Annexure K: Water Sensitive Urban Design

SydneyOlympicPark

Sydney Olympic Park Master Plan 2050
Water management technical report

PREPARED FOR: Sydney Olympic Park Authority

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DISCLAIMER

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1 INTRODUCTION

Sydney Olympic Park is transforming into a thriving suburb strategically located in the centre of Greater Sydney. It is a suburb that benefits from diverse land uses, proximity to Sydney and Parramatta central business districts, and is of national significance, all of which have played an important role in its evolution since hosting the Sydney 2000 Olympic and Paralympic Games. As the 640-hectare site continues to evolve into vibrant neighbourhoods, it will reconnect with its Wangal roots and extensive natural assets to provide a meaningful connection to Country.

The Sydney Olympic Park 2050 Vision & Strategy (the Vision) was released in June 2022 and serves as a roadmap to inform decision-making for the next three decades. Sydney Olympic Park Master Plan 2050 (Master Plan 2050) is the next stage of strategic planning for Sydney Olympic Park. Master Plan 2050 will ensure a coordinated, long-term development plan is prepared for the whole precinct.

The most recent iterations of a master plan for Sydney Olympic Park were completed in 2018 and 2021, to support the delivery of Sydney Metro West. Building upon the Vision, Master Plan 2050 considers Sydney Olympic Park holistically, seeking opportunities to integrate thinking about the parklands and urban core together, enhancing its role in Greater Sydney.

The Vision articulates an aspiration to position Sydney Olympic Park as Sydney's Green Beating Heart: a place energised with everyday life, Country-first, nature positive and where Sydney comes to play.

In 2050, Sydney Olympic Park will be a complex, layered suburb offering a rich and varied range of experiences. Many will live and work here, and others will visit for events, diverse attractions, or everyday retail and entertainment. Master Plan 2050 aims to balance certainty with flexibility enabling Sydney Olympic Park's future to be resilient, dynamic and able to leverage future opportunities and technologies not yet known.

1.1 ABOUT THIS REPORT

1.1.1 Purpose

Sydney Olympic Park supports a diverse range of fresh and estuarine water features including wetlands, mangroves, lakes, creeks, ponds, and constructed features. They provide or support a broad range of values and services including:

- Scenic amenity,
- Hydrology management (including stormwater conveyance and flood mitigation),
- Water quality improvement,
- Water reuse and demand management,
- Community education,
- Biodiversity.

Civille has been engaged by SJB and Sydney Olympic Park Authority (SOPA) to provide advice on water management for the *Sydney Olympic Park Master Plan 2050* (Master Plan 2050). This report provides supporting information to inform water management directions, objectives and strategies to be considered or included in Master Plan 2050.

1.1.2 Scope

This report addresses surface water management within Sydney Olympic Park including urban areas and parklands. Figure 20 (p.36) shows the extents of Sydney Olympic Park and character precincts referred to in Master Plan 2050.

This report has been informed by:

- The study requirements (refer Section 1.1.3),
- The current SOPA Master Plan 2030, and supporting policies and guidelines to the 2030 Master Plan,
- Technical documents including the 2021 *Asset Management Plan for Wetlands, Waterways & Ecological Infrastructure*,

- Draft Sydney Olympic Park Master Plan 2050, and Landscape and Public Domain Report,
- Other SOPA policies,
- Our analysis and consultation with Master Plan 2050 team.

1.1.3 Study Requirements

Excerpts from the Department of Planning and Environment's study requirements (June 2023) relating to water management include:

- *The master plan is to include (but not limited to) public space connections, deep soils zones (including minimum requirements), soil volumes + quantum, urban canopy outcomes and targets, Water Sensitive Urban Design principles;*

- 5. Sustainability, Water & Waste Management and Resilience

  The Sustainability Report is to address whether the proposed changes to the master plan require:

  - *demonstrate how the Master Plan will contribute to the NSW Water Quality Objectives (WQO) for Sydney Harbour and the Parramatta River catchment;*
  - *understand resource consumption outcomes, including … water;*
  - *explore the viability of higher sustainable water (including the viability of the existing water recycling system for increased development), energy targets and pragmatic sustainability initiatives within the precinct;*
  - *The sustainability report is to address whether the proposed changes have any need to undertake further reporting or planning controls into contamination, noise and water quality, assessment of impacts on the river catchment and ensuring adequate controls for sediment management and stormwater run-off.*

- 6. Green Infrastructure, Ecology Urban Forest and Greening

  An urban canopy and landscape design plan is required to be prepared and included as part of the Public Domain Strategy. This plan should …

  - *include measures to address storm water retention management and opportunities for beneficial reuse through implementing various types of green infrastructure;*
  - *protect, conserve, enhance and connect natural waterways and watercourses, and enhance or restore engineered waterways and watercourses, particularly those classified 2nd order or above according to the Strahler system as per the NSW Water Management (General) Regulation 2018.*

- 7. Utilities Servicing

  Provide a Utilities and Infrastructure Servicing Report to identify:

  - *any sustainability initiatives that will minimise/reduce the demand for drinking water, including any alternative water supply and end uses of drinking and non-drinking water that may be proposed, and demonstrate water sensitive urban design (principles are used), and any water conservation measures that are likely to be proposed;*
  - *investigate how the Master Plan could enhance, contribute and use water from Sydney Olympic Park's Water and Reclamation and Management Scheme;*

1.2 HISTORY

In its first 20 years of operation, water management at Sydney Olympic Park was widely recognised as an example of innovative water management in an area with a complex natural, cultural and industrial history. Sydney Olympic Park's scale and diversity of land uses at varying intensities have offered unique challenges and opportunities around how to manage a place that accommodates this history, alongside new residential areas, protected fauna and their habitats, native vegetation, dynamic tidal and foreshore environments, First Nations recognition, major events, regulated contaminated sites, changing community needs and state government priorities. Water necessarily intersects with all of these in different ways.

Sydney Olympic Park has benefited from the application of a consistent set of environmental principles and objectives with guidance for design and development, overseen by a single authority. This approach has allowed SOPA to observe and understand the post-development progression of water management systems in place across the site.

Master Plan 2050 will allow continuing maturation of this approach so that SOPA can continue to demonstrate leadership in thoughtful and scientifically informed urban water management at a large scale.

1.3 REPORT STRUCTURE

This report first describes the existing policy and site context for Sydney Olympic Park, then examines the proposals in Master Plan 2050 and supporting documents. Based on these reviews the report then identifies key priorities for surface water management in the form of strategic directions and updated technical advice including mapping.

- Chapter 2 reviews the current policy context;
- Chapter 3 describes site and physical context, with current site conditions relating to surface water management;
- Chapter 4 reviews the key changes proposed in Master Plan 2050;
- Chapter 5 presents a summary of the challenges and opportunities as implications and impacts of the proposed changes, and identifies the issues that should inform ongoing priorities;
- Chapters 6 presents strategic directions for water management at Sydney Olympic Park and captures key recommendations, informed by chapters 1 to 5;

2 POLICY CONTEXT

2.1 OVERVIEW

This section addresses the current policy context relevant to water management at Sydney Olympic Park. It identifies key policies and reference documents that guide the management of surface water, describes their scope and application, and identifies the principles and key issues addressed by each document. The documents reviewed include:

a. Sydney Olympic Park Environmental Guidelines 2008

b. Master Plan 2030 for Sydney Olympic Park

c. SOPA *Stormwater Management and Water Sensitive Urban Design Policy*

d. SOPA *Water Sensitive Urban Design Guideline*

e. NSW Aquifer Interference Policy and related NSW government guidelines

f. Cultural and community guidance including:
  - ANZECC Water Quality Guidelines
  - *Our Living River* – make the Parramatta River swimmable by 2025
  - NSW Water Quality Objectives.

The scope and influence of water-related policies and guidelines are broad, and include protection of ecosystem values, guidance from Traditional Custodians, water demand management, and community access. Figure 1 shows several of the influences on water management at Sydney Olympic Park.

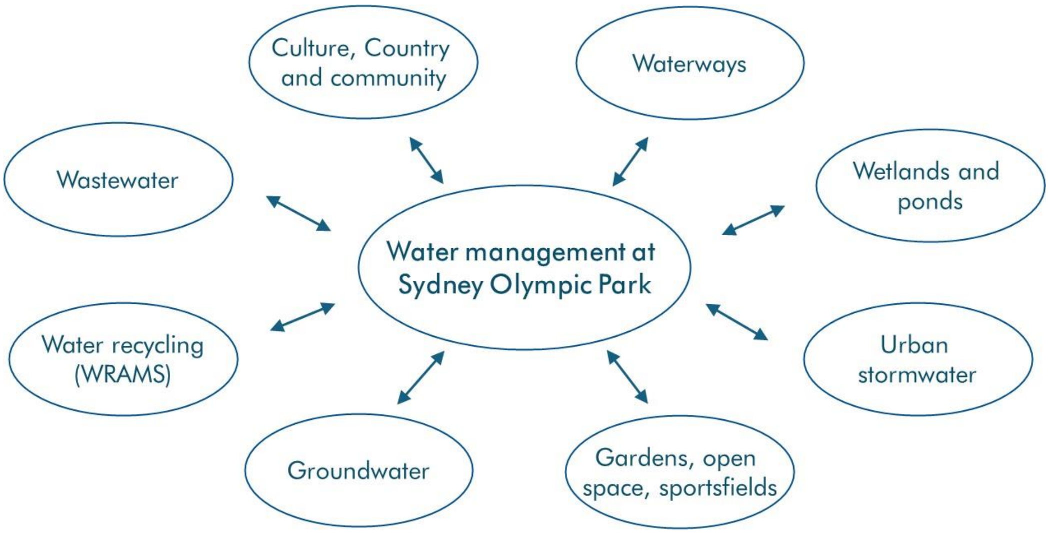


Figure 1. Water management influences at Sydney Olympic Park

2.2 ENVIRONMENTAL GUIDELINES 2008

2.2.1 Origin

The *Environmental Guidelines for Sydney Olympic Park* (updated 2008, 'the environmental guidelines') occupy a foundational role in environmental management at Sydney Olympic Park. First prepared in 1993, they formed part of Sydney's bid to host the Sydney 2000 Olympic Games to demonstrate commitment to ecologically sustainable development (ESD). They were then used to guide the rehabilitation and redevelopment of the area's landscapes during construction of Olympic sporting venues and while hosting the Olympic Games. The guidelines have undergone several revisions.

2.2.2 Description

The environmental guidelines set out a general scheme of environmental issues and commitments that aim to implement SOPA's Environmental Policy with regards to the care, control, management, and development of Sydney Olympic Park. The Environmental Policy forms part of SOPA's Environmental Management System which describes how SOPA will manage its environmental affairs.

The environmental guidelines are the foundation of SOPA's approach to environmental management and have legislative force under the *Sydney Olympic Park Authority Act 2001* (SOPA Act). Developments within Sydney Olympic Park must be consistent with the current Sydney Olympic Park Master Plan and the environmental guidelines. The environmental guidelines address eight areas of significance for management of Sydney Olympic Park and set objectives for each. These eight areas are:

1. Water conservation
2. Energy conservation
3. Material selection
4. Waste management
5. Transport
6. Pollution control
7. Biodiversity
8. Public open space.

The objectives set out for 'water conservation' and 'pollution control' are the most relevant for water management throughout Sydney Olympic Park. In the guideline, 'water conservation' includes practices such as protection and management of water resources, as well as the act of using less water which may be a more familiar use of the term.

- Water conservation objectives include:
    - aim to minimise public domain water use through a range of demand management practices,
    - require all new developments to maximise opportunities to incorporate water collection and recycling systems,
    - avoid adverse impacts on water quality or quantity in local streams, wetlands and groundwater from operations, developments, and major event activities at Sydney Olympic Park,
    - work with lead agencies when promoting sustainable water resource management practices.
- Pollution control objectives include ensuring that development, operations, and event activities do not adversely impact on the water quality of wetlands and watercourses.

2.2.3 Relationship to SOPA Act

SOPA's ongoing commitment to ESD is interpreted in the guidelines and is set out as an obligation in Section 15 of the SOPA Act. The principles of ESD are defined in the *NSW Local Government Act* (1993).

The guidelines apply to all of the land identified as Sydney Olympic Park in the SOPA Act. Under the Act, before carrying out any proposed development SOPA must consider whether the proposed development is consistent with the Environmental Guidelines. The Act also requires that SOPA prepare and maintain a Master Plan for Sydney Olympic Park that is consistent with the Environmental Guidelines.

The SOPA Act allows for the Guidelines to be updated from time to time to account for future roles of Sydney Olympic Park, advances in research and technology, changes to our understanding of the environment, and lessons learned through the practical application of the original guidelines.

The guidelines are not prescriptive but they provide a key reference point for planners, developers, event and place managers, as well as assessment and consent authorities to check the adequacy of development and operational proposals at Sydney Olympic Park regarding environmental and sustainability outcomes.

2.2.4 State Environment and Planning Policy (Biodiversity and Conservation) 2021

The *State Environment and Planning Policy (Biodiversity and Conservation) 2021* (Biodiversity and Conservation SEPP) applies at Sydney Olympic Park. It identifies biodiversity values associated with the water bodies and their catchments including:

- Biodiverse riparian land
- Additional protections for wetland areas
- Threatened species or communities with potential for serious and irreversible impacts.

These matters are dealt with elsewhere in Master Plan 2030 however are identified here to highlight the connection between urban stormwater management and ecosystem protection. Works that have the potential to impact water bodies at SOP must comply or demonstrate consistency with the Biodiversity and Conservation SEPP and related legislation.

2.3 MASTER PLAN 2030

Master Plan 2030 is the current plan guiding the long-term development of Sydney Olympic Park including the area's existing water management regime. The plan undergoes a scheduled five-yearly review as required by NSW Department of Planning and Environment. The current version incorporates the 2018 Review and the subsequent Interim Metro Review.

The Master Plan 2030 (Interim Metro Review) outlines changes to the built form and street network in the Central Precinct area of Sydney Olympic Park directly impacted by the new metro station.

The 2030 Master Plan includes planning controls for new development in Sydney Olympic Park, including:

- Sustainability Planning Principle, which describes how environmental and social sustainability will underpin the next stage of development,
- A requirement to include an ESD consultant in the project team,
- A requirement to connect new development to the recycled water system,
- Design criteria related to groundwater,
- Design criteria related to stormwater retention and stormwater quality.

The 2030 Master Plan refers to the Environmental Guidelines 2008 for Sydney Olympic Park, which provides a thorough framework for achieving these outcomes.

2.4 STORMWATER MANAGEMENT

2.4.1 Water Sensitive Urban Design Policy

SOPA's Stormwater Management and Water Sensitive Urban Design Policy (2016) (the WSUD Policy) sets SOPA's objectives and requirements for stormwater management associated with development planning, design and construction. The WSUD Policy provides the environmental context for reducing the impacts of urban stormwater on receiving environments.

The Policy:

- Promotes appropriate water sensitive urban design in development,
- Seeks to optimise local harvesting and on-site utilisation of stormwater,
- Requires proper management of stormwater from construction sites,
- Requires appropriate management of stormwater from and within development sites post-construction.

The WSUD policy position states that development within Sydney Olympic Park must:

- Comply with best practice water sensitive urban design practices,
- Comply with best practice stormwater quality and quantity measures,
- Manage stormwater from construction sites to best practice standards.

The policy requirements include the use of best practices for WSUD and for stormwater quantity and quality and is supported by technical guidelines (see Section 2.4.2). The WSUD Policy includes the following requirements:

1. Maximise harvesting and reuse of roof-water,
2. Minimise volume and frequency of stormwater discharge from hardstand areas such as paving, driveways and car parks, and maximise quality of any stormwater discharged,
3. Water conservation,
4. Riparian protection (development within 40 metres of a creek, river, lake or estuary),
5. Offsets,
6. Stormwater design excellence,
7. Construction management,
8. Asset maintenance,
9. Information to be submitted with a development application.

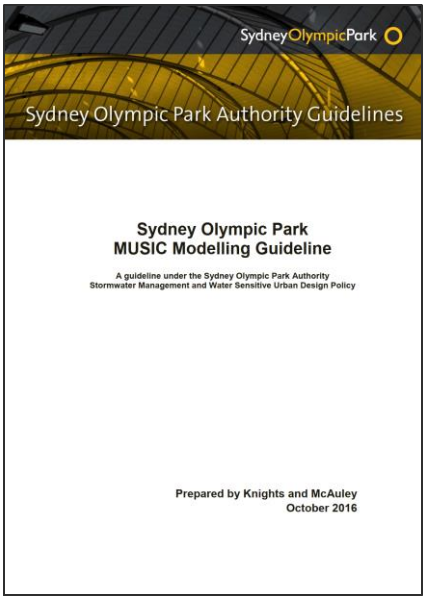
It identifies measures and targets in support of this and includes a map, detailed policy compliance checklist, and general technical guidance to achieve performance targets for managing surface water quality and quantity. Technical guidance is included in the Water Sensitive Urban Design Guidelines (see section 2.4.2).

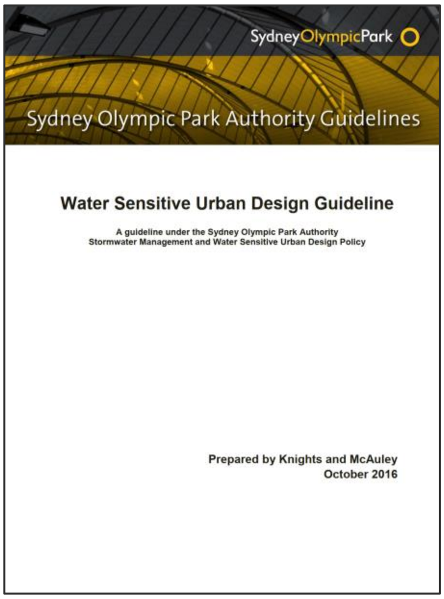
2.4.2 Water Sensitive Urban Design Guidelines

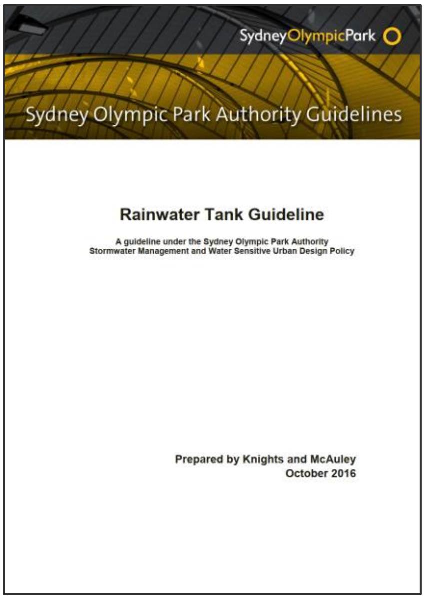
SOPA's Water Sensitive Urban Design Policy is accompanied by a set of technical guidelines produced by SOPA to assist proponents in implementing the WSUD Policy. The intent is to provide consultants, developers and SOPA with a consistent and uniform approach to stormwater management within Sydney Olympic Park so that the intent of the policy is achieved during site planning, design and construction.

The three guideline documents include:

- MUSIC Modelling Guideline
- Water Sensitive Urban Design Guideline
- Rainwater Tank Guideline







2.4.3 Infrastructure Engineering and Construction Manual

SOPA's Infrastructure Engineering and Construction Manual (IECM) includes details on requirements for water management.

The 'Water Management & Irrigation Network Policy and Objectives' section of the IECM includes a policy statement, and the following objectives are listed:

> *1. To ensure the works comply with ESD principals including energy and water efficiency, standardisation of materials and equipment to minimise waste and reduce maintenance services costs.*
>
> *2. To standardise water management control systems and the progressive development of back-to-base monitoring to facilitate fault and malfunction identification. Early identification of operational issues and rectification in a timely manner minimises waste (water and energy) and impacts, such as erosion and excessive surface water that may affect site amenity.*
>
> *3. To standardise the selection of products and equipment across the site to minimise waste associated with incompatibility with existing products and equipment.*
>
> *4. To standardise control systems in order to reduce training, servicing and operational error, this can occur when multiple operation interfaces are used.*
>
> *5. To reduce manual labour and site travel by introducing back-to-base control and monitoring of all pump stations and reference water meters.*
>
> *6. To adopt environmental best practice in design, construction and maintenance services.*

Some aspects of the IECM require coordination with the WSUD policy. For example:

> *When selecting [stormwater] treatment devices, the device should be consistent with existing devices within the precinct and maintenance and life cycle costs must be considered. Approval must be sought from SOPA Manager Building and Infrastructure during the concept development phase of the design for treatment devices that differ from existing devices within the precinct.*

The standard drawing included in the IECM for a bio-swale (Figure 2) may not be appropriate for all applications. In particular, the 100mm mulch layer should not be organic mulch, a pebble mulch can be used at a reduced thickness.

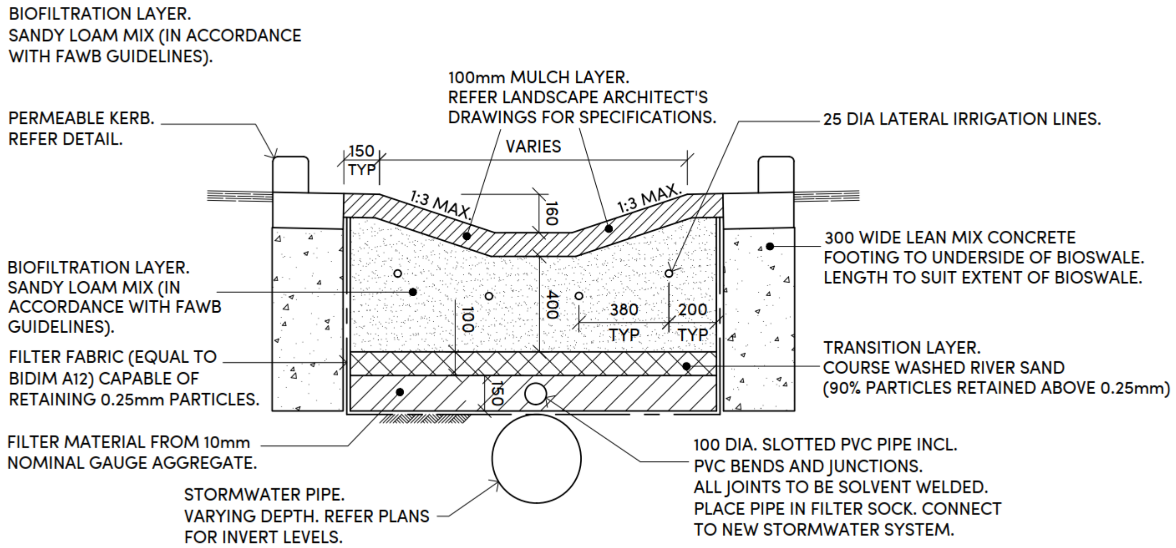


Figure 2. IECM Standard drawing SW009 bio-swale

2.4.4 Water harvesting and reuse

Water harvesting and reuse practices are integrated into SOPA policies and guidelines as well as the water conservation objectives in the *Environmental Guidelines 2008* (see Section 2.2). These serve to manage the offsite impacts of higher stormwater volumes from developed areas, and to reduce the demand for potable water.

The WSUD Policy Requirements (see Section 2.4.1) state:

> *Locally-harvested rainwater must be the primary source of non-potable water for developments located within a Sydney Olympic Park non-stormwater harvesting catchment (shaded red on Map 1) to minimise the impacts of stormwater quantity on sensitive receiving waters and to conserve potable water supplies.*
>
> *Developments located within a Sydney Olympic Park stormwater harvesting catchment (shaded blue on Map 1) must meet their non-potable water demand from non-potable water sources, including WRAMS recycled water and/or locally harvested rainwater.*

Non potable water demands at Sydney Olympic Park are defined as approved uses of the Sydney Olympic Park recycled water scheme and include irrigation, car washing, toilets, water features, washing machines and cooling towers.

A significant component of the reuse requirements are implemented under Sydney Olympic Park's Water Reclamation and Management Scheme (WRAMS) which began operating in 2000 and was Australia's first large-scale urban water treatment scheme. It uses a dual reticulation system for recycled water and parts of the scheme are regulated by the NSW EPA under Environment Protection Licence #10020.

Several water bodies around Sydney Olympic Park function as water storage reservoirs as part of the harvesting and reuse program. Refer to Section 3.6 for further information about these water bodies, on site water harvesting and reuse and the recycled water (WRAMS) scheme.

2.5 GROUNDWATER

2.5.1 Introduction

Dewatering associated with building excavations and construction can impact groundwater systems, ground stability, and the environment. Ongoing dewatering after construction can also place long term energy, water, maintenance and administrative requirements on the future owners or occupiers of a development. For these reasons, groundwater management is regulated by the State Government. The following sections describe the relevant groundwater legislations and policies that apply to construction and development in Sydney Olympic Park.

2.5.2 Context

Excavation for work such as building basements that receive groundwater inflows or seepage is subject to the *Water Management Act 2000* (the WM Act), relevant water sharing plans and the *NSW Aquifer Interference Policy*. The WM Act requires "no more than minimal harm" resulting from the activity or work and the Department of Planning and Environment (DPE) adopts a precautionary approach in approvals, such as limiting the take of groundwater to the building construction period only. The Aquifer Interference Policy scope includes construction dewatering (such as buildings, transport projects or civil works) and activities with the potential to contaminate an aquifer. The policy also provides information about licensing and approval.

The DPE *Minimum requirements for building site groundwater investigations and reporting* (2022) states that best practice is considered to include engineered drainage around and beneath a tanked basement to restore natural groundwater flow conditions once construction of the building has been completed. It includes further information and advice for developers and consultants.

There are separate guidelines and requirements for other work such as tunnelling for transport engineering but the overall investigation and reporting process is similar.

2.5.3 Regulation

The NSW water management framework requires that all water taken from a water source must be licensed unless an exemption applies. Dewatering activities must also be conducted in accordance with the WM Act, the Aquifer Interference Policy, and other relevant conditions applied to the development, licences and approvals.

Department of Planning and Environment

The DPE's minimum requirements identify three reports that would typically be required during the water licensing process:

1. Site hydrogeology report
2. Dewatering management plan
3. Dewatering completion report.

DPE recommends discussing proposals with the relevant agency before lodging a development application.

Water NSW

WaterNSW carries out regulatory functions including for water resources management, licensing and approvals. Guidance from WaterNSW about groundwater management for construction is set out in a series of fact sheets including:

- *Construction dewatering – Information for councils and applicants*
- *General terms of approval – Construction dewatering*
- *Geotechnical investigation reports – Minimum requirements*
- *Completion report – Construction dewatering.*

NSW Environment Protection Authority

Areas of Sydney Olympic Park (including groundwater) are also regulated by the NSW EPA under the *Contaminated Land Management Act 1997* (NSW) (CLM Act). These sites are included on the NSW EPA's CLM Act Public Register and list of notified sites. They require ongoing maintenance to manage residual contamination.

2.5.4 Exemptions

An exemption under the *Water Management (General) Regulation 2018* allows up to 3 megalitres (ML) of groundwater to be taken through certain aquifer interference activities without the need for a water access licence. Under the exemption, a person can take "up to 3ML of groundwater through an aquifer interference activity per authorised project per water year" provided they meet conditions around water end-use, record keeping and reporting. (A 'water year' is a 12-month period that captures annual seasonal cycles and doesn't necessarily correspond with a calendar year.)

The exemption applies for activities such as ongoing dewatering of basements, excavation to construct or maintain a building, road or infrastructure, groundwater monitoring and contamination remediation.

For projects where the groundwater take is likely to exceed 3ML over 12 months, the process described in Section 2.5.3 should be followed.

Even if an exemption for groundwater dewatering applies, proponents should check whether an approval and an assessment of impacts are required to carry out the activity. This is especially relevant for areas of Sydney Olympic Park where some biological treatment wetlands are regulated under the *Contaminated Land Management Act 1997* (NSW). Groundwater contamination must also be notified under the WM Act.

2.6 OTHER GUIDANCE

2.6.1 Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC guidelines) include advice and information about the cultural significance of water in Australia. The guidelines state that cultural and spiritual values may relate to a range of uses and issues, including spiritual relationships, language, songlines, stories, sacred places, customary use, the plants and animals associated with water, drinking water, and recreational or commercial activities.

Native title legislation, and Commonwealth and state cultural heritage and water legislation and agreements (including the National Water Initiative), provide for the recognition and management of Indigenous interests in water.

The significance of this for surface water management in Master Plan 2050 is to ensure that consultation, planning, design and communication about waterways at the site takes a shared, inclusive approach to water management that acts in service of culturally sensitive outcomes – an approach that reflects the changing meaning of best practice water management.

2.6.2 'Our Living River' – make the Parramatta River swimmable by 2025

The Our Living River initiative for the Parramatta River was launched in 2014 and is overseen by the Parramatta River Catchment Group. A comprehensive strategy *Duba, Budu, Barra: Ten Steps to a Living River – the Parramatta River Masterplan* followed in 2018 and is informed by science, cultural advice, outcomes of collaboration, and community decision making. The 'ten steps' include improvements in stormwater runoff, planning controls, sewer overflows and community education. Two of the Masterplan's goals where standards for new development will play an important role are:

- Clean, clear water that is safe and supports life in the river
- Healthy ecosystems in the river, the catchment and natural creeks.

The surface water management recommendations in this report are intended to support the objectives of both *Our Living River* and the Parramatta River Masterplan. SOPA's 2016 WSUD Policy is also consistent with this initiative.

2.6.3 NSW Water Quality Objectives

The NSW water quality objectives (NSW Government, 2006) set out criteria and key water quality indicators for visual amenity, and for primary and secondary contact recreation for catchments across NSW. This includes objectives derived for Sydney Harbour & Parramatta River upper estuary and waterways affected by urban development (Figure 3).

The water quality objectives are for protection of:

- Aquatic ecosystems - *Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term.*
- Visual amenity - *Aesthetic qualities of waters.*
- Secondary contact recreation - *Maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed.*
- Primary contact recreation - *Maintaining or improving water quality for activities such as swimming, where there is a high probability of water being swallowed.*
- Aquatic foods (cooked) - *Refers to protecting water quality so that it is suitable for the production of aquatic foods for human consumption and aquaculture activities.*

These objectives are relevant for Master Plan 2050 as its vision includes greater access to and recreational interaction with water bodies around Sydney Olympic Park, some of which experience periodic or ongoing catchment inputs that can influence water quality and related opportunities for public recreation.

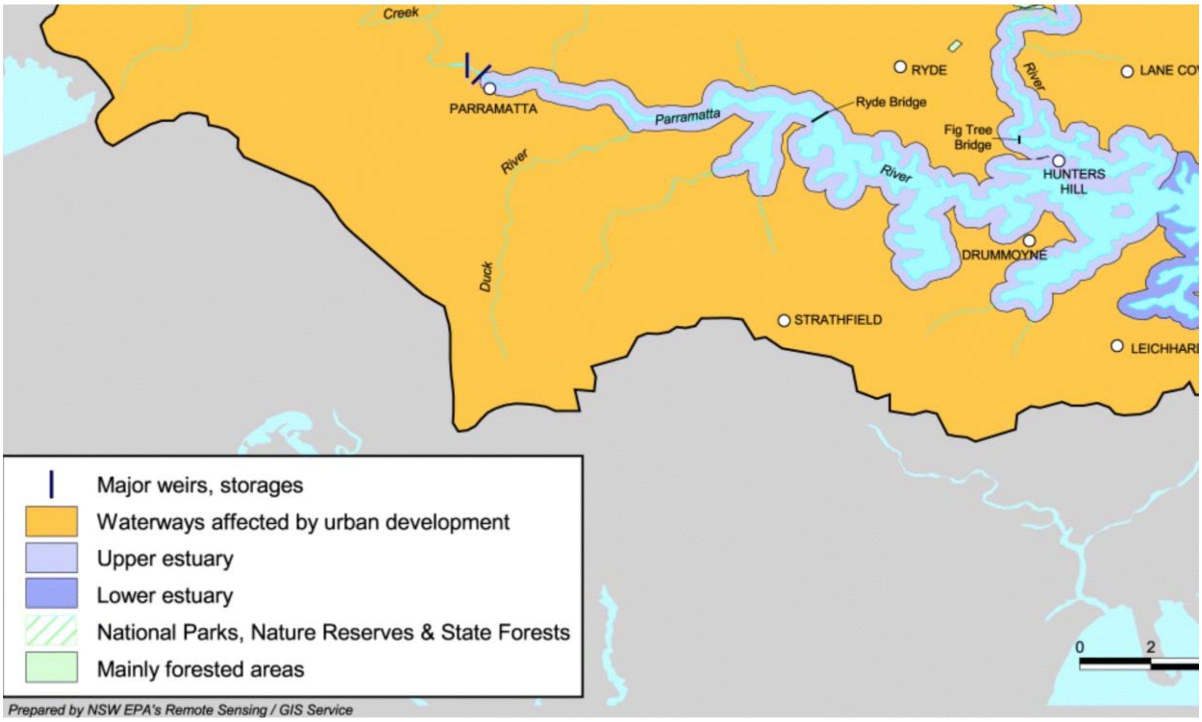


Figure 3. NSW Water Quality Objectives application area for Sydney Harbour and Parramatta River (source: NSW Government 2006)

2.6.4 Resilience and Hazards SEPP

The Resilience and Hazards State Environmental Planning Policy (2021) includes requirements for coastal management (provisions from the former SEPP Coastal Management 2018). Assessments of potential impacts are required on 'proximity areas' and there are strong restrictions on works in the 'coastal wetlands' zones (refer Figure 4).

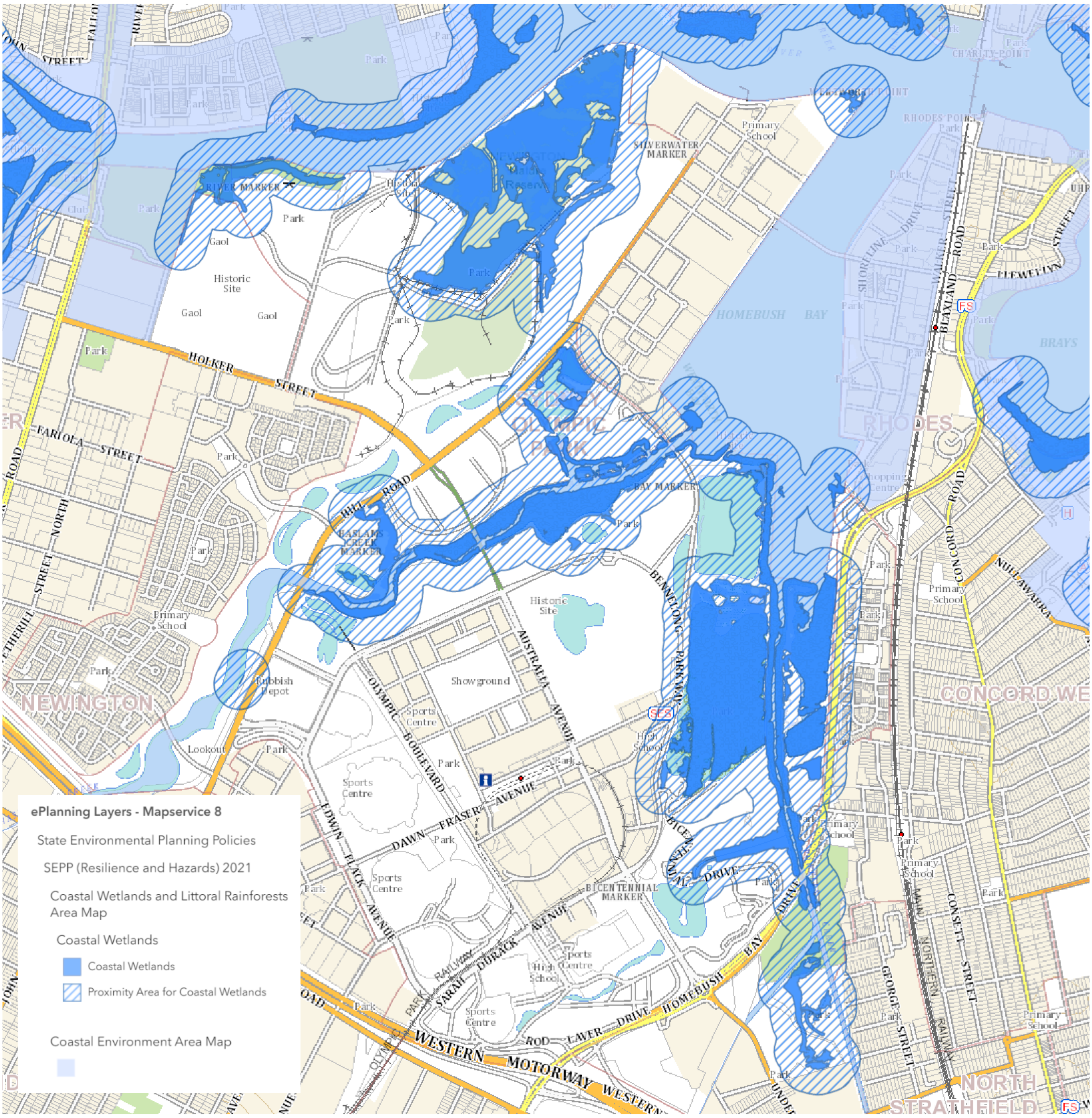


Figure 4. Resilience and Hazards SEPP mapped coastal wetlands and proximity areas (source: NSW Planning Portal Spatial Viewer)

3 SITE AND PHYSICAL CONTEXT

The following sections describe the existing site context for water management, including:

- Catchments and receiving waters
- Flooding
- Water bodies, stormwater treatment systems
- Water harvesting and recycling
- Landfill leachate

3.1 CATCHMENTS AND RECEIVING WATERS

Sydney Olympic Park is downstream of large highly urbanised catchments. Large quantities of pollutants are conveyed from these catchments via constructed drainage into Haslams Creek, Boundary Creek, and Powells Creek. Litter booms and gross pollutant traps (GPTs) are currently installed along these creeks at the upstream park boundaries to help control and reduce these upstream inputs.

The main receiving waters are summarised in Table 1 and shown in Figure 5. Figure 6 shows the drainage catchments within Sydney Olympic Park, each of which is further described in Section 3.5. Water bodies and their aquatic ecosystems make up more than 130 hectares of Sydney Olympic Park.

Table 1. Main receiving waters

Major receiving water	Main water bodies in Sydney Olympic Park	SOPA Catchments (ha)
Parramatta River	Wilson Park Wetland, Wharf Pond, Newington Nature Reserve Wetland	139
Haslams Creek	Teal Pond, Narawang Wetlands, Northern Water Feature, Eastern Water Quality Control Pond	260
Brickpit	Brickpit Ponds, Grebe Pond	27
Powells Creek	Boundary Creek, Lake Belvedere, Bennelong Pond, Badu Mangroves, Triangle Pond	191

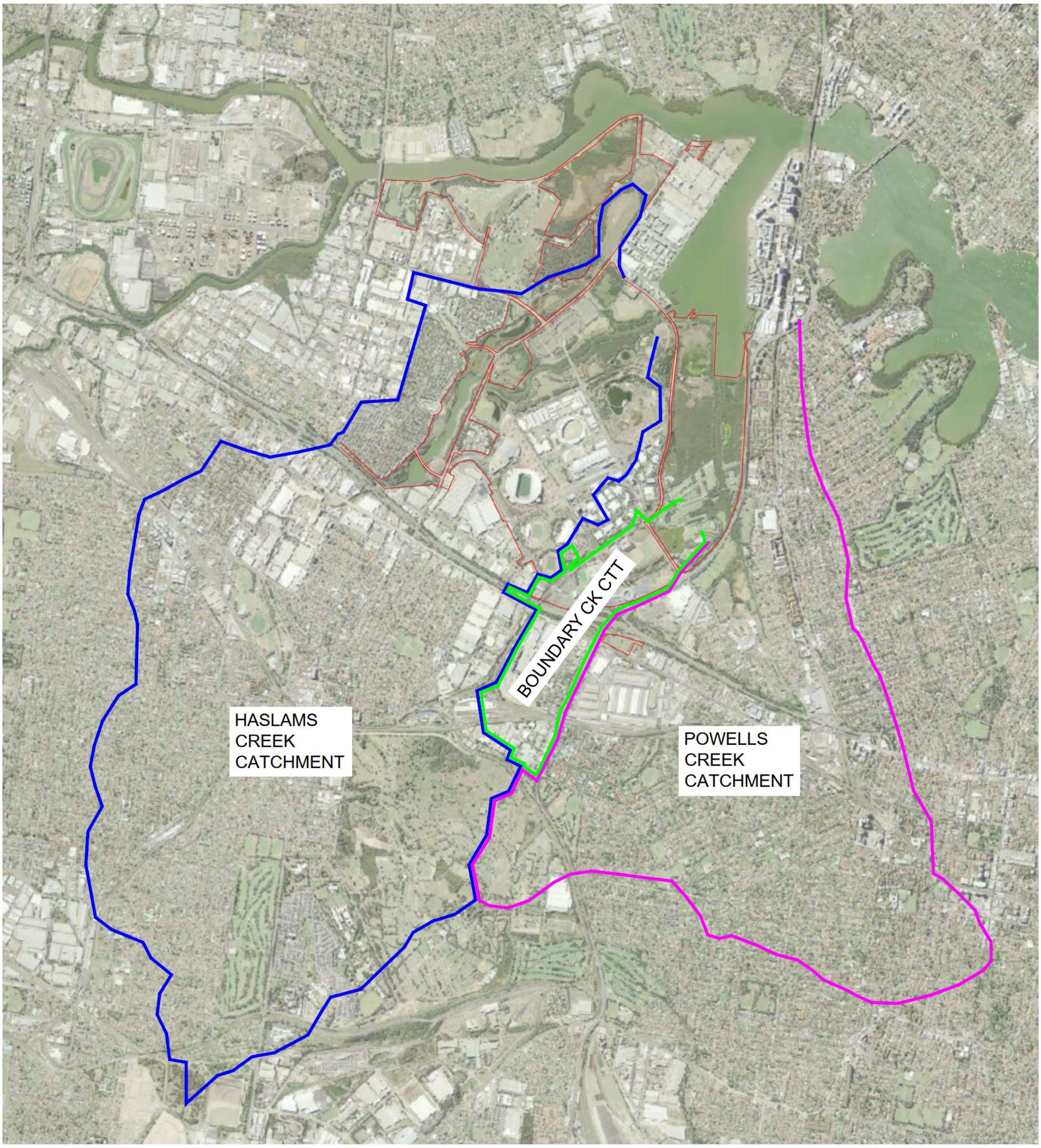


Figure 5. Map showing context of Sydney Olympic Park with upstream catchments

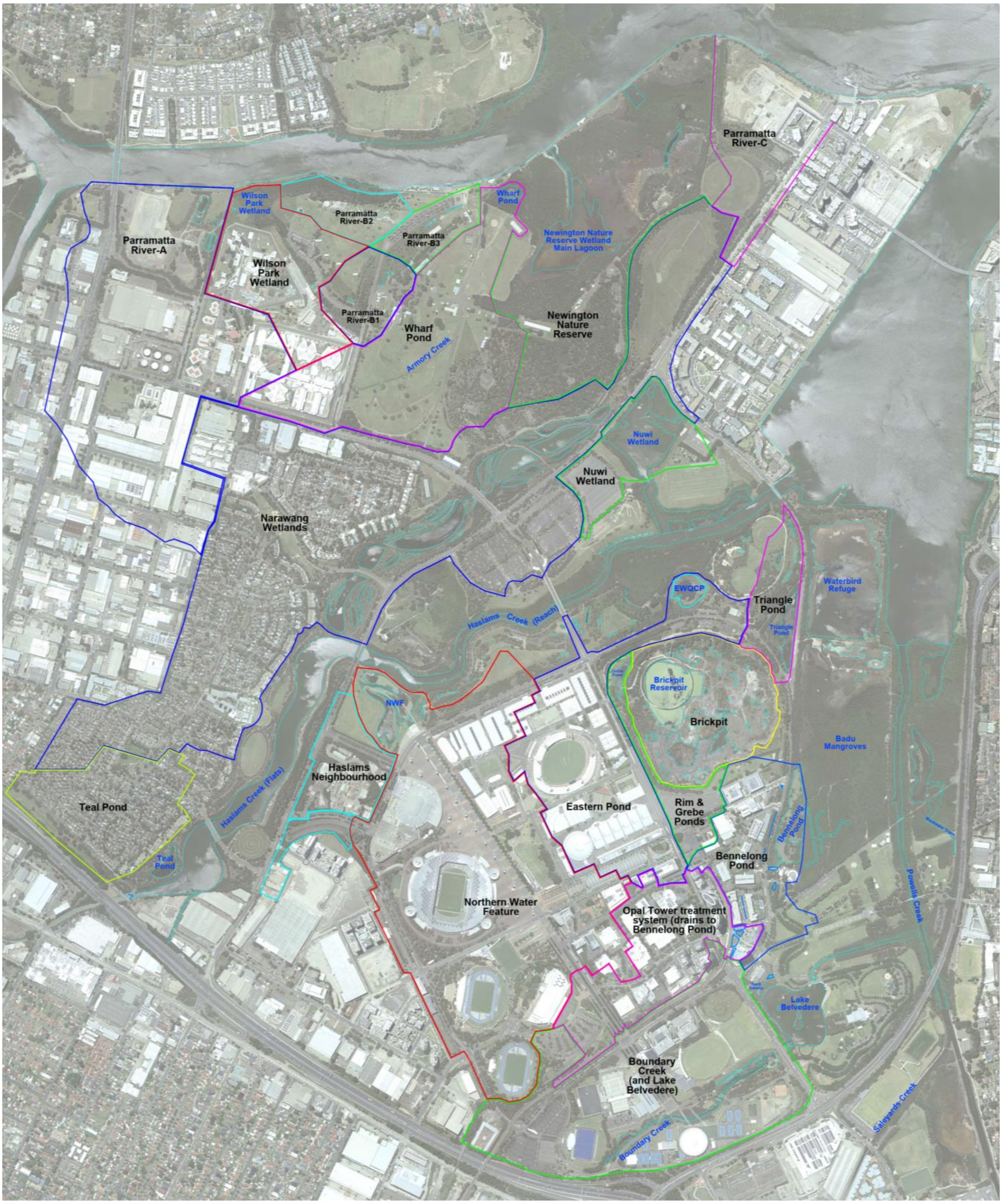


Figure 6. Map showing catchments and water bodies at Sydney Olympic Park

3.2 FLOODING

There is limited flooding data available for Sydney Olympic Park. The mapping in Figure 7 is taken from the Parramatta Light Rail Stage 2 (PLR2) EIS and should not be relied upon as some areas are inaccurate (e.g. flooding at Site 18EN is shown for the old Southern Water Quality Control Pond).

