Greater Sydney Harbour Coastal Management Program

Stage 2, Study 2:

Catchment management options study

Final report

Prepared for Sydney Coastal Councils Group

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Civille

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DISCLAIMER

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EXECUTIVE SUMMARY

This study (known as 'Study 2') has investigated catchment management options for the Greater Sydney Harbour (GSH) catchment and responds to the objective to "enable councils, Sydney Water and relevant state agencies, to collaborate more effectively in the management of urban stormwater and marine litter and in so doing address community values and expectations." It forms part of Stage 2 of the Greater Sydney Harbour Coastal Management Program (CMP) that is focused on determining risks, vulnerabilities and opportunities.

Previously, Stage 1 of the GSHCMP, the Scoping Study (BMT, 2018) identified community values and priority threats to Greater Sydney Harbour. Following agreement with the DPIE Leadership team in July 2020, the aim of the CMP was re-focussed on sustaining waterway health through improved coordination, consistency and leadership. The priority threats were distilled to the following issues, which became the focus of Stage 2:

- **Urban stormwater discharge** – in particular, the management of diffuse stormwater pollution.
- **Marine debris** – in particular, the management of land-based litter as a key source of marine debris.
- **Sewage discharge** – in particular, wet and dry weather overflows and leaks from the wastewater network.

Climate change – in particular, sea level rise and its various impacts. Stage 2 of the CMP includes several components. The first of these (Study 1) was finalised in August 2022 (McAuley, Adams, & Davies, 2022) and it identified three fundamental constraints hindering the effective management of diffuse stormwater pollution and planning for sea level rise:

1. **Fragmented governance,** within which there is poor vertical (state to local) integration and horizonal (between state agencies and between councils) coordination.
2. **Inconsistent and inadequate funding** arrangements to effectively deliver on policy intent and operational needs.
3. **Collaborative efforts are constrained** as a consequence of the fragmented governance arrangements and funding gaps.

Study 2 has maintained a focus on these important issues and the high-level objectives of:

- Identifying opportunities and constraints to coordinate stormwater and litter management with a more holistic and strategic, catchment-wide approach.
- Assessing management options to:
    - Align waterway health with community values
    - Plan for climate change and the risks of sea level rise in keeping with community expectations

Both Studies 1 and 2 have included in-depth consultation with local councils and Sydney Water, including interviews during Study 1 and a full-day workshop during Study 2. Study 2 has also been informed by a series of expert workshops (refer to Wave Consulting Australia, 2022). Over this series of consultations, stakeholders identified multiple layers of complexity in both the goals to improving waterway health and planning for climate change, and limitations in current management arrangements, which are constrained by fragmented governance and inadequate funding. These constraints limit the capacity of catchment managers to address

complex goals. At the workshop with councils and Sydney Water during Study 2, more than half the participants agreed that current management practices are only "somewhat" supporting the CMP vision, and almost two-thirds of participants agreed that it is very important to improve the management framework for Greater Sydney Harbour.

Consistent needs identified across both waterway health and climate change were:

- State government **leadership** to address matters of regional significance and establish the business case for regional investment in environmental and liveability outcomes.
- **Coordination** of a more systematic approach to knowledge-building.
- More effective **collaboration,** between different parts of government, with research organisations and the community. These collaborations need to focus on both short-term projects and to sustain a focus on long-term goals.
- Stronger governance arrangements, which ensure a **consistent** approach, and enable an **adaptive** approach.

Collaboration was identified as a key positive feature of how councils and Sydney Water currently work together, notwithstanding more could be done. This study revealed that a whole of catchment approach to collaboration is needed involving government, community and research institutions. Management effectiveness and efficiency would also be improved through greater collaboration.

Creative approaches were identified by workshop participants as an important feature of successful efforts to tackle complex challenges, including support for innovation, experimentation, and knowledge-building.

Six features were identified to describe a new management framework that has the potential to enable a holistic and strategic, catchment-wide approach: creativity, collaboration, adaptation, coordination, consistency and leadership.

