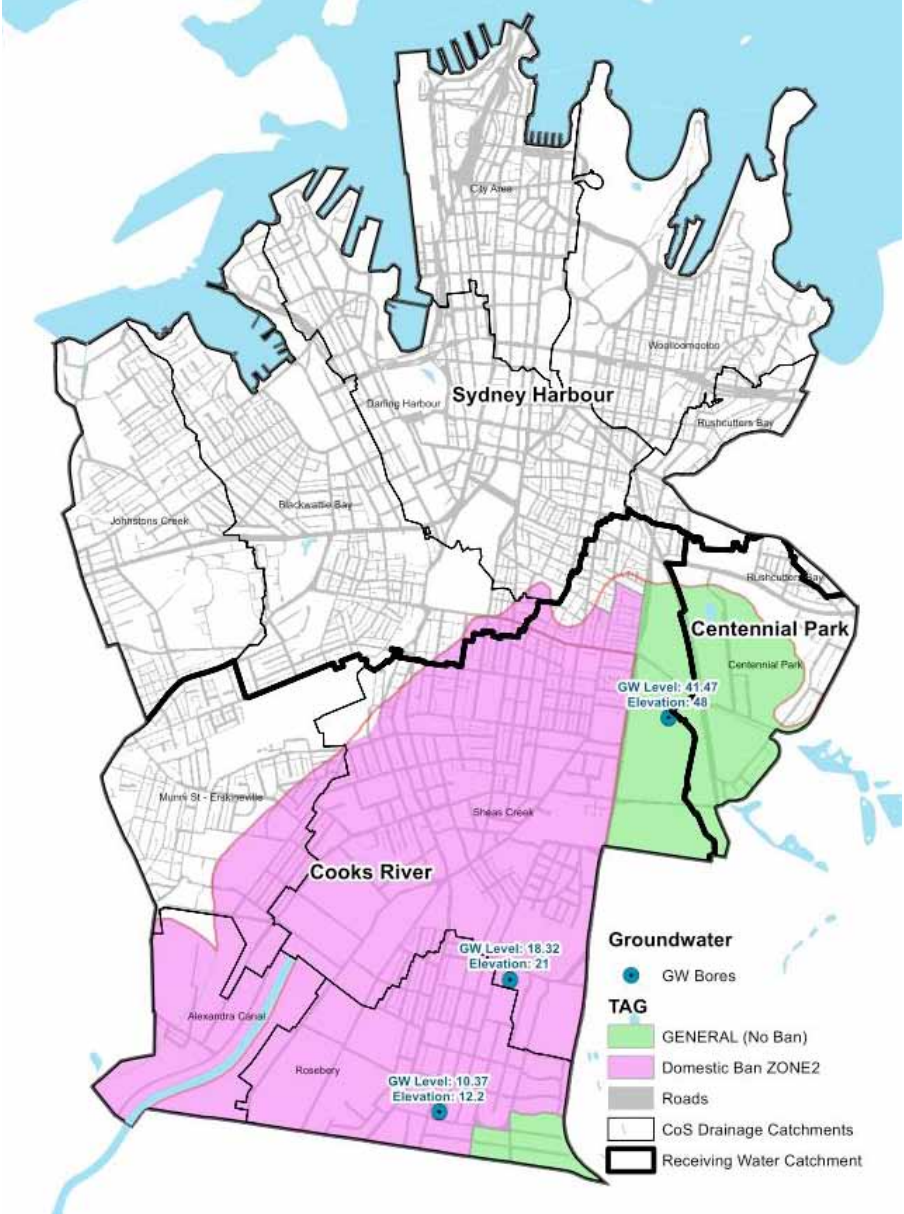
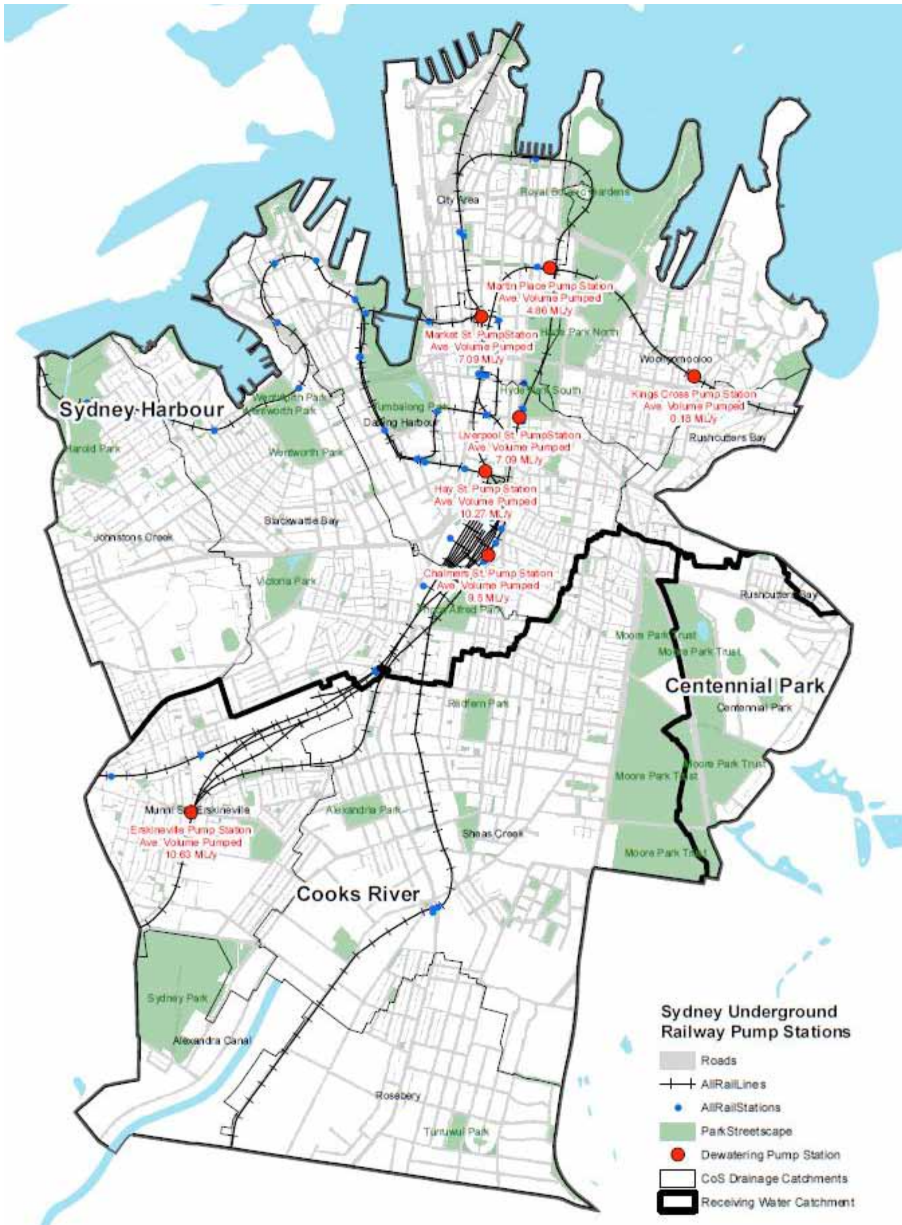


Figure 2.14: Tunnel seepage water dewatered in tunnels



The total volume dewatered from railway tunnels annually is about 257 million litres. This is nearly 1.2 per cent of the total non-drinking water demand in 2030

Layer E
Wastewater

Water treatment technology has advanced significantly in the last decade to the extent that using innovative technology even the dirtiest of wastewater can be converted into clean water fit for any non drinking use without posing unacceptable risk to health and safety.

Figure 2.15 shows a map of the existing wastewater collection system, including pipes and pumping stations within the city. This enabled the location and yields of wastewater to be estimated as a local water resource for producing recycled water suitable for non drinking purposes.

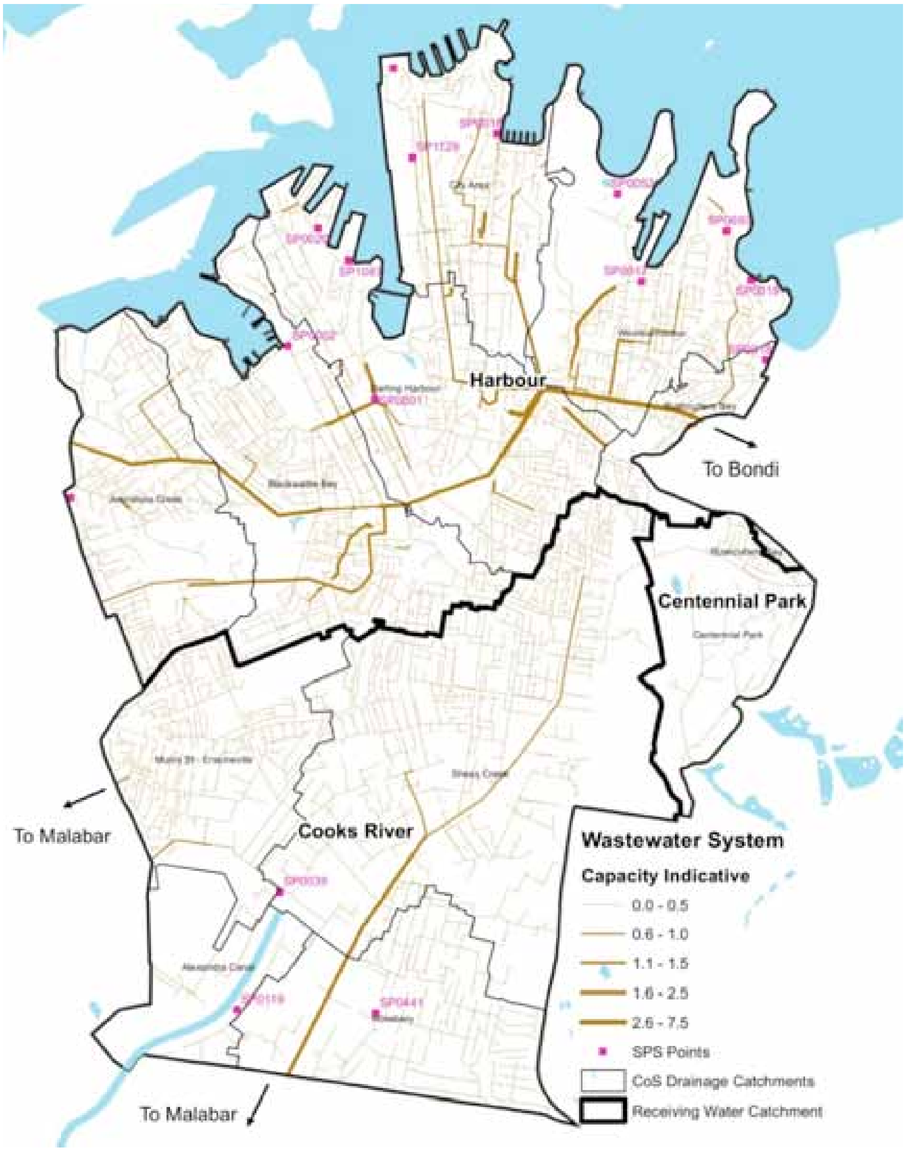
There are two wastewater catchments relevant to the city – the Bondi Ocean Outfall Sewer (BOOS) which collects wastewater from the north of the city and transfers it to the Bondi wastewater treatment plant and the Southern and Western Suburbs Ocean Outfall Sewer (SWSOOS) which transfers the wastewater from the south-west of the city to the wastewater treatment plant in Malabar.

The volume of wastewater collected relates to the volumes discharged from individual properties in the city area as well as volumes from neighbouring areas. There can also be considerable ingress of stormwater and groundwater into the sewer system through cracks developed in the ageing sewer pipes.

Pumping stations are often the preferred location for harvesting wastewater from the network to avoid additional pumping costs.

Nearly 28 billion litres of wastewater is collected annually from the city and dumped into the ocean after primary treatment. This is more than the volume of water that we would need in 2030 to supply non-drinking water demand.

Figure 2.15: Wastewater network system



Layer E
Future wastewater volumes

Future Wastewater Volumes

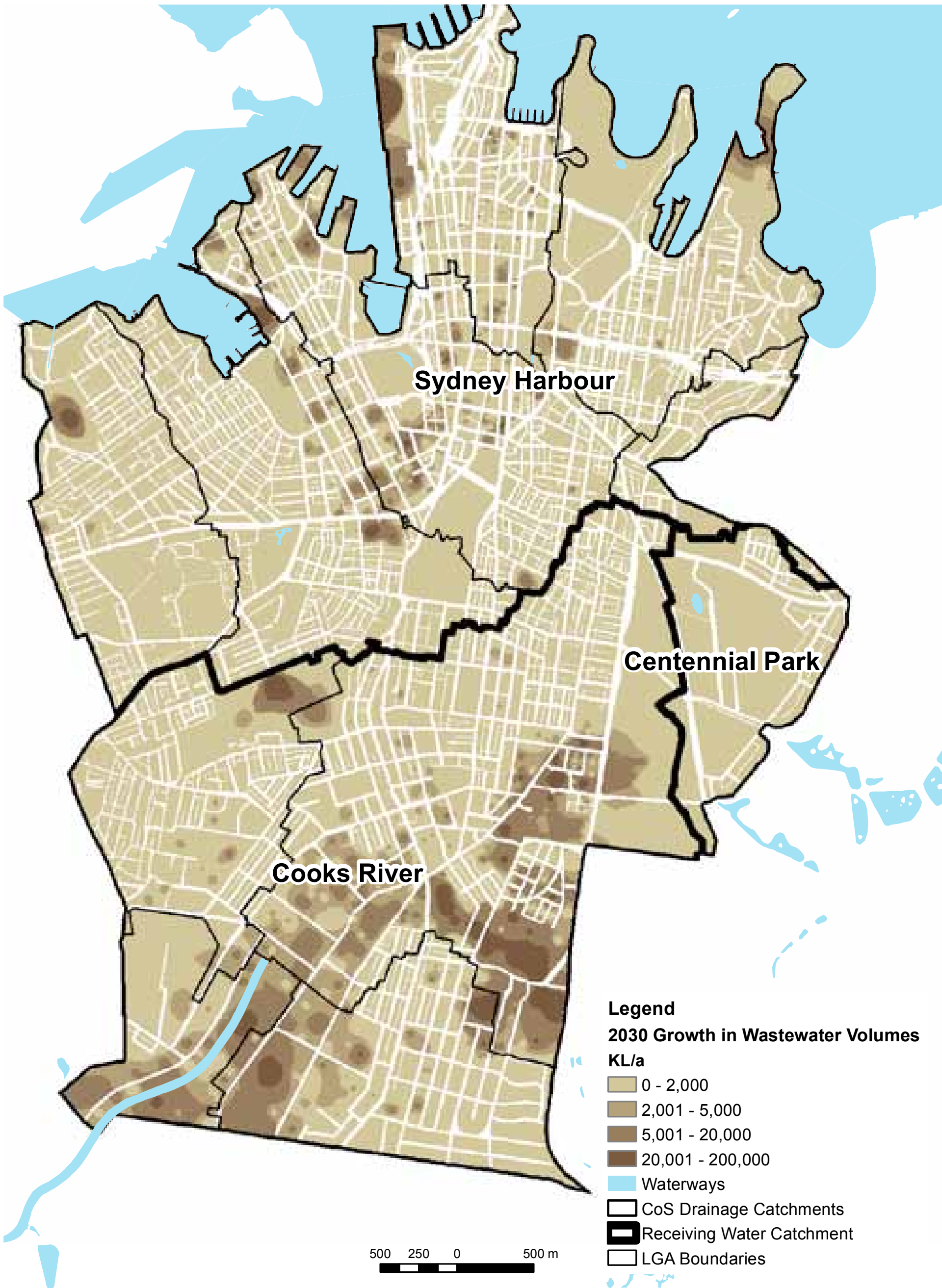
Figure 2.16 shows the projected wastewater volumes generated from individual properties in the City of Sydney by 2030. This estimate was based on the growth in water demand. Understanding how much wastewater is generated was necessary to map and analyse the precinct and catchment scale oppprtunities for using wastewater as an alternative source for producing recycled water to meet non-potable water demand.

Decreasing Sewer Capacity and Wastewater Overflows

Wastewater overflows occur during wet weather events and result in discharge of wastewater to the stormwater system and waterways. Tree roots, fat and grease and debris choking the system are common causes of dry weather overflows. In the case of the City of Sydney, significant population growth and development that has occured since the sewer pipes were laid also contributes to dry weather wastewater overflow.

Reducing water demand (and the assciated dry weather wastewater flow) through water efficiency measures and harvesting and recycling of wastewater from sewer pipes (sewer mining) have the potential benefit of relieving the sewer capacity and potentially reducing the frequency or volume of sewer overflows, particularly those related to dry weather.

Figure 2.16: Growth in wastewater volume by 2030



Layer F

Land use and surface type

Figure 2.17 maps the surface characteristics of the city. The proportion of roads, roofs, hard surfaces and parks determines the volume of stormwater run-off as well as the pollution load generated and carried by the stormwater and discharged into the Sydney Harbour, Cooks River and Centennial Park ponds.

Based on the surface type breakdown in each sub-catchment, an estimate was made of the pollution load currently discharged by each sub-catchment.

The stormwater pollutants that are key to the protection of the waterways for their aesthetic, environmental and recreational values include visible pollutants such as gross pollutants (litter and floatable matter) and suspended solids (sediments and debris). Not so visible but harmful to the environment and ecosystem of the river are: nutrients, heavy metals, faecal matter and hydrocarbons.

Nutrients are generated in the catchment from the use of fertiliser on the parks and gardens as well as animal and bird faeces. Nutrients have the potential to cause algal blooms. Heavy metals make their way to the waterways from the wear and tear of the metal parts of the vehicles on the road. Heavy metals can have an adverse cumulative effect over a long period of time on the flora and fauna living within the waterways.

Hydrocarbons make their way from the noxious fumes in the atmosphere released by vehicular traffic.

Faecal pollution occurs by wastewater overflowing from the sewer system and making its way to the stormwater drainage network in the proximity.

Figure 2.17: Surface type breakdown of the LGA

Comprehensive water balance and stormwater pollution balance analysis

This master plan has modelled gross pollutants, total suspended solids and nutrients (total nitrogen and total phosphorous) to develop a baseline against which to set pollution reduction targets.

The sediment removal process tends to also remove hydrocarbons, heavy metals, oil, grease and phosphorous because they generally attach themselves to the heavy sediment particles.

Faecal pollution occurs by wastewater overflowing and making its way to the stormwater drainage network in the proximity.

In relation to faecal contamination, Sydney Water has a mandatory obligation to manage the wastewater overflows (and the associated wastewater contamination). The City of Sydney will continue to lobby and advocate for the elimination of overflows. This pollutant is not under the direct control or influence of the City, and therefore has not been included among the pollutants for setting targets.

The City's targets of reducing its reliance on mains water by local water capture and achieving 50 per cent reduction in stormwater pollution discharged into the waterways requires re-thinking the urban water management environment.

Figures 2.17, 2.18 and 2.19 respectively display the results of the comprehensive city wide water balance and pollutant load balance analyses. These two models underpin the analysis for mapping and determining the solutions identified in the Decentralised Water Master Plan.

Figure 2.18: LGA water balance

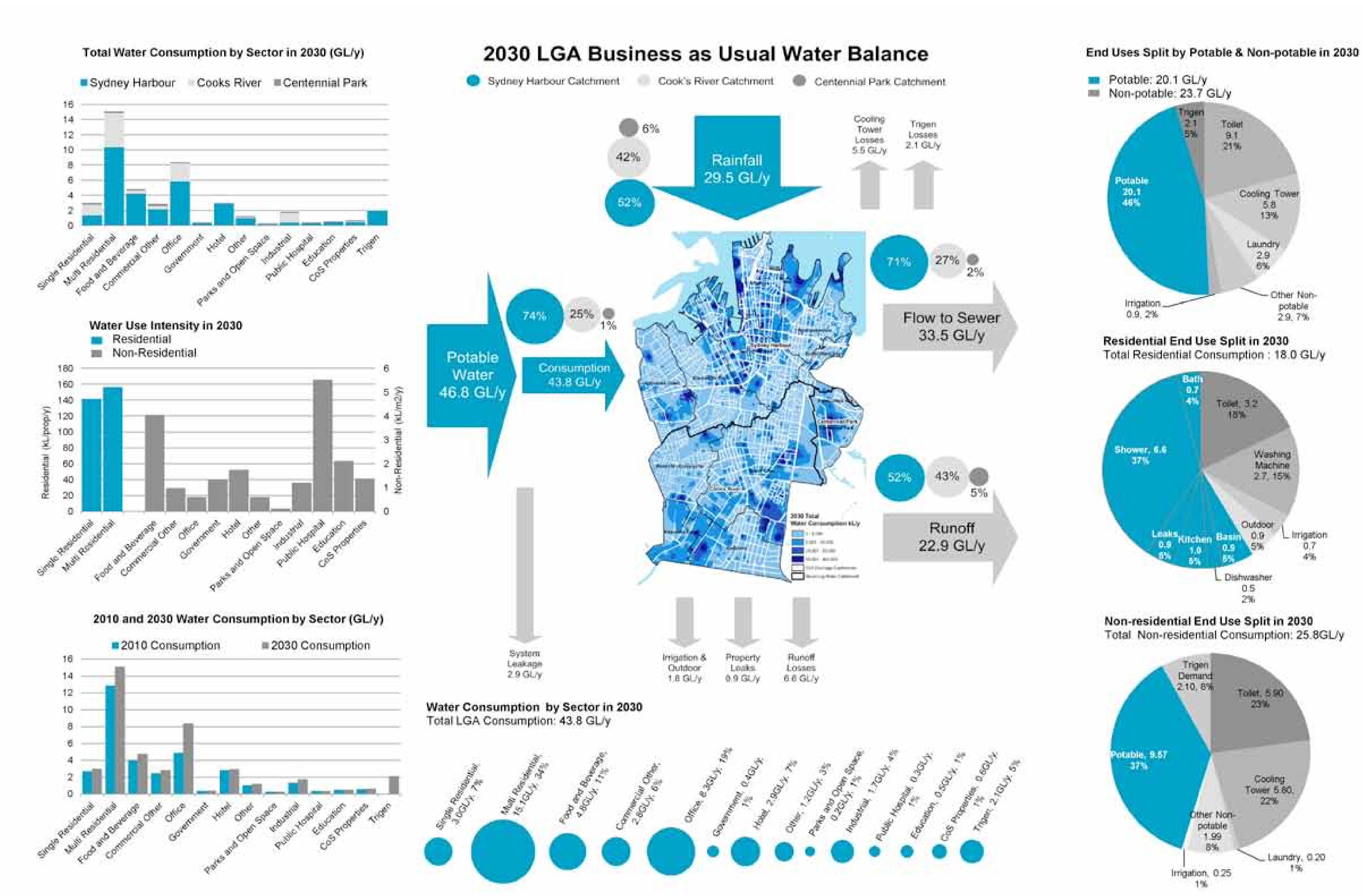


Figure 2.19: Catchment Summary: City of Sydney LGA

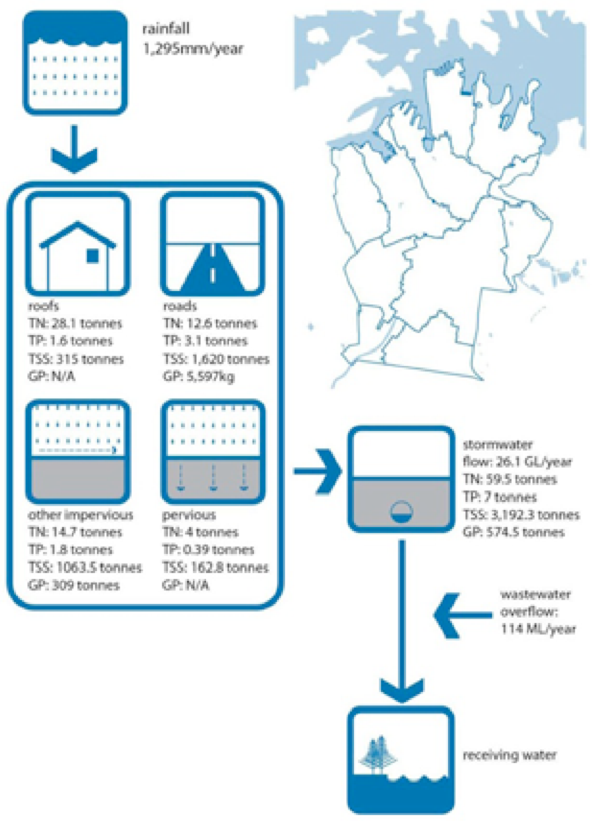
Sub-Catchment Area: 2,660 ha
Estimated stormwater runoff volume: 26.1 GL/year
Assumed Rainfall: 1,279 mm/year using 1962-66 as sample years

The City of Sydney LGA is a highly urbanised catchment draining to three receiving water bodies, being the Cooks River (to Botany Bay), Sydney Harbour and the Botany Bay Wetlands. The LGA is further divided into 11 sub-catchments, each with specific characteristics that influence the quality of stormwater draining from it, including the proportion of pervious and non-pervious areas, and the nature of those non-pervious areas (e.g. road, roof, car park etc).
The predominant water demand in the LGA is from residential and commercial/industrial users.
There are significant open spaces within the LGA that provide major opportunities for harvesting and reuse of stormwater.
Overland flow paths have been obstructed through development resulting in flooding events impacting property, roadways and open space.