Developments in Sydney Olympic Park are required to complete a flood assessment as part of their development application with provision of suitable controls.

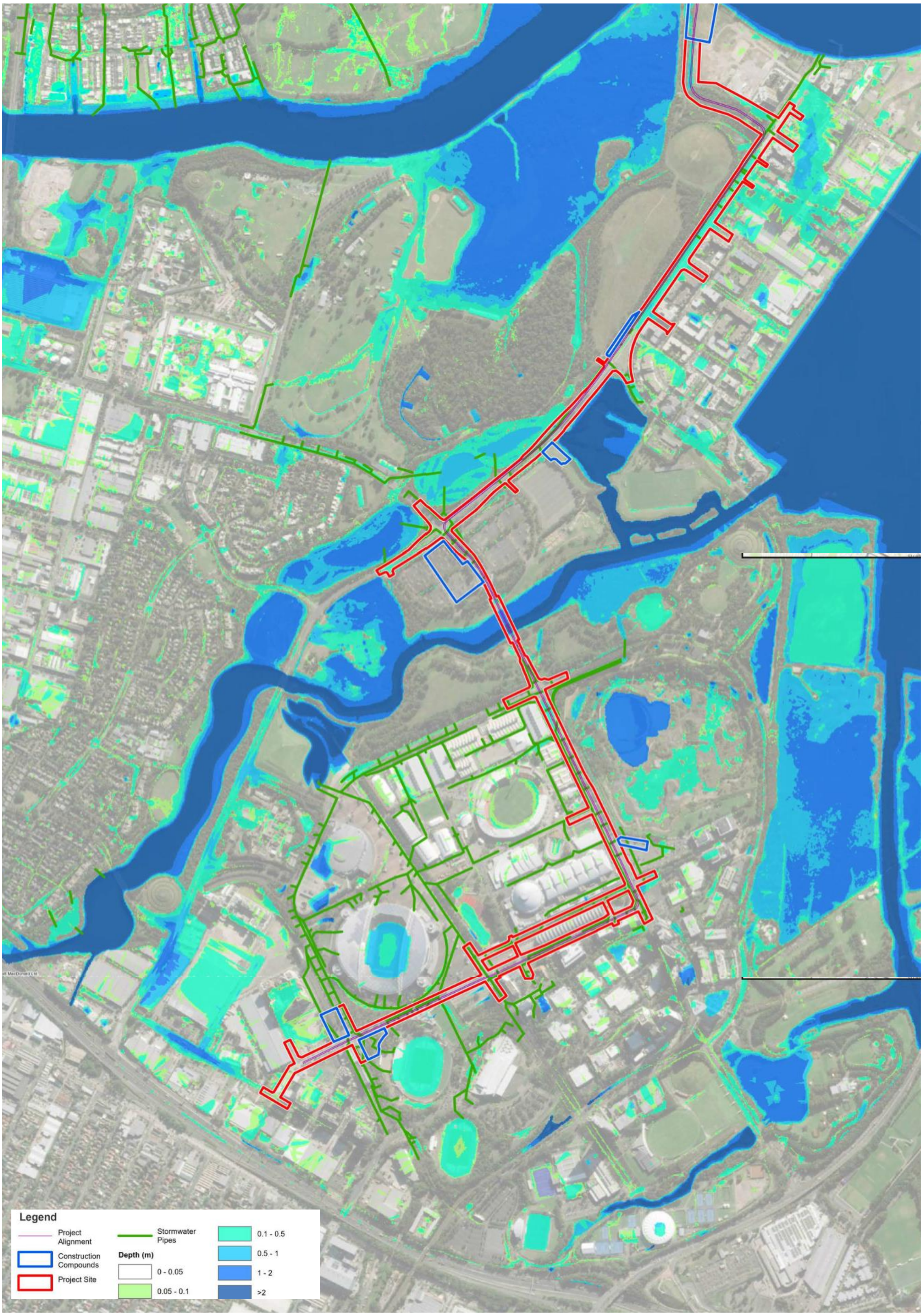


Figure 7. 1% AEP flood depth mapping (Paramatta Light Rail Stage 2 EIS, Mott Macdonald, 2022)

3.3 WATERWAYS, PONDS AND WETLANDS

The waterways, ponds and wetlands (also referred to as water bodies, or ecological assets) within Sydney Olympic Park make up the aquatic receiving environments for stormwater runoff. Some of these were built specifically for ecological restoration, biodiversity conservation, stormwater treatment and water harvesting and often serve more than one objective.

While managed by SOPA, many of these water bodies (natural, restored or constructed) are protected or regulated by State and federal policies and legislation. Objectives include habitat, ecosystem and coastal zone protection and management. This report includes a summary of the NSW biodiversity protection planning policy to contextualise the role of appropriate stormwater management as an environment protection measure.

The water bodies are listed in Table 2, Figure 6 shows the locations of the major water bodies located within Sydney Olympic Park, and Section 3.5 includes further descriptions including information about their catchments and existing treatment systems.

Table 2. Sydney Olympic Park water bodies, type and values (E2, 2021, p.26)

	Type											Values								
	Waterways/ creeks	Estuarine Wetland	Stormwater Treatment	Stormwater Treatment Ponds	Stormwater Harvesting	GGBF pond / wetland	Swales	Bioretention Systems	Stormwater pond	Amenity Lake	Amenity Asset Class	Stormwater Treatment	Harvesting/ storage	Conveyance	Scenic Amenity	Biodiversity	GGBF Habitat	Migratory shorebird habitat	Estuarine EECs, mangroves, aquatic habitat	Education
Brickpit Rim Pond and Channel									X		3			X		X	X			
Badu Mangroves (Bennelong Pond)		X		X							2	X		X		X	X		X	
Badu Mangroves (Mangrove Forest & Saltmarsh)		X									2				X	X			X	X
Badu Mangroves (Waterbird Refuge)		X									2				X	X		X	X	X
Bennelong Parkway Bioretention Systems								X			2	X		X						
Bennelong Parkway Swales							X				2	X		X						
Bicentennial Park Ausgrid Pond				X							2	X				X				
Bicentennial Park Back Swamp									X		2			X		X				
Bicentennial Park Exit Gate Pond				X							2	X		X		X				
Blaxland Riverside Park GGBF Ponds						X					3					X	X			
Boundary Creek	X										2			X		X				
Brickpit Constructed Ponds						X					3					X	X			
Brickpit Natural Ponds						X			X		3				X	X	X	X		X
Brickpit Reservoir					X						2		X			X				
Eastern Pond			X		X						2	X	X		X	X	X			
Grebe Pond (Brickpit Rim)									X		2			X		X	X			
Haslams Creek	X										3			X	X	X			X	
Kronos Hill GGBF Ponds						X					3					X	X			X
Lake Belvedere									X	X	1			X	X	X				
Narawang Wetland: Habitat Ponds (22)						X					2					X	X	X		X
Narawang Wetland: Irrigation Storage (1-3)					X						2		X							
Narawang Wetland: Ornamental Lake (North and South)										X	2				X	X				
Newington Armory Creek	X										2			X		X	X			
Newington Nature Reserve wetland (Estuarine Areas)		X									3					X		X	X	
Newington Nature Reserve wetland (Wharf Pond)									X		3			X	X	X	X	X		
Northern Water Feature			X		X						1	X	X		X	X	X	X		
Nuwi Wetland		X							X		2			X		X			X	
Opal Towers Bioretention Systems								X			1	X			X					
Powells Creek	X										3			X		X			X	
Teal Pond									X	X	2			X	X	X				
Triangle Pond						X			X		3					X	X			
Wentworth Common GGBF Ponds						X					3					X	X			
Wilson Park GGBF Tubs						X					3					X	X			
Wilson Park Wetland									X		3					X	X			

Protecting these receiving environments (and related ecological infrastructure such as frog underpasses) from the impacts of urban development underpins the planning, design and operation of surface water management at the park. Ecological reports and related elements of Master Plan 2050 would include further detail.

Boundary Creek and its catchment area is the only waterway in Sydney Olympic Park that is within the urban development area and not the Parklands. It is zoned *B4 Mixed Use* zoning. Other water bodies are generally within *C2 Conservation* or *RE1 Recreation* zones.

3.3.1 Condition

The *SOPA Asset Management Plan – Wetlands, Waterways & Ecological Infrastructure* (E2designlab, 2021) (the AMP) addresses the wetlands, waterways and ecological infrastructure located within Sydney Olympic Park.

The AMP is also intended as a strategic financial management plan that can inform budget planning. Its findings are based on a visual audit of condition at a component level for wetlands, waterways and ecological infrastructure assets as of June 2021.

The AMP identified 12 assets requiring major renewal works and/or assets whose condition is 'on a rapid trajectory to further decline' (Table 3). Four of the assets are common to both categories. The most common related drivers of declining condition were recorded as:

- Poor hydrology
- Water quality
- Emerging catchment development.

A 2008 study on persistent organic pollutants (POPs) in wetlands at Sydney Olympic Park noted the remediation program's success in reducing POP contamination at most of the wetlands to within the chemical bounds expected from urban wetlands in Sydney. It also noted influence of catchment-based contamination sources. The study emphasised:

1. the need for ongoing monitoring of concentrations of POPs in Boundary Creek, Eastern Pond (EWQCP), SWQCP [*replaced by Site 18EN forecourt treatment system*] and the Northern Water Feature.
2. the importance of avoiding the disturbance of wetland sediments to minimise mobile and bioavailable contaminants in the water column.
3. the necessity of investigating the potential effects of POPs at the ecological population and community level to more fully assess the ongoing ecological risk that POPs pose in Sydney Olympic Park, or other urban wetlands.

The recommendations included in this report include selected findings from the AMP audit. They describe approaches to maintain ongoing asset health for water bodies in Master Plan 2050. They will help SOPA to continue to achieve its legislated obligations for the protection of endangered and threatened species, along with the other values and services identified above. They contribute to managing the 3 drivers of asset condition decline as identified above.

Table 3. Key Sydney Olympic Park surface water assets with high maintenance priority identified in 2021 AMP

Water body	Rapid trajectory condition decline (from AMP)	Major asset renewal works required (from AMP)	Comment
Northern Water Feature	✓	✓	• Water storage pond, part of northern catchment / WRAMS managed storage system • Mangrove, saltmarsh mudflat, frog ponds, frog habitat
Lake Belvedere	✓	✓	• Adjacent to mapped contaminated land. • Leachate drainage connections: rising main and line / drain – northern bank of Boundary Creek and southern edge of Lake B. *Ref: Turf report s1.2.9* • Potential frog habitat, immediately upstream of saltmarsh mudflat, mangroves
Boundary Creek	✓	✓	• The Southern Neighbourhood is proposed to include new residential development and promote the restoration of Boundary Creek. • Adjacent to mapped contaminated land. *Ref: Turf report s1.2.9* • Potential frog habitat
Triangle Pond	✓	✓	• Situated in between Brickpit, EWQCP, and Badu Mangroves N. • Not affected by proposed development areas • Roadside. • Only remaining original Homebush Bay foreshore boundary • Frog ponds, frog habitat, frog underpasses
Badu Mangroves	✓		• Receiving ecosystem for Bennelong Pond, Site 18EN treatment system, Boundary Creek, Powells Creek • Saltmarsh mudflat, mangroves, frog habitat, potential frog habitat, swamp oak floodplain forest
Bennelong Pond	✓		• High visibility, Turf report s3.9: "Water Feature" • Mangroves, downstream of frog habitat, Swamp oak floodplain forest
Brickpit Reservoir	✓		• Water storage pond, part of northern catchment / WRAMS managed storage system • Frog ponds, frog habitat, frog underpasses
Newington Nature Reserve Mangroves	✓		• At northern boundary of Sydney Olympic Park on Parramatta River. • Outside managed urban catchment areas • Outside proposed development areas

Water body	Rapid trajectory condition decline (from AMP)	Major asset renewal works required (from AMP)	Comment
Eastern Pond (EWQCP)		✓	• Water storage pond, part of northern catchment / WRAMS managed storage system • Frog ponds, frog habitat, frog underpasses
Wharf Pond		✓	• At northern boundary of Sydney Olympic Park on Parramatta River. • Outside managed urban catchment areas; Outside proposed development areas
Wilson Park Wetland		✓	• At northern boundary of Sydney Olympic Park on Parramatta River. • Outside managed urban catchment areas; Outside proposed development areas
Blaxland Riverside Park frog ponds and finger ponds		✓	• At northern boundary of Sydney Olympic Park on Parramatta River. • Outside managed urban catchment areas; Outside proposed development areas

3.4 STORMWATER TREATMENT

A wide range of stormwater treatment measures at Sydney Olympic Park reduce stormwater pollutant loads from wet weather events on local waterways. These measures include gross pollutant traps (GPTs) and proprietary systems, vegetated swales, porous paving, detention ponds, wetlands and bioretention systems.

Some of the ponds and wetlands have a secondary function as water storage for irrigation and reuse as described in Section 3.6.

In 2022-23 SOPA's GPT's captured approximately 270 tonnes of stormwater pollutants, 95% of which was recycled instead of being disposed to landfill (SOPA, 2023, p 12).

The diversity of the stormwater treatment measures allows water quality and flow management to be dispersed across a catchment and to address the key water quality risks that are identified for that area.

Further details on stormwater treatment systems can be found in the Asset Management Plan (E2, 2021).

3.5 EXISTING STORMWATER CATCHMENTS

3.5.1 Northern Water Feature

The Northern Water Feature (NWF) receives stormwater runoff from an approximately 81-hectare catchment covering the 'Stadia Precinct', 'Sports & Civic Precinct', 'Urban Centre Neighbourhood' and 'Edwin Flack Neighbourhood' as shown in Figure 8.

The NWF catchment includes the following stormwater management systems:

- 6 GPT's.
- A rainwater harvesting system at Stadium Australia, with a total of 2 ML storage, for irrigation of the sportsfield turf.
- A significant area of permeable paving including Olympic Boulevard and open spaces around the stadia
- Three OSD tanks with cartridge filters in the Metro station development (sites 10UC and 11UC).

The NWF is intended to be a vegetated wetland, and expansion of macrophytes has been identified as being required to improve the treatment performance of the system (E2Designlab, 2021).

A pump station at the NWF can direct stormwater to the Eastern Pond as part of the recycled water scheme (refer Figure 15, p.31).

Stormwater discharges from the Northern Water Feature to Haslams Creek.

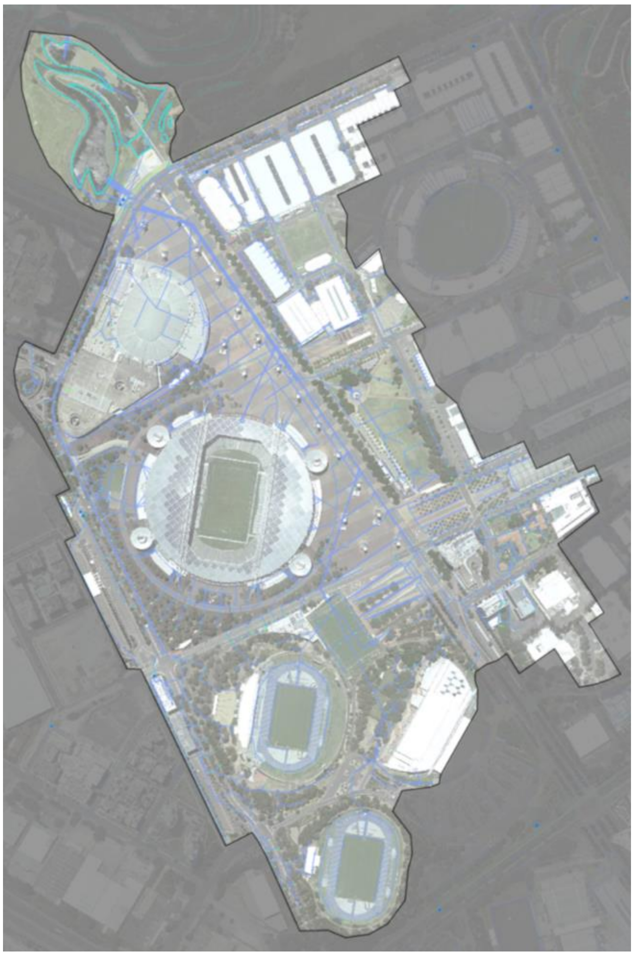


Figure 8. Northern Water Feature catchment

3.5.2 Eastern Water Quality Control Pond

The Eastern Water Quality Control Pond (EWQCP) receives stormwater runoff from an approximately 35-hectare catchment covering part of the 'Stadia Precinct', and 'Urban Centre Neighbourhood' as shown in Figure 9.

The catchment includes the following stormwater management systems:

- 7 GPT's.
- A rainwater harvesting system at the Sydney Showground Stadium for irrigation.
- Permeable paving

The treatment performance of the EWQCP can be improved with provision of rectifications and maintenance as identified in the Asset Management Plan (E2Designlab, 2021).

A pump station at the EWQCP can divert stormwater (from both the EWQCP and NWF catchments) to the Brickpit reservoir as part of the recycled water scheme.

Stormwater discharges from the EWQCP to Haslams Creek.

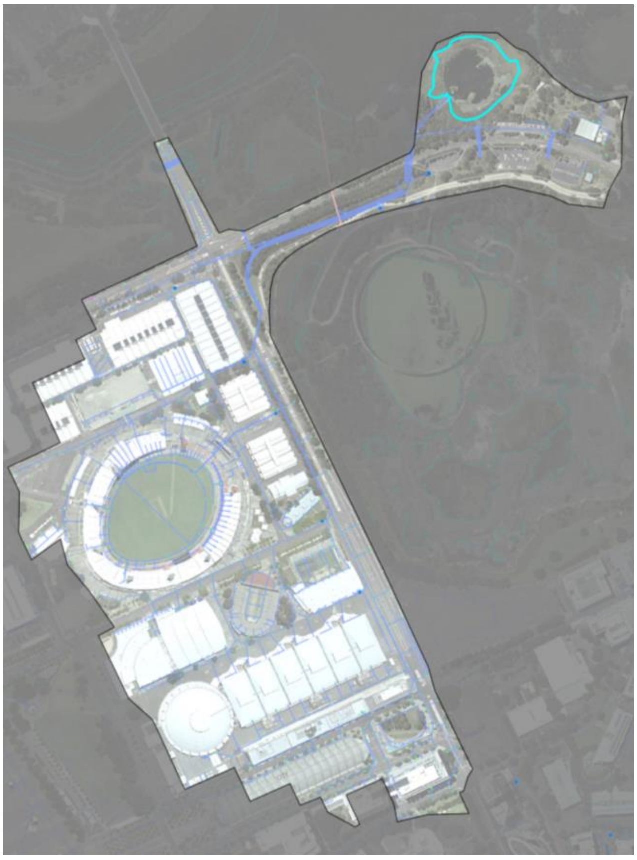


Figure 9. Eastern WQC Pond catchment

3.5.3 Bennelong Pond

Bennelong Pond receives stormwater runoff from an approximately 38-hectare catchment covering the 'Urban Centre Neighbourhood', 'Eastern Neighbourhood' and a small part of 'Sports & Civic Precinct' as shown in Figure 10.

The catchment includes a significant stormwater treatment system in the forecourt of Site 18EN (formerly Site 68) which plays a major role in treating runoff from the upstream 19-hectare catchment including a large portion of the 'Urban Centre Neighbourhood'. The arrangement of this treatment system is shown indicatively in Figure 11. The sediment basin within the tank of the Site 18EN treatment system significantly reduces the sediment load entering the Bennelong Pond sediment basin.

In addition to the Site 18EN treatment system, the Bennelong Pond catchment includes:

- 14 GPT's
- A GPT and raingarden treating stormwater from the Murray Rose Avenue subcatchment (sites 3EN, 4EN and 5EN).
- A GPT and bioretention swale treating stormwater from the Parkview Drive subcatchment.
- Pump-out water from train tunnels
- A vegetated median swale in Betty Cuthbert Avenue
- A proprietary treatment system for stormwater runoff from the residential development at Betty Cuthbert Avenue (sites 16En and 17EN).
- A vegetated wetland treating stormwater from Bicentennial Park.

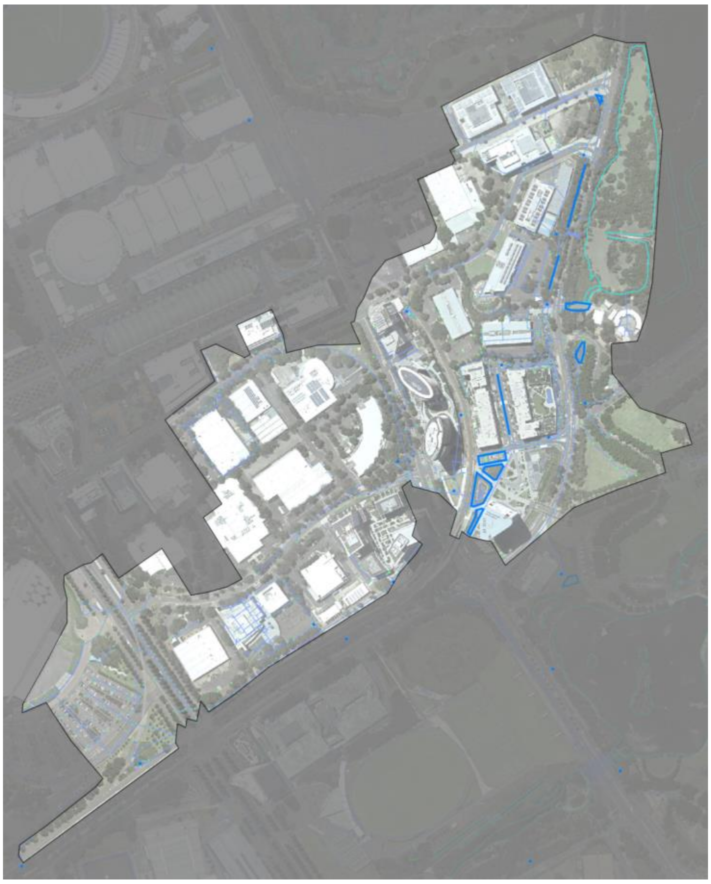


Figure 10. Bennelong Pond catchment

Stormwater discharges from Bennelong Pond to the Badu Mangroves.

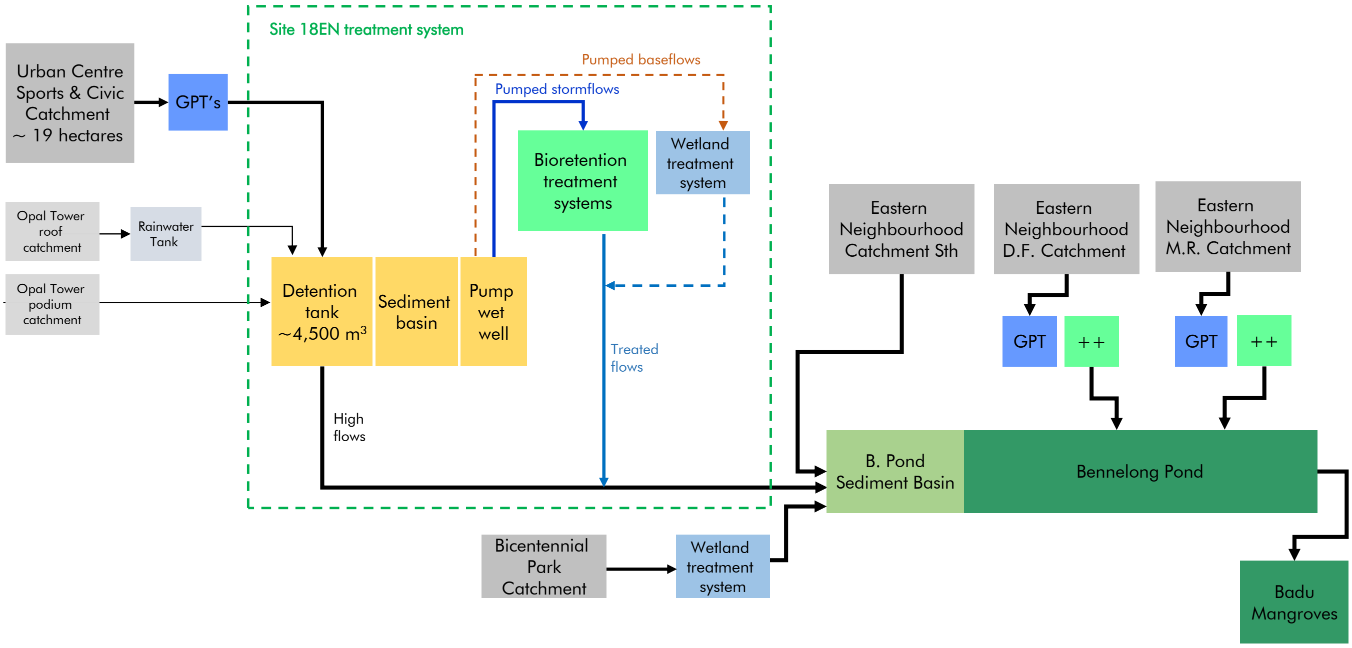


Figure 11. Bennelong Pond catchment treatment

3.5.4 Boundary Creek

Lake Belvedere, at the downstream end of Boundary Creek, receives stormwater runoff from an approximately 138-hectare catchment covering the external Flemington sub-catchment to the south of the M4 motorway (part of Strathfield LGA) as well as the 'Southern Neighbourhood' and part of the 'Sports & Civic Precinct' as shown in Figure 12.

Approximately 62 hectares of the total 138-hectare catchment are part of Sydney Olympic Park. This portion of the Boundary Creek/Lake Belvedere catchment includes:

- 13 GPT's
- A vegetated wetland at the Ausgrid zone substation
- A rainwater harvesting system in site 2SN

Lake Belvedere effectively functions as a large sedimentation basin. That is, sediment and silt in stormwater from the upstream catchment would settle out and accumulate in the Lake.

A constructed fishway links Lake Belvedere to Powells Creek.

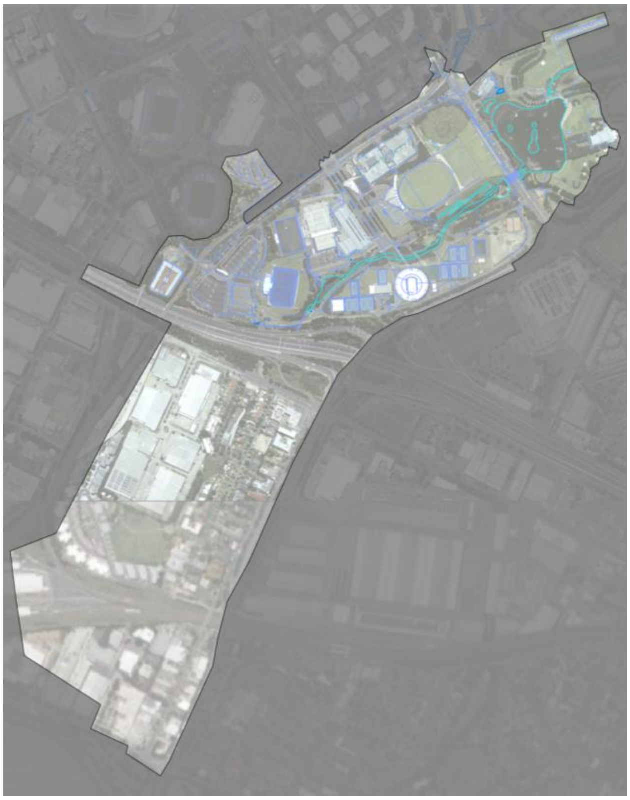


Figure 12. Boundary Creek and Lake Belvedere approximate catchment

3.5.5 Brickpit rim and Grebe Pond

The Grebe Pond at the northwestern side of the Brickpit, receives stormwater runoff from a 6-hectare catchment, part of the 'Eastern Neighbourhood' as shown in Figure 13.

The Grebe Pond catchment includes:

- Castigated kerb & gutter and vegetated swales in Murray Rose Ave
- A stormwater basin (with large fig tree) at the corner of Murray Rose Ave and Australia Ave.
- A vegetated channel approximately 300m long to the Brickpit Rim.

The intended outlet for stormwater discharging from the Grebe Pond is to Haslams Creek via a pipeline that passes below Little Kronos Hill. However, it is understood that this pipeline is no longer functional and stormwater overflows from the Grebe Pond into the Brickpit.

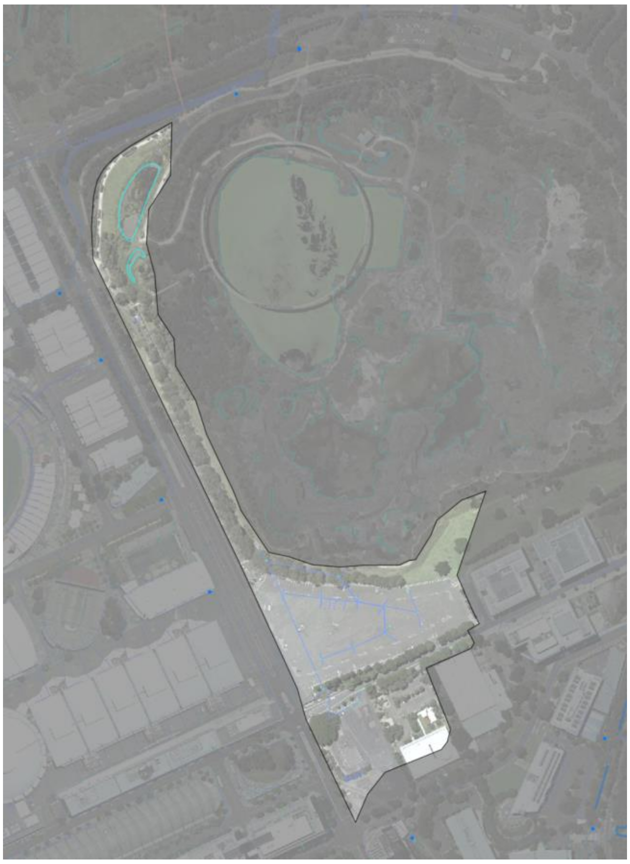


Figure 13. Grebe Pond catchment

3.5.6 Parramatta River

Several catchments at the northernmost side of Sydney Olympic Park discharge directly to the Parramatta River as shown in Figure 14. In summary:

- 'Parramatta River-A' catchment of approximately 65 hectares is primarily industrial land within the Cumberland Council LGA; This catchment includes several wetlands in Wilson Park that are for treatment of leachate, not stormwater.
- The Wilson Park Wetland catchment of approximately 18 hectares is primarily the Correctional Complex.
- The outlet of 'Parramatta River-B1' catchment is a trapped low point drained only by a pipe running out to the river;
- 'Parramatta River-B2' catchment is untreated but largely parkland
- 'Parramatta River-B3' catchment includes a large at-grade carpark with treatment provided in some small ponds.
- Armory Creek catchment, approximately 39 hectares, flows to Wharf Pond.
- Newington Nature Reserve Wetland is an estuarine wetland with inlet/outlet control structures.
- 'Parramatta River-C' catchment is drained primarily by a City of Parramatta drainage line.

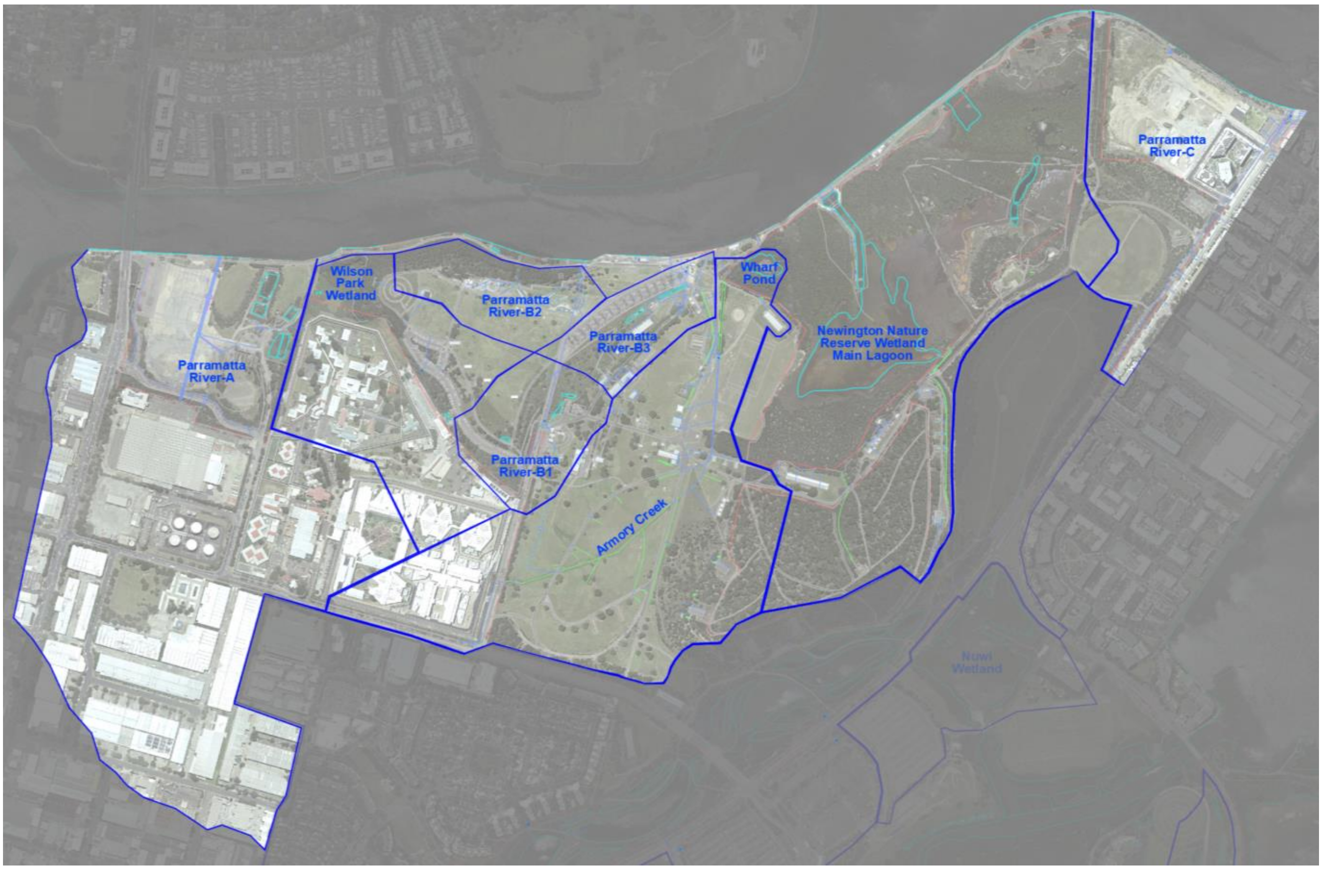


Figure 14. Parramatta River sub-catchments

3.6 WATER HARVESTING AND RECYCLING

Sydney Olympic Park includes a significant water reuse system that utilises harvested wastewater (sewage) and stormwater. Recycled water as part of WRAMS is currently used for garden irrigation, ornamental fountains and non-potable connections throughout Sydney Olympic Park to office and residential buildings, sporting and entertainment venues as well as residences in Newington.

The water recycling system is currently included within the SOPA Act 2001 as "the Authority must maintain and extend, to the greatest extent practicable, the use of the Water Reclamation and Management Scheme at Sydney Olympic Park."

The WRAMS scheme currently relies on two water sources:

- Harvested stormwater
- Reclaimed wastewater (sewage)

SOPA (2023) reported that in 2022-23 approximately 1,049 ML of recycled water was produced from 597 ML of harvested stormwater and 772 ML of sewage.

The configuration of the water reuse systems including stormwater is shown indicatively in Figure 15. The amount of stormwater taken from the Narawang Wetlands, Northern Water Feature (NWF), and Eastern Water Quality Control Pond (EWQCP) is understood to have reduced as many areas with fully established native vegetation are no longer irrigated.

The sewer-mining function of WRAMS treats wastewater that would otherwise be directed to the existing Sydney Water sewerage system. The activity is regulated by the NSW EPA under Environment Protection Licence #10020. The current arrangement of the main components of the water recycling system (WRAMS) is shown in Figure 16.

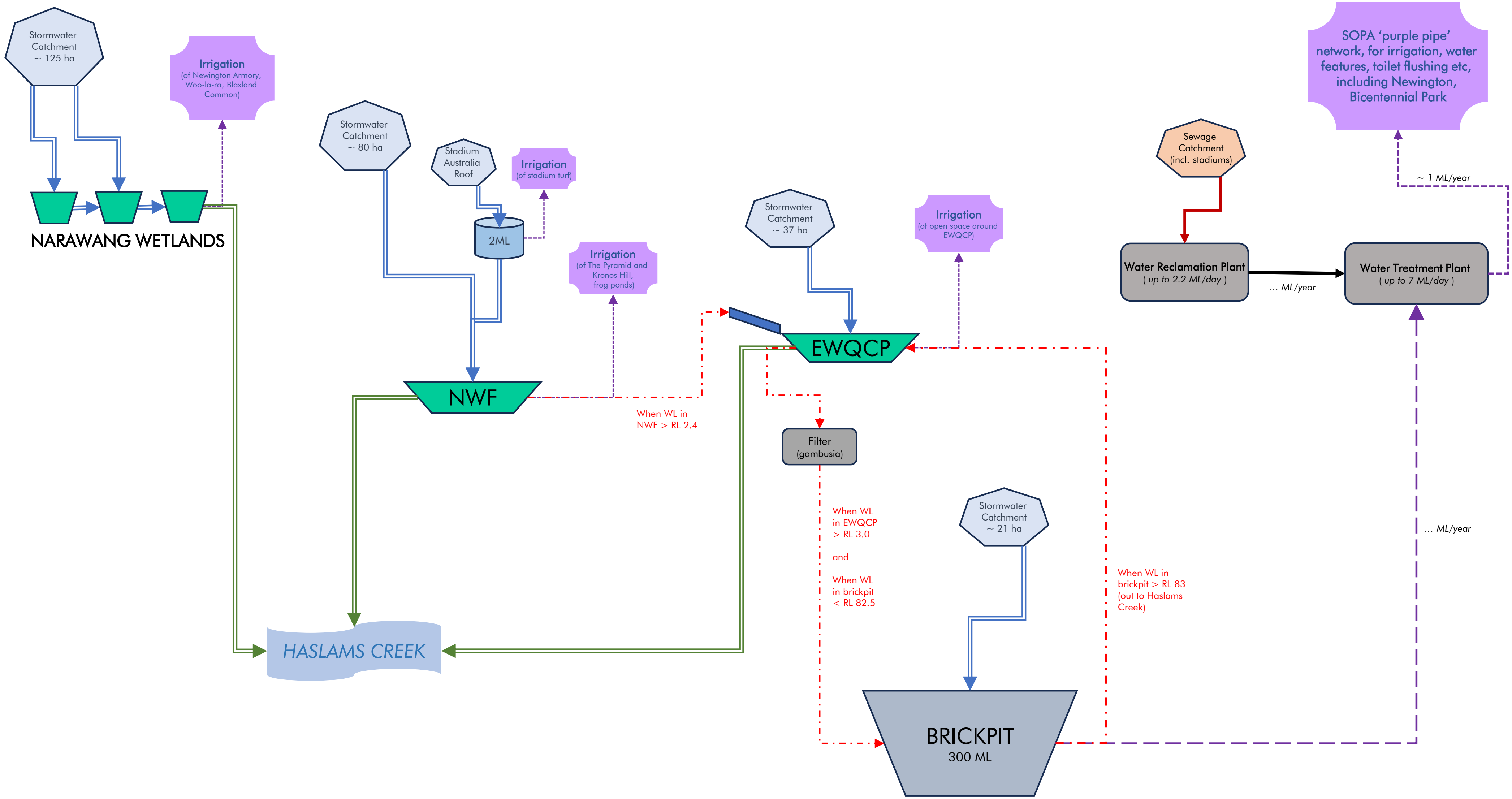


Figure 15. Indicative diagram of water reuse systems at Sydney Olympic Park

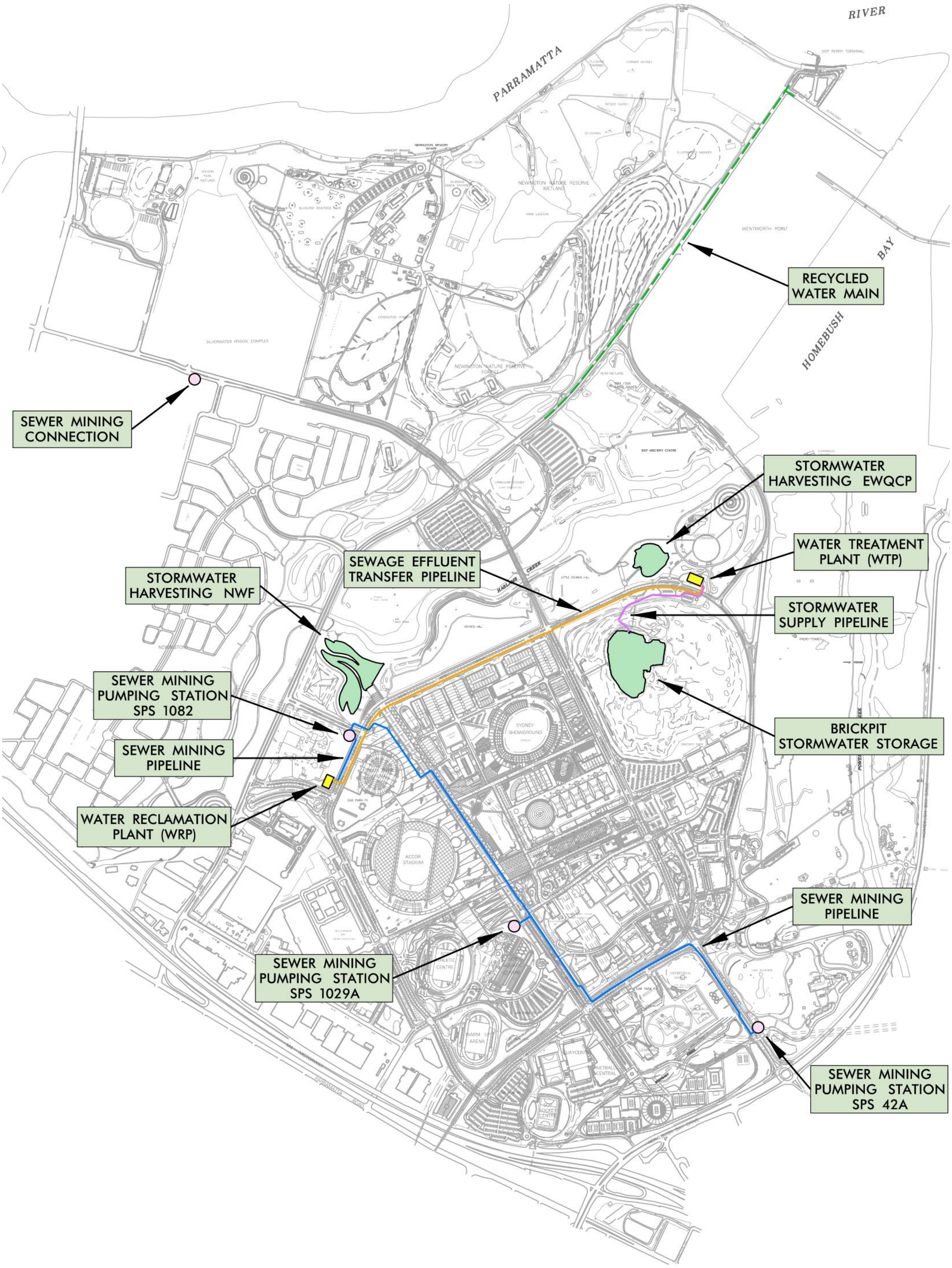


Figure 16. Map showing WRAMS key components (SOPA, 2023)

A dual reticulation system is in place (including a separately metered purple-pipe system) to distribute recycled water. The extent of the recycled water reticulation network is shown in Figure 17.