Aligned with these six features are ten recommendations for a new approach to manage the Greater Sydney Harbour catchment:

Leadership 	1. Develop a clear, long-term program (e.g. the CMP) that takes a catchment-wide approach, is well-supported by stakeholders, and includes planning and implementation over an extended period of many years 2. Provide an existing or new entity with authority to drive program implementation
Creativity 	3. Create a culture within institutions that fosters innovation and experimentation as a deliberate process 4. Foster a culture of creativity across traditional boundaries
Collaboration 	5. Develop collaborative partnerships between government, academia, industry, and community 6. Foster shared ownership of urban waterways
Adaptation 	7. Implement a more iterative and adaptive approach to catchment management 8. Develop a more systematic approach to knowledge sharing and technical capacity building
Coordination 	9. Build accountability for catchment management and transparency into funding, planning and reporting mechanisms 10. Establish a permanent whole-of-catchment core monitoring program for Greater Sydney Harbour
Consistency 	11. Establish new whole of catchment-based funding models to ensure diffuse stormwater pollution can be addressed in line with community and government expectations 12. Improve consistency in the planning system

1 INTRODUCTION AND BACKGROUND

This study reports on catchment management options for the Greater Sydney Harbour (GSH) catchment (the project) and responds to the objective to ***"enable councils, Sydney Water and relevant state agencies, to collaborate more effectively in the management of urban stormwater and marine litter and in so doing address community values and expectations."***

This study forms part of Stage 2 of the Greater Sydney Harbour Coastal Management Program (CMP) that is focused on determining the risks, vulnerabilities and opportunities (NSW Office of Environment and Heritage, 2019). The CMP process is depicted in Figure 1. Stage 1, the scoping study, was completed by BMT in 2018 (BMT, 2018). Following the BMT report, Stage 2 was commissioned and comprises four studies, as shown in Figure 1. This report presents the outcomes of Study 2.

1.1 STUDY AREA AND RELEVANT STAKEHOLDERS

Stage 2 of the Greater Sydney Harbour CMP has been led by a Project Control Group (**PCG**) comprising representatives from the following organisations:

- Sydney Coastal Councils Group (SCCG)
- Parramatta River Catchment Group (PRCG)
- Department of Planning and Environment (DPE) Environment, Energy and Science (EES) section
- NSW Coastal Council

Stage 2 (and particularly Studies 1 and 2) has included in-depth consultation with local councils across the GSH catchment. The GSH catchment area is shown in Figure 2. There are 21 councils that have all or part of their local government areas (LGAs) within the catchment. All but one of these 21 councils (all except for Strathfield Council) have participated in Stage 2 of the CMP. Therefore, throughout this report we refer to the 20 GSH councils.

In addition to the councils, there are many other stakeholders relevant to the project and represented on the CMP's Project Management Committee (**PMC**). The PMC is chaired by Prof. Bruce Thom of the NSW Coastal Council, and includes representatives from SCCG, PRCG, DPE-EES and the following other organisations:

- DPE Planning and Assessment – Environmental Policy team
- NSW Environment Protection Authority (EPA)
- Sydney Water Corporation
- Transport for NSW (TfNSW) – Maritime division
- NSW Health
- Sydney Institute of Marine Science (SIMS).

The PCG, PMC, and the 20 GSH councils have been invited to comment on a draft of this report and comments have been addressed in this final version. The final report will be presented to the PMC for their consideration, along with the outputs of Study 1, Study 3, and the expert workshops.

