STRATEGIC AND STATUTORY PLANNING REVIEW TO CREATE OUR LIVING RIVER

PARRAMATTA RIVER MASTERPLAN, STEP 4

FINAL RECOMMENDATIONS PAPER

FEBRUARY 2021

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Parramatta River Catchment Group

Co-ordinating agency and end client

Sydney WATER

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- Blacktown City Council
- Burwood Council
- City of Canada Bay
- Canterbury Bankstown Council
- Cumberland Council
- Hunters Hill Council
- Inner West Council
- City of Ryde
- City of Parramatta
- Sydney Olympic Park Authority
- NSW Department of Planning, Industry and Environment
- Greater Sydney Commission

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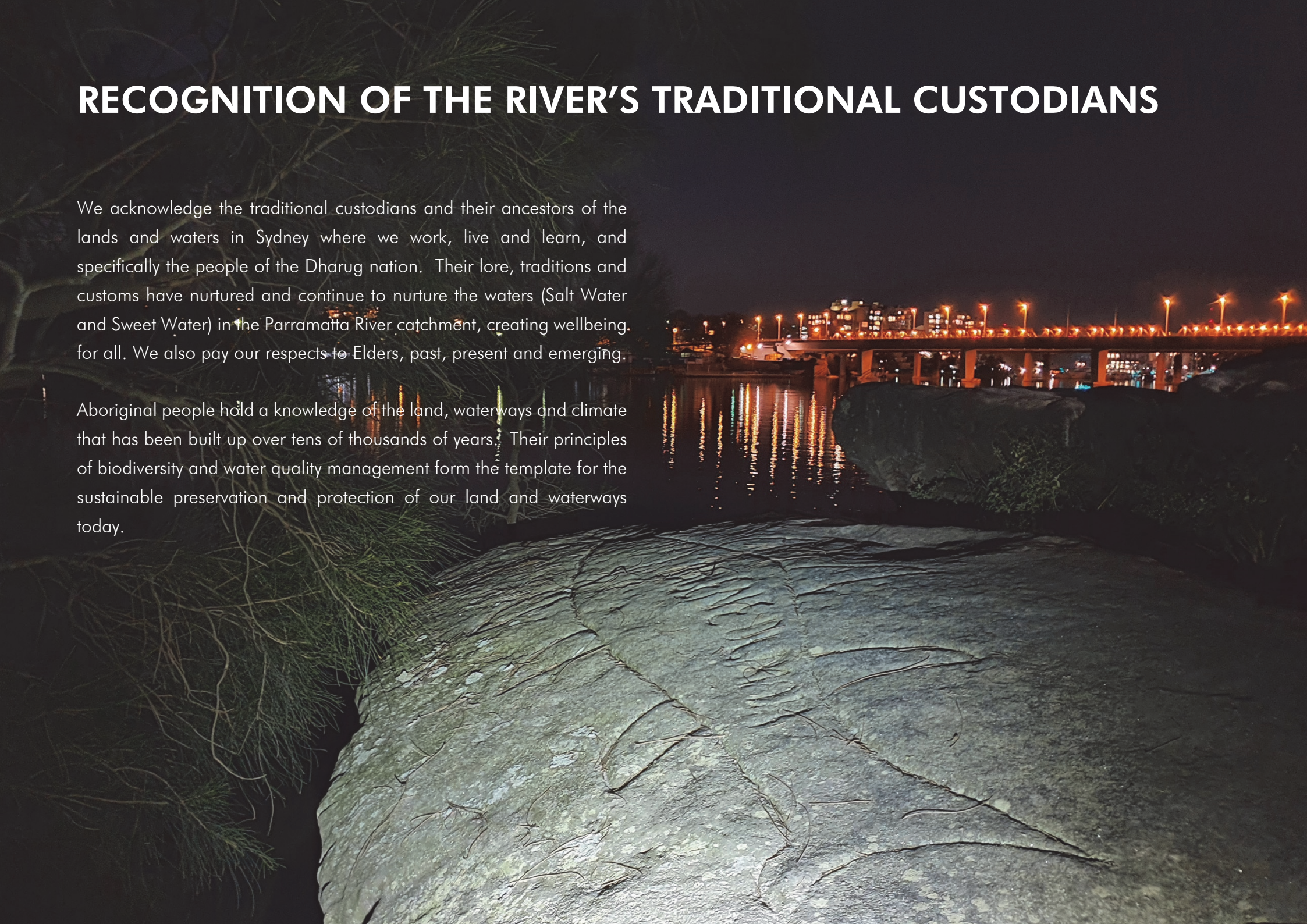
RECOGNITION OF THE RIVER'S TRADITIONAL CUSTODIANS

We acknowledge the traditional custodians and their ancestors of the lands and waters in Sydney where we work, live and learn, and specifically the people of the Dharug nation. Their lore, traditions and customs have nurtured and continue to nurture the waters (Salt Water and Sweet Water) in the Parramatta River catchment, creating wellbeing for all. We also pay our respects to Elders, past, present and emerging.

Aboriginal people hold a knowledge of the land, waterways and climate that has been built up over tens of thousands of years. Their principles of biodiversity and water quality management form the template for the sustainable preservation and protection of our land and waterways today.



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GLOSSARY OF TERMS

BASIX	Building Sustainability Index – NSW's scheme to regulate residential building performance in terms of energy and water efficiency and thermal comfort.
Blue-green infrastructure	Infrastructure for sustainable urban water management, including both natural (green infrastructure) elements and engineered systems such as water harvesting and recycling networks.
Canopy cover	The extent of the canopy for an individual tree, or the cumulative areal extent of the canopy of all trees within a defined area (often expressed as a percentage).
DCP	Development Control Plan
Deep soil	Deep soil is the soft landscaped part of the site area used for growing trees, plants and grasses, unimpeded by buildings or structures above and below ground providing opportunities for groundwater infiltration and canopy trees. Deep soil permeable zones exclude basement car parks, services, swimming pools, tennis courts and impervious surfaces including car parks, driveways and roof areas.
Developer contributions	Financial contributions from developers for public infrastructure.
DPIE	NSW Department of Planning, Industry and Environment
Enterococci	Enterococci are bacteria that live in the intestinal tracts of warm-blooded animals, including humans, and therefore indicate possible presence of faecal material (including disease-causing bacteria, viruses, and protozoa) in rivers and streams.
Evapotranspiration (ET)	The sum of evaporation and plant transpiration from the Earth's land and ocean surface to the atmosphere.
GPOP corridor	Greater Parramatta Olympic Park growth corridor
GSC	Greater Sydney Commission. A body established under the *Greater Sydney Commission Act 2015* to lead metropolitan planning in Sydney.
Green Factor tools	A family of tools that use a scoring system to set targets for green infrastructure provision in new development, while allowing flexibility in the specific approaches adopted in each development.
Green Grid	A proposed network of high-quality green space that connects town centres, public transport hubs, and major residential areas across Sydney, designed to support active transport and recreation.
Green infrastructure	Green infrastructure is the network of green spaces, natural systems and semi-natural systems that supports sustainable communities and includes waterways; bushland; tree canopy and green ground cover; parks, and open spaces that includes parks; and open spaces that are strategically planned, designed and managed to support a good quality of life in the urban environment.
Hydroline data	A NSW Government spatial dataset, which maps watercourses across the state.
Infiltration	The process by which water on the surface of the ground enters the soil below.

In-lieu contributions	A financial contribution to public infrastructure, made in place of (to offset) a requirement to deliver an equivalent outcome in the private domain.
IWCM	Integrated Water Cycle Management
Leaky tank	A rainwater tank which slowly releases stored water to a passive irrigation/infiltration area.
LEP	Local Environmental Plan
Life cycle costs	Costs to design, build, operate, maintain, renew and decommission an asset.
LSPS	Local Strategic Planning Statement
Mean annual runoff	The average annual quantity of stormwater that is generated from a defined site or catchment area.
Mean annual pollutant load	The average annual quantity of a pollutant transported in stormwater runoff from a defined site or catchment area.
MUSIC	Model for Urban Stormwater Improvement Conceptualisation
Ongoing contributions	Routine payments made by landowners/ratepayers.
OSD	On Site Detention – temporary storage of stormwater runoff to reduce peak flows.
Overland flowpath	An above-ground component of an urban drainage system that caters for flows beyond the capacity of underground drainage systems. Overland flowpaths may pass through private property, along streets or through parkland. They typically follow low points in the landscape, but are normally dry
Pathogen	A bacterium, virus, or other microorganism that can cause disease.
Passive irrigation	Direction of rainwater or stormwater runoff from an impervious (sealed or paved) catchment area to a vegetated area, allowing the vegetation to benefit from a greater volume of water supply.
Pervious area	Any area that allows rainfall to infiltrate into underlying soils, including shallow soils over structures.
PRCG	Parramatta River Catchment Group
Rain garden	A type of vegetated stormwater treatment system, also known as a bioretention system.
Rainwater harvesting	The capture and use of roof runoff for purposes such as irrigation, toilet flushing, laundry and hot water supply.
REP	Regional Environmental Plan
Riparian zone/ corridor	Land alongside creeks, streams, gullies, rivers and wetlands.
Risk-based framework	A strategic framework for considering waterway health outcomes in strategic land-use planning decisions.
S3QM	Small Scale Stormwater Quality Model
SEPP	State Environmental Planning Policy
Strahler stream order	A standard method for classifying streams, based on their position within a hierarchy from the source (or headwaters) downstream.
TN	Total Nitrogen (including dissolved and particulate nitrogen in stormwater).
TP	Total Phosphorus (including dissolved and particulate phosphorus in stormwater).
TSS	Total Suspended Solids.
Vegetated stormwater treatment systems	These typically include constructed wetlands, bioretention systems and swales.
Water sensitive urban design (WSUD)	An approach to urban water management that aims to minimise impacts on the natural water cycle.

EXECUTIVE SUMMARY

The purpose of this report is to examine the strategic and statutory planning frameworks that can contribute to making Parramatta River a world class river that is living and swimmable again. This goal is based on the 2018 Parramatta River Masterplan, published by the Parramatta River Catchment Group (PRCG), and aligns with the District Plans of the Greater Sydney Commission and the local strategic plans of the catchment councils. A key to delivering this goal is to develop a whole-of-catchment land use policy and statutory planning mechanisms that are consistent across the catchment, is supported by state environmental planning instruments and is enabled with a funding mechanism to support maintenance and monitoring.

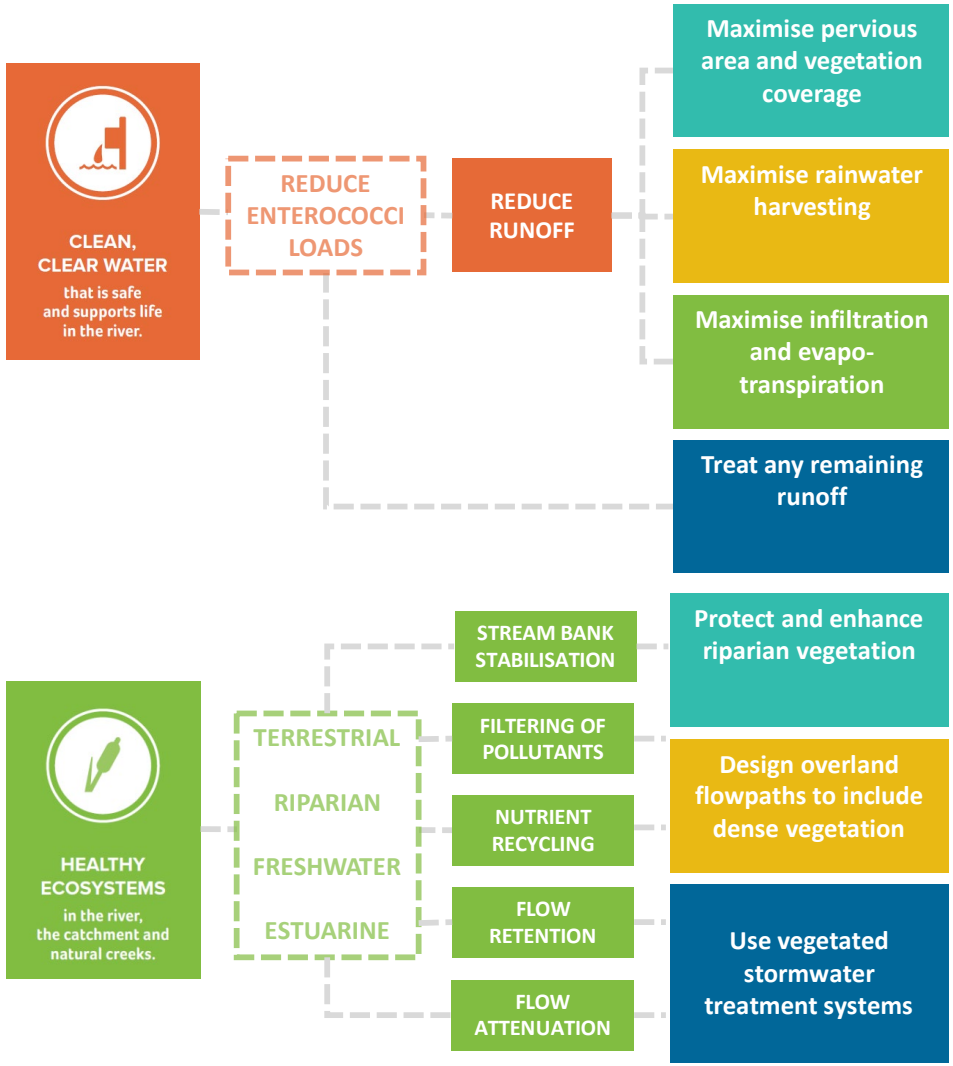
In the Parramatta River Masterplan, the vision for Parramatta River is holistic, incorporating environmental, social and economic aspects. Two goals where standards for new development will play an important role are:

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

Based on the research undertaken to support the Parramatta River Masterplan, this recommendations paper presents seven strategies that can be applied to the planning and design of new development, to help achieve these goals:

1. Maximise pervious area and vegetation coverage
2. Maximise rainwater harvesting
3. Maximise infiltration and evapotranspiration
4. Treat any remaining runoff
5. Protect and enhance riparian vegetation
6. Design overland flowpaths to include dense vegetation
7. Use vegetated stormwater treatment systems

The recommendations in this paper also respond to the issues identified in the 2019 Standardising the Standards Discussion Paper, including the challenges inherent in taking a holistic approach that aims for integrated delivery with other infrastructure, to achieve multiple objectives in all development types, across both public and private domains, and requires the support of adequate funding and resources at all stages.



This paper presents recommendations for three stages of policy reform:

Stages	The opportunity	The recommendations	Implementation	
SHORT-TERM UPDATES (Councils to implement over next 1-3 years) **Simple updates to LEP and DCP controls**	Minor changes to Local Environmental Plans (LEPs) and Development Control Plans (DCPs) can improve existing and add new provisions to ensure that development does more to reduce stormwater pollution and foster healthy ecosystems.	**Strengthen the wording in LEPs and DCPs.** This should be directed to improve outcomes for the Parramatta River and its catchment. Specific recommendations have been made for changing current LEPs and DCPs, reflecting the seven strategies identified above. Suggested wording is also provided. It is up to each council to consider these recommendations in balance with other local planning objectives, and to determine how best to implement them locally.	LEPs are updated via a Planning Proposal, prepared by local government and reviewed by the NSW Department of Planning, Industry and Environment (DPIE). The NSW Parliamentary Counsel's Office completes the final wording of the instrument. DCPs are updated by local councils. The PRCG can provide support.	
		Specific actions	**Responsibility**	**Timing**
		Update LEPs to strengthen aims of plan, zoning provisions and local provisions relating to: • Landscaped areas • Stormwater management and WSUD • Waterways and riparian land • Foreshore development	All PRCG member councils	2021-23
		Comprehensive update of DCPs to strengthen provisions for: • Landscaped areas • Deep soils • Trees • Native vegetation • Rainwater harvesting • Stormwater quantity • Stormwater quality • Riparian vegetation • Overland flowpaths • Vegetated stormwater treatment systems	All PRCG member councils	2021-23
		Update relevant design guidance, technical specifications, and standard drawings, to support new/updated DCP provisions	All PRCG member councils	2021-23

Stages	The opportunity	The recommendations	Implementation	
LONGER TERM, MORE SUBSTANTIAL REFORMS (PRCG to lead over next 1-5 years) **Develop, pilot and locally adopt new frameworks: a Blue-Green Index and a Blue-Green Grid**	New planning policy approaches are needed to address current and projected pressures related to development in the catchment. Major systemic changes are required to deliver blue-green infrastructure to meet waterway health and liveability goals. This is particularly for infill development that under current approaches will reduce deep soil and increase impervious areas. Modelling undertaken for the 2018 Masterplan showed that existing initiatives to improve water quality would result in only minor, localised water quality improvements in the Parramatta River.	**Develop, pilot and locally adopt new frameworks** for improving water quality and waterway health for new development: A **Blue-Green Index.** This would be a performance-based tool, incorporating multiple objectives into a scoring system to rate the water and landscape inputs. It would be designed to meet the needs of developers (clarity and certainty in the objectives and targets, with flexibility in specific design solutions) and planners (ease of use and policy alignment, with clear outcomes). It would be evidence-based and vertically aligned to state policies and plans to support water sensitive urban design and landscape outcomes. **A Blue-Green Grid.** This would be a new framework for classifying waterways and mapping riparian zones for land use planning purposes. New approaches are needed to protect, restore and support water quality, waterway health and ecological outcomes and community access along key waterway corridors. The creation of a Blue-Green Grid aligns and builds on existing state government green grid guidelines and riparian policies. For the Parramatta River catchment, it would be tailored to respond to specific pressures, conditions and potential restoration opportunities.	The PRCG should lead the development of both these frameworks. Development of the Blue-Green Index can commence with a pilot involving a small number of councils. It would benefit from collaboration with other agencies working in green infrastructure implementation. For the Blue-Green Grid, initial mapping of waterways and riparian zones across the catchment is partially complete and can be finalised rapidly. These supporting policy approaches would need to be developed in conjunction with councils and the state planning and water agencies.	
		Specific actions to develop the Blue-Green Index	**Responsibility**	**Timing**
		Establish a working group including members from PRCG and selected council representatives	PRCG	2020
		Develop an initial pilot version of the tool	PRCG + working group	2021
		Test the pilot among PRCG councils	PRCG + member councils	2022
		Develop a public facing Blue Green Index tool	PRCG + member councils	2023
		Staged local implementation	All PRCG member councils	2023-25
		Explore potential inclusion in a state environmental planning instrument	PRCG + NSW Government	2021-25
		Specific actions to develop the Blue-Green Grid	**Responsibility**	**Timing**
		Establish a working group including members from PRCG and selected council representatives	PRCG	2020
		Refine the waterway categories and objectives	PRCG + working group	2021
		Waterway and riparian area mapping, including: 1. Identify and categorise waterway reaches, catchment-wide 2. Refine the categorisation of waterway reaches based on local data 3. Add planning layers and identify where there is potential for waterway and riparian restoration 4. Define extent of proposed riparian zones and identify specific objectives that apply within each zone 5. Field validation and ongoing review	PRCG + member councils	2021-25
		Update LEPs	All PRCG member councils	2023-25
		Update DCPs	All PRCG member councils	2023-25

Stages	The opportunity	The recommendations	Implementation	
SUPPORTING ACTIONS: SHORT- AND LONG-TERM (PRCG to work with DPIE over next 1-5+ years) **Strengthen and support local reforms, including revisions to State policies**	Ensure water quality and waterway health are considered in all planning and approval pathways, beginning as early as possible in the process. This will require broader reform, beyond local government.	**Rebuild the business case for blue-green infrastructure**. Blue-green infrastructure can support a productive, liveable and sustainable development and places across the catchment. The business case should extend to public and private domains and apply to stakeholders across the life-cycle stages, including how funding is to be provided. **Implement State-level policy reforms.** A liveable river will require a transformation in policy and practice. To ensure blue-green infrastructure can achieve its objectives, change is needed across planning and approval pathways.	This will require collaboration and coordination within and between catchment councils and state government. New frameworks (above) should assist with this process, but will need further planning and design input and research, including technical input (to build the evidence base) and economic (to build the business case).	
		Specific actions	Responsibility	Timing
		Develop a business case for blue-green infrastructure policy reforms	PRCG	2022-23
		Explore options to strengthen financing mechanisms for blue-green infrastructure in new development, including: • Developer contributions • In-lieu contributions • Ongoing (i.e. ratepayer) contributions	PRCG + NSW Government	2023-25
		Provide input to relevant state-led policies and strategic plans such as: • Review of the NSW Water Quality Objectives • Development of a Parramatta River case study to demonstrate the application of the Risk-based Framework • Review of the NSW Diffuse Source Water Pollution Strategy • Greater Sydney Harbour Coastal Management Program	PRCG + NSW Government	2020-23
		Provide input to upcoming revisions to State Environmental Planning Policies, including: • Potential revision of the BASIX SEPP • New Design and Place SEPP • New Water Catchments SEPP	PRCG + NSW Government	2020-23
		Provide input to new guidelines being developed by state government, including: • Coastal design guidelines • Design guidelines to support the Water Catchments SEPP • Design guidelines/specifications/rating schemes to support the Design and Place SEPP	PRCG + NSW Government	2020-23
		Advocate for further policy reforms, including: • Stronger consideration of blue-green infrastructure objectives in all assessment pathways • Improvement of State agencies' internal policies for blue-green infrastructure in their projects • Potential changes to the *Water Management Act*	PRCG + NSW Government	2020-25+
		Monitor policy and environmental outcomes	PRCG	2020-ongoing

1 INTRODUCTION AND BACKGROUND

'Standardise the Standards', Step 4 in the 2018 Parramatta River Masterplan, involves developing a whole-of-catchment land use policy and statutory planning mechanisms

This paper has been prepared to recommend appropriate policies, planning instruments and sustainable funding mechanisms that will support the goals of the Parramatta River Masterplan, and the particular actions identified under Step 4.

1.1 The Masterplan and its supporting studies

The mission of the Parramatta River Catchment Group (PRCG) is to create a world class river and make the Parramatta River swimmable again. The Parramatta River Masterplan was released by the Parramatta River Catchment Group in 2018 (PRCG 2018). In the Masterplan, the PRCG partners and the community have defined six elements of a healthy living Parramatta River:

- An engaged community that loves and cares for their waterways
- Clean, clear water that is safe and supports life in the river
- Business opportunities enabling thriving local businesses due to the river's popularity
- Healthy ecosystems in the river, the catchment and natural creeks
- Ease of access through improved public transport and connected cycleways and walkways
- Quality facilities for events, leisure, recreation and family fun.

The Masterplan (PRCG 2018) sets out ten steps to a living river, which are:

1. Get swimming
2. Keep watch
3. Create new swimming spots
4. Standardise the standards
5. Reduce stormwater run-off
6. Improve overflows
7. Involve the community
8. Bring in nature
9. Report back regularly
10. Create new leadership.

Step 4: Standardising the Standards involves establishing a whole of catchment land use policy and statutory planning mechanisms. Under Step 4, the Masterplan calls for:

- Standards that align with the *Risk-based framework for considering waterway health outcomes in strategic land-use planning decisions* (NSW Office of Environment and Heritage and The Environment Protection Authority 2017)
- The creation of an overarching policy mechanism for the entire catchment, potentially as a State Environmental Planning Policy
- Alignment of the above with council policies across the catchment
- Ensuring sustainable funding is allocated to monitoring and maintenance.

These actions are particularly focused on improving water quality and ecosystem health, but also have the potential to assist with other aims of the masterplan.

The Masterplan's supporting studies provide the detailed background research, action plans and processes behind each of the ten steps. Behind Standardising the Standards, the water quality modelling study (Sydney Water 2018) and the ecological health study (CT Environmental 2016) identify what kind of physical changes are needed in the catchment in order to improve the water quality health of the Parramatta River. The governance review (Macquarie University 2017) establishes a set of principles guiding the policy interventions that should be adopted to bring about these changes.

1.2 The Standardising the Standards discussion paper

As part of the Standardising the Standards project, a Discussion Paper was developed and shared with stakeholders for comment. A draft Discussion Paper was circulated in November 2019, and detailed feedback was received from six different stakeholder organisations. An updated final discussion paper was issued in February 2020, incorporating revisions in response to stakeholder feedback (McAuley and Davies 2020).

1.2.1 State environmental policy context

The Discussion Paper looked at the evolving policy context relevant to Standardising the Standards, including NSW's framework for marine and coastal management. Marine and coastal management has undergone substantial legal (e.g. *Marine Estate Management Act 2014* and *Coastal Management Act 2016),* policy and strategy changes in recent years and the development and implementation of new approaches are still underway.

An important feature of recent policy reforms has been the introduction of the Risk Based Framework (NSW Office of Environment and Heritage and The Environment Protection Authority 2017) as a method to improve water quality in catchments and coastal waterways. This framework is shown in Figure 1, modified from the original source to emphasise how it can be applied adaptively.

Another initiative underway, as an action of the Marine Estate Management Strategy, is to update NSW Water Quality Objectives (WQOs). The update will be piloted in targeted NSW coastal catchment areas to ensure they reflect current community values. The WQOs are the NSW Government endorsed environmental values and long-term goals for NSW's surface waters. They underpin NSW water quality policy by defining the community uses and values of waterways and the water quality that is needed to support these, therefore they are an important part of the framework for waterways and catchment management in NSW. The Parramatta River Masterplan and its actions should all be working towards the community's environmental values and goals for the Parramatta River.

Reforms to the State's environmental planning instruments are also ongoing. Notably the NSW government has signalled its intention to create:

- A new Design and Place SEPP, which would build on the recommendations in the Draft Greener Places Design Guide (NSW Government Architect 2020)
- A Water Catchments SEPP, which will consolidate and update four existing catchment-based instruments including Sydney Harbour Catchment REP, Georges River Catchment REP, Hawkesbury Nepean Catchment REP and the Sydney Drinking Water Water Catchments SEPP.

The NSW Government Architect has indicated that the intention for the Design and Place SEPP is to establish the principles and performance basis for "good" design, with the Greener Places Design Guide supporting the SEPP with additional detail. This is a move away from more traditional prescriptive planning provisions, which require compliance with minimum standards. A principle- and performance-based approach is intended to encourage creative approaches to meet multiple objectives and deliver connected benefits.

1.2.2 Land use and development planning

The *NSW Environmental Planning and Assessment Act* 1979 has been subject to ongoing amendments, most notably as part of the 2017 reforms that come into effect March 2018. Important features relevant to this report include:

1. A focus on vertically integrated planning that aims to support land use outcomes that have consistency between the agendas of national, state and local government
2. An emphasis on "good design and amenity of the built environment", as one of three new objects of the Act
3. Greater weight assigned to strategic planning and in particular the role councils play in setting the forward plans for their local area
4. A new requirement for councils to prepare Local Strategic Planning Statements (LSPSs) (NSW Government 2018a)
5. A direction to make planning as simple as possible. This is of particular relevance to local government in their preparation of LEPs and DCPs to a standard template
6. The introduction of new provisions for voluntary planning agreements, and in high growth areas (such as the Greater Parramatta Olympic Park (GPOP) corridor), DPIE has the powers to prepare special infrastructure contribution determinations.

Figure 2 shows the structure of the NSW planning framework and illustrates the vertical integration of policies and plans.

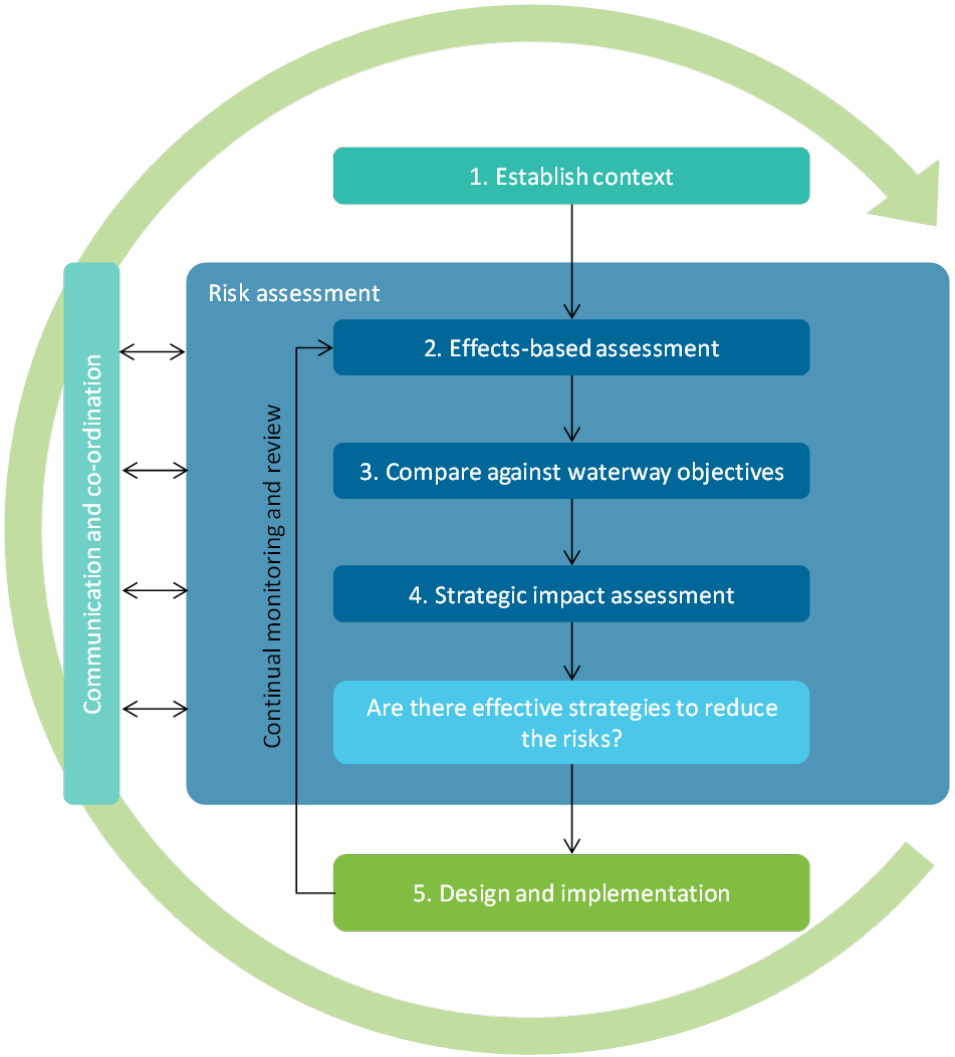


Figure 1: The risk-based framework, modified from Dela-Cruz J et al (2017) to emphasise how it can be applied adaptively

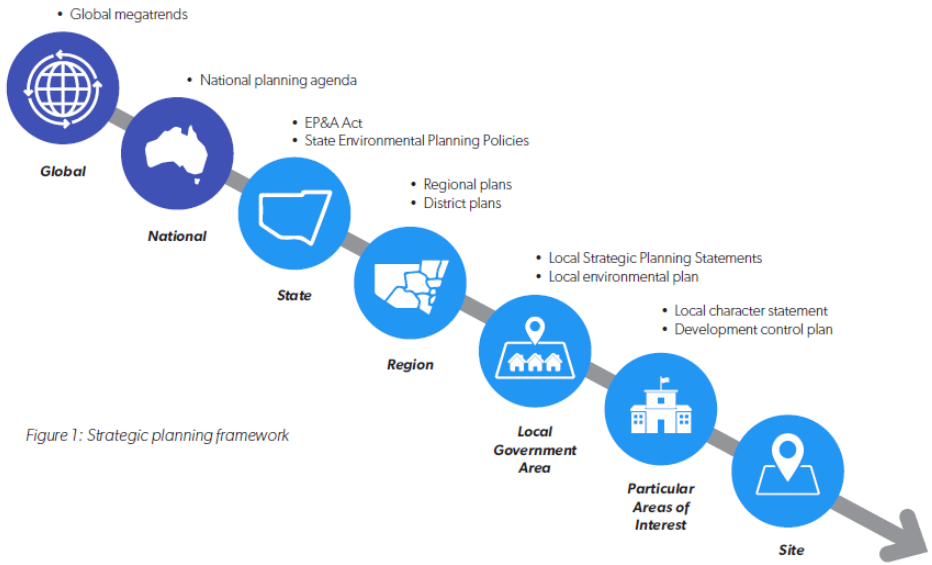


Figure 1: Strategic planning framework

Figure 2: NSW Strategic planning framework (Greater Sydney Commission 2018e)

Responding to these changes, a new Regional Plan and a set of District Plans were prepared for Sydney in 2018 by the Greater Sydney Commission (Greater Sydney Commission 2018a to d). These plans set a strategy for accommodating Sydney's growth over the coming decades, within which it is identified that there will be significant development within the Parramatta River catchment. The Discussion Paper looked at the scale and the nature of this proposed growth (McAuley and Davies 2020).