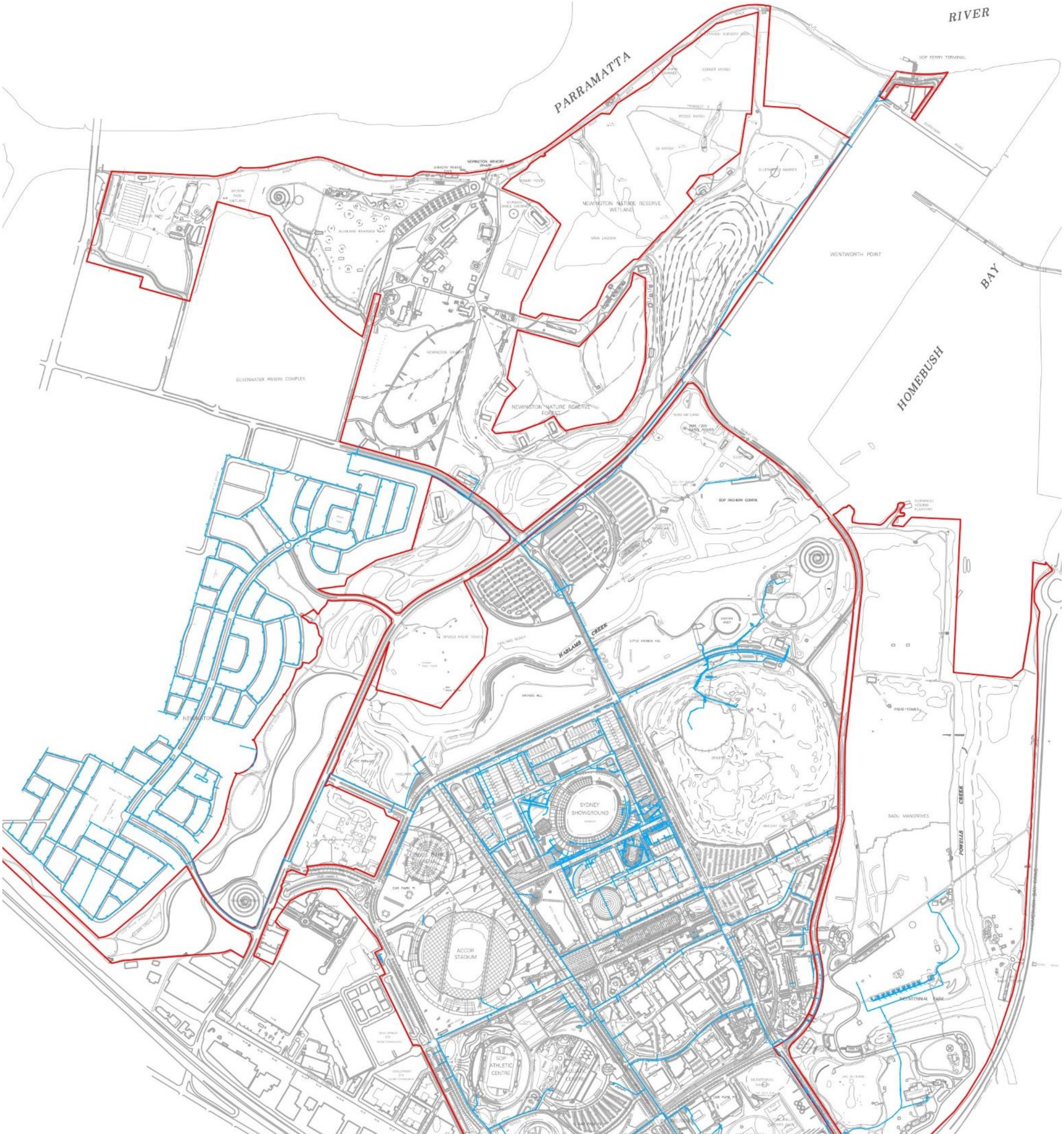


Figure 17. Map showing coverage of WRAMS recycled water reticulation network (SOPA, 2023)

Stormwater harvesting

Stormwater harvesting is carried out at Sydney Olympic Park by capturing stormwater runoff from the catchment areas shown in Figure 18. As shown in in Figure 15 water is taken from the Northern Water Feature, the Eastern Water Quality Control Pond, and three of the water bodies in the Narawang Wetlands. Some stormwater is reused directly from these water bodies for irrigation and other non-potable use, including topping up wildlife habitat ponds.

Stormwater from the Northern Water Feature and the Eastern Water Quality Control Pond is also able to be pumped into the Brickpit reservoir to be treated and supplied as part of the WRAMS scheme (refer Figure 15). The catchments of the Northern Water Feature and the Eastern Pond are therefore identified as WRAMS stormwater harvesting catchments.

Figure 18. Sydney Olympic Park stormwater harvesting catchment areas

The requirements for on-lot harvesting for developments within Sydney Olympic Park are based on which catchment they are located within:

- Within the WRAMS catchment areas, developments are not required to have their own rainwater harvesting system, as runoff from these sites is able to be harvested downstream as part of the WRAMS scheme.
- Developments outside the WRAMS catchment area are required to include their own lot-based harvesting and on-site reuse system. This is because runoff from these developments is not able to be harvested as part of the WRAMS scheme.

Demand reduction

Design and management practices for reducing water demand in use at Sydney Olympic Park include the following examples:

- Use of drought-tolerant native plants in landscape plantings across Sydney Olympic Park,
- Night-time irrigation of lawns and plantings when evaporation is lower,
- Use of permeable paving and porous gravel in much of the Town Centre, to provide rainwater infiltration for street trees and to reduce the volume of surface runoff,
- Sub-surface irrigation of the Wilson Park playing field, installed because it requires significantly less water than a surface irrigation system.

3.7 LEACHATE

Sydney Olympic Park manages ten remediated landfills and associated leachate systems including biological treatment wetlands that discharge to the Parramatta River (under an Environment Protection Licence), discharging to sewer (under a trade waste agreement with Sydney Water) or exporting leachate to a nearby licensed liquid waste treatment plant (SOPA, 2023, p.11). In 2023 around 29% of leachate was bioremediated onsite, 65% discharged to sewer, and 6% transferred to a liquid waste plant.

The biological leachate treatment wetlands are at:

- Wilson Park
- Blaxland Common (Figure 19), and
- Former Golf Driving Range, where all leachate is reused by irrigation of a 1.8 hectare area.

Figure 19. Blaxland sustainable leachate treatment wetland (SOPA, 2018)

4 MASTER PLAN 2050

Master Plan 2050 includes proposed changes to land use primarily within the urban zone that create a variety of opportunities to improve or upgrade water management. Land use changes in the study area mainly consist of:

- Infill development (intensification of catchment use through redevelopment),
- Changes to land use (move car parks underground, replace car park surfaces with buildings),
- Revitalisation or rehabilitation of natural waterways including increase public interaction with waterways,
- Add or increase structured public recreation options at open spaces that are currently in low use.

The precincts and neighbourhoods referred to in Master Plan 2050 are shown in Figure 20.

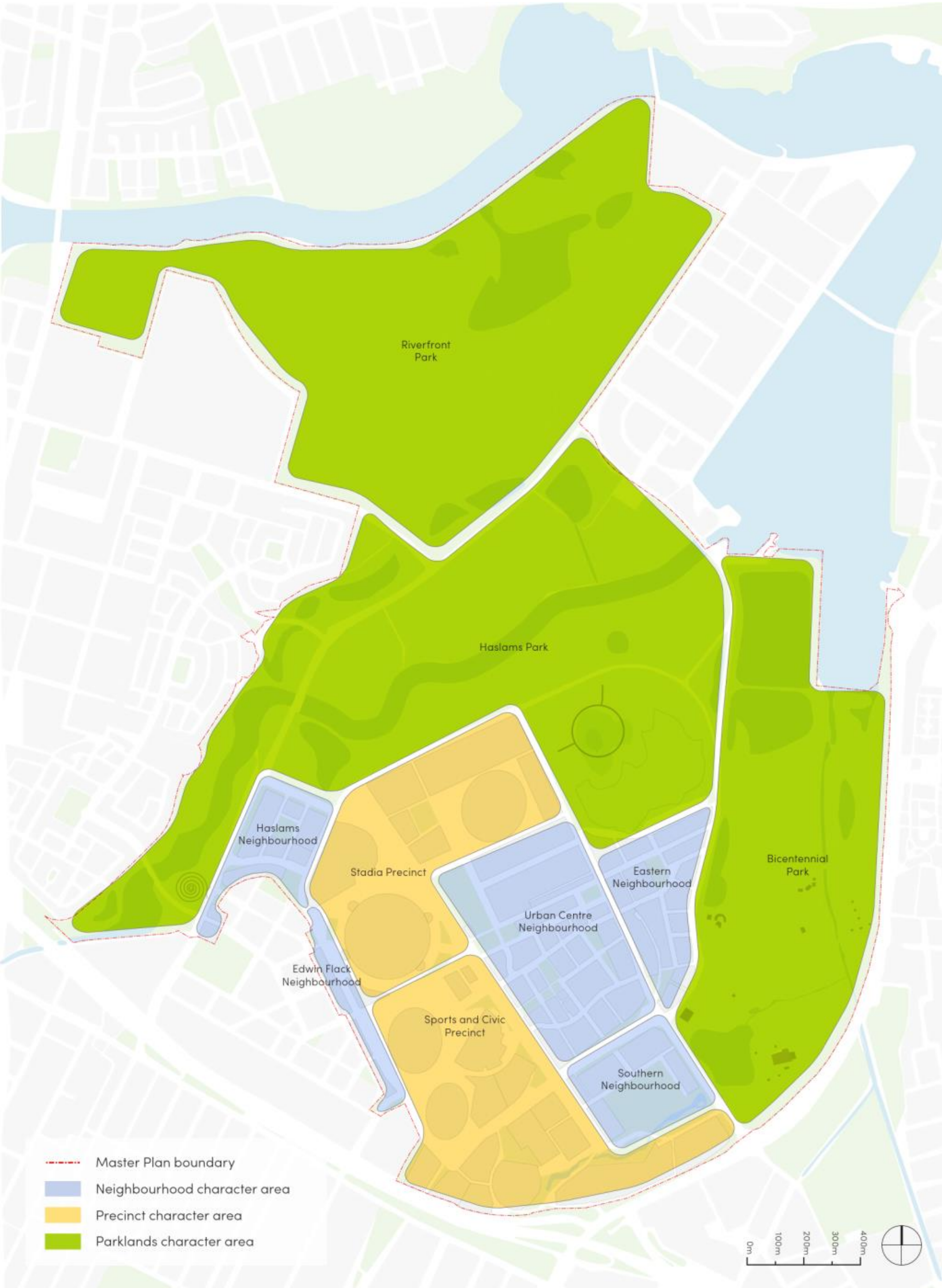


Figure 20 Sydney Olympic Park character area precincts (SJB, 2023, p.107)

4.1 KEY MOVES

The *Sydney Olympic Park: Vision and Strategy* sets out five "Key Moves" that help to shape Master Plan 2050. Figure 21 shows how these connect the Sydney Olympic Park Vision to the strategic directions. The Key Moves are:

1. Neighbourhood Heart
2. Lifestyle Enhancing
3. Nature Positive
4. Living Laboratory
5. Future Resilience.

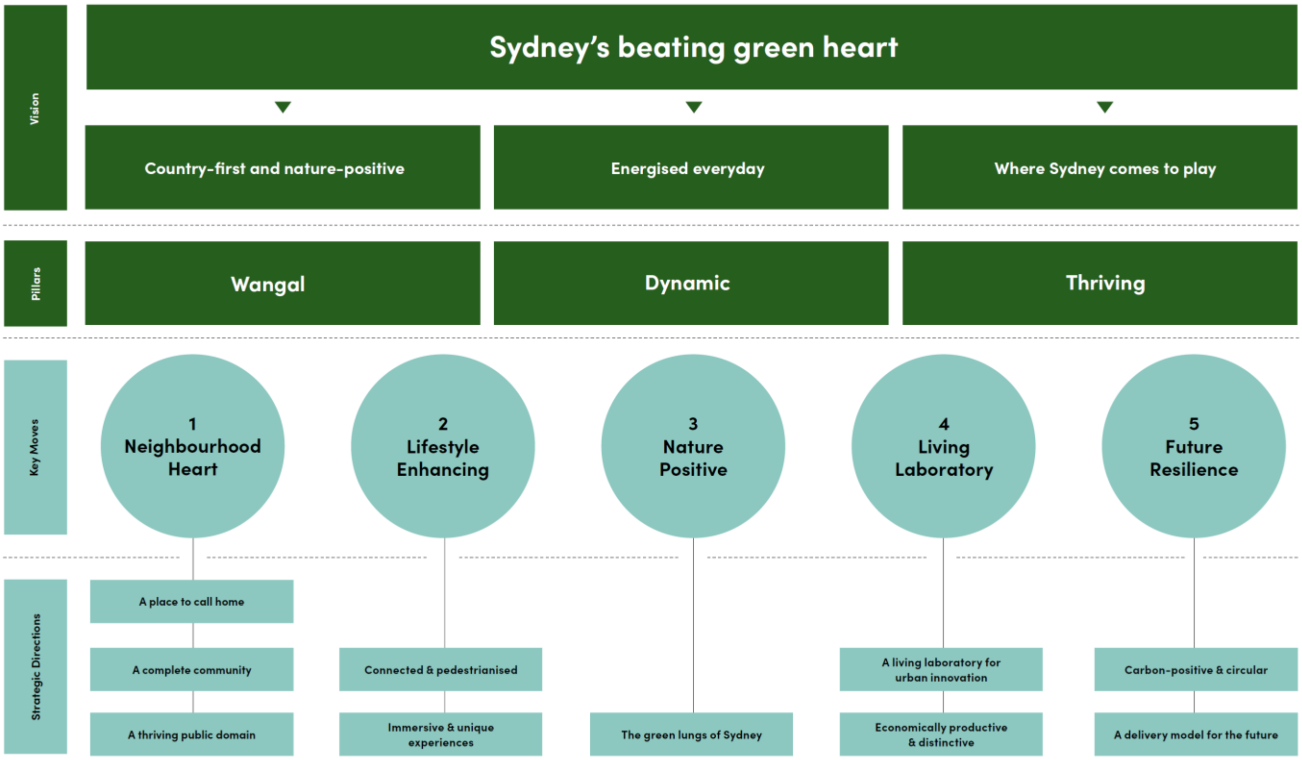


Figure 21. Vision, key moves and strategic directions from Sydney Olympic Park: Vision and Strategy 2050

4.2 DEVELOPMENT

Population and commercial growth

The projected population based on Master Plan 2050 estimates that around 28,550 residents are forecast to be living in Sydney Olympic Park by 2050. This is a significant increase from today's residential population of 3,700. The Vision for Sydney Olympic Park also includes higher visitor rates, increased commercial and recreational activity, and longer stays for visitors.

The changes associated with population and commercial growth are relevant for:

- Water recycling and reuse opportunities
- Expansion of dual reticulation (purple pipe system) beyond the existing WRAMS network
- Litter generation and surface runoff quality in areas earmarked for higher visitation.

An impression of Sydney Olympic Park showing the ultimate development proposed by Master Plan 2050 is shown in Figure 22.

Figure 22. Master Plan 2050 impression (SJB, 2024)

New Metro station

The new Metro station will be underground other than permanent access structures at street level, and with tower buildings over the southern and northern ends. The drainage systems have been designed such that all stormwater runoff from the metro site will flow to the Northern Water Feature.

Parramatta Light Rail Stage 2

PLR2 will include ground level linear infrastructure that passes through varied environments along its route. The changes associated with PLR2 are relevant for:

- Parts of Narawang Wetlands
- Eastern Pond and Northern Water Feature Catchments
- Services requiring relocation – irrigation, recycled water. New services lost below light rail should be future proofed.

5 WATER MANAGEMENT CHALLENGES AND OPPORTUNTIES

5.1 SITE-WIDE

5.1.1 Pressures / challenges

Anticipated major changes will include:

- Population growth 3,700 to around 28,550 by 2050; Residential population; Increased number of jobs; Increased number of visitors and dwell times, increased usage of natural assets and open spaces.
- Infill development intensifies impacts in specific catchments
- Major works including Metro, PLR2
- Externally driven: Flooding and sea level rise

Water-related impacts from the anticipated major changes will include:

- Increased stormwater runoff and pollutant load
- Increased water demands and wastewater discharge
- Ecology changes, fresh → brackish, or brackish → saline
- Potential drainage/flooding impacts from higher tailwater levels
- Possible increased need for demand management
- Changes to the recycled water system, whilst extent dual reticulation is expanded

All the above will cause additional pressure on waterways/ wetlands and water infrastructure.

5.1.2 Climate resilience

The ways in which governments and communities are planning to build resilience is slowly gaining maturity. The first *Resilient Sydney Strategy* was published in 2018 (Resilient Sydney, 2018) and a review and update of this strategy has recently been announced. During recent extreme weather and the Covid-19 pandemic, we gained lived experience with how communities respond to disasters and how more resilient communities might function in practice.

Climate change will exacerbate a range of extremes, many of them connected to water. Emerging knowledge and experience in all these areas suggests needs to refine approaches to:

- Sea level rise: the 2100 high tide extent is shown on maps through Master Plan 2050. Planning for sea level rise is different from flood planning. Sydney Olympic Park strategies are to consider both *peak* levels and the effects of higher *average* sea levels. Higher average sea levels can have real hydrological impacts on land systems, including increased salinity of soil systems, changes to viability of planting selections, reduced drainage window, impeded drainage of low-lying areas and siltation in low-lying drainage systems. This will be an important consideration in waterway-adjacent and intertidal areas around Sydney Olympic Park where the topography is lower and flatter.
- Flooding: NSW already has a fairly holistic approach to flooding including planning, preparedness, warning, response and recovery. However, recent floods have highlighted significant room for improvement. The NSW Flood Inquiry (NSW Government, 2022) makes 28 recommendations to improve many aspects of flood resilience.
- Drought: during the millennium drought there was a strong focus on water efficiency, and significant improvements were made. There are still opportunities for further efficiencies, but it is also clear that there are diminishing returns from an efficiency approach and in future, more diverse water supplies will also be important. During the millennium drought, councils were heavily impacted by water restrictions, and sports field irrigation

may come under pressure again in future droughts.

- **Heatwaves**: water can play an important role in helping communities to cope with extreme heat, and in the future there may be increasing demand for facilities such as aquatic centres, water play, fountains, misters and drinking water in public places, as well as irrigated landscapes that stay cooler and support vegetation through heatwaves.

5.1.3 Recycled water

With the current population of 3,700 residents and 15,000 jobs private recycled water consumption (not including SOPA) is estimated to be around 300 ML/year. In 2050 there is forecast to be around 28,000 residents and 30,000 jobs, so based on current use the recycled water consumption could increase to around 1500 ML/year.

Such an increase would occur gradually and infrastructure upgrades and augmentation would be required as demand increases. The Infrastructure Master Plan (Stantec, 2023) identifies that several recycled water supply services will need to be upgraded, and new main line extended to the Haslams Neighbourhood. It is also noted that changes to the recycled water supply may be considered by Sydney Water as part of GPOP.

As shown in Figure 16 (p. 32) the water reclamation plant that currently supplies secondary treated effluent to the water treatment plant is located within a site that is part of the proposed future Haslams Neighbourhood. It is understood that this is being considered in relation to the planning for the future recycled water scheme. The removal of the water reclamation plant will require a review of options, potentially including consideration of a larger volume of water to be provided from harvested stormwater.

SOPA are also reviewing the options in relation to the ongoing supply of recycled water to Sydney Olympic Park including suitable procurement arrangements. Additional investigations and analysis are recommended to evaluate whether stormwater harvesting and the brickpit storage reservoir could be more heavily used for supply of source/raw water to the recycled water scheme.

5.1.4 Water in the landscape

Suggested 'Primary WSUD streets' are shown in Figure 23. These streets were selected with Turf Design primarily based on landscape principles and avoiding streets with significant constraints, and have the objective of promoting cool streetscapes as well as reducing stormwater runoff volume and pollutant load. Precedents are shown in Figure 24 and SOPA's standard design for a streetscape swale from the IECM is copied in Figure 2 (p.12).

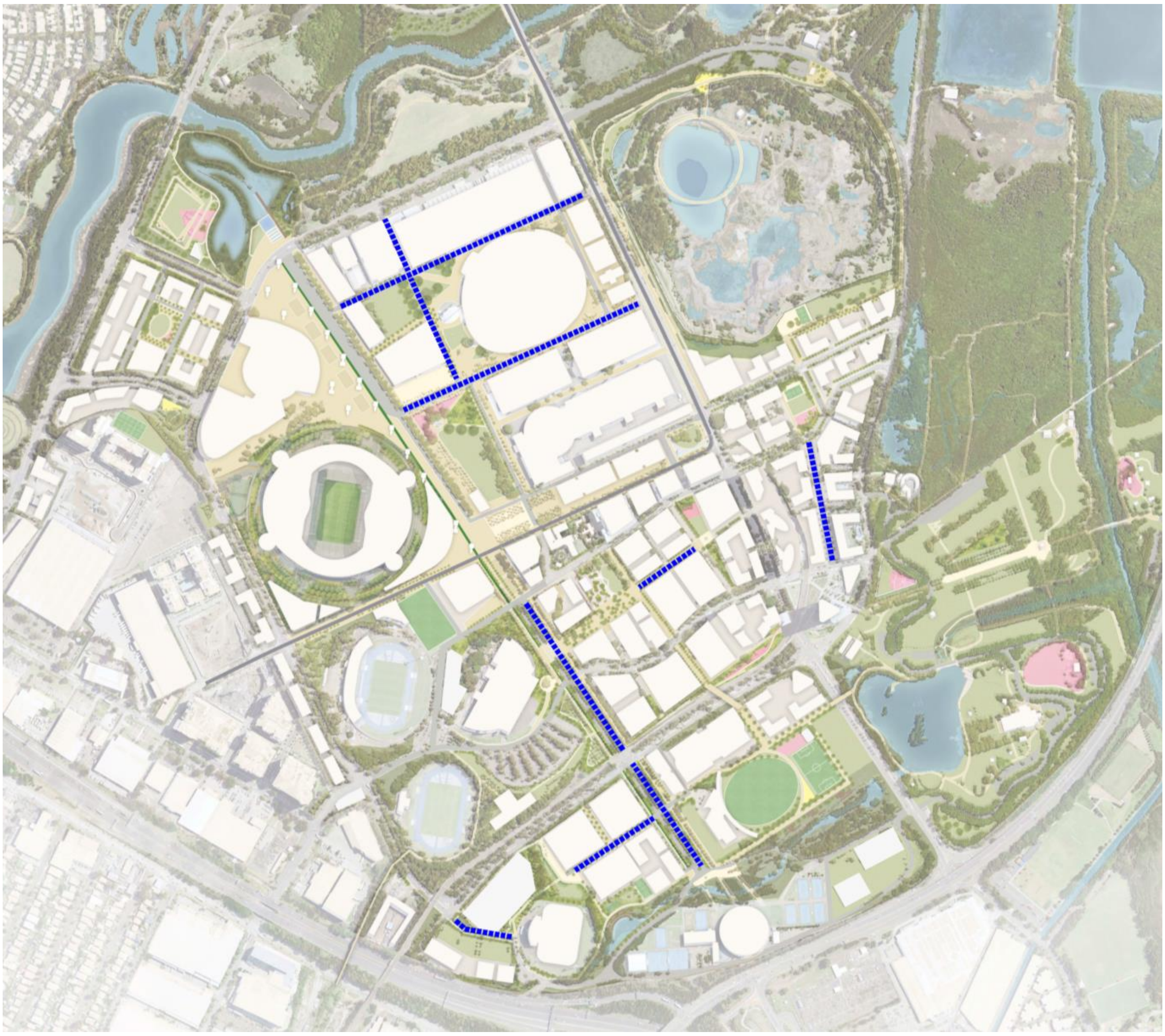


Figure 23. Streets identified for WSUD

Figure 24. Precedents for WSUD Streets

5.1.5 Sea level rise

Master Plan 2050 includes sea level rise as a key priority for water and site management in the Park. Sea level including tidal influences are directly relevant for long term strategic planning and the integrity of surface water management practices at key locations in the Park.

Current modelling of the 2100 highest astronomical tide levels (Figure 25) shows a tidal extent that has the potential to inundate or influence the Northern Water Feature, Eastern Water Quality Control Pond and the channel and riparian zones of Boundary Creek including Bicentennial Park and Lake Belvedere. It would also cause inundation of much of the northern Parklands area including Newington Armory and Blaxland Park.

SOPA will likely need to adopt adaptive maangement principles for a number of impacted water bodies, with options to be considered for species migration and/or potentially intervening to control water in systems where it is possible such as the bird refuge where water level can be managed by gates.

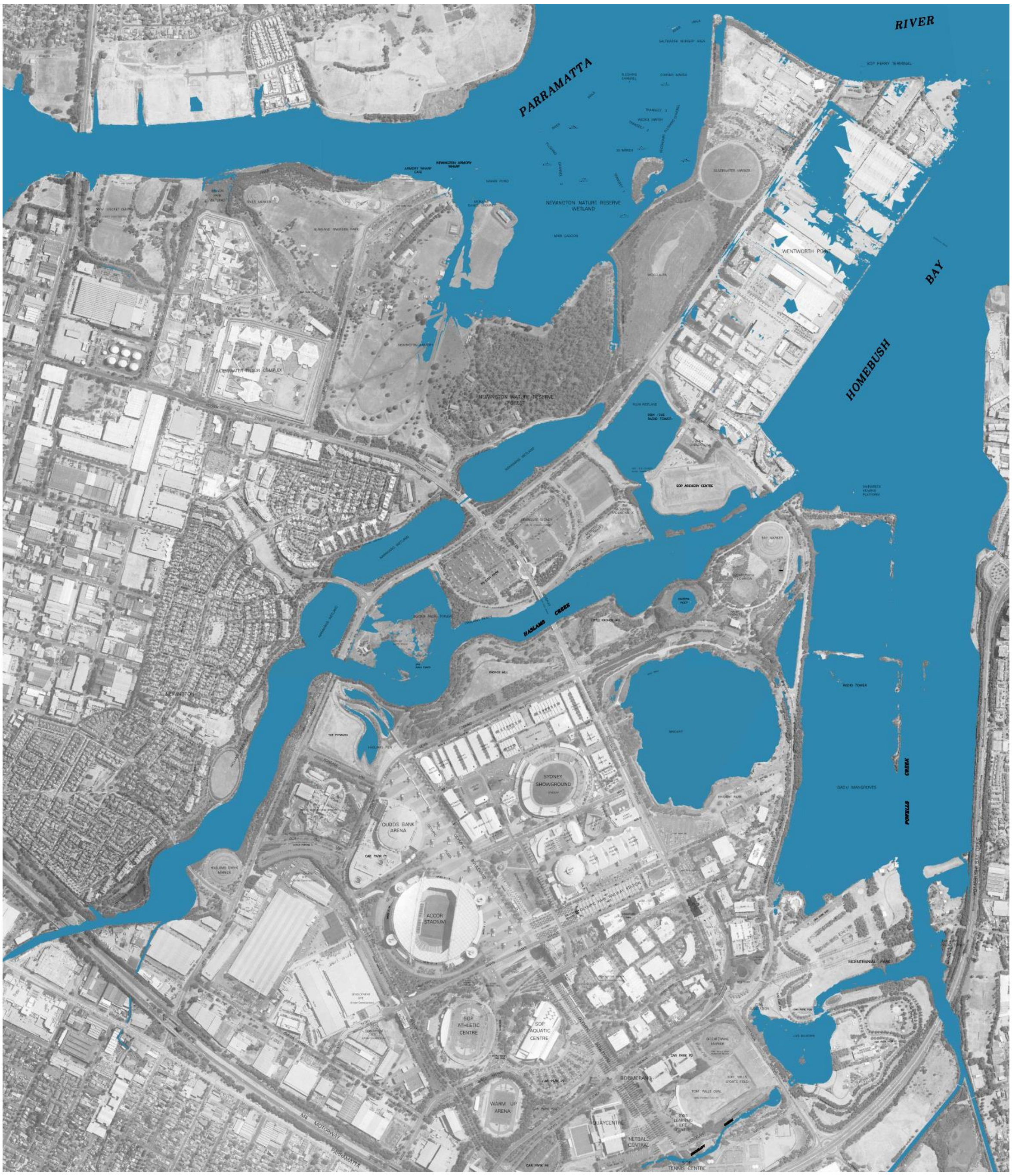


Figure 25. Sydney Olympic Park sea level rise map for HAT (SOPA, 2023)

5.1.6 Inter-catchment transfer

SOPA has proposed modifications to the trunk drainage arrangement in the Urban Centre Neighbourhood as shown in Figure 26.

Such works would result in:

- the catchment area draining to the EWQCP increasing from approximately 35 to 40 hectares.
- the catchment area draining to the site 18EN treatment system decreasing from approximately 20 hectares to 15 hectares. [This also means the catchment area draining to Bennelong Pond would decrease from approximately 38 to 33 hectares]

The purpose of these diversions may be to increase the volume of stormwater that can be harvested for reuse. This approach should be assessed as part of the broader review of the recycled water scheme.

The proposed diversions would also require detailed assessment of the capacity of the existing stormwater drainage services, and modelling of the entire network to ensure negative impacts are not caused by the changes. It is likely that augmentation of stormwater pipes will be required and additional onsite detention. Assessment would also be required to investigate whether any impacts would be caused by reduction of stormwater flows to Bennelong Pond.

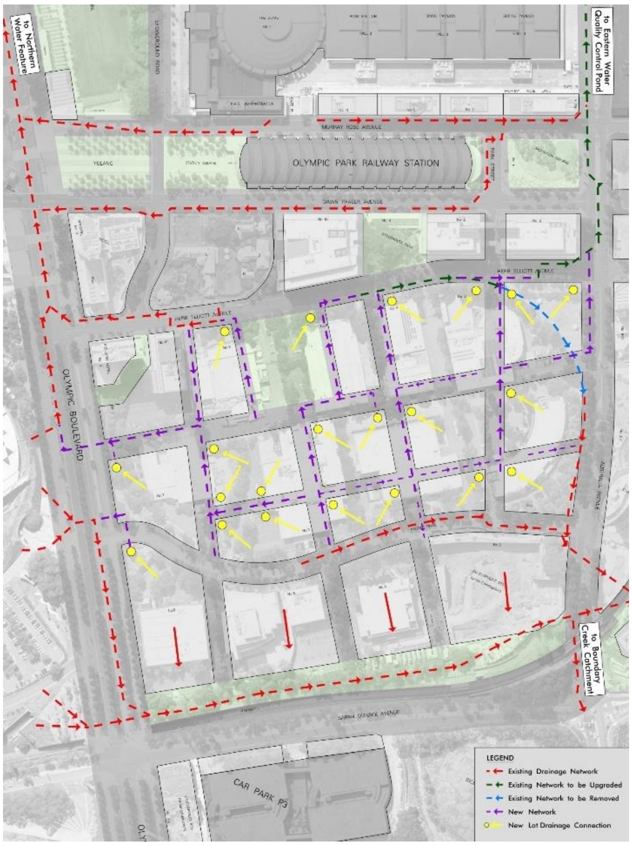


Figure 26. Drainage diversions in the Urban Centre Neighbourhood as proposed by SOPA

5.1.7 Management of existing systems

The existing waterways and water bodies of Sydney Olympic Park will continue to provide ecological and pollution control services, and as outlined in Section 3.3 will continue to require ongoing maintenance, upgrades and renewal. Whilst many of the natural stormwater systems are robust and may tolerate limited maintenance there is limitless potential for enhancing and restoring such systems.

Examples of projects recently completed by SOPA to improve the condition of natural systems include a new sedimentation basin to protect Bennelong Pond (Figure 27) and works to stabilise an eroding bank of Haslams Creek (Figure 28). Further works will need to be completed as part of SOPA's asset management systems. A consideration of Master Plan 2050 is that development and other changes to Sydney Olympic Park does not prevent these works from being carried out.

Figure 27. Works completed in 2019 to construct an inlet sedimentation basin at Bennelong Pond

Figure 28. Works completed in 2022 to address unstable banks of Haslams Creek near Kronos Hill

5.2 CATCHMENTS

Each sub-catchment and associated receiving water will be affected differently by the potential future development envisaged under Master Plan 2050. These changes are assessed in the following sub-sections.

5.2.1 Northern Water Feature

The potential future development envisaged under Master Plan 2050 will impact approximately 15 hectares of the total 81-hectare catchment as shown indicatively in Figure 29, including commercial/residential developments, a new Olympic Boulevarde streetscape, PLR2 and redevelopment of the Showground buildings.

As per the current WSUD policy developments within the catchment are required to include an on-lot treatment system to address stormwater impacts.

However given that the Northern Water Feature is undersized and currently not performing to its full design intent (E2DesignLab, 2021) SOPA may also consider the possibility of development contributions from the projects within the catchment to carry out upgrade and improvement works to the Northern Water Feature.

An opportunity has been identified to divert a portion of the catchment from the Stadia Precinct to a new perched bioretention system adjacent to the Northern Water Feature, as indicated 'B' in Figure 29, to reduce the pollutant load to the Northern Water Feature. This could be considered as a precinct scale system to treat runoff from sites 4ST, 5ST, 6ST, and part of 7ST.

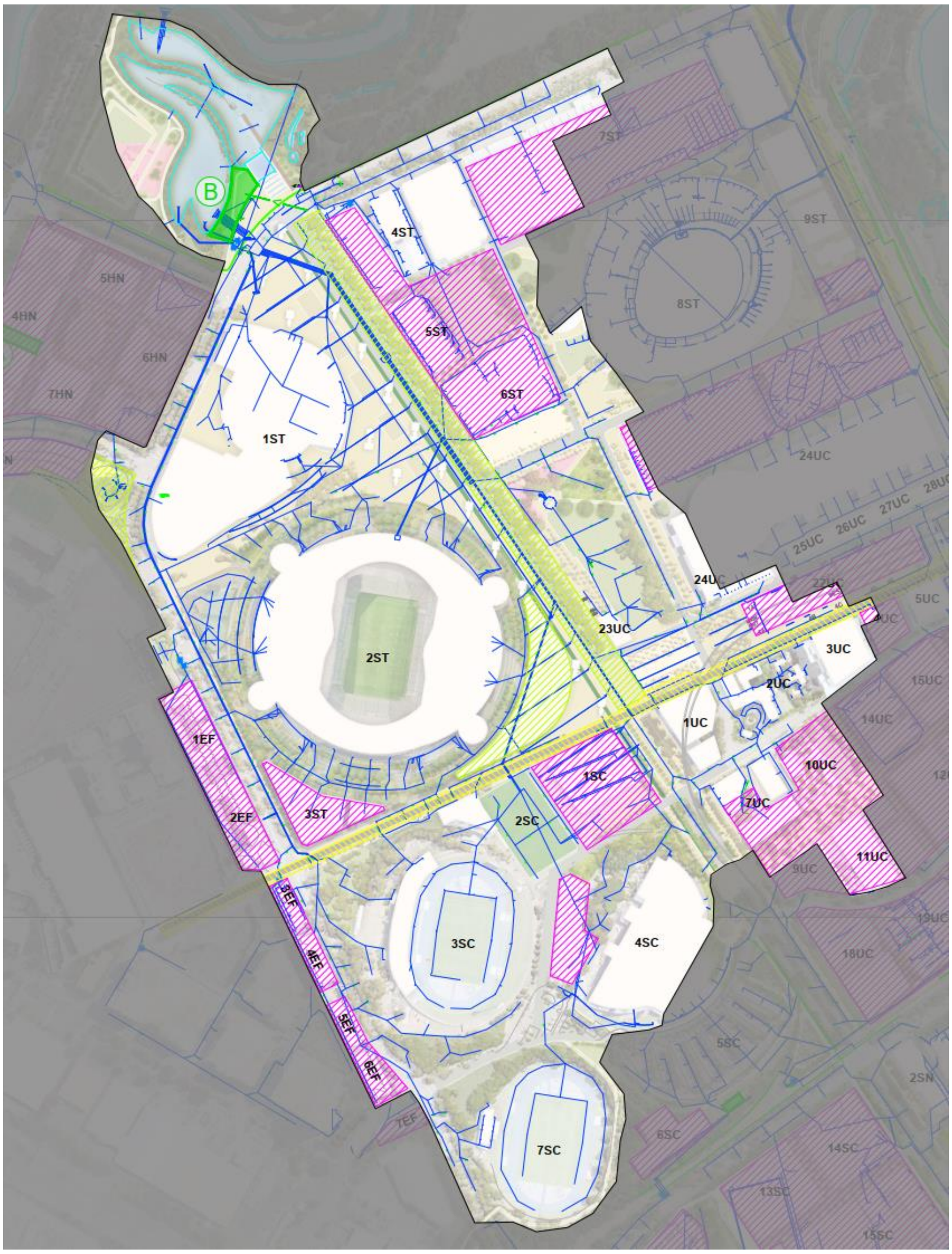


Figure 29. Northern Water Feature catchment with Master Plan 2050 development areas

5.2.2 Eastern Water Quality Control Pond

The potential future development envisaged under Master Plan 2050 will impact approximately 8 hectares of the total 35-hectare catchment as shown indicatively in Figure 30, including PLR2, redevelopment of sites 7ST and 9ST within the Stadia Precinct and sites 22UC and 4UC within the Urban Centre Neighbourhood.

As per the current WSUD policy developments within the catchment are required to include an on-lot treatment system to address stormwater impacts.

However given that the EWQCP is undersized and currently not performing to its full design intent SOPA may also consider possible development contributions from the projects within the catchment to carry out upgrade and improvement works to the EWQCP.

As described in Section 5.1.6 SOPA are also proposing changes to the drainage network such that additional sites from the Urban Centre Neighbourhood will drain to the EWQCP instead of the site 18EN treatment system and Bennelong Pond.

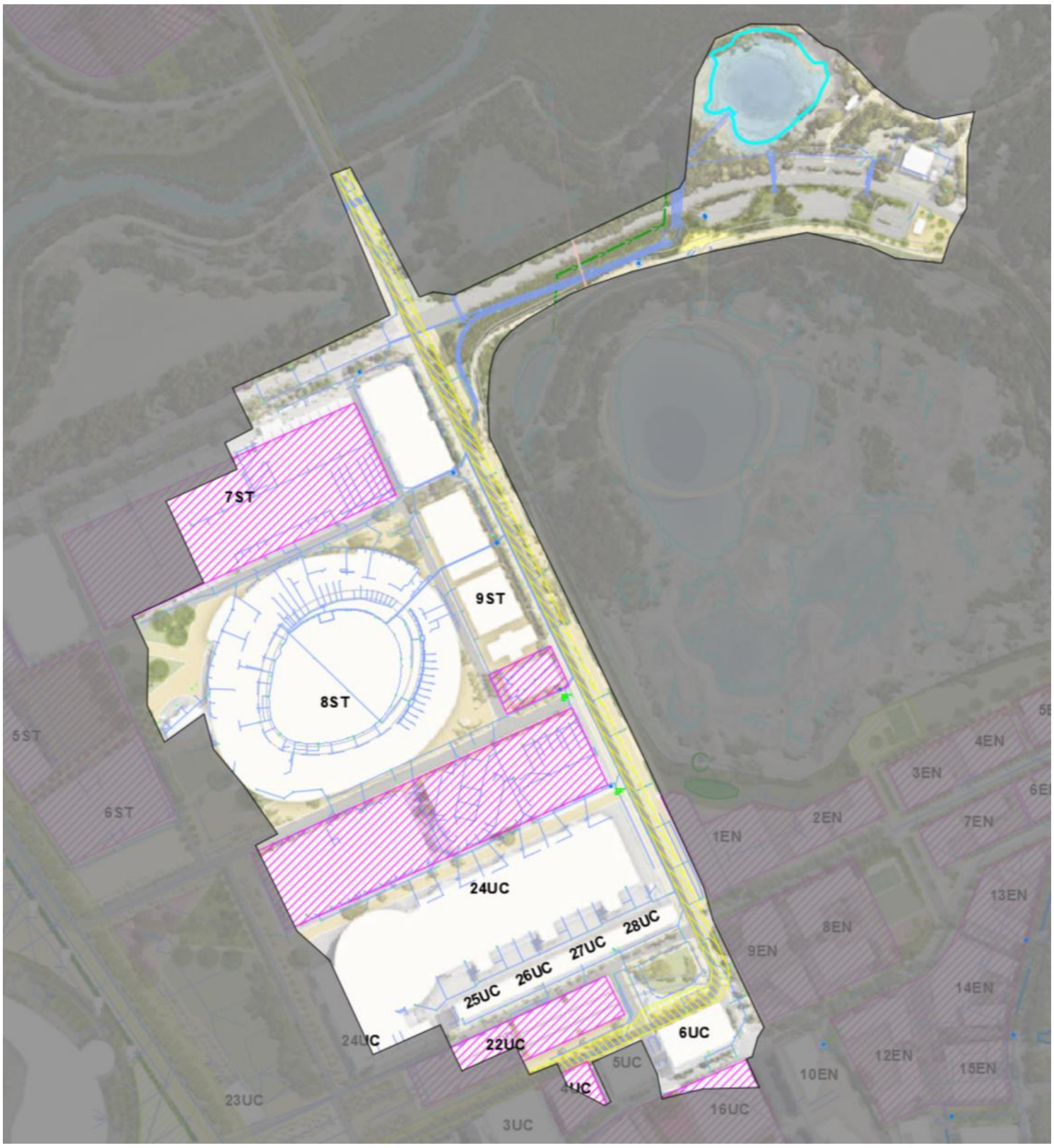


Figure 30. Eastern Pond catchment with Master Plan 2050 development areas

5.2.3 Bennelong Pond

The potential future development envisaged under Master Plan 2050 will impact approximately 16 hectares of the total 38-hectare catchment as shown indicatively in Figure 31, including commercial/residential development.

All sites in this catchment are required to include on-lot rainwater harvesting.

Around 9 of the 16 hectares of the potential future development (sites 14UC, 15UC, 16UC, 9UC, 12UC, 17UC, 18UC, 19UC, and 20UC) is upstream of the forecourt treatment system at site 18EN. These sites will require their own on-lot treatment systems to address stormwater impacts. Development on these sites would also likely have a significant impact on the site 18EN forecourt treatment system during construction and SOPA may consider a development contribution to allow for the increased maintenance that will be required on the treatment system as a result of construction activities.

Around 7 of the 16 hectares of the potential future development will occur in the 'Eastern Neighbourhood' where stormwater discharges directly to Bennelong Pond. Given that Bennelong Pond is a sensitive receiving water with a threatened species, and there is no available open space for downstream treatment, these developments will have to include their own on-lot treatment systems to address stormwater impacts, along with strict construction controls.

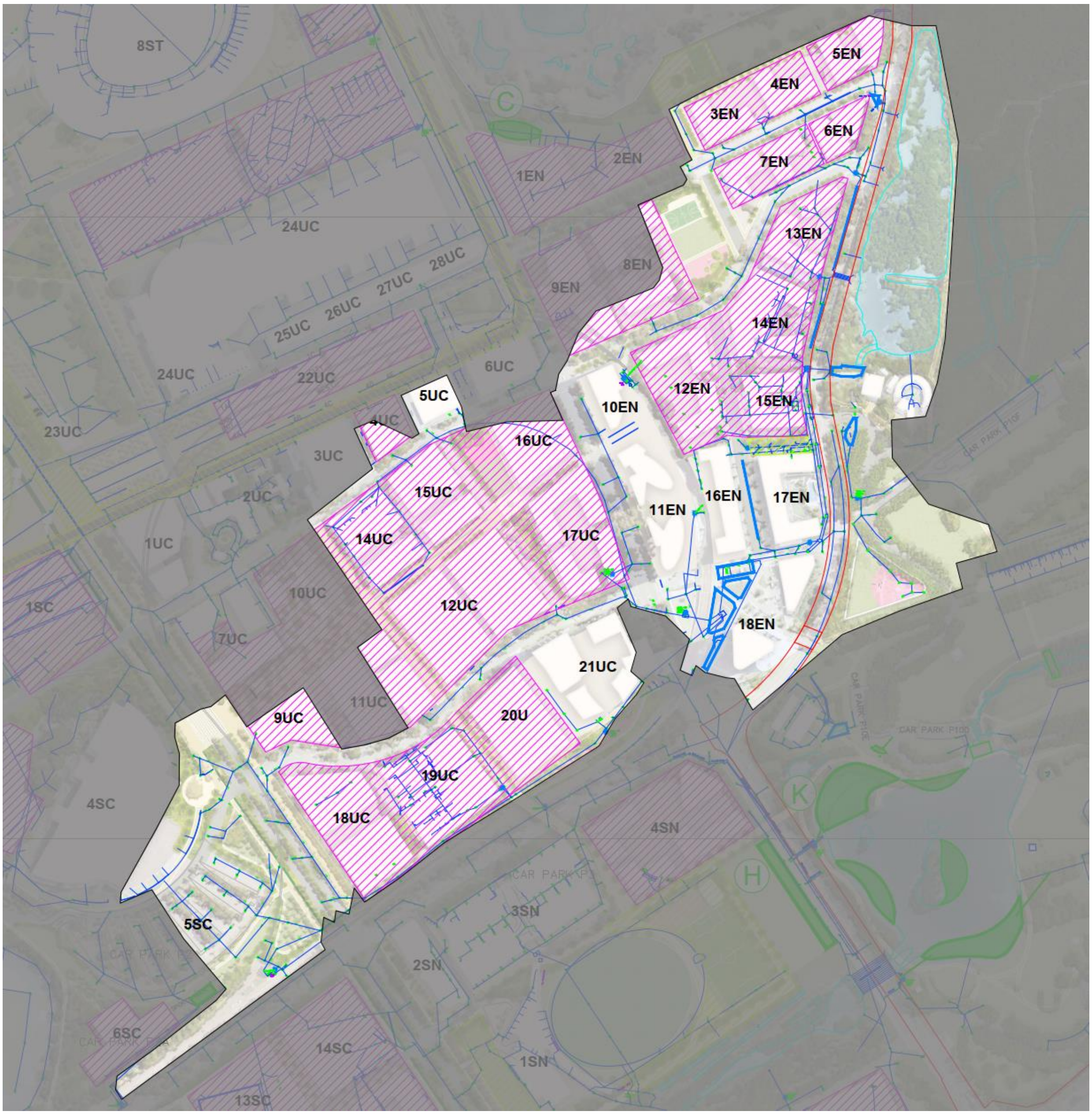


Figure 31. Bennelong Pond catchment with Master Plan 2050 development areas

5.2.4 Boundary Creek

The potential future development envisaged under Master Plan 2050 will impact approximately 14 hectares of the 63-hectare portion of the catchment that is covered by Sydney Olympic Park, as shown indicatively in Figure 32.