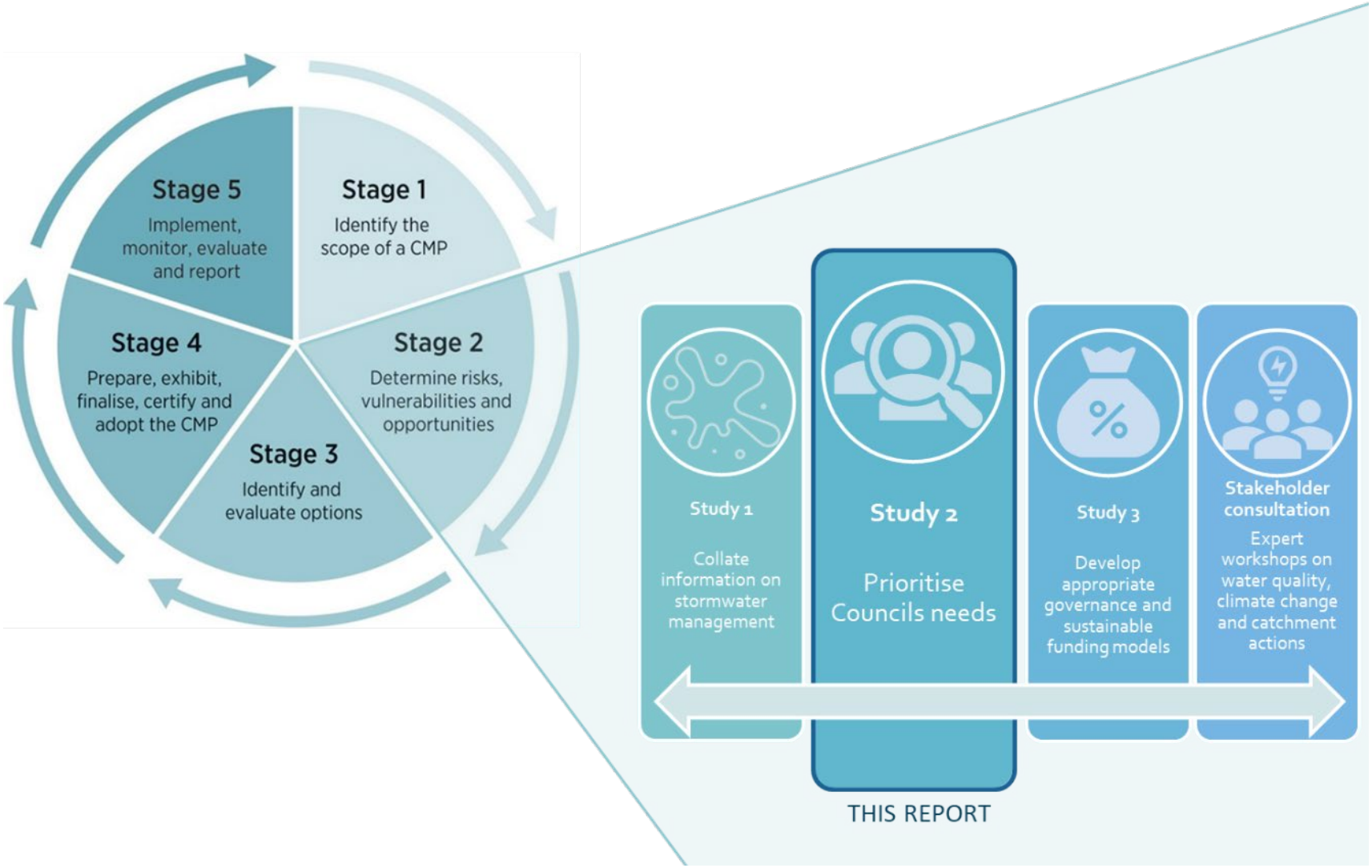


Figure 1: CMP Stages and the four main pieces of work comprising Stage 2 of the Greater Sydney Harbour CMP