New development presents a risk of water pollution and further degradation of natural waterways, but it is also an opportunity to change the way development is undertaken to improve water management across the catchment as redevelopment occurs.

Two major areas are identified that have the greatest scope to improve waterway outcomes:

- Major renewal areas including the Greater Parramatta Olympic Park (GPOP) corridor. Many of these renewal areas involve large-scale redevelopment that will transform former industrial lands to mixed use commercial and residential development. This transformation will increase green space in these areas, but at this scale there is also the potential for more substantial changes to the way water is managed.
- Smaller scale infill development will also take place throughout the rest of the catchment. Although individual developments may be small, this development will contribute to an increase in the overall impervious area in the catchment, and it will be important to address this increase.

The Regional and District Plans also describe how Sydney's growth should be supported through existing and new infrastructure and how this growth needs to meet liveability, productivity and sustainability goals. The Regional Plan establishes that "Improving the health of waterways is essential to the sustainability and liveability of Greater Sydney" (GSC 2018a, p.149) supported by objective 25 - "The coast and waterways are protected and healthier" (GSC 2018a). The strategies proposed under objective 25 are to:

- Protect environmentally sensitive areas of waterways and the coastal environment area
- Enhance sustainability and liveability by improving and managing access to waterways, foreshores and the coast for recreation, tourism, cultural events and water-based transport
- Improve the health of catchments and waterways through a risk-based approach to managing the cumulative impacts of development including coordinated monitoring of outcomes
- Reinstate more natural conditions in highly modified urban waterways.

Four District Plans overlap the Parramatta River catchment: Central, Eastern, Northern and Southern. Planning priorities in each of these plans include a requirement to protect and improve the health and enjoyment of the District's waterways. The Central, Eastern and Northern District Plans specifically refer to the Parramatta River Masterplan and its role in supporting waterway health. Relevant actions include:

- To improve the health of catchments and waterways through a risk-based approach to managing the cumulative impacts of development including coordinated monitoring of outcomes
- To work towards reinstating more natural conditions in highly modified urban waterways.

District plans also include related priorities such as "protecting and enhancing bushland, biodiversity and scenic and cultural landscapes" and "increasing urban tree canopy cover and delivering Green Grid connections" (GSC 2018b). When actioned in a coordinated manner, these actions offer synergistic benefits to both blue and green landscapes and concurrently contribute to liveability and sustainability goals.

In 2019 many councils commenced preparation of their Local Strategic Planning Statements (LSPSs) that will in turn inform a revision to their Local Environmental Plans (LEPs) and updating of their Development Control Plans (DCPs). Some councils have completed these tasks; others are still in preparation. The focus for the PRCG is now on translating these policy directions into local plans, policies and programs. This is discussed further in Section 3.

1.2.3 The case for change

The Discussion Paper explored the issues associated with existing measures for managing diffuse stormwater pollution and waterway health in the land use planning and development process (McAuley and Davies 2020).

Existing planning provisions for water sensitive urban design (WSUD) are typically focused on stormwater treatment to meet quantitative pollutant load removal targets. This focus draws from a substantial body of scientific investigation that has linked pollutant loads from urbanisation to the deterioration in waterway health. While this approach is supported by an understanding of factors contributing to what has been

described as the 'urban stream syndrome', achieving healthy waterways has proved problematic, particularly when it comes to infill development.

The water quality modelling study (Sydney Water 2018) also showed that under a "business as usual" development scenario, water quality in the Parramatta River would decline, while under various scenarios incorporating current "best practice" treatment measures, water quality would only improve to a modest degree in localised parts of the River. To achieve more widespread and significant improvements it will be essential to go beyond the current plans and methodologies and adopt new and transformative approaches.

Existing planning provisions for waterways and riparian corridors tend to focus on protecting high value natural streams. While this remains important, many of the streams in the Parramatta River catchment are highly degraded. The *Water Management Act 2000* provides a basic framework for waterway protection; however, it is unclear how it should apply to highly urban streams (e.g. concrete channels with no remaining riparian vegetation) and smaller streams that may not be recorded on topographic or land use maps.

Specific issues for further consideration as raised in the Discussion Paper included:

- The current focus on quantitative pollutant load removal targets that encourages a "least cost" outcome – that is, an outcome that can meet the targets (as modelled) in the least possible space at the lowest possible cost (typically for the developer at construction).
- Missed opportunities to provide other positive and complementary catchment outcomes that would help the River. These include reducing site impervious area, reducing runoff quantities and flow and integrating stormwater treatment into the landscape, where it can also function as habitat, improve microclimate and support urban greening.
- Missed opportunities to improve degraded waterways and riparian corridors via the development process. New development presents potential opportunities to restore degraded streams and even daylight streams that have been piped in the past.
- Insufficient focus on monitoring. Measuring load-based reductions in stormwater pollutants requires intensive monitoring over many (dozens of) rain events, and it is rarely undertaken. This lack of evidence limits the validity of evidence-based science-informed policy for the catchment.
- Inadequate focus on compliance. It remains uncertain that what was approved was built and whether the structural devices or landscape features are being maintained.
- Whether WSUD treatments are best implemented in the public or the private domain? This question can pivot around the capacities and capabilities (including financial) of private individuals, body corporates, councils or state agencies to maintain and eventually replace water treatment devices.

1.2.4 Directions for policy reform

The Discussion Paper also identified six key opportunities for improvement:

1. Consider the fundamental drivers of waterway health and link provisions more strongly with **waterway health goals**. This can focus on reducing impervious areas and disconnecting impervious areas from the stormwater systems to collectively reducing stormwater runoff.
2. Bring planning instruments and development controls '**back to basics**', meaning that the requirements need to be clear and straightforward to understand, as well as realistic and practical to implement, therefore more likely to succeed in the long-term. This is particularly important for smaller scale development, but needs consideration across the full range of development types and scales.
3. Encourage **integrated**, multi-purpose **green infrastructure** in both the private and public domain, including streetscapes to complement WSUD outcomes. Consider whether more codified or more flexible, performance-based methods for water and landscape outcomes are more appropriate in different types of development.
4. Provide stronger protections for **riparian corridors**, including where waterways have been highly modified, and plan for the restoration of riparian corridors
5. **Plan for monitoring and review**. Consider how compliance will be checked against development approvals (DA), as well as how outcomes will be checked both immediately after construction, and over the long-term. Consider how catchment-wide monitoring data (inclusive of physical, social and compliance) will be aggregated for reporting and review purposes.
6. Ensure that any planning instruments and development controls are supported in their implementation, including **sustainable funding** at appropriate levels.

These directions are complementary and synergistic and have a clear line of sight to achieve the directions of the PRCG strategic plan. The directions also complement the strategic plans of the catchment councils and relevant state agencies.

An important message in the Discussion Paper is that planning provisions – both for diffuse stormwater pollution and for waterways and riparian land – were developed at

a time when most of Sydney's new development was in greenfield areas. However, urban renewal and infill development now dominates the provision of new housing within metropolitan Sydney. Part of this challenge is to rethink planning provisions for the infill context.

The Discussion Paper also highlighted that:

- The challenge of creating a world class river and making the Parramatta River swimmable again is certainly a complex problem and has many of the hallmark features of a wicked problem, thus requiring an adaptive approach
- An adaptive approach needs to be grounded in a strong framework, with clear line of sight between waterway health goals and specific catchment and development policy/planning provisions
- The idea of "standardising" the standards identified as Step 4 in the Parramatta River Catchment Group Masterplan would be better thought of as a need for policy *consistency* rather than *uniformity*. Within any framework of standardised controls, there must be flexibility to allow State and local government authorities to implement context-specific development controls and stretch targets.

1.3 Stakeholder workshops

Following the release of the draft Discussion Paper, two stakeholder workshops were held for the Standardising the Standards project, one focused on water quality and water sensitive urban design (WSUD) (the "WSUD workshop") and one focused on waterways and riparian lands (the "waterways workshop"). The workshops were attended by representatives from most of the PRCG member councils as well as Sydney Water, DPIE and the PRCG co-ordinator.

In the workshops, participants:

- Looked at examples of planning provisions for WSUD, waterways and riparian land from different places
- Worked through local case studies, which represent different contexts in the Parramatta River catchment (e.g. different development densities, lot and precinct)
- Discussed what we want to achieve, how planning provisions would support this, how it could work in different types of development and what is most likely to succeed
- Discussed options to improve funding, monitoring and compliance, including the option of stormwater offsets
- Identified next steps and the resources required for catchment councils to adopt new planning provisions.

The input from these workshops was important in developing the content of this recommendations paper, and these workshops are referenced throughout the document, wherever specific ideas are introduced.

1.4 This recommendations paper

The 2018 Parramatta River Catchment Group Masterplan (PRCG 2018) identified a clear need for a whole-of-catchment approach to land use planning and development controls. The actions relevant to planning reform have been, in part, been overtaken by the rapid changes at state and local government levels leading to completion of many LSPS and subsequent lodgement of planning proposals for new LEPs. In this respect this recommendations paper seeks to leverage on strategic planning work completed, inform and direct the work that is still underway and guide the formation of local policy (e.g. DCP) revisions that will be occurring in 2020 and beyond.

The Discussion Paper revealed a strong support for WSUD and riparian policy to be strengthened at the state level so as to offer clearer direction and enable greater impact when implemented at the local level. At present, the greater reliance on local policies and planning provisions will not adequately address the scale of development proposed in the Parramatta River catchment and its impact on sustainability and liveability goals. However, it has been apparent throughout the Standardising the Standards project that reform to state level policy faces significant challenges and will not happen quickly. Therefore, this must be positioned as a longer-term prospect that will require ongoing and broader stakeholder collaboration.

This recommendations paper is, therefore, directed so as to offer guidance to the PRCG as to what are likely to result in short- term planning reforms while also maintaining a line of sight towards longer term policy change. Figure 3 outlines the structure of the paper, which includes recommendations for:

- The water quality and waterway objectives that should be incorporated into policy reforms (Section 2)
- Short-term updates to local policies and plans (Section 3)
- Development of new frameworks, including a performance-based WSUD tool (Section 4) and improved waterway and riparian policy (Section 5)
- Longer term strategies to strengthen and improve the implementation of new frameworks, including policy support at the state level (Section 6)
- Summary of recommended actions (Section 7).

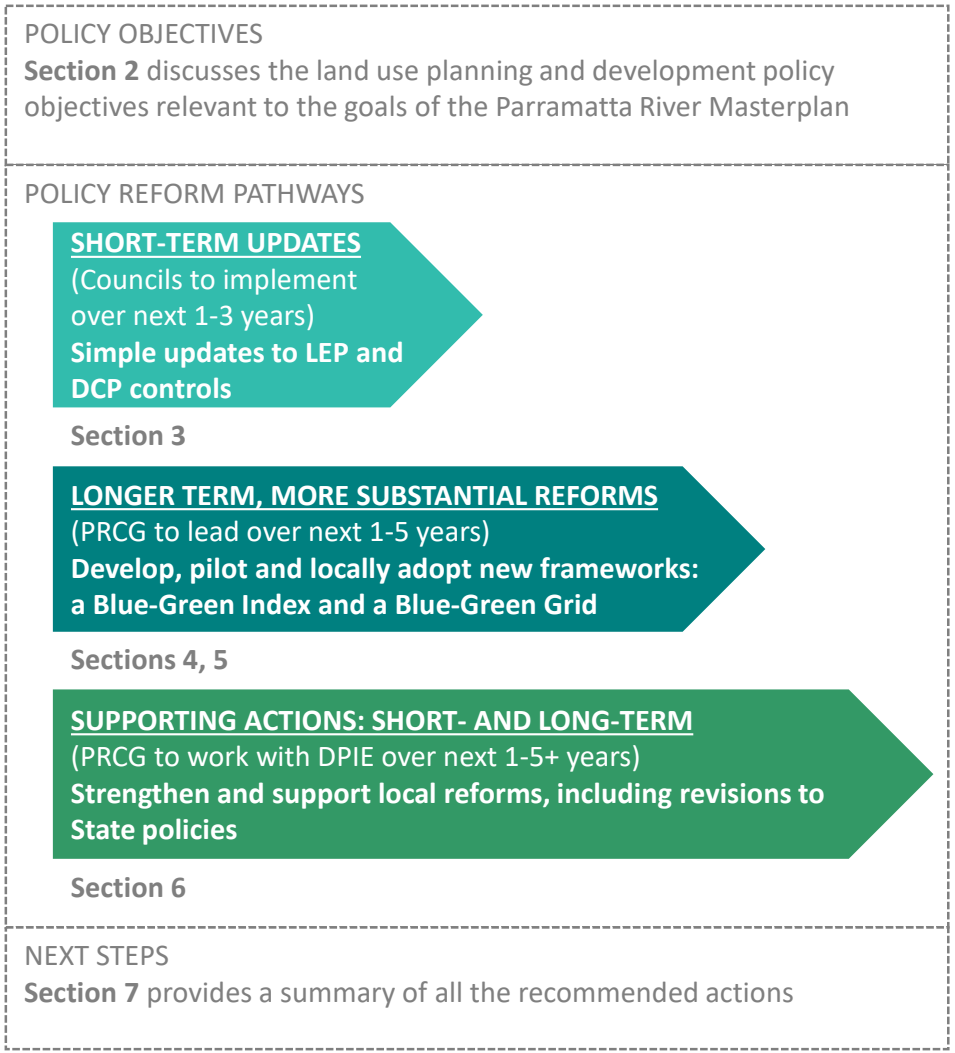


Figure 3: Structure of the recommendations in this document

During the development of this paper, project stakeholders were invited to comment on several drafts. Submissions were received from all of the PRCG member councils as well as the following divisions and groups of DPIE:

- Green & Resilient Places
- Central River City and Western Parkland City
- Planning Policy- Local Govt Economic Policy divisions:
    - Environment
    - Codes
    - Infrastructure Funding & Public Space
- Environment, Energy & Science (EES) divisions:
    - Place-based Science – Science Economics and Insights
    - Water for the Environment – Biodiversity and Conservation
    - Water, Floodplains and Coast – Biodiversity and Conservation
    - Marine, Coasts, Estuaries and Floods – Biodiversity and Conservation
- DPIE Legal
- Industry Assessment
- Social & other Infrastructure assessments
- Government Architect NSW

2 POLICY OBJECTIVES

A clear set of objectives forms the link between the vision and goals in the Parramatta River Masterplan, and the specific planning and policy recommendations made in this paper

The Discussion Paper explored the potential roles of land use planning and development policies in contributing to the goals of the Parramatta River Masterplan. The discussion paper identified:

- Across the whole catchment, development can play an important role in reducing stormwater runoff and reducing the loads of pollutants conveyed to the River in stormwater runoff
- Where development is adjacent to creeks and watercourses, it can play an important role in protecting and improving waterway and riparian habitat
- Certain development sites present opportunities to improve access to waterways, and improve facilities at swim sites and other recreational sites.

Therefore, the focus of this paper is on the first two points above, and to a lesser extent the third. However, policy for land use planning and new development can also contribute indirectly to meeting other goals of the Masterplan, including an engaged community and opportunities for business. Policy focused on stormwater management and waterway health can also contribute to broader liveability outcomes, such as the benefits associated with higher quality green infrastructure. These interconnected objectives and outcomes have been considered in formulating the policy recommendations in this paper, and should continue to be an important consideration as policy is developed in more detail.

One of the directions identified in the Discussion Paper is to create stronger links between planning provisions and waterway health goals. The Discussion Paper identified the Risk-Based Framework developed by the NSW Office of Environment and Heritage and Environment Protection Authority (2017) as the method to do this. The risk-based framework emphasises the use of scientific evidence to understand the effects of different land use planning scenarios on waterway health, and to design management measures to mitigate the negative effects and meet waterway objectives.

The waterway health goals for the Parramatta River are defined in the 2018 Masterplan (refer to Section 1.1). In the Masterplan, the concept of a living river is holistic, incorporating environmental, social and economic aspects. The goals most closely related to waterway health are:

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

The Masterplan's supporting studies provide the basis to translate these goals into more specific objectives:

- The water quality modelling study (Sydney Water 2018) provides the basis for water quality objectives
- The ecological health study (CT Environmental 2016) provides the basis for ecosystem health objectives focused on waterways and riparian land.

These two types of objectives are discussed in the following sections, stepping from the high-level goal down to specific objectives, working through the evidence base in-line with the risk-based framework.

2.1 Stormwater runoff objectives

The PRCG's Masterplan set a goal of "clean, clear water that is safe and supports life in the river" (PRCG 2018, p.26). The District Plans (Greater Sydney Commission b, c, d) include an action to "improve the health of catchments and waterways through a risk-based approach to managing the cumulative impacts of development including coordinated monitoring of outcomes". This suggests an approach that draws on the Risk Based Framework, and this approach is underway for the Parramatta River. The focus of the main water quality study authored by Sydney Water (Sydney Water 2018) was to address water quality from a swimming perspective via bacterial risk. Note that

this doesn't address all the risks (or even all the water quality risks) associated with bringing back swimming to the Parramatta River; but the focus of the Sydney Water study was on risks associated with runoff from the catchment, and sewer overflows. The focus of this recommendations paper is particularly on stormwater runoff from the catchment, as this is an area where land use planning and development controls can play an important role. Following the Masterplan, there is other work underway by the PRCG on a wide range of actions, including actions to reduce the impacts from sewer overflows (Step 6).

The water quality modelling study (Sydney Water 2018) assessed the expected effects of future development and various management strategies to improve water quality towards this goal. Figure 4 summaries the key findings from this study into a set of strategies to apply to new development. The study recommended:

- *Enterococci* should be used as the key indicator of water quality for the Parramatta River, as it is the current preferred indicator in recreational water quality guidelines
- Measures which reduce stormwater runoff would reduce *Enterococci* loads
- Various rainwater tank and rain garden scenarios that were tested in the modelling reported these would reduce *Enterococci* loads, however, all the modelled scenarios showed only moderate improvement in water quality in the river.
- Other measures that reduce runoff (from permeable paving to green roofs and infiltration systems) would also be expected to reduce *Enterococci* loads.

The use of *Enterococci* as a water quality indicator is not meant to diminish the importance of other stormwater pollutants to the health of the Parramatta River. As an indicator, *Enterococci* can encapsulate a wide range of water quality parameters, as measures that reduce runoff would also reduce the loads of all other stormwater pollutants including sediment, nutrients, hydrocarbons, heavy metals and other toxicants.

Therefore, three of the recommended strategies in Figure 4 are focused on reducing runoff. These include:

- Maximise pervious areas and vegetation coverage
- Maximise rainwater harvesting
- Maximise infiltration and evapotranspiration.

The framework in Figure 4 also recommends stormwater treatment as a fourth strategy to reduce *Enterococci* loads. This is recommended even though the modelling report (Sydney Water 2018) did not investigate the effectiveness of stormwater treatment systems to reduce *Enterococci* loads. Although bioretention systems were included in some of the scenarios undertaken by Sydney Water in their study, their modelled effect on *Enterococci* loads was based only on the reduction in runoff associated with these systems. However, there is a reasonable body of evidence in the scientific literature demonstrating the effectiveness of bioretention systems in reducing pathogen loads - see Box 1. Some studies have also looked at the effectiveness of other types of stormwater treatment systems. Therefore, stormwater treatment is recommended as part of this framework.

The caveat to this recommendation is that there is still a need for more scientific research to understand the performance of different treatment options for reducing *Enterococci* and other pathogen loads. For this paper, we make the following assumptions and recommendations:

1. Volumetric runoff reduction can be a surrogate for *Enterococci* reductions
2. Stormwater quality improvement devices designed to remove TSS, TP and TN will also remove pathogens including *Enterococci*
3. That the pollutant load removal targets of 85/65/45[1] remain as quantifiable targets and that these will assist in achieving water quality outcomes
4. Bioretention systems are encouraged over other treatment measures, as there is currently better evidence for pathogen removal in bioretention systems than in other types of treatment devices – particularly when a saturated zone is included
5. When there is further empirical evidence that validates or otherwise these assumptions, this shall inform an iterative update of policy and standards.

[1] 85% removal of the mean annual load of Total Suspended Solids
65% removal of the mean annual load of Total Phosphorus
45% removal of the mean annual load of Total Nitrogen

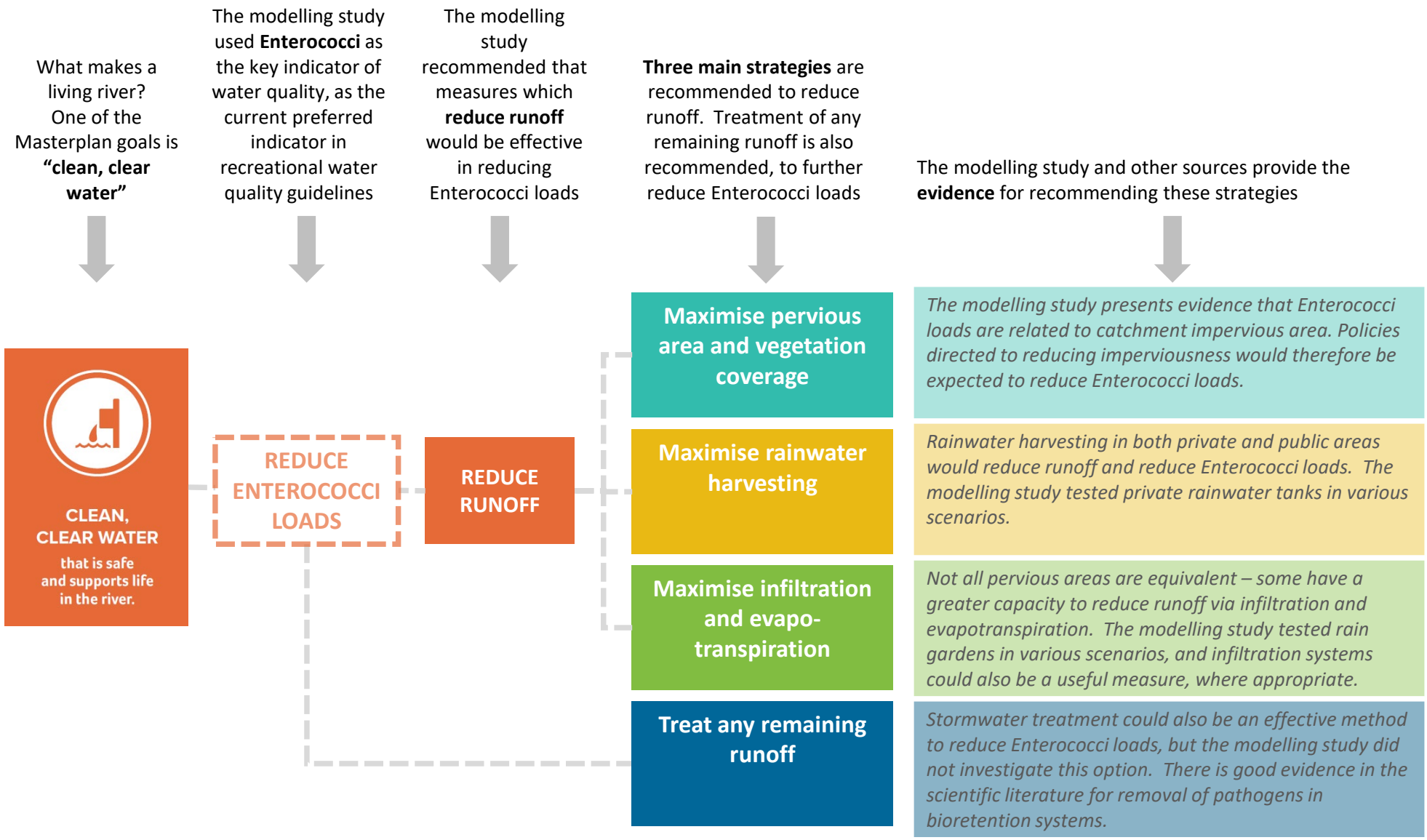


Figure 4: Strategies for stormwater runoff from the catchment

Box 1: pathogen removal in stormwater treatment systems

A recent literature review of microbial hazards in urban stormwater and their removal through WSUD (Lloyd *et al* 2020) looked at available performance data regarding the removal of faecal indicators and pathogens from urban stormwater by stormwater biofilters, constructed wetlands, green roofs and green walls. It identified the following findings:

- Microbial contamination in urban stormwater has multiple sources, and its characteristics can vary depending on which sources are contributors in a particular catchment.
- Pathogens include a wide range of different organisms with different characteristics. Differing removal rates for bacteria, protozoa and viruses have been observed in stormwater treatment systems. Physical straining in filter media may remove larger protozoan pathogens, while adsorption and predation are the most likely factors influencing removal of smaller organisms (bacteria and viruses).
- The most reliable pathogen removal rates come from stormwater biofilters. On average, a 90% (1 log) reduction in faecal indicator bacteria (FIB) can be expected with stormwater biofilters. Removal rates for other treatment types are more variable and/or there is less data available.
- There have been several studies that have looked at the design of stormwater biofilters and identified how various design factors influence performance. The strongest evidence for design criteria that promotes FIB and pathogen removal includes deeper profiles ($\geq$0.9m), low nutrient filter media, and the inclusion of a saturated zone. Emerging research also suggests that performance may be enhanced by copper-coated filter media and plant species from the *Myrtaceae* family.
- There is a need for more empirical research to understand the accumulated benefit of WSUD at a catchment scale, and its impact on waterway health.

2.2 Waterway and riparian land objectives

The Parramatta River Masterplan sets a goal to create "healthy ecosystems in the river, the catchment and natural creeks". The District Plans (GSC b, c, d) also call for "work towards reinstating more natural conditions in highly modified urban waterways".

The ecological health study (CT Environmental 2016) provided a set of recommendations to improve ecosystem health across four different habitat domains – terrestrial, riparian, freshwater and estuarine – using five iconic species as the representatives of each domain (with two representatives for the freshwater domain).

The report provided recommendations for habitat protection, habitat management and habitat creation. These recommendations are largely the focus of Step 8 (Bring in nature), however, there are connections with Step 4, as:

- There is a potential for new development to play a role in many of the recommendations
- Healthy tributaries in the catchment can play a role in water quality improvement, by attenuating and filtering flows.

Table 1 lists a summary of the recommendations from the ecological health study (CT Environmental 2016), noting where there are connections with waterway health, and where these could be translated into potential actions in new development.

This is presented graphically in Figure 5, which shows three strategies for improving waterway health, relevant to new development:

- Protect and enhance riparian vegetation
- Design overland flowpaths to include dense vegetation
- Use vegetated stormwater treatment systems.

These are strategies that will contribute to ecosystem health as well as reduced runoff and improved water quality. Healthy waterways and riparian lands are also connected to other benefits, including:

- Habitat connectivity
- Green grid links for recreation and active transport
- Urban heat mitigation.

2.3 Connected objectives

The strategies outlined in Sections 2.1 and 2.2 also provide complementary and synergistic benefits to supporting greener landscapes within the catchment and improving liveability outcomes. For example, increasing vegetation cover can support biodiversity outcomes through the provision of new and linked habitats and the shading and evapotranspiration from increasing vegetation (canopy cover) can also support cooler city outcomes. From a water conservation perspective, harvesting rainwater will also reduce potable water demand and can provide a source of water for landscaping that can sustain vegetated landscaped during drought and water restrictions. Figure 6 highlights the connectivity between objectives.