Key Stormwater Quality / Harvesting Opportunities

Open Space	
Royal Botanic Gardens / The Domain	Moore Park
Harold/ Jubilee /Bicentennial Park	Sydney Park
Wentworth Park	Hyde Park
Major Redevelopments	
Harold Park	Barangaroo
Redfern Waterloo	CUB / Frasers
Green Square	North Everleigh

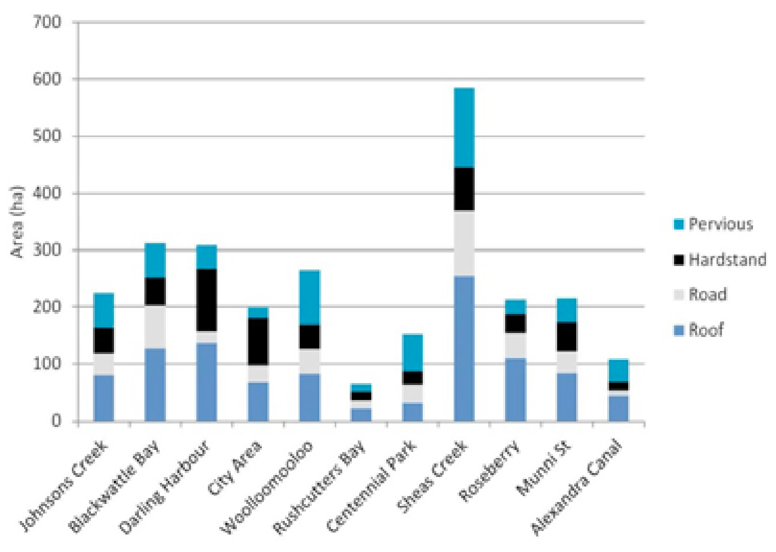
Stormwater Pollution Balance



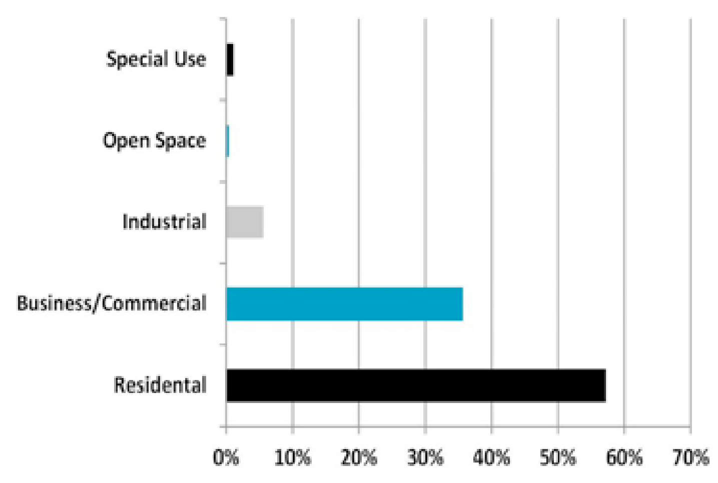
Stormwater Quality Baseline

Pollutant	Estimated Annual Load (tonnes)
TSS	3,192
TN	60
TP	7.1
Gross Pollutants	575

Surface Type (Ha)



Water Demand by End Use (%)

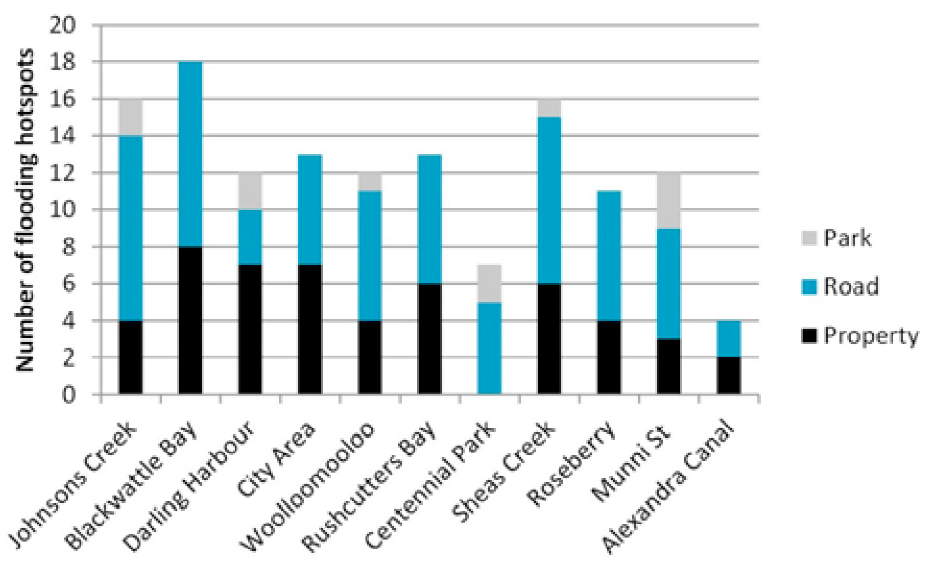


Existing Council Initiatives

Existing Stormwater Harvesting Projects		
Sydney Park (Stage 1)	Alexandria Park	Foley Park
Peace Park	Victoria Park	Barcom Ave Park
Prince Alfred Park	Darlinghurst Rd	Waterloo Park
Blackwattle Bay Park	Glebe Foreshore	Solander Park
Water Police Site	Harmony Park	Taylor Square Fountain
Redfern Park		

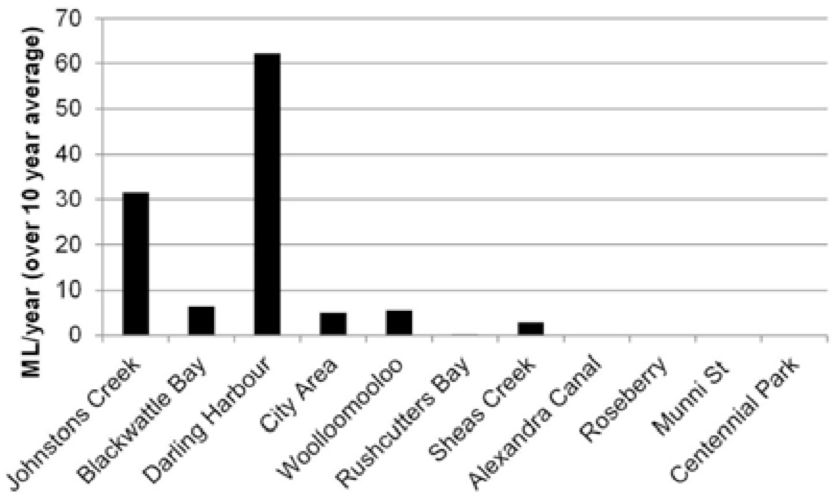
Existing Rainwater Harvesting Projects		
Alexandria Childcare Centre	Joseph Sargent Community Centre	Rushcutters Bay Kindergarten
Bay St Depot	Maybanke Recreation Centre	Sydney Park Nursery
Broughton St Kindergarten	Millers Point Activity Centre	Ultimo Community Centre
Epson Rd Depot	Millers Point Older Woman's Network	Jane Evans Day Care Centre
Hilda Booler Kindergarten	Redfern Occasional Child Care Centre	

Flooding Hotspots (by frequency)



Source: South Sydney Stormwater Quality and Quantity Study, Rushcutters Bay and City Area, December 2003 and Historical Flooding information for stormwater branch No. 30

Wastewater Overflow Hotspots (by volume)



Source: Sydney Water, City of Sydney Sewer Overflows

Government positions on recycled water

NSW Government

The NSW Office of Water and Metropolitan Water Directorate are the two state government agencies that have responsibility for policies and strategies for urban water supply in the Sydney Metropolitan area. The Metropolitan Water Plan outlines NSW Government's long term security of water supply in Sydney.

The Metropolitan Water Plan expects to provide water security until at least 2025 using a portfolio approach that includes:

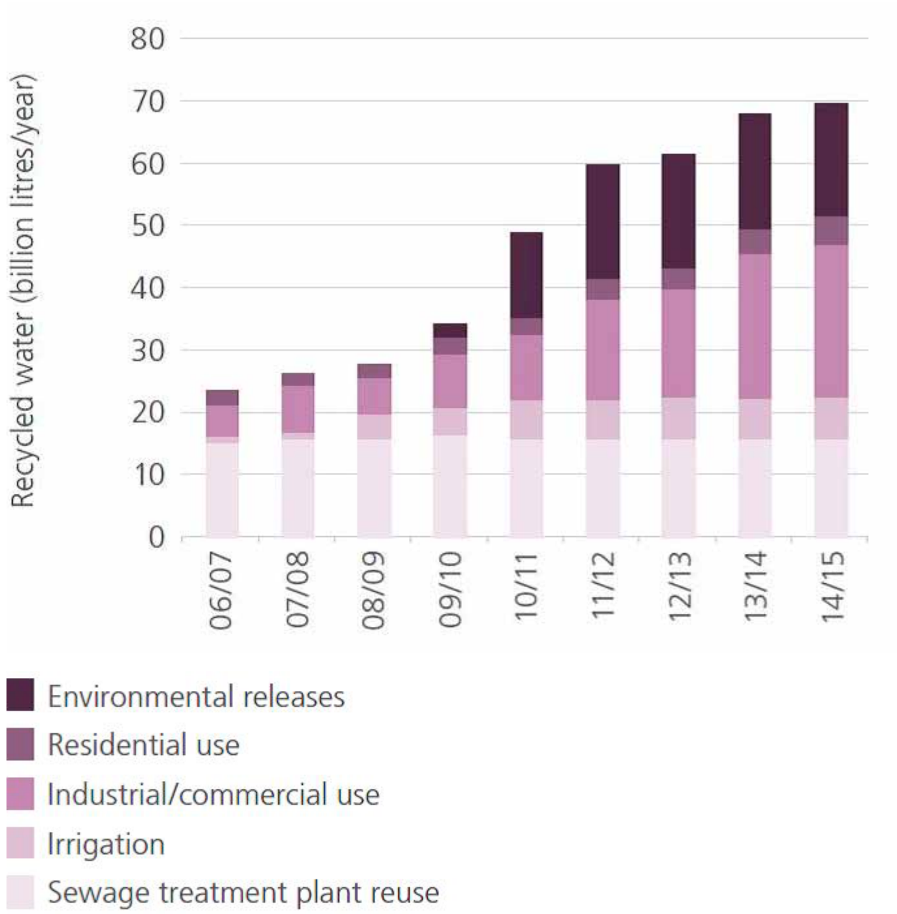
- Dams – up to 570 GL a year
- Recycled water – 70 GL per annum by 2015 and 100 GL per annum by 2030
- Desalination – up to 90 GL per annum (at full production)
- Water efficiency – 145 GL per annum saved by 2015 through BASIX and the WELS program.

Figure 2.20 provides a breakdown of how the Metropolitan Water Plan aims to achieve its recycled water target of 70 billion litres a year by 2015.

To put the Metropolitan Water Plan in perspective:

- 70 billion litres of recycled water makes up only 11per cent of 600 billion litres of 2015 demand of Greater Sydney.
- 15 billion litres sewage treatment plant reuse amounts to only 3 per cent of wastewater recycling, making it significantly below the National recycled wastewater target of 30 per cent
- Desalination uses an electrical energy intensive reverse osmosis process to achieve the water security objective.

Figure 2.20: Use of recycled water in Sydney: 70 billion litres a year by 2015



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Sydney Water

In development of its 25 years servicing strategy, Sydney Water investigated the condition of water and wastewater infrastructure and also explored the decentralised recycled water schemes in the South Sydney area and the CBD. The investigation concluded that:

1) Water and sewage infrastructure in both the CBD and South Sydney are in good condition.

2) Therefore, decentralised recycled water schemes would not provide any significant reductions in the avoided costs.

The current institutional and regulatory arrangements neither encourage nor require Sydney Water to invest in decentralised recycled water schemes.

However, Sydney Water has recently adopted a new Corporate Strategy that identifies its need to provide customers with solutions that they value, and to support its key role in contributing to Sydney as a liveable city.

As Sydney grows and as Sydney Water responds to the expectations of its customers, water management must become part of a broader plan for the city's future. Sydney Water is therefore shifting its focus from traditional water supply, wastewater treatment and disposal, to a greater range of fit for purpose sources and services that support a future city and respond to its customers' values and preferences.

Affordability, urban amenity, protection of waterways, energy and resource recovery, and resilience in the face of weather extremes and emergencies, are now seen as key outcomes that can be achieved through better integration of water management with urban planning, and collaboration with Council, developers, government agencies and other stakeholders.

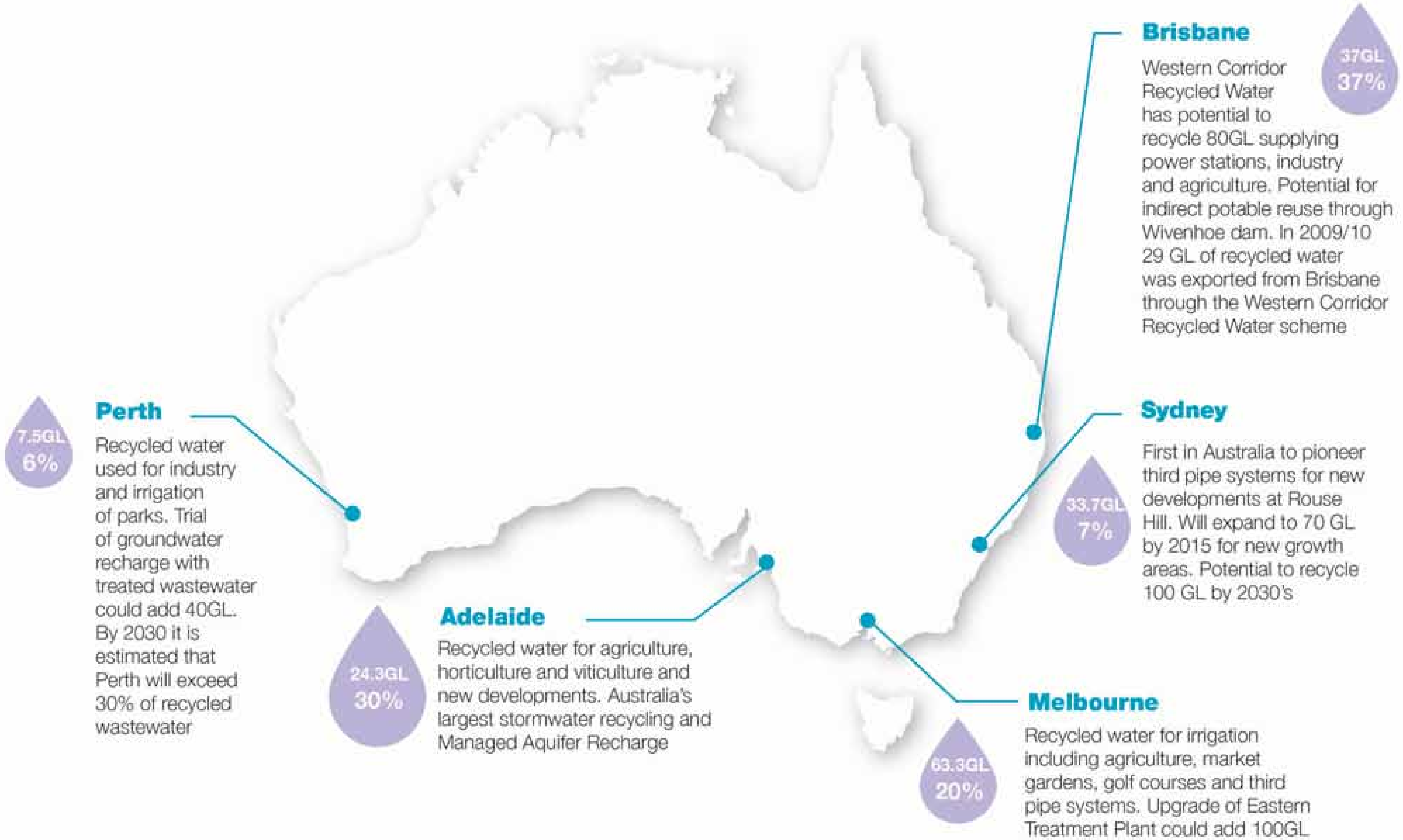
It should be noted that under legislation introduced by NSW government, the Water Industry Competition Act (WICA) 2006, Sydney Water has obligations to facilitate access to stormwater drainage network and sewer mains for those agencies that may choose to develop and operate decentralised water schemes. The plans and designs of such decentralised water services private agency have to be approved through a rigorous review process by IPART (Independent Pricing and Regulatory Tribunal).

Federal Government

In 2007, Federal Government set a recycled water target of 30 per cent (of wastewater collected) for the capital cities. There has been a significant investment in recycled water schemes across Australia and lessons learnt from these initiatives. The 2010 status report (see page 27) showed that Sydney recycled only 7 per cent of its wastewater compared to the other three major cities that achieved 20 per cent or greater.

This master plan presents a solution that is uniquely designed in the local context and therefore addresses these gaps whilst also contributing to the recycled water targets of State and Federal Governments.

Recycled water (% of wastewater collected) in 2009/10



3. Decentralised water solutions

The current approach to urban water management

Traditional approaches to managing urban water consider wastewater and stormwater as waste. They are managed independent of each other. As a result, opportunities are missed for developing integrated decentralised solutions that are tailored to local opportunities and issues and can achieve multiple objectives.

In the current approach, water, sewage and stormwater are managed as three different services. Water supply and sewage services are planned and managed by Sydney Water and stormwater management is the responsibility of the City. Consequently, any opportunities for integrating the management of these elements of the urban water cycle are often missed. Integrated approach to managing the three urban water streams often results in greater benefits for the community and environment, while also resulting in optimum whole-of-society cost.

There is evidence to suggest that the community is willing to conserve water resources and use recycled water, and are looking to their water service providers and local councils to make such alternative sustainable water available and accessible to them.

In the absence of recycled water being made available by external agencies, residents install rainwater tanks and carry out other measures such as collecting bath and laundry water to water their gardens. Businesses and owners of high-rise buildings have also been installing recycled water schemes on individual buildings. The driving force behind these installations is the tenants valuing and demanding buildings that demonstrate sustainable use of water and energy.

Lack of strategic and integrated management of the urban water cycle has resulted in outcomes which are not optimum solutions from community and environment perspectives. For example:

- **Scale back of water efficiency programs**
  As at 30 June 2012, per capita water use was 297 litres/person/day, well below Sydney Water's operating licence target of 329 litres/person/day. This reflects more than a decade of running state-of-the-art demand management programs.

  Having achieved the per capita consumption target, Sydney Water has significantly scaled back and reduced the funding for these effective programs. From Sydney Water's perspective continuing to invest in such programs after achieving their target incurs the potential risk of increasing water bills, to compensate for the loss of revenue resulting from reduced consumption.

From the City's perspective this represents regulatory failure since reducing mains water consumption will also reduce Sydney Water's costs through reduced water pumping, sewage treatment and operation of the desalination plant which could reduce water bills.

The per capita demand reduction achieved so far is not reflective of the water saving potential that exists within multi-residential apartments and the commercial sector such as office buildings, air conditioning cooling towers, hotels and restaurants that are predominant in the City of Sydney local government area. Therefore, there are significant efficiency gains to be made from continued investment in demand management programs.

There are also opportunities for these programs to be designed and implemented in partnership with local councils and water consumers, thus making such programs more cost effective.

- **Ad hoc nature of recycled water schemes**
  Several site-scale recycled water schemes are being implemented in privately owned buildings and in City-owned parks, gardens and playing fields. As these schemes are proposed and planned by different land owners, they tend to be ad-hoc and lack a strategic approach to recycled water solutions that could be developed as an integrated city-wide decentralised water solution.
- **Lack of focus on catchment management**
  City renewals and upgrades and capital works projects are opportunities to incorporate water sensitive urban designs that are aimed at slowing down and improving stormwater quality. Lack of strategic focus on actively facilitating city-wide water sensitive urban design (WSUD) means the opportunities for integrating them in a planned way are missed.

Determining the ideal solution for the city

This chapter outlines the decentralised water opportunities that were mapped using comprehensive analysis of data specific to the city and across the elements of the urban water cycle. It also then shows the solutions that emerged from those opportunities.

Decentralised water solutions are focused on all the three elements of the urban water cycle – water, sewage and stormwater:

- **Water Efficiency Solutions:** for reducing water demand and therefore sewage volumes through improving water efficiency;
- **Water Recycling Solutions:** for recovering and capturing local water resources such as rainwater, stormwater, groundwater, sewage and sea water to produce recycled water at a scale to match the demand and their proximity to the source; and
- **Water Sensitive Urban Design (WSUD) Solutions:** for retaining, detaining and harvesting stormwater to reduce the pollution discharged to the waterways through water sensitive urban design (WSUD).

Opportunities were first mapped to understand how much potential existed in which locations. Solutions were then designed to capture as much of the opportunities as practicable.

Water efficiency solutions

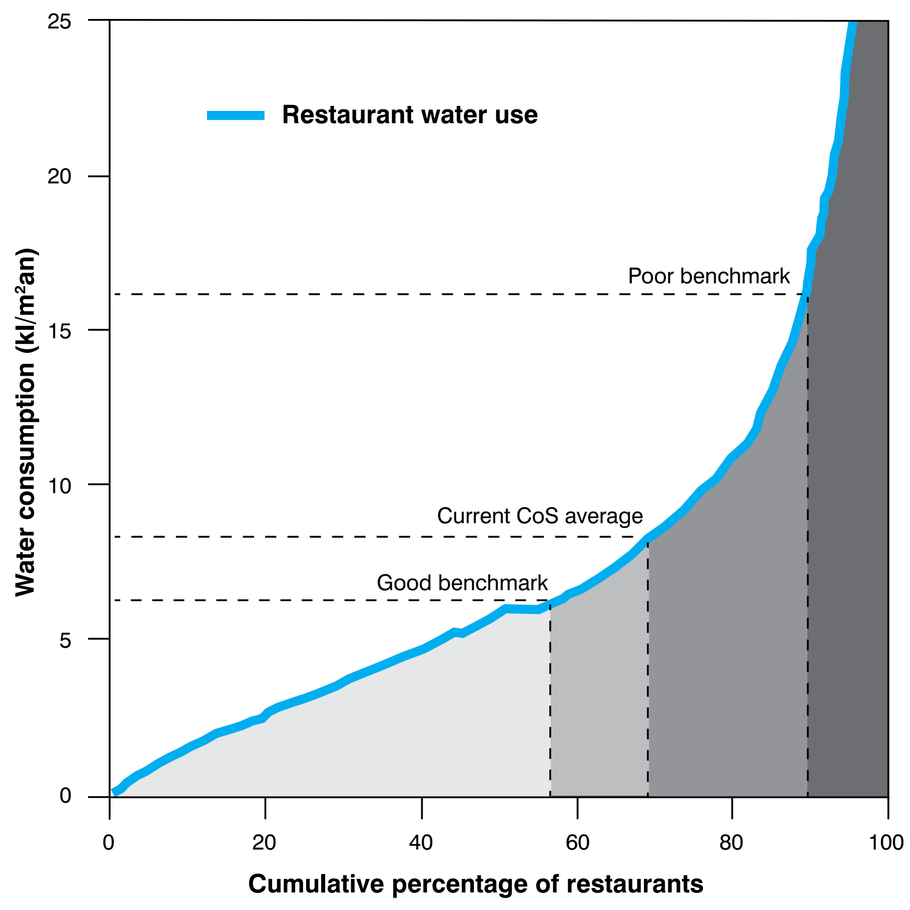
Water Efficiency solutions are aimed at reducing water demand by improving the efficiency of water use.

Mapping Water Efficiency Opportunities

Good and best practice water intensity benchmarks were determined for each sector through an extensive literature search of water audit and water efficiency programs in Australia. Distribution plots for the water intensity of all properties within each sector were developed to compare them against good and best practice benchmarks for the sector.

Figure 3.1 shows an example of a water usage plot for restaurants. It shows that about 58% of restaurants may be classified as being efficient, while only 10% are very poor. However, the gap between current average water intensity (8.4 kL/m2/an) and the 'good' efficiency benchmark (6.4 kL/m2/an) is relatively large, suggesting that there is room for improvement in the restaurant sector to bring average consumption closer to the 'good' benchmark.

Figure 3.1: Example demonstrating the method used for estimating water saving potential in a water using sector



Water efficiency solutions

Based on this approach, it was found that the end use sectors that showed significant scope for improving water efficiency to warrant development of water efficiency programs specifically targeted at them are:

- Single residential
- Multi-residential
- Hotels
- Restaurants
- Offices
- Cooling towers
- Council owned properties
- Aquatic centres

Together these sectors have a potential to reduce water demand through water efficiency by 24 per cent.

Achieving this target would require every single property (end use) within each of the sectors to become water efficient. While theoretically possible, industry experience would suggest only part of this potential can be realised.

A more realistic target was determined based on:

- Literature review of past programs implemented in Australia which had been evaluated for their water savings.
- Significant professional experience evaluating water-efficiency programs.

Finding Solutions

Two portfolios of water efficiency programs representing two levels of investment in water efficiency, either moderate or more intensive can achieve 5–10 per cent reduction in water consumption. The estimated sum of savings from these two portfolios is shown in Figure 3.2 along with the theoretical maximum efficiency potential.

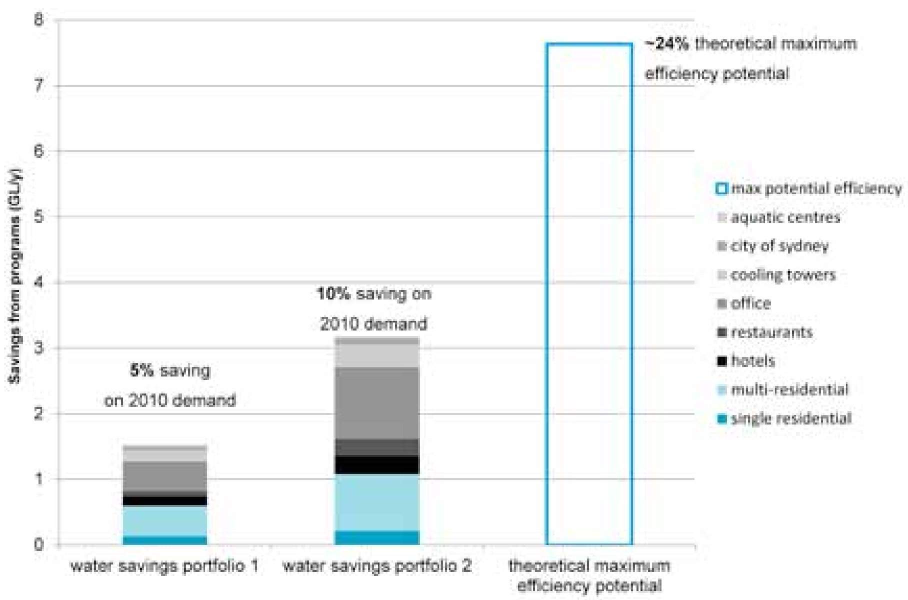
Using this evidence-based robust analysis, a water efficiency target has been set of 10 per cent reduction in 2006 demand by 2030.

These programs involve working closely with the Office of Environment & Heritage, Sydney Water, Better Buildings Partnership and other relevant industry peak bodies in designing and implementing water efficiency programs targeted to each sector.

Chapter 4 provides an assessment of these solutions on the basis of their levelised cost and the potential they represent to provide water savings, along with descriptions of how these solutions may be implemented.

Almost a quarter of annual water demand in the City could be reduced by switching to water efficient devices and operations.

Figure 3.2: Water savings from individual sectors upon improving water efficiency



Water-recycling solutions

Water-recycling solutions replace mains water with recycled water from locally available water resources for non-drinking water demand.

The analytical process for determining water recycling solutions was aimed at finding a match between supply (available yield) of a local water resource and water demand (non-drinking use) in the proximity of the water source.

Recycled water demand

The non-drinking water demands that were considered for supplying with recycled water include:

- Demand within existing properties:
  - – Toilet flushing
  - – Cooling towers
  - – Irrigation
  - – Washing bays, etc.
  - – Industrial processes
- Demand within new development:
  - – Toilet flushing
  - – Cooling towers
  - – Irrigation
  - – Washing bays etc.
  - – Laundry (in the case of residential development)
- Demand by trigeneration plants

An estimate of the total non-drinking demand in 2030 that may be suitable for recycled water was derived based on current metered consumption data (Layer A) and projected 2030 future water (Layer C) demands in Chapter 2. It was found that there is 24 billion litres of recycled water demand across the city. This represents 54 per cent of the water demand in 2030.