As per the current SOPA WSUD policy, each development will be required to include an on-lot treatment system to address stormwater impacts, as well as on-lot rainwater harvesting.

There are also opportunities for new stormwater management systems in this catchment including:

- Treatment systems in the Boundary Creek riparian corridor.
- Separation of flows from the upstream catchment from the Sydney Olympic Park catchment (avoiding double treatment by GPT's)
- Major improvement works within Lake Belvedere including bathymetry changes to provide macrophyte zones, island habitat improvements.

SOPA may consider seeking development contributions for developments in this catchment, which encompasses part of the Sports and Civic Precinct and Southern Neighbourhood, to undertake the above works.

SOPA may also consider the potential for the following precinct scale treatment systems, as referenced in Figure 32:

- Treatment system 'D' to treat runoff from lots 8SC, 9SC and 10SC.
- Treatment system 'E' to treat runoff from lots 13SC, 14SC and 15SC.
- Treatment system 'H' to treat runoff from lot 4SN.
- Treatment system 'J' to treat runoff from lot 17SC.

For management of stormwater from sites 3SN, and 4SN a more detailed feasibility assessment will be required during concept development.

Additional opportunities that could be considered by SOPA include:

- Treatment system 'F' to treat a portion of the stormwater runoff from Olympic Boulevarde.
- Treatment system 'K' as a vegetated wetland bench with extended detention within Lake Belvedere.
- Enlarging the island in Lake Belvedere to provide additional bird roosting/wading habitat.
- Raising the bed level of Lake Belvedere along some edges to improve safety and provide additional areas for macrophyte growth.

Detailed survey should be carried out on the Lake Belvedere outlet structures to allow a detailed assessment of how sea level rise and tidal inundation will influence salinity and resulting habitat within Lake Belvedere. The Lake could be divided into several zones to allow for adaptive management and possible species migration.

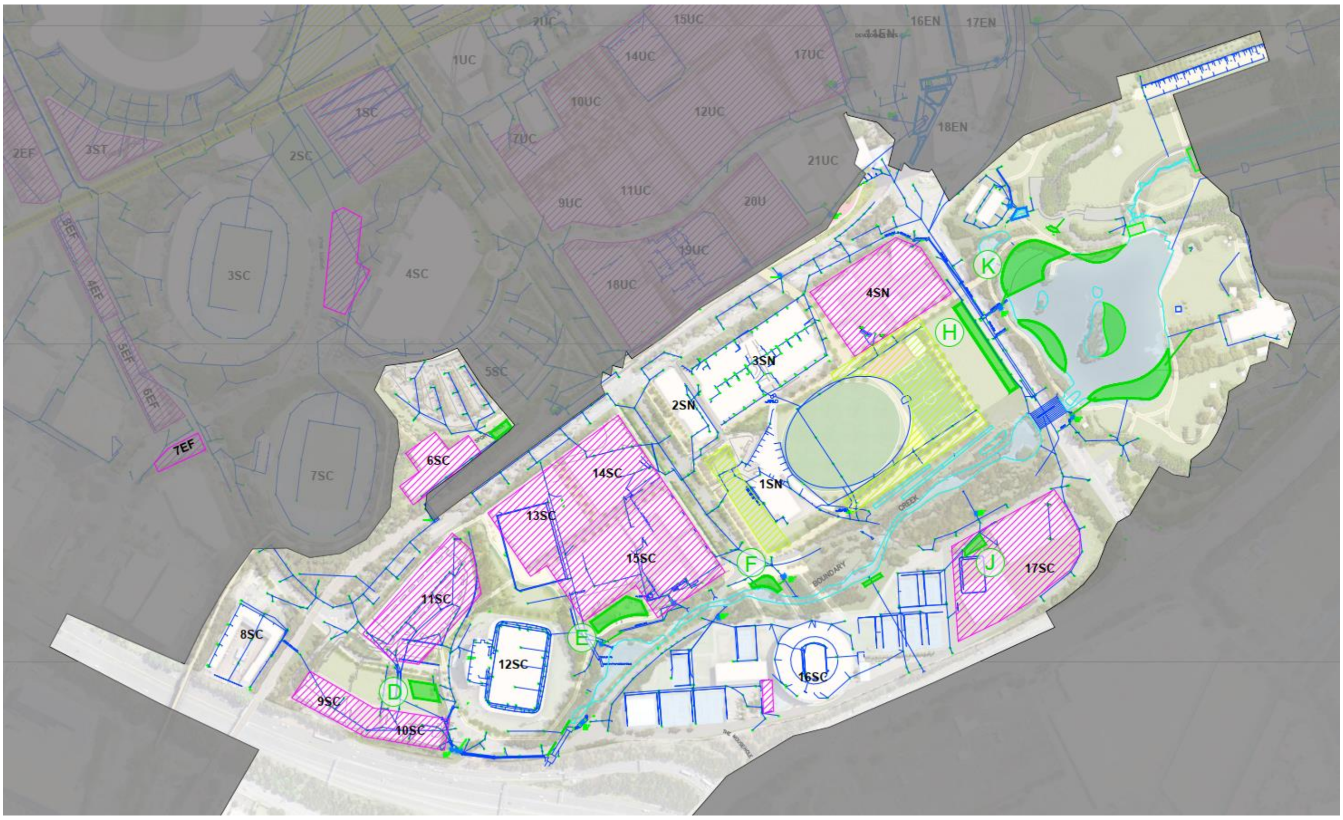


Figure 32. Boundary Creek and Lake Belvedere catchment with Master Plan 2050 development

5.2.5 Brickpit rim and Grebe Pond

The potential future development envisaged under Master Plan 2050 will impact approximately 3 hectares of the 6-hectare catchment as shown in Figure 33.

As per the current SOPA WSUD policy, each development will be required to include an on-lot treatment system to address stormwater impacts.

We understand that a set-back is required from the Brickpit rim where development cannot occur. This provides a good opportunity to install a treatment system to treat runoff from the developments in this catchment.

If suitable arrangements can be made for ongoing operation & maintenance of a precinct-scale treatment system then each development would not be required to provide any on-lot treatment system.

Additionally, a current issue with the Grebe Pond is that it currently overflows to the Brickpit due to a failed downstream pipeline. If the existing gravity outlet cannot be rectified a new pump-out system may be considered.

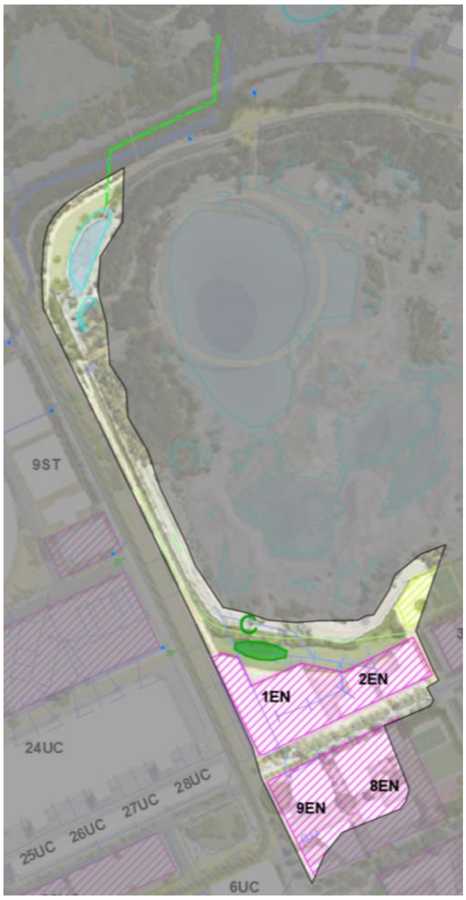


Figure 33. Grebe Pond catchment with Master Plan 2050 development

5.2.6 Haslams Neighbourhood

The potential future development envisaged under Master Plan 2050 will impact most of this catchment as shown in Figure 34.

Typically each building development would be required to include an on-lot treatment system to address stormwater impacts.

Our recommended alternative approach is to provide a centralised system (nominally indicated 'A' in Figure 34) that treats runoff from 4HN, 5HN, 6HN and 7HN. This approach could provide the following benefits:

- The treatment system could be constructed prior to any developments, and serve to minimise construction impacts on Haslams Creek.
- The system would require suitable arrangements for ongoing operation & maintenance that is contributed towards by applicable sites. There would likely be better efficiency and potentially more confidence of treatment performance by a precinct-scale system than around 4 individual systems each being managed separately by strata/body-corporate groups.

A precinct-scale stormwater treatment approach may be more feasible if sites 4HN, 5HN 6HN and 7HN are all delivered by one developer.

Figure 34. Haslams Neighbourhood catchment with Master Plan 2050 development

5.2.7 Narawang Wetlands

The anticipated development within the Narawang Wetlands catchment shown in Figure 35 includes the P5 carpark and the PLR2 project. Redevelopment of the P5 carpark would require inclusion of a treatment system within the site. That is, the Narawang Wetlands should be considered a receiving water for stormwater runoff from this zone.

There are also opportunities to retrofit additional treatment systems within the Narawang Wetlands to treat stormwater flowing into the wetlands from Newington. A detailed survey of the wetlands particularly the outlet structures would allow assessment of potential impacts from sea level rise.

The Hill Road Master Plan (City of Parramatta, 2021) also introduced the potential for stormwater improvements including WSUD along the Hill Road corridor.

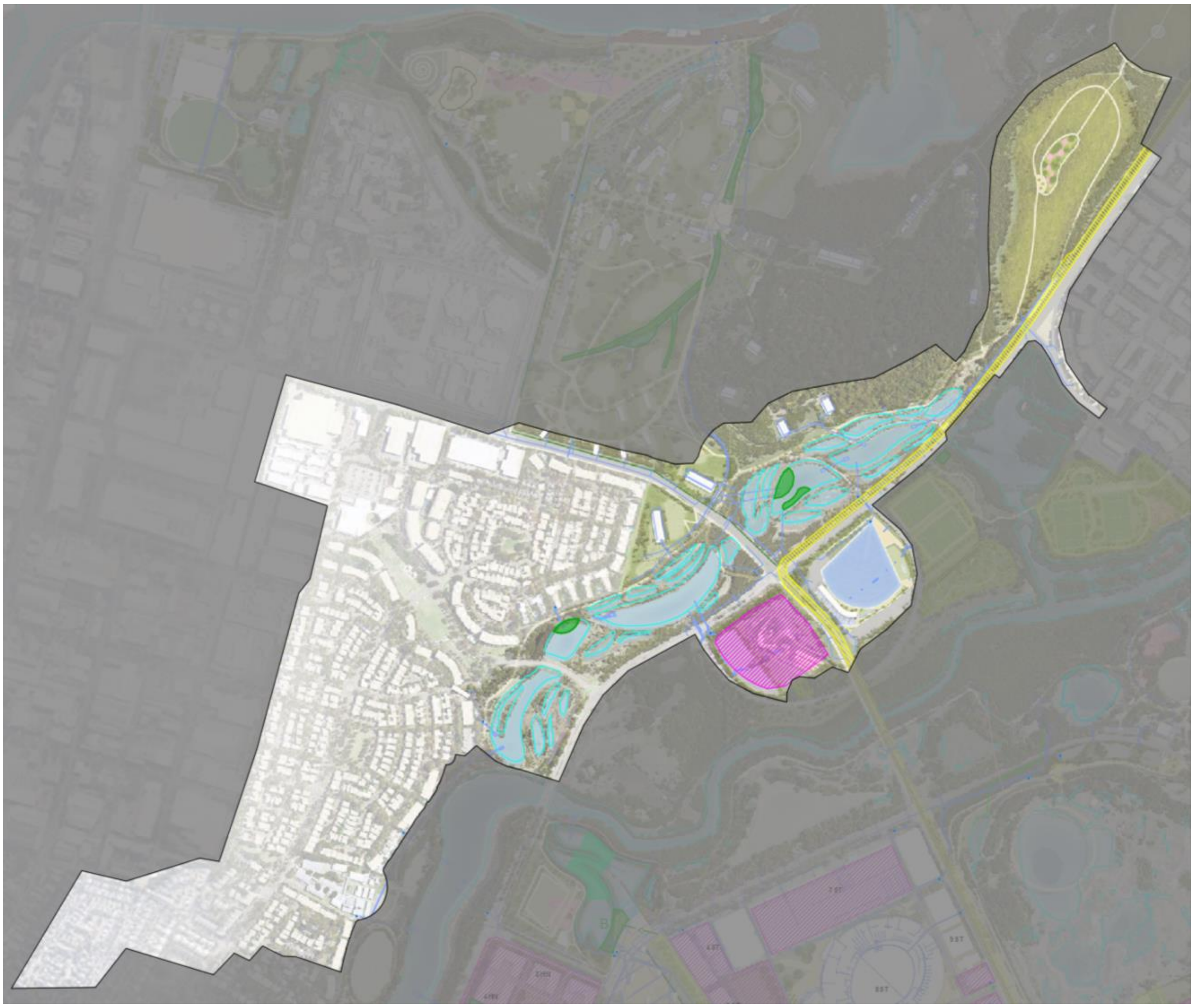


Figure 35. Narawang wetlands catchment opportunities

5.2.8 Parramatta River

There are no development sites proposed in the Parramatta River sub-catchments but PLR2 project will pass through the 'Parramatta River-C' sub-catchment, the landscape masterplan includes a range of upgrades and improvements across the other areas as shown in Figure 36.

A major opportunity is for the upgrade and renaturalisation of Armory Creek as a stormwater management system and a riparian corridor providing additional aquatic and ephemeral habitat.

Several upgrades have been proposed in the *Asset Management Plan - Wetlands, Waterways & Ecological Infrastructure* (E2DesignLab, 2021) including works to Wilson Park Wetland, and improvements to water circulation in the Newington Nature Reserve Wetland. Newington Nature Reserve Wetland is one of the assets that is more likely to require consideration and adaptation with regards to sea level rise.

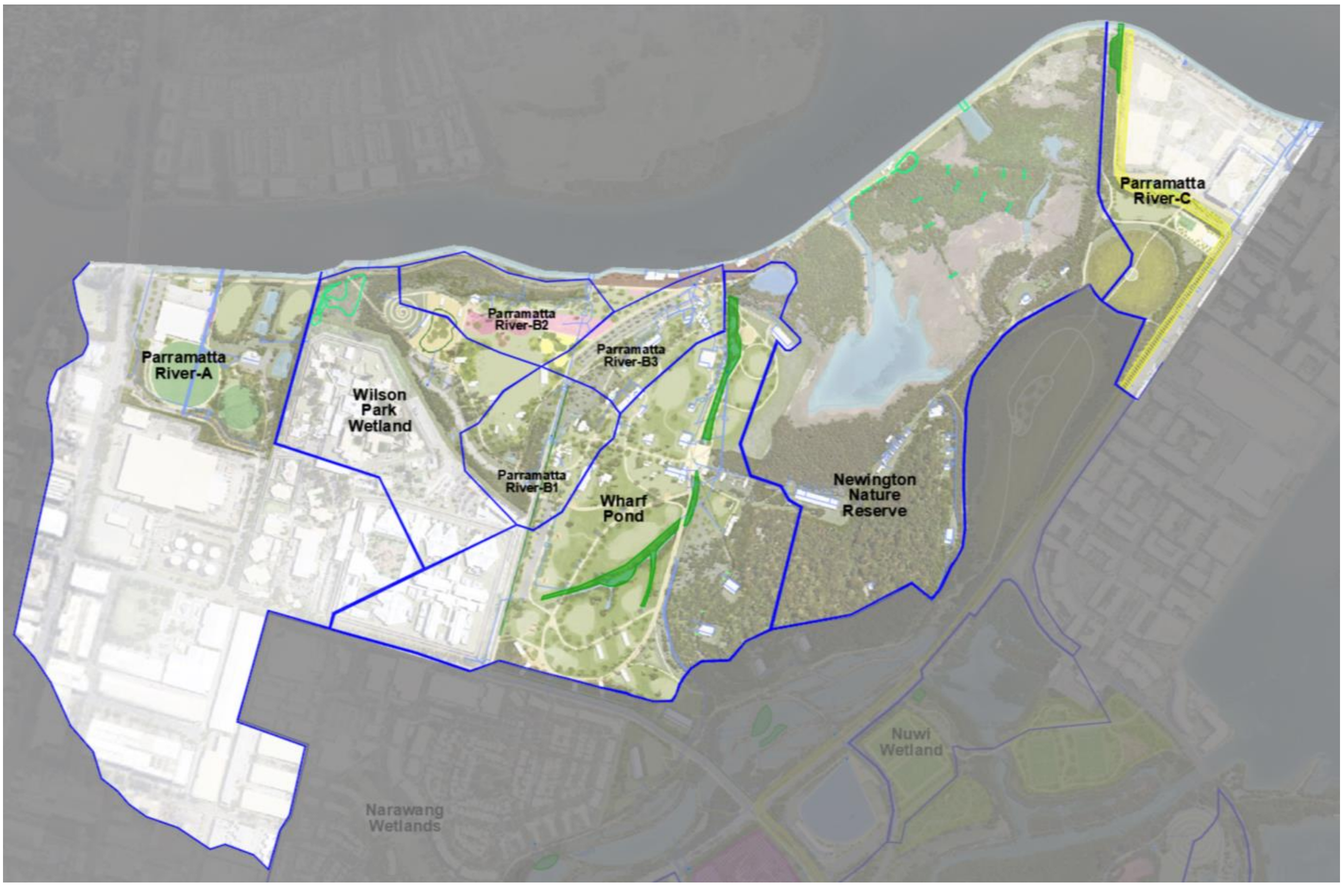


Figure 36. Parramatta River sub-catchments

6 RECOMMENDATIONS

This section provides recommendations for consideration to guide integrated water priorities, objectives, actions, and indicators for Master Plan 2050 based on the review of policies, site context, and goals and objectives for Sydney Olympic Park.

The approach to surface water in Master Plan 2050 should integrate the water management priorities, using methods that address the key water-related issues identified in this report.

6.1 MASTER PLAN 2050

6.1.1 Water management objectives

The following objectives are recommended for inclusion in Master Plan 2050:

a. Celebrate water as a precious resource and defining element of Sydney Olympic Park, where water is conserved, demand for potable water is minimised and aquatic ecosystems are protected.

b. Promote the sustainable use of water across Sydney Olympic Park through water harvesting and reuse and water conservation practices.

c. Continue to implement Water Sensitive Urban Design (WSUD) across Sydney Olympic Park to improve water quality, reduce stormwater runoff, and regenerate the waterways and sensitive ecosystems of Sydney Olympic Park.

d. Protect sensitive and functional riparian ecosystems within the Badu Mangroves, Powells Creek and Haslams Creek.

e. Promote the ongoing restoration of waterways and estuarine areas across Sydney Olympic Park, including the Parramatta River, Haslams Creek, Powells Creek and Boundary Creek.

f. Plan for sea level rise, ensuring resilience against flooding, and accommodating the migration of estuarine species.

g. Create opportunities for people to interact with and enjoy water at scales and locations compatible with conservation objectives.

h. Protect and manage existing wetlands and water bodies for ongoing storage, harvesting, water quality management, aquatic habitat and amenity functions/values.

6.1.2 Water management controls

The following controls are recommended for inclusion in Master Plan 2050:

Development of Sydney Olympic Park must:

1. Be planned and designed in accordance with:
    a. SOPA's Stormwater Management and WSUD Policy and accompanying Guidelines,
    b. SOPA's Environmental Guidelines, and
    c. The Parklands Plan of Management (where applicable).

2. Implement integrated precinct scale stormwater treatment systems [as identified in Figure 3.5.1 of Master Plan 2050].

3. Contribute towards upgrade and rectification works of the applicable downstream receiving water bodies [in accordance with the Infrastructure Contributions Framework].

4. Incorporate WSUD elements, such as raingardens and passive irrigation, in the design of new streets and upgrades of existing streets [as identified in Figure 3.5.1 of Master Plan 2050].

5. Have dual-reticulation with an alternative water supply to all approved uses. Developments are to connect to a recycled water network wherever it is available.

6. Incorporate water fittings and fixtures of the highest Water Efficiency Labelling Scheme (WELS) star rating available at the time of development and meet the requirements of State Environmental Planning Policy (Sustainable Buildings) 2022.

7. Provide an integrated water cycle management plan with development applications for new buildings, substantial alterations and additions to existing buildings and public spaces, in accordance with the WSUD guidelines.

8. Manage groundwater in accordance with regulatory requirements and best practices for protection of receiving waters, including addressing any contamination/leachate.

9. Provide appropriate sediment and erosion control measures and ensure that downstream waterbodies and waterways are not impacted during construction.

10. Demonstrate arrangements for effective ongoing operation and maintenance of any private water management systems.

11. Development must implement stormwater treatment suitable for each catchment in accordance with Table 3.3.4 of Master Plan 2050.

6.2 TECHNICAL ADVICE

This section lists the recommendations for further development at Sydney Olympic Park that will align with the integrated water priorities, objectives, actions, and indicators set out through this report for Master Plan 2050.

6.2.1 WSUD Policy

Key potential updates to the SOPA WSUD Policy that may be considered include:

- Use of precinct-scale stormwater treatment systems where suitable. The applicable sites would then be required to contribute towards the maintenance of the asset.
- Minimum area of deep soil and/or canopy on development sites
- Review targets for stormwater design excellence
- Restrict discharge of groundwater to stormwater system.
- Update policy compliance checklist

6.2.2 WSUD Guidelines

A key requirement for the three guideline documents is that they are made available on SOPA's website.

Updates to these documents should ensure that the guidelines continue to support practitioners in understanding the site context, SOPA's requirements, and the specifications for design, operation and maintenance of constructed water management devices in Sydney Olympic Park.

Several updates would be required once SOPA has resolved their preferred approach to precinct-scale stormwater treatment systems.

The WSUD guideline refers to a set of reference design guidelines (such as those prepared by *Water By Design*) that can be generally be found online. These references can be updated to include publications that have been prepared after 2016. Further clarifications can also be included regarding the suitability of proprietary treatment devices.

6.2.3 Onsite stormwater harvesting

As per the current WSUD policy, any development that is *not* within the catchment area shaded blue in Figure 37 must implement their own on-lot rainwater harvesting and reuse scheme. Conversely, any development within the catchment area shaded blue in Figure 37 is not required to implement on-lot rainwater harvesting. If SOPA proceed with their proposed inter-catchment transfer (refer Section 5.1.6) then the extent of the harvesting catchment would increase, and sites 4UC, 5UC, 14UC, 15UC and 16UC may not be required to implement an onsite rainwater harvesting. This would need to be assessed further at the time those sites are developed.

Figure 37. Potential future development sites with WRAMS harvesting catchment

As noted in Section 5.1.3 with the anticipated Sydney Olympic Park population rise the demand for non-potable (WRAMS) water is expected to increase from the current 300 ML/year up to around 1500 ML/year and this additional demand could be partially met by stormwater. Around 700ML/year flows to the Northern Water Feature and 300 ML/year flows to the Eastern Water Quality Control Pond, a large portion of which could potentially be harvested utilising the brickpit storage reservoir. Additional stormwater could potentially be diverted from the Narawang Wetlands (Newington catchment) if required.

6.2.4 Water bodies

The *Asset Management Plan - Wetlands, Waterways & Ecological Infrastructure* (E2Designlab, 2021) describes approaches to maintain ongoing asset health for water bodies. Whilst these are detailed and site-specific to each asset, Master Plan 2050 should ensure that these can be implemented in future. The proposed works will allow SOPA to continue to achieve its legislated obligations for the protection of endangered and threatened species, along with the other values and services identified above. They contribute to managing the 3 drivers of asset condition decline (hydrology, water quality and catchment development) as identified in the AMP.

The water management approaches included in Master Plan 2050 should ensure that development does not cause further deterioration of these assets particularly those that have high ecological significance.

Additional interventions should be considered in sub-catchments that will have a significant redevelopment, to manage construction water quality impacts during prolonged construction periods.

In addition to this, development could be required to contribute towards improvement works in the downstream receiving waters.

6.2.5 Groundwater

Note the following are general comments and further advice should be sought from hydrogeological specialists and planning and regulatory authorities.

- SOPA may wish to note the requirements described in Section 2.5 for future developments that includes subsurface works during or post construction.
- As well as managing groundwater in new development, Sydney Olympic Park includes documented contaminated sites and leachate management processes that are subject to separate regulation by the NSW EPA. These matters should be addressed separately by hydrogeological contamination specialists.
- Dewatering that is formally approved by the appropriate authorities for disposal to surface water should also take into account the additional volumes of water that may be directed to systems designed to receive modelled rainfall volumes only for a given catchment area, and whether any issues such as salinity (EC) of the groundwater may present issues for vegetated treatment devices such as swales.
- Consider level of risk to lessees or operators of private or recreational places where e.g. sites may be subject to further regulation under the *CLM Act* (e.g. an Ongoing Maintenance Order under Section 28 of the CLM Act). For example, the potential for facilities management to include ongoing groundwater monitoring or management where there is permanent dewatering around basement areas.
- Refer to maps showing the footprint of landfills and remediated land, including leachate management systems, during further stormwater management and WSUD design, and any significant ground works. In particular, note the leachate drains and rising mains in the Boundary Creek catchment.

7 REFERENCES

ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*

Cardno (2011) Review of Stormwater Impacts on Bennelong Pond; Job Number W4391-13

Cardno (2012) Condition Assessment of the Eastern and Southern Ponds; Job Number W4391-15

City of Paramatta (2021) Hill Road Master Plan – Wentworth Point; Prepared by City of Parramatta - Capital Projects - Landscape Architecture

Department of Planning and Environment (2022) Minimum requirements for building site groundwater investigations and reporting, October 2022, Information for developers and consultants. Accessed on 6th June 2023

E2Designlab (2021) Asset Management Plan – Wetlands, Waterways & Ecological Infrastructure

NSW Government (2006) Water Quality and River Flow Objectives, Sydney Harbour and Parramatta River. Accessed 14 June 2023 at: https://www.environment.nsw.gov.au/ieo/SydneyHarbour/report-03.htm#P435_34752

SJB (2023) Sydney Olympic Park Master Plan 2050 Draft 17.11.2023

Stantec (2023) Sydney Olympic Park Infrastructure Master Plan, 3 November 2023

Sydney Olympic Park Authority (2008) Environmental Guidelines Sydney Olympic Park

Sydney Olympic Park Authority (2010) Sydney Olympic Park Master Plan 2030

Sydney Olympic Park Authority (2016) Stormwater Management and Water Sensitive Urban Design Policy - POL13/04, including MUSIC modelling Guideline, WSUD Guideline, and Rainwater Tank Guideline.

Sydney Olympic Park Authority (2023) State of Environment Report, appended to Annual Report 2022-23

Turf Design Studio (2023) Sydney Olympic Park 2050 Master Plan Landscape and Public Domain Report

APPENDIX A SOPA WSUD POLICY & GUIDELINES

Policy Name	Stormwater Management and Water Sensitive Urban Design
Policy No.	POL13/4
Department File No.	F02/1538.02
Business Unit	Operations
Office Responsible	Senior Manager Environment & Ecology
Approving Officer	Chief Executive Officer
Date of Approval	18 October 2016

Version	Review	Date	Approved by
1	-	October 2013	CEO
	Reviewed	January 2014	
	Reviewed	January 2015	
	Reviewed	February 2016	
2	-	October 2016	CEO

Implementation notes:

Glossary: Terms related to this policy are defined in the glossary at Attachment 5.

Related documents: The Authority has produced a set of technical guidelines to assist in implementation of this Policy. The Policy should be read in conjunction with the Guidelines. Guidelines may be accessed on the website of the Sydney Olympic Park Authority: www.sopa.nsw.gov.au/resource_centre/publications

STORMWATER MANAGEMENT & WATER SENSITIVE URBAN DESIGN POLICY

Introduction

This policy sets Sydney Olympic Park Authority's requirements for stormwater management associated with development design, planning and construction.

The Authority is obliged and committed to better practise in holistic stormwater management, with a particular emphasis on mitigating the detrimental local and downstream impacts on the environment from poor quality and/or excessive volume of stormwater flowing from developments during and after construction.

The Authority's policy aims to achieve this by:

- Promoting appropriate water sensitive urban design in development
- Optimising local harvesting and on-site utilisation of stormwater
- Requiring proper management of stormwater from construction sites
- Requiring appropriate management of discharge of stormwater from and within development sites post-construction

Policy Position

Development within Sydney Olympic Park must:

- Comply with best practice water sensitive urban design practices
- Comply with best practice stormwater quality and quantity targets
- Manage stormwater from construction sites to best practice standards

Best practice within Sydney Olympic Park includes allowing for appropriate and innovative offsets in circumstances where there are genuine physical constraints, due to the intrinsic nature of the particular site, which limit an on-site design and control solution (as may be approved by SOPA on a case-by-case basis).

Applicability

This policy applies to all development design and construction within Sydney Olympic Park including new developments, extensions or alterations to existing developments, public domain infrastructure (including new and altered roads, paths and car park facilities, new and altered sporting facilities, new public domain and public buildings, new and altered infrastructure including utilities and transport infrastructure) and all hard landscape areas.

The policy requirements apply to:

- private developments which alters and/or adds more than 150m^2 of impervious area and/or developments which result in an addition of gross floor area of more than 150m^2. The policy requirements are to be applied to the whole site area.
- public infrastructure and public asset developments which alters and/or adds more than 150m^2 of impervious area. The policy requirements for public

infrastructure and assets is to be applied to the area of altered or new assets only.

The policy will be enforced through commercial agreements and landholders consent procedures for all private property development, and provisions may be adopted as development consent conditions.

Developments smaller than those outlined above are still required to meet the intent of the policy. These developments are to adopt the principles outlined in the Sydney Olympic Park Authority's Environmental Guidelines as well as water sensitive design principles. All works are to minimise runoff, maximise treatment of stormwater by directing stormwater to landscape based treatment systems, maximise capture and reuse of runoff and ensure there is no impact on receiving waters during construction.

Policy Basis

Urban development can significantly impact the natural and constructed environment by reducing the quality, and increasing the quantity and rate, of stormwater runoff from the buildings and hard surfaces typically constructed therein. This stormwater may flow into natural wetlands degrading habitat; into waterways causing erosion and fish-kills; into public places and private land creating flood damage; across roads and pathways presenting hazards for traffic and pedestrians, and in all cases polluting the stormwater and places through which it passes or rests (i.e. polluted by litter, sediment, nutrients, heavy metals and hydrocarbons).

In the Sydney region, there are typically up to 100 rainfall events per year – which under natural conditions, would result in stormwater runoff on only about ten of these events, with the remaining water infiltrating into the ground. Urban development tends to disrupt this natural cycle by significantly increasing the number of rainfall events that generate stormwater runoff.

The policy takes a water sensitive urban design approach, integrating water cycle management with broader planning and design approaches, and thereby achieving more sustainable urban development. It provides an alternative to the traditional approach of conveying stormwater to a downstream destination for disposal into the environment. It requires developments to adopt a decentralised approach to water quality and volume management that is more attuned to the natural hydrological and ecological processes of the Park's natural environment and includes on-site collection, treatment and utilisation of water flows as part of an integrated treatment train. Any changes to the flow rate and flow duration within the receiving watercourse as a result of the development should be minimised as far as practicable, and improved where possible to better match natural flows.

Town Centre catchments are shown on the map at Attachment 1. The northern catchments (shaded blue) were developed with a SOPA-managed centralised and integrated stormwater management system designed to protect the receiving waters from development impacts. This is not the case for other, non-water harvesting catchments (shaded red). Retrofitting such a centralised system in these catchments is not possible due to topography and land availability constraints. Localised solutions to stormwater management are required in non-water harvesting catchments to protect the Park's wetland and waterway habitats. Where an area is not shown on the map in Attachment 1 it is to be assumed that this area is in a non-harvesting catchment unless otherwise advised by SOPA.

The Sydney Olympic Park Authority has a number of duties and obligations for stormwater management as the owner and manager of the place, and has developed this Policy in response thereto.

The following key statutory sources and practice standards are driving this Policy:

- Obligation to protect the environment within the parklands (s28 of the *Sydney Olympic Park Authority Act 2001*);
- Requirement for development consistency with the principles of ecologically sustainable development within the meaning of the *Local Government Act 1993* (s15 of the *Sydney Olympic Park Authority Act 2001*);
- Requirement for compliance with the SOPA Environmental Guidelines (s20 of the *Sydney Olympic Park Authority Act 2001*);
- Obligation for development consistency with Master Plan 2030 (s18 of the *Sydney Olympic Park Authority Act 2001* & Part 23 of *State Environmental Planning Policy (Major Development) 2005*;
- Extension of the water reclamation and management scheme to the greatest extent practicable, in compliance with s48(1) of the *Sydney Olympic Park Authority Act 2001*;
- Avoidance of pollution of waters (s120 of the *Protection of the Environment Operations Act 1997*); and
- Compliance with the 'Guidelines for riparian corridors on waterfront land' (NSW Office of Water, July 2012).

The Policy is also consistent with:

- Parramatta River Catchment Group's mission to make the Parramatta River swimmable by 2025
- the NSW EPA's Strategic Plan 2016-2019 to work with other relevant agencies to make the Parramatta River Swimmable by 2025 (NSW EPA, 2016)

Policy Requirements

1. <u>Maximise harvest and reuse of roof-water</u>

Locally-harvested rainwater must be the primary source of non-potable water for developments located within a Sydney Olympic Park non-stormwater harvesting catchment (shaded red on Map 1) to minimise the impacts of stormwater quantity on sensitive receiving waters and to conserve potable water supplies.

(a) At least 90% of roof area shall be connected to rainwater storage(s) which supply non-potable water reuse from this source,

(b) Rainwater supply schemes must be supplemented with recycled water as a back-up to rainwater supply schemes where connection to the Park's WRAMS recycled water supply is available.

(c) A minimum of 0.25 kL rainwater storage is to be supplied per dwelling and an additional 1 kL of rainwater storage is to be supplied per 100m^2 of non-residential net floor area.

(d) Refer to accompanying SOPA guidelines for further details on rainwater tank modelling requirements.

(e) Rainwater tank storage does not contribute to on site detention volume and cannot be used to offset on site detention requirements

(f) Where non-potable demand within a development site is low, alternative uses for roof water such as landscaping, roof gardens, as well as off-site re-use, should be considered so as to minimise the volume of stormwater discharged to local waterways.

Developments located within a Sydney Olympic Park stormwater harvesting catchment (shaded blue on Map 1) must meet their non-potable water demand from non-potable water sources, including WRAMS recycled water and/or locally harvested rainwater.

Non potable water demands at Sydney Olympic Park are defined as approved uses of the Sydney Olympic Park recycled water scheme and include irrigation, car washing, toilets, water features, washing machines and cooling towers.

2. <u>Minimise volume and frequency of stormwater discharge from hardstand areas such as paving, driveways, car parks and roofs, and maximise quality of any stormwater discharged.</u>

(a) All stormwater discharged from the site is to meet

- water quality pollutant load reduction targets as outlined in Attachment 1.
- water quantity volume reduction targets and peak flow reduction targets as outlined in Attachment 1.

(b) Design of landscaped and paved areas must incorporate water sensitive urban design elements and pollution control devices including but not limited to:

- Appropriate stormwater management measures as detailed in Master Plan 2030
- Retaining a minimum of 20% of the site's open space area as deep soil. Areas included as deep soil are to have a minimum depth of two metres. Consolidate areas of deep soil within sites and between adjacent sites to increase the benefits
- Minimising impervious areas that are directly connected to the stormwater system. Runoff from impervious areas such as driveways, paving and rainwater tank overflows should be directed onto landscaped areas designed to accept such flows
- Removal of gross pollutants, sediments and nutrients prior to stormwater discharge to the trunk drainage system, through use of devices such as bioretention systems, wetlands, swales, sand filters, gross pollutant traps, and litter baskets.
- Installation of oil and grease traps in surface and basement carparks
- Using plant species native to the Sydney region in water sensitive urban design features and associated landscaping, to avoid spread of weed propagules to downstream wetlands.

3. <u>Water conservation</u>

(a) Connect all new development to Sydney Olympic Park's recycled water system, where available, for all approved uses of recycled water (including supplementation of locally harvested stormwater where required by this policy)

(b) All residential development must comply with the Building Sustainability Index (BASIX). Mixed use development must comply with the requirements detailed in Master Plan 2030.

(c) Individual water metering must comply with Sydney Water's "Multi-level individual metering guide"

4. Riparian protection

Development within 40 metres of a creek, river, lake or estuary must have regard for the 'Guidelines for riparian corridors on waterfront land' (dated July 2012, or subsequent revisions) issued by NSW Office of Water. Any necessary approvals required under the NSW Water Management Act 2000 must be obtained, and copies provided to the Authority.

5. Offsets

Where genuine physical constraints on site exist on a particular development site, the stormwater policy allows for offsets to be considered. Offsetting

- Can be applied to meet the water quality, water reuse and/or on-site detention requirements for the site
- Includes substitution of stormwater management measures on the proposed development site to another site and/or substitution of treating the proposed development site to treating an external catchment on the proposed development site
- Requires an alternate sub-catchment (within the same stormwater catchment) to be managed to achieve the same or better outcomes at an alternate site
- Requires that any offsets must be within the same stormwater catchment
- Must achieve the same or better outcomes than if no offset approach was undertaken.
- May be for the whole of, or part of, the requirements for the site
- Requires approval from SOPA
- Requires that all policy requirements are to be met including pollutant load removal objectives, rainwater reuse objectives, reductions in quantity and reductions in peak flow either on site or offset off-site
- Is catchment-based. Developments must meet the requirements for centralised stormwater harvesting catchments (shaded blue in Map 1), and non-water harvesting catchments (shaded red on Map 1)
- Is not allowed for construction management objectives. All sediment and erosion control measures must be undertaken on site.

Any developments considering the use of offsets are encouraged to seek early advice from Sydney Olympic Park Authority on the applicability and suitability of any proposed offset. Approval of any offset is at the discretion of SOPA.

Onsite solutions to stormwater management are generally preferred in non-water harvesting catchments to protect the Park's wetland and waterway habitats. For these catchments any offset must be upstream of the first receiving water downstream of the development.

If the offset is to occur on land that is not owned by the proponent of the development, approval from the landholder is required and must be provided with the development application submission.

6. Stormwater design excellence

To promote the application of innovative and sustainable stormwater management at Sydney Olympic Park design excellence criteria have been developed. The stormwater design excellence criteria are listed at Attachment 3.

7. Construction management

All developments, where the site is disturbed, shall provide appropriate Erosion and Sedimentation Control measures to control runoff, mitigate soil erosion and trap pollutants before they can reach downslope lands and receiving watercourses.

Soil erosion and sediment control measures shall be designed in accordance with the document Managing Urban Stormwater–Soils & Construction Volume 1 (2004) by Landcom.

Development applications must include a Draft construction management plan addressing the requirements set out in Attachment 2. The final Plan must be submitted with an application for a construction certificate.

8. Asset maintenance

All water sensitive design assets must be properly maintained on an ongoing basis. An establishment, handover and operation and maintenance plan must be developed and implemented for all water sensitive design assets and integrated water cycle management, including rainwater reuse assets, for the life of the asset:

(a) a Draft establishment, handover and operation and maintenance plan is to be submitted with the development application.
(b) the final plan and evidence of a maintenance contract for the maintenance of the stormwater management measures with a reputable and experience maintenance contractor is to be included in any application for an Occupation Certificate.

The Draft establishment, handover and operation and maintenance plan is to be prepared by the designer(s) of the system stormwater treatment, detention and reuse systems. The final plan must include a written signoff from the design engineer(s) responsible for the construction drawings of the system that the system has been constructed in accordance with the construction drawings or, where modified, has not adversely affected the performance of the system.

The contract must be an executed contract, and for a minimum of 5 years. Should the contract be terminated for any reason during this five-year period, a new contract covering these works must be established for the remainder of five-year period.

Copies of the plan and maintenance contract must be provided to the Authority:

(a) The plan must include routine checking, cleaning and servicing of all devices in accordance with the manufacturer's and/or designer's recommendations. Records of all maintenance activities undertaken must be kept and provided to the Authority annually by 30 June each year, and at any other times upon request.
(b) The maintenance contract must include quarterly maintenance visits. Records of the visits are to be submitted to the Authority

(c) The maintenance contract must be supplemented by an annual independent audit undertaken by a suitably qualified WSUD professional. The audit is to verify the condition of the treatment system(s), verify and document that the system(s) is working as intended, verify the system(s) has been cleaned adequately, verify there is no excessive build up of material in the system(s) and identify any issues with the treatment system(s) which require rectification for the system(s) to adequately perform its intended function. The Audit Report is to be submitted to the Authority by 30 June each year.

(d) The pollution retention efficiency of structural stormwater treatment measures must be maintained up to the design discharge and must not decrease with build-up of materials

(e) Where necessary system components become unavailable, an alternative system is required to be retrofitted into the development to achieve an equivalent pollutant reduction and water management outcome.

All constructed stormwater water quality and quantity assets that will be transferred to SOPA

(a) shall be maintained by the developer for a period of no less than 3 years post practical completion.

(b) Practical completion requires

- Written approval from the principal certifying authority (PCA).
- Certification by the PCA requires written sign off from the designer responsible for developing the construction drawings that the system has been constructed in accordance with the designs or if modified from the construction drawings that it has not compromised the performance of the stormwater management system
- Written confirmation from SOPA that practical completion has been achieved

(c) Are subject to inspections which may be held during the 3 year maintenance period.

(d) Are subject to an inspection to be held on completion of the 3 year maintenance period and prior to the transfer of ownership to SOPA.

(e) If the asset is not of an acceptable standard to SOPA at these inspections, the asset shall be rectified to the satisfaction of SOPA. This will include extension of the maintenance period.

(f) Require the proponent to submit inspection and asset handover checklists for the assets which are to be based on the Healthy Waterways Guideline Series for Transferring Ownership of Vegetated Assets (latest version)

9. Information to be submitted with a development application:

The following information is to be submitted with a development application:

(a) Integrated water cycle management plan, including a water balance report. This Plan is to clearly demonstrate how the proposal meets the policy objectives and specifically how the proposal achieves the outcomes required in Attachment 1 and Attachment 2 of this Policy.

The integrated water cycle management plan is to be prepared as early as possible in the design process, by a suitably qualified professional such as a registered civil engineer with a minimum of five years demonstrated professional experience in the field of stormwater management, and where relevant, a suitably qualified professional with a minimum of five years demonstrated professional experience in the field of Water Sensitive Urban Design

Refer to the SOPA stormwater technical guidelines for further details on design, modelling and reporting requirements.

(b) All calculations, assumptions and modelling used to develop the Integrated Water Cycle Management Plan and water balance report, including items specified in the checklist at Appendix 4 of this Policy, and the following electronic files:

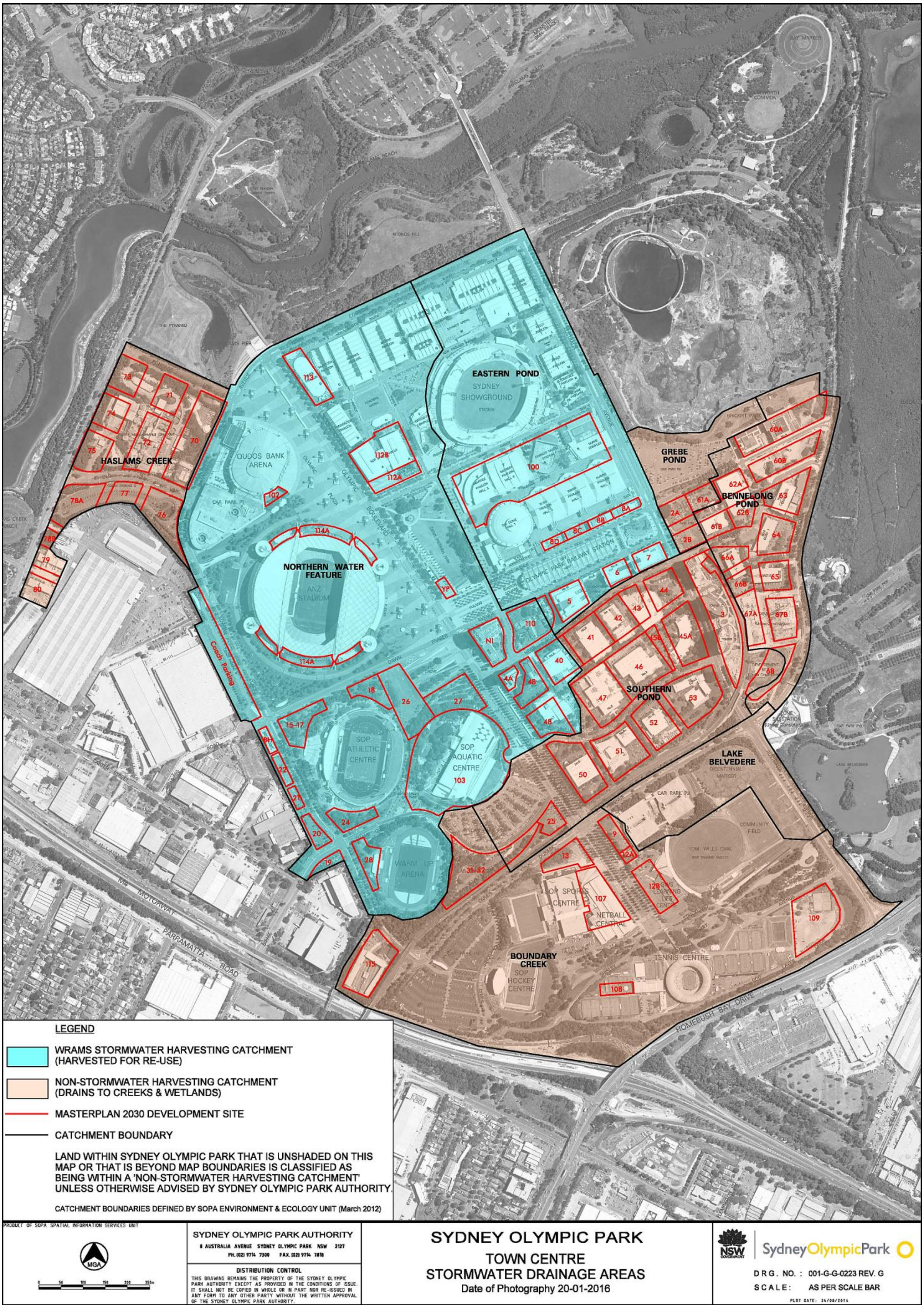
- Electronic copy of MUSIC water quality model and summary of results in report
- Electronic copy of hydraulic model (Drains or equivalent) and summary of results in report
- Electronic dwg file of the sub-catchments and proposed stormwater system including all detention, reuse and treatment elements

(c) Draft construction management plan addressing the requirements set out in Attachment 2 of this policy

(d) Draft establishment, handover and operation and maintenance plan that addresses requirements of this policy (clause 8 above).