Table 1: Summary of recommendations from the ecological health study (CT Environmental 2016, pp. 45, 57, 71, 83), translated into potential roles for new development

Habitat domain	Recommendations (CT Environmental 2016)	Connections with waterway health (CT Environmental 2016)	Potential roles for new development
Terrestrial *Urban bushland reserves* *Urban with bushland pockets*	**Manage** patches of native vegetation with dense riparian and gully vegetation and large canopy trees. **Protect** areas with known populations of Powerful Owls and important prey species by incorporating core areas into biodiversity offset schemes such as BioBanking. **Protect** the presence of large hollow bearing trees in natural areas. **Protect** mature trees in urban areas for the habitat of owls and their prey. **Create** Powerful Owl and prey species habitat by revegetating riparian and bushland areas with dense canopy vegetation taking care when replacing exotic species that also provide dense cover **Create** artificial habitats by forming artificial hollows and re-standing of dead trees **Create** and expand habitat through the Sydney Green Grid to support movement within and between catchments	Dense terrestrial vegetation regulates overland flows and provides surface resilience, inhibiting gully and stream-bank erosion. Vegetation filters diffuse sediment and pollutants generated and carried by overland flows before they enter waterways, mitigating degradation of water quality.	Protect and enhance riparian vegetation Design overland flowpaths to include dense vegetation
Riparian *Urban freshwater creeks and rivers*	**Manage** patches of native vegetation with dense riparian and gully vegetation and large canopy trees which support hollows **Create** future roosting habitat by regenerating existing riparian corridors with dense understory and canopy plantings **Create** new habitats by installation of artificial hollows, roosting boxes and re-standing dead hollow bearing trees **Create** off-line wetlands to expand habitat diversity and foraging opportunities	Dense riparian vegetation stabilises banks and mitigates stream bank erosion Riparian vegetation and constructed wetlands filter diffuse sediment and pollutants from entering the waterways, therefore mitigating degradation of water quality Riparian vegetation and wetlands enhance instream processes such as nutrient recycling and flow retention which provide benefits to water quality Constructed wetlands regulate flow velocity thus reducing erosion and degradation of instream habitat	Protect and enhance riparian vegetation Use vegetated stormwater treatment systems to combine water treatment with flow attenuation and habitat benefits
Freshwater *Urban freshwater creeks and rivers*	**Protect** patches of native vegetation with dense riparian and gully vegetation **Construct** fish crates to create submerged and emergent habitat **Construct** off-line wetlands to create habitat and improve water quality **Protect** frog and turtle nesting sites from fox predation	Native vegetation corridors act as filters to overland flow, cleansing water before it enters waterways Native vegetation stabilises creek banks which limits erosion and sedimentation therefore suppressing further water quality decline The construction of off-line wetlands will assist to mitigate against altered hydrology which is typical of urban streams Increased flow in urban streams, exacerbates erosion of creek bed and banks and results in sedimentation and elevated turbidity	Protect and enhance riparian vegetation Design overland flowpaths to include dense vegetation Use vegetated stormwater treatment systems to combine water treatment with flow attenuation and habitat benefits
Estuary *Estuaries, Bays and Lagoons*	**Protect** areas of intertidal mudflat, saltmarsh and mangrove **Create** artificial oyster reefs to protect habitats Conduct a feasibility study to determine the viability of the creation of artificial oyster reefs Create a dog beach at Canada Bay to draw this recreation activity away and protect sensitive (feeding) areas Detailed survey and mapping of Godwit feeding and roosting sites to support efforts to manage these critical areas	Sydney Rock Oysters have been shown to filter 49% of suspended solids, 58% of bacteria and up to 80% of nutrients from the water column, thus providing direct water quality benefits	

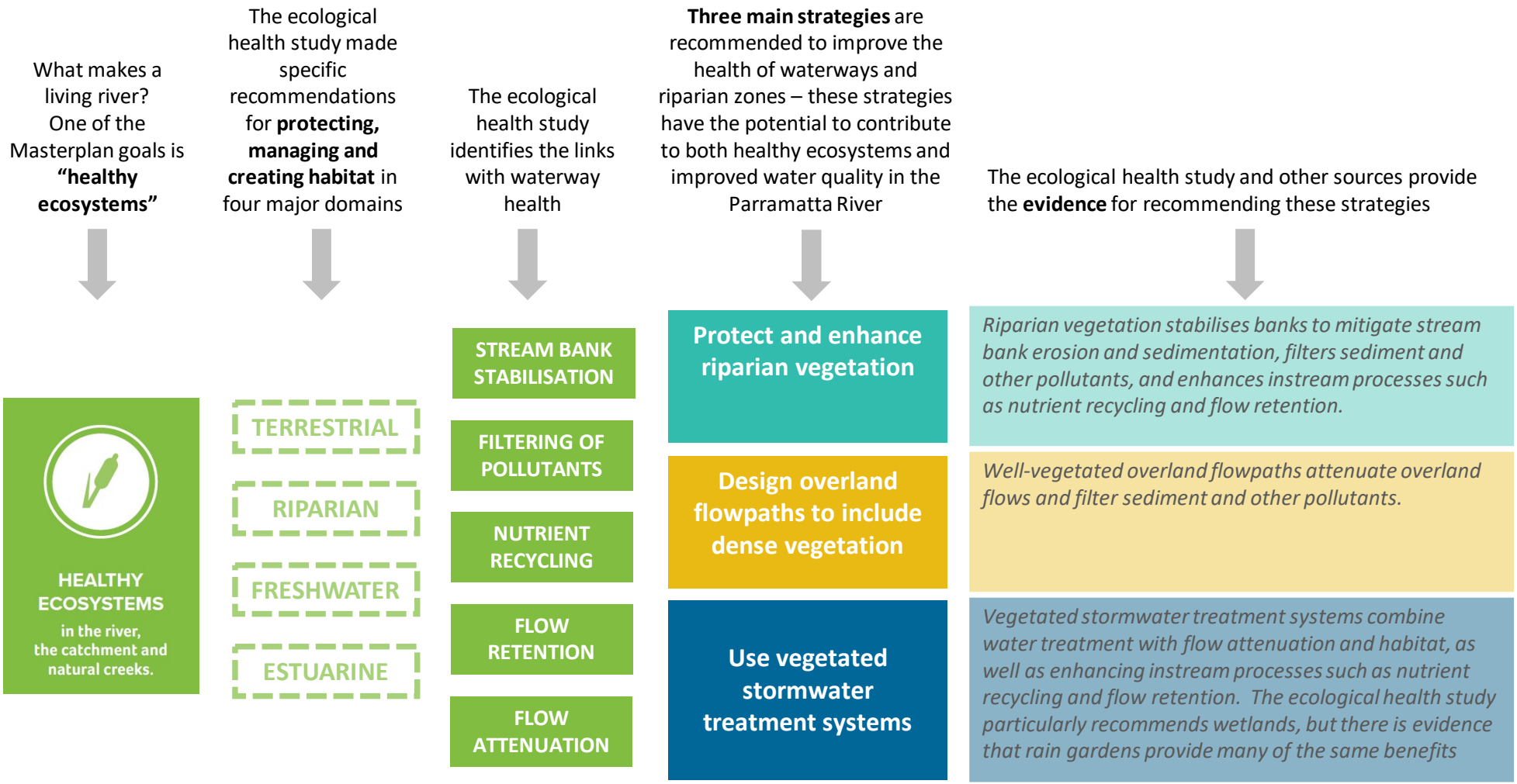


Figure 5: Strategies for improving the health of waterways and riparian land

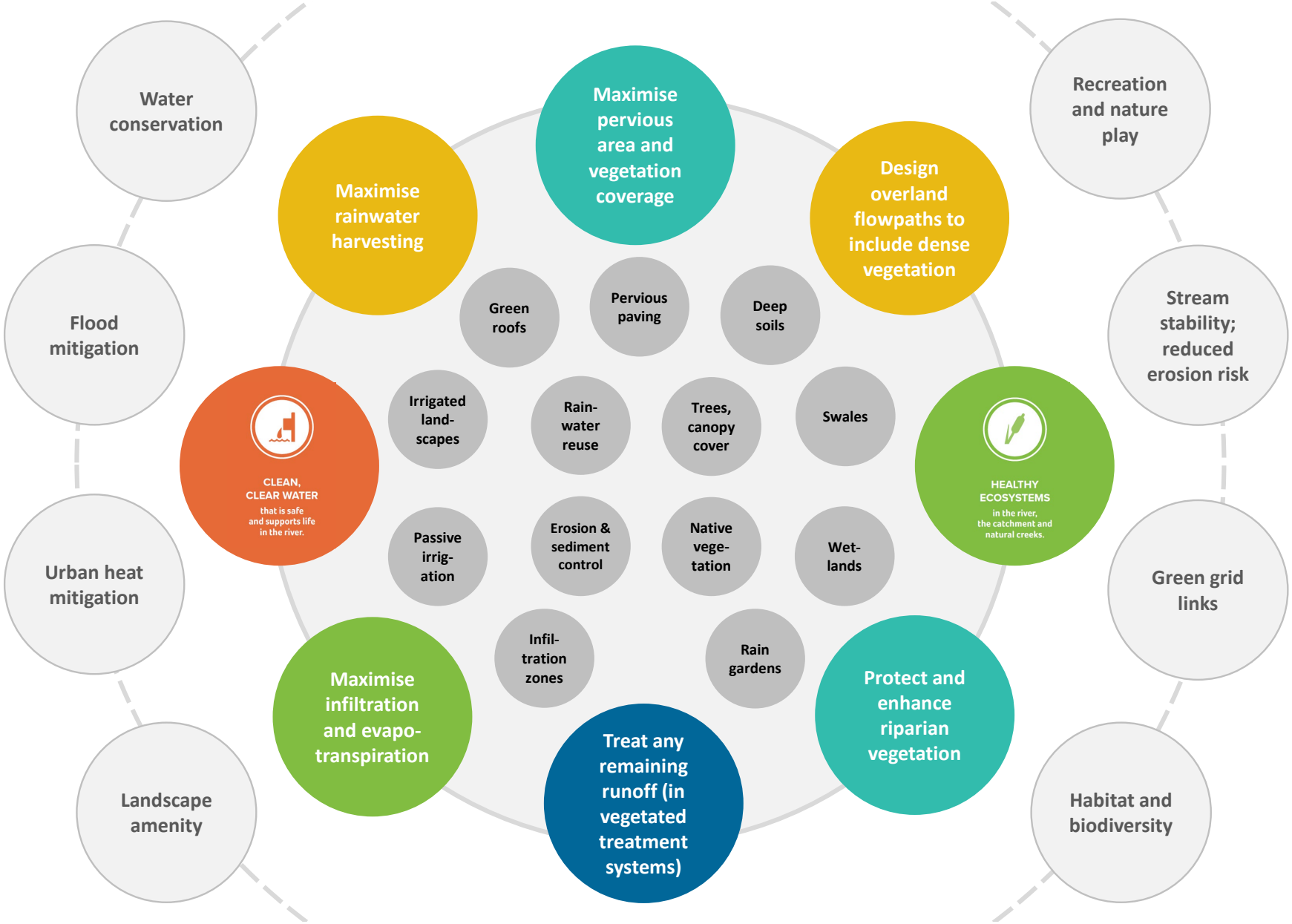


Figure 6: Strategies for reducing runoff, reducing pathogen loads, improving waterways and riparian land will also contribute to meeting other related objectives

3 SHORT-TERM UPDATES TO LOCAL POLICIES AND PLANS

Parramatta River catchment councils are all at various stages in the process of updating local policies and plans, and these updates can incorporate changes that align with the Parramatta River Masterplan

An important goal identified under Step 4 of the Parramatta River Masterplan is to create a single overarching policy mechanism for the entire Parramatta River catchment. This remains relevant as a long-term goal; however, it is unrealistic in the short-term.

In 2020, all of the catchment councils have prepared new LSPSs, and most of these include actions related to updating local planning provisions and development controls, to improve outcomes for the Parramatta River (see Section 3.1 below). However, the councils are working to different timeframes to complete these updates.

Currently, many of the catchment councils are updating their LEPs and DCPs; however, for most of the Parramatta River catchment councils who have been through mergers, the main focus of these updates is 'harmonisation' to consolidate existing provisions into a single new LEP and DCP for the new LGA. Most councils are not prepared to consider substantial changes to planning provisions as part of this process, and this current round of updates will not address all the actions in their LSPS.

Where councils have made a commitment in their LSPS to update LEP and DCP provisions, it is expected that they should address this commitment in a future round of updates, within the next few years. Each council will undertake these future updates on their own timeframe, but there is a requirement for LEPs to be reviewed every 5 years.

The recommendations in this section are intended to support each of the catchment councils whenever they are ready to update their LEPs and DCPs to improve outcomes for the Parramatta River.

The recommendations seek to support local planning reforms so that they are:

- Aligned with the objectives presented in Section 2
- Consistent with approaches already in practice
- Consistent with the structure of existing planning documents.

Sections 3.2 and 3.3 provide several recommendations for potential changes to LEPs and DCPs. Model planning clauses are provided in Appendix A. It is expected that each council would use these recommendations and model clauses as a starting point, but would need to consider locally-specific needs and opportunities, and develop their own provisions to reflect differences across the catchment and within each LGA.

This short-term update of councils' LEPs and DCPs will not complete Step 4 of the Parramatta River Masterplan, but the intent of the recommendations is to make realistic progress on Step 4 within the next few years. This means working within existing frameworks, keeping the changes relatively simple and consistent with existing approaches. While Sections 4 and 5 outline longer-term actions to make more substantial policy changes, with future implications for planning provisions, the recommendations in Sections 3.2 and 3.3 do not rely on these longer-term actions and can be implemented in the short-term.

Recommended updates in Sections 3.2 and 3.3 are focused on reinforcing the four strategies for: reducing runoff; improving water quality; improving the health of waterways; and improving the health of the riparian zones (refer to Figure 4 and Figure 5). These strategies are listed in Table 2, along with a set of potential areas where existing planning provisions could be amended or improved to better implement each strategy. This list is not exhaustive, but provides a level of consistency with existing approaches, so that the recommendations may be adopted more readily.

Table 2: Ideas for local planning provisions

Strategies for new development	Potential areas where local planning provisions could assist
Maximise pervious area and vegetation coverage	Set minimum landscaped areas Provisions for deep soils within landscaped areas Provisions for trees and other vegetation
Maximise rainwater harvesting	Provisions for rainwater harvesting for the purpose of reducing runoff
Maximise infiltration and evapotranspiration	Mean annual runoff reduction targets
Treat any remaining runoff	Mean annual pollutant load removal targets
Protect and enhance riparian vegetation	Waterway and riparian zone mapping Provisions for revegetation in riparian zones
Design overland flowpaths to include dense vegetation	Overland flowpath design standards
Use vegetated stormwater treatment systems	Landscaped area, deep soil, vegetation, flow reduction and pollutant load removal targets provide indirect incentives to use vegetated treatment systems

Well-formulated local planning provisions should also assist in ensuring ongoing maintenance of blue-green infrastructure, for example by:

- Encouraging integrated, multi-purpose green infrastructure
- Setting realistic requirements for different development types and scales
- Carefully considering (subject to local context) which requirements should be met within the private domain and which should be met within the public domain
- Where development includes public assets that will be handed over to Council, being clear about the design, construction and establishment standards that Council expects to be met prior to asset handover
- Where development includes private water quality treatment assets, including provisions for positive covenants requiring future maintenance.

3.1 Local Strategic Planning Statements

Local Strategic Planning Statements (LSPSs) are an important strategic link between regional and local plans, as shown in Figure 2. LSPSs serve to link strategic and statutory plans and give effect to higher-level (district, regional and state) plans relevant to each local council. LSPSs consider local characteristics and opportunities, and the council's own priorities in the community strategic plan. They also draw in planning priorities identified through State, regional and district strategic planning work, and translate these into the local context, providing local actions and priorities. LSPSs inform the preparation of local statutory plans and development controls including LEPs and DCPs (Department of Planning and Environment 2018).

In the Parramatta River catchment, the Parramatta River Masterplan is a regional plan that should find expression in the LSPS, although noting this does not carry the statutory weight of an environmental planning instrument or associated strategy. Before the draft LSPSs were prepared in 2019, Sydney Water provided PRCG member councils with six proposed objectives and actions relevant to the Parramatta River Masterplan, to consider including in each LSPS. These are listed in Table 3, although have been edited in response to feedback received during the Standardising the Standards project.

Most Sydney councils finalised their LSPSs in March 2020. A summary of relevant objectives and actions included by PRCG member councils within their LSPSs is included in Table 3.

Each of the councils' LSPS incorporate different priorities and actions, depending on the local context, but each picks up on the themes of waterway health, biodiversity and the Green Grid that are priorities in the District Plans. Of the ten councils who are members of the PRCG, nine include a planning priority that refers to waterway health. Most of these use wording similar to the District Plan - "improving the health and enjoyment of waterways". Some use the terms "access" or "swimmability" rather than enjoyment. One expands the concept into seven related priorities.

When it comes to translating this priority into action there are varying levels of commitment made in different LSPSs:

- Four make a specific commitment to supporting whole of catchment land use policy and statutory planning mechanisms.
- Five make specific commitments to updating local policy/planning documents to improve waterway health outcomes.
- Five make a commitment to develop catchment/blue grid plans including options to reduce stormwater runoff.

Table 3: Suggested LSPS content relevant to the Parramatta River Masterplan

Suggested objectives	Suggested actions	What has been included in PRCG member councils' LSPSs, March 2020
Protect the Parramatta River catchment by ensuring policies and planning instruments contribute to the Parramatta River Catchment Group's mission to make the Parramatta River swimmable again.	Work with members of the Parramatta River Catchment Group to develop whole of catchment land use policy and statutory planning mechanisms that improve water quality (Short term)	Seven out of ten include at least one action related to updating planning provisions and development controls. Four of these use the wording suggested in Table 3, "to develop whole of catchment land use policy and statutory planning mechanisms". Five make specific references to local documents (e.g. LEP, DCP) that will be reviewed and updated. Most of them broaden the focus of these policy updates beyond water quality to include objectives such as ecological health, access and recreation.
Identify opportunities to implement water sensitive urban design infrastructure across areas providing best return on investment.	Work in partnership with key stakeholders to adopt a regional approach to reduce stormwater runoff through water sensitive urban design infrastructure (short term). Also develop funding mechanisms for regional scale infrastructure.	The concept of a regional approach to reducing runoff through WSUD infrastructure has not come through clearly in the LSPSs. Only one of the ten includes an action using this wording. However, four others do include actions to develop "blue grid" or catchment plans, including options to reduce stormwater runoff.
	Incorporate water sensitive urban design principles into infrastructure plans at all levels, to facilitate Green Grid and Parramatta River Masterplan implementation.	The concept of embedding WSUD specifically in other infrastructure plans/projects is not included in any of the current LSPSs
Protect and preserve cultural heritage associated with local waterways.	Engage with Aboriginal leaders and historians of European settlement in the area to identify and celebrate the long cultural history of the Parramatta River and its tributaries.	Cultural heritage is generally included elsewhere in the LSPSs, linked to the liveability theme and the priorities under that theme, rather than being mentioned specifically in relation to waterways.
Provide cool, green links to waterways, open space and bushland for recreation and exercise through the implementation of the Greater Sydney Green Grid.	Identify opportunities for increasing green infrastructure on public and private land, including expanding urban tree canopy and prioritising opportunities for bioretention systems along preferred Green Grid corridors (medium term).	Implementing the Green Grid and increasing tree canopy cover has clear expression in the LSPSs. One of the District Plan priorities is "Increasing urban tree canopy cover and delivering Green Grid connections" and this priority carries over to all the LSPSs. Several of the LSPSs include high-level Green Grid mapping, and several identify the intention to develop more detailed Green Grid strategies.
Maintain, improve and create new habitats for iconic species identified in the Parramatta River catchment.	Map and reference key habitat areas and priority corridors for iconic species in the Parramatta River catchment within Council's LEP (short term).	One of the priorities in the District Plans is "protecting and enhancing bushland, biodiversity and scenic and cultural landscapes" and this carries through to the LSPSs. The LSPSs do not refer specifically to the iconic species, but several of the councils make a commitment to undertake more detailed planning for bushland and biodiversity beyond the LSPS.
Activate proposed swimming site locations within the Parramatta River.	Identify and map new swimming sites in Council's LEP and reference these in Council's strategic planning documents (short term).	This is only relevant to councils with Parramatta River foreshore areas, and the three high priority sites identified in the Parramatta River Master Plan are located in just two LGAs. None of the LSPSs commit to mapping swimming sites in the LEP, but Ryde's LSPS includes a target to activate a swimming/recreation site along the Parramatta River by 2025.

With LSPSs recently completed, they may not be reviewed again for several years (maximum seven years). However, for any councils updating their LSPS in the short-term, the suggested objectives and actions in Table 3 remain relevant.

3.2 Local Environmental Plans

Local Environmental Plans (LEPs) need to go through a formal process to be gazetted into law, including a Planning Proposal, Gateway determination, community consultation, assessment and legal drafting. Planning Proposals are assessed by DPIE and need to demonstrate the strategic merit of the proposed LEP amendments. In applying the recommendations in this section, each council will need to consider how they can demonstrate the merit of proposed provisions based on their local context, including the directions established in their LSPS.

LEPs must also be based on the template Standard Instrument. This stipulates the specific provisions that should and can be included in an LEP. The Standard Instrument applies state-wide, therefore amendments to the Standard Instrument are not recommended at this stage. Any amendments to the Standard Instrument would require widespread support and major amendments are unlikely to be achieved in the short term. Therefore, following sections make recommendations within the framework of the Standard Instrument. Recommendations are organised by key sections of the LEP:

- Aims of the plan
- Zoning provisions
- Local provisions.

3.2.1 Aims of plan (Standard Instrument Section 1.2)

This is a compulsory section of an LEP, but the aims are non-standard, written specifically for each LEP. They cover a range of topics, often including waterway health and water quality. For example, the aims typically include statements such as:

- "To preserve and enhance watercourses, groundwater, riparian habitats, wetlands and water quality…" (Blue Mountains LEP 2015)
- "To ensure that development meets any local water quality objectives adopted by Council in relation to groundwater, rivers, estuaries, wetlands and other waterbodies" (Great Lakes LEP 2014)

The aims in the LEP should reflect all the goals in the LSPSs. Therefore, the aims should also cover topics including, but not limited to, habitat protection and restoration, green infrastructure (the creation of new habitats), the green grid and urban heat mitigation.

The recommended aims do not make specific reference to the Parramatta River. The aims of each LEP need to be relevant to the whole LGA, and as most councils have only part of their LGA in the Parramatta River catchment, general (not catchment specific) statements are therefore more applicable. Most existing LEPs currently state their aims without specific reference to local places. Where councils wish to create different planning provisions for different waterways/catchments in their LGA (consistent with a place-based approach), this can be achieved in local provisions within the LEP, and/or within the DCP. These place-based provisions can be supported by mapping to clarify where they apply.

Recommendation: Aims of LEP

Write the aims of the LEP to be relevant across the LGA. This is consistent with the way most LEPs are currently written.

For each council within the Parramatta River catchment, the aims will differ depending on their local context, which includes other waterways and their catchments.

Suggested wording for the Aims of LEPs, which would support the vision of the Parramatta River Masterplan, as well as being consistent with broader aims across most LGAs, are:

> *"To improve the health of local waterways by ensuring that new development reduces the quantity and improves the quality of stormwater runoff, including meeting any runoff quantity and quality standards adopted by Council."*
>
> *"To ensure that new development preserves, restores and enhances waterways and riparian zones."*
>
> *"To ensure that where opportunities exist, new development provides for improved recreational access to waterways, through improved public transport and connected cycleways and walkways."*
>
> *"To ensure that along major waterways, foreshore development includes quality facilities for events, leisure, recreation and family fun."*

3.2.2 Zoning provisions (Land Use Table)

Zoning provisions define what type of development is permitted with or without consent, in different places. Zoning provisions are not well suited as a lever to manage diffuse stormwater pollution in the catchment, as they focus on what is permissible development and its impacts within the particular zone. Stormwater pollution is diffuse, occurs across all zones, to varying degrees, and needs to be managed across zone boundaries. However, zoning provisions are useful as a mechanism to protect waterways and riparian land from inappropriate development, and to encourage appropriate works in these areas (e.g. protection/restoration works, environmental facilities, recreational facilities).

Zone definitions are established in the LEP Standard Instrument. For each land use zone, the Standard Instrument includes a set of objectives, defines what development is permitted with/without consent and what is prohibited. However, there is provision for additional objectives that may be included in a zone at the end of the listed objectives to reflect particular local objectives of development, but only if they are consistent with the core objectives for development in the zone as set out in the Land Use Table. Further, specified uses may be added to (but not removed from) the list of development that is permitted or prohibited in a zone. Additional uses may be added to an item of a zone even if some uses are already specified in that item. Additional permitted uses for particular land (but not all land in a particular zone) may be set out in Schedule 1. These optional provisions can further define and refine considerations to the impacts of stormwater runoff on the overall health of the river and more broadly the social and environmental outcomes of the catchment.

Current LEP zoning, shown in Figure 7, puts many of the Parramatta River tributaries and their riparian areas into the following zones:

- W1 Natural waterways
- W2 Recreational waterways
- E1 National Parks and nature reserves
- E2 Environmental conservation
- E3 Environmental management
- RE1 Public recreation
- RE2 Private recreation.

Zone W3 (Working waterways) is not currently used in the Parramatta River catchment. Further, the Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005 currently includes zones W4-W8, including W6—Scenic Waters: Active Use, W7—Scenic Waters: Casual Use and W8—Scenic Waters: Passive Use. The intention in the proposed Water Catchments SEPP is to align the naming of the Sydney Harbour REP waterway zones with the Standard Instrument. Their objectives and permitted land uses will remain largely unchanged.

Recommendations: zoning provisions

The objectives and permissible development types in each of these zones are reviewed in detail in Appendix A. Specific recommendations are made in Appendix A on potential additional objectives in each zone, for better alignment with the Parramatta River Master Plan.

The main recommendations are:

- Better definition of objectives for W1 and W2 zones, including:
    - Inclusion of an objective to improve waterway health
    - Inclusion of cultural and scientific values (ecological, scenic and fishing values are already included)
    - Recreation should be included as a relevant objective in the W1 zone, not only in W2.
- In the E3 and RE2 zones, which permit more development than the others, consider an additional objective to minimise impacts on the water cycle, including runoff quantity and quality.
- In the RE1 and RE2 zones, which include many small waterways and watercourses, consider an additional objective to protect and restore waterways and riparian lands, ensure that recreation infrastructure incorporates WSUD, and that recreational use minimises impacts on the natural environment

No changes are recommended to the permissible development types. These are considered reasonable and there is no need for additional development to be permitted in any of these zones. Where existing LEPs currently permit additional development types in these zones, it is recommended that these permissible development types be reviewed to consider whether they remain appropriate or important to include within the zone.

As part of a comprehensive LEP review, councils could also consider rezoning of land as waterway, environmental or recreation land, as these zones restrict the extent of permissible development. This requires site-specific consideration and a strong evidence base for any rezoning proposal. Any rezoning requires DPIE's approval and where major changes are proposed, then consultation with DPIE is recommended prior to lodging the Planning Proposal.

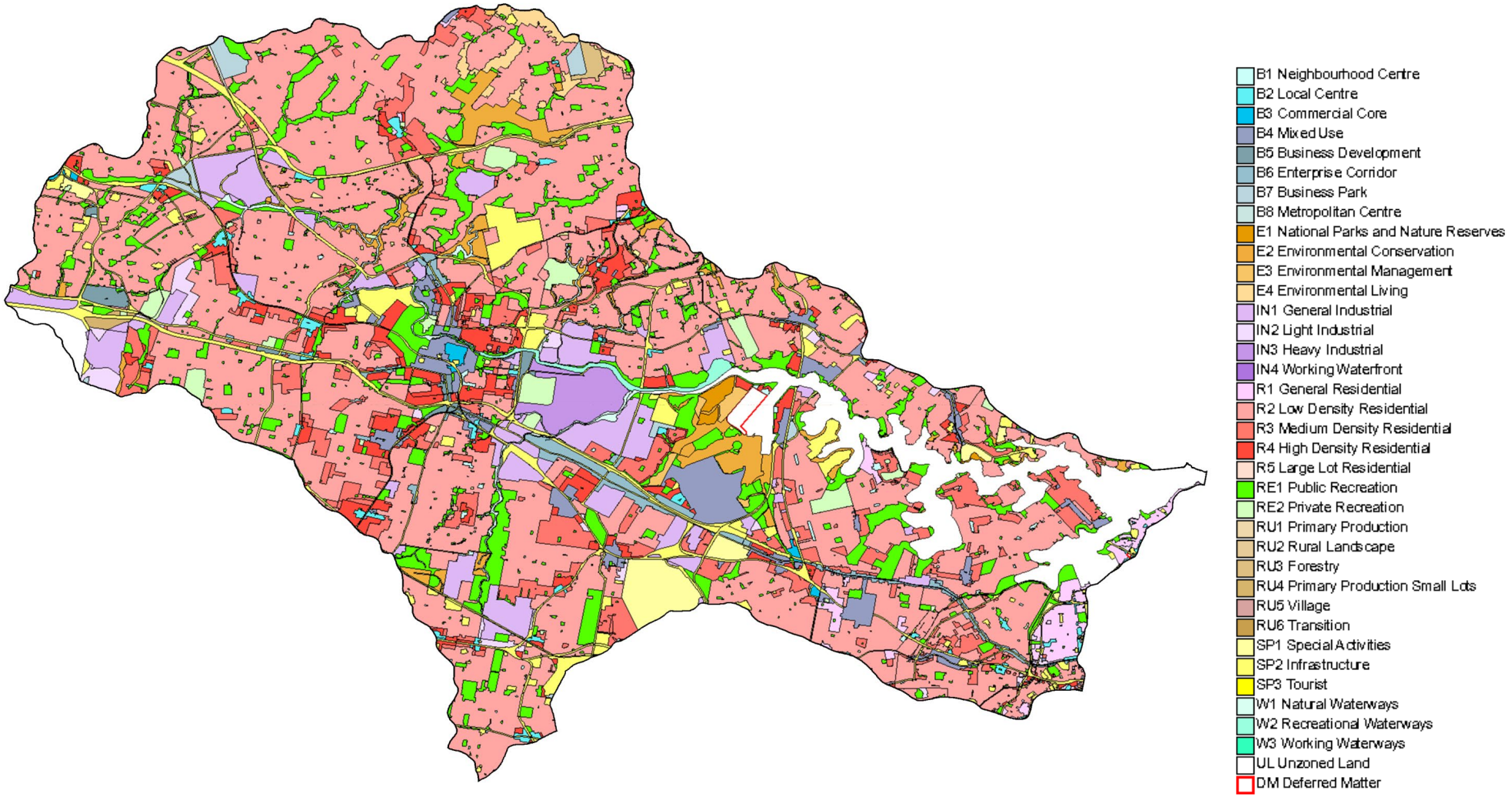


Figure 7: Current land use zoning in the Parramatta River catchment

The waterway, environment and recreation zones listed above set objectives related to protection of natural and recreational values, and permit (with conditional approval) limited types of development related to these objectives. Given the relatively small amount of development occurring in the waterway and environmental zones, changes to these provisions would only affect a relatively small proportion of the development in the catchment. Much of the land in these zones is in public ownership. Accordingly, this would materially impact public development, although may influence private development outcomes where these impact at the boundaries. However, as these zones cover the waterways themselves and riparian zones, they could play an important role in protecting waterway health and supporting water-based recreation in the Parramatta River and its tributaries.

3.2.3 Local provisions

Local provisions, also referred to as additional provisions or model local clauses, enable councils to include topics of common or local importance within their standard instrument LEP. For example, these may relate to:

- Landscaped areas
- Stormwater management and WSUD
- Waterways and riparian land
- Foreshore development.

A summary of recommended local provisions for the catchment councils is included in the box below. These recommendations are explained in more detail in the following text and specific recommended clauses are included in Appendix A.

Note that exempt and complying development undertaken under the State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 (the Codes SEPP) would circumvent some of the local provisions in an LEP. For example, the Codes SEPP includes its own landscaped area targets. It is not clear whether WSUD controls could be applied via the Codes SEPP. In the Codes SEPP, there is a requirement (in various sections including 3.31, 3B.59, 3C.34, 3D.62): "All stormwater drainage systems and connections to public drainage systems or inter-allotment drainage systems must either be approved under section 68 of the *Local Government Act 1993* or comply with the requirements for the disposal of stormwater contained in the development control plan that is applicable to the land." This is clearly applicable to stormwater drainage; it is not clear whether stormwater quality requirements could apply (if they are also listed in a DCP as stormwater "disposal" requirements). This could be explored further, but would require specialist statutory planning/legal consideration.

Exempt and complying development cannot be carried out on certain land identified in the Codes SEPP, Clause 1.19. This includes land in a foreshore area, and land that is identified in an environmental planning instrument as being environmentally sensitive, within a buffer area, a river front area, an ecologically sensitive area, or a protected area. If a council's LEP identifies riparian or other land in a manner consistent with these exclusions, then complying development could be excluded from these areas, and more appropriate local provisions applied.

Recommendations: local provisions

Include minimum **landscaped area** targets. These targets are often left to DCPs, but there are a few examples where these provisions are included in LEPs. Bringing these provisions into LEPs strengthens these requirements, as the LEP has additional weight as an environmental planning instrument. Setting a minimum landscape area reinforces the critical role that vegetated spaces play in supporting infiltration (reducing runoff and improving water quality) and increasing green landscapes (with benefits for urban cooling and biodiversity).

Include a **stormwater management and WSUD** provision. The wording should reflect the objectives defined in Section 2 of this recommendations paper. WSUD solutions will improve the quality of stormwater runoff and in turn contribute to healthier waterways.

Include a **waterways and riparian land** provision. The best way to do this would be to include a mapping overlay of affected land supported by a local policy, but an interim clause is recommended where mapping is not complete or where a mapping layer could be added or amended later. This would support the protection, restoration and creation of riparian zones across the catchment with positive water and biodiversity outcomes and can support liveability goals.

Review existing **foreshore development** provisions and strengthen where possible. Buffers to protect the foreshore are needed in support of waterway health outcomes as well as protecting against flooding and storm risks.

Landscaped areas

"Landscaped area" is defined in the Standard Instrument LEP as "a part of a site used for growing plants, grasses and trees, but does not include any building, structure or hard paved area", therefore there is a direct correlation with pervious area. Landscaped area targets are often left to DCPs, but can be set in an LEP – this would

provide more statutory weight to the provision of landscape area in the assessment of development applications. It could also mean a clearer, more consistent approach which is able to provide more certainty over its outcomes.

An existing example is Sutherland Council's existing (2015) LEP, which includes landscaped area targets ranging from 10% to 40%. Sutherland Council has a mapping overlay that defines where different landscaped area targets apply. Georges River Council has also proposed minimum landscaped area targets in their 2019 planning proposal for their new LEP. They have proposed minimum landscaped areas that would apply to different zones, including:

- 20-25% in residential zones R1-R3
- 10% in residential zone R4
- 70% in zone E2 (only one site in LGA).

The Sutherland Council approach (with a mapping overlay) allows place-based application of minimum targets – a more nuanced approach than applying the same target to all development within a zone. A model clause is included in Appendix A, based on Sutherland's existing clause.

Stormwater management and WSUD

There are a few examples of local stormwater management provisions within existing Parramatta River catchment LEPs, including Ryde, Holroyd and Hunters Hill. These take similar forms, however differ in some respects. In particular:

- They all include at least one objective (the most comprehensive set of objectives is in the Holroyd LEP)
- The Ryde and Hunters Hill LEPs are specific about the zones to which the clause applies (limiting its application to the zones included)
- They all include the same set of three provisions for the consent authority to consider as part of merits-based assessment, before granting development consent (maximise the use of water permeable surfaces, incorporate on-site stormwater retention and avoid stormwater runoff on adjoining land).

Similar WSUD clauses in the Blue Mountains and Ku-ring-gai LEPs were also considered as relevant precedents. The Blue Mountains "Stormwater management" clause includes the most comprehensive list of specific considerations for new development, which is a strength of this example. The Ku-ring-gai "Stormwater and water sensitive urban design" clause defines four water sensitive urban design principles, which is a way to expand on the considerations for new development and encourage developers and approving authorities to consider related objectives and multi-purpose green infrastructure. The principles include:

- Protection and enhancement of water quality, by improving the quality of stormwater runoff from urban catchments
- Minimisation of harmful impacts of urban development on water balance and on surface and groundwater flow regimes
- Integration of stormwater management systems into the landscape in a manner that provides multiple benefits, including water quality protection, stormwater retention and detention, public open space, and recreational and visual amenity
- Retention, where practical, of on-site stormwater for use as an alternative supply to mains water, groundwater or river water.