Figure 3.3 maps the recycled water demand and reveals that this demand is concentrated in areas such as:

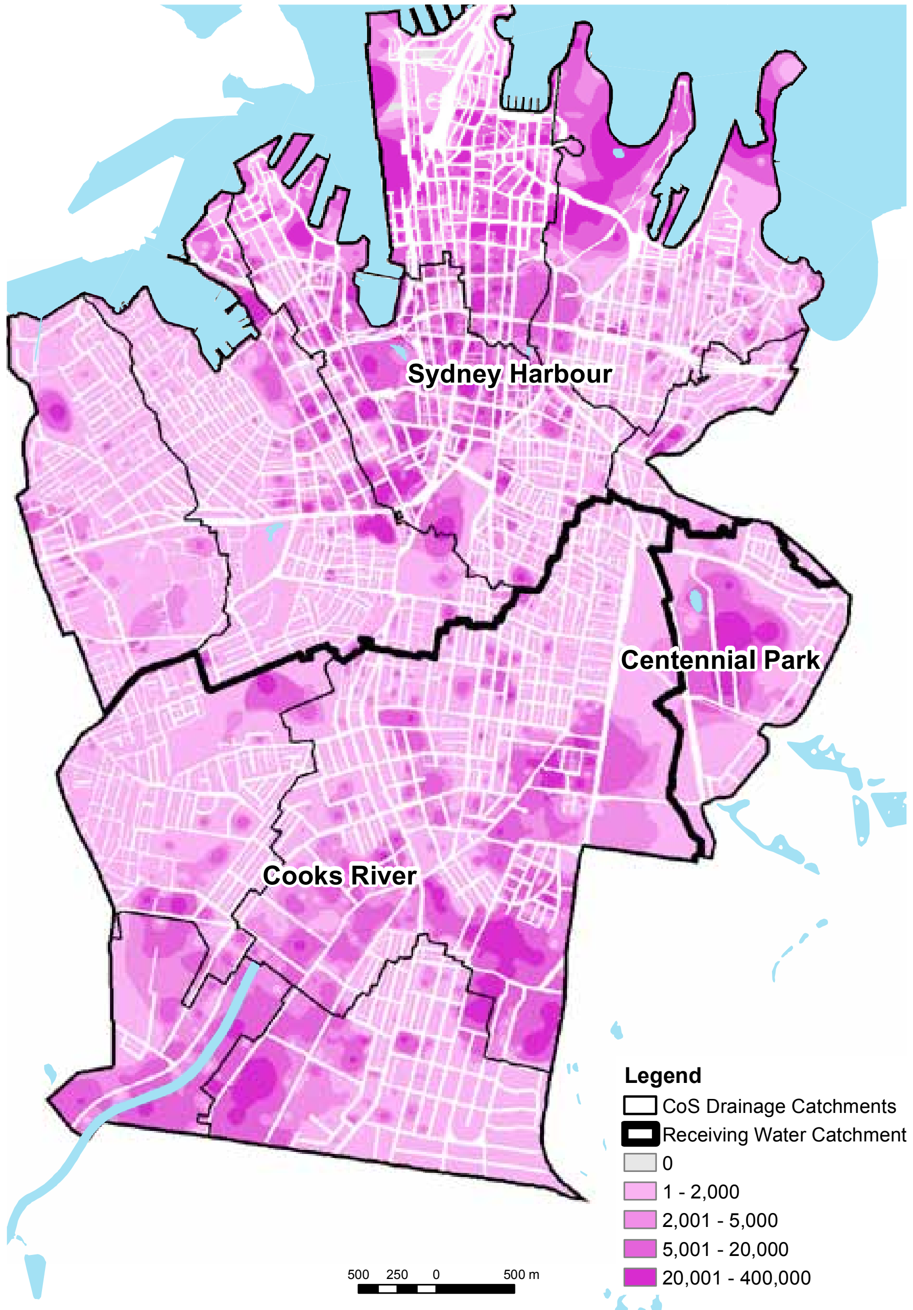
- Central Sydney
- Darling Harbour and Pyrmont
- Greater Green Square area
- Area around Sydney Park and Alexandra Canal.

Other smaller pockets of high projected recycled water demand exist in planned major developments in:

- Redfern-Waterloo
- Harold Park
- Sydney Cricket Ground and surrounds
- Garden Island.

Over 50 per cent of the city's water demand in 2030 could be supplied with recycled water.

Figure 3.3: Recycled water demand in 2030



Mapping opportunities – matching supply and demand

The local water resources that were analysed for their yield and how it matched with the recycled water demand included (refer inset boxes in next pages for definitions of each term below):

- **Roof water**
- **Stormwater**
- **Groundwater (including tunnel seepage water)**
- **Sewage and Blackwater (Sewer Mining)**
- **Greywater**
- **Sea water (Thermal Desalination)**

The adjacent bubble chart shows a comparison between supply and demand potentials within each of the 11 sub-catchments. The size of the bubble is indicative of the size of the opportunity. Size of the blue bubble (supply) relative to the size of the lilac bubble (recycled water demand) indicates the contribution the water source can make towards meeting the recycled water demand.

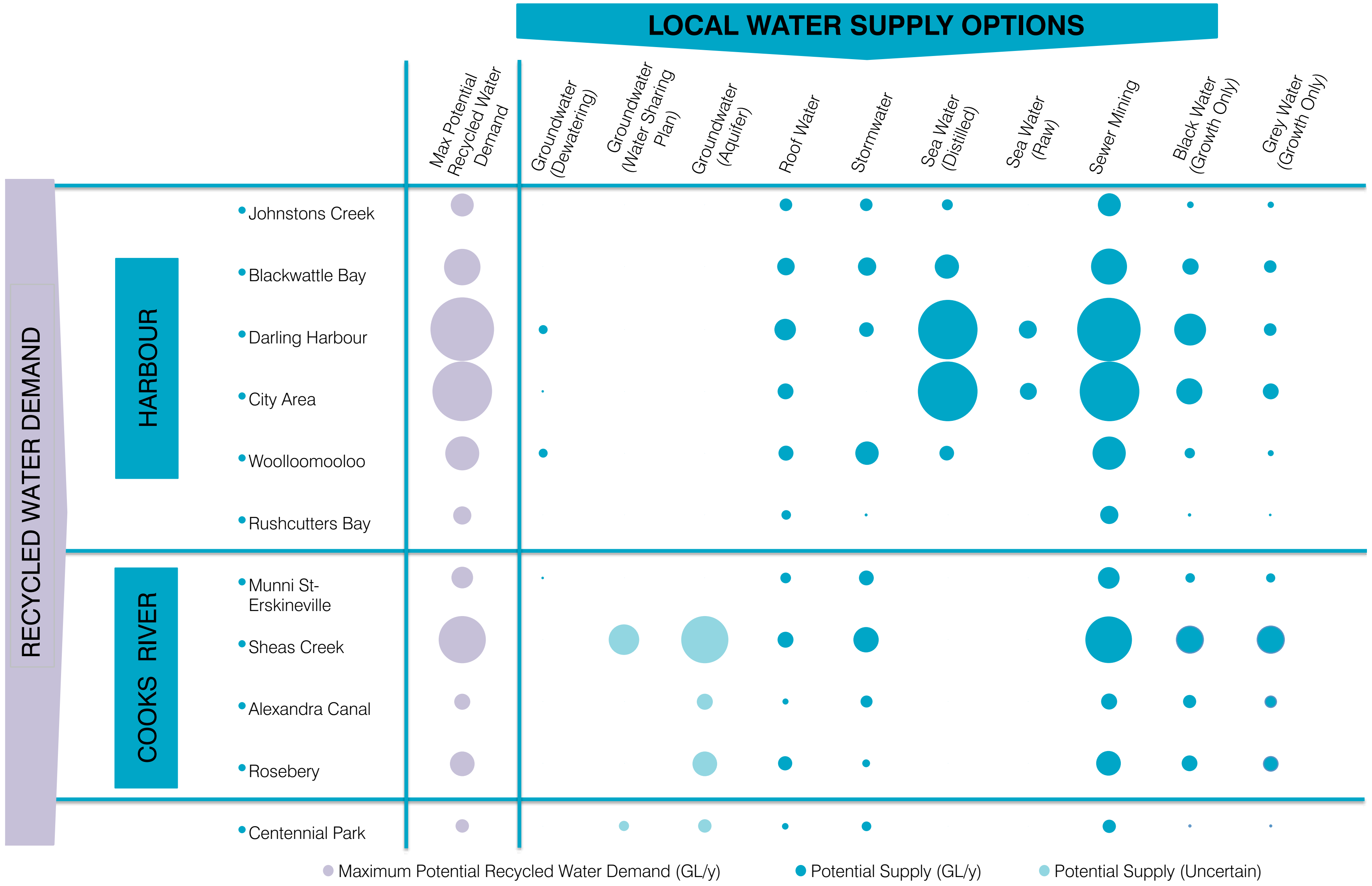
For example, in Johnstons Creek sub-catchment sewer mining will provide enough water to satisfy all of the recycled water demand. Whereas, roof water and stormwater can be used to meet a proportion of the recycled water demand.

Full view of the bubble chart reveals that there is sufficient volume of locally available water sources to meet all of the recycled water demand within the city. The potential recycled water demand is greatest in Darling Harbour and the City Area sub-catchments, followed by Sheas Creek and Blackwattle Bay, with relatively small non-potable water demand in the other sub-catchments.

Over 300 small-scale opportunities were identified by scanning mapped data of every sub-catchment and matching every type of local water resource with recycled water demand in the proximity of the water resource.

There is sufficient volume of local water sources available to meet all of the recycled water demand within the City.

Figure 3.4: Recycled water demand and local water supply options in the 11 sub-catchments



Roof water

Roof water is rain water that runs off from the roof area of buildings and diverted into a large storage tank before it reaches the stormwater system. When collecting roof water, the first flush which generally carries with it the pollutants on the roof surface is allowed to be discharged before the rest of run off from the roof is diverted for storage and use. As the water collected after the first flush is generally free of pollutants, no treatment is necessary if it is used for non-drinking purposes.

Roofwater Harvesting

Stormwater

Stormwater is rain water that runs off of all surfaces within the City including roofs, roads, pathways, parks and other open areas, and ends up in the drainage system that is designed to divert the stormwater away from roads and properties and to discharge into the waterways. Stormwater picks up a wide range of pollutants from the surfaces it flows off and its quality is highly variable over time.

Stormwater treatment generally involves some form of filtration to capture the suspended solids and pollutants attached to the sediments followed by disinfection. Vegetated systems that are carefully designed to use natural processes for filtering the pollutants are now commonly used to provide effective treatment of stormwater with none to low energy and chemical input.

Sydney Park Stormwater Harvesting Scheme

Harvesting stormwater has the dual benefit of reducing demand for drinking water and reducing the volume of polluted stormwater discharged to waterways. Stormwater harvesting schemes can also incorporate stormwater detention basins that capture stormwater runoff during large storm events and mitigate the risk of flooding.

Sydney Park is an excellent example of a stormwater harvesting initiative where there is a large supply of stormwater close to significant non-potable demand and storage capacity in an existing constructed wetland that has been designed to naturally treat stormwater.

There is potential to divert more stormwater to this storage, which could potentially be combined with Managed Aquifer Recharge and Recovery, as it is close to the Botany Sands aquifer.

Groundwater (including tunnel seepage)

Groundwater is naturally infiltrated and stored in shallow and deep water aquifers. The major aquifer in the City of Sydney area is the Botany Sands aquifer, which is relatively shallow. Groundwater is accessed through bores for domestic and industrial purposes, which are licensed through a Water Sharing Plan managed by NSW Office of Water. Groundwater can also seep into tunnels and is pumped and discharged to the stormwater system. This is potentially a source of recycled water.

Groundwater requires treatment processes similar to stormwater involving filtration and disinfection.

MARR Scheme at Glenelg Golf Course in South Australia – City of Holdfast Bay
(photo courtesy of EPA)

A desktop study was commissioned by the City to investigate the potential for using groundwater as an alternative water source using a sustainable method called “managed aquifer recharge and recovery (MARR)”. The study has recommended undertaking field studies to determine the quality and quantity of groundwater.

Sewage and Blackwater (Sewer mining)

Sewer mining involves extraction of wastewater directly from the sewerage system (sewage) or directly from the sewage network of the buildings before they connect to City’s network (blackwater). In both cases, the wastewater is treated, using a package treatment plant located close to the extraction point. The treatment of sewage and blackwater involves advanced filtration processes (such as membrane biofiltration) that can remove not only the suspended solids but also the high amount of organic and nutrient content.

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Grey water

Grey water is wastewater that excludes toilet waste and is therefore a higher quality than sewage. It includes waste from uses such as hand washing, showering and clothes washing. Separating grey water from sewage requires special plumbing within buildings and is only cost effective and feasible for new buildings.

Grey water is separated from the sewage generated by buildings by collecting it in a dedicated grey water collection network and treated using a filtration process to remove the suspended solids followed by a disinfection process to produce recycled water that is clean and safe to use for non-drinking purposes.

Sea water (thermal desalination)

Thermal desalination is the process of changing saline water into vapour. This vapour or steam is generally free of the salt, minerals and other contaminants that were in the saline water. When condensed, this vapour forms high purity distilled water. There are several different methods of achieving this distillation but the method in this Master Plan is based on using the zero carbon waste heat from local electricity generation from the City's trigeneration system. Although the distilled water produced by thermal desalination is of a purer quality than conventional drinking water supplies the regulatory barriers to decentralised water means that it would be more expensive to use this water in the drinking water mains than using the water in a recycled water network.

Thermal desalination using the waste heat from cogeneration or trigeneration is significantly more efficient in the production of electricity and water compared with conventional electrically driven sea water reverse osmosis systems such as the Sydney desalination plant at Kurnell.

Conventional reverse osmosis desalination plants consume significant quantities of electricity supplied from remote centralised power generation via the grid. Coal fired centralised power generation loses two thirds of primary energy at the power station in the form of waste heat rejected into the atmosphere via cooling towers with further losses in the grid so the efficiency of grid electricity can be less than 30% of primary energy consumed at the power station by the time it arrives at the desalination plant.

Conventional reverse osmosis desalination plants purchase some or all of their electricity requirements from a power purchase agreement from a renewable energy project such as the Capital Wind Farm near Canberra used for the Sydney desalination plant 250km away. It prevents renewable energy being utilised elsewhere, perhaps mitigating an even greater potential environmental impact.

Thermal desalination with cogeneration or trigeneration captures the waste heat that would otherwise be rejected into the atmosphere at remote power stations and uses the zero carbon waste heat to distil sea water leaving the generated electricity available to supply buildings in the city via the trigeneration network.

Finding water-recycling solutions

Using a set of technical, environmental, social and economic criteria, as shown in Figure 3.5, over 300 opportunities were further refined into 34 precinct scale recycled water solutions.

Considerations during the filtering process included local characteristics, potential synergies and reliability and effectiveness such as those outlined in Table 1.

Thirty-four recycled water solutions are represented in the map in Figure 3.6. The map shows the areas where recycled water demand is concentrated and locations of supply sources that can meet the demand.

In some precincts more than one supply source could meet the recycled water demand in each catchment as summarised in Table 1.

Stakeholder and Community Reference Groups were established to provide input into the Master Plan from key agencies, neighbouring local councils and community groups. Project teams met four times with both groups through the development of this Master Plan.

Figure 3.5: Process for filtering preliminary opportunities

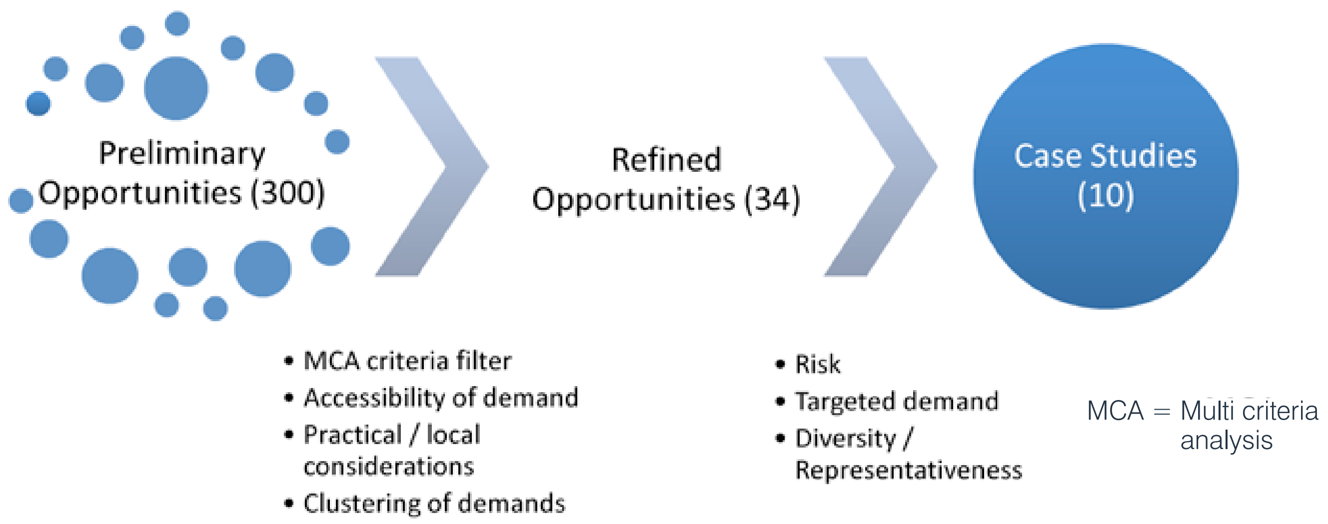


Table 1: Considerations used to filter preliminary opportunities

Local Characteristics
• Target larger residential and commercial buildings with fewer connections and higher demand • Avoid older areas and terraced properties requiring multiple connections with low demand • Target new developments to include third pipe and plumbing during construction • Consider topography to avoid pumping and energy costs
Synergies
• Synergies with existing and proposed infrastructure and initiatives • Utilise existing infrastructure including sewerage pumping stations and collection networks • Co-location of infrastructure to minimise disruption and avoid costs e.g. trigeneration network • Minimise energy use and carbon emissions and reduce waste e.g. utilise waste heat from trigeneration to distil seawater
Reliability and Effectiveness
• Reliability of supply e.g. stormwater and roof water reliability is driven by yield and storage • Sewer mining is more cost effective with increase in scale. Small opportunities were clustered to improve economies of scale • Small opportunities targeting only a few properties suit lot-scale solutions • Network effectiveness targets clusters of high recycled water demand and minimises length of supply network

Precinct-scale water-recycling opportunities

Sewer Mining (6 precincts)

Recycled water from sewer mining opportunities involve harvesting sewage from sewer mains with high dry weather flows, treating it using a biological treatment process such as membrane biofiltration followed by ultrafiltration and disinfection. Sewer mining has the greatest potential as a source for recycled water in the CBD, Darling Harbour, Sydney University surrounds, Harold Park surrounds, Sheas Creek and Rosebery.

Grey Water Reuse (1 precinct)

The area surrounding Alexandra Canal has been identified for potential grey water reuse where there is a high volume of recycled water demand associated with growth forecast. The trade waste discharge in sewer pipes from industrial properties in the area may make sewer mining unsuitable. A dedicated grey water collection system may avoid this issue. Grey water is not cost effective compared to sewer mining in other areas.

Thermal Desalination of Sea Water (4 precincts)

Thermal desalination opportunities have been identified in areas close to Sydney Harbour and the proposed trigeneration plant locations. It is assumed that the trigeneration energy centres will be designed to provide sufficient waste heat for distilling sea water to produce recycled water.

Roof Water Harvesting (3 precincts)

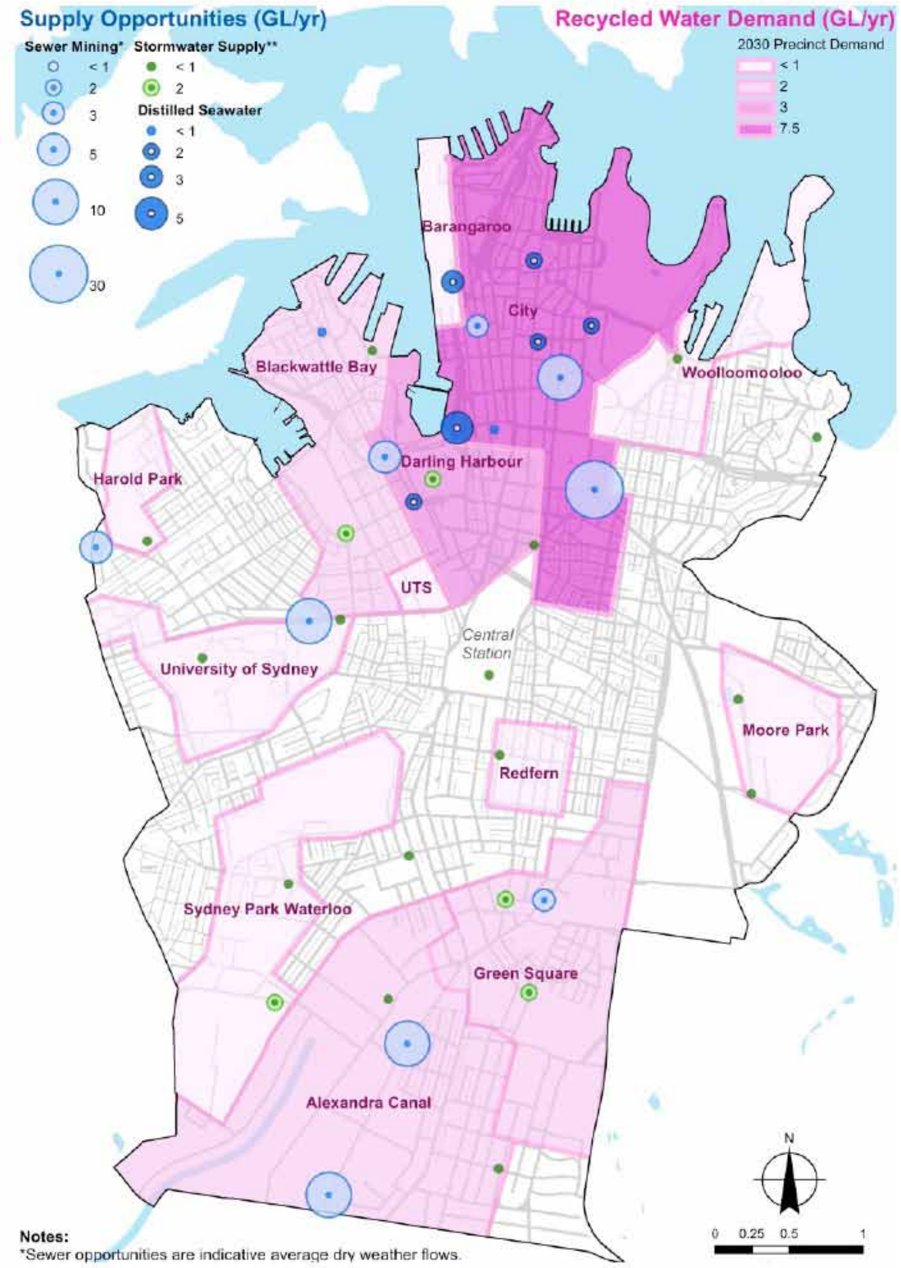
Areas best suited for roof water harvesting include Darling Harbour, Moore Park and the area surrounding Alexandra Canal. These areas represent clusters of large roof catchment areas per unit of recycled water demand.

Stormwater Harvesting (20 precincts)

Ideal stormwater harvesting opportunities are located at the confluence of large stormwater mains near the downstream end of the sub-catchment, near a site large enough to accommodate a storage facility, typically in a park or large open space. Storage sizes were based on a land-take of up to 10 per cent of the identified park area or a sub-surface storage of equivalent volume. Figure 3.6 shows 20 precincts where such conditions are conducive to stormwater harvesting, along with the average annual yield.

The recycled water target was based on the further assessment of the solutions detailed in Chapter 4.

Figure 3.6: Precinct scale recycled water solutions across the city



Stormwater pollution reduction solutions

Pollutants of concern at city scale

Gross pollutants, total suspended solids and total nitrogen are the key pollutants that have been considered for assessing water sensitive urban design opportunities for their pollution reduction performance, at a city-wide scale.

Gross pollutants are floatable litter including rubbish and leaf litter, grass clippings and twigs that cause visual as well as environmental pollution of waterways.

Total suspended solids is the silt and organic or inorganic suspended particles that get picked up by fast-moving stormwater run-off from the roofs, hardstands, roads and any uncontrolled construction activities in the city.

Total nitrogen is the nutrients from leaf litter, dog droppings, fertilisers from gardens and parks. Although not as visible as gross pollutants and total suspended solids, total nitrogen causes serious harm to the waterways and results in algal blooms which are damaging to the ecological health of the waterways.

Pollutants such as oil, grease, heavy metals and hydrocarbons from vehicular traffic are also harmful to the waterways.

Research suggests that these pollutants tend to attach themselves to sediments and debris and therefore total suspended solids removal also aids the removal of heavy metals and hydrocarbons.

Source control

The City's source control initiatives prevent pollutants entering the stormwater drainage. For example, street cleansing, education and awareness about not using the stormwater drain for any discharge other than 'rain water'.

The solution

Stormwater pollution reduction solutions are aimed at capturing the pollutants at the top and middle of the catchment before they have a chance to accumulate at the bottom of the catchment. Therefore water sensitive urban design solutions that are distributed within the catchment and are designed for slowing down, retaining and treating stormwater flows and pollution are proposed in this Master Plan.

The water sensitive urban design solutions include construction of raingardens, swales, infitration trenches within streetscapes and open spaces, use of permeable pavers on footpaths and installation of gross pollutant and sediment trapping devices. Stormwater harvesting and reuse schemes also are included.

Water sensitive urban design is a decentralised solution to reducing water pollution.

Wastewater pollution

The other key pollutant of concern is the faecal contamination from sewer overflows and ingress of sewage into stormwater systems.

Sewer overflows – what are they and how are they regulated?

Sewer overflows occur at designated points in the sewer system when the hydraulic capacity of the system is exceeded. They direct excess wastewater into natural watercourses and stormwater drains as an alternative to uncontrolled surcharges on to private property.

In May 2000, the NSW Environment Protection Authority (EPA) placed legally binding conditions (licences) on Sydney Water to protect the environment from sewer overflows and to ensure continuous improvement. This includes the requirement for Sydney Water to fix leaky sewers, as well as upgrades to over 200 sewage pumping stations and improvement of the overall maintenance of the system.

Long term overflow frequency targets have also been established, to ensure that over a 10 year period the number of overflow events do not exceed by:

- 10 for sensitive freshwaters.
- 20 for ocean beaches and sensitive estuaries.
- 40 for not sensitive freshwaters and estuaries.