(e) A completed checklist (as per Attachment 4) that demonstrates compliance with Policy requirements.

Map 1 Town Centre Stormwater Drainage Areas



Attachment 1: Water quality and water quantity targets

1. All development must as a minimum meet the following baseline water quality targets:

    - 45% reduction in the mean annual load of Total Nitrogen*
    - 65% reduction in the mean annual load of Total Phosphorus*
    - 85% reduction in the mean annual load of Total Suspended Solids*
    - 90% reduction in the mean annual load of hydrocarbons*
    - 95% reduction in the mean annual load of gross pollutants*

2. Development within a Sydney Olympic Park non-stormwater harvesting catchment (shaded red in Map 1) must strive to the maximum extent practicable, to meet the following water quality targets:

    - 65% reduction in the mean annual load of Total Nitrogen*
    - 85% reduction in the mean annual load of Total Phosphorus*
    - 90% reduction in the mean annual load of Total Suspended Solids*
    - 90% reduction in the mean annual load of hydrocarbons*
    - 95% reduction in the mean annual load of gross pollutants*
    - 10% reduction in the mean annual runoff volume from the entire site*

    (* Note that all targets above are to be measured as a reduction from the developed site without any management measures (treatment, reuse, etc) compared to the developed site with management measures).

3. A suitable drainage design is to be developed for the site which safely and effectively conveys stormwater through and from the site to the trunk drainage system. Drainage within the development is to be designed to the following standards:

    (a) All internal piped drainage systems are to be designed to cater for the 1 in 20 year ARI design event and is to discharge to SOPA's drainage system.

    (b) All Roof drainage is to be designed for the 1 in 100 year ARI event.

    (c) All surface runoff in the 1 in 100 year ARI event, including any external discharge onto the site, must have a safe passage through the site along an internal pathway, public domain or road system. Depth x velocity for all overland flow paths must be limited to less than 0.4 m^2/s

    (d) All habitable floor levels are to have the following minimum freeboard requirements:

    - 0.5m above public drainage infrastructure, creeks and channels
    - 0.3m above internal overland flow paths

    (e) On site detention is to be provided to attenuate peak flows from the development such that both the:

    - 1 in 1 year ARI event post development peak discharge rate is equivalent to the pre development (un-developed catchment) 1 in 1 year ARI event
    - 1 in 100 year ARI event post development peak discharge rate is equivalent to the pre development (un-developed catchment) 1 in 100 year ARI event

    (f) Note that detention storage is additional to any reuse storage requirements

4. A Drains model is to be submitted with the development application

Attachment 2: Construction Management Plan requirements

Erosion and sediment management

(a) All works involving soil disturbance:

Erosion, sediment and dust control measures must be installed and maintained throughout the works in accordance with the provisions of the “Blue Book” Part 1. [Landcom (2004) Managing Urban Stormwater: Soils and Construction, 4th edition]

(b) Cleared area 250-2500m^2 OR where soil stockpiles will be in place for over 10 days:

An Erosion and Sediment Control Plan prepared by an appropriately qualified person, must be submitted with an application for development consent, and implemented throughout the works. The Plan must be prepared in accordance with the provisions of the “Blue Book” Part 1. [Landcom (2004) Managing Urban Stormwater: Soils and Construction, 4th edition]. The plan must consider likely stages of the works and provide for appropriate control of sediment and erosion for each stage.

The plan must contain a daily and weekly site inspection checklist consistent with IECA Best Practice Erosion and Sediment Control documents.

(c) Cleared area >2500m2:

A Soil and Water Management Plan prepared by an appropriately-qualified person must be submitted with an application for development consent, and implemented throughout the works. The Plan must be prepared in accordance with the provisions of the “Blue Book” Part 1. [Landcom (2004) Managing Urban Stormwater: Soils and Construction, 4th edition]. The plan must consider likely stages of the works and provide for appropriate control of sediment and erosion for each stage. This Plan shall show:

- location and extent of all necessary sediment and erosion control measures for the site
- catchment plan
- sediment basin(s) locations including details showing how runoff from the entire site will be directed to the sediment basin(s)
- All relevant details and calculations of the sediment basins including sizes, depths, flocculation, outlet design, all relevant sections, pump out systems, and depths
- all details of basement and other excavation pump out and dewatering treatment systems including flocculation and any proposed discharge from the site from dewatering and pump out systems
- identification and management of any stormwater run-on to the site from adjacent sites
- location of any temporary stockpiles (soil, spoil, top soil or otherwise) and accompanying sediment and erosion control measures
- location and details of all vehicle wash down bays and associated erosion and sediment control measures such as earthen bunds
- A daily and weekly site inspection checklist consistent with IECA Best Practice Erosion and Sediment Control documents

A sediment basin is required for every catchment discharging from the site as part of any Soil and Water Management Plan. The sediment basin is to be designed

- According to the NSW Blue Book (section 6.3.4 and Appendix E). The calculations of the sediment basin size must be submitted with the Development Application.
- Type D soils (unless otherwise demonstrated by an analysis of site soils by a qualified geotechnical consultant and which must be submitted with the development application).
- For all events up to the peak flow rate from the 1 in 10 year ARI event for the site for the 5 day rainfall event
- A gypsum flocculent is to be added to the sediment basin in accordance with Appendix E of the Blue Book (note that Alum is not to be used as a flocculent at Sydney Olympic Park).

In accordance with the Blue Book, some small flat sites or sites with minimal stormwater discharge from the site during construction, may not require a sediment basin. If a sediment basin is not being proposed it must be demonstrated that the average annual soil loss from the total area of land disturbance is less than 150 cubic metres per year. Soil loss must be calculated in accordance with Appendix A of the Blue Book. In such circumstances, alternate measures must be employed to protect the receiving waters.

Attachment 3: Stormwater design excellence

To achieve design excellence the development must as a minimum achieve the following:

1. Water quality targets
    - 65% reduction in the mean annual load of Total Nitrogen*
    - 85% reduction in the mean annual load of Total Phosphorus*
    - 90% reduction in the mean annual load of Total Suspended Solids*
    - 90% reduction in the mean annual load of hydrocarbons*
    - 95% reduction in the mean annual load of gross pollutants*
    - Landscape based treatment system
2. Water quantity reduction targets
    - 10% reduction in the mean annual runoff volume from the entire site*
3. Water conservation targets
    - Minimum of 0.5kL of rainwater storage per apartment/dwelling and 1L per 100 sqm of net residential floor area connected as the priority supply to the non-potable demands for the development
    - Connection to WRAMS as a back-up for non-potable water demand

** Note that all targets above are to be measured as a reduction from the developed site without any management measures (treatment, reuse, etc) compared to the developed site with management measures.*

Offsetting may be used to meet the stormwater design excellence criteria.

Attachment 4: Policy compliance checklist

Policy requirement	Policy requirement met ? – yes/no	Notes
1. Maximise harvest and reuse of roof-water		
(a) Locally-harvested rainwater must be the primary source of non-potable water for developments located within a Sydney Olympic Park non-stormwater harvesting catchment (shaded red on Map 1)		
(b) At least 90% of roof area shall be connected to rainwater storage(s) which supply non-potable water reuse from this source,		
(c) Rainwater supply schemes must be supplemented with recycled water as a back-up to rainwater supply schemes where connection to the Park's WRAMS recycled water supply is available.		
(d) A minimum of 0.25 kL rainwater storage is to be supplied per dwelling and an additional 1 kL of rainwater storage is to be supplied per 100m^2 of non-residential net floor area.		
(e) Refer to accompanying SOPA guidelines for further details on rainwater tank modelling requirements.		
(f) Rainwater tank storage does not contribute to on site detention volume and cannot be used to offset on site detention requirements		
(g) Where non-potable demand within a development site is low, alternative uses for roof water such as landscaping, roof gardens, as well as off-site re-use, should be considered so as to minimise the volume of stormwater discharged to local waterways.		
(h) Developments located within a Sydney Olympic Park stormwater harvesting catchment (shaded blue on Map 1) must meet their non-potable water demand from non-potable water sources, including WRAMS recycled water and/or locally harvested rainwater.		
2. Minimise volume and frequency of stormwater discharge from hardstand areas such as paving, driveways and car parks, and roofs and maximise quality of any stormwater discharged.		
(a) All stormwater discharged from the site is to meet the • water quality pollutant load reduction targets as outlined in Attachment 1. • water quantity volume reduction targets and peak flow reduction targets as outlined in Attachment 1.		
(b) Design of landscaped and paved areas must incorporate water sensitive urban design elements and pollution control devices including but not limited to:		
• Appropriate stormwater management measures as detailed in Master Plan 2030		
• Retaining a minimum of 20% of the site's open space area as deep soil. Areas included as deep soil are to have a minimum depth of two metres. Consolidate areas of deep soil within sites and between adjacent sites to increase the benefits		
• Minimising impervious areas that are directly connected to the stormwater system. Runoff from impervious areas such as driveways, paving and rainwater tank overflows should be directed onto landscaped areas designed to accept such flows		
• Removal of gross pollutants, sediments and nutrients prior to stormwater discharge to the trunk drainage system, through use of devices such as bioretention systems, wetlands, swales, sand filters, gross pollutant traps, and litter baskets.		
• Installation of oil and grease traps in surface and basement carparks		
• Using plant species native to the Sydney region in water sensitive urban design features and associated landscaping, to avoid spread of weed propagules to downstream wetlands.		
3. Water conservation		
(a) Connect all new development to Sydney Olympic Park's recycled water system, where available, for all approved uses of recycled water (including supplementation of locally harvested stormwater where required by this policy)		
(b) All residential development must comply with the Building Sustainability Index (BASIX). Mixed use development must comply with the requirements detailed in Master Plan 2030.		
(c) Individual water metering must comply with Sydney Water's "Multi-level individual metering guide"		
4. Riparian protection		
Development within 40 metres of a creek, river, lake or estuary must have regard for the 'Guidelines for riparian corridors on waterfront land' (dated July 2012, or subsequent revisions) issued by NSW Office of Water. Any necessary approvals required under the NSW Water Management Act 2000 must be obtained.		
5. Offsets		
Where genuine physical constraints on site exist on a particular development site, the stormwater policy allows for offsets. Offsetting:		
(a) Can be applied to meet the water quality, water reuse and/or on-site detention requirements for the site		

Policy requirement	Policy requirement met ? – yes/no	Notes
(b) Includes substitution of stormwater management measures on the proposed development site to another site and/or substitution of treating the proposed development site to treating an external catchment on the proposed development site		
(c) Requires an alternate sub-catchment (within the same stormwater catchment) to be managed to achieve the same or better outcomes at an alternate site		
(d) Requires that any offsets must be within the same stormwater catchment		
(e) Must achieve the same or better outcomes than if no offset approach was undertaken.		
(f) May be for the whole of, or part of, the requirements for the site		
(g) Requires approval from SOPA		
(h) Requires that all policy requirements are to be met including pollutant load removal objectives, rainwater reuse objectives, reductions in quantity and reductions in peak flow either on site or offset off-site		
(i) Is catchment-based. Developments must meet the requirements for centralised stormwater harvesting catchments (shaded blue in Map 1), and non-water harvesting catchments (shaded red on Map 1)		
(j) Is not allowed for construction management objectives. All sediment and erosion control measures must be undertaken on site.		
6. Stormwater design excellence		
Outline whether and how the development meets design excellence criteria		
7. Construction management		
All developments, where the site is disturbed, shall provide appropriate Erosion and Sedimentation Control measures to control runoff, mitigate soil erosion and trap pollutants before they can reach downslope lands and receiving watercourses.		
Soil erosion and sediment control measures shall be designed in accordance with the document Managing Urban Stormwater–Soils & Construction Volume 1 (2004) by Landcom.		
Development applications must include a draft construction management plan addressing the requirements set out in Attachment 2. The final Plan must be submitted with an application for a construction certificate.		
8.Asset maintenance		
All water sensitive design assets must be properly maintained on an ongoing basis. An establishment, handover and operation and maintenance plan must be developed and implemented for all water sensitive urban design assets and integrated water cycle management, including rainwater reuse assets, for the life of the asset.		
(a) a Draft establishment, handover and operation and maintenance plan is to be submitted with the development application. the final plan and evidence of a maintenance contract for the maintenance of the stormwater management measures with a reputable and experience maintenance contractor is to be included in any application for an Occupation Certificate.		
(b) The Draft establishment, handover and operation and maintenance plan is to be prepared by the designer(s) of the system stormwater treatment, detention and reuse systems.		
(c) The final plan must include a written signoff from the design engineer(s) responsible for the construction drawings of the system that the system has been constructed in accordance with the construction drawings or, where modified, has not adversely affected the performance of the system.		
(d) The plan must include routine checking, cleaning and servicing of all devices in accordance with the manufacturers and/or designer's recommendations. Records of all maintenance activities undertaken must be kept and provided to the Authority annually by 30 June each year, and at any other times upon request.		
(e) The maintenance contract must include quarterly maintenance visits. Records of the visits are to be submitted to the Authority		
(f) The maintenance contract must be supplemented by an annual independent audit undertaken by a suitably qualified WSUD professional. The audit is to verify the condition of the treatment system(s), verify and document that the system(s) is working as intended, verify the system(s) has been cleaned adequately, verify there is no excessive build up of material in the system(s) and identify any issues with the treatment system(s) which require rectification for the system(s) to adequately perform its intended function. The Audit Report is to be submitted to the Authority by 30 June each year.		
(g) The pollution retention efficiency of structural stormwater treatment measures must be maintained up to the design discharge and must not decrease with build-up of materials		
(h) Where necessary system components become unavailable, an alternative system is required to be retrofitted into the development to achieve an equivalent pollutant reduction and water management outcome.		
(i) All constructed stormwater water quality and quantity assets that will be transferred to SOPA shall be maintained for a period of no less than 3 years post practical completion by the developer.		

Policy requirement	Policy requirement met ? – yes/no	Notes
9. Information to be submitted with a development application:		
A. Integrated Water Cycle Management Plan including a water balance report, developed in accordance with this Policy, and all calculations, assumptions and modelling used to develop this Plan, including:		
(a) Clearly demonstrate how the proposal meets the policy objectives and specifically how the proposal achieves the outcomes required in Attachment 1 of the Policy		
(b) Provide a description of how all stormwater generated on the site will be managed and include a water balance report.		
(c) Assessment of the impact of flows on the receiving environment, the capacity of downstream infrastructure to manage such flows, and any required enhancement works proposed to be implemented		
(d) Show all stormwater catchments for the site including an assessment of whether the site is in a SOPA stormwater harvesting or non-stormwater harvesting catchment as per Map 1		
(e) Include a site layout and drainage plan showing the location of each element of the proposed stormwater system and treatment train		
(f) Show all stormwater drainage system elements for the site including long sections for all drainage elements including hydraulic grade line calculations		
(g) Show all elements of the detention system including sufficient sections and details demonstrating how the system is to operate.		
(h) Confirm the entire site is included in the detention sizing calculations, including land to be dedicated to SOPA (such as future public roads, community facilities and the like)		
(i) Show all elements of the stormwater treatment system including sufficient sections and details demonstrating how the system is to operate and the diversion flow rate into the treatment system.		
(j) Confirm the entire site is included in the water quality sizing calculations including land to be dedicated to SOPA (such as future public roads, community facilities, and the like)		
(k) Confirm on site detention systems are not to be included in the calculations for water quality		
(l) Provide justification of why each element of the treatment system has been selected over alternate approaches.		
(m) Provide details of all stormwater connections to the existing SOPA stormwater system, including the capacity of downstream infrastructure to manage such flows and any upgrades required.		
(n) Provide details of the overland flow system and calculations to demonstrate the capacity to safely convey flow through the site including DxV calculations		
(o) Provide all calculations showing how the intent of the SOPA Stormwater Management and Water Sensitive Urban Design Policy is met		
(p) Impervious percentages for all catchments and justification for the adoption of these impervious percentages using measurements off the concept plan		
(q) All details of the treatment system as entered into MUSIC (e.g. low flow and high flow bypass, filter size, extended detention, infiltration rate, hydraulic conductivity, rate, etc.). All parameters need to be consistent with the MUSIC modelling guideline including;		
• For rainwater tanks and reuse schemes the user demand profile that has been adopted and the size of the rainwater tank (kL)		
• Summary of the results (Flow, TSS, TP and TN) without any treatment measures ("Do Nothing")		
• Summary of the results (Flow, TSS, TP and TN) with proposed treatment measures for each option tested		
• Summary of the results (Flow, TSS, TP and TN) with proposed treatment measures for proposed preferred option including comparison of results with the "Do Nothing" option including a total summary of the treatment (kg/yr and % reduction) and for each component of the treatment system (kg/yr and % reduction)		
• For any parameter which deviates from the default recommended value as outlined in the MUSIC modelling guideline documentation of the values adopted and justification for the values adopted		
• Electronic copy of the MUSIC water quality model and summary of results in report		
(r) Electronic copy of the hydraulic model (Drains or equivalent) and summary of results in report		
(s) Plans showing all of the proposed management measures to meet the objective including building hydraulics, drainage, contours and catchments		
(t) An electronic dwg file of the sub-catchments and proposed stormwater system including all detention, reuse and		

Policy requirement		Policy requirement met ? – yes/no	Notes
	treatment elements		
B.	Description and justification of any proposed offsets and how the proposed approach meets the outcomes required in Attachment 1 (only required if offsets are proposed)		
C.	Draft construction management plan addressing the requirements set out in Attachment 2 of this policy. This is to include either an Erosion and Sediment Control Plan or Soil and Water Management Plan (as applicable, and based on the NSW 'Blue Book'.) The Plan is to contain the following information:		
	(a) Sediment and erosion control calculations based on the NSW "Blue Book" and summary of results in report		
	(b) The sediment and erosion control plan includes calculation of average slopes of disturbed areas		
	(c) The sediment and erosion control plan includes calculation soil classification group		
	(d) The sediment and erosion control plan includes calculation of Emerson Class Number		
	(e) The sediment and erosion control plan includes calculation of duration and area of soil disturbance		
	(f) The sediment and erosion control plan includes assessment of potential waterway and receiving water impact		
	(g) The sediment and erosion control plan includes documentation of any external catchments entering the site		
	(h) The sediment and erosion control plan includes calculation worksheet for sediment basins and justification for sizing of basins		
	(i) The sediment and erosion control plan includes the following as a minimum • location and direction of temporary drainage showing flows into the sediment basin • Identification of any problematic soils including acid sulphate soils • Identification of key environmental values on site (e.g. existing trees to be retained, habitat areas and/or existing drainage lines of value) • Construction access points and control measures at those locations • Site contour map including existing, and proposed contours • o Location of temporary stockpiles		
D.	Draft establishment, handover and operation and maintenance plan that addresses requirements of Clause 8 of this policy and applies to all stormwater management devices including water quality, detention and reuse components		
E.	A completed copy of this checklist		

Attachment 5: Glossary

Best practice

Structural and planning measures used to manage urban stormwater runoff to mitigate the impacts of urban development on the environment. These measures are the most effective proven measures currently available and when used singly or in combination are able to achieve stormwater pollutant and/or quantity reductions to meet or exceed regulatory requirements.

Bioretention systems

Bioretention systems are vegetated systems that filter polluted stormwater through a soil media. To treat stormwater bioretention systems use traditional filtration processes as well as uptake of pollutants by plants. Bioretention systems are also referred to as raingardens.

Blue Book

Blue book is the common name used to refer to (the former) Landcom's "*Managing urban stormwater: soils and construction Volume 1*" 4th Edition, 2004. The Blue Book provides guidance on mitigating the impacts of land disturbance activities on soils, landforms and receiving waters by focussing on erosion and sediment control.

Capture and reuse of runoff

Refer "harvesting"

Cleared area

Cleared area refers to the removal of the existing surface (whether vegetated or urban development) such that the underlying natural soils, fill material or waste material are exposed. Cleared areas also refers to any construction works to any areas that expose any materials which are able to then be entrained in stormwater and discharged from the site in runoff.

Deep soil

Deep soil zones are areas of natural ground with relatively natural soil profiles within a development. Deep soil zones should be designed in such a way that is free of conflicts with infrastructure, services and drainage pipes.

Directly connected

A directly connected stormwater system is when runoff from an impervious surface area drain from a collection point (pit, grate, gutter etc) to a stormwater conveyance system consisting of pipes and culverts to a stormwater receiving water without any buffer between the impervious catchment area and the receiving water.

Frequency of stormwater discharge

Frequency of stormwater discharge refers to the number of times that stormwater runoff leaves the site. It is commonly expressed as number of days of stormwater runoff from a site per year.

Gross pollutants

Gross pollutants refers to large particles (e.g. gravel, large sand particles), anthropogenic litter, and organic debris (leaf litter, etc).

Harvesting

Harvesting refers to the capture of roofwater (also referred to as rainwater) or stormwater in a storage system and treatment of the captured water for reuse to substitute potable water.

Hydraulic grade line

A line representing the pressure head along a pipeline, corresponding to the effective water surface elevation in the piped portions of the stormwater drainage systems.

Impervious area

The area within a drainage catchment that does not allow water to enter into natural ground and includes roof surfaces, concrete surfaces, asphalt surfaces, paved surfaces. Permeable paving is not considered impervious area in this context.

Independent audit

An independent audit is an examination of the maintenance records, maintenance practices, and maintenance processes of the maintenance contractor. "Independent" refers to the fact that the auditor is not an employee or have any vested interest in the asset or the maintenance contractor undertaking the maintenance and hence is "independent."

Landscaped areas

Landscaped areas in the context of this policy refers to areas which include planting and soils to support the planting and which are permeable and allow water to enter into the ground.

Landscape based treatment systems

A landscape based treatment system is one which is in a landscaped area and includes a stormwater management measure which reduces stormwater pollutants, or stormwater runoff volumes, or stormwater runoff peak flow rates or a combination of these. A landscape based treatment system is planted and contains a soil media to support the planting.

Locally harvested rainwater

Locally harvested rainwater in the context of this policy refers to the capture of runoff from roofs which are on the subject development site and which retain the rainwater in a storage for subsequent reuse for non-potable uses.

Mean annual load

The long term average yearly amount of pollutants discharged from a defined area, typically a catchment, expressed as kg/yr.

Mean annual runoff

The long term average yearly runoff discharged a defined area, typically a catchment, expressed as ML/yr (or kL/yr for small sites).

Net floor area

Net floor area means the sum of the areas of each floor of a building where the area of each floor is taken to be the area within the inside face of the external walls, excluding the following:

- Columns, fin walls, sun control devices, awnings, and any other elements, projections or works outside the general lines of the outer face of the external wall;
- lift towers, cooling towers, machinery and plant rooms and ancillary space and vertical air-conditioning ducts;
- car-parking and any internal access thereto;
- Space for loading and unloading of goods;
- Internal public arcades and thoroughfares, terraces, balconies with outer walls less than 1400 millimetres high and the like.

Non-potable demand

Non potable demands at Sydney Olympic Park are defined as approved uses of the Sydney Olympic Park recycled water scheme and include irrigation, car washing, toilets, water features, washing machines and cooling towers.

Non-potable water sources

Non potable water sources in the context of this policy refer to recycled water from WRAMs or on-site harvested rainwater.

Non-water harvesting catchments:

The non stormwater harvesting catchments are defined as those areas shown on the map in Attachment 1. They are catchments within SOPA that do not contribute to the current supply of stormwater to the WRAMS scheme. These catchments drain directly to the receiving water without any interception and diversion into the WRAMS storage.

On-site

Within the boundary of the development site that is the subject of the approval application

On site detention

The temporary detaining of stormwater on the development site to ensure that there is no increase in runoff peak flow rates due to impervious surfaces.

Paved areas

Paved areas are areas at the ground level (such as courtyards, plazas, footpaths, etc) which include 'hard landscaping' and are impermeable and prevent rainfall from entering natural ground. For the purpose of this policy permeable pavers are not considered paved areas.

Pollution retention efficiency

Pollution retention efficiency is the ability of a treatment measure to capture and store pollutants within the treatment system as intended. For example a gross pollutant trap which captures pollutants in a sump, has no capacity for pollution capture and storage if the sump is full and hence is unable to perform as per its design intent.

Post construction:

Post construction is the period once construction has been completed and the development site is being used for its intended purpose. For a dwelling, office, retail area and other similar development type post construction commences at the point when an occupation certificate is issued. For development types which do not require an occupation certificate, such as a road, carpark, etc this is when the facility is used for its intended purpose.

Practical completion

Practical completion" means when the relevant stormwater management works are complete except for minor omissions and defects that do not prevent the stormwater management works from being reasonably capable of being used for their intended purpose. Practical completion requires written agreement from SOPA.

Rainwater

Rainfall which drains from a surface area such as a roof, road, paved area, etc.

Rainwater supply schemes

Systems which use stored rainwater to different non-potable end uses (e.g. toilet flushing, irrigation)

Rainwater storage

Refer storage

Recycled water

In the context of SOPA recycled water refers to the supply of treated stormwater and wastewater supplied by the WRAMS water reuse scheme for non-potable end uses.

Runoff

The portion of precipitation on a drainage area or surface that is discharged from the drainage area to drainage.

Receiving waters

A waterway (creek, river, stream etc.), lake, pond, wetland, estuary, ocean or other water body into which stormwater or wastewater is discharged.

Sediments

Sediments are soil particles consisting of sands, silts and clay particles. Sediments also contain other pollutants bound to the sediment particles such as nutrients and heavy metals.

Sensitive receiving waters

Highly valued receiving waters, which have significant ecological values. These ecological value of sensitive receiving water can be significantly impacted by changes in their upstream catchments due to urban development during or after construction.

Storage

Tanks used to collect and store rainfall from household roofs for subsequent reuse.

Stormwater

Rainfall which drains from a surface area such as a roof, road, paved area, etc.

Treatment train

A series of stormwater treatment measures located in a catchment to provide a staged approach to removal of stormwater pollutants from runoff

Trunk drainage

The trunk drainage system includes kerbs and channels, roadside channels, inlets, underground drainage, junction pits or access chambers and outlets designed to fully contain and convey a design minor stormwater flow of specified Average Recurrence Interval (ARI).

Water balance

A water balance is a mass balance accounting for water entering, accumulating and exiting a system. It includes rainwater, potable mains water, evapotranspiration and infiltration, wastewater and stormwater.

WRAMS

Water Reclamation and Management Scheme (WRAMS) collects, stores and treats stormwater and wastewater for reuse for non-potable uses for urban development and irrigation within SOPA and adjacent areas.

Sydney Olympic Park Authority
Stormwater Management and Water Sensitive Urban Design Policy

Guidelines for policy implementation

Sydney Olympic Park Authority has produced a set of technical guidelines to assist in implementation of the Stormwater Management and Water Sensitive Urban Design Policy. The Policy should be read in conjunction with these Guidelines.

Guidelines may be accessed on the website of the Sydney Olympic Park Authority: www.sopa.nsw.gov.au/resource_centre/publications

Guidelines:

1. MUSIC Modelling Guideline
2. Water Sensitive Urban Design Guideline
3. Rainwater Tank Guideline

Sydney Olympic Park
MUSIC Modelling Guideline

A guideline under the Sydney Olympic Park Authority
Stormwater Management and Water Sensitive Urban Design Policy

Prepared by Knights and McAuley

October 2016

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Table of Contents

Related documents

This Guideline is one of a set of technical guidelines produced by Sydney Olympic Park Authority to assist proponents in implementing the Stormwater Management and Water Sensitive Urban Design Policy. Each Guideline covers a different aspect of policy implementation. The Policy should be read in conjunction with these Guidelines.

Guidelines may be accessed on the website of the Sydney Olympic Park Authority: www.sopa.nsw.gov.au/resource_centre/publications

1 INTRODUCTION

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC) can be used by designers, consultants, developers and Sydney Olympic Park Authority to undertake conceptual design of stormwater treatment systems. This document provides guidance on how MUSIC is to be applied within Sydney Olympic Park. It includes recommended input parameters and configurations which are acceptable to Sydney Olympic Park Authority.

This guideline is provided to ensure consultants, developers and Sydney Olympic Park Authority have a consistent and uniform approach to stormwater quality and harvesting modelling within Sydney Olympic Park. This Guideline is provided to allow practitioners to conceptualise stormwater treatment systems to meet requirements of the Sydney Olympic Park Authority *Stormwater Management and Water Sensitive Urban Design Policy*. The Guideline provides specific guidance on rainfall and evaporation inputs, source node selection, rainfall runoff parameters, pollutant generation parameters and stormwater treatment nodes.

Applicants for development approval, who are required to design stormwater treatment systems and prepare a WSUD strategy, should refer to this MUSIC modelling guideline to ensure that any MUSIC modelling is undertaken in accordance with Sydney Olympic Park Authority's requirements. Any MUSIC models that are not consistent with this guideline must justify the differences in parameters and/or assessment methods.

Note that this Guideline is not intended to replace the MUSIC User Guide, however provides additional information relevant to Sydney Olympic Park.

This Guideline should be read in conjunction with other technical Guidelines produced by Sydney Olympic Park Authority to support implementation of the Stormwater Management and Water Sensitive Urban Design Policy. These Guidelines are available on the Authority's website.

2 MUSIC MODEL SETUP

There are several steps to be undertaken prior to running a MUSIC model network, as summarised in Figure 1. These steps include:

- Selection of appropriate meteorological data (rainfall and evaporation inputs);
- Defining catchment areas (source nodes) to be incorporated into the model;
- Input of soil properties (rainfall runoff properties); and
- Input of pollutant generation characteristics for selected source nodes.

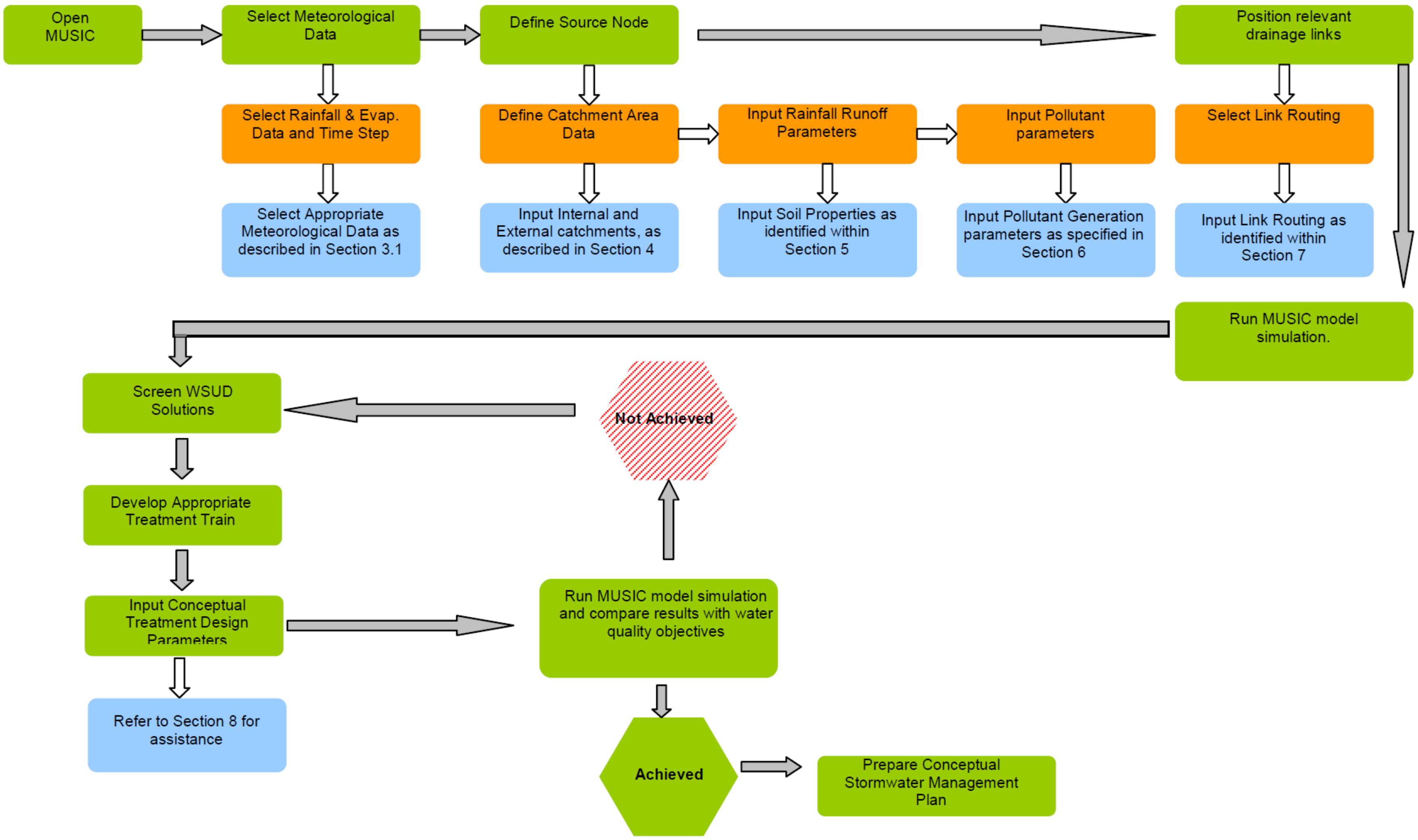

Figure 1: Schematic of MUSIC modelling process

3 RAINFALL AND EVAPORATION INPUTS

Sydney Olympic Park is located between the Sydney CBD and Parramatta, on the southern side of the Parramatta River estuary. There is a rainfall gauge at Sydney Olympic Park (066212 – Archery Centre) however it has a relatively short rainfall record. Other nearby rain gauges with longer records are listed in Table 1. All of the daily rainfall gauges in the vicinity of Sydney Olympic Park are shown in Figure 2.

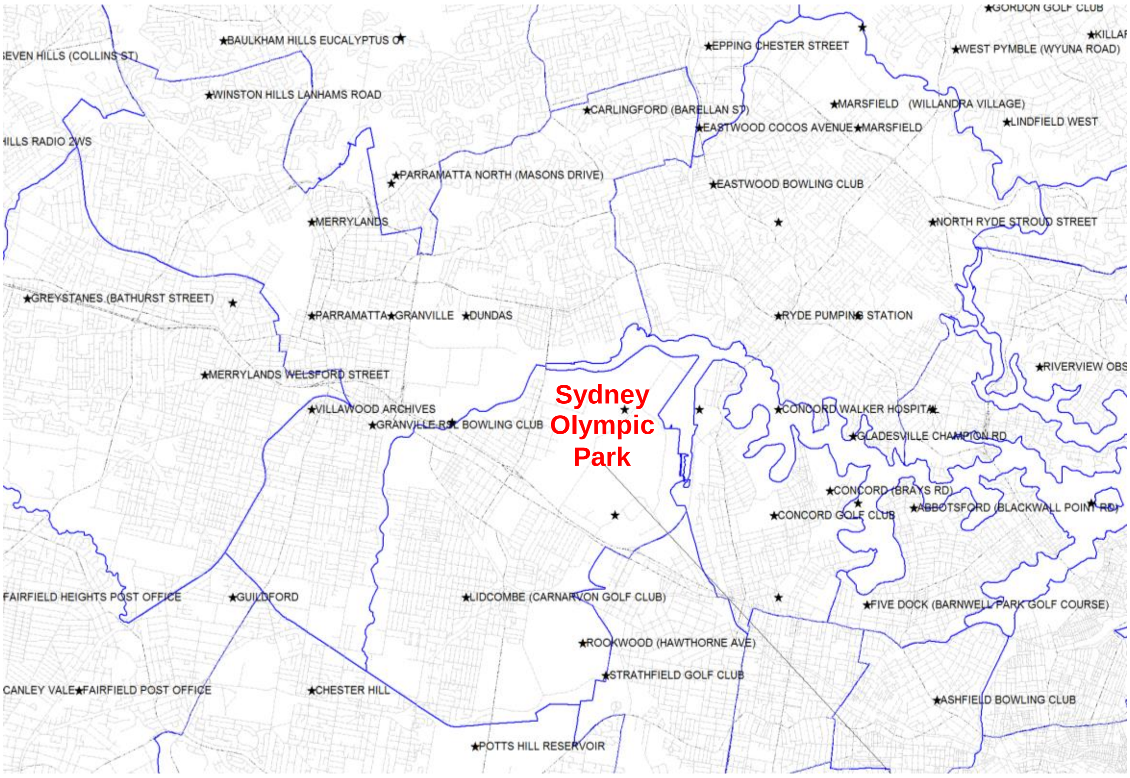

Figure 2: Daily rainfall gauges in the vicinity of Sydney Olympic Park

Table 1: Daily rainfall stations near Sydney Olympic Park

Station number	Station name	Distance from Sydney Olympic Park	Length of rainfall record	Mean annual rainfall (mm)
066013	Concord Golf Club	3 km	1930-	1123
066134	Granville Shell Refinery	3 km	1959-2014	889
066057	Ryde Pumping Station	4 km	1894-1978	978
066070	Strathfield Golf Club	5 km	1952-	938
066087	Eastwood Bowling Club	5 km	1955-2004	1098
066124	Parramatta North (Masons Drive)	7 km	1965-	970

Based on the local rainfall gauges listed above, it is expected that the mean annual rainfall at Sydney Olympic Park would be approximately 1,000 mm/year.

Stormwater runoff (represented as surface runoff and baseflow) is generated in MUSIC through the interaction of rainfall, evapotranspiration and the MUSIC Rainfall-Runoff Model (see MUSIC User Manual for full description of Rainfall-Runoff Model). The following sections outline Sydney Olympic Park Authority's preferred rainfall and evapotranspiration datasets to be used when undertaking stormwater quality assessments.

3.1 Rainfall data for hydrologic modelling

Sydney Olympic Park Authority requires the following approach to rainfall simulation be adopted for hydrologic assessment modelling (i.e. stormwater harvesting and stormwater storage design including rainwater tank sizing):

- Continuous simulation of a minimum of 20 years should be used; and
- A daily time step should be utilised for simulating rainwater/stormwater storage sizes and estimating supply reliability.

The rainfall gauges shown in Table 1 were further examined to compare the average monthly rainfall at each gauge. This is shown in Figure 3. This shows that each of the gauges is similar, however Concord Golf Club and Eastwood Bowling Club stand out in some months.

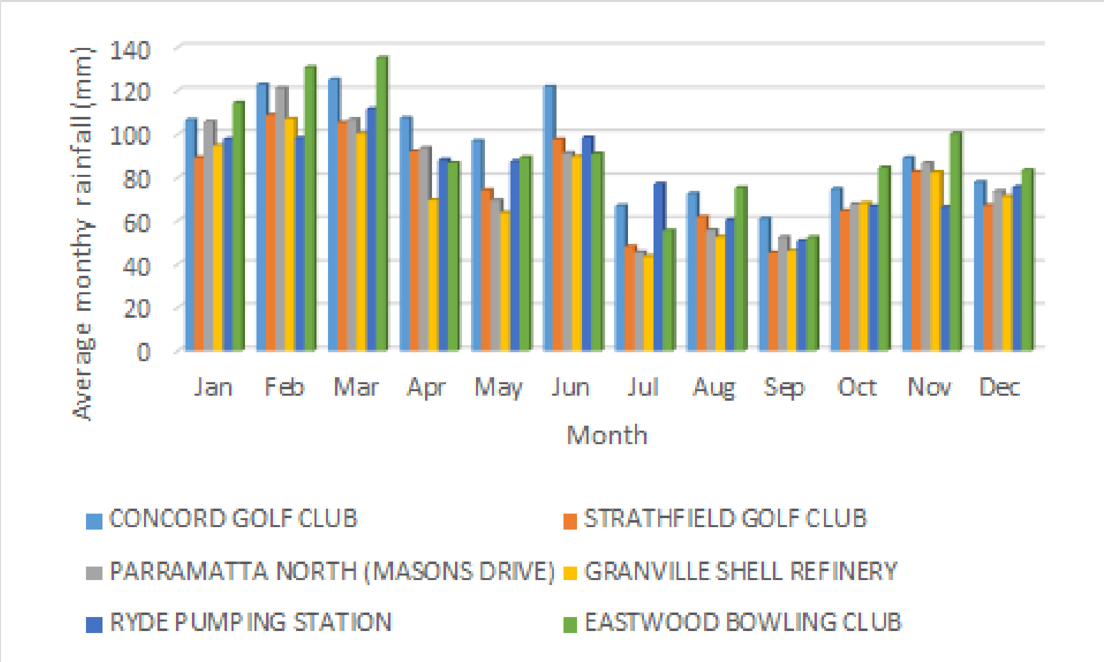

Figure 3: Average monthly rainfall at rain gauges around Sydney Olympic Park

Overall, the Ryde Pumping Station gauge (066057) is recommended as the most appropriate for Sydney Olympic Park. This has:

- Close proximity to Sydney Olympic Park
- A relatively long rainfall record, extending from 1894-1978
- The available data has no significant gaps
- Mean annual and average monthly rainfall consistent with other gauges in the area

To provide a consistent approach to modelling in Sydney Olympic Park, it is recommended that the

- **Ryde Pumping Station gauge (066057) should be used in MUSIC whenever a daily time step is required (e.g. for modelling rainwater tanks for water reuse)**.
- As there is a short gap in the data in 1916 and another in 1975, **therefore it is recommended that a time period from 1/01/1917 to 31/12/1974 should be used (58 years) for this rainfall station**

3.2 Rainfall data for water quality modelling

Sydney Olympic Park Authority requires the following approach to rainfall simulation be adopted for stormwater quality modelling:

- Continuous simulation of a minimum of 5 years should be used; and
- A six (6) minute time step is to be utilised as this allows for the appropriate definition of storm hydrograph movement through small-scale stormwater treatment processes such as vegetated swales and bioretention systems.

In order to provide a consistent approach to stormwater quality modelling and assessment within the MUSIC model several 6 minute data stations (pluviographs) were examined to ascertain the most suitable dataset for Sydney Olympic Park. Two 6 minute data stations were investigated for their suitability. These were the pluviograph stations at:

- 66063 Wahroonga Reservoir located ~ 14 km north of Sydney Olympic Park and;
- 066037 Sydney Airport AMO located ~ 15 km south east of Sydney Olympic Park.

Rainfall data from each of these stations was compared to daily data selected for Sydney Olympic Park (gauge no. 066057), to see which station had a closer resemblance to rainfall conditions within the local area. A common period was compared for all stations: 1940 to 1973. The results of this investigation are shown in Figure 4. Based on this assessment it can be clearly seen that the Sydney Airport rainfall station closely matches rainfall at Sydney Olympic Park whereas Wahroonga Reservoir typically has higher monthly rainfall than Sydney Olympic Park .

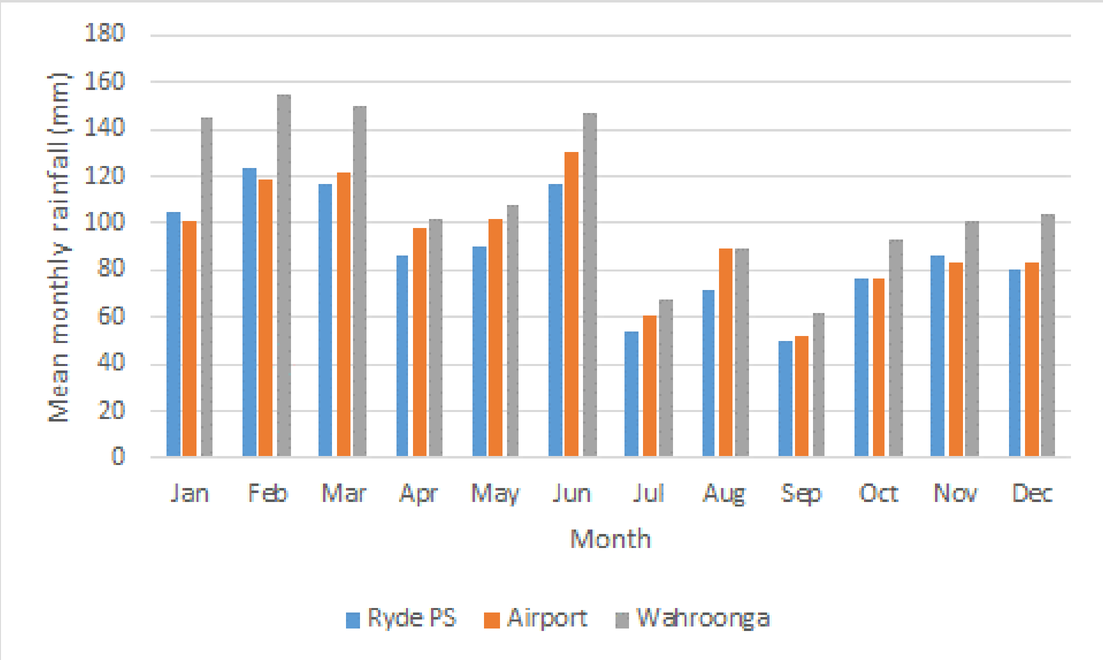

Figure 4: Comparison of 6-minute rainfall stations

Hence, Sydney Airport pluviometer is recommended as the most appropriate for Sydney Olympic Park, as it has a similar monthly rainfall average to the local area. An extensive length of record is available from the Airport pluviograph, with 6 minute records starting in 1929 and continuing to present.