Suggested wording for a local provision relevant to the Parramatta River catchment councils is included in Appendix A.

Waterways and riparian land

Waterways and riparian can be included as a local provision with an additional mapping overlay. Ku-ring-gai, Blue Mountains, Holroyd and Blacktown Councils LEP clauses have been considered as relevant precedents. The existing Parramatta LEP also includes a similar clause, called "Water protection". A key consideration is that the clause needs to be consistent with the *Water Management Act 2000*. Ku-ring-gai's clause provides the best example in this respect, noting, however, their catchments are predominantly low-density residential development with substantial bushland areas in the lower and steeper parts.

Suggested text for a riparian lands provision is included in Appendix A. While based on Ku-ring-gai's provision, it has been modified to allow its application before any new mapping is undertaken. Ultimately, updated mapping of riparian lands is still recommended. As a starting position this could rely on existing maps of waterways, however, based on the experience of Ku-ring-gai Council, these 'base' maps need to be validated and where possible the condition of the riparian area should be assessed, as well as future development outcomes considered.

Foreshore development

Councils in the Parramatta River catchment with direct frontage to the Parramatta River include a local foreshore provision in their LEPs. These include: City of Parramatta; City of Ryde; Hunters Hill; Canada Bay; and Inner West (within the Leichhardt LEP).

The local provision sets a foreshore building line which limits development between this line and the Parramatta River foreshore. Most of the foreshore model provisions contain elements designed to ensure that development does not impact on the natural foreshore processes or amenity, and if development is to occur in this zone it is subject to a merits-based assessment that considers among other factors, water pollution, impacts on marine habitats, amenity and public use. By way of example, Canada Bay's provision is included as the model in Appendix A.

3.3 Development Control Plans

This section looks at ways in which Development Control Plans (DCPs) could be revised in the short-term, so that they better support the goals of the Parramatta River Master Plan and the objectives identified in Section 2.

Parramatta River catchment councils see value in adopting a consistent set of water management controls in their various DCPs. It would provide developers with consistency across the catchment and would also allow councils to share standardised supporting practices and materials. However, it is also important that each council test proposed water management controls against other controls in their DCP, so that different provisions all work together without conflict or contradiction. This assessment would need to be done by each individual council, as part of any change to the DCP.

Therefore, the following recommendations for DCP provisions provide a starting point for this process. The recommendations in Table 4 below provide specific items that each council should consider including or updating, and the model clauses in Appendix A provide suggested wording, which each council can modify to suit their specific local needs.

3.3.1 Existing DCP controls

Within the Parramatta River catchment now, there are currently fourteen DCPs corresponding to the former councils. The following DCPs were reviewed:

- Ashfield 2016
- Auburn 2010
- Bankstown 2015
- Blacktown 2015
- Burwood 2018
- Canada Bay 2017
- Hills 2012
- Holroyd 2015
- Hunters Hill 2013
- Leichhardt 2013
- Marrickville 2011
- Parramatta 2011
- Ryde 2014
- Strathfield 2005

Sydney Olympic Park does not have a DCP but development within Sydney Olympic Park is assessed by Sydney Olympic Park Authority against a set of policies including their "Stormwater Management and Water Sensitive Urban Design" policy (SOPA 2016). This policy was also reviewed alongside the council DCPs.

The review focused on controls for landscape, water management, waterways and riparian zones. Landscape controls were included in the review because of the important role played by pervious areas, deep soils and vegetation at intercepting rainfall, retaining water in the landscape, encouraging infiltration and evapotranspiration and reducing runoff.

Table 4 provides a high-level summary of the status of controls in the respective DCPs across the councils and SOP. Overall, the analysis reveals an inconsistent concern for the promotion of green landscapes and stormwater quality. Most of the Parramatta River catchment DCPs include targets for landscaped and deep soil areas, however there is wide variability in how deep soil areas are defined. Most include targets for stormwater quality treatment, but rely on the BASIX SEPP to promote rainwater harvesting and/or stormwater reuse.

3.3.2 Recommended improvements to DCP controls

The Standardising the Standards Discussion Paper (McAuley and Davies 2020) identified that new development can play an important role to achieve a liveable river by:

- **Reducing runoff** to the Parramatta River, which will reduce enterococci loads and improve water quality. Reducing runoff is a particular focus for the DCP, which can drive a reduction in runoff via controls that require or encourage increased pervious area, rainwater harvesting, ran gardens and infiltration systems.
- **Improving waterways and riparian lands**, which will help restore healthy ecosystems in the river, the catchment and the creeks. A healthy network of tributaries in the catchment has the potential to improve water quality and

improve the health of the Parramatta River downstream. Waterway and riparian land protection and restoration will be driven by LEP controls, but should be supported by related DCP provisions.

- **Improving swim sites,** where development is located in the immediate vicinity. This is a more site-specific consideration, which is not covered in this document.

Some of the policy changes envisaged in this recommendations paper (for example, the new policy directions outlined in Sections 4 and 5) will require additional development before they can be implemented. However, most of the Parramatta River councils are updating their DCPs in the next few years, and this presents an opportunity to implement changes to their local planning instrument in order to support reform that is aligned with the direction of the PRCG strategic plan and other strategic planning documents including the District Plans and LSPSs. Table 4 provides recommendations on the elements to include in the next round of DCP updates, with specific model clauses provided in Appendix A. These are all aimed at meeting the objectives outlined in Section 2 of this paper.

The general recommendations on revisions that could be considered to strengthen DCP controls are in line with the objectives of the Parramatta River Masterplan. One of the common issues identified in the review of existing DCPs is that many existing provisions only apply to a limited range of development types and are not more broadly applied. There is, therefore, an opportunity to strength the blue and green controls within DCPs to apply to a greater range of development types. The recommendations in Table 4 are relevant to development in all land use zones, including residential, business, industrial and other development. However, specific development controls for different land use/development types will need further consideration (and potentially analysis of local scenarios) to set appropriate targets and other specific quantitative requirements.

Note that DCPs include other controls related to water management, including controls related to water efficiency, flooding and drainage. These controls are not directly related to the goals of the Parramatta River Masterplan, but need to be considered alongside the other water management controls recommended here. Inter-relationships between different controls need to be considered and measures which meet multiple requirements need to be accommodated (e.g. combined retention/detention measures).

3.4 Beyond the LEP and DCP

Beyond the planning provisions in LEPs and DCPs, these documents also often refer to more detailed design guidance, technical specifications, and standard drawings, which may include the following:

- Engineering guidelines
- WSUD guidelines
- Public domain design guidelines
- Streetscape design guidelines

Councils updating their local planning provisions should also review these documents and update them where appropriate. Overland flowpath design standards are mentioned in Table 4. One other important area to consider, as planning provisions include more emphasis on reducing runoff, is to provide additional guidance on measures to reduce runoff, such as permeable paving, rainwater tanks, soakaways and infiltration systems.

As councils begin to address this need, the PRCG should continue working with its member councils and seek to understand how they can best provide support.

Table 4: Overview of recommended DCP updates to reduce diffuse stormwater pollution in the Parramatta River catchment

Strategies	What is in existing DCPs?	Recommendations for DCP updates
Maximise pervious area and vegetation coverage	**Landscaped area:** 14 out of the 15 DCPs reviewed include requirements for a certain proportion of the site/block area to be "landscaped", with the percentage ranging from 10-50%. A minimum area is not always defined for all development types. A "landscaped area" does not always mean a planted or pervious area. In most cases, it's stated as a percentage of the site/block area, but in some cases it is defined with reference to specific site elements (e.g. as a proportion of the front garden, the setback, or the common area), making it harder to determine how much is really required.	Consider shifting landscaped area targets into the LEP, as discussed above. Or if landscaped area targets remain in the DCP, strengthen these requirements by: • Specifying minimum landscaped areas for all development types • Defining landscaped areas as a percentage of the site area, so that overall outcomes are clear • Clearly defining the landscaped area as a vegetated, pervious area • Providing guidance and/or incentives to provide higher quality landscaped areas, including more vegetation and deeper soil zones, beyond minimum requirements • Adding requirements for a minimum maintenance period to be undertaken by the developer prior to asset handover (where the development includes public domain landscaped areas) Consider allowing a limited area of permeable paving to count towards landscaped area targets – potentially at a discounted rate – this would encourage the use of permeable paving where possible.
	Deep soils: Most DCPs include some reference to deep soils, and 11 out of the 15 DCPs include quantitative targets for deep soil. Deep soil requirements differ substantially between DCPs, and there are also significant gaps. Often deep soil requirements are only defined for certain development types, or defined differently for different development types. Where the deep soil requirement is given as a proportion of the site area (the most common approach, used in six DCPs at least for some development types), it ranges from 7% to 35%. In five DCPs, it is defined as a proportion of the landscaped area or of a setback area. Only four DCPs give minimum dimensions for the deep soil area.	Strengthen these requirements by: • Clearly defining what is meant by a deep soil zone (typically no structures below such as underground car parks) • Defining not only the required area of deep soils, but how areas with different soil depths are able to be counted towards the total landscaped area • Defining minimum targets for all types of development • Defining minimum dimensions for deep soil zones (e.g. a minimum width or square area or similar dimension) so that the space can support a tree/s of a specific sizes (small, medium, large) depending on the site and immediate context) • Defining physical features to be avoided, wherever possible, in deep soil zones (e.g. shallow bedrock, steeply sloping land), to maximise potential for deep soil zones to support canopy cover and stormwater runoff mitigation
	Trees: Ten out of the 15 DCPs include at least some specific requirements to plant new trees as part of a new development (e.g. a number of trees is specified in relation to the site area, the landscaped area, the number of car parking spaces or length of frontage (for street trees). Often these requirements apply to only certain development types.	Strengthen these requirements by: • Specifying a minimum number of new trees to be provided (in relation to site area or other features) in all development types • Consider specific requirements for trees to be provided in particular locations (e.g. within the deep soil zone, along the street or frontage, within a car park) • Clarifying the size of new trees proposed both at construction/ approval (e.g. height/size of pot) and at maturity (e.g. species that will grow to at least 12 m) • Providing a list of suitable species, considering future canopy coverage and a warming climate. • Include tree replacement provisions requiring each tree removed to be offset with multiple replacement trees.

Strategies	What is in existing DCPs?	Recommendations for DCP updates
		Note that strengthened tree provisions are also important to help meet the Greater Sydney Region Plan's target of 40% canopy cover, as well as Greener Places targets, and the Premier's Priority to plant one million trees by 2022.
	Native vegetation and other habitat requirements: Eight out of the 15 DCPs have a requirement for at least some native vegetation in certain development, in certain circumstances. Most of these include a list of suitable species. Only one DCP refers to other habitat features (tree hollows and rock outcrops)	Strengthen these requirements by: • Specifying minimum standards for all development types • Specify the proportion of the landscaped area that needs to be locally native species, and needs to include canopy, mid and understorey plantings • Include a recommended (not mandated) species list Encourage the inclusion of other habitat features in landscaped areas, including elements which retain water in the landscape
Maximise rainwater harvesting	Six of the DCPs make rainwater tanks mandatory in development where BASIX does not apply (i.e. in non-residential development). The Marrickville DCP includes a rainwater tank as part of its deemed-to-comply option for residential and other developments of 700-2,000 m^2 in area to meet stormwater quality improvement targets. The City of Parramatta's proposed "high performing buildings" clause in their CBD LEP encourages developers to meet higher BASIX targets with the incentive of additional floor space. SOPA's stormwater management and WSUD policy (SOPA 2016) includes a requirement to install rainwater tanks in certain development (including residential) and specifies the tank volume required.	Rainwater harvesting is an important strategy to reduce runoff. Stronger rainwater harvesting controls are recommended as an immediate strategy. While Council DCPs do not currently mandate rainwater tanks as a water efficiency measure in residential development (to avoid tension with the BASIX SEPP), there are some ways (with existing precedents) that DCPs can still encourage greater rainwater harvesting: • In development where BASIX does not apply (e.g. commercial and/or industrial development), rainwater harvesting can be made mandatory. While long-term maintenance may be an issue, rainwater tanks are relatively common, and their maintenance requirements are straightforward and well understood. • Rainwater harvesting can be encouraged for purposes other than water efficiency – for example as a strategy to reduce stormwater runoff and pollutant loads (as in the Marrickville example). • Rainwater tanks can be incentivised, as in the City of Parramatta example. Councils could also consider DCP provisions that simply make rainwater tanks mandatory in residential development, as is done in SOPA's policy, noting that this approach may be challenged due to tension with BASIX. When including rainwater tank provisions, it is recommended that DCPs specify minimum standards including minimum tank volume per unit roof/floor area, and mandatory connections (e.g. to irrigation, toilets, laundry, hot water systems). SOPA's (2016) policy is a good example that includes these details.
Maximise infiltration (where appropriate) and evapotranspiration	Two DCPs include flow volume reduction targets of 10-15% reduction in post-development mean annual flows	Flow volume reduction targets are recommended, as a strategy to reduce runoff. This target would likely encourage more rainwater harvesting as well as measures that increase infiltration and evapotranspiration. A flow volume reduction target is a relatively straightforward condition, at least for any development that also has pollutant load targets (they can use the same modelling approach to quantify expected flow volume reduction). The target itself should be tested for a range of different development types and scenarios, but could potentially be set higher than 10% or 15% as applied by some councils. Additional investigation is required to set targets for different developments types and or by location. Ensure that water pumped out from basement dewatering schemes and discharged to the stormwater system is accounted for within total runoff volumes.

Strategies	What is in existing DCPs?	Recommendations for DCP updates
		Note that runoff volumes can be reduced by rainwater harvesting, which is already encouraged in most development, but DCPs could also explicitly encourage measures such as leaky tanks and soakaways, which will help to further reduce runoff.
Treat any remaining runoff to reduce pathogen and other contaminant loads	Ten of the DCPs include quantitative targets for pollutant load reduction (TSS, TP and TN)	The short-term recommendation is to continue using best practice targets for TSS (85%), TP (65%) and TN (45%). While the long-term aim is to replace these 'generic' targets with locally specific targets, based on the community's values and desired outcomes for the Parramatta River, further work is required to develop these locally-specific targets. Therefore, until this work can be completed, the best practice targets listed above are considered the most appropriate targets to include in DCPs. Further work is also required to develop modelling tools for pathogens such as *Enterococci*, and set appropriate targets. When this becomes possible, it is recommended that the DCP should be updated to include this target. An erosion and sediment control clause is recommended, to reinforce erosion and sediment control requirements. Erosion and sediment control is governed by legislation (*Protection of the Environment Operations Act 1997*) and well established guidelines (the Blue Book). A recent "Get the Site Right" compliance blitzes in the Parramatta River catchment have revealed relatively low rates of compliance. Inclusion in DCPs could serve as a reminder that these requirements are being checked, although this will only be effective in the long run if councils are undertaking regular compliance checks and enforcing erosion and sediment control requirements. Contaminated land can also impact on waterway health, via groundwater flows. A simple contaminated land clause in DCPs could also reinforce the requirements covered by SEPP 55 – Remediation of Land.
Protect and enhance riparian vegetation	Some of the DCPs include basic riparian corridor provisions; one includes a comprehensive set of controls for watercourses and riparian corridors One of the existing DCPs includes provisions to manage 'stream forming flows' and reduce erosion of natural waterways. Some include provisions to control the discharge of stormwater into waterways, riparian lands and other bushland areas.	Where development occurs along waterways and riparian land, DCP provisions can help protect and enhance riparian land. Useful provisions could include: • A requirement for a vegetated buffer along the edge of the property where it adjoins waterway/riparian land. Appropriate buffer widths and vegetation types would need to be defined based on available local information. Where fully structured vegetation (i.e. canopy, mid and under storey) is not achievable, define appropriate minimum standards to ensure as much vegetation as possible is included within these buffer zones • Design standards where private properties discharge stormwater directly into waterways/riparian land, to minimise scour, erosion, sediment deposition and weed propagation Stream erosion can threaten riparian vegetation, and can be an issue in urban areas, as urban development increases the frequency and duration of erosive flows. However, many streams in the Parramatta River catchment are not susceptible to erosion – they have been piped or channelised, or some are formed in sandstone landscapes that are reasonably robust to erosive flows. The most vulnerable streams are those in the shale-derived soil landscapes of the southern and western parts of the catchment, and the small number of these streams that remain unlined. Where stream erosion controls are considered worthwhile, the recommended approach is stormwater detention to reduce peak flows to pre-development levels in 1-2 year ARI events. This is a simple approach, easily included alongside stormwater detention provisions. The Stream Erosion Index is an alternative approach used in Blacktown Council's 2015 DCP.
Design overland flowpaths to	This is a departure from current typical approach, where overland flowpaths designed for efficient conveyance, to minimise their footprint.	Overland flowpaths are required to convey major storm flows, beyond the capacity of the minor drainage system. They need to be located and designed to safely convey these flows. There is no intention to change these

Strategies	What is in existing DCPs?	Recommendations for DCP updates
include dense vegetation		fundamental requirements, rather a suggestion to consider where overland flowpaths could be designed to function also to attenuate frequent flows, improve stormwater quality and reduce runoff. Often overland flowpaths are in streetscapes or over other hard surfaces, offering little opportunity for additional vegetation. However, where overland flows pass through open space, in either the private or public domain, they could incorporate more vegetation. Where overland flowpaths are well-vegetated, they could also be designed to encourage infiltration and filtering of frequent stormwater flows. Overland flowpath design standards are typically included in supporting technical guidelines rather than within the DCP itself. Review design standards for overland flowpaths and encourage designs that include dense vegetation, infiltration and surface filtration (as in a swale). An incentive to include these features in the design could also come from other provisions above that encourage more vegetation and more infiltration of stormwater runoff.
Use vegetated stormwater treatment systems	Most DCPs do not specify what type of stormwater treatment systems should be used – load-based targets are deliberately set to provide flexibility in the design of stormwater treatment systems.	Include a DCP clause which requires the use of vegetated stormwater treatment systems in most situations. Bioretention systems with saturated zones are preferred, as they combine pathogen removal with water retention and increased evapotranspiration. Technical guidelines, separate to the DCP, could help reinforce this provision.

4 A BLUE-GREEN INDEX FOR WSUD AND GREEN INFRASTRUCTURE

For a healthy, living, Parramatta River, we need to manage diffuse pollution in the catchment. WSUD planning provisions should be improved to encourage better outcomes from new development

While a range of DCP provisions can be strengthened to potentially reduce urban runoff, they still need to balance traditional policy tensions. Examples of the policy tensions include managing for flood control versus retaining water in the landscape and how to achieve urban consolidation outcomes versus increasing the deep soil areas to support infiltration and tree planting. The Parramatta River catchment will continue to develop, and it is expected that the impervious area will increase (Sydney Water 2018). Under a business as usual approach, the incremental increase in imperviousness will impact negatively on the local waterways. This highlights the value for new integrated approaches in urban policy and planning.

The Standardising the Standards workshop participants expressed the need for a new approach to WSUD. They supported performance-based outcomes that also meet multiple environmental and liveability outcomes. Given the diversity of development types, land-uses, catchments and their condition and aspirations, it is important that any tool is both flexible and reflective of these variables.

This section provides a basic framework as a starting point for this new approach. The new framework has been termed a **"Blue-Green Index"**. This section presents a recommended structure and content for the Blue-Green Index, and demonstrates how it could be applied to different types and scales of development. It suggests a pathway for development, implementation and improvement over time.

There are a variety of tools and other methods that are used to support healthy waterways and green infrastructure implementation in new urban development. Workshop participants looked at examples of several different frameworks used around the world to drive WSUD and green infrastructure implementation in new development. Table 5 identifies a wide range of different performance-based tools and frameworks, listing their key features, advantages and disadvantages. Box 2 describes the Helsinki Green Factor tool as one example. Another noteworthy example is the City of Melbourne's new Green Factor Tool, developed in collaboration with the University of Melbourne and launched in May 2020. This is available online at https://www.greenfactor.com.au/. Both the Helsinki and Melbourne Green Factor tools are similar to the proposed Blue-Green Index, which would also be a "green factor" type of tool, but would be built to meet different objectives to either the Helsinki or Melbourne tools. The Parramatta River catchment needs a tool that is designed to meet the specific objectives of the Parramatta River Masterplan.

Note that the draft Greener Places Design Guide includes a recommendation for a potential "building rating scheme that incentivises the construction and retrofitting of buildings, stormwater infrastructure, and public spaces to incorporate urban ecology and facilitate connectivity in key corridors" (NSW Government Architect 2020, p.53). This could also be a similar type of tool.

Considering the range of potential options, workshop participants identified that:

- The tool should build on the performance-based approach and flexibility embedded within the **BASIX SEPP** and associated tool
- Consideration be given to other rating tools used in NSW such as Green Star Communities
- There is an opportunity to frame planning provisions that encourage **proactive** outcomes (e.g. to retain more water in the landscape) rather than reactive outcomes (e.g. to reduce pollutant loads)
- The tool incorporates different **performance outcomes** and scoring for different catchments, development typologies and catchment objectives
- **Deemed to comply** provisions should be included for low density/small scale development to ensure their collective contribution to a liveable river but not place a disproportional obligation on these development types
- **Simplicity** should be a priority when comparing different frameworks. That is, the tool should be simple to use to guide development design and assessment outcomes, within which the complexity is distilled.

Table 5: Comparison of performance-based tools and frameworks that encourage better water management outcomes in new development

Options	Examples of performance-based tools and models used to drive green infrastructure and stormwater quality treatment outcomes	Simplicity and ease of use	Multi-objective and capable of driving high performance / stretch targets[2]	Appropriate at a range of scales[3]		Online/potential to provide online	Widely used and industry accepted
				Small	Large		
Proprietary modelling software	Stormwater pollutant load removal targets + MUSIC modelling tool	LOW	✗	✗	✓	✗	✓
Online models	Stormwater pollutant load removal targets + online assessment tools such as S3QM, STORM Calculator, InSite Water or UNDO. BASIX is a similar example, for water efficiency	MODERATE	✗	✓	✓	✓	✓
Simple calculators	Deemed to comply solutions such as Water by Design (South East Queensland Healthy Waterways Partnership) or Hume City Council tool for industrial development	HIGH	✗	✓	✗	✓	In specific jurisdictions
Green Factor tools	Green Factor tools such as: - Berlin - Biotope Area Factor; - Helsinki - Green Factor method; - Malmö Green Space Factor; - Seattle - Green Factor; - Southampton Greenspace factor	HIGH	✓	✓	✓	✓	City of Melbourne's new tool is the first of this kind in Australia
Living Waterways Framework	Living Waterways Framework is placed in its own category as it is uniquely positioned between green factor tools and sustainability rating tools	LOW	✓	✗	✓	✗	✗
Sustainability rating tools	Green Star / Green Star – Communities NABERS	LOW	✓	✗	✓	✗	✓

[2] While a tool can be designed to meet any objective, many of the examples below have been designed for the specific purpose of stormwater quality treatment performance assessment.

[3] In this table, "small" development and "large" development scales are distinguished due to the differing capacity of the industry on small/large scale projects. At the smaller scales (e.g. single dwelling residential), there is significantly less capacity to use expensive, complex and time-consuming tools, which also often involve the extra expense of specialist consultants.

Box 2: The Helsinki Green Factor

The overarching objective of Helsinki green factor tool is to value the benefits of green surfaces in the urban landscape from a lot to regional level. The premise of the tool is that by increasing green areas ecosystems services will be improved (City of Helsinki 2016). The ecosystem services anticipated are many and varied and include a reduction in stormwater runoff, improving stormwater quality, local climate regulation and benefits to biodiversity. Presently the tool is voluntary within the Helsinki planning system.

The nexus between the Helsinki green factor tool and the PRCG is that it promotes sustainability through both water and landscape controls. The development of the tool followed a similar path to the preparation of the PRCG strategic plan in that it defined the ecological needs (Icon project), focused on functionality (swim and liveability objectives), was orientated to the cityscape (link to strategic land use planning processes and standards) and considered maintenance (as raised by PRCG members), but this is limited to frequency not cost. The tool incorporates 43 different green/blue elements that are individually weighted and are then used to provide the overall score.

In a review of the effectiveness of the tool (Juhola 2018) planners noted it was easy to use and its logic in the MS Excel format was simple to comprehend. The numeric based system also offered clarity to applicants and planners - a higher score implies better environmental outcomes. Like many tools, it is prospective, and does not offer a function to monitor effectiveness or assess the validity of implementation. As a voluntary tool it is not embedded in the planning system, thus must provide a supportive role in the decision-making process.

Workshop participants reinforced that a simple tool is preferable to guide development design and assessment (the framework should encompass the complex ideas but should be distilled down to a simple tool). Simplicity was identified as a priority when comparing different frameworks.

"Green Factor" tools are rated positively in comparison to other tools (Table 5) and as such a similar tool is recommended for the Parramatta River catchment because:

- It can easily accommodate **multiple objectives**, in a transparent and clear manner
- A **points-based** tool was seen as an appropriate way to capture multiple benefits and reward positive outcomes
- Its design can be **evidence-based**, and they provide a framework within which the details can be improved over time as new and updated evidence emerges
- It is **performance-based** allowing different methods to achieve equivalent outcomes. Also, while minimum standards tend to encourage compliance, a performance-based approach could encourage more aspirational outcomes.
- It allows **flexible** application across different scales and types of development
- It can incorporate '**deemed to comply**' solutions for smaller developments – small developments can be given simple pathways to achieve their required score
- It can also incorporate **locally-specific targets** or **stretch targets** for larger developments, to encourage more ambitious outcomes (e.g. in Seattle everyone uses the same score sheet, but there are different minimum scores for different development types and specific places).

Some of the important challenges to consider with a tool such as this are:

- Time and resources involved in development as well as ongoing support
- Designing the tool to encourage better outcomes against multiple objectives and allow flexibility, while avoiding perverse outcomes
- Balancing the need for a simple user experience with the need for robust evidence to underpin the tool
- Developing a tool that works for a wide range of development types and scales, so ideally, it can be applicable to all development
- Need to integrate into an existing complex planning and regulatory framework
- Reviewing and updating the tool over time, so that it continues to drive best practice outcomes, as industry standards change (hopefully improving over time).

4.1 Building the Blue-Green Index tool

Table 6 outlines a suggested framework for a Blue-Green Index (BGI) tool for the Parramatta River catchment. This is based on the same principles as Green Factor tools, but termed "Blue-Green Index" to emphasise its focus on water management as well as the landscape and green infrastructure. It is built on the four strategies identified in Figure 4, and is aimed at creating incentives for the design of new developments to follow those strategies.

Table 6: Recommended architecture of a "Blue-Green Index" tool for the Parramatta River catchment

Strategies	Specific objectives	Potential points structure	Minimum standards
Maximise pervious area and vegetation coverage	Maximise total pervious area including pervious paving, green roofs, and any other planted areas	Points per unit pervious area	Set minimum pervious, well-vegetated and deep soil areas (% of site) requirements for different development types
	Maximise areas of at least moderate soil depth and dense vegetation, including shrubs and understorey vegetation	Additional points per unit area of well-structured vegetation on at least moderate soil depth Encourage retention of existing vegetation as well as planting new	
	Maximise deep soil area and potential future tree canopy	Points per unit area of deep soil with tree planting according to guidelines Encourage retention of existing mature trees as well as planting new	
Maximise rainwater harvesting	Maximise proportion of roof connected to rainwater tank	Build in a rainwater harvesting tool to quantify the expected reduction in runoff based on these factors. Allocate points per unit reduction in runoff	Set a minimum standard for runoff reduction (% of post-development flows) for different development types
	Maximise connections to different end uses (e.g. garden, toilets, laundry, hot water)		
	Maximise tank volume		
	Encourage "leaky" tanks where water trickles out to a passive irrigation/infiltration area, increasing potential to capture future runoff	Build this feature into the infiltration tool below.	N/A
Maximise infiltration (where appropriate) and evapotranspiration	Encourage passive irrigation of landscaped areas	Build in a tool for infiltration and evapotranspiration calculations. Allocate points per unit reduction in runoff, from a baseline of post-development with no flow retention.	Set a minimum standard for runoff reduction (% of post-development flows) for different development types
	Encourage well-designed infiltration systems including unlined rain gardens		
	Encourage use of stormwater treatment systems that retain water (e.g. wetlands and bioretention systems with saturated zones)		
Treat any remaining runoff to reduce pathogen and other contaminant loads	Encourage use of vegetated stormwater treatment systems including swales, rain gardens and wetlands	Build in a tool for stormwater treatment calculations. Allocate points per unit reduction in pollutant loads	Minimum standards for pollutant load reduction for larger developments

The WSUD workshop undertaken as part of this project recognised the need to overcome resistance to policy change. Concurrently, it was identified that there is a need to improve the culture of planning and engineering design consultants (acting for developers) and those in government and private sector leadership and management roles if a new framework is to be developed, implemented, and be successful. In this context it was agreed that:

- The framework needs to be **developed collaboratively** with multiple stakeholders
- The framework should be **expert-led** and based on best practice
- The framework must be based on **cross disciplinary** policy input. This needs to consider multiple objectives, for example seeking to advance water (blue) and landscape (green) outcomes as well aiming to improve the condition of the environment and liveability of suburbs
- Because of the multi-disciplinary and multi-council and agency input any new framework will take **time and effort** to get right.

Based on the above considerations, a proposed architecture of the BGI tool is provided in Table 6, noting that specific the details are left to be developed and that this is recommended to be undertaken collaboratively with relevant stakeholders as part of a future project (refer to section 4.3).

As part of the development of the tool, it will need to include:

- A user-friendly interface
- "Back end" modules for rainwater harvesting, infiltration, evapotranspiration and stormwater treatment calculations
- The points structure to be defined and tested for different projects/development scenarios
- Targets set for various development scales, types and locations. Targets could include stretch targets
- Guidelines on its use and on the design of the green infrastructure it encourages
- Links to relevant studies to validate its evidence basis such that the tool can be updated when new information is available.

The following sections outline proposed contents for each module, noting where supporting information would be required.

4.1.1 Module 1: maximise pervious area and vegetation coverage

Maximising the amount of pervious area and vegetation coverage is an important part of the framework:

- Pervious areas and vegetation are linked to many other benefits beyond stormwater runoff reduction (e.g. heat mitigation, habitat and biodiversity)
- There are multiple policies and plans calling for greater canopy cover, including the Greater Sydney Region Plan's target of 40% canopy cover, Greener Places targets, and the Premier's Priority to plant one million trees by 2022
- Minimum targets for landscaped areas are already specified in existing planning provisions – this is not asking anything new or additional of developers and is likely to be accepted by the industry
- There is no need for detailed modelling – it is a straightforward requirement
- Maintenance requirements are straightforward and there is a low risk of failure.

Proposed inputs to the tool are summarised in Table 7. This is designed to capture both the nature of the pervious area and the depth of soils below. It does not account for the infiltration capacity of soils – this is included in module 3.

Inputs from Table 7 would be used to calculate a green factor score, in a similar fashion to other existing green factor tools. The scoring system will need to be developed, with appropriate weightings for different vegetation types and soil conditions. If there is sufficient supporting evidence available, the scoring system could account for the expected quantitative benefits, in terms of runoff reduction, of different vegetation types and soil conditions. The scoring system could also account for other benefits such as urban heat mitigation and habitat provision.

The scoring system could include bonus points for demonstration of additional commitments, such as landscaped areas designed by an experienced landscape architect or subject to a maintenance contract with an experienced landscape maintenance provider.

Table 7: Inputs – pervious area and vegetation cover

Pervious areas	Soil and subsurface conditions		
	Deep soils (natural soils)	Soils on structures	
		Moderate depth (e.g. >0.5 m)	Shallow depth (e.g. <0.5 m)
Pervious paving			
Green roofs			
Turf			
Annuals			
Understorey and mid storey vegetation - Grasses, groundcovers and low shrubs to 0.5 m - Groundcovers, grasses and large sedges/shrubs >0.5 m			
Trees (number of trees) - Small - Medium - Large			
Existing protected vegetation to be retained (e.g. EEC, riparian zone). This vegetation is not to be counted above			

The intention is that developers would need to meet both:

- Minimum standards for important parameters (e.g. minimum landscaped area and deep soil requirements can still be defined for different development types, and protected vegetation has also been identified separately – the idea is not to reward the protection of vegetation that must be retained under existing legislation, but to incentivise the retention/provision of additional vegetation.
- A minimum overall score. The target score could vary for different development types, and should be set so that it encourages developers to combine a range of different elements, beyond minimum standards, to achieve the minimum score.
- It would also be possible to offer incentives (e.g. bonus floor space) to developers who meet higher target scores.