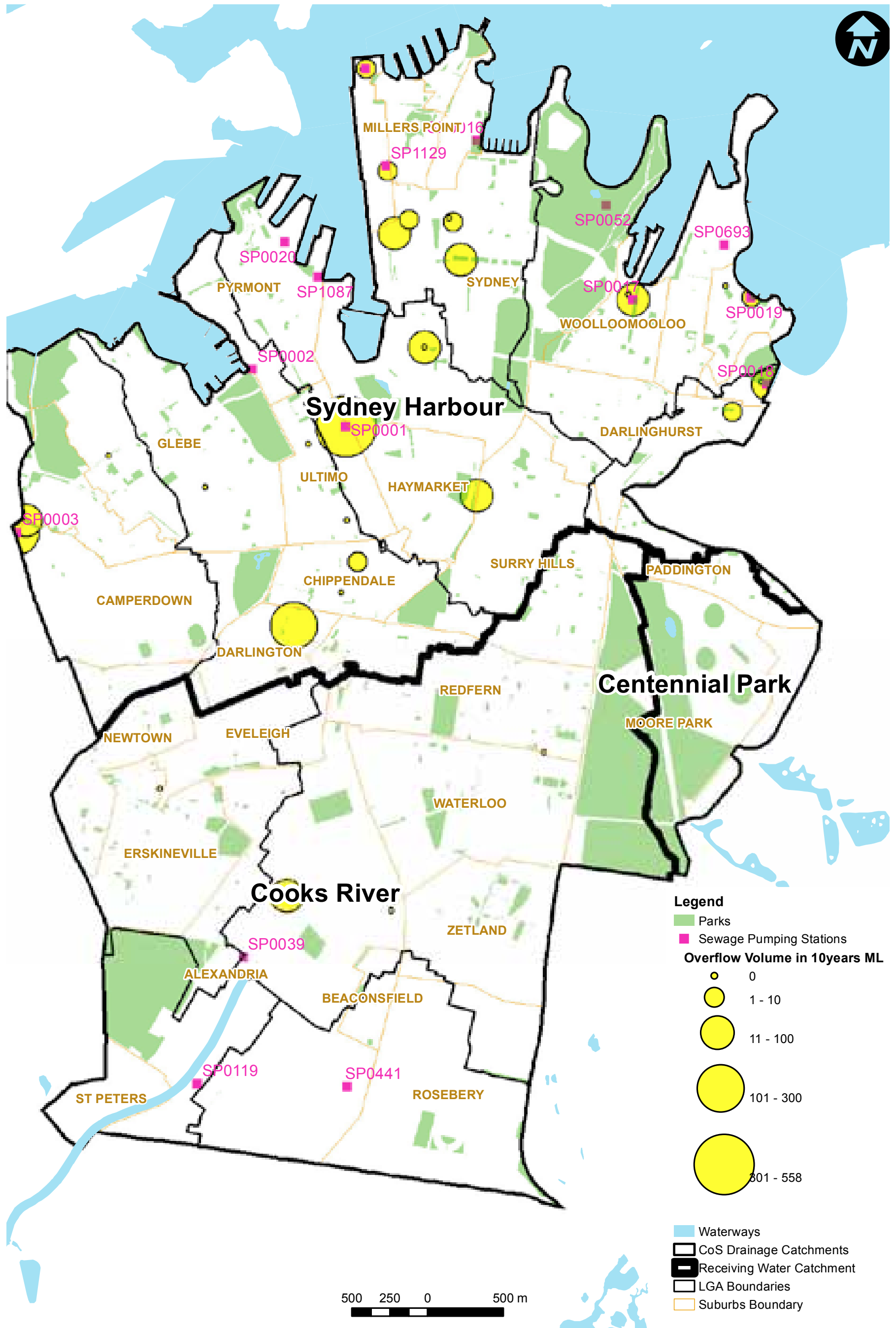
Sewer overflows in City of Sydney

In the City of Sydney the sewer pipes have reached their hydraulic capacity as the population has grown exponentially since they were built. A large proportion of the pipes are more than 50 years old.

The worst sewer overflows in Sydney are located in Middle Harbour and Lane Cove River in Sydney Harbour and the Cooks River area of Botany Bay. To compound this problem, flushing rates in these areas are slow, and it may take days before bacterial contamination falls to acceptable levels. The time taken for these waterways to recover to acceptable levels is influenced by the quality of the water in the local tidal region and the proximity of the site to clean oceanic waters.

Figure 3.7 shows the location and frequency of sewer overflows in the City of Sydney. As can be seen in the figure, the Sydney Harbour catchment that is served by the Bondi Ocean Outfall System (BOOS) experiences numerous overflows with frequencies ranging from one overflow in 10 years to more than 60 overflows in 10 years.

Figure 3.7: Sewage overflows in City LGA



Wastewater pollution

According to the 2008 Annual Report of Sydney Water, the percentage of Harbourwatch sites that complied with recreation water quality guidelines more than 90 per cent of the time drastically fell from 61 per cent to 37 per cent (in winter season) and from 89 per cent to 32 per cent (in summer season).

According to the same Annual Report, wet weather overflows to Port Jackson at Lane Cove, Middle Harbour at Quakers Hat Bay, Tunks Park and Scotts Creek have decreased since the commissioning of the Northside Storage Tunnel in 2000.

In 2007, works were finished to separate remnant combined sewage/stormwater systems that were discharging into Darling Harbour and Circular Quay. Combined systems south of the city are being separated to improve water quality at Blackwattle Bay. Works are also in progress to reduce wet weather overflows on the lower north shore near Hayes Street Beach.

The Sydney Water Annual Reports of 2009, 2010 and 2011 do not provide further reports on the water quality compliance of Harbourwatch and Beachwatch sites. Nor do they report on the number of overflow events in the reporting year, which make it difficult to assess the performance of any measures put in place by Sydney Water to address the sewer overflow issue.

From the City's perspective, given the high frequency and intensity of overflows in half of its local government area, it is imperative that Sydney Water report on overflow events and water quality specific to the City of Sydney to ensure that they are being monitored and measures implemented are achieving the desired performance.

Addressing sewage pollution is not within the direct control and influence of the City, but it is the responsibility of Sydney Water. However, as a local council, the City has the obligation to represent community concerns about a pollutant that has the potential to adversely impact on the recreational and environmental value of Sydney Harbour. Hence, the City seeks continued engagement with Sydney Water & NSW Department of Environment – the agencies responsible for managing and regulating the problem, by providing input and seeking answers as a key stakeholder.

Figure 3.8: Percentage of harbourwatch sites complying with beachwatch recreational water quality guidelines 90% of the time

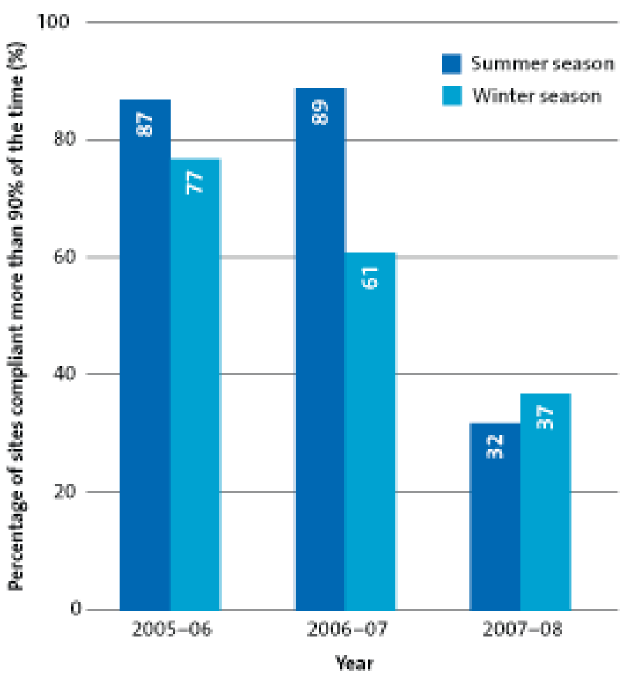
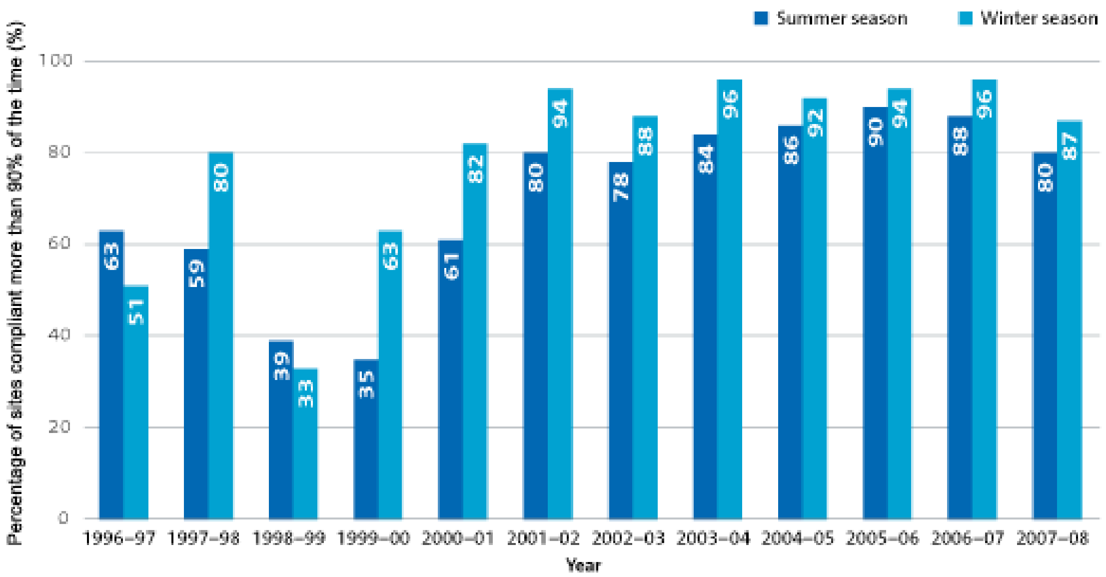


Figure 3.9: Percentage of beachwatch sites complying with recreational water quality guidelines 90% of the time



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Stormwater pollutant – current levels

Baseline pollutant load

City-wide baseline total suspended solids and total nitrogen annual loads were estimated by modelling pollution loads from each of the 11 sub-catchments taking account of the surface type characteristics of each. The modelled baseline pollutant load for total suspended solids was modified by deducting the pollution reduction achieved annually from existing (pre-2006) pit cleaning operations. Historical records of pit clean outs were used to estimate the tonnage of suspended soilds removed to arrive at an annual average value.

The total suspended solids removal from existing pits is largely from trapped gully pits and to a small extent from existing gross pollutant traps in the city. The trapped gully pits are artefacts of the old combined sewerage and stormwater system that were designed to prevent the escape of sewage odour. Since the separation of the sewerage system, the trapped gully pits, now part of existing stormwater drainage, tend to trap the sediments and litter resulting in a maintenance intensive drainage system.

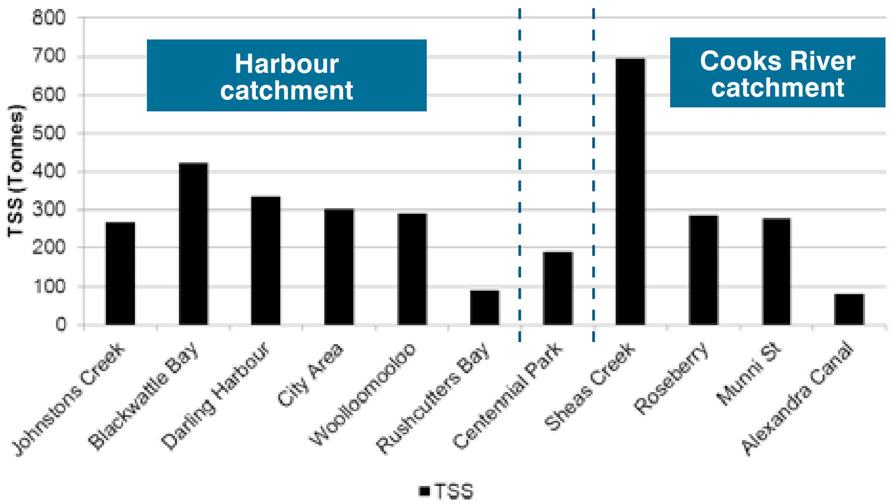
Figures 3.10 and 3.11 show the baseline pollutant loads for total suspended solids and total nutrients for the 11 sub-catchments and three receiving water catchments in the city.

The greater the area of hard surfaces directly connected to the drainage network in the city, the larger the amount of stormwater pollutant discharged into the waterways.

Each year nearly 3,000 tonnes of stormwater pollutants are discharged from the city into its waterways. This pollution load is expected to increase with major redevelopments planned to accommodate an increase in population of 30,000 by 2030.

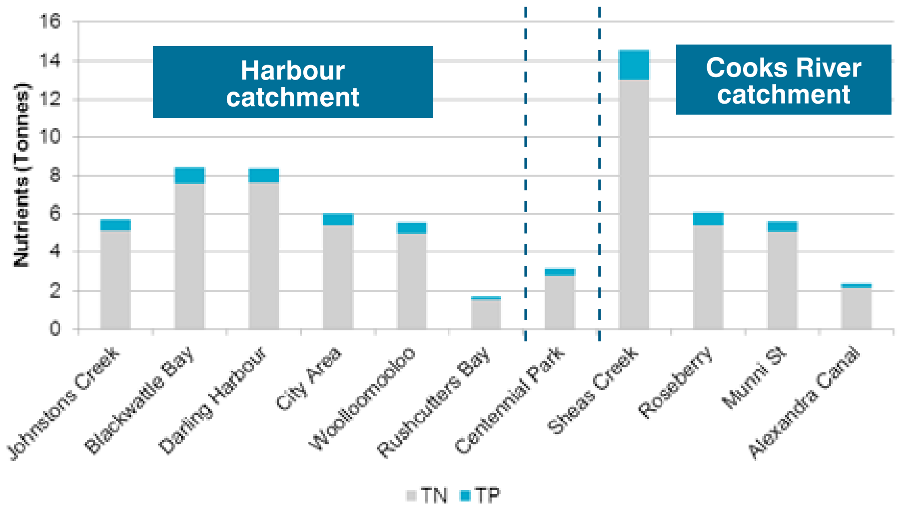
By introducing raingardens and permeable surfaces that capture and treat the stormwater run off, the area of hard surfaces directly connected to drainage pipes is decreased thereby reducing the pollutants discharged to the waterways.

Figure 3.10: Total Suspended Solids' baseline load for the 11 sub catchments in the city



TSS=Total suspended solids

Figure 3.11: Total Nutrients and Total Phosphorous baseline load for the 11 sub catchments in the city



TSS=Total suspended solids
TN= Total nitrogen

Mapping WSUD opportunities

Water Sensitive Urban Design (WSUD) Opportunities for reducing stormwater pollution were mapped for each of the 11 sub-catchments in the city, by using the framework:

- **Redevelopment WSUD**
- **Renewal WSUD**
- **Retrofit WSUD**
- **Recycle/Reuse**

Redevelopment

In the past, stormwater management within a development was only concerned with moving stormwater as quickly as possible, away and out of the development site, via a network of pits and pipes. Redevelopments provide the opportunity for integrated stormwater retention, detention and treatment systems. Incorporation of WSUD within re-development is the most cost effective way of disconnecting stormwater flows and pollutants from polluting the waterways.

Renewal

In an old and highly urbanised catchment such as the city, there are on-going opportunities for renewal of infrastructure and assets out in the streetscapes and public domain. Every year the City and other agencies such as Sydney Water, Transport for NSW, Roads & Maritime Services and other utilities that have their assets in the city spend tens of millions of dollars in major upgrades and improvements of roads, footpaths and parks. Such capital works projects associated with renewal are initiated or coordinated by the City. Therefore renewal projects are unique opportunities for incorporating WSUD in a planned way, thereby adding more value to the asset renewal investment and making the WSUD integration cost effective.

Retrofit

As WSUD requires space, urban areas being space constrained, public open spaces such as parks and open spaces and privately owned open space and landscape areas present an opportunity to retrofit WSUD. Stormwater drainage also presents opportunities to retrofit gross pollutant traps (GPTs). These retrofits could be used to address multiple problems by locating them strategically in sub-catchments that have ongoing issues with nusiance flooding, sewage overflows and failing drainage assets. Such solutions are effective in reducing pollution discharging into waterways while also resulting in reduced nuisance flooding and enhanced aesthetics.

Recycle/Re-use

Stormwater harvesting and reuse requires that stormwater is treated to produce water that is fit for non drinking uses. Conseqently, these initiatives by default provide pollution reduction.

The 20 stormwater harvesting initiatives identified in the water recycling solutions are also opportunities that reduce pollution being discharged into the waterways.

In addition to reducing the stormwater pollution discharged into waterways, WSUD solutions provide other environmental and social benefits such as:

- **Improved aesthetics and amenities.**
- **Enhancement of biodiversity**
- **Greener and cooler microclimate within the city.**
- **Additional sources of water for irrigation and other non-drinking uses.**
- **Relief from unnatural and nuisance flooding**
- **Celebration of water by making it more visible and appealing part of the urban landscape.**

WSUD in Victoria Park development, Zetland

Raingarden in Bay Street

WSUD and Stormwater Recycle in Sydney Park

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Finding pollution reduction solutions

Pollution reduction potential of WSUD opportunities

The WSUD best practice for redevelopments prescribe water quality targets for gross pollutants, total suspended solids and total nitrogen as well as total phosphorous in relation to baseline pollutant loads for the development site. Enforcing best practice targets for redevelopment sites through development controls would contribute to reducing stormwater pollution.

In the case of WSUD integrated in renewal and retrofit, the total suspended solids and total nitrogen reduction potential were estimated based on the modelled treatment performance of the WSUD footprints for the catchment areas.

Due to the opportunistic nature of these WSUDs, the pollutant reduction potential per unit catchment area treated is relatively lower than the water quality targets prescribed for redevelopments. However, these WSUDs are still valuable due to the cumulative impact of them over the long term.

Finding solutions

Figures 3.12 and 3.13 (on next page) show the range of solutions and their maximum potential for sediment reduction (3.12) and nutrient reduction (3.13). Solutions that emerge from the WSUD opportunities mapped are:

- Introducing planning controls requiring best practice water quality targets to be met in new development in all areas of the city.
- Ensuring that developments meet the water quality targets prescribed for the re-development sites.
- Implementing processes and policies within the City so that renewal and retrofit projects incorporate WSUD opportunities as identified under this category in this master plan.
- Retrofitting drainage network with gross pollutant traps in strategic locations throughout the city.
- Implementing on-scale and precinct-scale stormwater harvesting and reycling opportunities.

Green roofs and walls as water sensitive urban design (WSUD) elements

Green roofs and walls in the urban environment can incorporate water sensitive design features and make a positive contribution to urban catchments.

In addition to reducing stormwater pollution green roofs and walls in cities such as Toronto, Washington and New York have demonstrated the following benefits:

- reduced heating and cooling costs for buildings:
- reduced urban heat island effect by influencing urban microclimate;
- reduced noise (as a result of the insulating effects);
- improved urban air quality and absorbing greenhouse gases;
- provision of biodiversity with increased habitat;
- improved aesthetic quality of buildings and the urban environment; and
- opportunities for urban food production.

Therefore, City of Sydney has developed a Green Roofs and Walls Strategy which will research, quantify and better understand the various benefits provided by green roofs and walls in the city.

Key actions identified in the City of Sydney's **Green Roofs and Walls Strategy** are:

- **Green Roofs and Walls Perception Study** to determine drivers promoting green roofs and walls;
- **Green Roofs and Walls Opportunity Analysis** to identify potential locations and create opportunities to promote the installation of green roofs and walls;
- **Green Roofs and Walls Cost Benefit Study** to model the costs, benefits and risks associated to scenarios for the locations identified above and make available the knowledge needed to inform a Green Roofs and Walls Policy; and
- **Green Roofs and Walls Policy & Implementation Plan** which will set out a framework for developing a Green Roofs and Walls Policy while also articulating a clear policy position of the Council, based on the findings of the three above-listed studies.

Figure 3.12: Decentralised solutions for achieving Total Suspended Solids reduction target

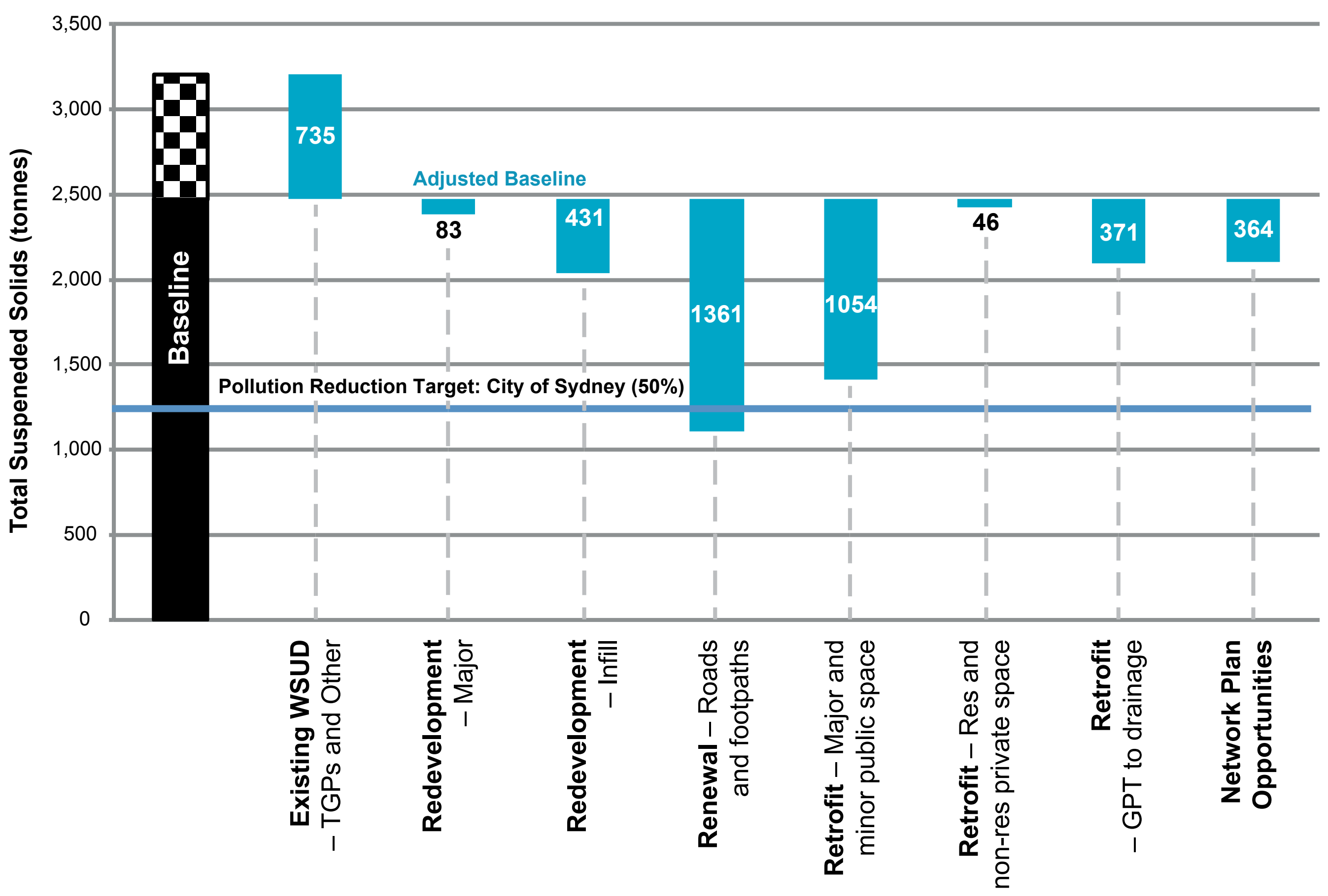
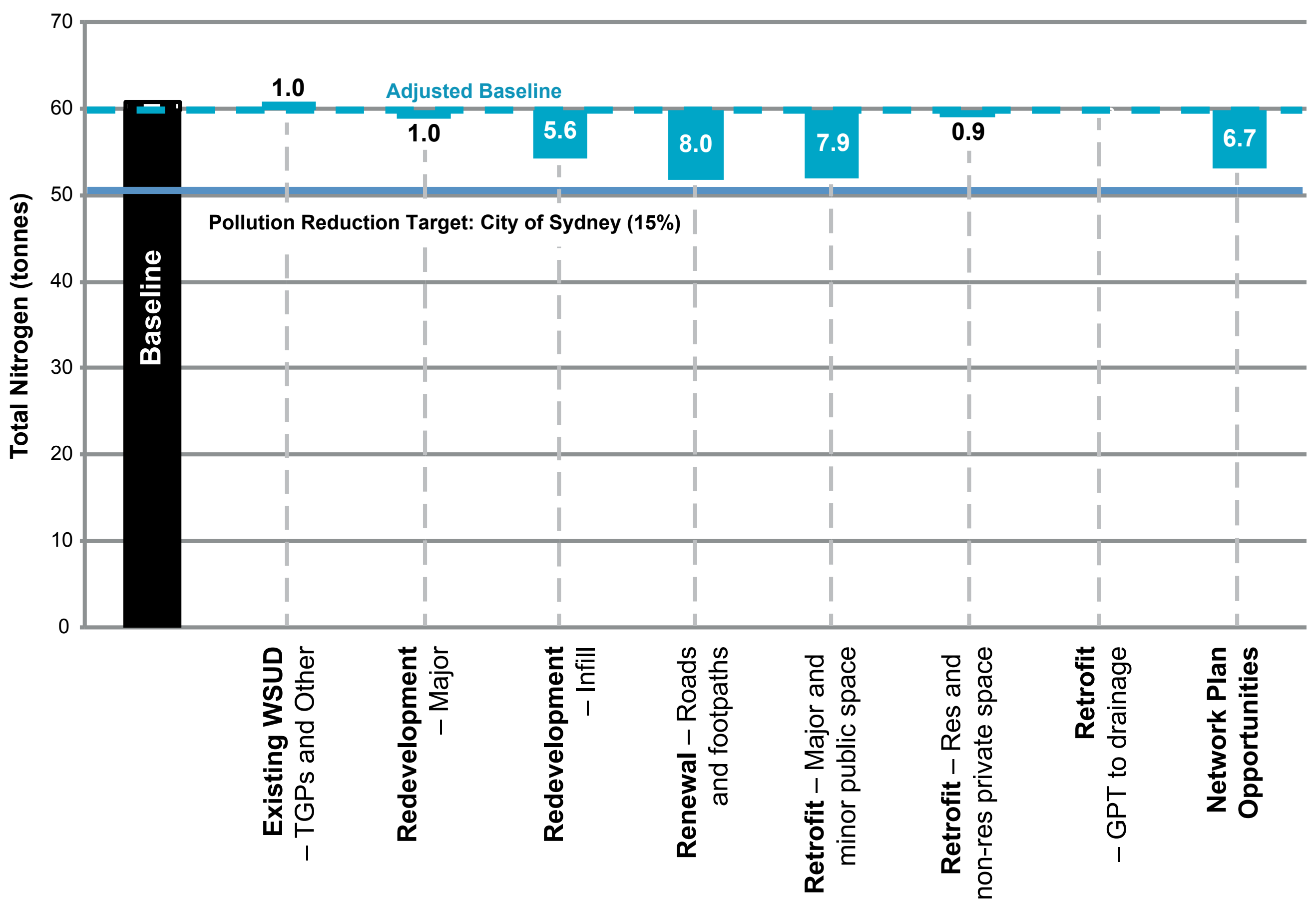


Figure 3.13: Decentralised solutions for achieving Total Nitrogen reduction target



4. Performance and implementation

Performance of water efficiency solutions

Water efficiency solutions were developed as water efficiency programs targeting different water using sectors (See Table 2). Each program was conceptualised in two versions. One version of the program was assumed to have a lower level of investment, with the City driving the program with its own resources. The second version of the program assumed a higher level of investment, with the City seeking support and resource from the NSW Office of Environment & Heritage and Sydney Water.