Given the above, **Sydney Olympic Park Authority requires all stormwater quality modelling in MUSIC to be undertaken using the Sydney Airport AMO 6-minute rainfall data. A modelling period of 1/1/1988 to 31/12/1998 is recommended, as for this period**, the annual rainfall is representative of the long-term average.

3.3 Potential Evapo-transpiration data

Sydney Olympic Park Authority requires the following when considering Potential Evapotranspiration (PET) data in MUSIC:

- Local PET information is preferred (where available)
- In most cases, local data will not be available in which case average monthly data from Sydney (available within the MUSIC model) can be used.

Average Sydney PET data is suitable for use in modelling water quality and hydrology. The monthly PET values for the Sydney region, including Sydney Olympic Park, are shown in Table 2.

Table 2: Monthly Evapotranspiration for the Sydney Region

Month	J	F	M	A	M	J	J	A	S	O	N	D
PET (mm)	180	135	128	85	58	43	43	58	88	127	152	163

4 SOURCE NODES

Once the meteorological data has been input into the model the user must then define the source nodes to reflect the details (i.e. area, landuse) of the contributing catchments. MUSIC currently has five land uses, these being:

- Urban;
- Agricultural;
- Forest;
- User Defined; and
- Imported Data.

Normally the Urban Source Node should be used for all MUSIC modelling in Sydney Olympic Park. The urban source node is used to describe low to high density residential, retail, and commercial areas, including pervious and impervious areas. These areas comprise private allotments together with all associated facilities, such as roads, parks, car parks, stadiums, paved areas, etc.

Agricultural, forested user-defined and imported data nodes will not normally be applicable in Sydney Olympic Park for development sites. If they are utilised in a MUSIC model, their use will need to be justified for the particular scenario.

4.1 Area

Each individual Source Node, with the exception of the Imported Data Node, requires the total area and impervious percentage of the site to be defined. See the following section (4.2) for an overview of how to set the impervious percentage.

4.2 Land type split

The urban node must be split into the various land types (i.e. roads, roofs, other impervious and pervious surfaces) when the modeller intends to model the following:

- a single allotment (including commercial and industrial)
- a single street (including allotments)
- the influence of rainwater tanks within a development (regardless of the size of development)

When utilising this approach:

- Roof areas are to be modelled as 100% impervious unless a green roof is being adopted (refer to section 8.14). If there is
    - a rainwater tank then it should be modelled immediately downstream of the roof.
    - only a portion of the roof which drains to the rainwater tank, then the roof will need to be split into two separate nodes, one of which bypasses the rainwater tank;
- Roads, car parks, shared zones and other areas open to vehicular traffic should be modelled with all the impervious area in the “Roads” node. Any

pervious areas associated with roads, car parks, etc (e.g. verges) should be included in the “Pervious areas” node;

- The “Other impervious areas” node should include areas such as courtyards, paved open space, footpaths, decks, etc;
- All pervious areas should be included in the “Pervious areas” node. Pervious areas should model
    - the storm flow component as *draining* to the treatment train, as runoff from these areas would typically connect to the treatment systems
    - the baseflow component as *bypassing* the treatment train, as runoff from these areas would not be directly connected to the drainage system and therefore would not enter the treatment system. This can be set up with a secondary drainage link.
- Pervious areas on basements are to be modelled
    - as “pervious” where the soil depth is greater than 200mm.
    - as “other impervious” where the soil depth is less than 200mm

An example MUSIC model including rainwater tanks is provided in Figure 5 below. The relevant pollutant parameters for the various land types are provided in Table 4 and the application of rainwater tanks is described in more detail in Section 8.6.

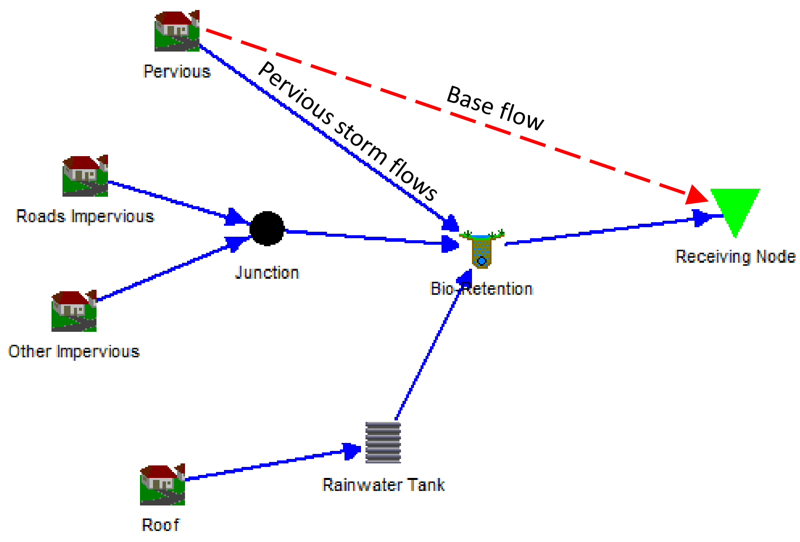

Figure 5: Example MUSIC model setup including a rainwater tank

5 RAINFALL-RUNOFF PARAMETERS

As outlined in Section 3, stormwater runoff (represented as storm flow and baseflow) is generated in MUSIC through the interaction of rainfall, evapotranspiration and the MUSIC Rainfall-Runoff Model. A full description of the MUSIC Rainfall-Runoff Model is provided in the MUSIC User Manual. If the reader of this document has no MUSIC modelling experience they should review Appendix A of the User Manual before reading below.

MUSIC rainfall-runoff parameters have been derived for NSW from model calibration studies. Table 3 outlines the soil properties highlighted for adoption in MUSIC modelling in NSW by the NSW Department of Environment and Climate Change (DECC). The DECC recommends adoption of these parameters, but also suggests that a sanity check can be performed on total runoff volumes by comparing with the values presented in Figure 2.3 of the CRCCH's Technical Report 04/8 ('*Stormwater Flow and Quality, and the Effectiveness of Non-proprietary Stormwater Treatment Measures – A Review and Gap Analysis*, Fletcher et. al., 2004).

The steps for setting up the rainfall runoff parameters are described below:

Step 1: Estimate Fraction Impervious
An initial estimate of the impervious fraction for the particular landuse should be made. The impervious area must be based on the landscape and planting plans for the site which clearly shows the pervious landscaped area.

These estimates should also be compared to aerial photos of similar recent developments in the vicinity of the proposed development.

Sydney Olympic Park Authority building density controls that are of relevance include minimum soft landscaping area (currently a minimum of 20% of total site area), maximum building envelopes, floor space ratios and road design guidelines.

Typical impervious fractions at Sydney Olympic Park are:

- Typical residential development site – 70 to 80%
- Typical commercial site – 95 to 100%
- Typical road - 95%

Step 2: Split MUSIC catchments into land use types
All areas should be classified as Roads, Roofs, Other impervious and Pervious areas and entered into the model at appropriate locations (see Section 4.2).

Step 3: Set Soil Properties
For impervious source nodes, the only rainfall-runoff parameter that plays a part is the Rainfall Threshold, which should be set to 1.4 mm. For all pervious source nodes, the following soil characteristics shown in Table 3 should be adopted in MUSIC. Soils at Sydney Olympic Park typically consist of fill over underlying clay soils. Hence it is assumed that the soils are clay and these values are to be adopted unless site specific soil investigations can show otherwise. Where locally specific site soil parameters are to be adopted they should be used in accordance with the latest

version of the *NSW Music Modelling Guidelines* (currently refer to Table 3-7 and Table 3-8 in the 2010 Draft version of the Guidelines)

Table 3: Soil properties for MUSIC source nodes

Parameter	Units	Urban	Non-urban
Impervious area parameters			
Rainfall threshold	mm	1.4	1.4
Pervious area parameters			
Soil capacity	mm	93	187
Initial storage	%	30	30
Field capacity	Mm	68	127
Infiltration capacity coefficient a		135	135
Infiltration capacity coefficient b		4.0	4.0
Groundwater properties			
Initial depth	Mm	10	10
Daily recharge rate	%	10	10
Daily baseflow rate	%	10	10
Deep seepage	%	0	0

6 POLLUTANT GENERATION

As outlined in the MUSIC User Manual, a comprehensive review of stormwater quality in urban catchments was undertaken by Duncan (1999) and this review forms the basis for the default values of event mean concentrations in MUSIC for TSS, TP and TN. Table 4 presents the recommended stormwater quality parameters for various land use categories in MUSIC. These values are consistent with those recommended by the DECC for application in NSW.

Note that for all simulations the MUSIC model must be run with pollutant export estimation method set to "*stochastically generated*" as opposed to the "mean" estimation method.

Table 4: Stormwater quality parameters for MUSIC source nodes

Land-use category		Log_{10} TSS (mg/L)		Log_{10} TP (mg/L)		Log_{10} TN (mg/L)	
		Storm Flow	Base Flow*	Storm Flow	Base Flow*	Storm Flow	Base Flow*
Roof Areas	Mean Std Dev	1.30 0.32		-0.89 0.25		0.30 0.19	
Road Areas	Mean Std Dev	2.43 0.32		-0.30 0.25		0.34 0.19	
Other Impervious Areas (including residential, industrial, commercial and other urban areas)	Mean Std Dev	2.15 0.32		-0.60 0.25		0.30 0.19	
Urban pervious Areas	Mean Std Dev	2.15 0.32	1.20 0.17	-0.60 0.25	-0.85 0.19	0.30 0.19	0.11 0.12
Forest/natural areas	Mean Std Dev	1.60 0.2	0.78 0.17	-1.10 0.22	-1.52 0.13	-0.05 0.19	-0.52 0.13

* Base flows are only generated from pervious areas, therefore these parameters are not relevant to impervious areas

7 LINK ROUTING

For all MUSIC model simulations it is recommended that the channel routing option in MUSIC be set to “No Routing” as this is the most conservative modelling scenario.

For larger catchments (typically greater than 5 hectares) routing may be used to reflect the travel time for flood wave propagation through the catchment, however any use of routing must be supplemented with justification of the selection of the method of routing (translation only method or Muskingham-Cunge method) and the values used in routing. The user is referred to the MUSIC User Manual for further details.

8 STORMWATER QUALITY TREATMENT MEASURES

Within the current version of MUSIC (version 6) the user has several treatment options available including:

- Bioretention systems
- Gross pollutant traps
- Wetlands
- Swales
- Rainwater tanks
- Infiltration systems
- Water quality ponds
- Sedimentation basins
- Detention basins
- Buffers
- Media filtration systems (e.g. sand filters)
- Generic node

Note that regardless of the treatment system applied, the following general rules apply:

- The default parameters in MUSIC for the first order decay k-C* model used to define the treatment efficiency of each treatment device should be used unless local relevant treatment performance monitoring can be used as reasonable justification for modification of the default parameters. Reference should be made to the MUSIC User Manual.
- All "advanced properties" including orifice and weir coefficients, number of CSTR cells, etc should be set to MUSIC's default values
- Seepage loss (exfiltration rate) should normally be zero.
- Evaporative loss should normally range from 75% of PET for completely open water to 125% of PET for heavily vegetated water bodies.

Note: The following existing receiving waters are not to be modelled within the MUSIC model (i.e. receiving waters provide no credit towards the stormwater quality treatment requirements): natural waterways, natural wetlands, naturalised channel systems, environmental buffers and lake/pond systems.

Sydney Olympic Park Authority provides the following advice for modelling stormwater quality treatment systems within Sydney Olympic Park. Use of treatment systems outside of these bounds is unlikely to be accepted by Sydney Olympic Park Authority and full justification for use outside the guidance below is required.

8.1 Bioretention systems

Bioretention systems are a combination of vegetation and filter substrate that provides treatment of stormwater through filtration, extended detention and some biological uptake.

The systems are designed to accept stormwater runoff and allow it to percolate through the filtration media. At the base of the filter media, treated stormwater is collected within a drainage layer comprising a system of perforated pipes laid in gravel, to ensure the devices are drained adequately. Bioretention systems need to be densely planted out with sedges, shrubs, ground covers and other plants to help maintain the conductivity of the filter media, promote nutrient removal, and create an attractive landscaped form/feature.

Table 5: Input parameters for bioretention systems

Parameter	Notes	Recommended range
Low and high flow bypass	Identify whether a bypass structure shall be included within / upstream of the device to control flows. High flow bypass rate should be calculated by the designer	
Extended detention depth	Identify the extended detention (ponding) depth of stormwater runoff prior to its overflowing the control weir of the device. Depths greater than 0.4 m are not recommended with 0.1-0.3 m recommended for plant sustainability and adequate draining times	0.1-0.3 m
Surface area and filter area	Provide the estimated surface area of the device (area at the top of the extended detention) and filter area based upon concept design	
Unlined filter media perimeter	Due to the nature of soils in Sydney Olympic Park all bioretention systems are to be lined with an impervious HDPE or GCL liner (unless detailed site soil investigations prove infiltration is acceptable)	0
Saturated hydraulic conductivity	A sandy-loam mixture is recommended to provide adequate organic material for vegetation/root yet still ensure sufficient drainage characteristics. A typical saturated hydraulic conductivity is 100 mm/hr	50-200 mm/hr
Filter depth	Provide the proposed depth of filter media within the device. The following depths are recommended as a minimum within the device: 0.5 m for sedges and shrubs and 0.8 m for tree species proposed to ensure adequate area for root growth are provided within the device. This depth does not include the drainage layer	0.5-0.8 m
TN content of filter media	Dependent on soil materials available for construction.	500-600 mg/kg
Orthophosphate	Dependent on soil materials available for	40-60 mg/kg

Parameter	Notes	Recommended range
content of filter media	construction	
Exfiltration rate and lining of the base	Due to the nature of soils in Sydney Olympic Park all bioretention systems are to be lined with an impervious HDPE or GCL liner (unless detailed site soil investigations prove infiltration is acceptable) Exfiltration is only appropriate given certain soil conditions (see Section 8.7). At Sydney Olympic Park bioretention systems should be lined to prevent exfiltration.	0 mm/hr
Vegetation	Bioretention systems should be vegetated with plants which are effective for nutrient removal	Effective
Underdrain	Bioretention systems without exfiltration must include under-drainage	*Ticked*
Submerged zone	Note that a submerged (saturated) zone requires a specially designed outlet pit configuration	Typical depth = 0.2-0.6 m

Note: When locating bioretention devices ensure the ability of the devices to drain adequately has been assessed. Also ensure the device has sufficient pre treatment bypass flows or contains structures to ensure flows within the device are kept below the scour velocity of the chosen filter media.

8.2 Gross pollutant traps – Coarse material

GPTs typically remove rubbish and debris, and can also remove sediment and hydrocarbons from stormwater runoff. These devices can be very effective at removal of solids conveyed within stormwater which are typically larger than 5 mm in size.

Table 6: Input parameters for GPTs

Parameter	Notes	Recommended range
High flow bypass	Typically the 3-month ARI peak flow	
Gross pollutant removal	Gross pollutant removal should be obtained for the specific GPT type proposed from the supplier – preferably independently verified	
TSS removal	TSS removal = 0 (unless a vortex-type system, when TSS removal can be up to 70% for inflow	0 For vortex type

Parameter	Notes	Recommended range
	concentrations greater than 75 mg/L).	systems adopt values in MUSIC manual
TP removal	TP removal = 0 (unless a vortex-type system, when TP removal can be up to 30% for inflow concentrations greater than 0.5 mg/L)	0 For vortex type systems adopt values in MUSIC manual
TN removal	TN removal = 0 for all systems	0

8.3 Proprietary treatment systems

Proprietary cartridge treatment systems have some capacity to remove finer sediment and nutrients. The cartridge filters typically contain either media placed inside a removable cartridge or membrane filters within a cartridge. Cartridge filters work predominantly through the process of filtration, settling of sediment and sorption of pollutant particles to the media within the cartridge.

Sydney Olympic Park Authority has a model (as developed by Blacktown City Council) with the nodes for various proprietary treatment systems. Proponents need to contact Sydney Olympic Park Authority to obtain these models. The nodes within the model set the removal rates for pollutants within MUSIC. This model must be used if proprietary treatment systems are to be adopted to meet the policy guidelines.

In addition to this the following model set up for proprietary treatment systems is required to be adopted:

- Standard underground on site detention systems are not to be incorporated into the MUSIC model. The use of onsite detention system has the potential for optimistic pollutant load removal rates caused by the addition of the on site detention basin. Refer also to section 8.10 for further details on modelling detention basins
- The minimum flow rate to be diverted through the treatment must be clearly stated and incorporated in the MUSIC model
    - as a high flow bypass rate and
    - must match (or be less than) the treatable flow rate for the proposed model of the proprietary treatment system and must be clearly stated

8.4 Wetlands

Constructed wetland systems use enhanced sedimentation, fine filtration and pollutant uptake processes to remove pollutants from stormwater. Constructed wetland systems consist of an inlet zone (sediment basin to remove coarse sediments), a macrophyte zone (a shallow heavily vegetated area to remove fine particulates and uptake of soluble pollutants) and a high flow bypass channel (to protect the macrophyte zone).

Wetlands are suitable downstream of pre-treatment measures such as swales, sediment basins or GPTs designed to remove coarse sediment.

Table 7: Input parameters for wetlands

Parameter	Notes	Recommended range
Low and high flow bypass	Input the appropriate bypass characteristics to reduce the impacts on macrophytes within the wetland. The high flow bypass flowrate should typically be set to the peak 1 year ARI flowrate	High flow bypass = 1 year ARI peak flow
Inlet pond volume	Estimate the inlet pond volume based on a surface area of 10% of the macrophyte zone surface area, and a depth of 2.0 m	
Surface area	Enter the proposed surface area of wetland macrophyte zone under “Storage Properties”	
Extended detention	Set extended detention depth of between 0.25-0.75m. Note that any flood storage above the extended detention depth must not be included in the extended detention depth	0.25-0.75 m
Permanent pool volume	Set the permanent pool volume as the volume of water permanently submerging macrophytes. Set by multiplying the average depth (typically 0.2-0.3 m) by the surface area	
Exfiltration rate	Generally assume 0 mm/hr for wetlands, which should be lined to retain water	0 mm/hr
Equivalent pipe diameter	Adjust the Equivalent Pipe Diameter to ensure the device has a notional detention time of approximately 48-72 hrs	Notional detention time of 48 to 72 hrs

8.5 Swales

Vegetated swales are open vegetated channels that can be used as an alternative stormwater conveyance system to conventional kerb and channel along roads and associated underground pipe. The interaction of surface flows with the vegetation in a swale facilitates an even distribution and slowing of flows thus encouraging particulate pollutant settlement. Swales can be incorporated into streetscape designs and can add to the aesthetic character of an area. They are also ideal as a pre-treatment measure for stormwater, particularly for coarse sediment removal.

Table 8: Input parameters for swales

Parameter	Notes	Recommended range
Bypass	Identify any high flow or low flow bypasses proposed for the device	
Length	Identify the length of the swale based upon location and site constraints	
Bed slope	Determine the longitudinal slope of the swale. Swales with bed slopes > 5% are not recommended as treatment devices (however rock check dams can be used to design swales with steeper slopes and these can still be used as conveyance devices). Swales with bed slopes < 1% are to incorporate a gravel trench within the base of the device to promote adequate drainage	1-5%
Geometry	To be determined by designer. Provide dimensions for the base and top width of the swale as well as the depth	
Vegetation height	Vegetation heights of 0.05-0.5 m are acceptable, however MUSIC assumes that swales are heavily vegetated when modelling their treatment performance. Mown grass swales should not be expected to provide significant stormwater treatment and should not be modelled in MUSIC	0.05-0.5 m
Exfiltration rate	Exfiltration is only appropriate given certain soil conditions (see Section 8.7) and swales should not encourage exfiltration at Sydney Olympic Park. When modelling a swale, exfiltration losses must be set to zero.	0

8.6 Rainwater Tanks

Rainwater tanks are required in non-stormwater harvesting catchments at Sydney Olympic Park. For full details refer to the rainwater reuse technical manual.

Rainwater tanks can serve two main purposes. Primarily, they are designed to provide an alternative source of water for non-potable uses such as irrigation, toilet flushing, laundry, hot water or industrial process water. To design a rainwater tank for reuse involves balancing the supply and demand and selecting an appropriate tank size to meet a reasonable proportion of demand. This can be achieved in MUSIC and a suitable process is described in Section 8.6.1.

Rainwater tanks can also act as a stormwater treatment measure, as some settling occurs in the tank, and when rainwater is utilised, some pollutants are removed along with the water. Modelling this aspect of rainwater tank performance is described in Section 8.6.2.

8.6.1 Hydrological modelling for supply reliability

Where a rainwater tank is used to store roof runoff for reuse, its performance in balancing supplies and demands can be modelled using MUSIC.

In this case a daily time step should be used with a longer time series for hydrological purposes (<u>but not water quality</u>).

Table 9: Input parameters for rainwater tanks (daily supply modelling)

Parameter	Notes	Recommended range
Bypass	Identify any high flow or low flow bypasses proposed for the device	
Storage volume	Input the tank volume	
Geometry	The depth above overflow, surface area and overflow pipe diameter can be estimated roughly from the anticipated tank geometry for the development.	
Reuse parameters	Enter re-use details to represent the intended demands on water from the rainwater tank. For full details refer to the rainwater reuse technical manual.	Refer rainwater reuse manual

For further details of rainwater reuse at Sydney Olympic Park refer to the Rainwater Reuse Technical Manual.

8.6.2 Water quality modelling for treatment performance

In order to appropriately model the treatment efficiency of a rainwater tank, Sydney Olympic Park Authority recommends the following methodology be utilised:

- The catchment should only include the roof and pollutant generation should be modified to reflect roof runoff parameters (see Table 4).
- Sydney Olympic Park Authority recommends that the applicant develop a treatment train utilising the rainwater tank node as was shown in Figure 5.

Where rainwater tanks are included in a particular stormwater strategy the various "land types" need to be delineated in the MUSIC model to ensure the pollutant export and treatment processes are appropriately considered (i.e. less TSS and TP is exported from roof areas so rainwater tanks play only a small role in the management of these pollutants). An example MUSIC model setup, showing the location of a rainwater tank, was shown in Figure 5.

Where the rainwater tank is included as part of the water quality treatment train a 6 minute step must be used with a 10 year times series as outlined in 3.2.

For further details of rainwater reuse at Sydney Olympic Park refer to the Rainwater Reuse Technical Manual.

8.7 Infiltration Systems

Infiltration measures encourage stormwater to infiltrate into surrounding soils. Infiltration measures are highly dependent on local soil characteristics and are best suited to sandy and sandy clay soils with deep groundwater.

Due to the clay soils and legacy of past industrial practices at Sydney Olympic Park **infiltration is generally not effective at the Park**.

If infiltration is being proposed it is strongly encouraged to discuss the proposal with SOPA early in the design process to gain preliminary advice. Where infiltration is proposed as a minimum a detailed geotechnical assessment is required to be undertaken.

8.8 Ponds

Due to the nature of development at Sydney Olympic Park, with predominantly high density residential and commercial development, ponds are generally not applicable at Sydney Olympic Park. While ponds are generally not recommended as part of the pollutant removal train, they may be incorporated as part of a stormwater reuse or stormwater detention strategy for a site.

If ponds are being proposed which are to be used as part of the treatment train it is strongly encouraged to discuss the proposal with Sydney Olympic Park Authority early in the design process to gain preliminary advice. Where ponds are proposed as a minimum a detailed geotechnical assessment is required to be undertaken.

8.9 Sedimentation Basins

Sediment basins are used to retain coarse sediments from runoff. They operate by reducing flow velocities and encouraging sediments to settle out of the water column.

They are frequently used for trapping sediment in runoff during construction activities and for pre-treatment to measures such as wetlands (e.g. an inlet pond). They can drain during periods without rainfall and then fill during runoff events. They are sized according to the design storm discharge and the target particle size for trapping (generally 0.125 mm).

At Sydney Olympic Park, sediment basins are required during the construction phase, to control sediment and erosion discharge from the site. However MUSIC is not to be used to size sediment basins for this phase of development. Sediment basins are to be sized in accordance with the 2004 'Blue Book' as outlined in the stormwater technical manual.

Post construction, due to the nature of development at Sydney Olympic Park, with predominantly high density residential and commercial development large open water sediment basins are not recommended at Sydney Olympic Park.

If sediment basins are being proposed at Sydney Olympic Park it is strongly encouraged to discuss the proposal with Sydney Olympic Park Authority early in the design process to gain preliminary advice. Where ponds are proposed as a minimum a detailed geotechnical assessment is required to be undertaken.

In some instances sediment basins may be appropriate as underground treatment systems. In this instance sediment basins should be modelled as outlined below. It should be noted that sediment basins must have a permanent pool volume (i.e. on site detention basins with no permanent pool are not considered sediment basins) and must

- Have a minimum permanent pool depth of 1m.
- Have a minimum extended detention depth of 0.25m

Sediment basin systems which do not meet these criteria are not to be included in the MUSIC model.

Table 10: Input parameters for sedimentation basins

Parameter	Notes	Recommended range
Low and high flow bypass	Identify any high flow or low flow bypasses proposed for the device	
Surface area	Surface area at normal water level	
Extended detention	A typical extended detention depth is 0.25-1.0m. A minimum extended depth of 0.25m is required.	Min 0.25m 0.25-1.0 m
Permanent pool volume	A typical permanent pool depth is 1.0 to 2.0 m. The sediment basin must have a permanent pool depth of at least 1.0m.	Min 1.0m Typically 1 to 2m in depth
Exfiltration rate	Construction-stage sediment basins may not be lined – in this case the exfiltration rate should be based on the properties of the surrounding soil	0
Outlet properties	Modify the discharge pipe diameter to ensure a detention time long enough to allow settling of the target particle size	

8.10 Detention basins

On site detention is not to be included as part of the treatment train in MUSIC. On-site detention is not able to provide any significant water quality improvements. Detention basins which have a permanent sump can be modelled as sediment basins provided they meet the minimum requirements for sediment basins.

8.11 Buffers

Proponent are encouraged to use buffers for podium drainage areas where hardstand areas (paved areas) can be directed to vegetated areas before they are directed to stormwater drainage.

Buffer or filter strips, in the context of urban stormwater, are grassed or vegetated areas over which stormwater runoff from adjoining impervious catchments traverses en route to the stormwater drainage system or receiving environment. Buffer strips are intended to provide discontinuity between impervious surfaces and the drainage system. They take water from impervious surfaces in a distributed manner, promote even flows and filter sediments and coarse pollutants entrained in the runoff. The key to their operation is an even shallow flow over a wide vegetated area. Distributed flows and a shallow grade (1-5%) are essential. The low hydraulic loading over the vegetation allows flows to filter through the vegetation and pollutants to settle out. They also provide a detention role to slow flows down.

Table 11: Input parameters for buffer strips

Parameter	Notes	Recommended range
Percentage of upstream area buffered	Calculate the percentage of upstream area that shall actually pass over buffer	
Buffer area	Calculate the size of the proposed buffer area as a percentage of the upstream catchments impervious area. Buffer strips are only applicable where runoff is distributed across the whole buffer strip, therefore this should be the area which is actually active in buffering flows	
Exfiltration rate	Exfiltration should generally be set to zero	0 mm/hr

Note: buffers are typically used upstream of other treatment devices to assist in sediment drop out prior to stormwater entering secondary treatment devices.

8.12 Media filtration systems

Sand filters treat stormwater via infiltration through a soil media. In some ways they are similar to bioretention systems, however sand filters are normally not vegetated and can be constructed with much higher filtration rates. Note for MUSIC modelling guidelines for proprietary media filtration systems refer to section 8.3.

Due to the fact that sand filters are not vegetated, they can be prone to clogging unless adequate pre-treatment is provided upstream of the sand filter. Sediment removal is particularly important to minimise the risk of clogging, and it is recommended that pre-treatment should meet the target for 85% removal of the TSS load.

Where sand filters are constructed of medium or coarse sand (or coarser materials), they should not be expected to remove a significant pollutant load, and it is not recommended that they are modelled in MUSIC. However, where sand filters are constructed using fine sand or sandy loam filter media, they can be modelled as a media filtration system. This section describes how to model a fine sand or sandy loam sand filter.

Table 12: Input parameters for media filtration systems

Parameter	Notes	Recommended range
Low and high flow bypass	Identify any high flow or low flow bypasses proposed for the device	
Extended detention depth	Identify the extended detention (ponding) depth of stormwater runoff prior to its overflowing the control weir of the device. Depths greater than 0.4 m are not recommended due to a propensity for settled solids to clog the surface under a deep pool	0.1-0.3 m
Surface area and filter area	Provide the estimated surface area of the device (area at the top of the extended detention) and filter area based upon concept design	
Exfiltration rate	Most media filtration systems should be lined	0 mm/hr
Filter depth	Typically 0.5-1.0 m	
Filter median particle diameter	Typically 0.5 mm for fine sand	
Saturated hydraulic conductivity	Typically 50-200 mm/hr for fine sand	
Depth below underdrain pipe	The depth below underdrain pipe should normally be zero – it is only relevant when the filter media extends below the slotted drainage pipe	

8.13 Generic Node

This node allows the user to simulate the treatment performance of devices not listed within the default parameters.

This use of the generic node is similar to the processes identified for a Gross Pollutant Trap with the exception of a Flow transfer function to replicate any flow attenuation produced by the proposed device.

Note: The use of the Generic Node shall only be permitted if sufficient justification can be provided and where Sydney Olympic Park Authority supports this information. Typically the use of this node is discouraged within Sydney Olympic Park. If this node is utilised the user is to identify the proposed treatment efficiency along with any additional supporting information to Sydney Olympic Park Authority's requirements.

8.14 Green roofs

A green roof is a fully vegetated area built upon a roof structure. The roof structure is protected by a high quality waterproofing and root repellent system. The green roof consists of a drainage layer, a filter cloth and/or root repellent layer, a growing medium and plants, and typically a mulch layer.

Sydney Olympic Park Authority is looking to encourage the uptake of green roofs due to the multiple benefits provided by green roofs. All areas of green roof can be counted as pervious areas in the MUSIC model provided they

- contain greater than 100mm in average depth of soil across the green roof area
- each green roof 'cell' or 'individual area' is greater than 25 m^2
- have a low nutrient growing media to ensure that nutrients do not leach from the soil of the green roof

8.15 Podium vegetated areas

In high density developments in Sydney Olympic Park the typical pattern of development is for podium courtyards and landscaped areas to be located on top of basement carparks. Typically these podium areas have a combination of paved and other hardstand areas and landscaped areas including garden beds and lawn. Typically the landscaped areas on podiums are designed in similar ways to a bioretention system as they contain subsoil drains and waterproof membranes to prevent water ingress into the basement carpark below.

Sydney Olympic Park Authority is looking to actively encourage the use of vegetated podium landscape areas to treat stormwater runoff particularly from adjacent podium areas, as well as where possible adjacent roof drainage. This provides multiple benefits including cost effective stormwater treatment, dual use of landscaped areas, passive irrigation and reduction in potable water use, and an improvement to local microclimate (particularly by reducing temperatures).

To achieve this the following simple modifications are required to standard podium drainage and landscape design:

- Hardstand podium areas are to drain towards garden beds
- The surface of the garden bed is to be lowered by 100mm to 200mm in the centre to allow for extended detention
- Drainage pits are to be located in the garden beds with the cover of the drainage pit 100mm above the surface of the
- Ensure that there is subsoil drainage to the garden bed (commonly found in the

When these measures are adopted the garden beds can be modelled as bioretention systems as outlined in section 8.1 which treat any adjacent podium area draining to it. This can be undertaken without having to provide a full bioretention system profile (e.g. a transition layer and drainage layer are encouraged but not necessarily required) as long as a free draining soil media is used (e.g. sandy or sandy loam with low organic matter and meeting the nutrient values adopted in the MUSIC model).

8.16 Water quality offsets - modelling requirements

Sydney Olympic Park Authority allows for water quality offsets to be considered as per the Sydney Olympic Park Authority Stormwater and WSUD Policy. Water quality offsets are typically undertaken by treating a catchment outside of the subject development site and through treating the external catchment achieve the same (or better) pollutant load reduction required for the development site. This allows a portion, or all, of the subject development site to pass untreated.

This can be beneficial in a number of instances including when it is

- difficult to drain all of the site to one location,
- space is limited for treatment systems for some parts of the site,
- basements limit the potential to use some treatment systems,
- more cost effective to treat an external catchment.

Water quality offsets can also be a particularly beneficial way to meet the water quality requirement stretch target requirements.

Offsetting is mostly likely to occur in three ways at Sydney Olympic Park (in order of likelihood):

1. Treatment of adjacent public road runoff (and any adjacent catchments which drain to the road) which is not part of the subject development site. The public road runoff could be treated in kerbside raingardens or street tree bioretention systems which are constructed as part of the development
2. Where Sydney Olympic Park Authority’s trunk drainage system passes through the development or within close proximity to the development and where it is feasible to treat this system by diverting or all or a portion of the flows into a treatment system <u>on land within the subject development site</u>
3. Where Sydney Olympic Park Authority’s trunk drainage system passes through the development site or close to the development = site and where it is feasible to treat this system by diverting or all or a portion of the flows onto a treatment system <u>on adjacent</u> <u>Sydney Olympic Park Authority land</u> which is not constrained by other uses

In all instances of offsetting, it is strongly recommended to seek preliminary advice from Sydney Olympic Park Authority as to the feasibility of an offsets approach.

Where water quality offsetting is proposed, the requirements for MUSIC modelling are as follows:

- the water quality offsets are to achieve the equivalent (or better) pollutant load reduction that would be required by the policy if offsetting was not to be adopted
- The portion of the development site which is to be treated and the water quality treatment train and its pollutant loads and pollutant load removals are to be clearly stated and quantified using MUSIC
- The portion of the development site which is to be un-treated and its pollutant loads are to be clearly stated and quantified using MUSIC
- The portion of the flows from the external catchment to be diverted, the water quality treatment train and the pollutant loads and pollutant load removals are to be clearly stated and quantified using MUSIC
- If only a portion of the external catchment flows are to be diverted to the treatment system a high flow bypass must be adopted in the treatment system train which reflects the portion of flows to be diverted and must be clearly stated
- The treatment train treating the external catchment **must** be sized to achieve a minimum 45% removal of nitrogen for the flows which are diverted into it. This is to ensure that the treatment system is not under-sized relative to the flows diverted to it.
- The treatment train that is proposed for the external catchment is to be modelled as outlined in this guideline
- Green roofs and podium vegetated areas are not considered suitable for treating external catchments or for the use of water quality offsetting

Water Sensitive Urban Design Guideline

A guideline under the Sydney Olympic Park Authority
Stormwater Management and Water Sensitive Urban Design Policy

Prepared by Knights and McAuley
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Table of Contents

Glossary

Refer to the glossary in the policy document for a definition of terms used in this guideline.

Related documents

This Guideline is one of a set of technical guidelines produced by Sydney Olympic Park Authority to assist proponents in implementing the Stormwater Management and Water Sensitive Urban Design Policy. Each Guideline covers a different aspect of policy implementation. The Policy should be read in conjunction with these Guidelines.

Guidelines may be accessed on the website of the Sydney Olympic Park Authority: www.sopa.nsw.gov.au/resource_centre/publications

1 Introduction

Sydney Olympic Park ("the Park") is currently undergoing significant re-development and will continue to do so in the short and medium term. The Sydney Olympic Park Masterplan considers a range of potential development including commercial, retail and residential development as well as ongoing development of sporting facilities. This development has the potential to impact on the sensitive and high value receiving waters within Sydney Olympic Park. Sydney Olympic Park Authority (SOPA) has developed a policy to manage stormwater runoff during the construction and post construction phase.

Within much of the Town Centre of the Park there is limited space available downstream of the development and upstream of the receiving waters and it would not be feasible to treat all of the catchments upstream of the receiving water using an 'end of pipe' stormwater management approach. Hence, a decentralised stormwater management approach was adopted which includes the treatment of all runoff at source such that new:

- development must treat its stormwater on site before discharge from site
- roads and car parks must treat its stormwater within the road reserve before discharge from the site
- public domain and pubic infrastructure and similar works must treat its stormwater before discharge from the site

SOPA has also identified a number of works in the public domain that could be undertaken to 'retrofit' into existing stormwater catchments to improve the water quality discharging to the receiving waters. To date, SOPA have completed a number of these projects including the construction of a number of treatment systems including bio-swales and a wetland to treat runoff from various catchments within the Park.

This Guideline is provided to ensure consultants, developers and Sydney Olympic Park Authority have a consistent and uniform approach to stormwater quality and quantity within Sydney Olympic Park and to ensure that the intent of the policy is met during the implementation phase. The Guideline is provided to allow a wide range of practitioners to understand the

- context of stormwater management within Sydney Olympic Park
- the local specific requirements of Sydney Olympic Park Authority
- specific requirements for treatment systems and their adoption at the Park

Applicants for development approval, who are required to design stormwater treatment systems and prepare a WSUD strategy, should refer to these guidelines to ensure that any proposed stormwater management system is undertaken in accordance with SOPA's requirements. Any stormwater management designs that are not consistent with this Guideline risk potential delays to the approval process

This guideline should be read in conjunction with other technical Guidelines produced by Sydney Olympic Park Authority to support implementation of the Stormwater Management and Water Sensitive Urban Design Policy. These Guidelines are available on the Authority's website.

2 Sydney Olympic Park Stormwater Management Context

This section of the guideline is recommended for those who wish to gain an overview of the existing receiving waters at the Park and their ecological values, the local water recycling and reuse system scheme and existing stormwater treatment systems at the Park.

Sydney Olympic Park has a unique and highly valuable water ecosystem and an innovative decentralised stormwater and wastewater reuse system supplying non-potable recycled water to development at the Park. Also, the Park has considerable ecological value providing ecologically sensitive habitats for a diverse range of flora and fauna including a number of native and migratory birds, the endangered green and golden bell frog and sensitive vegetation.

SOPA takes a whole of catchment approach to water management within the Park and this section provides the context of this approach. Sydney Olympic Park has a wide range of existing stormwater treatment measures across the public domain including gross pollutant traps (GPTs), kerbside litter baskets, drainage swales, porous paving, ponds, wetlands and bioretention systems.

2.1 Receiving Waters and Ecology

Sydney Olympic Park has extensive estuarine and freshwater ecosystems spanning more than 130 hectares of the Park. Stormwater from the Park drains to these ecosystems and has the potential to negatively impact on them.

The estuarine vegetation at the Park consists of both natural remnant and constructed communities. There are more than

- 70 hectares of mangroves
- 35 hectares of saltmarsh (an endangered ecological community) and mudflats
- 5 hectares of Swamp Oak Floodplain Forest (an endangered ecological community)

Mangroves at Sydney Olympic Park

Saltmarsh at Sydney Olympic Park

The key habitats of the Park are shown in Figure 1. The park contains some very high ecological values which have the potential to be negatively impacted by stormwater discharge from the Park including

- Estuarine wetlands of Newington Nature Reserve and Badu Mangroves which are listed on the Directory of Important Wetlands in Australia
- The largest stand of Mangrove Forest, containing grey mangroves, on the Parramatta River. Mangroves are protected marine vegetation.

- The largest remaining stand of coastal saltmarsh on the Parramatta River. The endangered ecological community contains *Wilsonia backhousei,* a threatened saltmarsh plant in the Sydney region.
- One of the largest populations of the endangered Green and Golden Bell Frog in NSW
- Extensive waterbird breeding feeding and roosting habitats includes those used by internationally-protected migratory birds such as Bar-tailed Godwits, Sharp-tailed Sand-pipers and Latham's Snipe
- *Zannichellia palustris*, an endangered submerged aquatic plant protected under state legislation which is found within Bennelong Pond.

The Park also has a number of constructed freshwater wetlands and storage ponds which have been established on remediated land in the 1990s. The freshwater wetlands include:

Northern Water Feature and Eastern Pond – Runoff from a 100 hectare catchment including parts of the main central Town Centre drains to the Northern Water Feature. The Northern Water feature includes a water quality control pond. Water can be transferred from this pond into the Eastern Pond. Water is harvested from these ponds for irrigation and the Water Reclamation and Management Scheme (WRAMS). They are important habitat for the green and golden bell frog as well as birds.

Northern Water Feature

The Brickpit – The brickpit is a physically isolated catchment which contains a large storage which is the main storage for the WRAMS recycling scheme as well as habitat ponds and wetlands for Green and Golden Bell Frogs (GGBFs). The water storage reservoir is supplied by water pumped from the Eastern Pond and Northern Water Feature, direct rainfall on the isolated brickpit catchment, and treated effluent from the WRAMS wastewater treatment plant. The Brickpit is highly valued as GGBF habitat because it has supported a large and self-sustaining population of the species over a relatively long time period, has an isolated catchment, and is free of predatory fish.

Brickpit Water storage (right) and habitat ponds (left)

Lake Belvedere – Boundary Creek drains into the Lake which drains the southern part of Sydney Olympic Park as well as the suburb of Flemington. The Lake includes aerators to improve oxygen levels within the Lake.

The Lake is important for fish habitat and provides waterbird breeding habitat.

Lake Belvedere

Narawang Wetland – a 20 hectare, 1.6km reach of constructed wetlands and habitat ponds. The system provides flood mitigation, water storage and breeding habitat for the GGBF and other wildlife. The system treats runoff from a 105 hectare catchment including Newington, Parkland Junction and Hill Road.

The system includes three large water storage ponds which are used for parkland irrigation.

It receives flood waters from Haslams Creek in large events simulating a coastal floodplain environment as well as providing flood mitigation.

Narawang Wetland

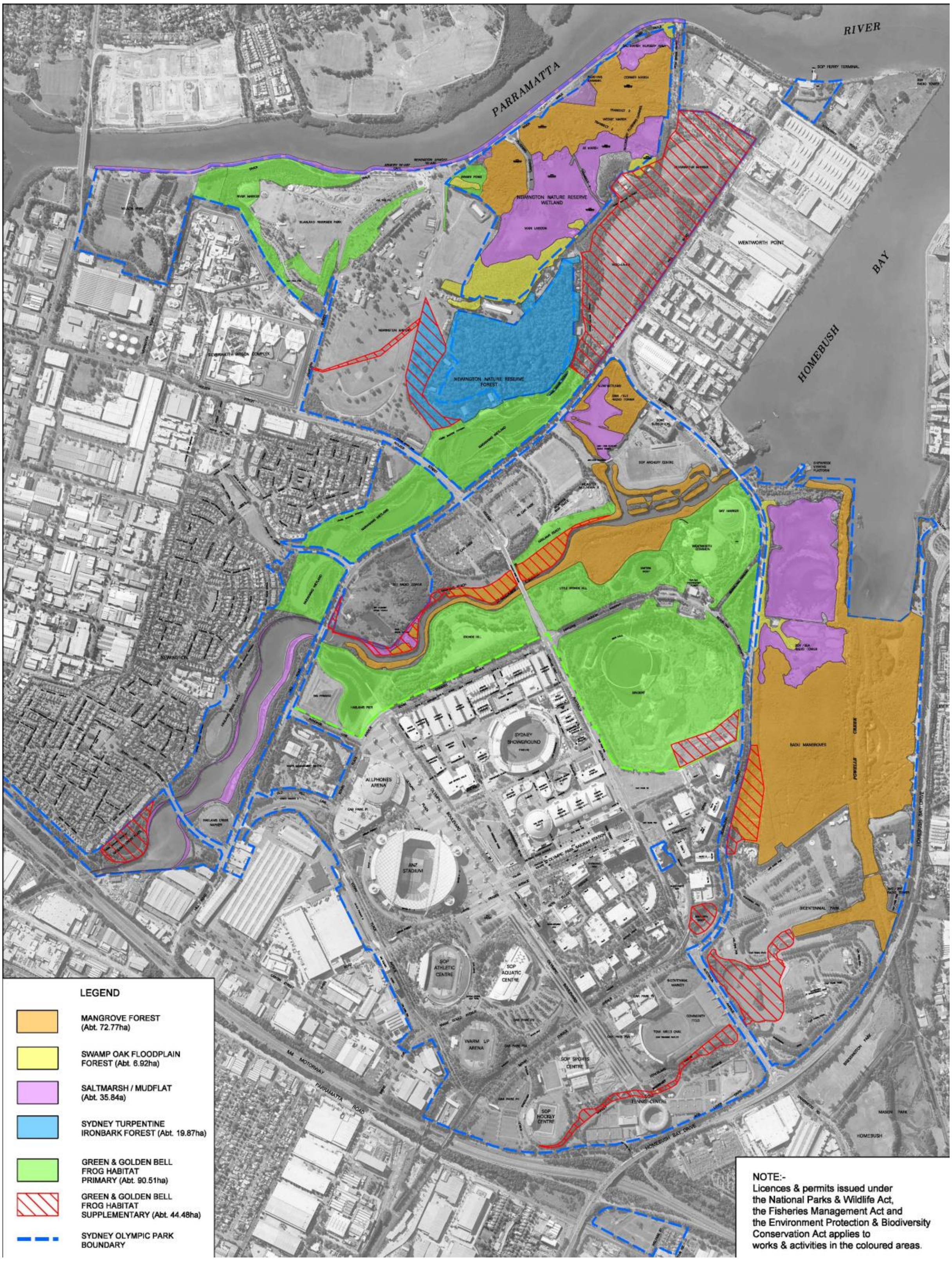


Figure 1 Key habitats of Sydney Olympic Park

2.2 Catchments

Sydney Olympic Park drains to the waterways of Haslams Creek, Powells Creek, Boundary Creek and the Parramatta River, typically through fringing estuarine habitat. Significant parts of the Town Centre drain to constructed freshwater systems, before discharging to these waterways.