Module 1 aims to build on current planning provisions for landscaped areas and deep soils by recognising the roles played by:

- Pervious pavements
- Green roofs
- Soils of at least moderate depth on structures
- Well-structured understorey and mid-storey vegetation
- Trees – particularly those that will grow to have a larger canopy area.

This module will need to be supported by guidelines including:

- Design guidelines for pervious paving
- Vegetation and tree species lists, including information on which species classify as grasses, groundcovers, shrubs and trees and which can be counted as large/medium/small
- Planting guidelines (including planting density, minimum deep soil area per tree)
- Minimum dimensions of deep soil areas.

4.1.2 Module 2: maximise rainwater harvesting

This part of the framework builds on existing planning provisions for rainwater tanks, but shifts the emphasis from water conservation to reducing runoff. Rainwater tanks can be designed to achieve both outcomes, and in many ways, each objective helps reinforce the other.

Inputs to module 2 would be as per any other rainwater tank model or calculator:

- Tank volume (including active storage/leaky storage)
- Roof area to be connected to the tank
- Leaky outlet size/flow rate
- End uses connected
- Basic development characteristics, that will allow estimation of non-potable water demands (e.g. floor space, number of bedrooms, irrigated areas, etc).

This module would need to include a modelling tool that can calculate the expected reduction in runoff (which is the same as the amount of water used from the tank). It would need to include basic data including:

- Local rainfall data (that will not vary significantly across the catchment)
- Typical water demands associated with different end uses
- Typical annual distribution of demands (e.g. irrigation demands vary seasonally).

The BASIX tool already includes a suitable rainwater harvesting model, and one option could be to use the same model as BASIX. This would provide consistency in the approach and the results.

The BASIX model currently does not allow for modelling of non-residential properties (with their specific end uses for non-potable water) or leaky tanks, as proposed here. These features would need to be added to the model, so that it can be used for a wider range of scenarios.

Even with additional features added to the BASIX model, there are always likely to be some situations, particularly in larger developments, where a more complex, bespoke design is proposed, which cannot be modelled in a simplified tool. For these situations, the option could still be left open for developers to do their own modelling in a more flexible platform (e.g. in MUSIC), to estimate the expected volumetric runoff reduction for their proposed design configuration, and submit model outputs into the tool. They would also need to submit the model itself and a report detailing the assumptions and modelling results, for review and approval.

Rainwater tanks have become a relatively standard feature in new development, and there is good design guidance already available – this module may simply need to refer to existing guidance and standards.

Note that some local council on-site detention (OSD) policies currently allow detained volumes to be partially offset with rainwater storage, and rainwater tanks can also be designed with an additional airspace volume to meet detention requirements. If leaky tanks are also encouraged, then rainwater tanks could potentially include a storage volume, a leaky volume and a detention volume, with potential interaction between the three. New modelling techniques are emerging which enable the stormwater detention benefits of rainwater tanks to be better quantified (e.g. Jamali et al 2019). Councils should revisit OSD policies to clarify when rainwater tanks can be used to offset OSD requirements.

Rather than having specific rainwater harvesting targets, rainwater harvesting (as well as infiltration and evapotranspiration) should be covered by runoff reduction targets, which encourage all these approaches, but leave it up to individual developers to determine the best mix of strategies (harvesting/infiltration/evapotranspiration) to meet their runoff reduction target, depending on their specific site conditions and the nature of the proposed development. This approach would also allow the Blue-Green Index to sit alongside BASIX, without any conflict with the existing residential water efficiency targets set in the BASIX SEPP.

4.1.3 Module 3: maximise infiltration and evapotranspiration

Module 3 adds an element not typically accounted for in existing planning provisions, but infiltration and evapotranspiration (ET) are potentially important mechanisms to reduce runoff. Retaining more water in the landscape for infiltration and ET is also an important strategy for mitigating urban heat, and has links with habitat and biodiversity. This module would need to include a modelling tool that can calculate the expected reduction in runoff associated with infiltration and ET. This will require inputs to define:

- Catchment areas connected to infiltration/ET areas
- Sizes, water storage volumes, vegetation characteristics and other parameters of various systems that provide infiltration and ET:
    - Passive irrigation areas
    - Infiltration systems
    - Rain gardens
    - Wetlands and ponds
    - Green roofs
    - "Leaky" rainwater tanks that discharge flows to any of the above.

It will require the following parameters to be built into the model:

- Local rainfall and ET data
- Local soil parameters
- Infiltration and ET parameters associated with different systems.

Infiltration depends on the characteristics of local soils, and across the Parramatta River catchment, the potential for infiltration varies significantly. In the sandy soil landscapes of the northern part of the catchment, infiltration will be able to play a greater role than in the clayey soil landscapes of the southern and western parts of the catchment. This spatial variability will need to be accounted for within the tool.

The infiltration potential of local soils (i.e. hydraulic conductivity) could be either hard-wired in the model (which would reduce the potential for error or misuse) or could be another input. Soil landscape maps, available across the whole catchment, give a reasonable initial indication of the potential for infiltration, but actual infiltration rates can vary widely within the landscape, and local features – such as steep slopes and

shallow bedrock – can make infiltration unsuitable at some sites. Users could be asked to submit basic details of these local site characteristics, to show that they have been considered, and ensure that they obtain the necessary geotechnical information for planning and design.

This module will need to be supported by guidelines, which should cover the geotechnical considerations and should also include design guidelines for each type of system.

Infiltration and ET could be modelled in a simplified modelling tool such as the Small Scale Stormwater Quality Model (S3QM). Currently the S3QM model only reports on TSS, TP and TN removal in stormwater treatment systems, but the capability to model infiltration and ET and report on flow reduction could be added to S3QM or a similar modelling tool. Infiltration and ET can currently be modelled in the Model for Urban Stormwater Improvement Conceptualisation (MUSIC), and (as suggested for rainwater tanks) MUSIC modelling could remain an option for large developments where bespoke systems are proposed. If systems are modelled in MUSIC, developers would need to submit details for review and approval.

As noted in Section 4.1.2 above, rather than specific targets for infiltration and evapotranspiration, runoff reduction targets should be set to encourage all these approaches and allow developers to determine the best mix of measures for their particular development.

4.1.4 Module 4: treat any remaining runoff

The stormwater treatment module should ultimately drive the design of stormwater treatment systems to maximise pathogen removal. As discussed above, existing modelling tools (including MUSIC) are not yet capable of modelling pathogen removal. There is a need for more research and development work before this becomes possible.

As recommended in Section 2.1, this module should initially be built to include current best practice targets for TSS, TP and TN. Quantitative treatment performance could be based on MUSIC modelling or could use a tool such as S3QM.

When enough research data is available to develop a pathogen removal performance assessment tool, this should be built into this module. In the interim, it would be possible for the tool to encourage treatment measures that are known to reduce pathogen loads – for example, by including bonus points for the use of bioretention systems with a saturated zone, as these are the treatment measures with the best current evidence for pathogen removal performance.

4.2 Application to different development types

Even though the goal is to achieve consistent application across the Parramatta River catchment, there is a need for flexibility in responding to different parts of the catchment (spatial variability) and the socio-political pressures (related to diverse development and planning outcomes). Consistent application could mean consistent use of the same framework, with different performance standards set for different locations and development types. An advantage of the tool-based approach is that it will make it easier to set place-based and context-specific targets, building them into the tool while keeping LEP and DCP provisions simple.

Table 8 outlines preliminary recommendations for application of the Blue-Green Index to different development types and scales. Additional considerations include:

- Which elements need to have a **minimum standard** and whether these minimum standards should be consistent across the catchment. Table 6 made basic recommendations on where minimum standards are required, and
- Opportunities to apply a place-based planning approach to support local to regional planning controls including consideration to identify specific sites where higher standards may be appropriate.

Table 8: Suggested application of the Blue-Green Index in different development types and scales

Strategies	Applicability to different development types and scales	
	APPLICABILITY NOW	FUTURE EXPANSION
Maximise pervious area and vegetation coverage	**All types of development** can be encouraged to maximise pervious areas and vegetation coverage, however detailed consideration will need to be given to setting specific minimum standards for different development types and scales. Some LEPs and many DCPs already include minimum standards for landscaped and deep soil areas in certain development types. Targets should be set for both **public and private land**, as many larger-scale developments include works in the public domain, and the targets could also be applied to public works.	
Maximise rainwater harvesting	Rainwater harvesting has become a relatively standard part of **detached and attached residential development**, as most of these developments require a rainwater tank to meet BASIX targets (unless an alternative water supply is available). It is also a relatively straightforward requirement to extend to **multi-unit residential development**, where rainwater tanks can also be modelled in BASIX. Some existing local planning provisions (e.g. at Sydney Olympic Park) already include rainwater harvesting requirements for multi-unit residential development. For mixed-use, commercial and industrial development, rainwater tanks can be modelled in MUSIC, but simpler tools are lacking. Therefore, at this time it may only be appropriate to require rainwater harvesting in **larger scale mixed-use, commercial and industrial development developments**, where their design team should have the capability for MUSIC modelling.	Development of a simple rainwater tank modelling tool for **common types of commercial development**, including shopping centres and office buildings, should be a priority. The inclusion of leaky tanks in a simple modelling tool is also an option to be added in the future.
Maximise infiltration (where appropriate) and evapotranspiration	Currently, infiltration and ET calculations would need to rely on MUSIC modelling. This makes it inappropriate to set targets for smaller developments. Runoff reduction targets could be applied to **larger scale developments of all types** – the same developments as below.	Develop a simple tool to model infiltration and ET for a range of different scenarios. Infiltration and ET can be improved with simple systems, appropriate to **most development types and scales** – anywhere there is green space, infiltration and ET can be encouraged
Treat any remaining runoff to reduce pathogen and other contaminant loads	As above, pollutant load removal calculations would need to rely on MUSIC modelling. This makes it inappropriate to set targets for smaller developments. Pollutant load reduction targets are already in place in many DCPs for **larger scale developments of all types**.	Stormwater treatment systems specifically designed for pollutant load removal will likely remain appropriate only in **larger scale development**, where owners have the capacity for long-term maintenance of these devices.

4.3 Implementation

As mentioned above, a staged implementation of the Blue-Green Index is recommended. This is suggested as follows:

A. Establish a working group

This paper has outlined a recommended framework for the Blue-Green Index tool. This framework will need further development to inform and build a working tool for developers and planners. The tool will need to define the parameters, incorporate relevant data, place appropriate weighting on the variables, test its application under different scenarios and settings and determine its usability. It is recommended that the PRCG should establish a working group to drive this process. This working group should include representatives from different councils, with different roles and disciplinary backgrounds. It could also include DPIE representation.

As part of the mandate of this working group, it should have responsibility for liaising with state government agencies who are currently working on related projects to improve green infrastructure and riparian outcomes for Sydney. For example, the Green and Resilient Places Division within DPIE has been working on the Greener Places Design Guide and is now developing a new Design and Place SEPP.

The working group should also liaise with entities in other jurisdictions such as the City of Melbourne, to understand how they developed and are implementing their Green Factor tool. The Melbourne Green Factor and other existing tools have utility in how they can inform the design of the Blue Green Index, although it is important to understand that these tools are built within differing social, geographic, regulatory and policy environments.

B. Develop an initial pilot version of the tool

A key outcome of the working group is to commission or otherwise develop a pilot version of the tool. The purpose of the pilot is to assess its feasibility and adaptability using a limited number of common development types and scenarios across the catchment (real or hypothetical), refine its functionality, and assess its future scope to incorporate most development types within the catchment. The pilot should also enable the collection of information as to the costs and benefits of the tool and determine support for its wider implementation.

The initial pilot phase should be led by the PRCG with input of the working group and be structured as a consultancy and research project (like Melbourne's Green Factor tool).

Steps within the pilot phase should include:

- Refine the objectives (as outlined in Table 6)
- Identify the quantitative evidence for each of the strategies and objectives
- Develop an initial points system
- Undertake a sensitivity analysis against generic development types (checking each variable independently)
- Develop a working version of the tool, which can be operated by the tool developer and demonstrated to working group participants
- Undertake a scenario analysis by testing the tool with a limited number of typical development typologies (assessing the effect of changing all input variables)
- Refine the points structure and set appropriate parameters and targets for different development types.

C. Test the pilot among PRCG councils

This step is recommended to gather input from a wider range of stakeholders beyond the working group, and ensure that as the tool is developed, it is designed to meet their needs.

It is recommended that this phase should also be led by the PRCG. All its members should be invited to test the tool. Each council should be encouraged to test the tool using a range of example developments. Participants should experiment with each example to see what it would take to meet the targets set in the tool. Tested examples should be saved in the tool's database for later analysis, and the testers should be invited to provide detailed feedback. This information will then inform the next iteration of the tool.

For this testing phase, the user interface will need to be developed into a user-friendly version that can be easily operated by others. This user interface can remain 'unpolished' would be for internal (not public) release, but must support the needs of non-technical users.

Based on this testing, the tool should then undergo iterative refinement to:

- The points structure
- Fixed and variable parameters
- Targets for different development types
- Usability of the interface.

This iterative stage should also be useful to help consider the tool's finer-grained architecture at the next development stage.

D. Develop a public facing Blue-Green Index tool

This stage will involve refining the tool based on the testing phase, and will also require the user interface to be developed to be suitable for public use. Information from the testing phase should be used to refine the following, which will need to be finalised in the public-facing version of the tool:

- Format of inputs and outputs. The testing phase will provide useful information on the functionality of the tool with a wide range of different examples and for a wide range of different users, highlighting where there is a need for additional, fewer or different inputs/outputs.
- Customisation options. Which elements of the tool can be the same across all PRCG councils, which need to be set locally but should be fixed within the tool, and which need to be open to user input. For example, infiltration parameters will need to vary across the catchment depending on local soil conditions, but could be fixed for each location or could be open to user input. Each council may prefer to set their own local targets for different development types (which could also vary within the LGA).
- Potential integration of existing tools (or elements thereof), for example elements of S3QM, the City of Melbourne's Green Factor tool, or other existing tools could be integrated into the tool.

At this stage, the tool's development should also consider potential future updates and expansion. Consider which parts of the tool may need to be revisited as new information becomes available. For example, water quality targets may be updated in the future and additional parameters, such as pathogens, may be added to the tool. New products may become available. Local research may provide more information on infiltration and evapotranspiration in different vegetated systems.

E. Staged local implementation via LEPs and DCPs

Based on the experience of the Helsinki and Melbourne tools, a staged or phased implementation can offer a stepwise pathway for policy change given it impacts both the development sector and councils within the catchment. The early adopters will most likely be the ones with the strongest socio-political and administrative support for this policy initiative.

Staged implementation could occur in a few different ways, yet to be determined:

- As has taken place in the City of Melbourne, the PRCG could initially make the tool available and encourage voluntary use by the development industry.
- Individual councils could adopt the tool one-by-one, via their local planning instruments. This could also be a staged process within each council, for example:
    - The tool could be applied first to certain *locations*, before being made more widely applicable (e.g. it could be adopted first for the Parramatta River catchment, then customised for application to other catchments in the LGA)
    - The tool could be applied first to certain *development types* (e.g. beginning with larger scale developments) before being made a requirement for smaller developments
    - Staging could also involve adding *modules* (as described in Section 4.1) to the tool one-by-one

Staged implementation should be supported by industry training, to facilitate uptake.

F. Aim for inclusion in a state environmental planning instrument

The Blue Green Index has the potential to form the basis of a state environmental planning instrument, which could strengthen its application within the Parramatta River catchment, as well as guiding water sensitive urban design and landscape outcomes elsewhere in NSW. DPIE are currently undertaking several projects designed to support waterway health and green landscapes, including the potential development of a building rating scheme for green infrastructure, as mentioned above.

Some of the issues which would need to be considered for the tool to work at a broader scale include:

- Potential integration with existing environmental planning instruments such as the BASIX tool
- Potential inclusion of broader objectives for blue-green infrastructure, for example in mitigating the impacts of urban heat
- Ensuring that local objectives remain strongly represented
- Customisation to different catchment and development contexts
- Finalisation of the current draft Green Places Guideline as prepared by the NSW Government Architect (2020).

By involving DPIE early in the process of developing the Blue-Green Index, as part of the initial working group, there exists greater potential for any future state environmental planning instrument and/or rating scheme to incorporate the important elements of the Blue Green Index and to be effective in meeting the objectives of the Parramatta River Masterplan.

5 A BLUE-GREEN GRID OF WATERWAYS AND RIPARIAN LAND

A healthy, living, Parramatta River needs healthy ecosystems in the river, the catchment and its creeks. New development has an important role to play, but improved planning provisions are required

One of the goals of the Parramatta River Masterplan is to improve ecosystem health in the river, its catchment and its creeks. The ecological health study (CT Environmental 2016) showed that one of the main strategies that can be employed towards this goal is to protect and enhance riparian vegetation. The water quality modelling study (Sydney Water 2018, p.85) also suggested that protecting and restoring urban riparian buffers could help improve water quality in the Parramatta River, although this strategy was not modelled.

New development has a role to play in protecting and restoring waterways and riparian zones. This is particularly true where new development occurs immediately adjacent to these zones. In return, nearby enhanced waterways and riparian zones can greatly increase the quality of life for those in the new developments. At workshops held as part of the Standardising the Standards project, participants discussed the potential for a more holistic approach to waterway planning, to ensure that when new development occurs adjacent to waterways, its impacts are minimised and opportunities are realised.

The existing framework for waterways and riparian zones is based on the *Water Management Act 2000*, which defines what should be considered a "river" and defines "waterfront land" as including any land within 40 metres as measured from the river's top of bank line. It places restrictions on activities in waterfront land. In an urban development context, the application of the *Water Management Act 2000* has been guided by the NSW Office of Water, and in particular by their "Guidelines for riparian corridors on waterfront land" (NSW DPI Office of Water 2012). This defines riparian corridors to be protected based on:

- Watercourses identified in the NSW "Hydroline" dataset (the same dataset used to map watercourses on the 1:25,000 topographic maps)
- Riparian corridor widths based on the Strahler stream order of the watercourse, with greater widths required for higher order streams
- Rules for averaging the riparian corridor width along the length of the watercourse.

There is more information on this methodology and its relevance to the Parramatta River catchment in Appendix B.

This methodology was developed at a time when most of Sydney's development was occurring in greenfield areas, and it does not always translate effectively to an infill development context within established urban areas. Notably, within the Parramatta River catchment, many smaller tributaries have not been mapped in the Hydroline dataset and while larger waterways are mapped, many of the higher-order waterways have been piped or channelised with limited or no riparian vegetation remaining.

Figure 8 illustrates a range of riparian systems within the Parramatta River catchment. Across the catchment, there are many examples where it is unclear how the *Water Management Act 2000* should apply. In a review of the riparian provisions with the *Water Management Act 2000*, Ives et al (2013) pointed out that small tributaries may be defined as streams even if they are not currently mapped. Their inclusion would turn on the definition of a "river" which includes "any watercourse, whether perennial or intermittent and whether comprising a natural channel or a natural channel artificially improved." However, Ives et al (2013) also point out uncertainties and practical difficulties defining stream order in these situations. For this approach to work, it needs to be supported by updated mapping, that is included as an overlay in the LEP and supported by a local provision – this is the approach that has been followed in Ku-ring-gai LGA (Ku-ring-gai Council 2019).

The upper reach of Archer Creek is not mapped on the Hydroline layer, but has values worth protecting

Small tributaries of Hunts Creek are not mapped on the Hydroline layer, but also have values worth protecting

Duck River in this reach is mapped as a second-order stream but it is a concrete channel and has very little riparian vegetation remaining. The scope for restoration is limited by existing development

Pendle Creek is mapped as a first order stream. While the reach through Civic Park has some potential for restoration, elsewhere the scope for restoration is limited by existing development

Figure 8: Examples of waterways in the Parramatta River catchment

Across the Ku-ring-gai local government area, waterways have been included in the mapping if they:

- "Follow natural linear depressions as indicated by the contours (i.e. are in an appropriate geomorphic setting);
- Have sufficient catchment size to enable sufficient runoff to form an identifiable channel and/or channel features (considering the area's high rainfall);
- Have a definable channel and/or known flow regime;
- Demonstrate fluvial features; or
- Have aquatic/riparian flora or fauna species present."
  (Ku-ring-gai Council 2009, p.33)

Due to historical development and engineering practices across the catchment, many larger tributaries are included on the Hydroline but lack many of the geomorphic features associated with natural rivers. While their inclusion as a mapped river offers protection under the *Water Management Act 2000* and the NSW riparian corridor guidelines (NSW DPI Office of Water 2012), their future landscape, ecosystem and waterway utility can be substantially improved if a new framework is implemented that enables the restoration or recreation of supporting riparian environments.

The following sections of this chapter provide a policy framework and categorisation for the protection, management and creation of riparian corridors within the Parramatta River catchment. It is intended that this will form the basis of the development of a riparian policy for the Parramatta River catchment councils.

The framework has been developed following a workshop focused on this topic. At the workshop, participants identified key concepts that should be included in the new framework. A crucial point is that there are a wide variety of different waterways across the catchment – both in terms of their physical form and the development context (existing and future). Participants also noted the need to consider a **place-based approach** consistent with current environmental and planning directions of state and local government. This could be based around a consistent framework for the catchment, which can then be applied selectively depending on the context. Key attributes of a riparian framework should include:

- Classification of different **waterway/riparian corridor types** that may consider the physical form, connectivity, condition, potential for improvement/recovery and surrounding development context. This may be similar to Ku-ring-gai Council's approach but would need to reflect the differing socio-environmental characteristic of the Parramatta River catchment
- Identification of different **roles** that each type of waterway/riparian corridor could provide, and the **objectives** that should apply. Feedback from the workshops reinforced the value of 'social' (e.g. recreation) and 'urban' (e.g. green grid) roles of waterways. This is in addition to the more traditional 'ecological' and 'natural' roles. This is particularly pertinent to the Parramatta River catchment and the goals in the strategic plan when compared to the ecological focus of the Ku-ring-gai Council approach.
- Potential **planning provisions/mechanisms** that could be applied, and advice on where each may be appropriate, based on local considerations.
- **Mapping** to define different waterway types and where different objectives and planning provisions apply.

Suggested aims of the policy are **to guide the strategic management of riparian zones in the catchment and to inform development and operational decisions in the catchment to support riparian systems and in turn the health of the Parramatta River.** Subordinate to these aims a future riparian policy would include several riparian categories within which specific objectives would apply designed to reflect the current condition and future potential social and ecological values to the Parramatta River catchment.

The ideas for riparian corridor management stem from multiple sources and references therein. These include: the NSW Department of Primary Industries, Office of Water, Guidelines for riparian corridors on waterfront land (July 2012); the Riparian Policy introduced by Ku-ring-gai Council in 2004 (Ku-ring-gai Council 2004); the Urban Ecology Renewal Investigation Project (National Green Infrastructure Network 2017); a summary of best practice undertaken by the CRC for Water Sensitive Cities (2017); and a review by the US National Academy of Sciences (National Research Council 2002). The underlying principles for the management of ecology in cities is drawn from the Urban Ecology Renewal Investigation Project by the National Green Infrastructure network that posits the need to protect existing habitats and create or re-establish habitats and corridors (National Green Infrastructure Network 2017).

5.1 Waterway types in the Parramatta River catchment

The Parramatta River catchment is a highly modified and diverse environment. Its waterways are also highly diverse. Reflective of this diversity, three broad waterway categories are identified based on their physical form:

1. **"Natural" waterways**: there exist areas of natural and relatively undisturbed waterways and riparian areas in good condition, particularly on the northern side of the catchment, for example within the upper parts of the Darling Mills

and Hunts Creek catchments. There are also some high ecological value natural waterways within Sydney Olympic Park, including the lower reaches of Haslams and Powells Creeks. Some examples are shown in Figure 9.

2. **"Degraded" waterways**: there are many waterways that retain some of their natural features, such as an unlined channel, yet are highly disturbed by urban development. Urban stormwater flows have caused erosion and channelisation, riparian vegetation is patchy and weedy, yet these waterways still have ecological and recreational value, and there is potential for recovery (if not restoration). Examples include Archer Creek, Toongabbie Creek, Girraween Creek and Duck River. Some examples are shown in Figure 10.
3. **Channelised and piped waterways**: there are many waterways, particularly on the southern side of the catchment, that have been replaced by concrete channels and pipes. Some of these pass through open space and sometimes urban development extends to the edges of the channel. Most have only patchy riparian vegetation, which may include trees but little understorey. Examples include Pendle Creek, Coopers Creek, Finlaysons Creek, Clay Cliff Creek, Duck Creek, Haslams Creek and Powells Creek (upstream of Sydney Olympic Park) and Iron Cove Creek. Some examples are shown in Figure 11.

Note that many waterways have reaches that fall into more than one category, including the examples given above. For example, Brickfields Creek in Oatlands and North Parramatta includes natural reaches at its upstream end, then piped and channelised reaches as it progresses downstream. Therefore, in many cases it will be important to classify waterways reach-by-reach.

(a) Hunts Creek tributary

(b) Vineyard Creek at Telopea

(c) Darling Mills Creek upstream of Cumberland Highway

Figure 9: Examples of natural waterways in the Parramatta River catchment

(a) Tributary of Grove Creek between Parry Park and Acacia Ave, Ryde

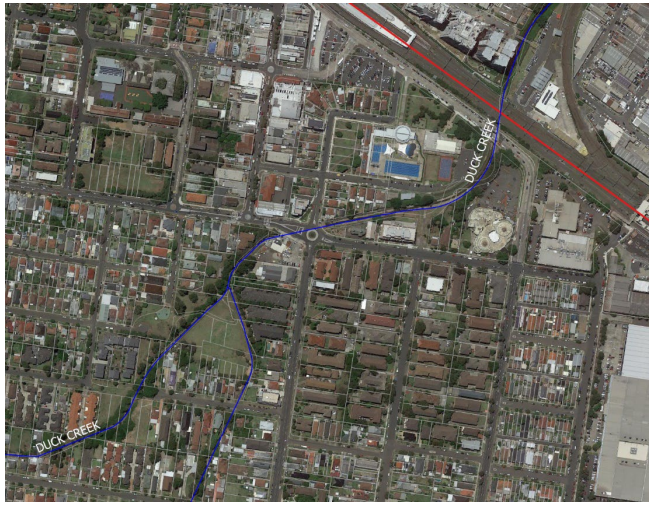
(b) Blacktown Creek at Seven Hills

(c) Vineyard and Subiaco Creeks downstream of Victoria Road

Figure 10: Examples of degraded waterways in the Parramatta River catchment

(a) Tarban Creek upstream of Manning Road, Hunters Hill

(b) Missing link in Subiaco Creek, between Kissing Point Road and Reid St, Ermington



(c) Duck Creek upstream of Main Western Railway Line

Figure 11: Examples of channelised and piped waterways in the Parramatta River catchment

5.2 Planning framework

Each of these broad waterway categories needs a different approach to planning and development. The following sections outline, for each waterway category, a framework describing what roles they could play in the catchment, what objectives should apply, and what opportunities there are for new development to protect and enhance their values.

Ideally, the objectives listed in each section below should refer to and be supported by guidelines, which explain design strategies relevant to each objective. Some relevant guidelines exist (e.g. NSW Government's 2009 Environmentally Friendly Seawalls guide), however there is a need for more up-to-date and locally appropriate guidance on waterway restoration in other contexts, explaining how to restore modified watercourse beds and banks to more natural forms that incorporate habitat and help improve water quality.

5.2.1 Natural waterways

These waterways range from small headwater streams to large waterways. Selected examples at different scales were given in Figure 9. These all have substantial, well-connected riparian corridors. They range from a first-order stream (the tributary of Hunts Creek) to a fourth-order stream (Darling Mills Creek) (where stream order is based on the Strahler system).

Ku-ring-gai Council's riparian policy provides a useful reference framework for 'natural' waterways. Across the Ku-ring-gai LGA many natural streams exist and have been assessed as being in good condition using the Rapid Riparian Assessment methodology. This mapping represents a significant body of work that has informed planning provisions designed to protect riparian lands from inappropriate development. The approach has been developed to be consistent with the *Water Management Act 2000*, is supported by a thorough scientific study, has also been in place for almost a decade and its validity has been tested a number of times in the NSW Land and Environment Court.

Three categories of streams within the Ku-ring-gai Council approach are relevant in relation to supporting ecosystem function:

1. Environmental corridor
2. Terrestrial and aquatic habitat
3. Channel stability and water quality

The fourth category, a variation of Category 3, represents discontinuous, poorly defined and piped channels, is relevant to the degraded waterways category as discussed in Section 5.2.2.

Darling Mills Creek in Figure 9(c) is a good example of an environmental corridor. Vineyard Creek in Figure 9(b) would likely be classified as a terrestrial and aquatic habitat waterway. The tributary of Hunts Creek in Figure 9(a) would likely be classified as a channel stability and water quality waterway. For these natural waterways, the main objectives revolve around protection and restoration of ecological values. The names of each waterway category in Ku-ring-gai's framework go some way to describing the purpose of each type of stream. Ku-ring-gai Council's DCP (2016) lists specific objectives for each waterway category, which are summarised in Table 9.

Table 9: Objectives for Ku-ring-gai's Category 1-3 waterways

Environmental corridors	Terrestrial and aquatic habitat waterways	Bank stability and water quality waterways
To provide a corridor for the movement of flora and fauna species between reserves and areas of remnant vegetation		
To preserve and enhance the viability, condition, connectivity and extent of native riparian vegetation and allow for adaption to climate change		
To protect and/or provide habitat for terrestrial and aquatic fauna, including key fish habitat		
To provide a riparian buffer to counter edge effects on the urban interface		
To provide for bushfire asset protection zones outside the core riparian zone		
To protect and/or provide bank and bed stability		
To contribute to improved water quality within the catchment		

In Ku-ring-gai LGA, Category 1-3 waterways are protected with a local provision and mapping overlay in the LEP (2015), as well as detailed provisions in the DCP (2016).

These provisions call for the following riparian zones to be retained, revegetated and protected on either side of Category 1-3 streams (measured from top of bank):

- Environmental corridors: 40 m core riparian zone + 10 m buffer
- Terrestrial and aquatic habitat: 20 m core riparian zone + 10 m buffer
- Channel stability and water quality: 10 m core riparian zone

Ku-ring-gai's LEP maps and categorises all the waterways in the LGA, and maps the riparian zone widths. Ku-ring-gai Council (2019, pp. 32-33) states that waterway categorisation has considered:

- "The width and continuity of vegetated riparian corridors;
- The connectivity between riparian vegetation and formal reserves (for example linking Council bushland reserves and adjoining National Parks);
- The continuity of open / natural stream channels;
- Relative length and location sequence of piped sections
- Current and likely future housing and other development under current land use zoning;
- Potential for riparian corridor maintenance, re-instatement or restoration;
- Aquatic ecosystem condition;
- Native vegetation condition, as reflected by the presence and density of weeds;
- Habitat value; and
- Presence of threatened species, populations or plant communities."

The Ku-ring-gai DCP Part 17 (2016) defines what can and can't be undertaken in the core riparian and buffer zones of each waterway category, as well as defining a set of design standards for regeneration and rehabilitation of vegetation in the core riparian zone.

5.2.2 Degraded waterways

These waterways also range from small headwater streams to large waterways. Selected examples at different scales were given in Figure 10. These all have unlined channels and patchy, disconnected riparian corridors. They range from a first-order stream (the tributary of Grove Creek) to third-order streams (Vineyard and Subiaco Creeks).

In these cases, the objectives that Ku-ring-gai Council defines for their Category 3(a) streams in their DCP (2016, p.17-12) are relevant:

- "To re-create the core riparian zone.
- "To emulate a naturally functioning watercourse, with associated riparian vegetation where possible.
- "To prevent development from compromising the ability to re-create the core riparian zone (including the watercourse) in the future.
- "To contribute to improved water quality within the catchment."