Water savings and levelised costs were estimated for each of the programs to provide a relative performance assessment of each. **Water savings** (in megalitres per year) (See Figure 4.1) for each program were based on an exhaustive literature review of water efficiency programs targeting different end use sectors. The water savings were varied for increase in level of investment.

However, extensive experience in program design and evaluation informs that there is a maximum limit up to which the water savings from a program are directly proportional to financial investment in the program. **Program costs ($)** were estimated based on the cost to the service provider (running the program). **Levelised costs ($ per kL)** (See Figure 4.2) were then estimated using the program costs and estimated water savings program.

Based on this analysis, the City has set a water efficiency target of achieving 10 per cent reduction on 2006 demand levels by 2030 through water efficiency.

Table 2.1

Targeted Water Efficiency Programs	
AQ1	Aquatic Centre Audits
AQ2	Aquatic Centre major retrofits
CT1	Cooling Tower Retrofit
CT2	Cooling Tower Retrofit – Intensive
CoS1	Council Top 20 Retrofits
CoS2	All Council Properties Retrofits
H1	Hotels Partnership
H2	Hotels Partnership Intensive
MR1	Apartment Retrofit
MR2	Full Scale Hi-Rise
O1	Office Retrofits
O2	Office Retrofits plus DCP
R1	Restaurants Audits
R2	Restaurant Audits High Water Users
SR1	Household Retrofit
SR2	Household Retrofit High Water Users

More details about these programs can be found in Water Efficiency Plan in the Technical Appendices.

Figure 4.1: Water savings of water efficiency solutions

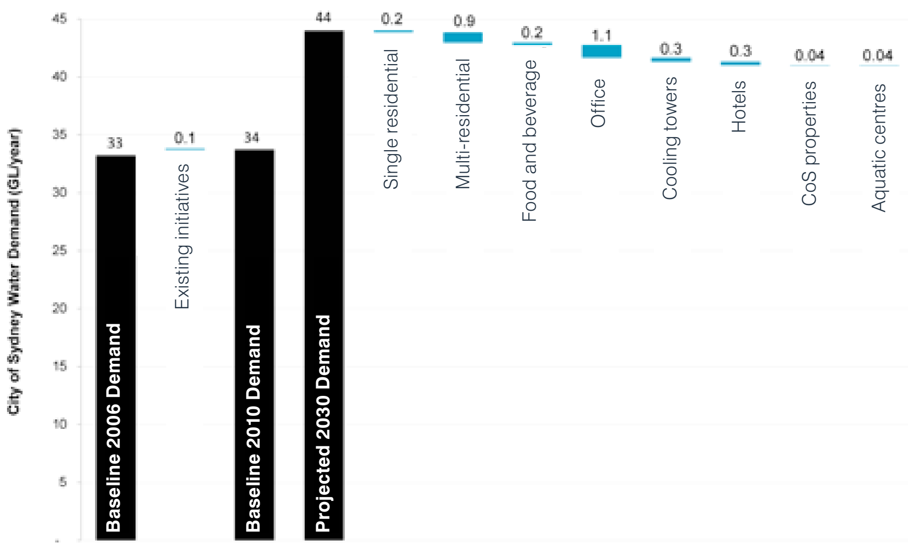
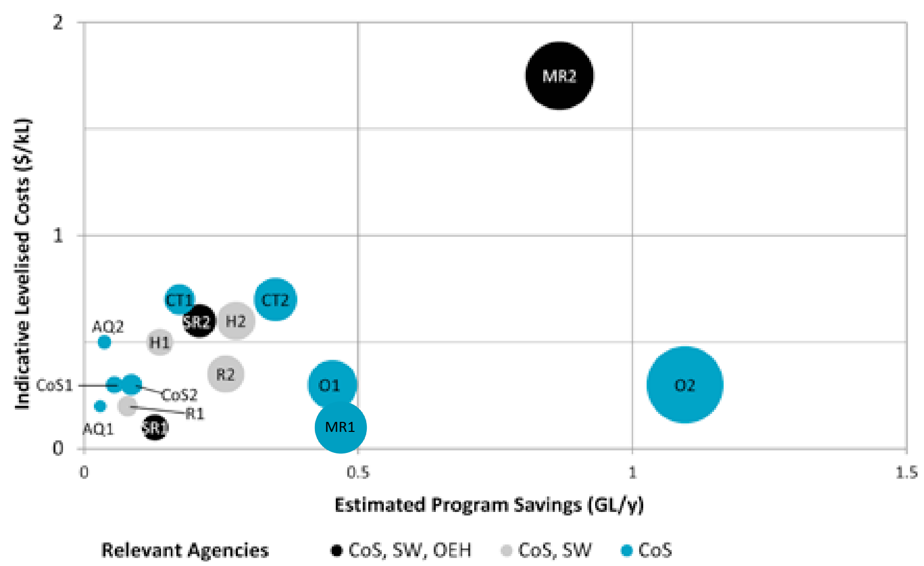


Figure 4.2: Levelised cost of water efficiency solutions



CoS = City of Sydney
SW= Sydney Water
OEH= NSW Office of Environment & Heritage

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Implementing water efficiency programs

Water-efficiency programs will be tailored to meet the needs of sectors identified to have high water-saving potential. These targeted programs could use one or a combination of instruments such as:

- **Education** (e.g. signage, case studies, tools, best practice guidelines and training)
- **Metering and Reporting** Providing information to the water users on the amount of water consumed has been found to result in water saving actions and behaviour by providing a feedback loop. This is particularly important for the multi-residential sector where there are no meters at unit or apartment level.
- **In-kind assistance** (e.g. water audits, low cost or no cost water efficient equipment)
- **Recognition and Reward** (e.g. certification, awards, promotion)
- **Financial Assistance** (e.g. rebates, subsidies, low interest loans, co-finance)

Design and development of water efficiency programs specific to sectors would be undertaken working collaboratively with:

- Existing partners such as the Better Buildings Partnership, to seek participation in and uptake of the programs developed.
- New partners that are strategic and relevant to the targeted end use or sector, to seek participation in and uptake of the programs developed.
- Government and agencies such as Federal Department of Environment & Climate Change, NSW Departments of Environment, Planning and Water, to seek funding and resources, to advocate and lobby for water-efficiency policies and regulation.
- Sydney Water, to learn from a decade-long experience of running highly successful water efficiency programs across residential, commercial and institutional sectors.

Water efficiency or demand management, traditionally, has been the responsibility of a water service provider. However, the City recognises promoting and facilitating water conservation and efficiency to its residents and businesses is a social and environmental imperative. Therefore, the City is committed to leveraging its unique reach and influence and collaborate with Sydney Water and NSW Government to deliver water savings much greater than each agency can deliver on its own.

Water efficiency programs

Example of a program involving education, training and tools

Water Efficient Cooling Tower System Program

By making simple operational changes and improving the maintenance of cooling tower systems, businesses can save water and money, while maintaining public health and safety. Yarra Valley Water in collaboration with the Australian Institute of Refrigeration Air Conditioning and Heating (AIRAH) and other Victorian utilities have provided an opportunity for businesses to improve their cooling tower performance through the Water Efficient Cooling Tower System Program.

The program has resulted in the production and publication of a number of resources for facility managers which include:

1. Development of a new training course on cooling tower efficiency delivered by AIRAH;
2. Publication of detailed best-practice guidelines for use by cooling tower professionals; and
3. Development of an innovative online cooling tower calculator which can provide an indication of the cooling tower efficiency.

Example of a program involving in-kind assistance

Showerhead exchange

Yarra Valley Water offers a range of water efficient showerheads to all business types. Businesses can participate in an exchange of old inefficient ones for new ones and can access as many as needed for free. Reduced water consumption also delivers reduced energy consumption, saving businesses significant operating costs. Thousands of businesses have benefited from the showerhead exchange offer, most commonly in the aged care and accommodation sector.

Example of program involving financial assistance

Rebate on a waterless wok stove

Victorian Government offers rebates for a range of water-efficient devices including waterless wok stoves.

Council water use – current and future

Council mains water demand 2006–2012

In the financial year 2005–06, Council-managed facilities and operations used a total of 413 ML mains water. Since 2006, Council has been actively implementing (mains) water saving actions. By 2012, these actions have resulted in a reduction of total mains water use to 398 ML, despite a net increase in mains water use due to increases in buildings and operations portfolio since 2006. The mains water saving actions implemented between 2006 and 2012 include:

- Retrofit of top ten water using Council sites with water efficient fixtures and appliances.
- Installation of smart water meters on 23 high water using sites to enable real-time metering that is valuable in responding promptly to any leakage in the system.
- Installation of rainwater tanks in 27 Council facilities that include child care centres, libraries, community centres and depots to substitute mains water use by toilet flushing, watering of landscapes and washing bay areas.
- Implementation of 12 small scale park-based stormwater harvesting schemes to provide alternative water sources for irrigation. They include – Solander Park, Peace Park, Harmony Park, Barcom Avenue Reserve, Sydney Park (stage 1), Pirrama Park, Joynton Park, Beare Park, Crystal Park, Crown Park, Lillian Fowler Reserve and Paddington Reservoir Gardens.

Without these water saving actions, the Council mains water demand would have increased by 44 ML.

Council water demand by 2030

By 2030, Council water demand is expected to rise on a 'business as usual' basis due to:

- New parks that are built as part of new developments such as Green Square, Harold Park and Barangaroo that will be added to Council's portfolio;
- Additional areas of existing parks that will be irrigated following upgrades of irrigation equipment and general facilities; and
- New properties that are anticipated will be acquired by Council to facilitate Green Infrastructure Plan facilities.

It is estimated that mains water demand would rise to 543 ML/year on a 'business as usual' basis, a 30 per cent increase on 2006 levels.

Council Water Use 2011–12

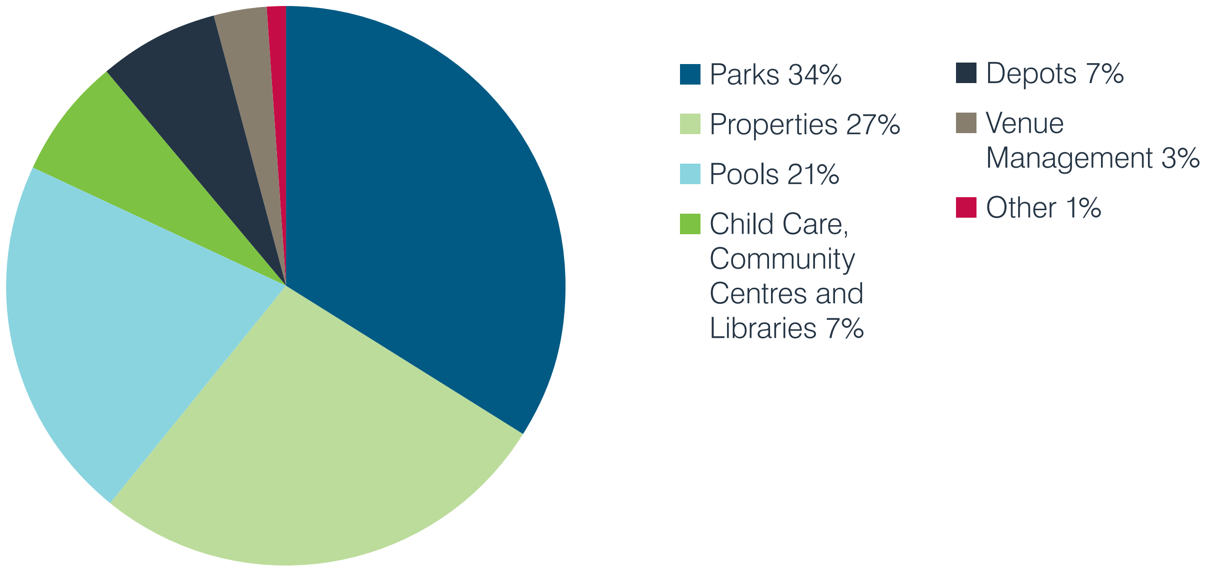
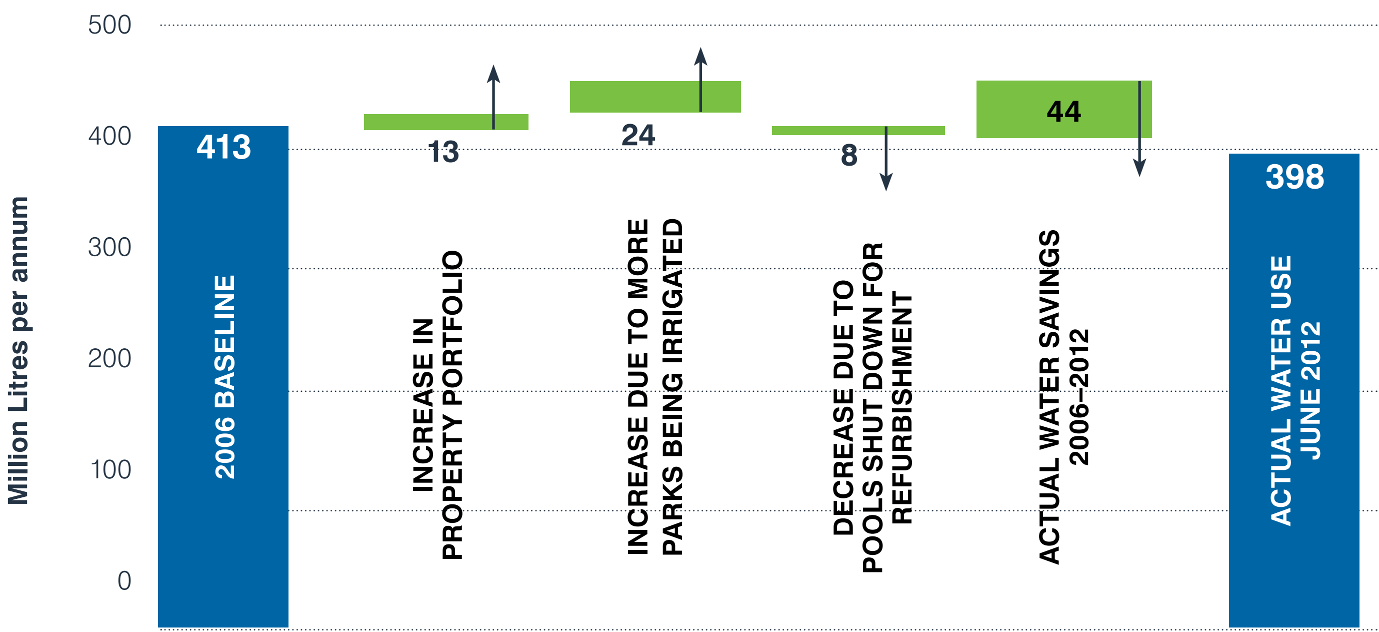


Figure 4.3: Council Water Use 2006 vs 2012



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Mains water demand of Council parks and sports fields

Council owned parks, playing fields and other open green spaces in the City of Sydney local government area provide valuable community amenities for local residents, office workers, visitors and tourists. They contribute to the city's social, environmental and economic well-being. Water is a critical input to the maintenance of these public green space amenities.

As of June 2012, the City owns and manages 417 parks and green spaces covering an area of 1,881,075 square meters (188 hectares). 50 of these sites are irrigated using mains water. Four sites make use of bore water and 11 sites make use of recycled water produced from park-based stormwater harvesting schemes and the remainder of sites are rain fed.

The City's buildings and operations consumed 413 ML of potable (mains) water in the Financial Year 2011–12, 34% of which i.e. 122 ML mains (potable) was used for irrigation of parks, sports fields, water features and tree maintenance operations. Council's mains water demand equates to 0.1% of total potable water use within the local government area.

A number of parks and green spaces within the City of Sydney local government area are iconic. They have very high amenity value and a high level of community use. The challenge for the City is to maintain the high amenity value and standards of its parks, sports fields and green spaces while conserving mains water.

Due to the increase in demand for park amenities, the City has responded to the community demand by either increasing the irrigated green space (e.g. Paddington Reservoir, Wentworth Park) or by acquiring new sites and transforming them into park amenities (e.g. Pirrama Park, Redfern Park and Oval). New additions of irrigated public open spaces to the City's portfolio also result from new development sites (e.g. Joynton Park in Victoria Park, Zetland) that have a mandatory requirement for more green space and vegetation to be integrated within the built form as part of public domain area.

It is anticipated that the area of irrigated green space managed by Council is likely to increase by 58%, as a result of new public open spaces acquired on account of Council's Greening Sydney Plan, land transfers and the new developments planned within the City (E.g. Harold Park, Green Square, Epsom Park, Berangaroo Development and Central Park on Broadway).

Council has been investing and will continue to invest in improving the water use efficiency of irrigation performance and providing alternative non potable water sources in order to reduce the reliance of these valuable community amenities on mains water.

Council mains water saving targets and actions for 2030

Council mains water saving projects – current

Some of the water saving projects that are currently underway or near completion include:

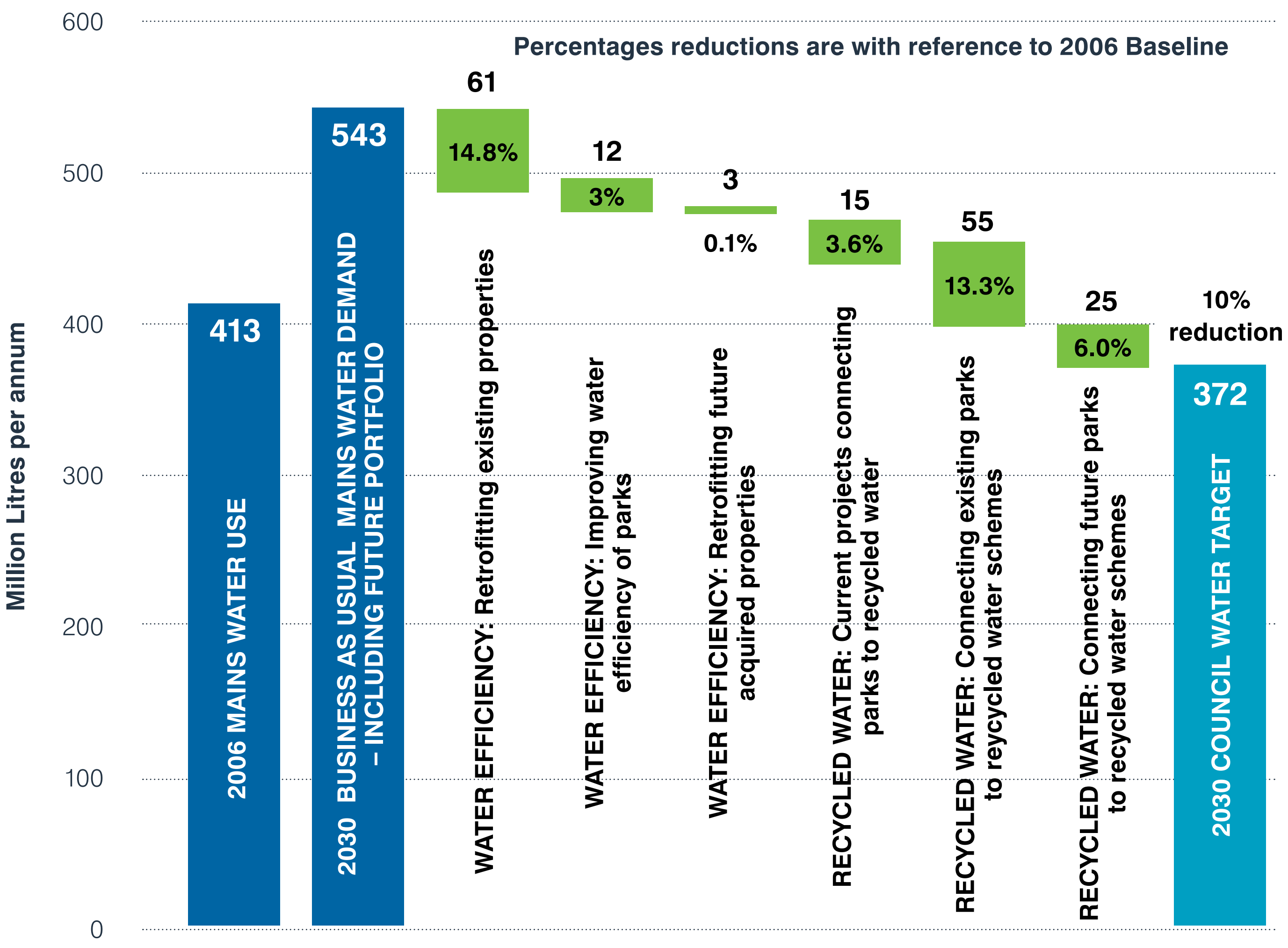
- Building water efficiency retrofits to 43 high-to-moderate water using properties with estimated mains water savings of 61 ML per year.
- Installation of smart meters to 30 additional parks to help early detection and fixing of leaks.
- Park-based small scale stormwater harvesting schemes on 3 sites (Prince Alfred Park, Alexandria Park and Waterloo Oval) with estimated mains water savings of 15 ML per year.
- Precinct scale stormwater harvesting schemes at Sydney Park (stage 2) and Green Square Town Centre with estimated mains water savings of 1,000 ML per year. These two projects have received co-funding from Federal government under their Stormwater Harvesting and Reuse grant program.

Council mains water saving projects – future

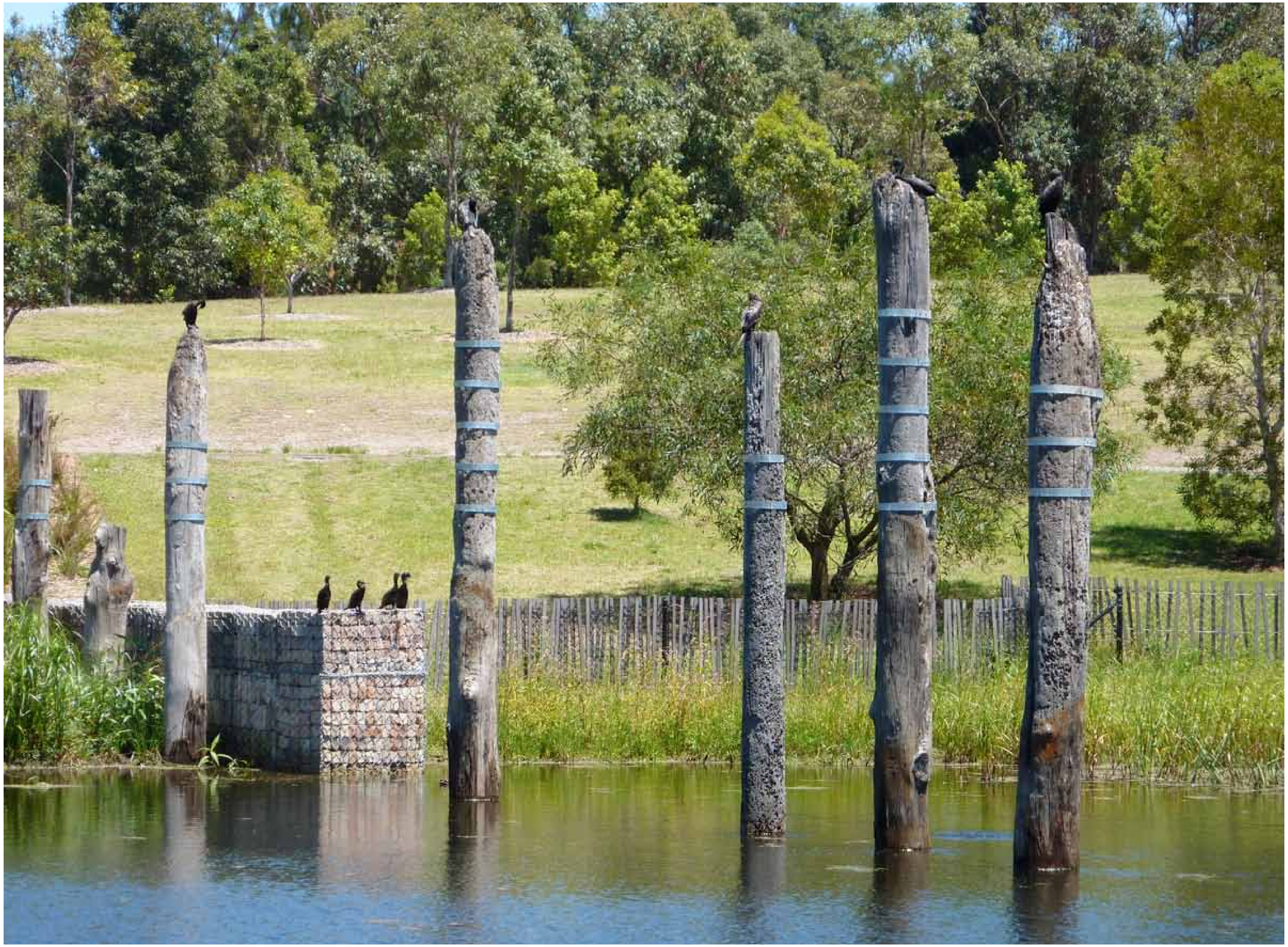
Council has set itself a target to reduce its mains water demand by 10 per cent of 2006 levels by 2030 despite an anticipated 30 per cent increase in its water demand by 2030. Council intends to achieve this target by investing in water efficiency and recycled or alternative non-potable water measures.

The mains water savings will be delivered by water efficiency measures on irrigation, park amenities and buildings and connection of Council facilities to recycled or alternative non-potable water schemes (park-based or precinct scale) that are planned to be built as a result of this Master Plan. Water efficiency measures will deliver mains water savings of 77 ML/year and connecting Council facilities to recycled or alternative non-potable water schemes will deliver mains water savings of 95 ML/year.

Figure 4.4: Mains Water Saving Target and Plan for Council Operations



1 DECENTRALISED WATER
2 RETHINKING WATER IN THE CITY
3 DECENTRALISED WATER SOLUTIONS
4 PERFORMANCE AND IMPLEMENTATION
5 ENABLING ACTIONS
6 CASE STUDIES



Performance of recycled water solutions

Assessing the performance of recycled water solutions tends to be more complex than assessing water efficiency solutions because there are several criteria that need to be considered. What adds to the complexity is the fact that response to the criteria varies depending upon the source of water used and location of the recycled water scheme. Therefore, the approach to assess the performance of water recycling solutions involved:

- **Performance assessment by water source** using two key criteria of recycled water demand met at full potential (Figure 4.5) and levelised cost (Figure 4.6) of operating and maintaining the scheme.
- **Performance assessment by location using a multi-criteria analysis (MCA)** by key stakeholders input. This involved stakeholders:
  - Selecting 10 case study water recycling schemes to represent the three catchment locations and all the water sources.
  - Agreeing on a list of quantifiable and non-quantifiable criteria and weighting them (Figure 4.7);
  - Scoring the 10 case studies (Figure 4.8) on the agreed list of criteria.