A summary of the catchments and main receiving waters of Sydney Olympic Park is shown in Figure 2. This figure shows

- The central northern part of Sydney Olympic Park and the suburb of Newington draining to Narawang Wetland and Haslams Creek
- The western part of Sydney Olympic Park containing the main stadiums draining to the Northern Water Feature
- The central part of Sydney Olympic Park (Parklands Precinct and Central Precinct of the Town Centre) draining to Bennelong Pond and Badu Mangroves
- The southern part of Sydney Olympic Park draining to Boundary Creek and Lake Belvedere (note Lake Belvedere also receives flows from outside of Sydney Olympic Park which are not shown in this map)

Note that Figure 2, does not show the most northern part of the Park, including Wilson Park, Blaxland Riverside Park, Newington Armory and Ferry Wharf, which drain to Parramatta

Figure 2 Catchments of Sydney Olympic Park Town Centre

The Brickpit reservoir is an isolated catchment, which can receive pumped flows from the Eastern Pond. Flows into the Brickpit are tightly controlled to ensure that there is minimal risk to Green and Golden Bell Frog habitat. All flows into the reservoir need to be appropriately treated and screened prior to discharge into the reservoir.

2.3 Water Reclamation and Management Scheme (WRAMS)

Sydney Olympic Park has a non-potable water reuse system which recycles stormwater and wastewater for a range of non-potable uses for development within the Sydney Olympic Park area. The reuse system is called the Water Reclamation and Management Scheme (WRAMS). The WRAMS scheme has been successful at reducing demand by over 50% of Sydney's average with 850 ML/yr of recycled water supplied to over 15,000 end users. Work commenced on WRAMS in 1999 and the system was commissioned and operational prior to the Sydney 2000 Olympic Games. WRAMS was connected to the residential suburb of Newington in April 2001.

WRAMS is approved for use for:

- toilet flushing
- irrigation
- car washing
- external wash down
- construction
- clothes washing
- water features
- fire fighting
- cooling towers

The WRAMS system at the Park consists of the following components:

- Stormwater treatment infrastructure including Northern Water Feature treatment wetland and storage ponds, and the Eastern Pond and storage ponds,
- Stormwater harvesting infrastructure including pump systems, rising mains and filtration systems
- Wastewater treatment plant including a Sequencing Batch Reactor (SBR), Biological Nutrient Removal (BNR) and UV disinfection
- Storage in the Brickpit reservoir (approximately 300 ML of storage)
- A water reuse treatment plant consisting of membrane filtration, reverse osmosis and chlorination
- A dual reticulation system which supplies sporting venues, Town Centre developments and the suburb of Newington.

A schematic of the WRAMS scheme is shown in Figure 3.

Most of the irrigation demands for the Parklands are met by water from WRAMS as well as a stormwater harvesting and reuse system. Bicentennial Park, the largest irrigation demand, uses WRAMS water. Other irrigation demands are met using harvested stormwater and from WRAMS recycled water. The stormwater reuse includes storages in Narawang Wetland, the Northern Water Feature and the Eastern Pond.

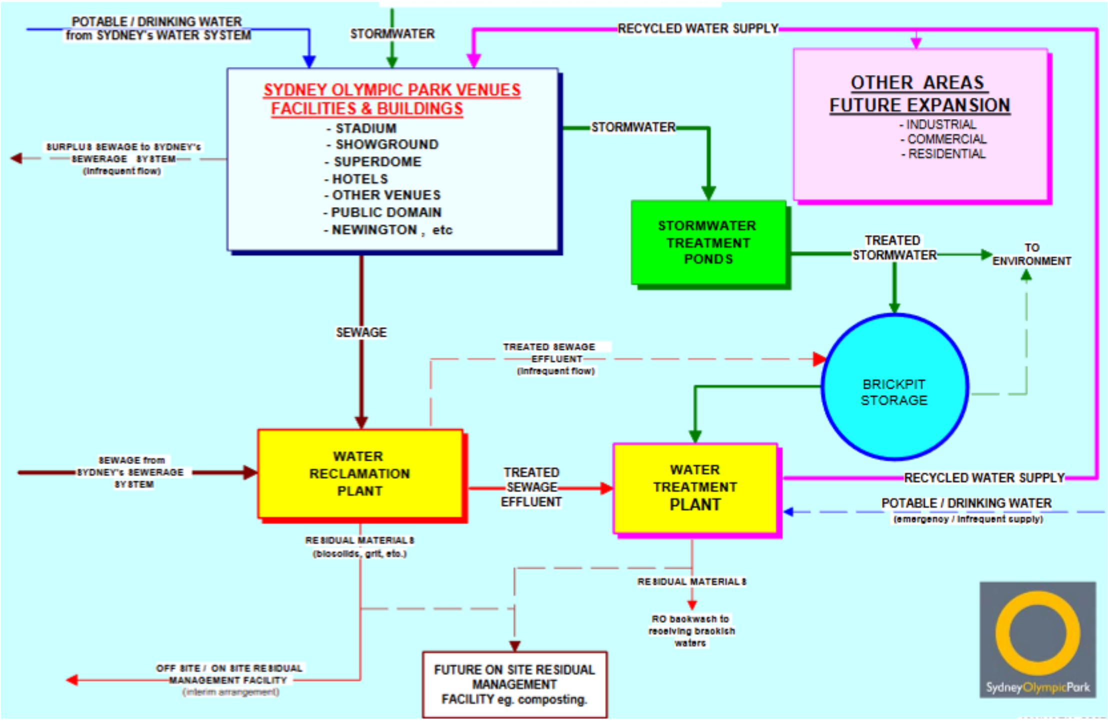


Figure 3 WRAMS schematic diagram (as of August 2000)

The eastern catchments draining to Bennelong Pond, Badu Mangroves and Lake Belvedere are not currently utilised for stormwater harvesting and reuse. Hence in these eastern catchments capture and harvesting of rainwater is required at redevelopment sites within the Park.

The Park also includes roof rainwater collection systems such as at Stadium Australia which harvests and stores water for irrigation.

2.4 Impacts of stormwater runoff

Stormwater runoff from new development has the potential to impact on both sensitive ecological receiving environments and the WRAMS recycling scheme. Inappropriately managed stormwater runoff during construction and post construction can have significant impacts to protected and sensitive flora and fauna as well as to water recycling infrastructure.

Sediment entrained in stormwater runoff during construction is a major concern at the Park. An example of the impacts that have occurred in the past at Sydney Olympic Park is shown in Figure 4. The top aerial image shows Bennelong Pond immediately prior to construction works commencing. The bottom figure shows the same site during construction with a large visible sediment plume in Bennelong Pond. Bennelong Pond contains threatened flora which is sensitive to smothering by sediment, reduced light visibility in the water column and change in levels due to sediment deposition.

Figure 4 Sediment impacts from construction runoff at Sydney Olympic Park

Exposed surfaces during construction are highly susceptible to erosion and need to be adequately controlled to protect downstream water recycling infrastructure and sensitive receiving waters.

Ongoing sediment deposition post construction, particularly fine particulate matter, is also an issue due to the volumes that are accumulated over time. If these are not captured prior to entering waterways they can have substantial impacts on both sensitive receiving waters as well as recycling infrastructure.

Poor water quality discharged from Sydney Olympic Park, such as stormwater high in nutrients can lead to algal blooms. An example of these algal blooms is shown on the right in the Brickpit Reservoir, the main storage reservoir for the WRAMS scheme. Poor water quality including hydrocarbons, heavy metals, pesticides, herbicides and other contaminants all have the

potential to impact on receiving waters and water management at Sydney Olympic Park.

Developments can also impact on downstream sensitive receiving waters by promoting and encouraging the growth of weeds. This can occur in two ways:

- The use of inappropriate plantings in the catchment are exported through cuttings or seeds downstream into receiving waters and which then establish in bushland, waterways or water bodies
- Through the deposition of stormwater and sediment high in nutrients, particularly phosphorous, encourage the growth of non-native invasive species which are more suited to high nutrient soil conditions and are able to out compete native species under these conditions

Examples of this can be found at Sydney Olympic Park for example in Bennelong Pond, receiving waters for the Parkview catchment.

The quantity of stormwater discharged at Sydney Olympic Park can also have significant impacts. Stormwater for examples discharges to sensitive mangroves which can lead to scouring and erosion and physical disturbance to mangroves and other receiving waters.

2.5 Soils

While the native soils of the Park are Blacktown Landscape soils with heavy clay B horizons, a significant portion of Sydney Olympic Park has a highly altered soil environment, with substantial areas of the Park with modified soils from land reclamation and landfilling activities. Large areas of the Park are affected by past practices of landfill which contains waste including power station ash, construction waste, asbestos, industrial hydrocarbons, hazardous chemical waste and dredged material from the Parramatta River.

The site soil conditions, including imported top soil material, heavy clay subsoils, areas of capped landfill, and history of poor quality groundwater limit the usefulness of infiltration to manage stormwater at the Park.

<u>Infiltration on or in close proximity to a landfill site is not acceptable in any circumstances.</u> It is recommended that at Sydney Olympic Park where stormwater treatment systems have potential to impact on former landfill areas or areas of impacted groundwater that they are lined with an appropriate impermeable liner such as 500mm of compacted clay, a 1.5mm thick HDPE liner or an equivalent low permeability geosynthetic clay liner.

Where infiltration is adopted, hydrogeological studies are required to confirm the underlying soil material and its capacity for infiltration. Also these studies need to assess whether infiltration must confirm that infiltration will not impact on leachate generation, remediated wastes, capping layers or increased exfiltration of poor quality groundwater from the site or any other adverse environmental impacts. The hydrogeological study is to be carried out by an experienced and qualified consultant.

In the 1990s the site was remediated with previous waste recovered, consolidated, and contained. Today ten engineered landfills remain at the site and extend over 105 hectares. The areas where waste material has been compacted and stored underground is shown in Figure 5. Use, management and development of these lands is regulated under the *NSW Contaminated Lands Management Act*, and specific provisions apply. Requirements must be discussed with SOPA.

Sydney Olympic Park also contains naturally occurring acid sulphate soils; an acid sulphate soil risk map is shown in Figure 6. These soils are found along Parramatta River and Haslams Creek. Acid sulphate soils which are expose to air, resulting in oxidation of the acid sulphate soils, produce significant quantities of sulphuric acid. The sulphuric acid leaches out of the soils and into waterways causing major impact on the receiving water chemistry and the ecology of the receiving water. Where acid sulphate soils have been disturbed, these materials have been contained on site in deep pits and mounds and capped.

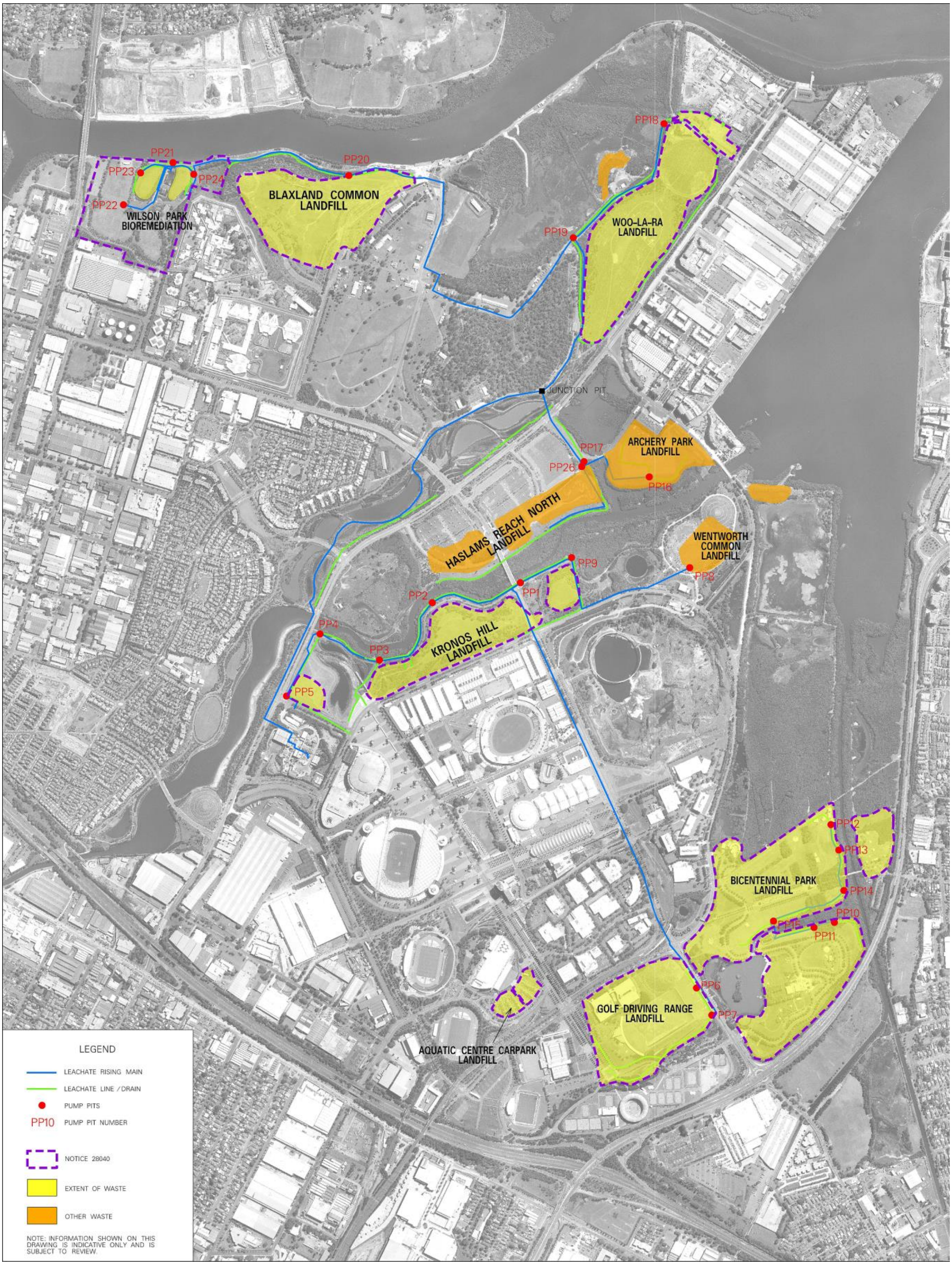
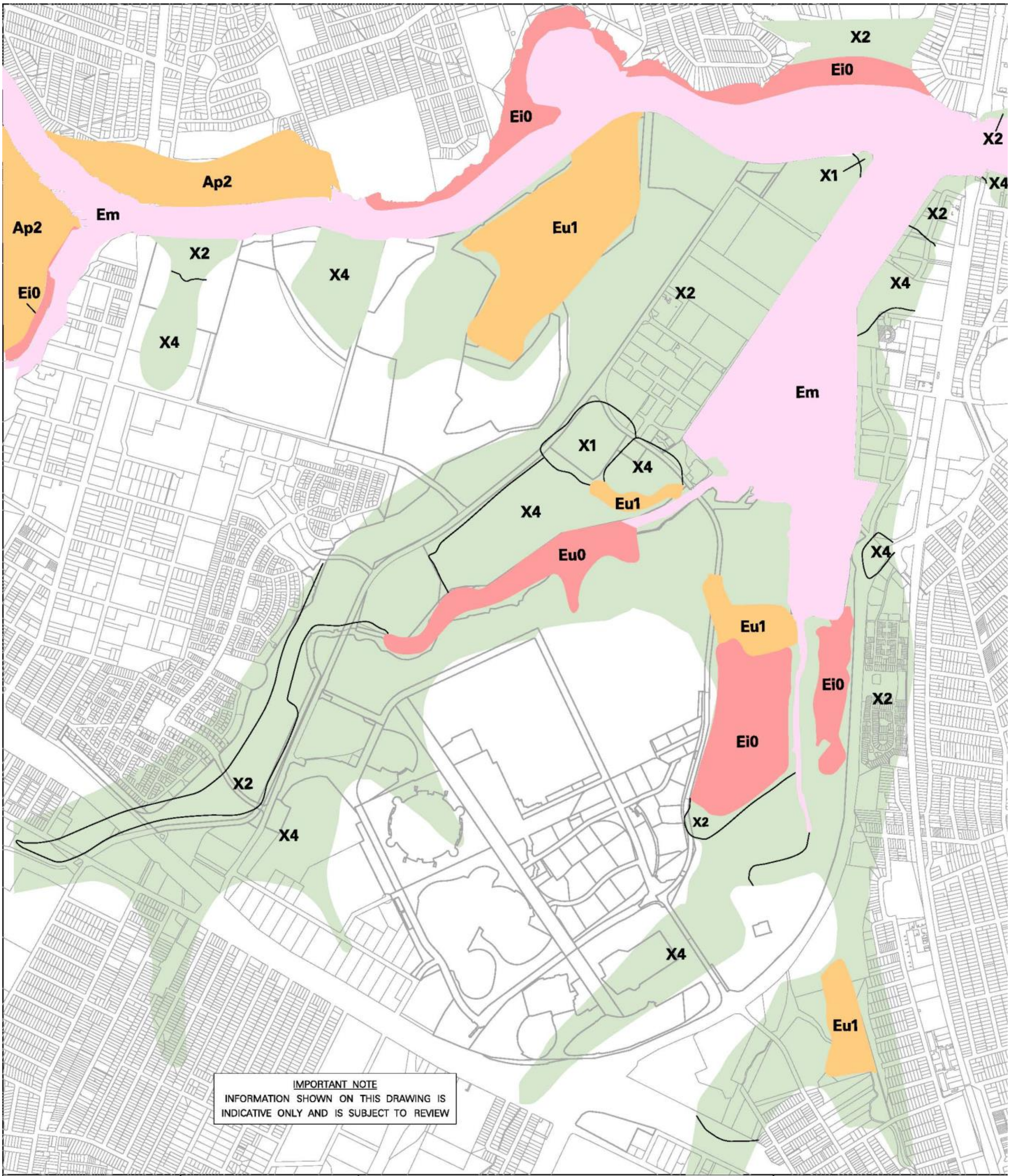


Figure 5 Remediated Lands



Map Class Description	Depth to Acid Sulphate Soil Materials		Environmental Risk	Typical Landform Types
HIGH PROBABILITY High probability of occurrence of acid sulphate soil materials within soil profile. The environment of deposition has been suitable for the formation of acid sulphate soil materials. Acid sulphate soil materials are widespread or sporadic and may be buried by alluvium or windblown sediments.	Below water level	Bottom sediments.	Severe environmental risk if bottom sediments are disturbed by activities such as dredging.	Bottom sediments of lakes, lagoons, tidal creeks, rivers and estuaries.
		At or near the ground surface.	Severe environmental risk if acid sulphate soil materials are disturbed by activities such as shallow drainage, excavation or clearing.	Estuarine swamps, intertidal flats and supratidal flats.
		Within 1 metre of the ground surface.	Severe environmental risk if acid sulphate soil materials are disturbed by activities such as shallow drainage, excavation or clearing.	Low alluvial plains, estuarine sandplains, estuarine swamps, backswamps and supratidal flats.
DISTURBED TERRAIN		Disturbed terrain may include filled areas, which often occur during reclamation of low lying swamps for urban development. Other disturbed terrain includes areas which have been mined or dredged, or have undergone heavy ground disturbance through general urban development or construction of dams or levees. Soil investigations are required to assess these areas for acid sulphate potential.		

Figure 6 Acid Sulphate Soil Risk Map

3 Implementation of stormwater management at Sydney Olympic Park

A general typical planning process has been developed to assist development applicants in the process of gaining preliminary advice and accessing relevant information to assist in the development of a strategy and design for managing stormwater quality, quantity and reuse. This is outlined in Figure 7. Early engagement with SOPA is encouraged during the planning and design process to ensure that the policy requirements are met.

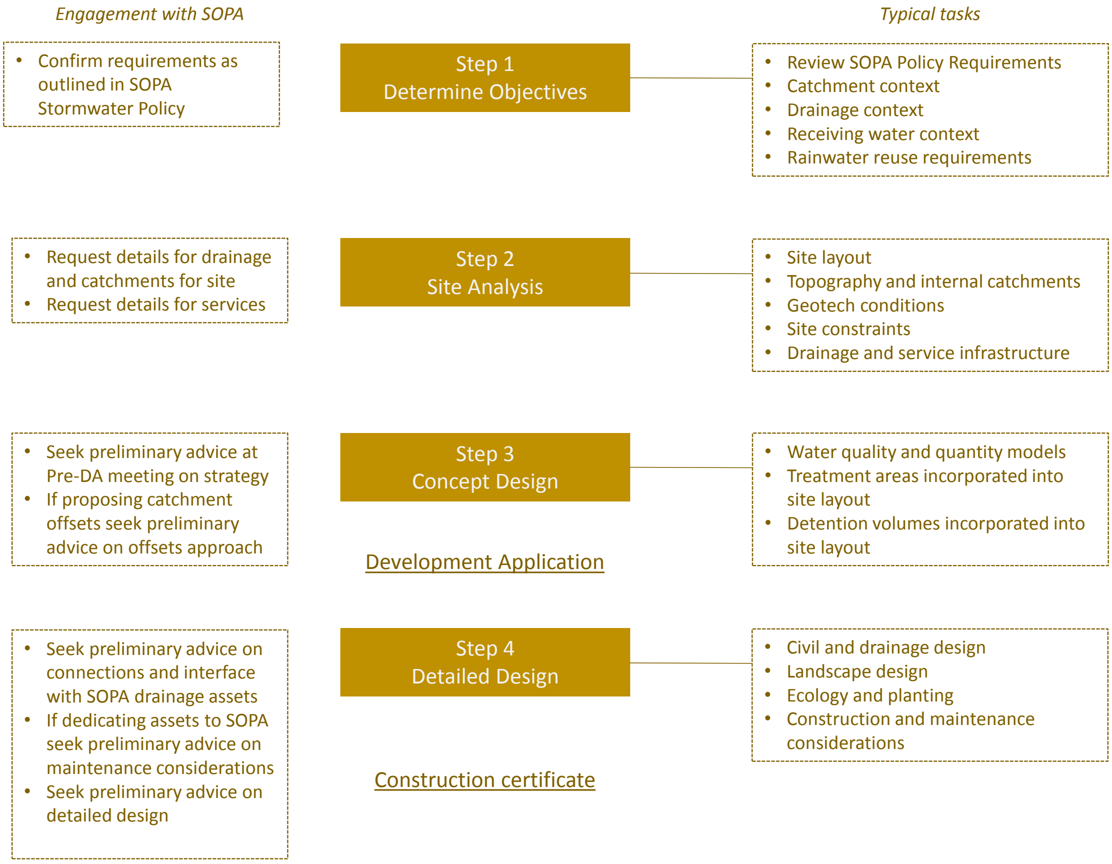


Figure 7 Planning process for stormwater management

3.1 Step 1: Determine Objectives

The first step in the planning phase is to clearly establish the project objectives required for the project site. Objectives and targets vary depending on the site and its catchment context in the Park, and hence it is important that the context of the site in relation to the Park's catchment and receiving water is established in the early phases of the project.

To gain an understanding of the hydrologic context at the Park it is recommended to read Chapter 2 of this document and to discuss with SOPA if there is any uncertainty about the site and its hydrologic context.

SOPA's policy contains four key elements:

- Stormwater quality management during the construction phase
- Stormwater quality during the operating phase (post construction)
- Stormwater peak flow reduction requirements
- Stormwater reuse requirements

The policy for each of these components is clearly outlined in detail in the Sydney Olympic Park Policy document and proponents must be familiar with this document to establish the quantitative stormwater management objectives for the site. It is also recommended that applicants seek preliminary advice from SOPA to confirm the objectives and targets.

All proposals will be considered on their merit, and consideration will need to be given to SOPA's preferred asset types which have been developed based on local site constraints, maintenance requirements and/or safety requirements. Hence, during this Step applicants should also discuss SOPA's preferred WSUD systems and WSUD system requirements. Further information is provided in Chapter 4 of this report on preferred WSUD asset types.

3.2 Step 2: Site Assessment

During this phase it is required to undertake a detailed site assessment to understand the local site conditions. The site assessment should include site investigations (survey, geotech, arborist report, etc), site visit and desktop study. The type of information that should be reviewed as part of the site assessment includes:

- Site layout
- Topographic information including contours
- Underground services
- Potential sediment and erosion risks during construction
- Geotechnical characteristics
- Existing trees
- Ecological features
- Cultural heritage features
- Planning constraints
- Climatic conditions
- Upstream catchments (particularly those draining onto or through the site)
- Catchment hydrology
- existing drainage systems
- Downstream receiving waters

The site assessment must be documented and any implications for the development of the concept design should be clearly stated.

During this step it is recommended to request information on Sydney Olympic Park's drainage and services Geographical Information System (GIS) data to assist in preparing the development application. The GIS data represents the best information available on drainage assets as well as other services, but may not be complete and accuracy cannot be relied on.

3.3 Step 3: Concept Design

A concept design is to be developed which meets the required WSUD objectives for the site, gives consideration to SOPA's preferred WSUD assets and the outcomes of the site assessment. During this phase it is highly recommended to explore a number of options to meet the objectives for the site to ensure that the best outcome is achieved for the site.

The integration of all stormwater management elements with existing or proposed drainage systems and the proposed site layout and landscape design should be thought about during the early stages of the development planning process. The integration of WSUD with the drainage system will likely influence the preferred type of stormwater management asset and its location within the site which will in turn influence the site's development layout.

The concept design needs

- to meet all of the objectives for the site
- to be clearly and logically incorporated into the site layout.
- consider SOPA's preferred treatment systems
- to be modelled using water quality modelling and hydrology and hydraulic modelling to confirm that the proposed concept design will meet the targets
- to include appropriately sized sediment basin designs to manage erosion during construction and all other sediment and erosion control measures
- Include a detailed Soil and Water Management Plan for the site
- to meet any SOPA site specific design requirements
- to ensure that future maintenance requirements are adequate including appropriate access is provided to all components of the stormwater management system

The concept design submission must include:

- Design report including objectives and site assessment
- Summary of the modelling outcomes
- Hydraulic models and water quality models
- Sediment and erosion control calculations
- Plans showing all of the proposed management measures to meet the objective including building hydraulics, drainage, contours and catchments

For full details on the design report requirements refer to section 3.5 and 3.6.

It is recommended to undertake a pre-DA meeting with SOPA to discuss your proposal and gain initial feedback on preliminary concept designs.

Where proponents are considering the use of catchment offsets to achieve the targets it is strongly recommended that early engagement with SOPA is undertaken to gain preliminary advice on whether the catchment offset approach is acceptable to SOPA. <u>Failure to do so, may result in delays in progressing development applications.</u>

3.4 Step 4: Detailed Design

During this stage of the planning process the detailed design is to be progressed based on the approved concept design. The detailed design will develop detailed design drawings, technical specifications, construction methodology a Final Soil and Water Management Plan and a design report as well as any other required design documentation.

During detailed design the designs needs to consider

- Site access (for construction and maintenance) for staff and machinery/vehicles
- Safety considerations during construction
- Public access
- Appropriate signage to identify risks (for example deep water, use of recycled water, confined spaces etc.)
- Vegetated batters– steepest 1 in 4 for vegetated batters and 1 in 6 for turf
- Risks of using recycled water, refer to NWQMS Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2) – Stormwater Harvesting and Reuse (2009)
- Flood depths and velocities
- Development in flood-prone areas
- Locations of existing services

3.5 Integrated Water Cycle Management Plan Submissions

The minimum information required to be submitted with a development application includes requirements for reporting on stormwater quality treatment, stormwater detention, stormwater reuse and construction stage management. These reporting requirements are required to allow for assessment of the development application and are specified in detail below.

An integrated water cycle management plan is to be submitted with a development application and is to include the following as a minimum:

(a) Clearly demonstrate how the proposal meets the policy objectives and specifically how the proposal achieves the outcomes required in Attachment 1 of the Policy.

(b) Provide a description of how all stormwater generated on the site will be managed and include a water balance report.

(c) Assessment of the impact of flows on the receiving environment, the capacity of downstream infrastructure to manage such flows, and any required enhancement works proposed to be implemented

(d) Show all stormwater catchments for the site including an assessment of whether the site is in a SOPA stormwater harvesting or non-stormwater harvesting catchment as per Map 1

(e) Include a site layout and drainage plan showing the location of each element of the proposed stormwater system and treatment train

(f) Show all stormwater drainage system elements for the site including long sections for all drainage elements including hydraulic grade line calculations

(g) Show all elements of the detention system including sufficient sections and details demonstrating how the system is to operate.

(h) Confirm the entire site is included in the detention sizing calculations, including land to be dedicated to SOPA (such as future public roads, community facilities and the like)

(i) Show all elements of the stormwater treatment system including sufficient sections and details demonstrating how the system is to operate and the diversion flow rate into the treatment system.

(j) Confirm the entire site is included in the water quality sizing calculations including land to be dedicated to SOPA (such as future public roads, community facilities, and the like)

(k) Confirm on site detention systems are not to be included in the calculations for water quality

(l) Provide justification of why each element of the treatment system has been selected over alternate approaches.

(m) Provide details of all stormwater connections to the existing SOPA stormwater system, including the capacity of downstream infrastructure to manage such flows and any upgrades required.

(n) Provide details of the overland flow system and calculations to demonstrate the capacity to safely convey flow through the site including DxV calculations

(o) Provide all calculations showing how the intent of the SOPA Stormwater Management and Water Sensitive Urban Design Policy is met, including:

  (i) Design assumptions including design rainfall events used to size rainwater tanks and water sensitive urban design elements. Relevant parameters specified by SOPA for use at Sydney Olympic Park are to be used in all strategies. Any variation from these parameters are to be clearly documented and justified.

  (ii) water quality model (MUSIC model)

  (iii) hydraulic model including detention (Drains model)

(p) An electronic dwg file of the sub-catchments and proposed stormwater system including all detention, reuse and treatment elements

(q) Where offsets are proposed, provide a description of the offsets and demonstrate how they meet the policy objectives and the outcomes required in Attachment 1 of the Policy.

Reporting on MUSIC modelling within the Integrated Water Cycle Management Plan is required to include the following (consistent with the MUSIC modelling guideline):

(a) Rainfall station used (consistent with the MUSIC modelling guideline)

(b) Pervious soil parameters used (or statement that they are consistent with the MUSIC modelling guideline)

(c) Pollutant generation parameters used (or statement that they are consistent with the MUSIC modelling guideline)

(d) Catchment map showing all sub-catchments and with an accompanying catchment map

(e) Impervious percentages for all catchments and justification for the adoption of these impervious percentages using measurements off the concept plan

(f) All details of the treatment system as entered into MUSIC (e.g. low flow and high flow bypass, filter size, extended detention, infiltration rate, hydraulic conductivity, rate, etc.). All parameters need to be consistent with the MUSIC modelling guideline

(g) For rainwater tanks and reuse schemes the

  i. user demand profile that has been adopted

ii. the size of the rainwater tank (kL)

(h) Summary of the results (Flow, TSS, TP and TN) without any treatment measures ("Do Nothing")

(i) Summary of the results (Flow, TSS, TP and TN) with proposed treatment measures for each option tested

(j) Summary of the results (Flow, TSS, TP and TN) with proposed treatment measures for proposed preferred option including comparison of results with the "Do Nothing" option including

i. a total summary of the treatment (kg/yr and % reduction)

ii. for each component of the treatment system (kg/yr and % reduction)

(k) For any parameter which deviates from the default recommended value as outlined in the MUSIC modelling guideline documentation of the values adopted and justification for the values adopted

An electronic copy of the following must be provided with the development application and made available to SOPA:

(a) MUSIC model

(b) Drains hydraulic model

(c) Dwg of the sub-catchments and proposed stormwater system including all detention, reuse and treatment elements

For sediment and erosion control A Draft construction management plan that addresses section 7 of the Policy, and includes an Erosion and Sediment Control Plan, or a Soil and Water Management Plan (as applicable and based on the NSW Blue Book). The Plan is to contain the following information:

(a) Calculation of average slope of disturbed area

(b) Soil classification group

(c) Emerson Class Number

(d) Duration of soil disturbance

(e) Area of disturbance

(f) Potential waterway impact

(g) Documentation of any external catchments entering the site

(h) Calculation worksheet for sediment basins and justification of sizing of sediment basins

(i) A plan showing the following as a minimum:

i. location and direction of temporary drainage showing flows into the sediment basin

ii. Identification of any problematic soils including acid sulphate soils

iii. Identification of key environmental values on site (e.g. existing trees to be retained, habitat areas and/or existing drainage lines of value)

iv. Construction access points and control measures at those locations

v. Site contour map Including existing, and proposed

vi. Location of temporary stockpiles

In addition the following documentation also needs to be provided as part of a development application submission:

(j) A Draft establishment, handover and operation and maintenance plan that addresses section 8 of the Policy and applies to all stormwater management devices including water quality, detention and reuse components

(k) A completed policy compliance checklist (refer Attachment 4 of the Policy)

Refer to the Technical Guidelines document for details on hydraulic modelling requirements.

3.6 Checklist

A checklist has been developed which is included in Attachment 4 of the Stormwater and Water Sensitive Urban Design Policy which must be submitted with the development application.

4 Stormwater Management Measures

The following table summarises the feasibility and SOPA preferences for various treatment and reuse systems at Sydney Olympic Park to meet the policy outcomes.

Table 1 Summary of preferred management measures

Treatment System	Preferred	Not permitted	Notes
Bioretention system			
GPTs			Used as a primary treatment system measure
Proprietary treatment systems			Not preferred if preferred measures are feasible
Wetlands			
Swales			Can be used for drainage systems
Rainwater tanks			Optional in SOPA's Northern and Eastern catchments
Infiltration systems			Due to site soils, infiltration systems will have limited applicability in the Park.
Ponds		Water quality	Not permitted as a key measure to manage water quality. Can be used for reuse, detention, and for landscape features
Sediment basins	Construction phase	Operation phase	Sediment basins are required for sediment and erosion control
Detention basins	Flow reduction	Water quality	Detention basins are not permitted as part of a water quality treatment train
Buffers	Podium drainage		
Media (sand filters)			Only permitted if other measures are demonstrated to be un-feasible
Green roofs			
Podium vegetated areas	Podium drainage		

Table Key

Preferred Option	
May be acceptable if preferred option not feasible	
Not permitted	
Not permitted for specified use (e.g. "water quality")	Water quality

4.1 Stormwater management reference guidelines

As summarised in Table 2 SOPA adopts the following guidelines as reference guidelines for a number of treatment systems. These reference guidelines are relevant for the following systems:

- Bioretention systems

- Wetlands
- Swales,
- GPTs – Coarse material
- Media (sand) filtration system
- Buffer strips

Table 2 Summary of reference guidelines at Sydney Olympic Park

Phase	**Reference Design Guideline**
Concept Design	Concept Design Guidelines for WSUD (Water By Design, 2009)
Technical Design	Bioretention Technical Design Guidelines (Water By Design, 2014) WSUD Technical Design Guidelines (Water By Design, 2006)
Construction and establishment	Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands (Water By Design, 2010)
Operation and maintenance	Maintaining Vegetated Stormwater Assets (Water By Design, 2012)
Green Roofs	Green Roof Design Resource Manual (City of Sydney) Growing Green Guide: Victoria's Guide to Green Roofs, Walls and Facades (2013)

For other management systems, not referred to in Table 2, refer to the following sections for further details.

Proponents are to submit planning, design, construction and operation consistent with these guidelines. If the proponent's submission is not consistent with these guidelines details are to be submitted on the variation from these guidelines and justification for the variation from the guidelines.

The following sections outline specific advice on treatment systems at Sydney Olympic Park. This guidance is provided as the above guidelines typically do not cover these elements or provide guidance on these elements.

4.2 Proprietary treatment systems

Proprietary cartridge treatment systems have some capacity to remove fine sediment and nutrients. The cartridge filters typically contain either, media placed inside a removable cartridge, or membrane filters within a cartridge. Cartridge filters work predominantly through the process of filtration, settling of sediment and sorption of pollutant particles to the media within the cartridge.

Sydney Olympic Park Authority adopts the model with the nodes for use of proprietary treatment systems as developed and used by Blacktown City Council. Proponents need to contact Sydney Olympic Park Authority to obtain these models. The nodes within the model set the removal rates for pollutants within MUSIC. This model must be used if proprietary treatment systems are to be adopted to meet the policy requirements.

4.3 Rainwater Tanks

Rainwater tanks are required in non-stormwater harvesting catchments at Sydney Olympic Park. For full details refer to the rainwater reuse technical manual.

4.4 Infiltration Systems

Infiltration measures encourage stormwater to infiltrate into surrounding soils. Infiltration measures are highly dependent on local soil characteristics and are best suited to sandy and sandy clay soils with deep groundwater.

Due to the clay soils and legacy of past industrial practices at Sydney Olympic Park infiltration is generally not recommended due to its limited ability to manage stormwater.

If infiltration is being proposed at Sydney Olympic Park it is strongly encouraged to discuss the proposal with SOPA early in the design process to gain preliminary advice. Where infiltration is proposed as a minimum a detailed geotechnical assessment is required to be undertaken.

4.5 Ponds

Stormwater ponds are permanent waterbodies and consist predominantly of open water eg Lake Belvedere, Narawang wetland storage ponds. Ponds are relatively deep (average depth greater than 1m) compared to wetlands. While ponds may have some limited vegetation around the edge of the treatment system, unlike wetlands they have relatively limited areas of wetland vegetation planting. Well designed ponds are able to effectively capture sediment, typically through efficient settling. However, ponds are less effective at removing dissolved nutrients and also are susceptible to re-release of captured nutrients. Ponds are highly susceptible to stratification, particularly during periods of low inflow, and high temperatures. In these conditions nutrients are re-released into the water column which are exported downstream during the next rainfall event and also lead to algal blooms.

Also due to the nature of high density residential and commercial development at Sydney Olympic Park ponds are not recommended at Sydney Olympic Park as part of the stormwater treatment train.

Ponds are generally acceptable as part of a stormwater detention, stormwater reuse and/or landscape element if and only if the stormwater water discharged into the pond is treated to the same level that would meet the pollutant load reduction targets in the policy. The pond in this instance is not to be included as part of the water quality treatment train, but may be included as peak flow reduction calculations (hydraulic models) and stormwater reuse (water balance models) if appropriate.

If ponds are being proposed at Sydney Olympic Park it is strongly encouraged to discuss the proposal with SOPA early in the design process to gain preliminary advice. Where ponds are proposed as a minimum a detailed geotechnical assessment is required to be undertaken.

4.6 Sedimentation Basins – Construction Phase

Sites with a cleared area of greater than 2500 m^2 require a sediment basin as part of a Soil and Water Management Plan. A sediment basin to control erosion and sediment from the site is required for every catchment discharging from the site.

In accordance with the Blue Book, some small flat sites or sites with minimal stormwater discharge from the site during construction, may not require a sediment basin. If a sediment basin is not being proposed it must be demonstrated that the average annual soil loss from the total area of land disturbance is less than 150 cubic metres per year. Soil loss must be calculated in accordance with Appendix A of the Blue Book. In such circumstances, alternate measures must be employed to protect the receiving waters.

The sediment basin is to be designed

- According to the NSW Blue Book (section 6.3.4 and Appendix E). The calculations of the sediment basin size must be submitted with the Development Application.
- For Type D soils (unless otherwise demonstrated by an analysis of site soils by a qualified geotechnical consultant and which must be submitted with the development application).
- For all events up to the peak flow rate from the 1 in 10 year ARI event for the site for the 5 day rainfall event
- A gypsum flocculant is to be added to the sediment basin in accordance with Appendix E of the Blue Book (note that Alum is not to be used as a flocculant at Sydney Olympic Park).
- A daily and weekly site inspection checklist consistent with IECA Best Practice Erosion and Sediment Control documents are included as part of the sediment plan

The key factors to be adopted for construction phase sediment basin design are outlined in Table 3.

Table 3 Construction Phase Sediment Basin Design Parameters

Parameter	Recommended Design
Soil Type	Assume that the soils are Type D soils unless site soil investigations are able to clearly demonstrate otherwise. Type D soils are soils with fine sediment, and this is typical of the shale derived clay soils at Sydney Olympic Park as outlined in section 2.5.
Flocculant	Required. Flocculant to be used is gypsum. Alum is not to be used without specific approval of SOPA due to the ecological sensitivity of receiving waters. As sediment basins rely on settling to function effectively for clay soils with fine particles settling times are very long and typically

	not achieved in a standard sediment basin. Hence a flocculant is required to be added to aid in the settlement of fine particles.
Flocculation Method	It is essential flocculant is to be spread very evenly over the entire basin surface for proper treatment. Refer Blue Book for recommended methods of dispersal. Gypsum should be applied at a rate of about 30 kilograms per 100 cubic metres of stored water.
Rainfall depth	5 day rainfall depth is to be adopted
Percentile Storm Depth	85th percentile due to the sensitivity of the receiving waters
Rainfall Location	Adopt Ryde as Per Table 6.3a and 6.3b in the Blue Book
5 day 85%ile rainfall depth	38.8 mm (based on Ryde data)
Sediment zone requirement	Sediment Zone = $= \frac{0.17 \times A (R \times K \times LS \times 1.3 \times 1.0)}{1.3}$ A = catchment area (hectares) R = rainfall erosivity factor, refer section A2 of the Blue Book K = soil erodiblity factor, refer section A3 of the Blue Book LS = Slope Length refer section A4 of the Blue Book

The proponent is to include the calculation worksheet as outlined in Appendix J2 of the Blue Book. This worksheet is to be included with a DA submission.

4.7 Sedimentation Basins – Operational Phase

Sediment basins are used to retain coarse sediments from runoff. They operate by reducing flow velocities and encouraging sediments to settle out of the water column.

They are frequently used for trapping sediment in runoff during construction activities and for pre-treatment to measures such as wetlands (e.g. an inlet pond). They can drain during periods without rainfall and then fill during runoff events. They are sized according to the design storm discharge and the target particle size for trapping (generally 0.125 mm).

At Sydney Olympic Park, sediment basins are required during the construction phase, to control sediment and erosion discharge from the site. However MUSIC is not to be used to size sediment basins for this phase of development. Sediment basins are to be sized in accordance with the 2004 'Blue Book' as outlined in the stormwater technical manual.

Post construction, due to the nature of development, with predominantly high density residential and commercial development sediment basins are not recommended at Sydney Olympic Park. Large open water sediment basins are generally not accepted as part of the pollutant removal train.

If sediment basins are being proposed as part of the operational phase treatment train it is strongly encouraged to discuss the proposal with SOPA early in the design process to gain preliminary advice. Where sediment basins are proposed as a minimum a detailed geotechnical assessment is required to be undertaken.

In some instances sediment basins may be appropriate as underground treatment systems. Sediment basins must have a permanent pool volume with a minimum depth of 0.5m (i.e. on site detention basins with no permanent pool are not considered sediment basins)

4.8 Detention basins

On site detention basins are an important management measure to assist in meeting the peak flow reduction targets. Refer to SOPA's *Technical Stormwater Management Manual* for full details on detention basin design and modelling for this aspect of detention basins.

On site detention is not to be included as part of the stormwater quality treatment train. On site detention basins are not to be included in MUSIC models as on-site detention is not able to provide any significant water quality improvements. Detention basins which have a permanent sump can be modelled as sediment basins provided they meet the minimum requirements for sediment basins.

4.9 Buffer strips

Proponents are encouraged to use buffers particularly for podium drainage areas where hardstand areas (paved areas) can be directed to vegetated areas before they are directed to stormwater drainage. Proponents are to refer to the reference documents outlined in section 0 for design and construction details and the MUSIC modelling guideline

4.10 Green roofs

A green roof is a fully vegetated area built upon a roof structure. The roof structure is protected by a high quality waterproofing and root repellent system. The green roof consists of a drainage layer, a filter cloth and/or root repellent layer, a growing medium and plants, and typically a mulch layer.

Sydney Olympic Park Authority is looking to encourage the uptake of green roofs due to the multiple benefits provided by green roofs. Proponents are to refer to the reference documents outlined in section 0 for reference guidelines for green roof design and the MUSIC modelling guideline.

4.11 Podium vegetated areas

In high density developments in Sydney Olympic Park, the typical pattern of development is for podium courtyards and landscaped areas located on top of basement carparks. Typically these podium areas have a combination of paved and other hardstand areas and landscaped areas including garden beds and lawn. Typically these landscaped areas are designed in similar ways to a bioretention system as they contain subsoil drains and waterproof membranes to prevent water ingress into the basement carpark below.

SOPA is looking to actively encourage the use of vegetated podium landscape areas to treat stormwater runoff particularly from adjacent podium areas, as well as where possible adjacent roof drainage. This provides multiple benefits including cost effective stormwater treatment, dual use of landscaped areas, passive irrigation and reduction in potable water use, and a reduction of the local microclimate (reducing temperatures).

4.12 Water quality offsets

SOPA allows for water quality offsets to be considered as per the SOPA Stormwater and WSUD Policy. Water quality offsets are typically undertaken by treating a catchment outside of the subject development site and through treating the external catchment achieve the same (or better) pollutant load reduction required for the development site. This allows a portion, or all, of the subject development site to pass untreated.

This can be beneficial in a number of instances including when it is difficult to drain all the site to one location, space is limited for treatment systems for some parts of the site, basements limit the potential to use some treatment systems, it may be more cost effective to treat an external catchment, etc.

Water quality offsets can be a particularly beneficial way to meet the water quality requirement stretch target requirements.