The PRCG Masterplan has a goal to improve access to waterways, including connected cycleways and walkways. Achieving this goal also places an emphasis on the Green Grid, as included in the Metropolitan Strategy and District Plans, where by degraded waterways should include provisions to support connected active movement links along their corridors. While the natural waterways with high quality riparian vegetation may accommodate bushwalking tracks, there exist opportunities for degraded waterway corridors to accommodate more formal shared paths and that these complement the restoration of riparian vegetation.

Planning considerations for these waterways include:

- Setting an appropriate core riparian zone width should refer both to the stream order of the waterway (and the riparian corridor widths recommended by NSW DPI Office of Water 2012), and the surrounding development context. While the stream order would indicate an ideal riparian corridor width, the surrounding development (existing and potential future) may suggest pragmatic revision down to a narrower width.
- When it comes to the specific activities to allow or encourage in the riparian corridor, there is a need to balance competing objectives (e.g. access and movement may compete with ecological restoration). This could mean:
    - Prioritising ecological restoration where there is strong potential to improve habitat connectivity, and
    - Prioritising access and movement where there is good potential to improve green grid links, and where access and movement can be provided in an environmentally sensitive way that allows for current and future habitat connectivity.
- There is potential for major redevelopment to open up corridors that are currently confined – this need not involve transfer of land into public ownership – it could be achieved with revegetation of setback areas on private land and/or public access easements across private land.
- For degraded waterways, the width of the riparian corridor and the opportunities to improve it are more dependent on the surrounding urban development context. Table 10 suggests three waterway categories and a set of objectives for each, that relate to the surrounding context.

Table 10: Suggested objectives for degraded waterways in the Parramatta River catchment

Open corridors	Confined corridors	Waterways on private land
To re-create the core riparian zone where possible	To prevent development from further compromising the ability to re-create the core riparian zone (including the watercourse) in the future	
To provide a corridor for the movement of flora and fauna species between reserves and areas of remnant vegetation		
To provide connected active movement links along the waterway corridor		
To enhance the viability, condition, connectivity and extent of native riparian vegetation		
To provide habitat for terrestrial and aquatic fauna		
To emulate a naturally functioning watercourse, with associated riparian vegetation where possible		
To protect and/or provide bank and bed stability		
To contribute to improved water quality – this could involve offline treatment systems and/or improvements to in-stream processes		

5.2.3 Channelised and piped waterways

These waterways range from small headwater streams to second order streams. Selected examples at different scales were given in Figure 11. These all have limited remaining riparian vegetation – even where there is a corridor of open space, the vegetation is dominated by trees and turf. For these streams, the restoration becomes less feasible, but there are still opportunities to improve habitat, water quality and access along these waterways. Potential objectives include:

- Waterway naturalisation where possible – noting that in practice, this can rarely restore a "natural" stream form, but can restore some natural elements such as vegetated banks or a vegetated low-flow channel
- Restoring vegetation along the corridor, which may not include fully structured riparian vegetation but should at least focus on creating a connected canopy and improving habitat
- Offline water quality treatment
- Provision of connected active movement links.

As with the degraded waterways, opportunities to improve piped and channelised waterways are also more dependent on the surrounding urban development context than the size of the waterway. Planning considerations for these waterways include:

- Potential for major redevelopment to open up corridors that are currently confined, creating space for revegetation and/or public access – as suggested for degraded waterways
- Potential to unlock strategic Green Grid links via private property purchase – Subiaco Creek is one example where this could be explored.

Table 11 suggests three waterway categories and a set of objectives for each, that relate to the surrounding context.

Table 11: Suggested objectives for piped and channelised waterways in the Parramatta River catchment

Open corridors	Confined corridors	Piped under private land
To naturalise where possible		
To improve water quality via offline treatment systems where possible		
To restore vegetation with habitat value, including canopy trees	To set back new development where possible, and revegetate within the setback	
To provide connected active movement links along the waterway corridor	To pursue strategic opportunities for public access easements across private land	To pursue strategic opportunities for connection (potentially via property purchase)

5.3 Implementation

The implementation of the riparian controls is suggested as a staged approach.

A. Establish a working group

It is recommended that the PRCG should establish a working group to guide the development of the Blue-Green Grid. This working group should include representatives from different councils, with different roles and disciplinary backgrounds. It could also include DPIE representation.

The working group would be tasked to undertake the following:

- Review the three suggested waterway categories, and three suggested types within each category, and make recommendations to the PRCG to refine the categories and types, ensuring that their definitions are clear, that they capture the range of waterways across the catchment, and that they provide a useful framework
- Examine options to map the waterways across the catchment, ensuring that mapping builds on work already undertaken by local councils, and adds value, providing a dataset that meets the councils' future needs
- Consider different options to map riparian areas, and the implications of different methods. A starting point should be the riparian corridor widths based on Strahler stream order, recommended in the NSW DPI Office of Water guidelines (2012). However, when it comes to degraded, channelised and piped waterways, alternative approaches will probably need to be considered. In these situations, the surrounding development context becomes more important.
- Review the mapping as it progresses, helping to refine the approach and its outputs
- Consider how the mapping will be used in the planning process, and provide input to LEP provisions
- Identify funding or other resource support for the implementation of the Blue Green Grid.

B. Waterway and riparian area mapping

Mapping of waterways and riparian areas is recommended to:

- Identify all waterways in the Parramatta River catchment
- Define the key physical characteristics of each reach of each waterway, i.e. whether it is a natural, degraded or piped/channelised waterway
- Further categorise individual reaches of natural waterways as environmental corridors, terrestrial and aquatic habitat or channel stability and water quality waterways
- Further categorise individual reaches of degraded, piped and channelised waterways in terms of the riparian corridor characteristics – whether the corridor is open, confined or fully within private land
- Map areas where there is potential for waterway and riparian restoration – e.g. where the redevelopment process could open access to riparian land, enable revegetation or even waterway naturalisation
- Map the extent of proposed riparian zones and identify specific objectives that apply within each zone.

Mapping of waterways and riparian areas is recommended as a high priority action, however, mapping can follow a staged approach. It could be staged spatially (e.g. commencing with pilot area/s within the Parramatta River catchment) and could be staged in terms of adding detail over time (e.g. commencing with basic layers, which can be refined over time). A suggested staged approach is outlined in Table 12.

Table 12: Staged approach to mapping waterways and riparian land

Stages	Mapping tasks
1. Desktop mapping to identify and categorise waterway reaches, catchment-wide	Build an initial waterways and riparian lands map based on existing catchment-scale mapping data, including (but not limited to): • Waterways identified in the NSW Office of Water Hydroline mapping • Locations of high ecological value waterways and water dependent ecosystems (note data on this has been recently prepared by DPIE) • Strahler stream order (mostly completed by councils or state agencies) • Relevant planning layers such as vegetation, cadastre, zoning and topographic data
2. Desktop mapping to refine the categorisation of waterway reaches based on locally available data	• Identification of drainage lines including overland flow paths (typically forming part of catchment flood studies), or flood prone land (modelled and reported), • Creek condition audits or mapping (such as River Styles or Rapid Riparian Assessment)

Stages	Mapping tasks
3. Desktop mapping to add planning layers and identify where there is potential for waterway and riparian restoration	• Consider the local council's existing strategic plans for ecology/biodiversity to understand where there are needs for strategic biodiversity corridors. • Consider district and local green grid and/or active transport plans, to understand where green grid links may coincide with waterways and riparian land. Following on from the LSPSs, many of the catchment councils are now preparing green grid strategies and plans. • Consider future urban development planning strategies of state and local government that may identify targeted development or redevelopment areas, notably where these could impact on or support open access to riparian land, enable revegetation or waterway naturalisation outcomes.
4. Desktop mapping to define extent of proposed riparian zones and identify specific objectives that apply within each zone	• Bring all the above layers together to map the extent of all riparian lands and the planning objectives that apply to each piece of riparian land
5. Field validation and ongoing review	• Field validation should be used to refine mapping over time, to improve mapping accuracy and to serve as a condition benchmark from which future audits can measure policy effectiveness over time. • Field validation should be prioritised in areas where major development/redevelopment is planned.

Stage 1 has commenced and is being led by the PRCG for the whole Parramatta River catchment, in collaboration with Macquarie University and with input from local councils. Stages 2-5 will require input from various teams within catchment councils.

These steps may be better led individually by each local council with support from the PRCG. Ideally the councils and PRCG should collaborate and coordinate on these steps with an aim to deliver a consistent, timely and practical outcome.

C. Update LEPs

The waterway and riparian mapping will result in a series of data layers and maps that will need to be iteratively updated and refined as the catchment changes, and can also be updated as more data becomes available. These layers will support both strategic and statutory decision making. The mapping layers will be critical to updates of LEPs and future local strategic planning statements.

In the short term it recommended that a basic waterways riparian land clause be included in each council's LEP (refer to Appendix A). The suggested clause can be applied before any new mapping is completed. As mapping is completed and improved within each LGA, it will be possible to improve LEP clauses for waterway and riparian land, making them more specific to different waterway types and categories of riparian land.

D. Preparation of updated riparian DCP controls

Once a waterways and riparian land clause is established within the LEP (even with the basic recommended clause as per Appendix A), it provides the enabling policy link for the development of local DCP controls.

As mapping is completed and refined for each LGA, and when the LEP is updated accordingly, DCP controls should also be updated at the same time.

The DCP and/or local policy would apply to the proposed development affecting the riparian areas and categories therein (noting that one stream may have more than one category that is reflective of its condition and development history).

6 SUPPORTING STRATEGIES

Effective development assessment, compliance enforcement, monitoring and funding – particularly for maintenance – are all needed to support better planning instruments

Improving urban waterways has long been a community aspiration in Australian cities and for Sydney was formalised through various catchment plans of the 1990s that focused on "clean" waterways (Davies & Wright 2014) and more recently has broadened its focus to "healthy" and "living" waterways. WSUD in new development has been identified as a key mechanism to improve urban waterway health, yet there have been significant challenges implementing WSUD in the development process.

The challenges for WSUD begin at the land use and development planning stages. This is where WSUD infrastructure competes for space with other demands on public and private land. At development approval stage, additional challenges are encountered to assess applications in a short timeframe and for most determining authorities occurs with limited resources. Depending on the development pathway, the assessment process differs (see Figure 12), but regardless of the process, when planning requirements and design standards are too complex, the merit-based assessment process can find incorporating WSUD an impractical task.

The Discussion Paper noted that monitoring and compliance is a gap in current practice. Council staff have limited capacity to check compliance with conditions of consent at construction/occupation certificate stages, and private certifiers face similar pressures. When design standards are too complex, thorough compliance assessment becomes unfeasible.

Once new developments are built, councils are also asking developers to put new assets in place that require long-term maintenance. Whether these assets are in the private or public domain, operation and maintenance has been a challenge to resource effectively:

- In the public domain, funding is the main barrier to effective operation and maintenance. Councils generally operate within constrained maintenance budgets, and increasing rates or levies is not always a realistic option.
- In the private domain, the reasons for poor operation and maintenance are more complex, but could be broadly said to relate to the capacity (knowledge, resources and motivation) of private landowners to maintain stormwater quality infrastructure. As stormwater treatment systems are placed in smaller properties, maintenance becomes more challenging (Ardren 2019).

Exempt Development	Complying Development	Local Development	State Significant Development
No development application or approval is required	Application is made to local council or Principal Certifying Authority for a Complying Development Certificate	Development Application made to local council	Application is made to Department of Planning and Environment
Self-assessed against the requirements of the State Environmental Planning Policy (Exempt and Complying Development Codes) 2008	Assessed by council or PCA against the requirements of the State Environmental Planning Policy (Exempt and Complying Development Codes) 2008	Assessed by local councils against any relevant SEPPs, LEP and DCP (as well as council policy). Can also include development where the Minister for Planning is the consent authority, if designated under a relevant SEPP	Assessed by the Department. Assessment against existing strategic planning and policies (including local) is undertaken Consultation occurs with local councils

Figure 12: Development approval pathways

With constraints on funding for public domain operation and maintenance, there can be pressure both from developers and local councils to treat stormwater in the private domain rather than making room and carrying the maintenance burden into the public

domain. Some councils, such as Blacktown, have tried to support private capacity with additional guidance, including staff resources and written materials, but this has also proven a challenging task (Cadman 2019). Other councils acknowledge that although stormwater treatment systems may be installed in private development, there is no follow-up beyond the development application to check that these systems are installed correctly and working. Yet others have avoided imposing or enforcing WSUD controls in private development, aware that they lack the capacity for effective implementation.

6.1 Redefine the problem

The Parramatta River Masterplan, the District Plans and LSPSs all reinforce the community aspiration for healthy, living waterways, including a swimmable Parramatta River. Yet with the same pressures remaining on blue-green infrastructure to compete for space and for limited operation and maintenance funding, it is unclear how these aspirations will be translated into support to implement more blue-green infrastructure in new development.

While one avenue is simply to continue advocating for more resources for blue-green infrastructure, the persistence of this problem suggests that there is also a need for a more fundamental reconsideration of how resources are allocated to blue-green infrastructure in urban development.

Three potential avenues to redefine the problem are:

1. Shift the perspective on WSUD infrastructure – from single-purpose stormwater quality treatment infrastructure to multi-purpose blue-green infrastructure contributing to multiple sustainability and liveability objectives. We are beginning to view tree canopy cover in this way, but taking the same perspective on a wetland or rain garden is a greater challenge.

2. Shift the emphasis from stormwater quality treatment to simpler measures to reduce runoff. While improving stormwater quality is a logical objective, a singular focus on stormwater quality has led to an emphasis on highly engineered treatment systems that rely on specialised maintenance and are prone to failure. Simpler measures that reduce runoff (e.g. greater pervious area, more rainwater harvesting and disconnection of impervious areas) may achieve less on paper, but if these measures are robust enough to work in the long-term, they will achieve more in practice.

3. Reconsider the balance between blue-green infrastructure in the public and private domain. Rather than asking developers to finance private infrastructure that is unlikely to be maintained, this money could be better spent elsewhere. Stormwater quality offsets or in-lieu contributions have been suggested as an option worth further investigation.

These approaches could reduce the issues associated with development assessment, compliance enforcement, funding and maintenance. But blue-green infrastructure still needs to be designed, built and maintained in the long-term, and there is still a need to consider how to support effective policy implementation.

The following sections outline recommended actions to build the business case for new policy and strengthen financing, simplify assessment, compliance enforcement and implement effective monitoring. Section 6.6 also recommends advocacy for State-level policy reforms, which would complement and reinforce, and may ultimately replace, local policies.

6.2 Rebuild the business case

The Parramatta River Masterplan (PRCG 2018) has identified the need for a business case to analyse the investments proposed in the plan and demonstrate their economic benefits. Substantial policy reforms such as the Blue-Green Index and Blue-Green Grid would benefit from the support of a business case.

A recent Productivity Commission paper, focused on integrated water cycle management (IWCM) (Productivity Commission 2020), highlights that "Funding issues with IWCM projects are often symptomatic of other factors", including:

- Unclear roles and responsibilities. When projects provide broad benefits such as urban amenity and environmental improvement, the responsibilities for those outcomes are distributed across different levels of government and different agencies. It is unclear who is responsible for these outcomes and therefore who should fund multi-objective projects.
- Lack of clear objectives for urban amenity and enhanced environmental outcomes. Unless the high-level aspirations in planning documents are translated into much more precise terms, it will be difficult to develop project proposals that are precise enough to justify funding.
- Poor linkages and limited integration between different planning process, for example land use planning and water planning, stormwater management and water supply/wastewater planning, local and system-wide planning. This can commonly lead to misalignment of priorities.

While these are significant challenges, the Productivity Commission report suggests some potential pathways forward:

- Clearly assigning roles and responsibilities for the provision of urban amenity and environmental outcomes
- Linking decision-making responsibilities with the need to fund those decisions
- Recognising that funding IWCM projects will frequently require cooperation across agencies
- Linking funding to who benefits, and the extent to which they benefit
- Recognising a defined role for government funding of IWCM projects, linked to governments' roles in delivering urban amenity, environmental improvement and protection of significant environmental values
- Considering the best way to raise the funds needed – i.e. which financing mechanism/s to use.

Drawing from these recommendations, a key message is that it is important to account for all the costs and benefits, and be clear about who benefits from and who pays for each of these. This will help identify what infrastructure should be placed where (e.g. public/private domain) and therefore who should fund its maintenance. Infrastructure with direct benefits to property owners, such as rainwater tanks, are more likely to be maintained in the private domain. Public funds may be allocated more readily to infrastructure with multiple benefits beyond stormwater treatment.

A business case will need to consider:

- Total life cycle costs to meet proposed planning and development requirements and design standards. Consider when and where these costs occur, and therefore who would pay
- Total benefits. This should include the full range of benefits, and should consider where they occur (who benefits). It should include indirect as well as direct benefits, including:
    - Improved water quality in the River
    - Improved waterways in the catchment
    - Local habitat
    - Local amenity
    - Local microclimate
    - Water conservation
    - Improved green grid connections.

Once costs and benefits have been quantified, it is important to assess whether the costs stack up – both as a whole and from the perspective of different groups. Consider what should be provided in the private domain and what in the public domain, as this can shift costs and benefits between different groups. The emphasis on integrated, multipurpose green infrastructure makes this assessment more complex, but also helps ensure that costs are offset by a range of benefits. The range of different measures proposed in the Blue-Green Index also allows the policy settings to be tweaked, to achieve a balance between costs and benefits.

Then there is a need to consider the best financing mechanisms. For infrastructure in the public domain, funding mechanisms are available through the planning system. Combined the *Local Government Act* 1993 and the *Environmental Planning and Assessment Act* (EP&A Act) 1979 offer several pathways to support funding. Several options are outlined in Section 6.3 below. The Sustainable Funding Options Paper (Adams 2020) provides further detail.

It is worth noting that many of these options could be constrained by institutional barriers to change. Some could be pursued by councils on their own, however, a consistent and proactive approach by all member councils is recommended if investment in public infrastructure, both capital and maintenance, is sought to support clearer waterways and greener precincts.

6.3 Strengthen financing for blue-green infrastructure

There are existing funding mechanisms in place to finance construction, operation and maintenance of blue-green infrastructure in new development, including:

- Direct funding of infrastructure built as part of the development, either in the private or the public domain
- Developer contributions for public infrastructure built separately to the development
- Rates and levies on property owners

Three potential avenues for strengthening financing are outlined below. It is recommended that the PRCG should discuss these options with IPART.

6.3.1 Seek developer contributions

There are a range of existing mechanisms available to seek financial contributions from developers for public infrastructure. These mechanisms could be reviewed and improved:

1. Standardise Value Capture/Voluntary Planning Agreement Policies. Voluntary agreements can serve to support the construction and maintenance of various assets where there is a clear link to the public benefit. The PRCG could develop a generic guidance policy designed to support blue and green infrastructure across the catchment. When land value uplift is captured at the

rezoning phase, councils should take the opportunity to scope increased investment in blue-green infrastructure.

2. Establish **a funding framework for major growth precincts,** with a specific focus on blue-green infrastructure, which would apply to places such as the GPOP corridor. This framework would apply largely to major development sites that would come under the auspices of regional planning bodies.
3. Reform **local infrastructure contribution policies**. Changes to the NSW planning system have removed the previous fixed cap on development contributions, potentially opening the door for councils (and other planning agencies) to require developers to pay a greater financial contribution towards blue/green infrastructure or other assets that provide a public benefit. Local Infrastructure Contributions Plans for contributions above the old caps must be approved by IPART. The assessment criteria include a list of essential works that can be funded via these plans. This includes "land and facilities for stormwater management" but excludes "bushland regeneration or riparian corridors" (Department of Planning and Environment 2019). It is unclear exactly what works would be considered acceptable within the definition of "stormwater management", but stormwater treatment systems would appear to fit in here. This will probably only become clear as councils take new plans through the process.
4. Develop **targeted contributions plans for high growth areas**. Separate from the point above, this recommendation would focus on high growth areas identified in council planning schemes or those of the Greater Sydney Commission. These high growth areas are distinct from general development due to the scale and intensity of development and therefore the impact and opportunities to embed outcomes at the design through to construction stage are also greater.
5. Participate in the process, led by DPIE, to develop **special infrastructure contributions** for development around major infrastructure projects or areas of particularly intensive growth. For example, this could apply to the construction or upgrade of state significant projects such as the Parramatta light rail, new metro systems or infrastructure linked to the Parramatta CBD upgrade.

These options will be subject to significant policy and legislative considerations. Currently, the NSW Government is developing a reform agenda to the infrastructure contributions system, in response to the Productivity Commissioner's review, documented in the Green Paper 'Continuing the Productivity Conversation' (NSW Productivity Commission 2020). All options should be considered in the light of the Productivity Commission's findings, to identify the best avenues for sustainable funding of blue-green infrastructure via the development process.

6.3.2 Consider in-lieu contributions for stormwater quality treatment

The concept of in-lieu stormwater quality contributions has been raised in the Standardising the Standards workshops as a potential mechanism to improve the allocation of developer finances towards stormwater quality treatment. Rather than asking developers to design and install small-scale stormwater treatment systems in the private domain (where the operation and maintenance burden would fall to property owners), an in-lieu contributions scheme would instead seek a contribution towards public domain stormwater quality treatment projects.

Workshop participants discussed the role of similar schemes, and their limitations. Participants looked at the features of Blacktown Council's stormwater quality offset scheme and Kingston Council's stormwater quality in-lieu contributions scheme. Overall, it was agreed that offsetting has a potential role in the Parramatta River catchment, but also has significant risks. Some of the concerns raised by workshop participants were:

- The need to ensure that we are still encouraging the best possible outcomes in the private domain. There was caution about missing opportunities at the development stage (as retrofits are unlikely to happen later).
- Spatial considerations – where is development occurring and where are offset projects proposed? This anticipated an issue of when offsets may be transferred into other catchments or to other LGAs. One concern is that if offsets are to occur in a distant location, then they may not be 'like for like' offsets. Any large-scale offsetting mechanism would have to be set up to ensure there are strong rules ensuring equivalence between different offset options.
- Timing considerations – if offset projects are large, it could take a long time to accumulate funds before anything is built.
- Offset projects may be directed to public open space that could otherwise be put to other uses.
- Existing examples of offset schemes are narrowly focused on stormwater quality treatment and are not necessarily providing many other benefits.
- When assets are built in the public domain, there is a need to fund operation and maintenance. Some offset/in-lieu contribution schemes only collect funds for capital works, however there are examples (e.g. Kingston, Victoria)

that set aside funding for operation and maintenance. This relies on a robust, defensible estimate of operation and maintenance costs.

Beyond these issues, it would also be important to consider where such a scheme would fit within the planning system, and how it would be implemented, including governance and administration. The Productivity Commission's review of infrastructure contributions (NSW Productivity Commission 2020) is also relevant here.

If stormwater quality treatment offsets are to be considered in the future, any scheme needs to be planned in the context of the proposed Blue-Green Index, and be enabled within the planning scheme. While local offset schemes could be implemented through existing mechanisms such as local developer contributions plans (if supported by IPART) and voluntary planning agreements, workshop participants also saw value in further investigation of a catchment-wide scheme. A catchment wide scheme could be developed and implemented through an inter-council agreement, or a State Environmental Planning Policy. As a catchment wide scheme this could enable the impact of development in one LGA to be offset in another, providing developers with many more options. This geographic flexibility and advantage must also consider the social and political concerns of the respective councils that may be seen to be advantaged by or not by such an approach.

6.3.3 Review ongoing contributions

Operation and maintenance funding has been a particular challenge for WSUD and other green infrastructure, and this has often meant that councils are reluctant to take on new assets in the public domain.

Part of the issue is that local government must deliver a wide range of services, with a limited capacity to set rates and other charges. Operation and maintenance generally needs to be funded from the council's rates and charges, as there are few other mechanisms available.

One important additional mechanism available to local government is the **Stormwater Management Service Charge** (also known as the stormwater levy). Most of the councils in the Parramatta River catchment have this charge. A survey of the use of the SMSC in NSW councils (Bright 2018) recommended that it is due for review, as:

- The charge was introduced in 2006 and pegged at the same value since, with no increase to account for inflation
- The rate is substantially lower than stormwater charges paid to utilities in Sydney and in other cities
- There is wide variation in how the funding is spent by different councils, but those councils surveyed were spending a significant proportion on planning, design and capital works, and relatively little on operations and maintenance – a potential issue given the lack of other mechanisms to fund operation and maintenance.

Given these findings, the PRCG should advocate for an increase to the rate of the stormwater management service charge. This can build on existing work: Stormwater NSW released a position statement on sustainable funding for stormwater management in 2020 (Stormwater NSW 2020) which calls for the SMSC to be increased to match Sydney Water's stormwater charge, which is levied within Sydney Water drainage catchments. It is understood that Infrastructure NSW has undertaken some research on the matter, which may also support the case. The Office of Local Government may also have relevant information.

A further option for consideration is to allow for a variable stormwater management service charge rate, with the amount to be based to some extent on the relative impact of a particular property. This would provide an incentive for property owners to reduce their impact.

Other potential mechanisms for ongoing contributions are:

1. Implement a **Special Rate Variation** across the catchment. This could be achieved by councils (with some of the catchment councils already having environmental levies)
2. **Sydney Water** levies a **stormwater charge** on properties within its drainage catchments, including large parts of the Parramatta River catchment. Sydney Water could review how this money is being spent and direct more of it towards managing diffuse stormwater pollution in the catchment, in line with the community's values and expectations for stormwater management

Both options would require considerable thought as to the overarching approval mechanisms and governance arrangements to ensure that funds raised are spent according to their intended purpose.

6.4 Simplify assessment and compliance enforcement

Planning provisions and development controls need to be supported by effective assessment, compliance and monitoring, to ensure they are being implemented effectively and meeting their intended effect.

6.4.1 Development assessment

At development assessment stage, there is pressure on assessors to review applications in a timely manner, while there is also limited capacity to work through complex technical details. This has been a challenge with existing WSUD provisions in DCPs, which often ask developers to demonstrate compliance with stormwater pollutant load targets by undertaking MUSIC modelling and submitting a report with the details. This is only effective if assessment staff have time and capacity to review those reports effectively.

Therefore, some councils have simplified this process by:

- Using MUSIC-Link to ensure that models are set up with the right parameters
- Using S3QM, which simplifies the modelling process even further, reducing room for error
- Providing "deemed to comply" options for small routine developments, which remove the need for modelling
- Setting a minimum development size, below which there is no need to meet stormwater pollutant load removal targets.

However, these initiatives have not fully overcome the issue of complexity in existing WSUD and water management provisions. And where provisions are too complex, they tend to be overlooked or implemented poorly. Therefore this recommendations paper explores new approaches, including the Blue-Green Index.

To simplify the development assessment process as much as possible, it is recommended that the Blue-Green Index, once it has been tested and refined, and if it is adopted, should be developed into an online tool with the following features:

- Its aims and objectives should be made clear, so users understand why it is required and how it contributes to the DA process
- All parts of the index should be built into a single online tool
- There should be the ability for councils to set different targets and minimum requirements for different locations and development types
- Modelling tools should be built in to the 'back end' like the way that rainwater tanks are modelled in BASIX or that water quality treatment systems are modelled in S3QM. This will need to include modelling of rainwater tanks, infiltration, evapotranspiration and water quality treatment
- The tool should allow users to trial different options to meet their targets, providing feedback to allow them to optimise their strategy
- The tool should produce a certificate and a summary of commitments. This will assist with checking detailed plans at construction certificate stage
- The tool should enable aggregated data collection by council area and catchment area. This will assist with monitoring, which is discussed in the following sections.

6.4.2 Checking compliance

Once detailed designs are complete, a construction certificate is the next step. The certificate verifies that the detailed construction plans and specifications of the development are consistent with the development consent and other relevant standards. Checking compliance with DCP requirements is a perennial challenge. As noted above, whether the principal certifier for a development is the local council or a private certifier, both have limited capacity to check all aspects of compliance with codes, standards and DCP provisions.

Some compliance issues are readily observable with a site inspection. For example, erosion and sediment control practices can be easily checked with a brief inspection. The Get the Site Right compliance blitzes, launched by the PRCG in 2016 and repeated regularly since then, have been a useful tool to highlight low levels of compliance with erosion and sediment control requirements, and raise awareness about the effects of sediment runoff on waterways. The blitzes do not require substantial resources to run, and they raise revenue via fines.

Other issues are harder to check – for example whether a vegetated stormwater treatment system has been installed correctly or well-maintained through the establishment period.

For systems such as rainwater tanks, infiltration, on-site detention and stormwater treatment systems, there is also a need to account for their long-term performance, and this depends on maintenance. When they are installed in the private domain, councils can create a positive covenant to require maintenance of these systems. Some councils (and DPIE when it is the consent authority) impose conditions on development, requiring maintenance plans to be prepared for stormwater treatment systems, and requiring independent audits.

However, checking long-term compliance and supporting private property owners to improve maintenance practices has proven challenging. In the 1990s, a review of OSD implementation in the Upper Parramatta River Catchment (Still & Bewsher 1999) found issues with the practical application of positive covenant powers, suggesting that property owners had limited understanding of OSD systems, inspections were limited, and when problems were identified at an inspection, councils had limited success asking property owners to rectify issues. Blacktown Council has had a WSUD compliance officer since 2014, responsible for close to 1,000 private properties with

4,500 WSUD, on-site detention and rainwater tank assets (Cadman 2019). Much of the compliance officer's work over the last five years has been focused on gathering information and improving record-keeping systems, and there is still more work to do to reduce the gap in maintenance of privately-owned systems (*ibid*).

Given the known challenges with private on-site detention and WSUD, it is recommended that:

- For smaller developments, the focus should be on simple measures with lower maintenance requirements and clearer private benefits. There is evidence from monitoring of BASIX dwellings that they are performing close to their water conservation target (e.g. Sydney Water 2012), suggesting that most rainwater tanks installed to meet BASIX requirements remain operational.
- For larger developments, where there is an opportunity to deliver infrastructure in the public domain, carefully consider what to allow in the private domain. Costs and benefits to developers may look quite different to public costs and benefits (e.g. Ardren 2019 showed how developers have an incentive to put WSUD infrastructure in the private domain, where maintenance was largely neglected), and therefore there may be a need to establish rules to balance public and private interests.

6.5 Monitor outcomes

There is a need to monitor the effects of new policy, including: the immediate outcomes (e.g. what is being installed?); the long-term effectiveness (e.g. is the infrastructure installed in new development still working over time?); and the catchment scale effects (e.g. is there any sign of improvement in water quality or health of the River?) An ability to demonstrate the effectiveness of a policy will help ensure ongoing community support and industry acceptance.

Monitoring will need to be appropriately resourced; it will require meaningful funding, ideally with a long-term commitment to an ongoing program.

6.5.1 Monitoring for policy effectiveness, review and improvement

Monitoring, including measurement of real-world outcomes, plays an important role in supporting policy implementation in the long-term, by demonstrating its effectiveness and enabling improvement where necessary.

Monitoring could include post-construction audits of individual developments, but should also involve monitoring policy effectiveness at the catchment scale. This could include:

- Measurement of green cover and/or canopy cover in the catchment
- Measurement of baseflows and stormwater flows in waterways
- Water quality monitoring – in tributaries, in the River, at swim sites
- Environmental health monitoring – e.g. waterway and riparian health assessment, macroinvertebrate monitoring, fauna surveys.

The Blue-Green Index also offers an opportunity to track the commitments made by individual developments at DA stage, within a centralised database. This would allow tracking of cumulative development effects as the catchment develops.

6.5.2 Monitoring for model development

As noted in Section 2.3, the current recommendations and policy approach assumes that WSUD will reduce pathogen loads. However, it is not known what the reduction is at a site by site basis, nor what the cumulative reduction is at a catchment scale. Site based and catchment-based modelling will help to better understand this relationship and in turn inform policy controls and the management of structures.

However, to set up better models, long-term environmental monitoring programs are required to inform predictive models to assess water quality health. Drawing from the experience of Beachwatch and Harbourwatch, these models rely on quality monitoring across multiple sites and over many conditions.

Another aspect that can be partially led by the PRCG, but will also require input of other stakeholders, is to develop the stormwater treatment module of the Blue-Green Index to include pathogen load reduction. There is a need to understand more deeply the relationships between pathogen and nutrient/sediment removal for the purpose of informing improvements to the design and function of stormwater quality improvement devices and to develop a predictive model on the swimming water quality of the Parramatta river from a health perspective that integrates weather, runoff and tidal influences. This work not only requires funding, but also requires a realistic time frame for academic research to progress our understanding of these processes.