Figure 4.5: Maximum potential for substituting mains water

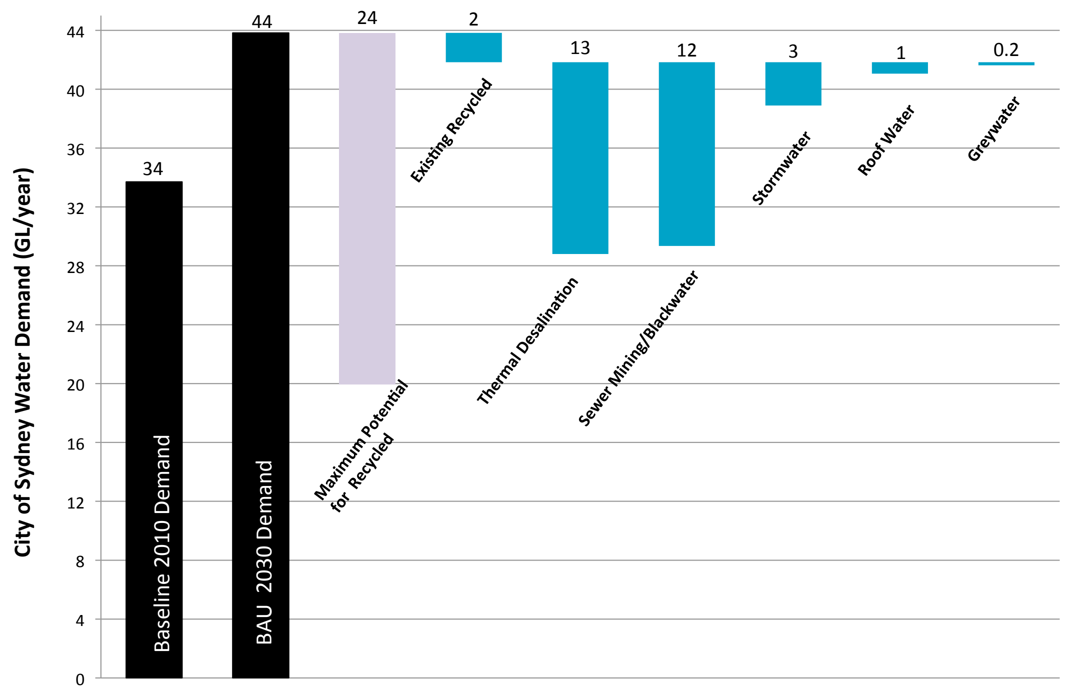
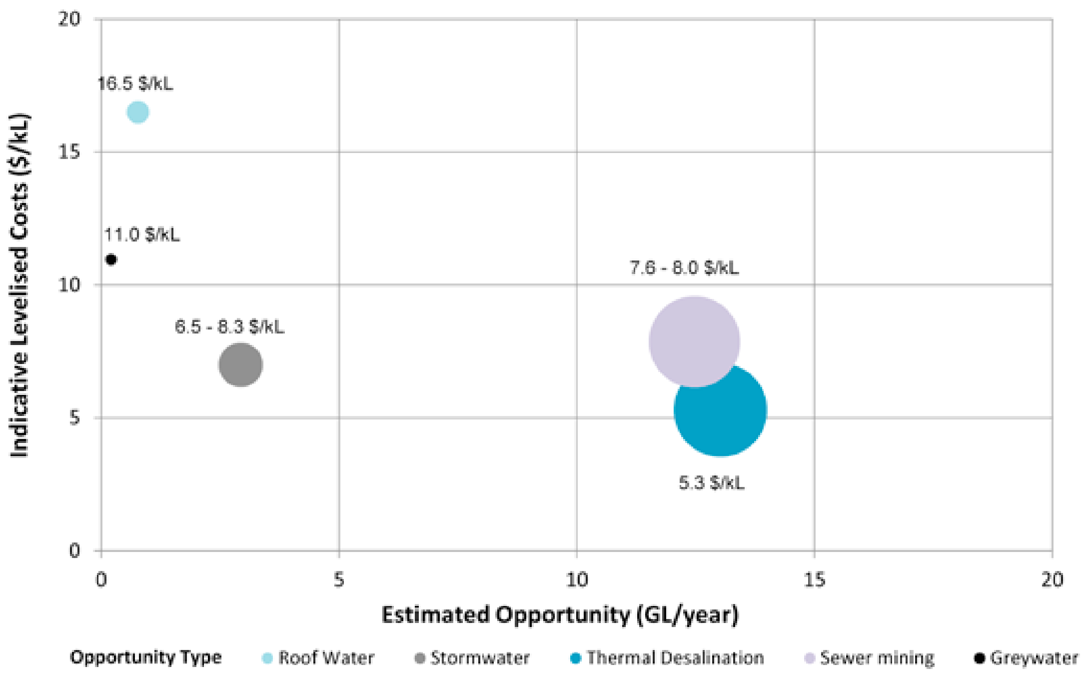


Figure 4.6: Indicative range of levelised cost of producing recycled water from each source



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Multiple criteria used for assessing the 10 case studies

Quantitative criteria used to assess the 10 case studies included:

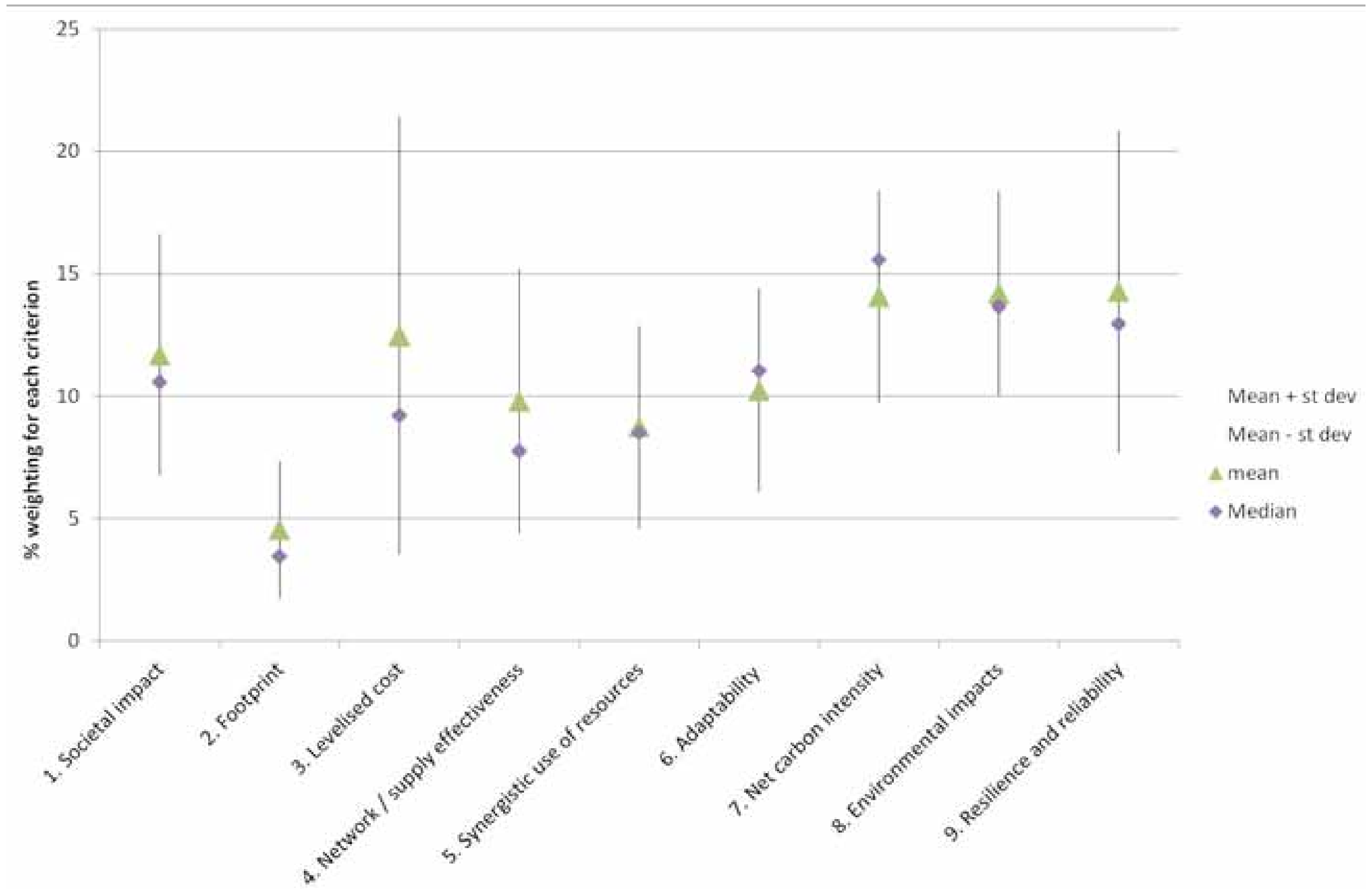
- **Network/supply effectiveness** (measured in per cent of total non-potable demand supplied by the scheme)
- **Net carbon intensity** (measured in tonnes of carbon equivalent per kL): Net carbon emissions arising from extraction, treatment and distribution of non-potable water supply.
- **Footprint area** (measured in square metres) – Total area occupied by various elements of the scheme (tanks, pumps, head works, and treatment plant).
- **Whole of society cost** (measured in net levelised cost, $ per kL) – i.e. the cost of a project over time discounted to today's dollars accounting for the volumes of water provided by the option.
- **Environmental impact** (measured in kilograms of pollutants a year prevented from being discharged to waterways and/or landfill). Net impacts on land and water not related to greenhouse gas emissions.

Qualitative criteria on which the case studies were assessed included:

- **Synergistic use of resources** Implementation of industrial ecology principles, e.g. reusing waste streams from the treatment process and from the adjacent solid waste and trigeneration systems.
- **Resilience and reliability** Capacity to effectively respond to changes in key trends (e.g. climate change, population growth) and shocks (e.g. drought, flooding)
- **Adaptability** Flexibility, modularity, potential to respond to changes in key factors.

The qualitative variables were assessed in the form of judgment provided by the key stakeholders.

4.7: Mean percentage weightings given to each criterion on the basis of individual percentage weighting provided by each stakeholder



Case studies: performance of 10 recycled water schemes

Figure 4.8 shows the outcome of the multi-criteria analysis (MCA) for the 10 case studies that were assessed. The greater the score (height of the band/bar), the better the performance of the case study for the corresponding variable.

As can be seen from Figures 4.9 and 4.10 (on the next page):

- Stormwater harvesting schemes do not perform as well on network/supply effectiveness, but perform very well on net carbon intensity and environmental impact (benefit).
- Sewer mining schemes, on the other hand, perform well on network/supply effectiveness but perform poorly on net carbon intensity due to the energy intensive treatment process the scheme relies on.
- Barangaroo thermal desalination process performs well on net carbon intensity a synergistic use of resources, as the scheme will make use of the zero carbon waste heat from trigeneration plant.

Table 3

Decentralised Water Recycling Solution	Demand Opportunity (gigalitres/ annum)	Footprint (m²)	Levelised cost ($/kL)	Network/ supply effective (ML/km/y)	Synergistic use of resources (Judgement)	Adaptability (Judgment)	Net carbon intensity (tCO_2e/ML)	Environ. impact (per cent reduction)	Resilience and reliability (Judgement)
1. Johnstons Creek Sewer Mining	0.40	3,200	11.3	60	0.38	0.72	1.7	0.0%	0.67
2. City Wide Sewer Mining	8	22,800	8.4	180	0.64	0.49	1.8	0.0%	0.84
3. Darling Harbour Sewer Mining	3.1	8,600	7.5	500	0.79	0.72	1.6	0.0%	0.84
4. Barangaroo Sewer Mining	0.77	4,900	6.8	450	0.75	0.72	1.6	0.0%	0.58
5. Greater Green Square Sewer Mining	2.1	6,100	8.0	160	0.68	0.72	1.6	0.0%	0.58
6. Wentworth Park Stormwater Harvesting	0.55	12,500	6.5	60	0.41	0.53	0.2	4.5%	0.38
7. Waterloo Oval Stormwater Harvesting	0.50	500	8.3	50	0.52	0.53	0.2	5.1%	0.38
8. Sydney Park Stormwater Harvesting	0.50	400	6.7	50	0.64	0.51	0.1	5.3%	0.38
9. Moore Park Roof Water Harvesting	0.07	100	16.5	40	0.48	0.36	0.4	3.2%	0.15
10. Barangaroo Thermal Desalination	2	1,100	5.3	140	0.89	0.52	0.1	0.0%	0.84

Figure 4.8: Quantitative and qualitative scoring of 10 case studies

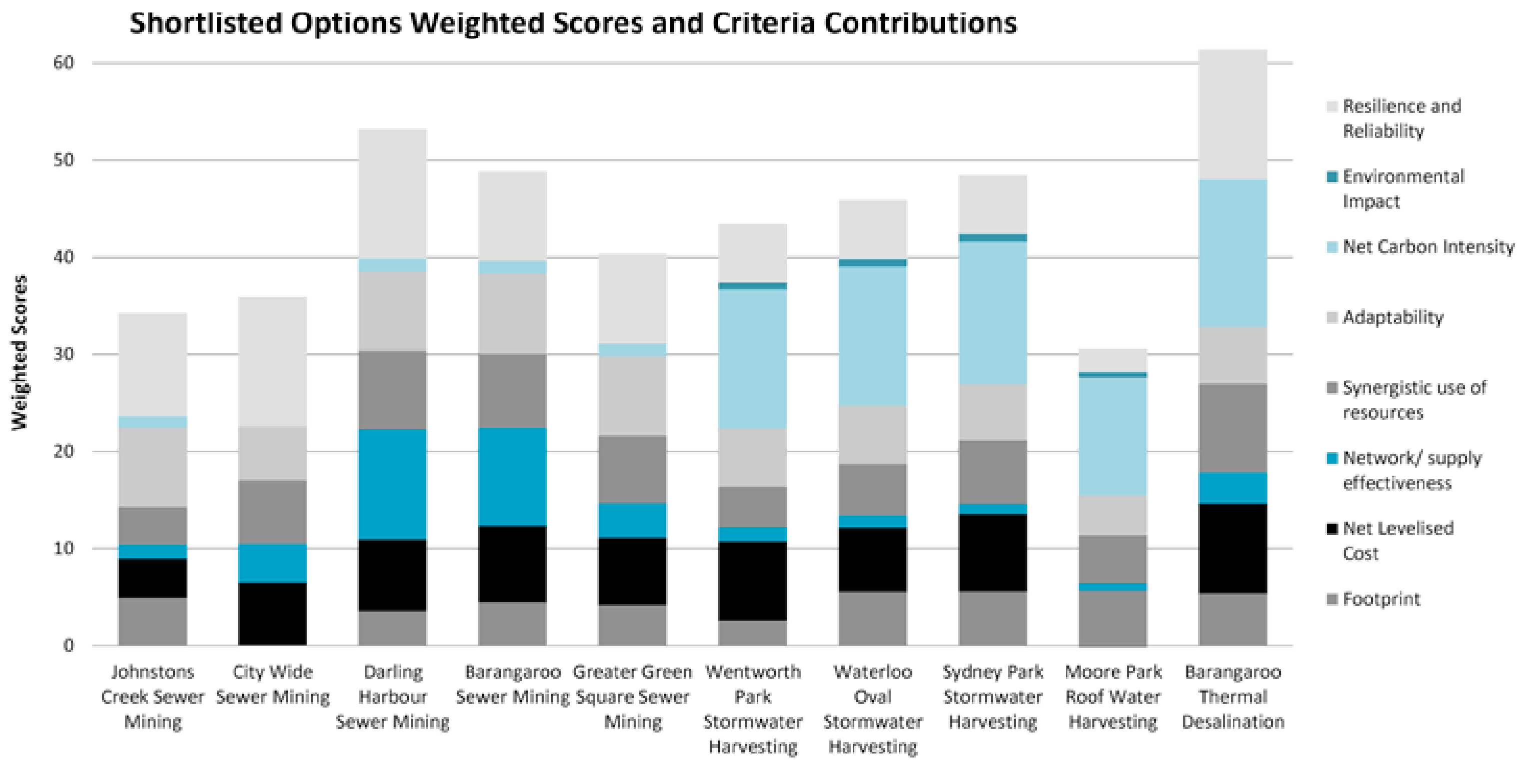


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Figure 4.9: Comparing the carbon footprint of 10 case studies with Sydney Water operated services

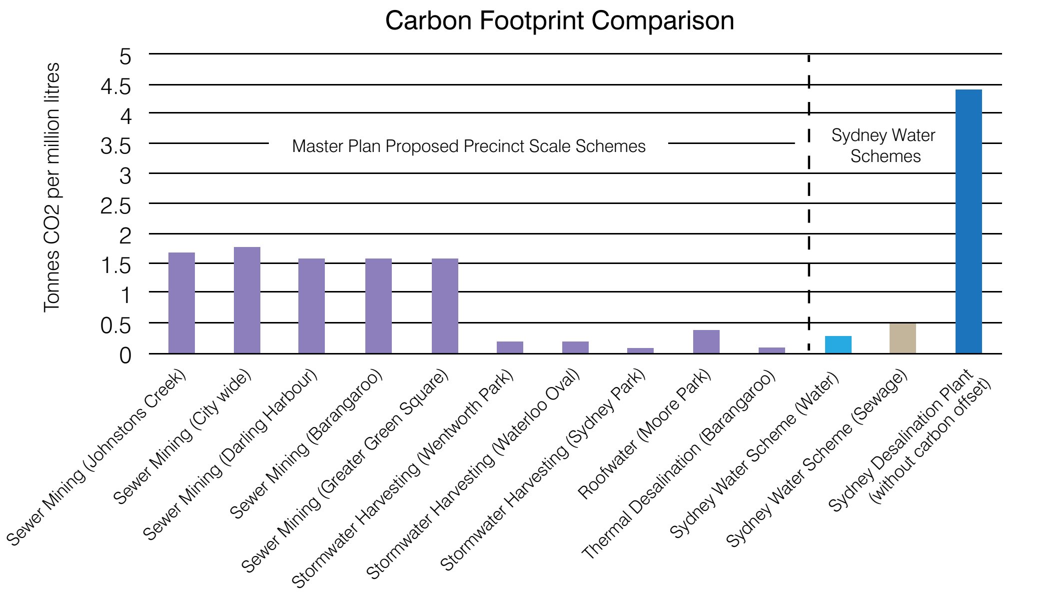


Figure 4.10: Comparing the capital cost, operating cost, business costs and maximum recycled water supply capacity of the 10 case studies

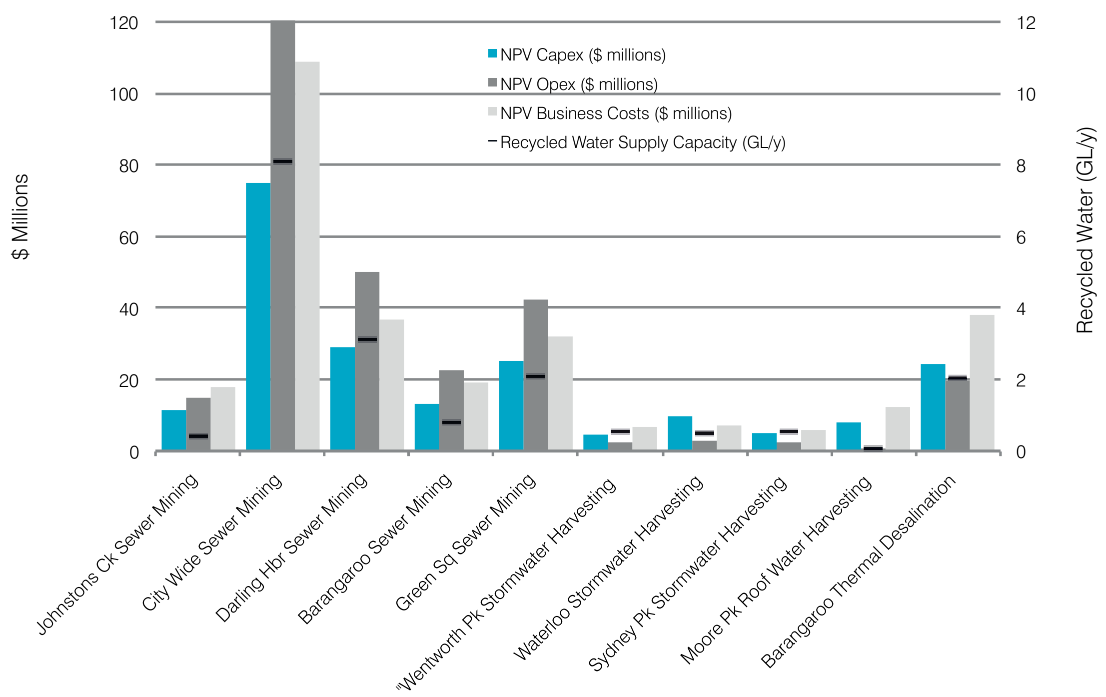
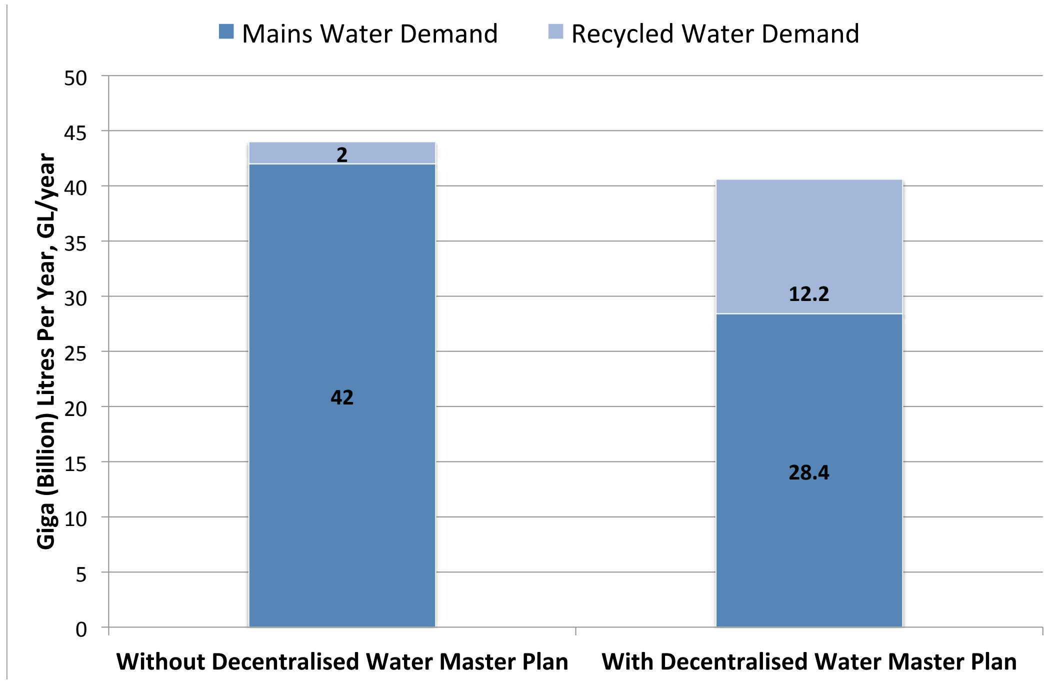


Figure 4.11: 2030 Master Plan performance vs business as usual



42 giga litres of annual business-as-usual mains water demand in 2030 would be reduced by a total of 13.6 litres if the Decentralised Water Master Plan is implemented to its full potential. The total reduction achievable in mains water demand is made up of 3.4 giga litres (due to water efficiency programs) and 10.2 giga litres (due to recycled water schemes providing substitute for mains water demand).

Implementing recycled water solutions

Implementation models for recycled water solutions is often dictated by the size of the scheme.

Major precinct recycled water schemes would be timed to align with the planned installation of trigeneration networks or other major infrastructure upgrade or renewal project. The scheme will be facilitated through the procurement of services for the design, build, operate and maintain as well as for the retail of recycled water. This may involve, any of the folllowing:

- The City procuring a contractor to undertake the services on behalf of the City.
- A water services company (WASCO) providing the services in conjunction with the City. The City may co-invest in the scheme and in return retain ownership of the recycled water distribution network.
- The City procuring a water services company (WASCO) to run the scheme as an independent service provider.

Minor precinct schemes located around a small re-development site or public open space.

Small re-development sites: The implementation would be through planning controls and entering into voluntary planning agreements with the developer to ensure that the infrastructure to receive and distribute the recycled water within the development is installed. Developers will be provided with details of the opportunities identified in this Master Plan.

Public open spaces: The implementation would be timed to the planned capital works and any major upgrades within the public open spaces.

To enable uptake of recycled water within existing buildings and operations, the City will use its own buildings and operations as the anchor customer and work in close collaboration with the Better Buildings Partnership to build market demand for recycled water services.

The City will also actively lobby for the introduction of planning rules that mandate the future proofing of buildings in new development by installing infrastructure for receiving and distributing recycled water in new developments, thereby providing more certainty to developers and operators of recycled water scheme.

Aerial view of Pennant Hills Golf Club Recycled Water Plant

(Photo Credit – Permeate Partners)

The recycled water plant harvests wastewater from the sewer pipe network and treats it to produce high quality water that is used for irrigation of the Golf Course, saving 70 million litres per year of mains water.

Rouse Hill residential development using recycled water since 2001

The development has a dedicated purple pipe network that supplies recycled water to more than 20,000 homes saving 1.7 billion litres of mains water each year.

(Photo Source: www.sydneywater.com.au)

Performance of Water Sensitive Urban Design (WSUD) solutions

The performance of **stormwater pollution reduction solutions** was assessed against the following key criteria:

- Contribution to total suspended solids reduction target
- Contribution to total nitrogen reduction target.
- Cost per kilogram of total suspended solids and total nitrogen removed.

Figures 4.9 and 4.10 show the contribution of each solution to the total suspended solids reduction target and cost per kilogram of total suspended solids removed.

On the basis of these criteria:

- Retrofit of water sensitive urban design (WSUD) into major and minor public open spaces provides value for money.
- However, WSUD retrofit to private spaces is least beneficial as it provides least value for money.

The cost of implementation includes the cost of construction and ongoing maintenance.