Offsetting is mostly likely to occur in three ways at Sydney Olympic Park (in order of likelihood):

1. Treatment of adjacent public road runoff (and any adjacent catchments which drain to the road) which is not part of the subject development site but which could be treated in kerbside raingardens or street tree bioretention systems
2. Where SOPA's trunk drainage system passes through a site or close to a site and where it is feasible to treat this system by diverting a portion or all of the flows into a treatment system onto the subject development site
3. Where SOPA's trunk drainage system passes through a site or close to a site and where it is feasible to treat this system by diverting or all or a portion of the flows onto a treatment system on adjacent SOPA land which is not constrained by other existing or future uses

In all instances of offsetting, it is strongly recommended to seek preliminary advice from SOPA as to the feasibility of an offsets approach. Furthermore, consultation with SOPA is essential for option 3 above where water quality offsets are being considered on SOPA land.

Where any offsets are being proposed on SOPA land or modifying SOPA's drainage system SOPA approval is required and approval for this should be sought from SOPA as early as possible in the design process.

In diverting flows onto the site for treatment

- proponents must ensure that there is no adverse impact on flooding upstream or downstream of the diversion.
- Weirs or pumped diversions to divert flows from a SOPA stormwater asset are not acceptable. Diversions are to occur using a sump or similar arrangement which do not restrict flows in the main drainage system
- Proponents must ensure that any flows diverted onto the proposed offset treatment area can be safely conveyed through the area and do not cause flooding or drainage issues on the site.
- Proponents must ensure that there are no catchment transfers in diverting flows. Catchment transfers may be acceptable in some circumstances where it can be demonstrated that there is no impact on flooding or downstream receiving water and must have in-principle support from SOPA prior to DA submission.

Proponents are to refer to the MUSIC modelling guideline for details on modelling catchment offsets.

SydneyOlympicPark

Sydney Olympic Park Authority Guidelines

Rainwater Tank Guideline

A guideline under the Sydney Olympic Park Authority
Stormwater Management and Water Sensitive Urban Design Policy

Prepared by Knights and McAuley
October 2016

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Table of Contents

Related documents

This Guideline is one of a set of technical guidelines produced by Sydney Olympic Park Authority to assist proponents in implementing the Stormwater Management and Water Sensitive Urban Design Policy. Each Guideline covers a different aspect of policy implementation. The Policy should be read in conjunction with these Guidelines.

Guidelines may be accessed on the website of the Sydney Olympic Park Authority: www.sopa.nsw.gov.au/resource_centre/publications

1 INTRODUCTION

Sydney Olympic Park drains to sensitive receiving environments, including mangroves, saltmarshes and swamp oak floodplain forest. Stormwater flows from urban development can have significant impacts on the vegetation and ecology of these ecological systems[1]. Stormwater quality and quantity are both important in these environments.

At Sydney Olympic Park rainwater harvesting refers to the capture, storage and reuse of runoff from roofs for reuse for non-potable use. It is one of the few effective ways in managing stormwater quantity management at Sydney Olympic Park. Rainwater harvesting can reduce the frequency and volume of stormwater runoff, by capturing roof runoff and storing it for reuse. While rainwater tanks connected to multi-storey residential or commercial buildings typically only meet a small proportion of total water demands, they can significantly reduce stormwater runoff because the rainwater tanks are subject to high demands and are therefore emptied quickly and hence have capacity to capture runoff when the next rain event occurs.

Rainwater harvesting reduces the quantity of stormwater runoff and therefore also reduces pollutant loads. While rainwater is cleaner than stormwater from ground surfaces, it still can still contain pollutants, including fine sediment, heavy metals, pathogens and nutrients.

Rainwater harvesting is required in non-stormwater harvesting catchments of Sydney Olympic Park. Non-stormwater harvesting catchments are defined as those catchments which aren't harvested as part of WRAMS (the Park's water Reclamation and Management Scheme). For further details on WRAMS and the non-stormwater harvesting catchments refer to the map in the Sydney Olympic Park WSUD Guideline for details.

Rainwater can be used in residential buildings for the same purposes as recycled water (at Sydney Olympic Park this means toilet flushing, laundry and outdoor demands, which are also able to be supplied by the WRAMS scheme). In non-stormwater harvesting catchments, rainwater is to be used as the primary supply for these non-potable uses, with backup supply from WRAMS. Rainwater use will not be able to meet all of the potable water demands and hence recycled water will still need to be supplied for times when rainwater is unavailable.

This document provides guidance on how to design a rainwater harvesting system at Sydney Olympic Park. It should be read in conjunction with other technical Guidelines produced by Sydney Olympic Park Authority to support implementation of the Stormwater Management and Water Sensitive Urban Design Policy. These Guidelines are available on the Authority's website.

[1] Refer to Sydney Olympic Park's WSUD Guideline for further details on the receiving waters.

2 DESIGNING AND SIZING THE RAINWATER TANK

2.1 Roof area

A minimum of 95% of the total roof area is to connect to the rainwater tank, and ideally the entire roof area will be connected to the tank. A high percentage of roof area is required to connect to the tank in order to maximise the benefits of stormwater runoff reductions.

In most cases, the whole roof area will be able to drain to a rainwater tank. In some cases, there might be a portion of the roof area which is impractical to drain to a rainwater tank (for example, a small isolated area of roof, separate from the main building/s).

When undertaking modelling to size rainwater tanks, only the roof area which will be connected to the rainwater tank is to be included in the model.

2.2 Water demands

The rainwater tank is to be connected into non-potable demands including:

- Washing machines
- Toilet flushing
- Outdoor use
- Garden irrigation
- Fire fighting
- Cooling towers

As outlined in further detail in section 4.1 it is not recommended to connect the rainwater tank to potable end uses.

It is recommended that the most practical and cost effective option in most cases at SOPA will be to connect the rainwater tank into the same system as the WRAMS scheme. This will minimise the requirement for additional pipework, and rainwater is suitable for all of the end uses to which WRAMS is supplied.

In order to size the rainwater tank appropriately, there is a need to understand the demands which it will be connected to. Water demands need to be broken down into different end uses to understand the demands for rainwater. Guidance on estimating water demands at Sydney Olympic Park is provided below, for residential and commercial buildings.

2.2.1 Residential buildings

New residential apartment buildings designed to meet best practice standards typically have water demands of less than 200 L/bedroom/day (Green Strata, 2016). It is recommended that 200 L/bedroom/day is adopted as the expected demand in residential buildings at Sydney Olympic Park.

This figure includes potable and non-potable demands. A typical breakdown into different end uses is shown in Figure 1. This shows that apartment toilets, washing machines, cooling towers, pool and spa and public area amenities make up approximately 24% of total demands, or 48 L/bedroom/day. It is recommended that this figure should be adopted for residential apartment buildings at the Park.

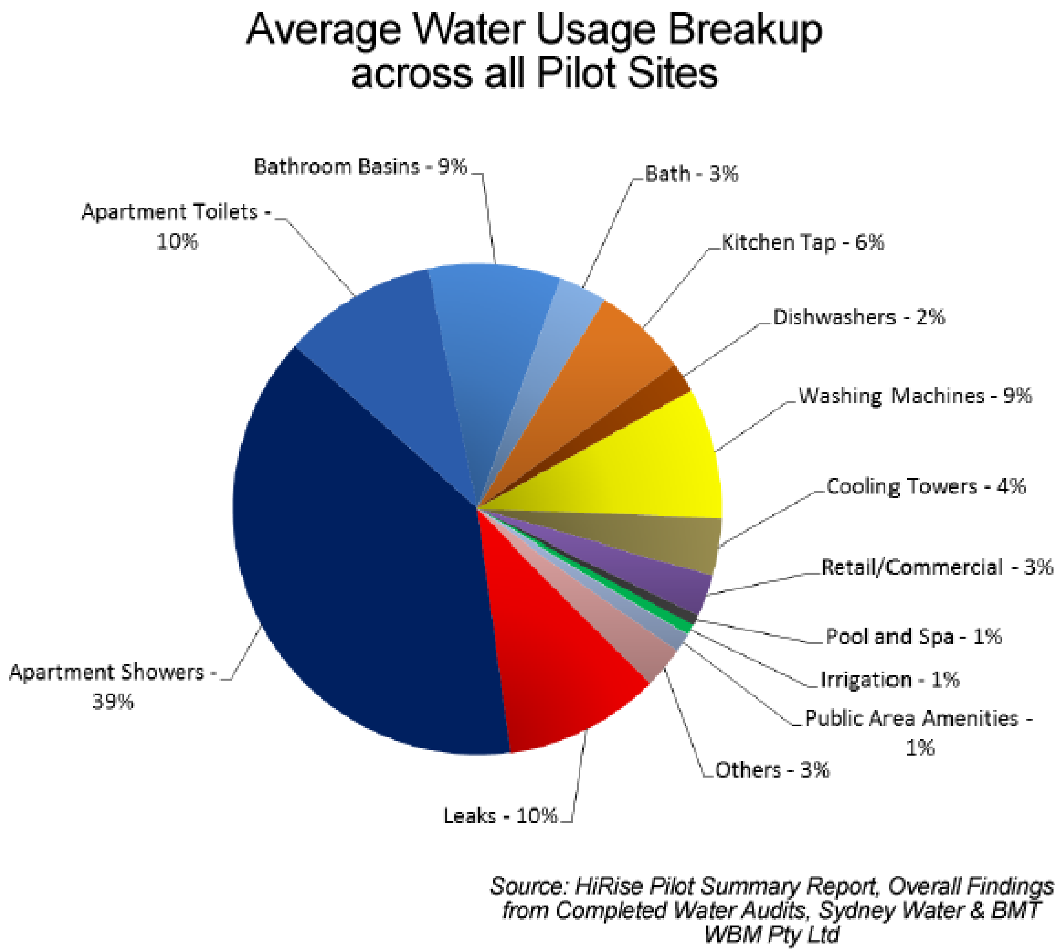

Figure 1: Typical end use breakdown in residential apartment buildings (Green Strata 2016)

Figure 1 shows irrigation demands as only 1% of the total. This figure is expected to vary at the Park, where some of the buildings have substantial green space. Therefore it is recommended that irrigation demands are estimated separately, based on the area expected to be irrigated.

Typical garden irrigation water demands are shown in Table 1. These are based on the area irrigated, which may include common areas as well as private gardens. Note that irrigation also varies throughout the year with higher irrigation demands in summer and lower irrigation demands in winter and modelling must account for this variation in demand.

Table 1: Typical water demands for garden irrigation

Vegetation type	Typical examples	Typical demands ($kL/m^2/year$)
High water demand	Productive gardens – fruit and vegetables	1.0
Medium water demand	Lawns, exotic ornamental plants in full sun	0.5

Vegetation type	Typical examples	Typical demands ($kL/m^2/year$)
Low water demands	Lawns and exotic ornamental plants in shade Irrigated native plants	0.2
No water demand	Native plants, drought-tolerant plants without irrigation	0

In addition to the demands outlined above, rainwater may also be used for car wash bays, water features, ponds, Pool/pond/spa backwashing, etc. and if this is the case, appropriate demands will need to be estimated for these end uses based on their proposed design and expected use.

An example of estimated non-potable water demands in a hypothetical residential building is shown in Table 2.

Table 2: Example non-potable water demand estimate for a residential building

Parameter	Value	MUSIC model inputs (refer Section 2.3
No. of bedrooms: 1-br/studio apartments (80 No) 2-br apartments (100 No) 3-br apartments (20 No) *Total*	 80 200 60 *340*	
Water demands for apartment toilets, washing machines, cooling towers, public area amenities (48 L/bedroom/day)	***16.3 kL/day***	*This should be entered as a constant "daily" demand in MUSIC*
Irrigated areas: Medium water demands Low water demands	 250 m^2 1,000 m^2	
Water demands for irrigation	***325 kL/year***	*This should be entered in MUSIC as an annual demand, distributed according to "PET – rain"*

2.2.2 Commercial buildings

It is expected that most commercial development at Sydney Olympic Park will be office buildings. Guidance on water demands in these buildings has been sourced from Sydney Water (2007). Where retail buildings are proposed at SOP, the same assumptions should be applied as for office buildings. However for large shopping centres, refer to Sydney Water (2007) for guidance on estimating water demands.

A relevant benchmark for total water demands in commercial buildings is **0.84 $kL/m^2/year$** (based on net lettable area). This is described as "economic best practice" for offices with cooling towers (Sydney Water 2007).

Of this demand, an estimated **37% (0.31 kL/m²/year)** is made up of toilet flushing and cooling tower demands, which can be supplied by rainwater. Typical end use breakdown is shown in Figure 2. Note that "amenities" make up 35% of total demands, but this is understood to include both toilet flushing and hand basin water demands. Toilet flushing is expected to be at least half of the amenities demand (18%).

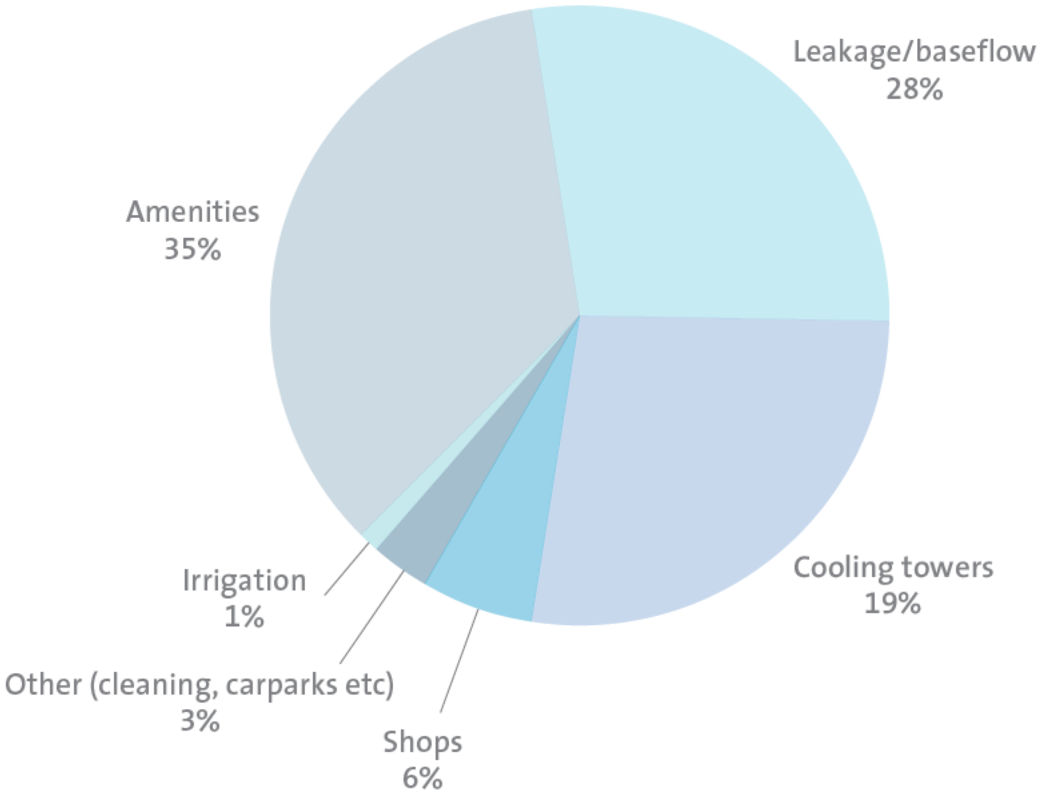

Figure 2: Typical end use breakdown in commercial office buildings (Sydney Water 2007)

In addition to toilet flushing and cooling tower demands, rainwater can also be used for irrigation. Irrigation demands should be estimated as described for residential buildings in Section 2.2.1.

An example of estimated non-potable water demands in a hypothetical commercial office building at SOP is shown in Table 3.

Table 3: Example non-potable water demand estimate for a commercial office building

Parameter	Value	MUSIC model inputs (refer Section 2.3
Net lettable area	5,000 m^2	
Water demands for toilet flushing and cooling tower (0.31 kL/m^2/year)	***1,550 kL/year (4.25 kL/day)***	*This should be entered as a constant "daily" demand in MUSIC*

Parameter	Value	MUSIC model inputs (refer Section 2.3
Irrigated areas: Medium water demands Low water demands	 200 m^2 100 m^2	
Water demands for irrigation	***120 kL/year***	*This should be entered in MUSIC as an annual demand, distributed according to "PET – rain"*

2.3 Storage Size

Sydney Olympic Park's stormwater policy states that the *minimum* rainwater tank size is:

- 0.25 kL of storage per apartment
- 1 kL of storage per 100 sqm of net floor area of non-residential demands

While the policy stipulates the minimum required storage tank volume, the rainwater reuse must be modelled to determine the preferred storage area for the particular development conditions (e.g. roof area, number of dwellings, etc).

Modelling will allow the performance of the storage tank in balancing supplies and demands and will provide an understanding of the required storage size.

A basic MUSIC model setup for rainwater tank sizing is shown in Figure 3.

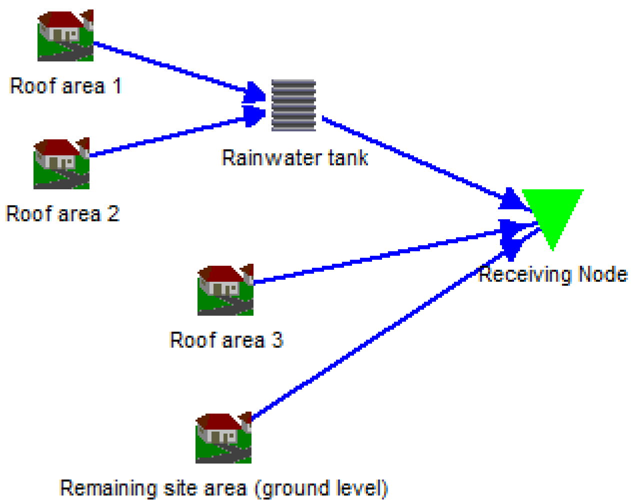

Figure 3: Typical model setup for rainwater tank sizing

SOPA requires the following approach to rainfall simulation be adopted for hydrologic assessment modelling (i.e. stormwater harvesting and stormwater storage design including rainwater tank sizing):

- Continuous simulation of a minimum of 20 years should be used; and
- A daily time step should be utilised for simulating rainwater/stormwater storage sizes and estimating supply reliability.

Local rainfall gauges were examined to compare the average monthly rainfall at each gauge. This is shown in Figure 4. This shows that each of the gauges is similar, however Concord Golf Club and Eastwood Bowling Club stand out in some months.

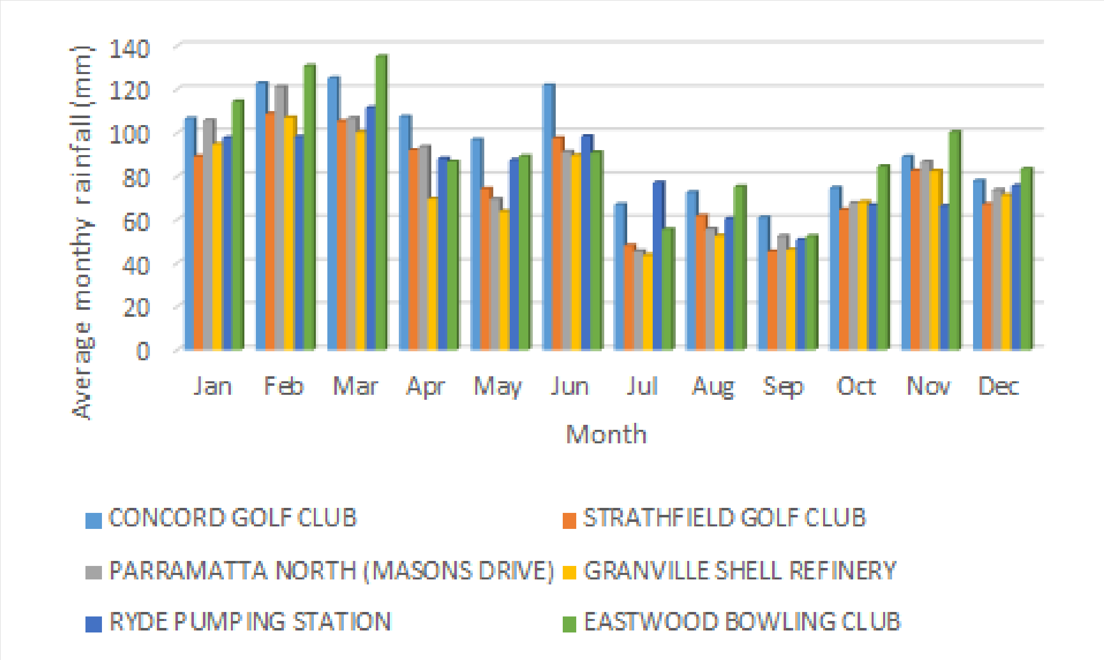

Figure 4: Average monthly rainfall at rain gauges around Sydney Olympic Park

Overall, the Ryde Pumping Station gauge (066057) is recommended as the most appropriate for Sydney Olympic Park. This has:

- Close proximity to Sydney Olympic Park
- A relatively long rainfall record, extending from 1894-1978
- The available data has no significant gaps
- Mean annual and average monthly rainfall consistent with other gauges in the area

To provide a consistent approach to modelling in Sydney Olympic Park, the Ryde Pumping Station gauge (066057) must be used in MUSIC for modelling rainwater tanks for water reuse. There is a short gap in the data in 1916 and another in 1975, therefore a time period from 1/01/1917 to 31/12/1974 must be used (58 years).

The roof catchment should be set up according to the following approach:

- Its area should be the area of the roof which will drain into the tank
- This should be 100% impervious. Any pervious areas (e.g. green roofs) should be excluded from the area
- The only rainfall-runoff parameter which is relevant (as the roof catchment is 100% impervious) is the rainfall threshold, which should be set to 1 mm/day

Note that where rainwater tanks are used as part of a stormwater treatment strategy, should be included in the stormwater quality model. To demonstrate compliance with SOPA's stormwater quality pollutant load reduction requirements modelling must be undertaken in a separate model using a 6-minute time step. Refer to SOPA's MUSIC modelling guidelines for further information on water quality modelling requirements.

The process for integrating the stormwater reuse model and stormwater quality model is as follows:

1. Step 1: Model the rainwater reuse scheme in MUSIC using a daily MUSIC model setup as outlined above
2. Step 2: determine the storage volume of the tank required, ensuring that it complies with the minimum storage volume requirements of SOPAs policy

3. Step 3: Include the adopted rainwater tank volume in the 6 minute stormwater quality MUSIC model (this step is optional, but is recommended as it will likely provide a net reduction in stormwater treatment system requirements)

Table 4 summarises the key parameters in MUSIC's rainwater tank node, with advice on each one.

Table 4: Input parameters for rainwater tanks (daily supply modelling)

Parameter	Notes	Recommended range
Bypass	It is assumed that the roof drainage is designed for events up to an including the 1 in 100 year AR event	100 as per default (i.e. a nominal large value to direct all flows to the tank)
Storage volume	Input the tank volume. Run the model for a range of volumes in order to select the most appropriate size	Run the model in 20 kL storage increments from 20kL to 500 kL (or larger for large developments)
Depth above overflow	If not known assume 200mm freeboard above outlet	0.2m
Surface Area	If not known assume the tank is 2m high (i.e. for a tank of 100 kL the surface area is 50sqm)	Varies with volume
Reuse parameters	Enter re-use details to represent the intended demands on water from the rainwater tank. Demands must be determined as per section 2.2.	*Indoor demands* set as constant daily demands. *Outdoor demands* set as a variable demand based on "Potential evaporation – Rain" option

2.4 Results and interpretation

In order to size the rainwater tank, run the MUSIC model for a series of different tank sizes. For each tank size, look at the volume of water supplied (or percentage of demand met) and plot these results on a curve. An example is shown in Figure 5.

These curves will always take a similar form, with an initially steep gradient at small tank sizes, which then flattens off as the tank volume increases. Sometimes there is a relatively sharp turning point and this makes it easy to select the appropriate tank size, however often (as in Figure 3) there is no distinct point of inflexion.

The tank size should be selected ensuring

- Minimum tank volume requirements are met in accordance with SOPA's policy
- that an optimal storage size is chosen which maximises benefits for an 'optimal' tank size

An example is shown in Figure 5. This figure suggests that a reasonable tank volume in this scenario is in the range of 150-190 kL.

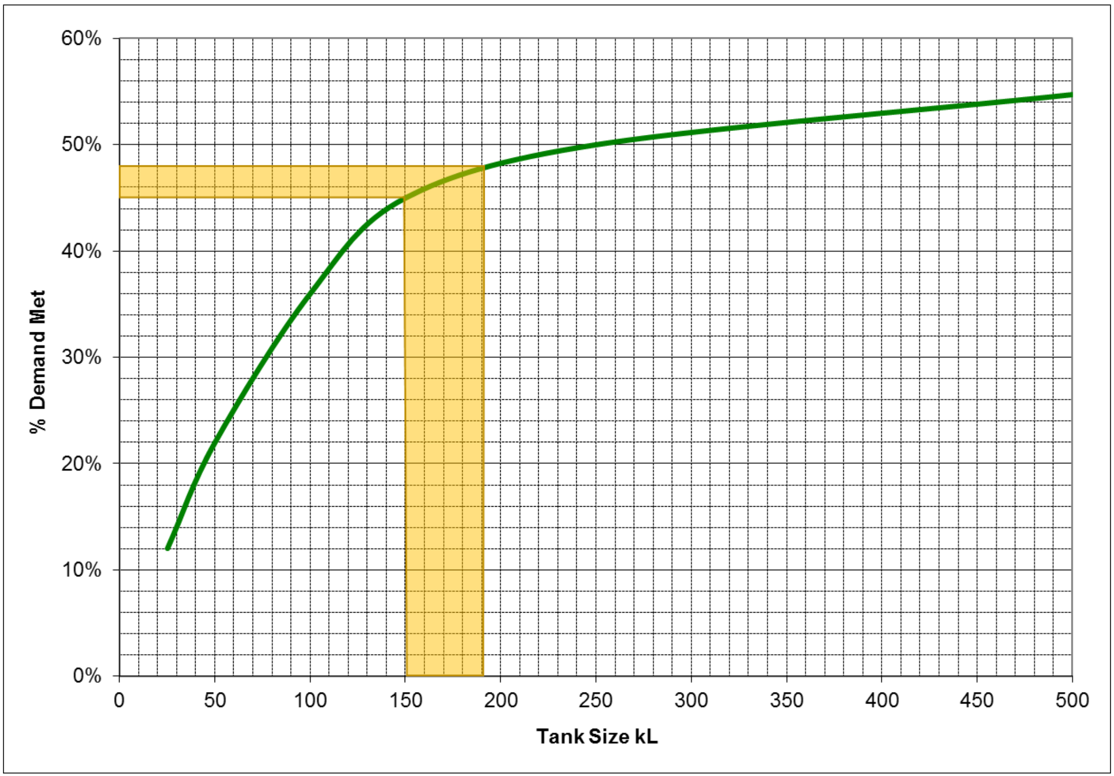

Figure 5: Example of a rainwater tank sizing curve

3 DESIGNING THE RAINWATER TANK

There are a number of risks associated with rainwater harvesting in larger buildings (NWC, 2008):

- Liabilities associated with the supply of water by an organisation, rather than by a homeowner for household uses.
- Greater risk of cross-connection due to larger network and more complicated system.
- More complex arrangements where different people are involved in planning, design and maintenance.
- Increased potential for access to the rainwater by people unfamiliar with the system (e.g. more visitor access compared to access by household residents).
- Generally larger roof areas and flows.

Therefore, for community, multi-unit and industrial buildings which capture rainfall particular attention should be given to the:

- quality of the roof catchment area;
- capture, filtration and storage systems; and
- monitoring and maintenance of the rainwater system.

3.1 Overall system design

A generic rainwater tank system setup, relevant to Sydney Olympic Park, is shown in Figure 6. This shows how rainwater, recycled water (from the WRAMS scheme) and mains water should all be supplied to a typical Sydney Olympic Park site, and how each of these water supplies relates to each other. Each unit essentially has two supplies: potable and non-potable, with the potable water supplied from mains water and the non-potable water supplied from either rainwater (when rainwater is available) or WRAMS (when rainwater is unavailable).

The system should be designed according to the following principles:

- Rainwater should be harvested from roof areas only, including as much of the roof area as possible
- Downstream of the rainwater tank, any overflow should be directed to the on-site detention system
- Rainwater and recycled water should be plumbed into the same system to meet the same water demands
- Rainwater should be connected downstream of the recycled water meter, so that it is not counted towards the volume of recycled water used on site
- Rainwater should be metered separately to track its use
- When rainwater is available, rainwater should be used in preference to recycled water
- Rainwater may be unavailable when the rainwater tank is empty, offline for maintenance or when there is a power outage to the pump
- When rainwater is unavailable, recycled water should be used instead

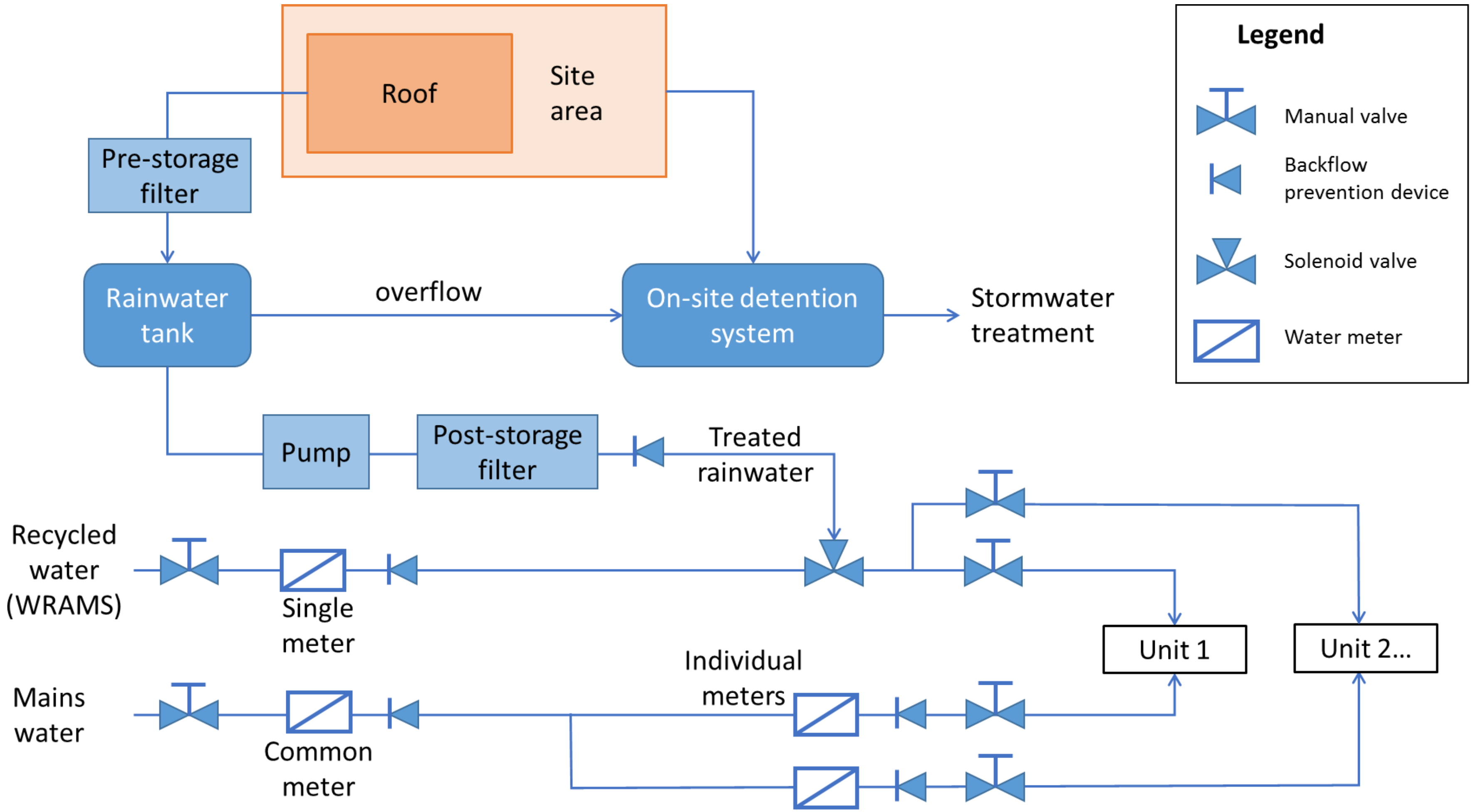

Figure 6: Rainwater tank system setup for Sydney Olympic Park

3.2 Storage design

The storage design must include the ‘active storage design’ which is the volume of the storage required as determined in section 2.3 plus the storage required for freeboard (storage above the overflow) and dead storage (storage below the pump offtake). The total tank size is typically in the order of 120% of the required active storage design (e.g. if the required storage volume is 100 kL the actual tank size required will be approximately 120kL).

In most cases, in multi-storey buildings, rainwater storage is built in to basements. Storage systems can be designed as a single tank or split into multiple interconnected tanks.

Rainwater storage tanks can be designed into the building’s structure or can be a standalone tank which is placed within the building. An example of a rainwater tank in a basement car park is shown below. The tank is constructed out galvanised steel and can be customised to various shapes. Note the cage on the left of the image housing the filter and pump and control panel.

The building’s structural engineer will need to have input into the tank’s location and design, to ensure that the tank itself is structurally sound and that the building can support the weight of the tank when it is full.

Rainwater storage should be designed in conjunction with roof drainage and on-site detention (OSD) systems. Roof drainage should be directed into the storage system via gravity. The rainwater tank should overflow into the OSD system via gravity.

When designing storage systems, allow room for the “active” volume as well as:

- Any volume at the base of the tank which is below the low-level cutout of the pump
- Any volume at the top of the tank which is above the overflow level

The design should allow for operation and maintenance of the tank including the following typical features:

- A water level sensor is required to
  - Operate the solenoid valves which control supply of non potable rainwater to the various end uses
  - ensure that the system shuts down in response to a low water level within the tank.
  - Monitor the water level in the tank to understand system operation
- Tanks need to be de-sludged periodically, which requires the tank to be able to be fully drained
- Maintenance access (e.g. manhole cover and step irons) is recommended, even if maintenance personnel are not expected to enter the tank on a regular basis

Key risks associated with the storage tank, and recommended design responses, are summarised in Table 5.

Table 5: Tank design recommendations

Risks	Recommended design response
Inappropriate entry of humans (e.g. children), animals, insects, surface water, ground water and rubbish	Appropriately secure all tank openings
Surface water or groundwater entering the tank	Ensure tank is appropriately sealed and located
Surface water entering access lids	Ensure access lids watertight, or terminate a minimum of 150 mm above finished ground level with the ground sloping away from the access lids
Mosquito breeding	Ensure inlets, overflows and other openings are protected with mosquito-proof mesh
Algae growth	Prevent light penetration to reduce potential algae growth
Sediment resuspension	Design a calmed inlet and ensure the pump offtake is above the sludge zone

3.3 Pumps

Rainwater will need to be pumped from the tank via the post-storage treatment system (refer to Section 3.5) to the points where it is used.

A dedicated rainwater tank pump is required with duty and assist pumps to ensure that if one pump is not available due to maintenance there is a back up pump available

The rainwater pumps must be appropriately designed to ensure that all end users have a minimum of 15m head of pressure at each end use.

Pump use must consider efficient energy use including use of multi-stage pumps, pressure tanks and variable speed drives to minimise energy use.

3.4 Pre-storage treatment

Upstream of the storage tank, there are numerous measures that can be undertaken to minimise pollutants entering the rainwater tank and maximise water quality in rainwater harvesting systems. Recommended control measures are summarised in Table 6.

Table 6: Control measures

Potential pollutants	Recommended control measures
Vegetation and other debris	Prune overhanging vegetation Install gutter guards Install screens on each downpipe Install first flush diversion devices
Chemical contaminants	On the roof, avoid lead and copper roofing materials, lead-based paint, bitumen-based materials, preservative-treated wood Avoid public access to the roof (maintenance access is acceptable) or avoid harvesting water from any areas where there will be public access Avoid structures above the roof which may corrode, rust or provide a resting place for birds Avoid chimneys and flues on the roof Where appliances are mounted on the roof (e.g. air conditioners, hot water services), ensure that discharge, overflow and bleed pipes are directed off the roof and away from harvesting systems If there is significant risk of atmospheric fallout of pollutants (e.g. the roof is adjacent to a busy road or factory generating airborne pollutants) then consider the need for additional water treatment either upstream or downstream of the tank

Screens/filters are essential upstream of most rainwater tanks, to minimise the risk of debris, vermin and insects entering the tank. There are a number of different options available including leaf diverters, downpipe screens, or in-ground filters for underground tanks.

First flush diversion is also recommended wherever there is a risk of vegetation overhanging the roof, debris accumulating on the roof or significant airborne pollutants being deposited on the roof. First flush devices should capture a minimum of 20 L per 100 m^2 and should operate automatically to divert water and drain between events.

A secondary pre-storage filter pit can assist in limiting silt, and prevent vermin, insects, (includes mosquitoes) and debris from entering the rainwater tank.

3.5 Post-storage treatment

While rainwater typically meets relevant water quality guidelines for non-potable use without treatment, it can have aesthetic issues particularly slight discolouration and occasionally odour. At Sydney Olympic Park, where rainwater is to be used interchangeably with recycled water for end uses including laundry and toilet flushing, it is considered important to ensure there is minimal variation in quality between rainwater and recycled water supplies. Thus <u>post storage filtration of rainwater is required prior to supply to end uses.</u>

Typical post-storage treatment for rainwater includes filtration to reduce the presence of fine sediment, colour and odour. Recommended filters include:

- “Triple action” filters (carbon filters capable or removing fine sediment, colour and odour)
- Bag filters
- Cartridge filters
- Screen filters

It is recommended that the filter be design to screen down to 1micron and is easy to clean. Filtration products need to be selected for the appropriate flowrate and pressure conditions expected in the system. Filters will require maintenance access and will require periodic back-flushing (automated or manual). An example of a dual pump set up (left hand side) with filtration (centre) is shown below.

3.6 Relevant standards

Australian and Australian/New Zealand Standards that apply to tanks and their associated fixtures and fittings are as follows:

- AS/NZS 3500 Plumbing and drainage
- AS 5200.000 Technical Specification for plumbing and drainage products
- ATS 5200.026 Technical Specification for plumbing and drainage products—
- Cold water storage tanks
- AS 3735 Concrete structures retaining liquids

In situ and underground rainwater tanks may be certified in accordance with the specified test method, performance requirements, pressure testing and objectives of AS/NZS 1546.1, AS/NZS 4766 and be designed, inspected and signed off by a qualified structural engineer

Rainwater tanks may be lined with approved coating in accordance with AS 5200.000

Materials and products used in a rainwater tank installation to connect to the water supply should comply with the requirements of the National Plumbing Products Certification Scheme and be of an approved type as specified in the appropriate Standard listed in AS/NZS 5200.000, in accordance with the Plumbing Code of Australia.

Pipes, outlets and fittings supplying rainwater must be clearly identified and be in accordance with AS/NZS 3500.1 and AS/NZS 3500.3.

The water supply systems (including irrigation) from a rainwater tank must be clearly marked with the contrasting coloured (white text on a green background) wording 'RAINWATER' in accordance with AS/NZS 3500.1.

Rainwater outlets should be identified as 'RAINWATER' with a label or a rainwater tap identified by a green coloured indicator. Rainwater warning signs should comply with AS 1319. This is shown below.

The NSW Code of Practice for Plumbing and Drainage (CUPDR 2006) includes additional information on installation requirements and relevant standards for rainwater tanks.

Note that in most cases at Sydney Olympic Park, the rainwater system will not be connected with the mains water system, as WRAMS provides an alternative non-potable supply as a backup to rainwater. However in any cases where there are connections to mains water (e.g. where mains water is supplied as a backup to rainwater) Sydney Water has specific requirements for installation including backflow prevention.

4 INSTALLING AND OPERATING THE RAINWATER TANK

4.1 Relevant legislation and approvals

The following relevant legislation and guidelines apply:

4.1.1 SEPP (Exempt and Complying Development Codes) 2008

The State and Environmental Planning Provision (SEPP) for Exempt and Complying Development stipulates when approval is required for rainwater tanks. The relevant sections are Subdivision 32 (Rainwater Tanks Above Ground) and Subdivision 33 Rainwater Tanks below ground.

In most cases at Sydney Olympic Park rainwater tanks are not exempt or complying development and will require approval as part of a development application.

In a limited number of cases rainwater tanks may be exempt including:

- An educational establishment with an above ground rainwater tank less than 25 kL in size
- An above ground rainwater tank less than 10 kL

Note that if you wish to determine if the rainwater tank is exempt development, you should seek your own legal advice on whether you meet the exemption requirements in the SEPP (Exempt and Complying Development Codes) 2008.

4.1.2 NSW Health

NSW Health[2] does not restrict the use of rainwater for any particular purpose. However, NSW Health notes that in urban areas the public water supply remains the most reliable source of drinking water for the community and hence in urban areas with a public water supply available, NSW Health

- supports the use of rainwater tanks for non-drinking uses.
- recommends that the public water supply is used for drinking and cooking because it is filtered, disinfected and generally fluoridated.

Due to the availability of a public water supply at Sydney Olympic Park it is recommended that rainwater harvesting is not used for potable water within SOPA, and is only used for non-potable purposes.

4.1.3 WICA

As of 2016, rainwater harvesting systems will be exempt from licensing under the Water Industry Competition Act (WICA), providing that the following conditions are met:

> *Water infrastructure that is used for the production, treatment, filtration, storage, conveyance or reticulation of water sourced only from roof water if:*
>
> *(a) the water is supplied for a non-potable use, and*
> *(b) the water is supplied without charge (either in the form of a fee or a requirement for other consideration).*[3]

Hence it is recommended that at SOPA rainwater schemes are

- Harvested only from roofs
- supplied to non potable uses only and
- are provided free of charge to all users

[2] NSW Health, June 2007, *Rainwater Tanks Where A Public Water Supply is Available*, accessed online at http://www0.health.nsw.gov.au/policies/gl/2007/GL2007_009.html

[3] Water Industry Competition (General Regulation) 2008- Schedule 3, Accessed online at http://www.austlii.edu.au/au/legis/nsw/consol_reg/wicr2008479/sch3.html

The benefits of the rainwater tanks will be distributed to the users of the water (e.g. individual households) in terms of 'free water'. This will also encourage the use of rainwater.

Note that if you wish to determine if you are exempt from the licensing requirements of WICA, you should discuss with IPART and seek your own legal advice on whether you meet the exemption requirements in WICA or in Schedule 3 of the *Water Industry Competition (General) Regulation 2008* (NSW). Schedule 3 provides a complete list of water industry infrastructure that is exempt from the licensing requirements.

4.1.4 Sydney Water Metering

Sydney Water (2014) requires that all new buildings must provide individual metering and plumbing to allow for equitable billing. Sydney Water has provided advice that this is only mandatory for potable water meters and <u>individual metering is optional for recycled water meters at Sydney Olympic Park</u>.

4.2 Maintenance

A summary of typical maintenance requirements for rainwater tanks is shown in Table 7. This summarises routine maintenance activities and indicates their typical frequency. This is provided here to assist designers in providing appropriate maintenance access.

In addition to routine maintenance, NWC (2008) has a useful checklist (Table 9.1, pp. 40-42) which lists common water quality problems and identifies probable causes, recommended preventative measures and corrective actions.

Table 7: Typical routine maintenance activities for rainwater tanks

Element	Maintenance Activity	Recommended frequency	Hints and Tips
Roof and gutters First flush device Inlet screen Overflow pipe	Clean and remove debris	Check each 3 months; clean as required	Leaves and debris may need to be removed from roofs, gutters, first flush device and tank inlets and outlets monthly where overhanging vegetation is present. Where overhanging vegetation can be avoided, anannual or 6-monthly clean may be sufficient. Commence with 3-monthly inspections and adjust as required.
Tank	Desludge	Each 5-10 years	First flush systems and mesh screens on tank inlets will reduce the amount of sediment and debris entering the tank thereby extending the time required before desludging
Pump	Regular service	Typically each 10 years	Service mechanical components according to manufacturer's recommendations.
Filter	Clean and replace cartridges	Typically each 6-12 months	Service mechanical components according to manufacturer's recommendations. Typically the filter (if present) will require the most frequent attention
Backflow prevention device	Regular testing to meet water utility requirements	As per water utility requirements	A licenced plumber will be able to undertake this task
Water meter	Record meter readings	3 months	Water meters are an easy way to tell if the system is working. The more frequently readings are performed, the sooner issues will be detected.

5 REFERENCES

Australian Government National Water Commission (NWC) 2008 *Rainwater Tank Design and Installation Handbook* November 2008. Available online: http://www.nwc.gov.au/__data/assets/pdf_file/0016/10753/RAINWATER_handbooknwc_logo.pdf

Committee on Uniformity of Plumbing and Drainage Regulations in NSW (CUPDR) 2006 *NSW Code of Practice – Plumbing and Drainage*.

Green Strata "Know Where Your Water is Used" website: http://greenstrata.com.au/topic/know-where-your-water-used

NSW Health (2007) Rainwater Tanks Where A Public Water Supply Available, Available online http://www0.health.nsw.gov.au/policies/gl/2007/GL2007_009.html

Sydney Water (2007) *Best Practice Guidelines for Water Conservation in Commercial Office Buildings and Shopping Centres* https://www.sydneywater.com.au/web/groups/publicwebcontent/documents/document/zgrf/mdu0/~edisp/dd_054580.pdf

Sydney Water (2014) Multi-level individual metering guide, Available online at https://www.sydneywater.com.au/web/groups/publicwebcontent/documents/document/zgrf/mdq1/~edisp/dd_045282.pdf

Water Industry Competition (General Regulation) 2008- Schedule 3, Available online http://www.austlii.edu.au/au/legis/nsw/consol_reg/wicr2008479/sch3.html