6.6 Advocate for State-level policy reforms

The Parramatta River Masterplan (PRCG 2018) was clear in its intention that Step 4 should involve a "whole of catchment land use policy and statutory planning mechanism", such as a SEPP. This remains a goal, but there are also many other intersections with NSW Government planning and environmental frameworks, and potential avenues for reform, which would support the goals of the Parramatta River Masterplan. There is a need for water quality and waterway health objectives to be

considered in all planning and approval pathways, beginning as early as possible in the process. This section provides a brief overview of options to ensure that this occurs. Further details were provided in the "Policy Options Paper" (Sydney Water 2020).

6.6.1 Provide input to relevant state-led policies and strategic plans

Various NSW State Government agencies are responsible for strategic planning for urban development and infrastructure. Important plans with relevance to the Parramatta River catchment include:

- The Metropolitan Strategy (Greater Sydney Commission 2018a) and District Plans (Greater Sydney Commission 2018b,c,d), which set the direction and guide the form of Sydney's growth
- Sydney's Future Transport Strategy 2056 (NSW Government 2018b), and the Greater Sydney Services and Infrastructure Plan (NSW Government 2018c), that define Sydney's transport needs and the network required to meet them, including new network links in the Parramatta River catchment
- The NSW State Infrastructure Strategy 2018-2038 (Infrastructure NSW 2018). This is linked to both the planning and transport strategies to co-ordinate infrastructure and land-use planning
- Sydney's Metropolitan Water Plan (NSW Government 2017) that defines how water services will be provided to support a liveable, growing and resilient Greater Sydney
- The NSW Marine Estate Management Strategy 2018-2028 (NSW Government 2018c) that defines how the NSW Government will protect and enhance coastal waterways and receiving waters.

These plans provide both high-level directions that align with the Parramatta River Masterplan as well as planning for new housing, jobs and infrastructure that will drive substantial development and land use change in the catchment. For example, the Metropolitan Strategy has a strong focus on healthy waterways, biodiversity, tree canopy, public open space and the green grid under the "city in its landscape" theme, which supports the PRCG Masterplan's vision for a world class river. Various state-led master plans also exist and inform a more granular level approach to development across the Parramatta River catchment, notably within the GPOP corridor.

The state government frequently updates its various land use, infrastructure and environmental plans as well as the more detailed corridor and precinct-level masterplans. When this occurs, the PRCG should take the opportunity to provide input and advocate for action, including specific site-based details of what is necessary to achieve a swimmable river.

There are three specific and immediate opportunities to collaborate with DPIE to support the PRCG masterplan. First, DPIE are proposing to review the NSW Water Quality Objectives. The PRCG should work with DPIE on this review, to ensure that updated objectives for the Parramatta River reflect the work undertaken by the PRCG to understand community values, collect waterway health data and assess potential strategies to improve waterway health. Second, DPIE have proposed to apply their Risk-based Framework for waterway health using Parramatta River as a case study. The PRCG should work with DPIE on this to advance their mission to make Parramatta River swimmable again by 2025 and broadly to advocate for living rivers. Third, DPIE has indicated the NSW Diffuse Source Water Pollution Strategy (DECC 2009) is being refreshed. Given the impact of diffuse stormwater pollution in the catchment and on the river, the PRCG should be involved and advocate for relevant policy, regulatory and other reforms.

6.6.2 Advocate for stronger consideration of blue-green infrastructure objectives in all assessment pathways

There are several pathways for development planning and assessment in NSW that depend on the type, scale and nature of development. This can range from exempt and complying development, local development (largely the domain of local councils) and regional to state development (assessed by planning bodies established under the *Environmental Planning and Assessment Act* 1979). Environmental planning instruments, such as SEPPs and LEPs, and local policies, such as council DCPs, are key to the decision-making process but do not always provide the clarity for applicants nor the determining authority.

To drive better WSUD outcomes, provide certainty to developers on what is required and consistency for planners as to what to conditionally approve, a detailed State level policy, such as an Environmental Planning Instrument (EPI) is needed. This can be designed for local to state significant projects (as would be defined under the Infrastructure SEPP and the State and Regional Development SEPP). To support greater certainty, we recommend that new green-blue policies should incorporate numerical standards where possible (e.g. percentage of landscaped area, development setbacks to watercourses, targets for runoff and pollutant load reduction) and design criteria (e.g. acceptable methodologies which could include references to appropriate design guidelines). This would reduce discretion at the assessment stage and reliance on conditions of approval to achieve desired outcomes.

The PRCG can advocate to DPIE to make changes to specific local planning templates and codes to include improved blue-green infrastructure considerations in line with

the directions established in the District Plans and in the Parramatta River Masterplan. Options include:

1. A new Ministerial Direction requiring consideration of blue-green infrastructure in Planning Proposals, listing relevant considerations (see below).
2. An updated template for Secretary's Environmental Assessment Requirements (SEARs) for projects assessed under Part 5 of the *Environmental Planning and Assessment Act 1979* (NSW).
3. Review existing standard requirements for the management of water quality and quantity and strengthen where possible.
4. Inclusion of improved blue-green infrastructure requirements in the SEPP Exempt and Complying Development Codes. This should include revision of existing provisions in the Codes SEPP, to ensure there is adequate space for blue-green infrastructure in all development types.
5. Updating the water management guidance in the Apartment Design Guide (NSW Department of Planning and Environment 2015)

The objectives established in Section 2 and the strategies recommended in Sections 4 and 5 of this report can form the basis for new local planning templates and codes, however where these are to apply state-wide, DPIE will need to consider the implications beyond the Parramatta River catchment.

The idea of a new Ministerial Direction for blue-green infrastructure was discussed with DPIE and other stakeholders during the development of this paper. This option has several issues which require further consideration. For example, most Planning Proposals are for small sites and generally directed at changing height, density, and zoning controls. While proponents can be directed to consider relevant policies or design guidelines, the assessment process does not typically consider detailed requirements such as blue-green infrastructure provisions, and such provisions may be seen as introducing additional unwarranted regulation.

At the other end of the development spectrum, a precinct-wide Planning Proposal would be expected to consider blue-green infrastructure, and this would follow through to the assessment process. However, if the Ministerial Direction is too broad (that is the blue-green infrastructure is to be considered but with little instruction), it will also only be given broad consideration and may not materially result in outcomes that support the improvement of the catchment.

The existing Ministerial Direction for Flood Prone Land was seen as a good example, where the Direction simply refers to the Floodplain Development Manual, and the Manual includes more detailed guidance. This could be a template for blue-green infrastructure in the future. A guideline or manual could provide strategic water management considerations (including high-level WSUD considerations, waterway and riparian land protection, and IWCM outcomes), for development at different scales. This could form the basis for a Ministerial Direction for the Parramatta River catchment.

Whether the planning mechanism is a Ministerial Direction, SEARs or a SEPP, there is a need to consider how these would be supported by more detailed guidelines. There are some existing guidelines available for specific situations (e.g. RMS (2017) WSUD guideline "Applying water sensitive urban design principles to NSW transport projects"). State government could refer to local government guidelines where they exist (e.g. Blacktown Council's online developers' toolkit for WSUD). However, there are significant gaps in existing guidelines. Addressing this gap is discussed below, in Section 6.6.5.

6.6.3 Advocate to state agencies who lead infrastructure projects

Major infrastructure projects (e.g. roads, rail and other transport infrastructure, hospitals, schools, buildings for other government services) are often led by State agencies. PRCG could work with these agencies to advocate for better blue-green infrastructure outcomes in these projects. This could focus on:

- Review and improvement of State agencies' internal policies for blue-green infrastructure in their projects.
- Review and improvement of assessment pathways for these projects.
- Specific projects in the Parramatta River catchment – consider creative, collaborative methods to deliver better outcomes.

6.6.4 Advocate for new or improved SEPPs

Catchment management groups have often advocated for a new SEPP that would strengthen the requirements on new development to manage diffuse stormwater pollution. As more and more local councils have incorporated similar stormwater quality targets in their DCPs, a State-based instrument has seemed like the next logical step.

The BASIX SEPP provides a good precedent where a similar issue has been managed with a SEPP. Local council requirements for water conservation in residential

development have been replaced by the BASIX SEPP, which has standardised the approach, while still allowing for local variation of the target. BASIX has simplified the development assessment process and improved compliance, and monitoring of post-BASIX developments has shown that water use consumption has dropped in line with the targets (Sydney Water 2012).

The BASIX SEPP could be revised to include objectives beyond water conservation, including the objective to reduce runoff. Currently, the water savings target in BASIX may perversely discourage large pervious areas, particularly irrigated areas on housing lots, to avoid the need for alternative water sources (such as rainwater or stormwater) for garden watering. If a target for a reduction in stormwater-runoff-volume per lot was introduced into BASIX, it would enable some informed policy choices for governments (local and state). BASIX settings could be 'tuned' to local policy priorities. For example, pervious, landscaped area on a residential lot could be assigned a higher priority than potable water savings, in the Parramatta River catchment.

Extending the BASIX tool to diffuse stormwater pollution would require many of the same data inputs, and the rainwater tank module in BASIX would be a useful starting point for measuring a reduction in stormwater runoff. Additional data inputs and calculations would be needed to account for green infrastructure, infiltration, evaporation and stormwater treatment. The BASIX tool could ultimately incorporate the whole Blue-Green Index, and could even be extended to cover urban heat mitigation, which has connections with the management of both water and energy at the design stage of a development.

It has also been suggested that the BASIX SEPP may be revised and wrapped into the proposed new Design and Place SEPP, which has broader aims to improve green infrastructure. At this stage, the exact scope of the Design and Place SEPP remains uncertain. The Explanation of Intended Effect for this SEPP is due for release in early 2021.

Protection and improvement of urban waterways and riparian land could also be incorporated into a SEPP, for example the proposed Water Catchments SEPP. DPIE has noted that the new Water Catchments SEPP will contain generic provisions suitable for the protection of water quality and other environmental assets across mapped catchments. It will also provide place-based provisions, e.g., for Sydney Drinking Water Catchment, the Sydney Harbour Foreshores and Waterways Area and Hawkesbury Nepean Environment conservation area sub-catchments. Several of the environmental planning instruments it is proposing to replace are map-based, with layers covering urban bushland, habitat, coastal wetlands and foreshore areas. To this end, waterways and riparian lands could potentially be added to this SEPP, using a mapping layer and place-based provisions as outlined in section 5. Many waterways extend across LGA boundaries, and therefore a SEPP could provide a consistent approach at a high level (while LEPs could still add local detail). However, DPIE has noted that at this stage, the Water Catchments SEPP will consolidate existing catchment environmental planning instruments only, and will not provide any new or strengthened provisions. Any new provisions could only be introduced as part of a future revision. The PRCG should continue to work with DPIE, and consider whether the Water Catchments SEPP could play a future role in implementing either the Blue-Green Index or the Blue-Green Grid.

The Coastal Management SEPP is one other potential avenue for protection of waterways and riparian land. The current function of this SEPP is that it only applies to coastal lands in four defined categories. This covers the Parramatta River estuary and foreshore area but does not apply to freshwater tributaries of the river, thus limiting its geographic extent. However, extending the Coastal Management SEPP's geographical application to extend further than the four coastal zone categories to include freshwater tributaries of the river would potentially require an amendment to the definition in the Coastal Management Act.

State agencies are currently developing a Coastal Management Program for Sydney Harbour, which will renew the focus on catchment management. This has the potential to integrate a new policy framework that could be implemented at the catchment scale. The PRCG is collaborating with the team developing the Greater Sydney Harbour Coastal Management Program.

Development of a new or modified SEPP must be driven by state government and most likely would need to be have a focus broader than any individual catchment, such as the Parramatta River. In this context, SEPP reform is a long-term goal and collaborative objective.

6.6.5 Support the development of new guidelines

It was highlighted in Section 6.6.2 that planning provisions work most effectively when supported by guidelines. This enables planning provisions to offer clear principles, objectives and targets that in turn are assisted by more detailed design guidance. As evidenced by Planning for Bushfire Protection guideline (NSW Rural Fire Service 2019) these can be updated as required to reflect best practice and these revisions are not subject to the regulatory processes affecting amendments to environmental planning instruments set by the *Environmental Planning and Assessment Act 1979*.

Several of the new or revised SEPPs noted in Section 6.6.4 will be accompanied by design guidelines. For example, the objectives of the Coastal Management Act and SEPP will be complemented by revised Coastal Design Guidelines.

The PRCG should seek to work with DPIE as these guidelines are developed, and consider how design guidance for blue-green infrastructure, relevant to the Parramatta River catchment, could either be included in the above guidelines, or covered in an additional guideline.

6.6.6 Advocate for other environmental policy reform

The *Water Management Act NSW 2000* is another legal approach to support the goals of the Parramatta River Masterplan. The *Water Management Act 2000*, as discussed in Section 5, places restrictions on development in "waterfront land" including land within 40m of any "river" (where the definition of a river is broad enough to include minor, ephemeral water courses and piped streams in urban areas). The application of the *Water Management Act 2000* in Sydney's urban areas is guided by the "Guidelines for riparian corridors on waterfront land" (NSW DPI Office of Water 2012). However, as also discussed in Section 5, these guidelines were written at a time when most of Sydney's new development was in greenfield areas, and they are less relevant to infill development, particularly in highly urbanised areas where waterways are degraded, channelised and piped. Updated guidelines from the NSW Office of Water could assist with the application of the Act in how it protects and otherwise address degraded urban streams.

Presently, the *Water Management Act 2000* has also proved to be a barrier to urban stormwater harvesting in Sydney. McAuley and Knights (2013) point out how stormwater harvesting in urban areas has been restricted by access to extraction licences. New extraction licenses are effectively impossible to obtain, even though urban streams are affected by an excess of stormwater flows rather than being affected by over-extraction. A change to this policy could facilitate more widespread urban stormwater harvesting, and it could be facilitated in a way that prioritises stream health outcomes.

6.6.7 Investigate a catchment wide scheme for stormwater quality offsets or in-lieu contributions

Stormwater quality offsets or in-lieu contribution schemes is discussed in Section 6.3.2 as a potential financing mechanism for stormwater quality treatment. This does not necessarily require new or modified policy at State level. For example, Blacktown Council has established an offset scheme based on section 7-11 (formerly section 94) of the *Environmental Planning and Assessment Act 1979*. However, it is worth investigating whether existing policy could support an improved scheme, including the ability to collect and save funds for life-cycle costs, and the ability to operate at a catchment scale. This brings in significant potential legislative, governance and administration complexities, all of which will require further detailed consideration. The Productivity Commission's review of infrastructure contributions (NSW Productivity Commission 2020) is also relevant here.

7 NEXT STEPS

Over the next 1-5 years, the PRCG can progress each of the key recommendations in this paper

The following sections recap the next steps recommended in this paper, to:

- Support councils to update LEPs and DCPs in the short-term
- Progress the development of the Blue-Green Index and the Blue-Green Grid
- Continue to advocate for policy reform at State level.

A summary of specific actions recommended in this paper is included in Table 13.

7.1 Short-term: Support councils updating LEPs and DCPs

This recommendations paper has provided a set of model LEP and DCP clauses in Appendix A, and explained the rationale behind them in Section 3. These would be appropriate for the next round of LEP and DCP updates – they do not address all of the issues raised in the Standardising the Standards Discussion Paper (McAuley and Davies 2020) but they provide a pragmatic way forward that is moving in the right direction.

Each of the PRCG member councils may benefit from additional support to adapt these recommended clauses for local use, and resolve questions that arise for their particular LGA. Each LGA has different physical characteristics, different catchments to consider beyond the Parramatta River catchment, and different community objectives, political and organisational pressures that will shape their LEP and DCP. The nature of the recommendations is that they touch on broad issues, particularly in the landscape domain, and need to be considered in context with other objectives that each council is trying to achieve with its LEP and DCP.

After LEPs and DCPs have been updated, a review is recommended, both to review the content that has been included in updated documents, and to survey council staff for their reflections as to the effectiveness of the current planning approaches. For example: Were the recommendations helpful? What were the challenges they faced? What could be improved next time?

7.2 Longer-term: Develop the Blue-Green Index and Blue-Green Grid

While these new frameworks are identified as longer-term pathways for policy reform, work should start now on developing each of them.

To develop the Blue-Green Index and Blue-Green Grid, it is recommended that the PRCG should take a leading role, with increasing input from local councils as each is developed in more detail. The recommendation is to start with a small working group and then gradually include wider engagement with the PRCG's member Councils.

Continued involvement of State agencies, as the Blue-Green Index and Blue-Green Grid are developed, will also help ensure that these remain consistent with State government directions and in a position to gain State-level support for implementation.

Development of both the Blue-Green Index and Blue-Green Grid should take a staged approach. Both need ample opportunity for review and refinement as they are developed.

7.3 Continue to work with State agencies

There are currently significant policy reforms underway at State level, including new and revised policies, strategic plans, SEPPs and guidelines with relevance to the Parramatta River catchment and particularly to Step 4 of the Masterplan. Therefore, it is recommended that the PRCG continue to work with state agencies to provide inputs into these. Specific actions are listed in Table 13.

This recommendations paper has also identified other actions that will require collaboration with State agencies, including actions to strengthen financing mechanisms for blue-green infrastructure, and other potential avenues for policy reform at State level. Again, specific actions are listed in Table 13.

Table 13: Summary of recommendations and specific actions

Stages	The opportunity	The recommendations	Implementation	
SHORT-TERM UPDATES (Councils to implement over next 1-3 years) **Simple updates to LEP and DCP controls**	Minor changes to Local Environmental Plans (LEPs) and Development Control Plans (DCPs) can improve existing and add new provisions to ensure that development does more to reduce stormwater pollution and foster healthy ecosystems.	**Strengthen the wording in LEPs and DCPs.** This should be directed to improve outcomes for the Parramatta River and its catchment. Specific recommendations have been made for changing current LEPs and DCPs, reflecting the seven strategies identified above. Suggested wording is also provided. It is up to each council to consider these recommendations in balance with other local planning objectives, and to determine how best to implement them locally.	LEPs are updated via a Planning Proposal, prepared by local government and reviewed by the NSW Department of Planning, Industry and Environment (DPIE). The NSW Parliamentary Counsel's Office completes the final wording of the instrument. DCPs are updated by local councils. The PRCG can provide support.	
		Specific actions	**Responsibility**	**Timing**
		Update LEPs to strengthen aims of plan, zoning provisions and local provisions relating to: • Landscaped areas • Stormwater management and WSUD • Waterways and riparian land • Foreshore development	All PRCG member councils	2021-23
		Comprehensive update of DCPs to strengthen provisions for: • Landscaped areas • Deep soils • Trees • Native vegetation • Rainwater harvesting • Stormwater quantity • Stormwater quality • Riparian vegetation • Overland flowpaths • Vegetated stormwater treatment systems	All PRCG member councils	2021-23
		Update relevant design guidance, technical specifications, and standard drawings, to support new/updated DCP provisions	All PRCG member councils	2021-23

Stages	The opportunity	The recommendations	Implementation	
LONGER TERM, MORE SUBSTANTIAL REFORMS (PRCG to lead over next 1-5 years) **Develop, pilot and locally adopt new frameworks: a Blue-Green Index and a Blue-Green Grid**	New planning policy approaches are needed to address current and projected pressures related to development in the catchment. Major systemic changes are required to deliver blue-green infrastructure to meet waterway health and liveability goals. This is particularly for infill development that under current approaches will reduce deep soil and increase impervious areas. Modelling undertaken for the 2018 Masterplan showed that existing initiatives to improve water quality would result in only minor, localised water quality improvements in the Parramatta River.	**Develop, pilot and locally adopt new frameworks** for improving water quality and waterway health for new development: A **Blue-Green Index.** This would be a performance-based tool, incorporating multiple objectives into a scoring system to rate the water and landscape inputs. It would be designed to meet the needs of developers (clarity and certainty in the objectives and targets, with flexibility in specific design solutions) and planners (ease of use and policy alignment, with clear outcomes). It would be evidence-based and vertically aligned to state policies and plans to support water sensitive urban design and landscape outcomes. **A Blue-Green Grid.** This would be a new framework for classifying waterways and mapping riparian zones for land use planning purposes. New approaches are needed to protect, restore and support water quality, waterway health and ecological outcomes and community access along key waterway corridors. The creation of a Blue-Green Grid aligns and builds on existing state government green grid guidelines and riparian policies. For the Parramatta River catchment, it would be tailored to respond to specific pressures, conditions and potential restoration opportunities.	The PRCG should lead the development of both these frameworks. Development of the Blue-Green Index can commence with a pilot involving a small number of councils. It would benefit from collaboration with other agencies working in green infrastructure implementation. For the Blue-Green Grid, initial mapping of waterways and riparian zones across the catchment is partially complete and can be finalised rapidly. These supporting policy approaches would need to be developed in conjunction with councils and the state planning and water agencies.	
		Specific actions to develop the Blue-Green Index	**Responsibility**	**Timing**
		Establish a working group including members from PRCG and selected council representatives	PRCG	2020
		Develop an initial pilot version of the tool	PRCG + working group	2021
		Test the pilot among PRCG councils	PRCG + member councils	2022
		Develop a public facing Blue Green Index tool	PRCG + member councils	2023
		Staged local implementation	All PRCG member councils	2023-25
		Explore potential inclusion in a state environmental planning instrument	PRCG + NSW Government	2021-25
		Specific actions to develop the Blue-Green Grid	**Responsibility**	**Timing**
		Establish a working group including members from PRCG and selected council representatives	PRCG	2020
		Refine the waterway categories and objectives	PRCG + working group	2021
		Waterway and riparian area mapping, including: 1. Identify and categorise waterway reaches, catchment-wide 2. Refine the categorisation of waterway reaches based on local data 3. Add planning layers and identify where there is potential for waterway and riparian restoration 4. Define extent of proposed riparian zones and identify specific objectives that apply within each zone 5. Field validation and ongoing review	PRCG + member councils	2021-25
		Update LEPs	All PRCG member councils	2023-25
		Update DCPs	All PRCG member councils	2023-25

Stages	The opportunity	The recommendations	Implementation	
SUPPORTING ACTIONS: SHORT- AND LONG-TERM (PRCG to work with DPIE over next 1-5+ years) **Strengthen and support local reforms, including revisions to State policies**	Ensure water quality and waterway health are considered in all planning and approval pathways, beginning as early as possible in the process. This will require broader reform, beyond local government.	**Rebuild the business case for blue-green infrastructure**. Blue-green infrastructure can support a productive, liveable and sustainable development and places across the catchment. The business case should extend to public and private domains and apply to stakeholders across the life-cycle stages, including how funding is to be provided. **Implement State-level policy reforms.** A liveable river will require a transformation in policy and practice. To ensure blue-green infrastructure can achieve its objectives, change is needed across planning and approval pathways.	This will require collaboration and coordination within and between catchment councils and state government. New frameworks (above) should assist with this process, but will need further planning and design input and research, including technical input (to build the evidence base) and economic (to build the business case).	
		Specific actions	Responsibility	Timing
		Develop a business case for blue-green infrastructure policy reforms	PRCG	2022-23
		Explore options to strengthen financing mechanisms for blue-green infrastructure in new development, including: • Developer contributions • In-lieu contributions • Ongoing (i.e. ratepayer) contributions	PRCG + NSW Government	2023-25
		Provide input to relevant state-led policies and strategic plans such as: • Review of the NSW Water Quality Objectives • Development of a Parramatta River case study to demonstrate the application of the Risk-based Framework • Review of the NSW Diffuse Source Water Pollution Strategy • Greater Sydney Harbour Coastal Management Program	PRCG + NSW Government	2020-23
		Provide input to upcoming revisions to State Environmental Planning Policies, including: • Potential revision of the BASIX SEPP • New Design and Place SEPP • New Water Catchments SEPP	PRCG + NSW Government	2020-23
		Provide input to new guidelines being developed by state government, including: • Coastal design guidelines • Design guidelines to support the Water Catchments SEPP • Design guidelines/specifications/rating schemes to support the Design and Place SEPP	PRCG + NSW Government	2020-23
		Advocate for further policy reforms, including: • Stronger consideration of blue-green infrastructure objectives in all assessment pathways • Improvement of State agencies' internal policies for blue-green infrastructure in their projects • Potential changes to the *Water Management Act*	PRCG + NSW Government	2020-25+
		Monitor policy and environmental outcomes	PRCG	2020-ongoing

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APPENDIX A: MODEL CLAUSES

LEP clauses

Zoning provisions

Table 14 reviews the provisions in the LEP Standard Instrument for zones W1, W2, E1, E2, E3, RE1, RE2 – these zones cover many of the waterways in the Parramatta River catchment. The final column makes recommendations on additional objectives that should be considered for each of these zones.

Table 14: Potential additions to standard zone provisions for waterway and environmental zones

Zone	Current application in the catchment	Current Standard Instrument		Recommendations: additional objectives
W1	Several of the Parramatta River's major tributaries including Subiaco Creek, Vineyard Creek, Toongabbie Creek, Duck River and Lake Parramatta.	1 Objectives of zone • To protect the ecological and scenic values of natural waterways. • To prevent development that would have an adverse effect on the natural values of waterways in this zone. • To provide for sustainable fishing industries and recreational fishing.	2 Permitted without consent Nil 3 Permitted with consent Aquaculture 4 Prohibited Business premises; Hotel or motel accommodation; Industries; Multi dwelling housing; Recreation facilities (major); Residential flat buildings; Restricted premises; Retail premises; Seniors housing; Service stations; Warehouse or distribution centres; Any other development not specified in item 2 or 3 Additional direction: The following must be included as either "Permitted without consent" or "Permitted with consent" for this zone: Environmental facilities Environmental protection works	Objectives should extend from just 'protect' to 'protect and enhance' (as per alignment with the text in the aims of the plan). Additional objectives could also better reflect the values of waterways under this zone in the Parramatta River catchment: • To improve/enhance waterway health • To protect cultural and scientific values • To provide opportunities for nature-based recreation and connection with nature
W2	A reach of Parramatta River between the Parramatta CBD and Melrose Park	1 Objectives of zone • To protect the ecological, scenic and recreation values of recreational waterways. • To allow for water-based recreation and related uses. • To provide for sustainable fishing industries and recreational fishing.	2 Permitted without consent Nil 3 Permitted with consent Aquaculture; Kiosks; Marinas 4 Prohibited Industries; Multi dwelling housing; Residential flat buildings; Seniors housing; Warehouse or distribution	As above, objectives should extend from just 'protect' to 'protect and enhance' (as per alignment with the text in the aims of the plan). Additional objectives could also better reflect the values of waterways under this zone in the Parramatta River catchment: • To improve/enhance waterway health • To protect cultural and scientific values

Zone	Current application in the catchment	Current Standard Instrument		Recommendations: additional objectives
			centres; Any other development not specified in item 2 or 3 Additional direction: The following must be included as either "Permitted without consent" or "Permitted with consent" for this zone: Boat sheds Environmental facilities Environmental protection works Water recreation structures	
E1	Specific areas within Sydney Olympic Park and within Parramatta River Regional Park	1 Objectives of zone • To enable the management and appropriate use of land that is reserved under the *National Parks and Wildlife Act 1974* or that is acquired under Part 11 of that Act. • To enable uses authorised under the *National Parks and Wildlife Act 1974*. • To identify land that is to be reserved under the *National Parks and Wildlife Act 1974* and to protect the environmental significance of that land.	2 Permitted without consent Uses authorised under the *National Parks and Wildlife Act 1974* 3 Permitted with consent Nil 4 Prohibited Any development not specified in item 2 or 3	No changes. The objectives are straightforward and as the zone prohibits essentially all development, there is no need for more specific objectives.
E2	Many bushland areas within the catchment are zoned E2, including at Sydney Olympic Park, areas around Lake Parramatta, upper reaches of Darling Mills Creek, along parts of Toongabbie Cree and in smaller patches along other creeks	1 Objectives of zone • To protect, manage and restore areas of high ecological, scientific, cultural or aesthetic values. • To prevent development that could destroy, damage or otherwise have an adverse effect on those values.	2 Permitted without consent Nil 3 Permitted with consent Oyster aquaculture 4 Prohibited Business premises; Hotel or motel accommodation; Industries; Multi dwelling housing; Pond-based aquaculture; Recreation facilities (major); Residential flat buildings; Restricted premises; Retail premises; Seniors housing; Service stations; Tank-based aquaculture; Warehouse or distribution centres; Any other development not specified in item 2 or 3 Additional direction: The following must be included as either "Permitted without consent" or "Permitted with consent" for this zone:	No changes. The objectives are straightforward and as the zone prohibits essentially all development, there is no need for more specific objectives.

Zone	Current application in the catchment	Current Standard Instrument		Recommendations: additional objectives
			Environmental protection works	
E3	Some areas at Sydney Olympic Park	1 Objectives of zone • To protect, manage and restore areas with special ecological, scientific, cultural or aesthetic values. • To provide for a limited range of development that does not have an adverse effect on those values.	2 Permitted without consent Home occupations 3 Permitted with consent Dwelling houses; Oyster aquaculture; Pond-based aquaculture; Tank-based aquaculture 4 Prohibited Industries; Multi dwelling housing; Residential flat buildings; Retail premises; Seniors housing; Service stations; Warehouse or distribution centres; Any other development not specified in item 2 or 3 Additional direction: The following must be included as either "Permitted without consent" or "Permitted with consent" for this zone: Environmental protection works Roads Home industries, kiosks, cellar door premises, neighbourhood shops and roadside stalls may (but need not) be included as permitted with consent.	This zone permits more development than other waterway or environmental zones, and therefore there may be a case for strengthening the objectives. A water quality objective could be included: • To minimise impacts on the water cycle, including runoff quantity and quality
RE1	Most of the parks are zoned RE1, including many riverside and foreshore parks	1 Objectives of zone • To enable land to be used for public open space or recreational purposes. • To provide a range of recreational settings and activities and compatible land uses. • To protect and enhance the natural environment for recreational purposes.	2 Permitted without consent Nil 3 Permitted with consent Aquaculture; Kiosks; Recreation areas 4 Prohibited Any development not specified in item 2 or 3	As this zone includes many waterways, consider adding an objective focused on protection and restoration of waterways and riparian lands: • To protect and restore waterways and riparian lands and ensure recreational use minimises impacts on the natural environment
RE2	Many golf courses are zoned RE2	1 Objectives of zone • To enable land to be used for private open space or recreational purposes. • To provide a range of recreational settings and activities and compatible land uses. • To protect and enhance the natural environment for recreational purposes.	2 Permitted without consent Nil 3 Permitted with consent Aquaculture; Community facilities; Kiosks; Recreation areas; Recreation facilities (indoor); Recreation facilities (outdoor) 4 Prohibited	This zone allows a greater range of development with potential impacts on the water cycle. Consider additional objectives focused on waterways and stormwater pollution: • To protect and restore waterways and riparian lands and ensure recreational use minimises impacts on the natural environment • To minimise impacts on the water cycle, including runoff quantity and quality

Local provisions

The following sections include model clauses for the following local provisions:

- Landscaped areas
- Stormwater management and Water Sensitive Urban Design
- Waterways and riparian land
- Foreshore area development

Landscaped areas

This model provision is based on the Sutherland Council (2015) LEP:

(1) The objectives of this clause are as follows—

(a) to ensure adequate opportunities exist for the retention or provision of vegetation that contributes to biodiversity and, in the case of trees, enhances the tree canopy
(b) to minimise urban run-off by maximising permeable areas on the sites of development
(c) to ensure that the visual impact of development is minimised by appropriate landscaping and that the landscaping is maintained
(d) to ensure that landscaping carried out in connection with development is sufficient to complement the scale of buildings, provide shade, screen parking areas and enhance workforce amenities.