Figure 4.12: Stormwater pollution reduction solutions and their pollutant reduction potential

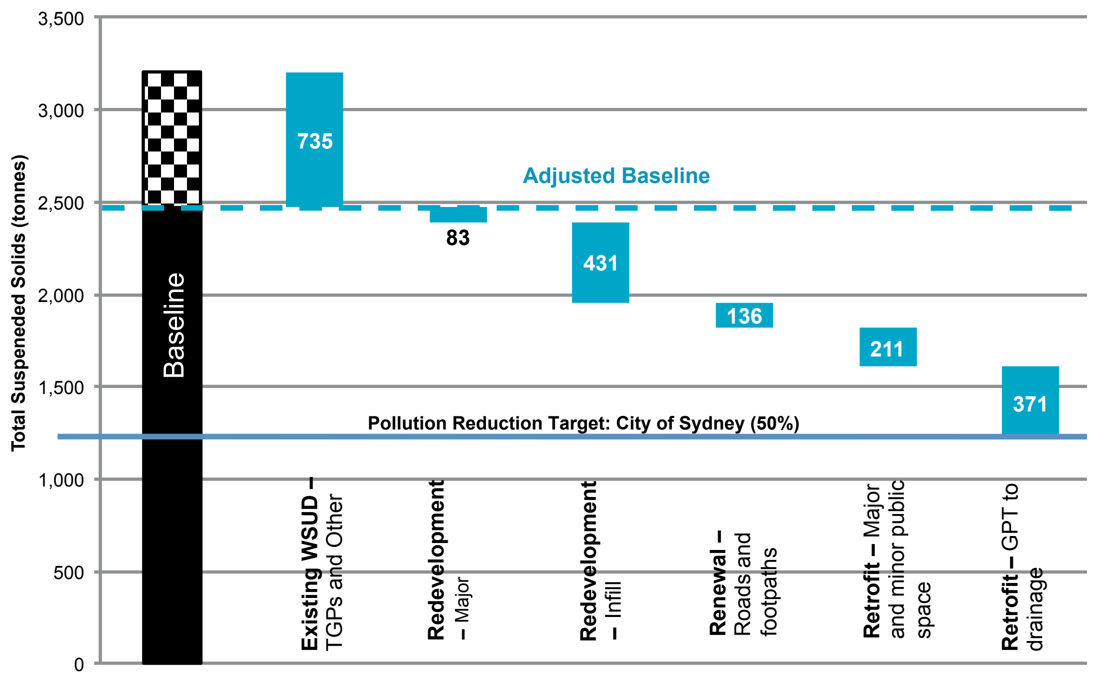
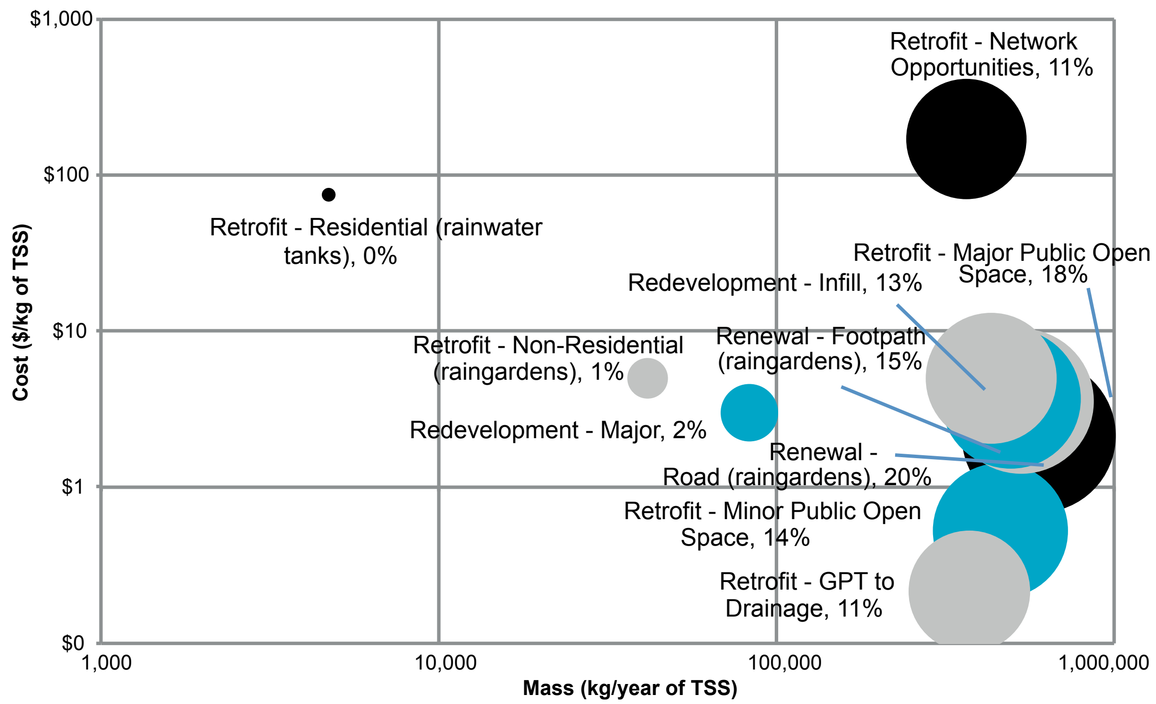


Figure 4.13: Cost benefit of stormwater pollution reduction solutions



Based on the cost benefit analysis, the City has set a target of achieving 50 per cent reduction in total suspended solids (sediments) load and 15 per cent reduction in total nitrogen (nutrient) being discharged to the waterways, by 2030. Figures 4.9 and 4.10 show the mix of measures that have been selected to achieve these targets along with the cost of each initiative per kilogram of sediment reduction they provide.

The mix of measures include:

- **Mandating WSUD in all new developments** would provide a reduction of 21 per cent of reduction in current sediment load, and 11 per cent reduction in current nutrient load.
- **Retrofitting of the drainage network with gross pollutant traps** into the existing drainage network will provide about 15 per cent reduction in the current sediment load. It will provide no reduction in current nutrient load.
- **Retrofitting of public open space** with a combination of raingardens, swales and wetlands in at least 10 per cent of the opportunities available can achieve 9 per cent of reduction in current sediment load and 3 per cent reduction in current nutrient load.
- **Incorporating WSUD** during at least 10 per cent of opportunities presented by renewal of road and other streetscape projects can provide a 5 per cent reduction in current sediment load and 1 per cent reduction in current nutrient load.

Implementing stormwater pollution reduction solutions

Implementation of stormwater pollution reduction solutions generally take the form of:

- **Water sensitive urban design (WSUD) in new developments**
- **WSUD in streetscapes and parks**
- **Gross pollutant traps in drainage networks.**

Although WSUD in new developments will be the responsibility of developers, the City will ensure that the planning instruments are in place as well as provide the tools and resources to assist developers in implementing the best practice WSUD. The City will also work towards building the capacity of its development assessment staff and provide them with the tools to help assess the WSUD provisions within development applications.

WSUD in streetscapes and parks will be implemented by the City as part of planned streetscape and park upgrades or renewals.

Gross pollutant traps will be implemented as part of planned drainage network upgrades and renewals.

In addition to its own capital works projects, the City will also make available the details of WSUD opportunities identified in this master plan to other agencies such as Sydney Water, Transport for NSW, Roads & Maritime Services, and other utilities, to help them incorporate and implement them as part of their planned major capital works within the city.

The City will be be undertaking active stakeholder engagement, both internal and external, to promote and inform the decentralised water solutions to ensure that the solutions identified are embedded within the plans and designs of future capital works projects.

WSUD in Victoria Park development, Zetland

The City of Sydney is home to one of the first developments in Australia to incorporate WSUD in new development.

Raingarden in Chippendale built as part of other traffic calming and pedestrian safety measures

About 10 raingardens were incorporated as part of the City's streetscape works that was aimed to calm the traffic for improved safety of pedestrians and bike riders.

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Mapping the mains and recycled water profile of the City of Sydney in 2030

Figure 4.14: 2010 Potable water consumption before implementing decentralised water solutions

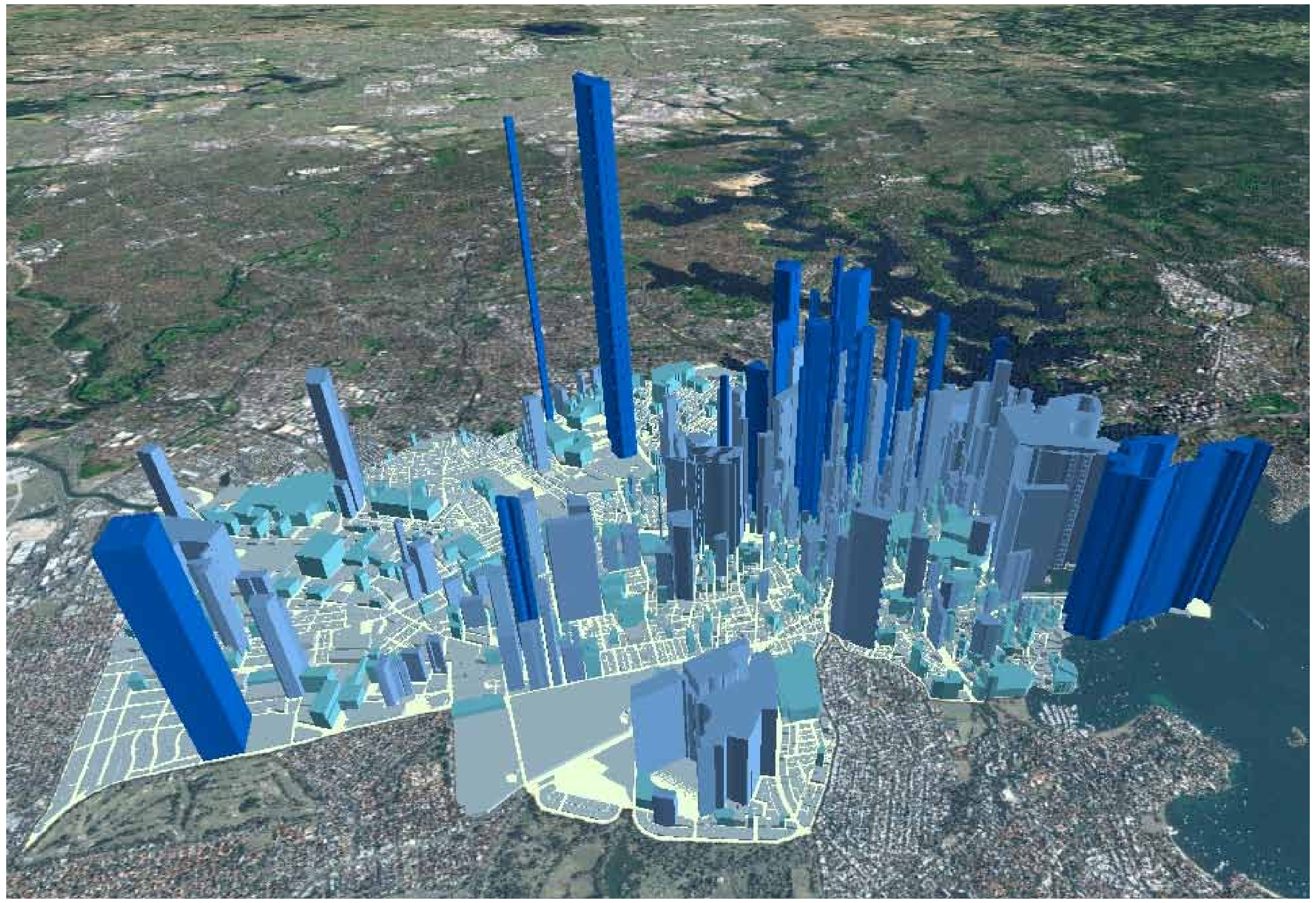
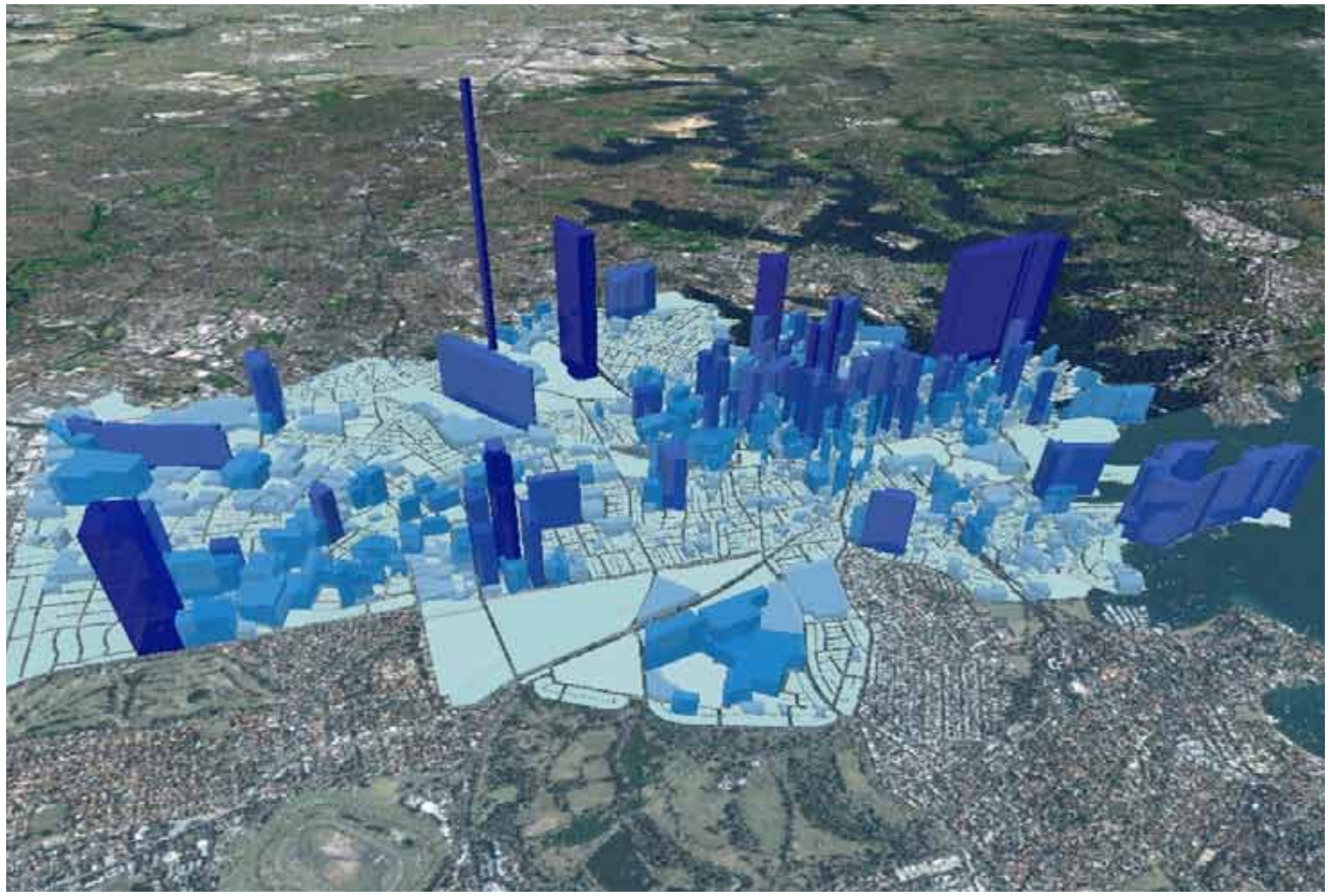


Figure 4.15: 2030 Potable water consumption after implementing decentralised water solutions



Mains water network

Figure 4.15 shows the city's mains drinking water supplies in 2030 after the implementation of the decentralised water solutions. Each bar displays the amount of potable or mains drinking water consumption through vertical height and the intensity through colour, the greater the stack the higher the water consumption, the darker the colour the greater the intensity per square metre of lot area.

Recycled or alternative non potable water network

Figure 4.16 shows the city's recycled or alternative non potable water supplies in 2030 after the implementation of decentralised water solutions. Each bar displays the amount of recycled or alternative non potable water consumption through vertical heights and the intensity through colour, the greater the stack the higher the water consumption, the darker the colour the greater the intensity per square metre of lot area.

Figure 4.16: Non potable recycled water consumption after implementing decentralised water solutions

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5. Enabling actions

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Eleven enabling actions

Enabling the Master Plan

The decentralised water solutions outlined in this Master Plan will provide a transformative water solution to the City of Sydney, significantly reducing mains drinking water demands by supplying non-drinking uses from a recycled water network. At the same time the decentralised water solutions will also reduce stormwater pollutants entering the city's waterways.

The responsibility for implementing this Master Plan rests with the City of Sydney, which is ideally placed to deliver on many of the necessary key components of the proposed network.

However, a network such as the one described within this master plan cannot be implemented without careful consideration and action on behalf of the residential and business communities and State and Federal Governments working in cooperation with the City of Sydney.

This Chapter outlines 11 enabling actions that would assist the implementation and delivery of the decentralised water master plan. These actions have been identified through consultation with key stakeholders in the public and private sector. They are included not as barriers that would prevent implementation but as enablers, to ensure the decentralised water master plan delivers its promised performance.

Primarily, this is a chapter about cooperation. There is no single entity in the Government or private sector that can implement a project of this type and scale on its own. Included are actions which would need to be delivered by all sectors of Government as well as private households, business and industry.

Eleven enabling actions

1. **Make sub metering mandatory in multi residential apartment buildings.**
2. **Increase the BASIX target for non-potable water to encourage the connection of new buildings to decentralised water networks.**
3. **Modify the City of Sydney development control plan to reflect decentralised water solutions.**
4. **Introduce mandatory disclosure for drinking and non drinking water consumption in buildings.**
5. **Incentivise water efficiency and decentralised water solutions.**
6. **Introduce demand management rebates and decentralised water offsets.**
7. **Make state and federal infrastructure funds available.**
8. **Introduce Environmental Upgrade Agreements for decentralised water to new developments.**
9. **Remove the regulatory barriers to decentralised water.**
10. **Introduce statutory rights for decentralised water infrastructure providers to undertake works in the public domain.**
11. **Implement City of Sydney specific sewer overflow monitoring and reporting by Sydney Water.**

1.

Make sub metering mandatory in multi-level buildings

It is difficult to retrofit water efficiency measures inside apartments of existing multi-residential, commercial, mixed or any other use buildings. As per one of the studies by Sydney Water on high rise apartment buildings, they form a significant proportion of water use within the multi-residential buildings. Individual sub-metering of apartments within a multi-residential building has the potential to raise more awareness of water use which can trigger water efficient actions and behaviour.

Metering is best introduced at the time of planning and design of the buildings. Therefore, sub-metering within new multi-residential buildings should be be mandated. For example as part of BASIX requirements.

2.

Increase the BASIX target for non-potable water to encourage the connection of new buildings to decentralised water networks

The decentralised recycled or alternative non-potable water network provides the infrastructure whereby all new residential construction could benefit from precinct scale or city-wide reticulated recycled water networks for effective and low cost BASIX compliance.

In recognition of this, NSW government should introduce recycled or alternative non potable water targets and increase the reduction in mains water demand to incentivise the connection of buildings to decentralised water networks.

3.

Modify the City of Sydney development control plan to reflect decentralised water solutions

Within the precinct scale reticulated recycled water network zones the City of Sydney should specify basic plant room and connection requirements for any new construction through future amendments to the comprehensive City's Development Control Plan. This would ensure that buildings built today are easily able to connect a precinct scale reticulated recycled water network infrastructure zone as it becomes available.

Any additional floor space required for treatment plant, storage, pumps and tanks should not be included within the floor space ratio assessment.

4.

Introduce mandatory disclosure for drinking and non drinking water consumption in buildings

Introduce mandatory disclosure for drinking and non drinking water consumption in commercial buildings similar to the Federal Government's mandatory disclosure legislation for the energy performance of commercial property of 2,000m2 or more.

Mandatory disclosure of a building's water consumption performance has the potential to create demand for buildings that are water efficient and drought resistant through reduced reliance on mains water by virtue of being connected to the decentralised recycled water network. This would allow buyers and tenants to compare the relative performance of different buildings.

5.

Incentivise water efficiency and decentralised water solutions

Incentivise water efficiency and decentralised water solutions by providing financial incentives similar to the NSW Government's Energy Savings Scheme (ESS).

A Water Savings Scheme (WSS) would be a mains water savings mandatory scheme which would work by establishing a market for tradable Water Savings Certificates (WSCs). The certificates would be made by Accredited Certificate Providers (ACPs) when they undertake mains water saving activities that improve water efficiency and/or replace mains drinking water with recycled non drinking water in a variety of residential, commercial, industrial and community settings. Once created WSCs must be obtained and surrendered by water retailers and other parties known as Scheme Participants, who need to meet annual targets as set out in legislation.

The Water Savings Scheme, if implemented, would have the potential to provide financial incentives that would increase the viability of the decentralised recycled water network and encourage building owners within precinct scale recycled water zones to connect to the networks.

6.

Introduce demand management rebates and decentralised water offsets

Introduce demand management rebates and decentralised water offsets where avoided costs to the mains water and sewerage network can be demonstrated.

The city's ageing and constrained mains water and sewerage infrastructure will require significant investment by Sydney Water to provide for population growth and the repair or replacement of assets in the medium and long term. Forward looking demand management offsets and rebates should be established where avoided costs (from reduced pumping, sewage treatment or the desalination plant operating cost savings) and deferred costs to upgrade, repair, replacement or augmentation of mains water and sewerage infrastructure can be demonstrated.

Local recycled water can also assist in the management of transmission and distribution network demand. Currently, there is no standard or recognised methodology for the recovery of avoided transmission or distribution costs by local recycled water producers. Avoided network costs are a potential source of revenue that could assist the viability of decentralised recycled water networks.

7.

Make state and federal infrastructure funds available

On the basis of the analysis undertaken in this Master Plan, the State and Federal Government should contribute to the implementation of the decentralised recycled water network. This would ensure that the largest central business district in Australia is drought proofed by a local, affordable recycled water solution.

The City of Sydney local government area is the most significant urban economy in Australia. As Australia's only global city, Sydney is the heart of the Australian economy. Economic activity within the City's local government area comprises 25% of New South Wales GDP and 8% of Australia's GDP – about $100 billion a year and up there with the mining industry. It is imperative that the city's water supply is guaranteed, drought proofed and utilised to adapt to climate change, particularly mitigating the effects of the urban heat island effect.

Although Federal Government has provided infrastructure funding for stormwater harvesting schemes, the funding should be extended to assist in the implementation of the decentralised recycled water network from all local water resources including sewage, grey water, black water and sea water (thermal desalination) in addition to sewage. This could result in a reduction in overall costs to consumers, whilst at the same time assisting Australia to deliver its 30% National Water Recycling Target.

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Introduce Environmental Upgrade Agreements for decentralised water to new developments

The Local Government (Environmental Upgrade Agreement) Act 2010 enables financing for energy and water efficiency retrofits in non residential and strata multi residential buildings and can include measures to reduce water consumption, prevent or reduce water pollution and eliminate or reduce discharges of wastes, or other substances, that are harmful to the environment.

This makes it easier for existing building owners and occupiers to connect to decentralised water networks. A similar legislative measure should be made available. However, Environmental Upgrade Agreements should be extended to new developments to incentivise developers to facilitate or connect to decentralised water networks.

9.

Remove the regulatory barriers to decentralised water

Although the financial performance of the more cost effective components of this Master Plan may be affordable under the current regulatory regime more could be achieved and more cost effectively if the regulatory barriers to decentralised water were removed.

Recycled water is part of a mix of solutions towards providing long term water security in Australia, particularly for cities, and yet precinct scale decentralised recycled water schemes are not treated in the same way as mains water schemes which benefit from regulatory support in recovering their costs from all water consumers. For example, the cost of the Sydney desalination plant at Kurnell is able to be recovered across 100% of the population base even though the full capacity of the plant is only 15% of the total water demand in the Sydney Metropolitan area, whereas the cost of decentralised recycled water networks can only be recovered from local authorities and/or a small number of customers connected to the scheme.

The regulatory barriers to decentralised recycled water networks should be removed to create a level regulatory playing field so that similar cost recovery mechanisms can be applied to precinct scale recycled water schemes in recognition of their contribution to the long term water security of the population of Metropolitan Sydney.

The water regulatory system should also be revised so that decentralised recycled water projects such as thermal desalination which can produce drinking water are able to utilise the Sydney Water mains water distribution network for distributing the desalinated water to water demands that would otherwise use non drinking water without being forced to participate in the general water retail market or being affected by a drought order.

The purpose of investing in decentralised recycled water projects to serve non drinking water demands such as air conditioning cooling towers, toilet flushing and irrigation would be defeated by the current regulatory system. Irrigation of parks, gardens, city treescapes, etc, in times of drought is a key part of the city adapting to climate change to address such issues as the urban heat island effect as well as increased amenity for Sydneysiders.

10.

Introduce statutory rights for decentralised water infrastructure providers to undertake works in the public domain

Introduce statutory rights for decentralised recycled water infrastructure providers similar to Sydney Water's statutory rights to undertake construction, operation and maintenance works in public streets, footpaths and other public domain areas.

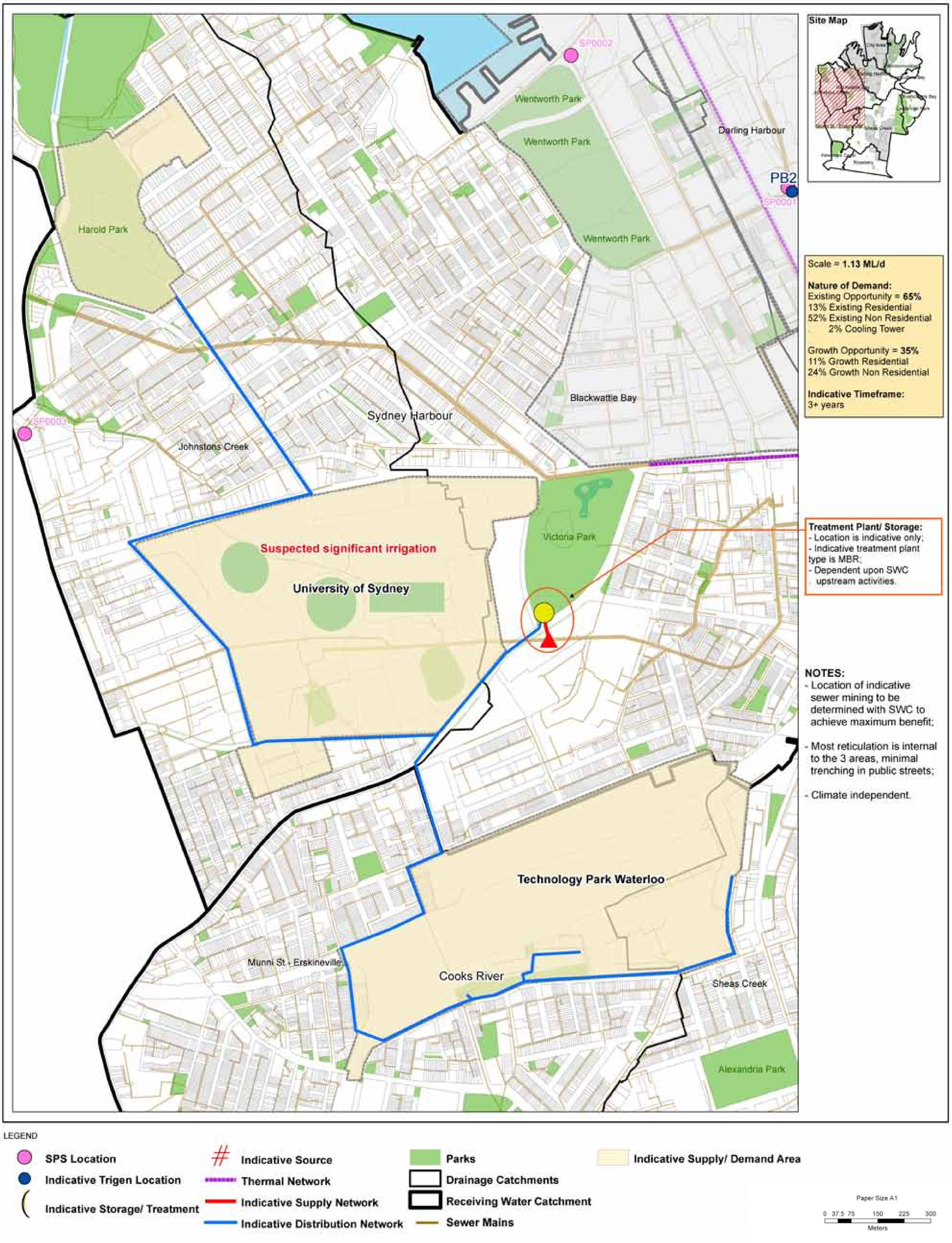
This is a practical measure as well as creating a level regulatory playing field between decentralised recycled water infrastructure providers and Sydney Water.

11.

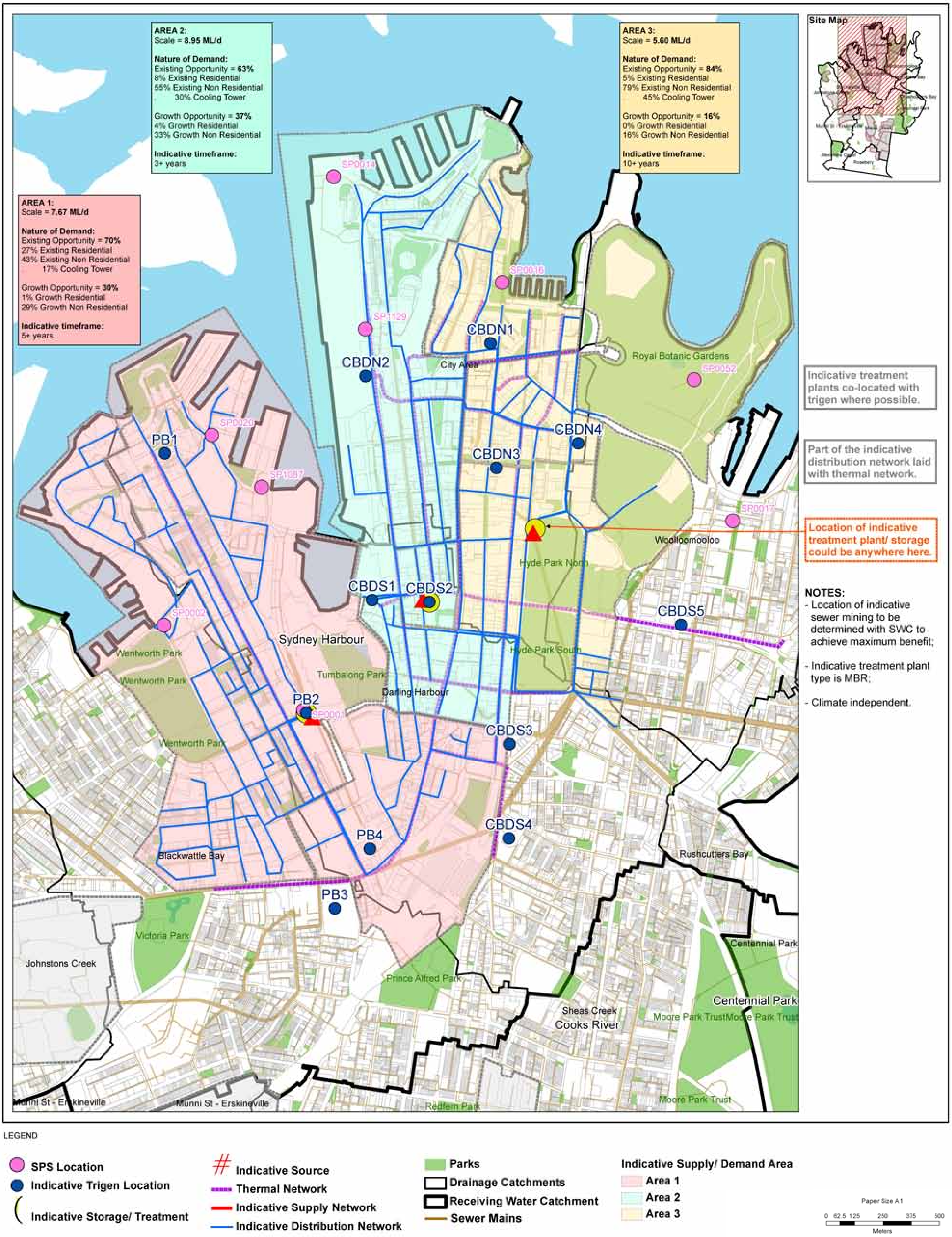
Implement City of Sydney specific sewer overflow monitoring and reporting by Sydney Water

Given the ageing and extensive stormwater and sewerage infrastructure owned by Sydney Water in the City of Sydney local government area and the high frequency of sewer overflows experienced in the Sydney Harbour catchment, NSW Office of Environment and Heritage should implement a transparent and regular public monitoring and reporting by Sydney Water of sewer overflows specific to the City of Sydney local government area. The reporting should also contain information on Sydney Water's plans to address the problems.

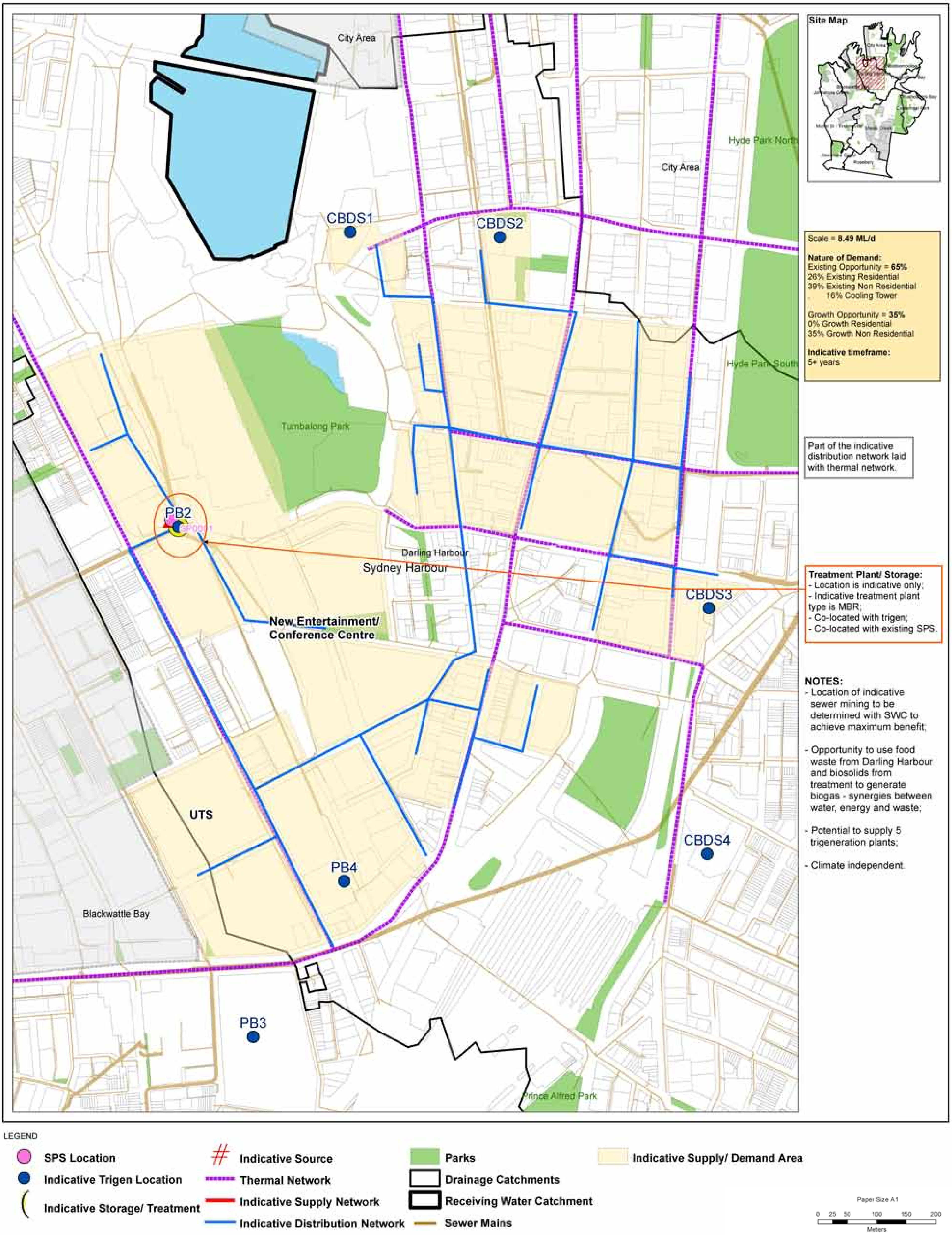
Case studies



1. Johnstons Creek sewer mining

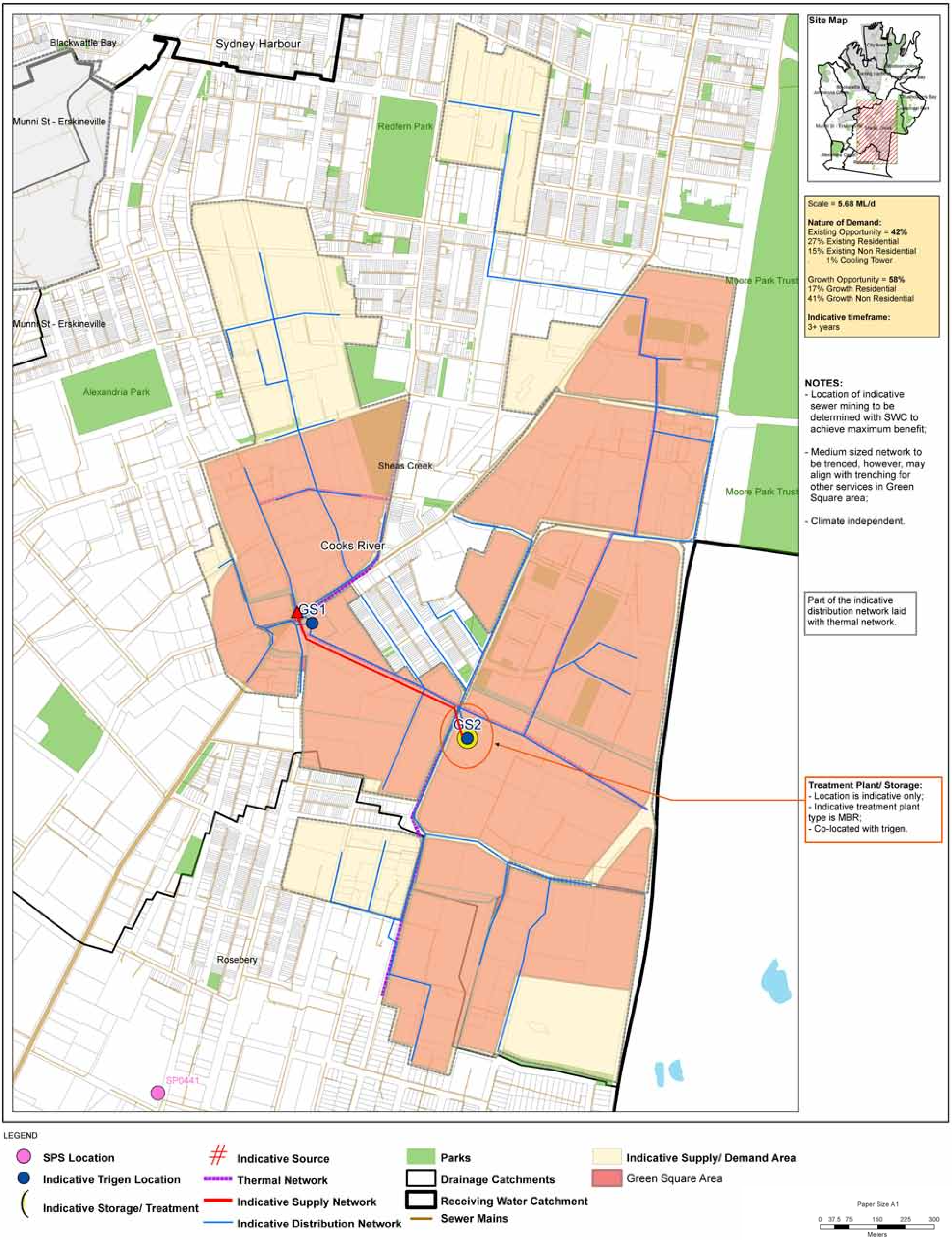


2. City wide sewer mining

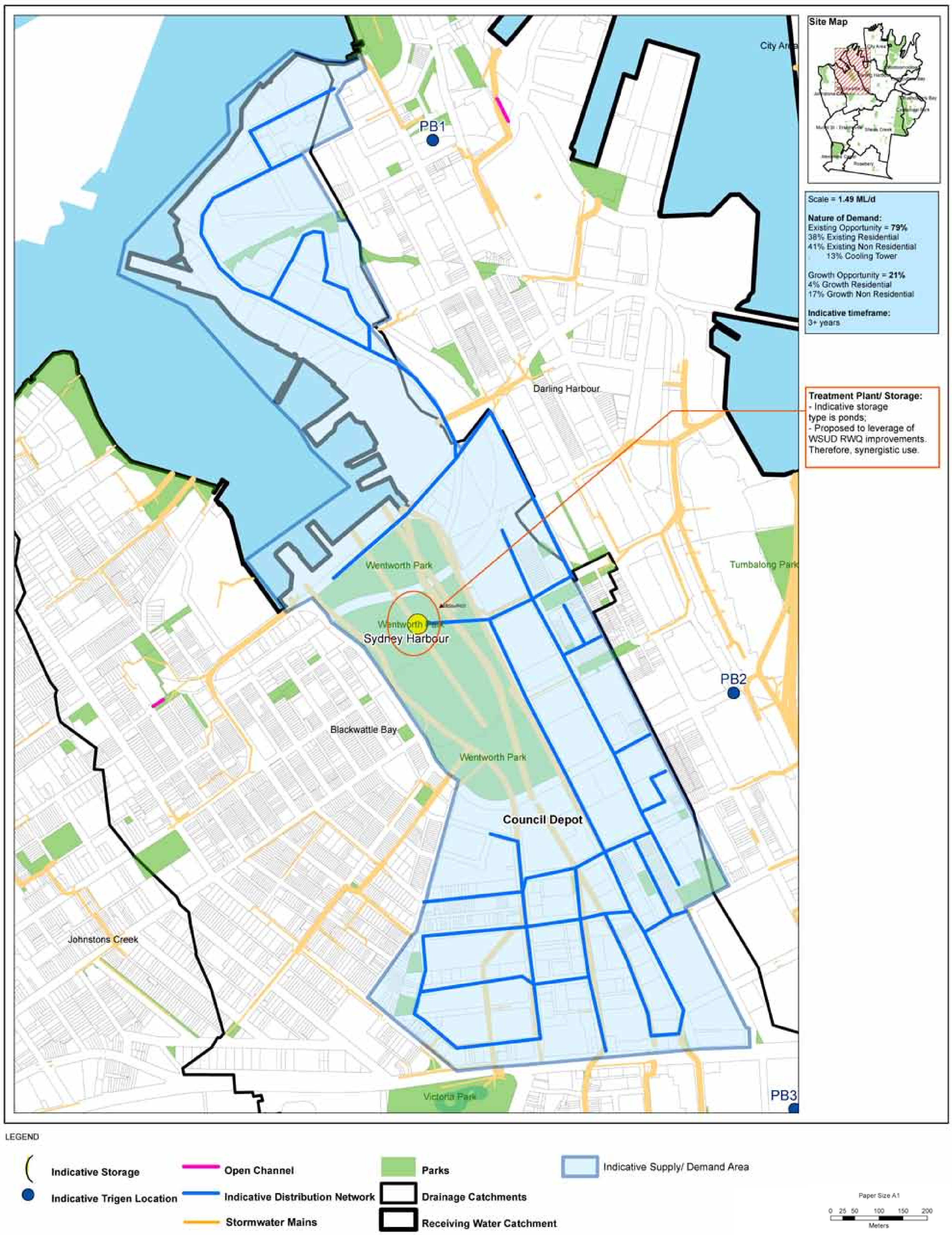


3. Darling Harbour sewer mining

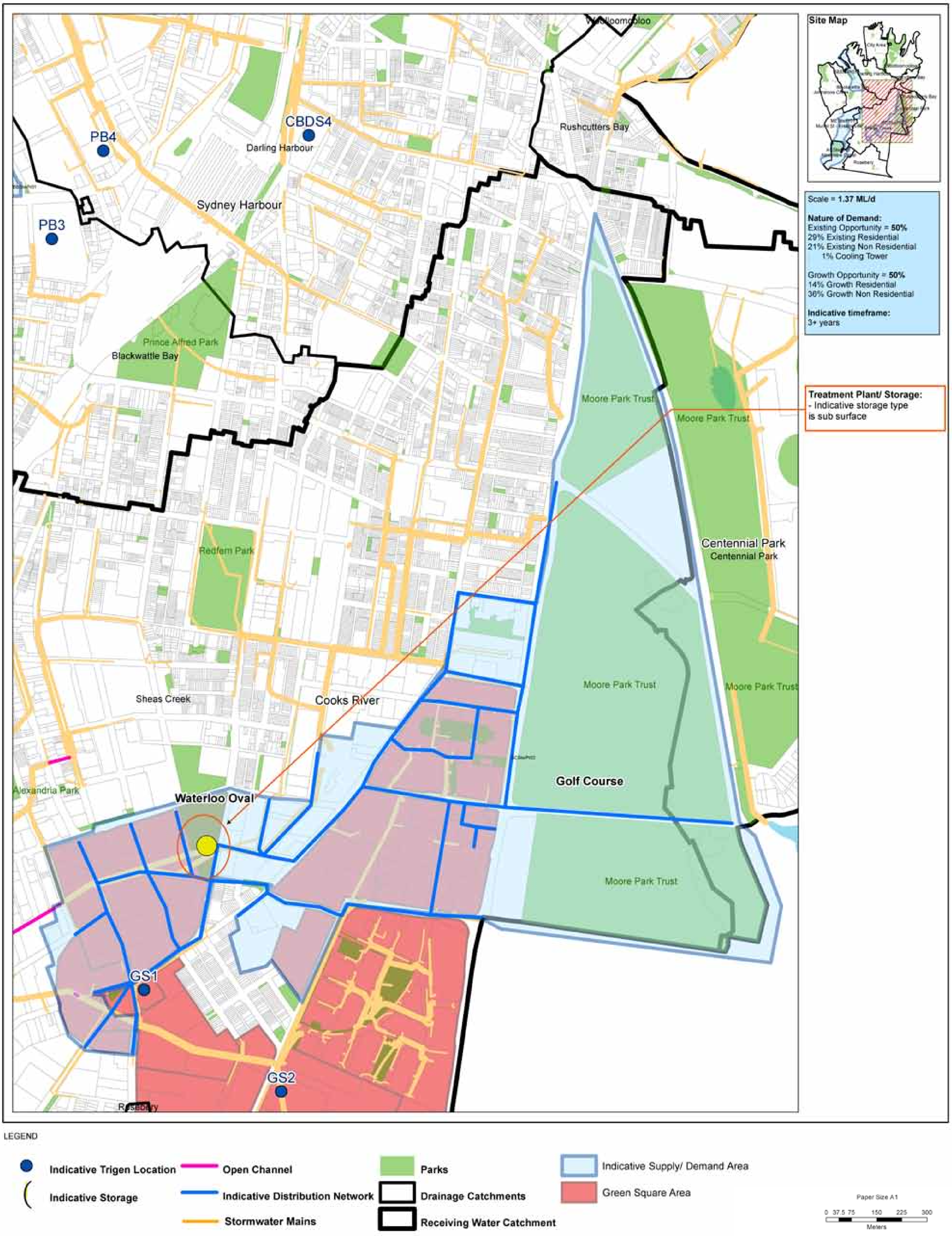
4. Barangaroo sewer mining



5. Greater Green Square sewer mining

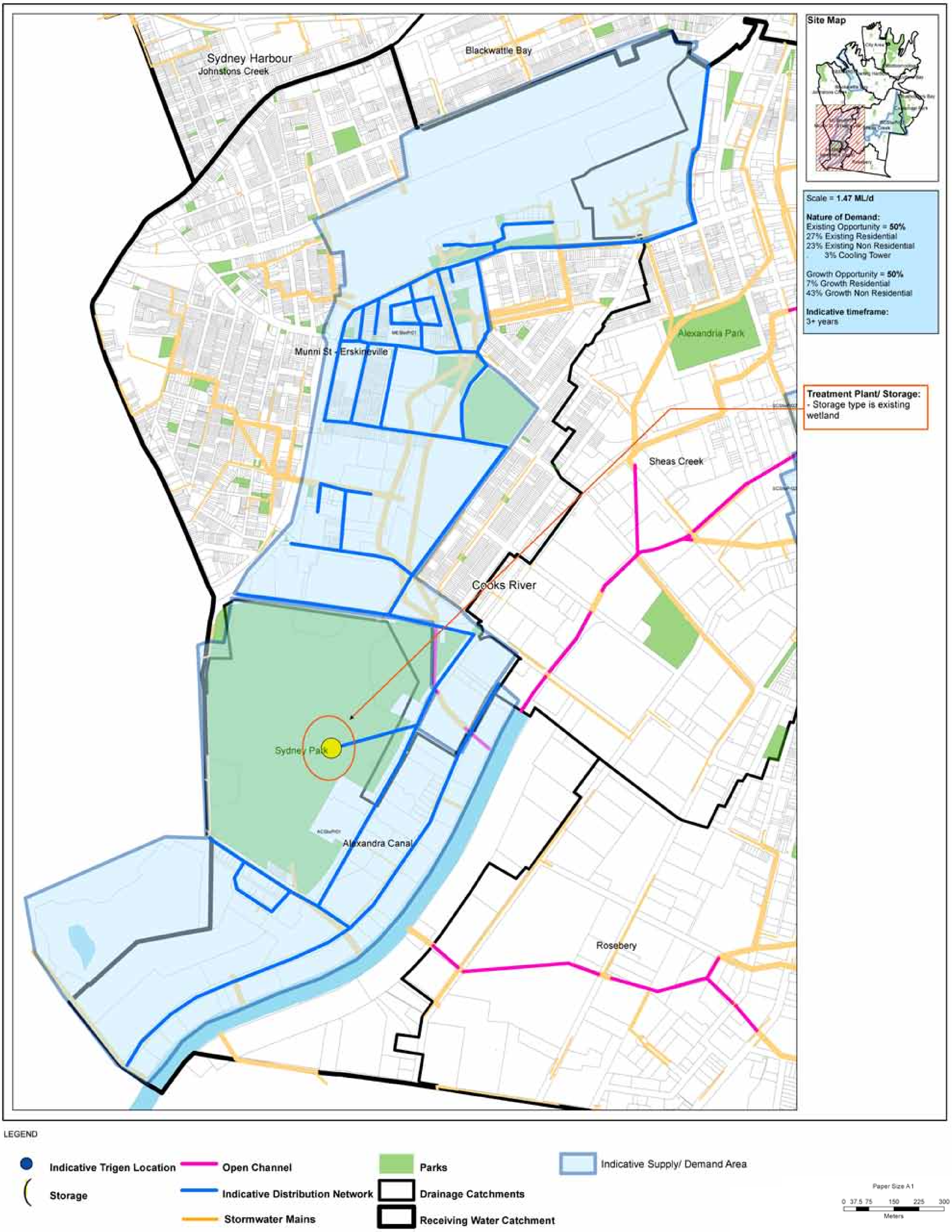


6. Wentworth Park stormwater harvesting

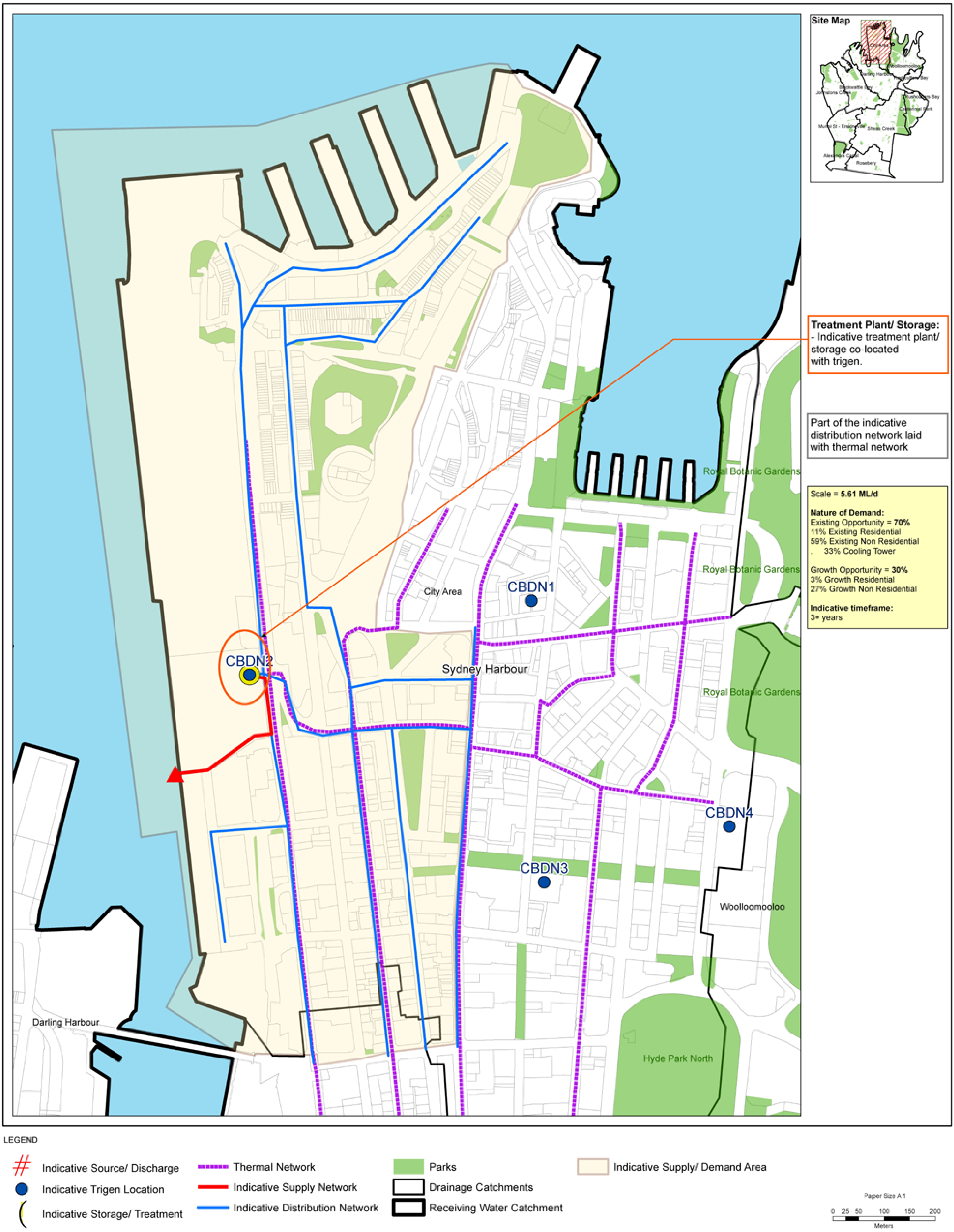


7. Waterloo Oval stormwater harvesting

8. Sydney Park stormwater harvesting



9. Moore Park roof water harvesting



10. Barangaroo thermal desalination

Technical Appendices

1. Water Efficiency Plan
2. Recycled Water Plan
3. Water Sensitive Urban Design and Stormwater Infrastructure Improvement Plan

CITY OF SYDNEY

Sydney2030/Green/Global/Connected

Decentralised Water Master Plan 2012–2030