(2) This clause applies to land in the following zones—

(a) Zone R1 General Residential
(b) Zone R2 Low Density Residential
(c) Zone R3 Medium Density Residential
(d) Zone R4 High Density Residential
(e) Zone B1 Neighbourhood Centre
(f) Zone B2 Local Centre
(g) Zone B3 Commercial Core
(h) Zone B4 Mixed Use
(i) Zone B5 Business Development
(j) Zone B6 Enterprise Corridor
(k) Zone B7 Business Park
(l) Zone B8 Metropolitan Centre
(m) Zone IN1 General Industrial
(n) Zone IN2 Light Industrial
(o) Zone IN3 Heavy Industrial
(p) Zone E3 Environmental Management

(3) On land to which this clause applies, the minimum percentage of the site area that is to consist of landscaped areas is the percentage shown on the Landscape Area Map in relation to that land.

(4) The minimum landscaped area for any lot of land to which this clause applies created by the subdivision of a lot containing a dual occupancy is the percentage shown on the Landscape Area Map in relation to the land.

(5) Subclause (4) does not apply to a subdivision of land under the *Community Land Development Act 1989* or the *Strata Schemes (Freehold Development) Act 1973*.

(6) The following are taken to be excluded from the site area for the purposes of this clause—

(a) land on which the development is prohibited under this Plan
(b) in the case of an internal lot—
(i) any access corridor to or from the lot, and
(ii) any right of way that traverses another lot.

Stormwater Management and Water Sensitive Urban Design

This model provision is draws on existing precedents, but the wording has been substantially modified for consistency with the Parramatta River Masterplan and the objectives defined in Section 2 of this recommendations paper:

(1) The objectives of this clause are as follows:

(a) to minimise the adverse impacts of stormwater runoff and diffuse stormwater pollution downstream of new development
(b) to ensure that development on properties adjoining bushland, riparian land or other areas of native vegetation is designed to minimise the impacts of stormwater runoff into those areas
(c) to ensure that new development contributes to achieving the NSW Water Quality Objectives
(d) to improve the health of the Parramatta River [and any others relevant to the specific LGA]
(e) to protect and enhance the values of all waterways in the Parramatta River catchment [and any others relevant to the specific LGA].

(2) This clause applies to all land in residential, business, industrial, special uses, recreation and environmental protection zones.

(3) Development consent must not be granted to development on any land unless the consent authority is satisfied that the development:

(a) is designed to maximise pervious surfaces and vegetation coverage
(b) is designed to reduce the quantity (volume) of stormwater discharged from the land, including:
  (i) maximising the harvesting and use of rainwater and/or stormwater for appropriate non-potable end uses, reducing the quantity of runoff
  (ii) maximising infiltration and evapotranspiration, having regard to the soil characteristics affecting on-site infiltration of water
  (iii) meeting the following Stormwater Runoff Reduction Targets: [to be specified]
(c) is designed to avoid, mitigate or offset stormwater quality impacts, including meeting the following Stormwater Quality Targets: [to be specified]
(d) will avoid, mitigate or offset any adverse impacts of stormwater runoff on adjoining properties, native bushland, waterways and groundwater systems
(e) is designed in keeping with the principles of water sensitive urban design.

(3) For the purposes of subclause (3)(e), the water sensitive urban design principles are—

(a) minimising demand on Sydney's centralised water supply system
(b) minimising wastewater discharge
(c) minimising stormwater runoff
(d) improving the quality of remaining stormwater runoff to a standard suitable to meet downstream water quality objectives
(e) minimising harmful impacts of urban development on surface and groundwater flow regimes
(f) protecting and enhancing natural waterways
(g) integration of stormwater management systems into the landscape in a manner that provides multiple benefits, including water quality protection, stormwater retention and detention, enhancement of ecological processes, habitat and biodiversity, urban heat mitigation, recreational value and visual amenity.

Waterways and Riparian Land

This model provision will need to be modified to suit the current state of mapping data available to support its implementation. However, even if the only available data is the NSW Government's Hydroline dataset, this provision could be implemented as written, simply deleting clause (2)(c).

(1) The objectives of this clause are as follows—

(a) to protect or improve—
  (i) water quality within waterways, and
  (ii) the stability of the bed and banks of waterways, and
  (iii) aquatic and riparian species, communities, populations and habitats, and
  (iv) ecological processes within waterways and riparian lands, and
  (v) scenic, recreational and cultural heritage values of waterways and riparian lands,
(b) where practicable, to provide for the rehabilitation of existing piped or channelised waterways to a more natural state,
(c) where practicable, to provide for improved habitat connectivity along riparian corridors.
(d) Where practicable, to provide for improved green grid (active transport and recreation) links along riparian corridors, having regard to protection of high-value vegetation, including endangered ecological communities that occur within these corridors.

(2) This clause applies to riparian land. Riparian land is identified by the presence of a waterway, where the presence of a waterway is either—

(a) Identified in the NSW Government Hydroline dataset
(b) Identified via physical features that are consistent with the definition of a "river" within the *Water Management Act* NSW 2000
(c) [if/when available, waterways and riparian land could also be identified via a mapping layer prepared by the local council as part of the LEP].

"Riparian Land" is defined according to the Strahler stream order, and measured from the top of bank on either side of the waterway. The width of the riparian corridor, on either side of the waterway, is as follows:

Stream order	Riparian land width (either side of the waterway, measured from top of bank)
1st	10m
2nd	20m
3rd	30m
4th	40m

Note. Some development types within 40 metres of a waterway will still require referral to the NSW Office of Water as integrated development.

(3) In deciding whether to grant development consent for development on land to which this clause applies, the consent authority must consider—

(a) whether the development is likely to have an adverse impact on the following—
  (i) the water quality in any waterway,
  (ii) the natural flow regime, including groundwater flows to any waterway,
  (iii) aquatic and riparian species, populations, communities, habitats and ecosystems,
  (iv) the stability of the bed, shore and banks of any waterway,
  (v) the free passage of native aquatic and terrestrial organisms within or along any waterway and riparian land,
  (vi) public access to, and use of, any public waterway and its foreshores,
(b) any opportunities for rehabilitation or re-creation of any waterway and its riparian areas,
(c) any appropriate measures proposed to avoid, minimise or mitigate the impacts of the development.

(4) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that the development—

(a) is consistent with the objectives of this clause, and
(b) integrates riparian, stormwater and flooding measures, and
(c) is designed, sited and will be managed to avoid any potential adverse environmental impacts, and
(d) if a potential adverse environmental impact cannot be avoided by adopting feasible alternatives—the development minimises or mitigates any such impact to a satisfactory extent.

Foreshore area development

This model clause is based on Canada Bay's current LEP (2013):

(1) The objective of this clause is to ensure that development in the foreshore area will not impact on natural foreshore processes or affect the significance and amenity of the area.

(2) Development consent must not be granted for development on land in the foreshore area except for the following purposes—

(a) the extension, alteration or rebuilding of an existing building wholly or partly in the foreshore area,
(b) the erection of a building in the foreshore area, if the levels, depth or other exceptional features of the site make it appropriate to do so,
(c) boat sheds, sea retaining walls, wharves, slipways, jetties, waterway access stairs, swimming pools, fences, cycleways, walking trails, picnic facilities or other recreation facilities (outdoors).

(3) Development consent must not be granted under subclause (2) unless the consent authority is satisfied that—

(a) the development will contribute to achieving the objectives for the zone in which the land is located, and
(b) the appearance of any proposed structure, from both the waterway and adjacent foreshore areas, will be compatible with the surrounding area, and
(c) the development will not cause environmental harm such as—
  (i) pollution or siltation of the waterway, or
  (ii) an adverse effect on surrounding uses, marine habitat, wetland areas, fauna and flora habitats, or
  (iii) an adverse effect on drainage patterns, and
(d) the development will not cause congestion or generate conflict between people using open space areas or the waterway, and
(e) opportunities to provide continuous public access along the foreshore and to the waterway will not be compromised, and
(f) any historic, scientific, cultural, social, archaeological, architectural, natural or aesthetic significance of the land on which the development is to be carried out and of surrounding land will be maintained, and
(g) in the case of development for the alteration or rebuilding of an existing building wholly or partly in the foreshore area, the alteration or rebuilding will not have an adverse impact on the amenity or aesthetic appearance of the foreshore, and

(h) sea level rise or change of flooding patterns as a result of climate change has been considered.

(4) In deciding whether to grant consent for development in the foreshore area, the consent authority must consider whether and to what extent the development would encourage the following—

(a) continuous public access to and along the foreshore through or adjacent to the proposed development,
(b) public access to link with existing or proposed open space,
(c) public access to be secured by appropriate covenants, agreements or other instruments registered on the title to land,
(d) public access to be located above mean high water mark,
(e) the reinforcing of the foreshore character and respect for existing environmental conditions.

(5) In this clause—

foreshore area means the land between the foreshore building line and the mean high water mark of the nearest natural waterbody shown on the Foreshore Building Line Map.

foreshore building line means—

(a) the line that is landward of, and at the distance specified on the Foreshore Building Line Map from, the mean high-water mark of the nearest natural waterbody shown on that map, or
(b) if no distance is specified, the line shown as the foreshore building line on that map.

DCP provisions

The following sections include a basic set of example provisions that can be used as a starting point to develop DCP provisions that are consistent with the goals of the Parramatta River Masterplan and the objectives in Section 2 of this recommendations paper. Each council will need to consider their local needs, and will need to modify these examples to suit their local context.

Each example begins with a brief introduction in *italics* to explain what is included in the example and why. Also note that:

- Where quantitative targets are recommended, these examples show X, Y, Z in place of specific numbers. Appropriate targets will need to be determined by each council as they develop their DCP provisions.
- Text placed in [square brackets] represents an optional element, or a detail that needs to be considered in each DCP.

Landscape

Landscape provisions in DCPs are multi-objective, and therefore this section does not provide a complete set of model landscape provisions, but includes the elements that are important from a water management perspective. These elements should be integrated into the landscape section/s of the DCP.

Minimum landscaped area

Most DCPs already include minimum landscaped area targets, at least for some development types. Increasing these targets would be beneficial for the Parramatta River, but may be unrealistic. Therefore, the provisions suggested below provide some ideas that add additional requirements for the landscaped area, beyond a minimum size.

Landscaped area means a part of a site used for growing plants, grasses and trees, but does not include any building, structure or hard paved area.

The following minimum landscaped areas are to be provided in new development:

- [List development types and minimum percentages – these will need to be locally appropriate].

[OPTIONAL] The following specific parts of the site must include landscaped areas that meet particular requirements:

- [list any specific parts of the site where particular landscape requirements apply – e.g. the front setback, back yards, streetscapes. Include minimum percentages and/or dimensions].

The following areas can be counted towards the landscaped area:

- Existing vegetation to be retained, except for any vegetation that is protected under legislation or under any other part of this DCP (e.g. vegetation within EECs and/or riparian lands) (these areas can account for up to a maximum of X% of the total landscaped area)

- Areas vegetated with trees, shrubs, grasses, groundcovers
- Garden beds with annual plantings
- Turfed areas (up to a maximum of Y% of the total landscaped area)
- Green roofs (up to a maximum of Z% of the total landscaped area).

Pervious paving can be counted towards the landscaped area provided that:

- It is designed with a permeable soil layer below, so that water can effectively infiltrate
- It is situated within or adjacent to a planted area, so that any excess runoff drains into the pervious area
- A maximum of X% of the total landscape area requirement can be contributed by pervious paving (i.e. if the total landscaped area is Y%, then the limit is X% of Y% = (X x Y)% of the total site).

[OPTIONAL] A minimum of [X%] of the total landscape area requirement must be vegetated with locally native species, and needs to include canopy, mid and understorey plantings. Refer to [insert reference] for a list of appropriate locally native species.

Deep soils

Many DCPs already include provisions for deep soil zones, at least in medium/high density residential development where basements are common and landscaped areas are often built over underground structures. The following wording includes a definition of a deep soil zone and suggests some provisions beyond the minimum percentage of the site area. Minimum dimensions are recommended to ensure that any area counted as deep soil is capable of supporting trees.

Deep soil zone means a part of the site where there is natural ground with no obstructions above or below and a relatively natural soil profile. Deep soil zones need to support healthy growth of large trees and other vegetation, protect existing mature trees and allow infiltration of rainwater into the water table to reduce storm water runoff.

Deep soil zones cannot include:

- Any paved areas
- Any built structure above or below the surface
- An impermeable liner below the surface
- A clay capping layer below the surface (e.g. over a former landfill)

The deep soil zone can include imported fill or modified soils, providing that the imported or modified soil layer is underlain by natural soils and is capable of supporting healthy trees and other vegetation.

A deep soil zone can be underlain by natural bedrock, providing the bedrock is at least 1.0 m below the surface.

The following minimum deep soil areas are to be provided in new development:

- [List development types and minimum percentages – these will need to be locally appropriate]

Where possible, deep soil zones should be consolidated, contiguous and connected to other deep soil systems. The following minimum dimensions apply to deep soil zones:

- To be counted towards the site's deep soil area, any deep soil zone needs to have a minimum width of X m

[OPTIONAL] The following specific parts of the site must include deep soil zones that meet particular requirements:

- [list any specific parts of the site where particular deep soil requirements apply – e.g. the front setback, the back yard. Include minimum percentages and/or dimensions]

Trees

Most DCPs include existing provisions for tree preservation, and many also include requirements for trees to be planted in specific situations. For example, where development includes streetscape works, there are often well-defined requirements for street trees. Where there are requirements for deep soils, it is logical that there should also be a requirement to plant trees within deep soil zones. The Greenfield Housing Code (within the Codes SEPP) requires trees to be planted in the front and rear yard of new homes. Council DCPs could call for new trees in a wider range of development types. The provisions suggested below provide a template for stronger tree provisions, with some supporting information on soil areas and volumes to support trees of varying size. However, any council looking to strengthen these provisions will need to consider what is locally appropriate and develop a case for their proposed provisions. New requirements for trees are likely to face a high level of scrutiny.

Trees are required in new development to reduce stormwater runoff and contribute to canopy targets. Large, medium and small trees are defined in a separate tree species list [to be developed so that it can be referenced here].

New [residential/business/industrial] development needs to include the following minimum number of trees:

- [list development types and minimum number of large/medium/small trees according to site area – this will need to be locally appropriate and consistent with landscaped area and deep soil requirements elsewhere in the DCP].

Trees need to be included in the following specific locations:

- [list any specific locations where trees are required, and minimum numbers – e.g. front setback, back yard, streetscape, deep soil zone].

Where trees are removed (in accordance with tree preservation requirements listed elsewhere in this DCP [reference]), replacement trees are to be provided at the rate of:

- X small trees, Y medium trees or Z large trees for every small tree removed
- X small trees, Y medium trees or Z large trees for every medium tree removed
- X small trees, Y medium trees or Z large trees for every large tree removed.

Where it can be demonstrated that it is not possible to provide all the required trees within the development site, Council will consider an in-lieu contribution for tree planting within the public domain. This option is subject to negotiation with Council and can be applied to a maximum of X% of the total number of trees required.

Each tree required under this provision needs to be supported with an appropriate soil zone. These are listed in Table 15.

Table 15: Soil requirements for trees (based on City of Sydney 2016)

Mature size	Height	Canopy width	Soil volume per tree	Soil area – deep soils	Soil area on structure	Min. depth
Small	6-8m	4m	9m^3	2m x 2m	3.5m x 3.5m	800mm
Medium	8-12m	8m	35m^3	4m x 4m	6m x 6m	1000mm
Large	12-18m	16m	150m^3	8m x 8m	10m x 10m	1200mm

Water management

Water management clauses in DCPs are also multi-objective, councils use their DCPs to manage multiple aspects of the water cycle and stormwater runoff, including water conservation, runoff quality and quantity, peak flows, flooding and drainage, erosion and sediment control.

The following clauses focus on stormwater quality and quantity, stormwater discharge to bushland and erosion and sediment control, as these are the aspects with most relevance to the goals of the Parramatta River Masterplan and the objectives identified in Section 2. Councils will need to consider how these should be integrated with other water-related controls in the DCP.

Rainwater harvesting and reuse

The following example is a template for mandatory rainwater tanks. It could be applied to non-residential development, but would not be appropriate for residential development, where BASIX applies.

Locally harvested rainwater must be the primary source of non-potable water for new development, to reduce stormwater runoff and minimise the impacts of stormwater quantity on sensitive receiving waters.

Rainwater tanks are to be provided when any of the following are present in the development:

- An irrigated area more than 50 m^2
- Any car or other vehicle washing facilities
- Commercial laundry facilities
- Three or more toilets
- A cooling tower.

Rainwater tanks or other alternative water sources need to be designed to meet the following requirements:

- At least 90% of roof area shall be connected to rainwater storage(s)
- Rainwater supply schemes may be supplemented with recycled water where connection to recycled water supply is available.
- A minimum of X kL rainwater storage is to be supplied per 100 m^2 of non-residential net floor area.

- Connect rainwater tanks to irrigation, car washing, toilets, water features, washing machines, hot water systems and cooling towers.
- 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 to minimise the volume of stormwater discharged to local waterways.
- Rainwater tank storage does not contribute to on site detention volume and cannot be used to offset on site detention requirements.

Stormwater quality and quantity targets

This suggested wording is consistent with many existing DCPs. It combines the strongest elements of existing examples.

These targets apply to the following development types:

- [specify where stormwater runoff standards will apply, including minimum lot areas].

Post development mean annual pollutant loads must be reduced by the following amounts:

- Gross pollutants (90%),
- Total suspended solids (85%)
- Total phosphorus (65%)
- Total nitrogen (45%).

Post-development mean annual runoff volume must be reduced by X% [10% is suggested as a starting point, however the amount could vary depending on the development type].

Post-development mean annual pollutant loads and runoff volume need to be estimated using a MUSIC model, with all MUSIC modelling undertaken in accordance with [Council's MUSIC modelling guidelines or other appropriate reference].

When accounting for post-development runoff, include all stormwater runoff as well as any other water discharged to the stormwater system. If the development includes a basement pump-out system that discharges to the stormwater system, this volume needs to be accounted for.

To demonstrate compliance with these targets, proponents will need to submit the following [consider what approach to take – this could include different requirements for different types of development]:

- WSUD report
- MUSIC model
- S3QM certificate
- Deemed to comply checklist.

Vegetated treatment should always be used as part of the stormwater treatment train, unless it can be clearly shown that this type of treatment is not possible at a particular site.

Stormwater treatment systems and infiltration systems/soakaways need to be designed in accordance with: [refer to design standards that apply in the local LGA]

All stormwater treatment systems that will be transferred to Council shall be maintained for a period of no less than 3 years post practical completion. Inspections may be held during the 3-year maintenance period. An inspection will also be held on completion of the 3-year maintenance period and prior to the transfer of ownership. If the asset is not of an acceptable standard to Council at these inspections, the asset shall be rectified to the satisfaction of Council. This will include extension of the maintenance period.

Where stormwater treatment systems are located in the private domain, a Positive Covenant for ongoing operation and maintenance of stormwater treatment measures must be provided and be registered with Council.

Erosion and sediment control

Erosion and sediment control is governed by legislation (POEO Act) and well established guidelines (the Blue Book) and there is no need to repeat the detail in DCPs; this example clause simply refers to these existing requirements as an additional reminder to help ensure that erosion and sediment control is considered early in the development process. However, note that there is a proposed action under the NSW Marine Estate Strategy to update guidance on erosion and sediment control. This is expected to include updated model provisions for council DCPs. These should be consulted when they become available.

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 (the "Blue Book").

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

Waterways and riparian land

While the LEP will define the various waterways and land to be classified as "riparian", and the considerations for development on that land, the DCP can also include more specific requirements. While there is limited mapping of different riparian land categories, the DCP requirements need to be broad enough to accommodate a range of different situations – from riparian lands with high natural value to those that are severely degraded. Therefore, several phrases include "where feasible…", "where appropriate…" or similar. If mapping is improved, classifying riparian lands into different categories, then the DCP provisions can also be improved, making them more specific to each category of riparian land.

Riparian land

This suggested provision assumes that "riparian land" is defined somewhere, ideally with a mapping layer. However, the assumption is that only one category of "riparian land" is defined. If existing mapping is more detailed, or if waterway and riparian land mapping is updated in the future to identify multiple categories, then more specific controls can be developed, appropriate to each category.

Wherever possible, all new development must provide for a development footprint outside the riparian land. Encroachments onto riparian land may be permitted, however, in determining whether an encroachment is acceptable, the following must be considered:

i. the location of existing hardstand structures to be retained within the riparian land;
ii. the scale of the development;
iii. the minimisation of any encroachment through the siting and design of the development;
iv. location above the 1% flood level;
v. enhancements proposed as part of the development such as offset areas;
vi. geomorphic and ecological values of the waterway.

Subdivisions (via perimeter roads) must front onto riparian land.

Minimise the following works within riparian lands:

- Impervious surfaces. Where feasible, reduce the existing building footprint and impermeable surfaces within riparian lands.
- Service infrastructure, including stormwater, sewerage and other piped services. Where necessary use non-destructive techniques such as direct drilling, where no part of the pipe is above ground or above the bed of the waterway. In exceptional circumstances piered crossings may be considered.
- Disturbance of soils, except where required for rehabilitation or remediation of the waterway.

No works shall be undertaken on or near a natural waterway or section of natural waterway that would cause straightening, significant relocation, widening, narrowing, piping or lining of the natural waterway.

Riparian vegetation is to be retained and enhanced. Where any existing vegetation is to be removed from riparian land, a Vegetation Management Plan prepared by a suitably qualified person, is required. Where the riparian land has been disturbed or degraded, appropriate riparian vegetation is to be revegetated or rehabilitated. Local native vegetation assemblages, capable of supporting the long-term ecological function of the riparian land, must be used. Where practicable, protection, regeneration and rehabilitation of vegetation in riparian land is to retain or achieve a density, species mix and structure of canopy, mid-storey and understorey vegetation that would occur naturally. Plantings within riparian land are to consist of 100% locally native species.

Channel and bank stability within the riparian zone are to be protected by avoiding the removal of natural stream structures, vegetation and woody debris, except where debris creates a flood hazard.

Stream bank stabilisation works are encouraged where there is risk of erosion. These works should be by use of re-vegetation methods, or if necessary, be of a 'soft engineering' design.

Development is to be designed to maintain or emulate a naturally functioning watercourse wherever possible. The development must be designed to ensure connectivity of vegetation, hydrological flows and fauna movement to, and within, the riparian land and waterway.

Re-instatement of piped or channelised watercourses to a more natural form is to be undertaken where feasible. Note: watercourse re-instatement is most likely to be feasible on larger developments where landscaping and drainage works are already significant and re-instatement of the watercourse can help achieve beneficial social and environmental outcomes.

Opportunities for the community or residents to connect with and explore waterways are to be provided where appropriate, however accessways must not compromise the integrity of riparian land. Any access to the waterway must be located at strategic points where the ecological integrity of the existing riparian vegetation, stream bed and bank stability will not be compromised.

Public access to riparian land is encouraged where feasible and appropriate. Walkways, tracks, cycleways and general access points may be established in riparian land, where:

i. they form useful links in the green grid network of active transport and recreational pathway links
ii. they are designed and constructed to ensure minimum impact on the riparian land; and
iii. they contribute to the management of edge effects or ongoing riparian maintenance.

Crossings (i.e. bridges) over natural waterbodies must maintain riparian connectivity; retain natural stream bed and bank profile; prevent scour and erosion of the stream bed or banks during storm events; not restrict bankfull or floodplain flows and not inhibit natural sediment transport. This is to be achieved by:

i. minimising the number of crossings;
ii. minimising the width of the crossing to allow for pedestrian access. Vehicle crossings will only be considered where required;
iii. establishing crossings at right angles to the flow rather than at an oblique angle; and
iv. minimising disturbance to existing native riparian vegetation

Safety fences are permitted within riparian land, where required to manage fall risks (e.g. over headwalls or other steep drops where there is public access). Fences must be set back an appropriate distance from the top of the bank, and be of an open design to minimise barriers to flora, fauna and water.

Watercourse and riparian land management must be integrated with flooding risk. Flood management studies must consider the impacts of rehabilitation and remediation of riparian land in the assessment of risk and in any proposed mitigation strategies.

Stormwater discharge to bushland, riparian land and/or natural waterways

The wording suggested below sets a cap on the proportion of the development that can drain to bushland, requiring the remaining proportion to drain into Council's stormwater system. This assumes that this option is available in the substantial majority of cases, and encourages a design where a reasonable proportion of the runoff can drain to the stormwater system, but acknowledges that it is often impossible to discharge all runoff into this system (e.g. where properties slope down from the street towards bushland). Councils may also wish to consider additional requirements for properties that discharge to bushland, such as higher runoff reduction targets in these locations.

Urban stormwater flowing into bushland, riparian land and natural waterways can cause erosion, and is the major factor that causes weeds to become established in natural areas. To minimise such impacts, the following controls apply to properties that border on bushland or discharge into riparian land or natural waterways:

1. The developer must demonstrate to Council that all stormwater entering bushland will be dispersed sufficiently so as to not cause downstream erosion, scour or pollution. This may be achieved by using a raingarden, infiltration or dispersal trench system or slotted pipe to practical depth (where site conditions prevent a deeper trench structure) established at the highest practicable level within the site, parallel to the site contours. Refer to design guidance in [insert reference] for acceptable design standards for these devices.
2. For new single dwellings, the maximum post developed built-upon area draining to the dispersal trench system, infiltration trench system or raingarden must not exceed X% of the built-upon area. The remaining Y% of the built-upon area needs to drain to the kerb or into a Council stormwater pit.
3. For alterations and additions, the post-development built-upon area draining to dispersal trench system, infiltration trench system or raingarden must not exceed the greater of

i. X% of the built-upon area; or
ii. the pre-developed built-upon area.

Stream erosion

This should be a minor amendment to flood detention controls (if not already included), to be applied where stream erosion is a risk.

Ensure that stormwater detention provisions require detention of peak flows to match pre-development flows not only in major storm events (e.g. the 10 to 100 year ARI events) but also in frequent events (1 and 2 year ARI events). It is the frequent storm events, typically 1-2 year ARI, which cause the most erosion in natural streams.

APPENDIX B: CURRENT NSW URBAN RIPARIAN LAND POLICY

The riparian zones and policy outcomes therein are designed to complement the NSW guidelines for riparian corridors on water front land (NSW Department of Primary Industries, Office of Water 2012) and support the goals of the Parramatta River Masterplan. The NSW riparian corridor guidelines use the Strahler stream order system as the basis for their classification. A map of rivers in the Parramatta River catchment is provided in Figure 13. This reviews a total of 210 km of streams ranging from 1st to 4th order based on the NSW 1:25,000 topographic map series (CT Environmental 2016). An analysis by CT Environmental, revealed 75% of the streams in the catchment were either 1st or 2nd order (Table 16). Mapping also reveals a greater presence, density and integrity of streams in the North West parts of the catchment. These riparian areas and associated bushland are also locations where a number Threatened ecological communities exist (CT Environmental 2016). Other areas of the catchment have been subject to longer and greater development pressure, particularly involving the clearing of native vegetation and the piping and channelisation of intermittent and ephemeral streams.

Table 16: Strahler stream order and total length of ordered creeks within Parramatta River catchment (CT Environmental 2016).

Strahler stream order	Length (km)
1	102.3
2	56.3
3+	52.2
Total	210.8

The Strahler stream order is used as the basis for the NSW policy. Importantly, in highly urbanised environments such as the Parramatta River catchment the capacity to achieve the proposed vegetated riparian zone buffer widths will be compromised based on historical development patterns and associated utilities. Table 17 provides the riparian corridor matrix that is used to determine what constitutes a controlled activity and thus may require approvals under the *Water Management Act 2000*.

Table 17: Riparian Corridor Matrix (NSW Office of Water 2012, p.3)

Stream order	Vegetated Riparian Zone (VRZ)	RC off-setting for non RC uses	Cycleways and paths	Detention basins		Stormwater outlet structures and essential services	Stream realignment	Road crossings		
				Only within 50% outer VRZ	Online			Any	Culvert	Bridge
1st	10m	•	•	•	•	•	•	•		
2nd	20m	•	•	•	•	•		•		
3rd	30m	•	•	•		•			•	•
4th +	40m	•	•	•		•			•	•

Key

Stream order: The watercourse order as classified under the Strahler System based on 1:25,000, 1:50,000 or 1:100,000 topographic maps whichever is the smallest scale available. A full list is provided at Part 2, Schedule 2 of the Water Management (General) Regulation 2011.

Vegetated riparian zone (VRZ): The required width of the VRZ measured from the top of the high bank on each side of the watercourse.

Riparian corridor (RC) off-setting for non RC uses: Non-riparian uses, such as Asset Protection Zones are allowed within the outer 50 per cent of the VRZ, so long as offsets are provided in accordance with the averaging rule as seen in Figure 3.

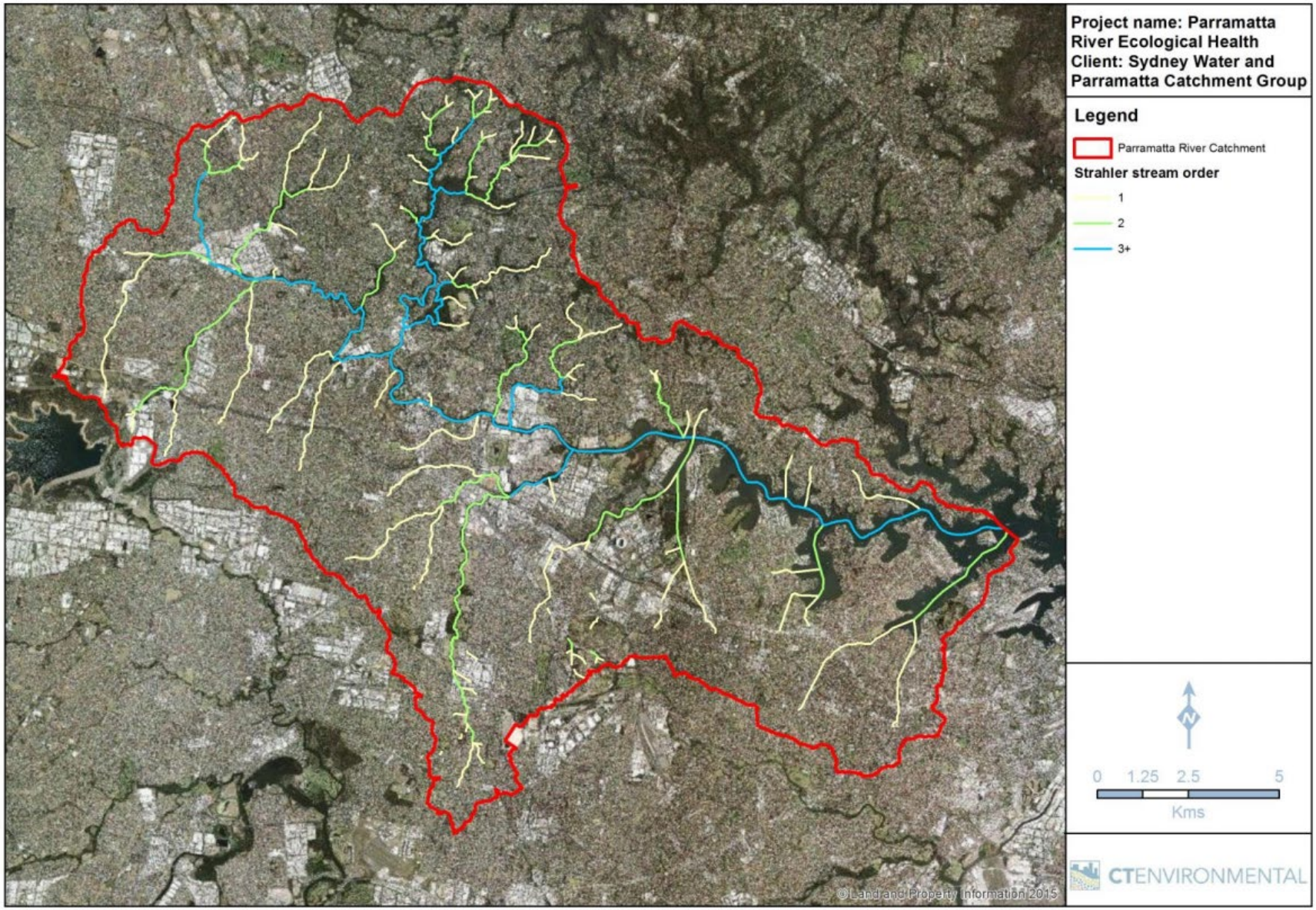

Figure 13: Strahler stream order of creeks in the Parramatta River (CT Environmental 2016)