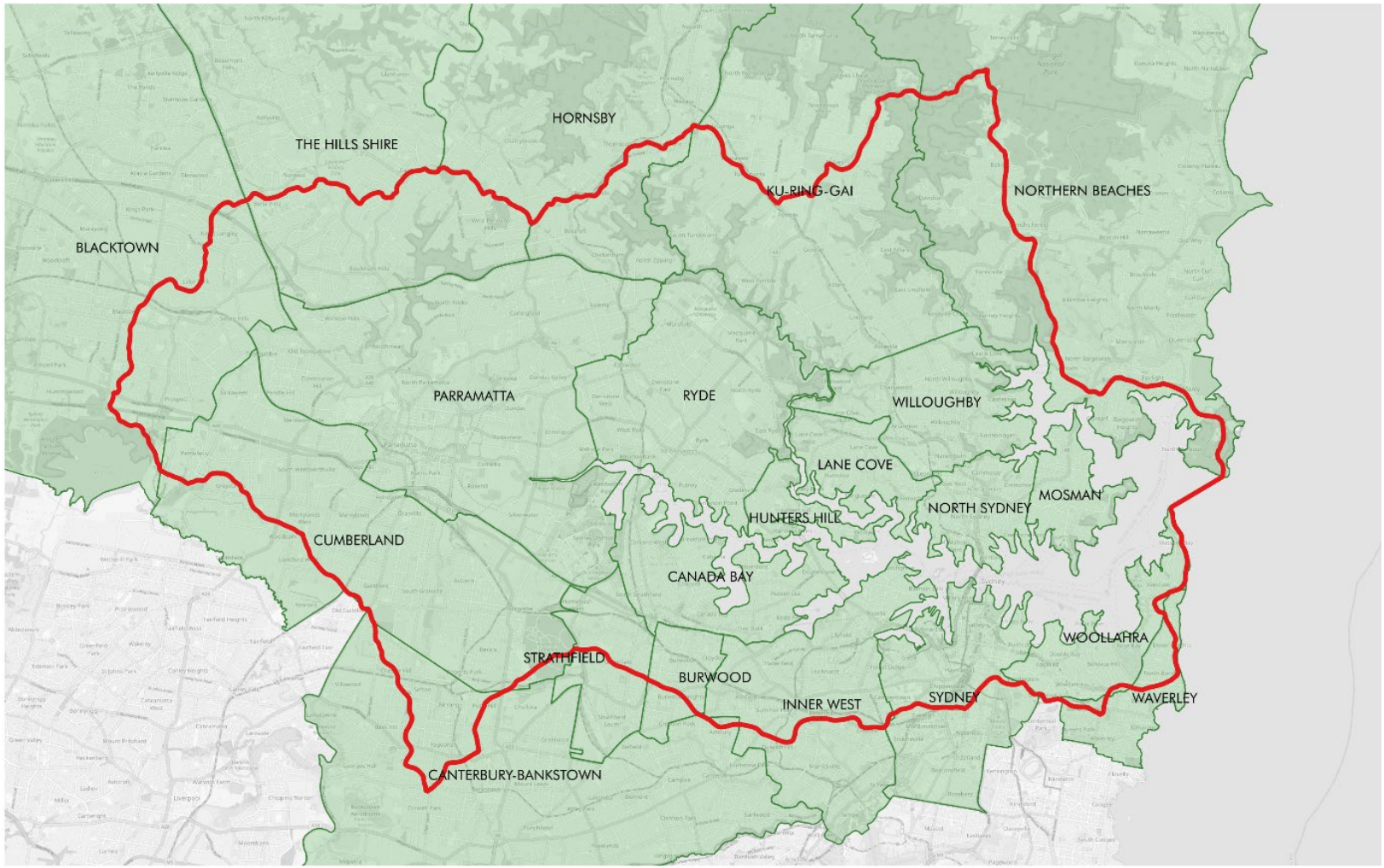


Figure 2: Greater Sydney Harbour catchment showing LGA boundaries

1.2 STUDY FOCUS: PRIORITY THREATS

The CMP process is depicted in Figure 1. The Stage 1 Scoping Study (BMT, 2018) identified community values of Greater Sydney Harbour and characterised threats to these values. 23 threats were screened in a first pass risk assessment to identify the highest priority threats, where the risks are more significant, there are gaps in current management and/or there is a likelihood of the hazard becoming problematic in the future. These findings are reviewed in Sections 3 and 4 of this report.

Following the Scoping Study and the first pass risk assessment, there was still a need to narrow down the focus of Stage 2. Therefore, following agreement with the Department of Planning, Industry and Environment (DPIE) Leadership team in July 2020, the aim of the Greater Sydney Harbour CMP was re-focussed on sustaining waterway health through improved coordination, consistency and leadership. Emphasis was to be placed on addressing the priority threats of stormwater, sewage, climate change and marine debris.

Therefore, the focus of this study has been:

- **Urban stormwater discharge** – in particular, the management of diffuse stormwater pollution.
- **Marine debris** – in particular, the management of land-based litter as a key source of marine debris.
- **Sewage discharge** – in particular, wet and dry weather overflows and leaks from the wastewater network.
- **Climate change** – in particular, sea level rise and its various impacts.

Note that in some contexts, urban stormwater management objectives include management of both runoff quality and quantity, to address all the impacts of urban stormwater runoff. Management of stormwater quantity is particularly important where increased flows cause erosion of streams. For the Greater Sydney Harbour Catchment, stream erosion has not been identified as a significant issue as many streams have been channelised. The remaining natural streams are mostly located in the sandstone landscape, where they are less prone to erosion than streams in Western Sydney's shale landscape.

Across the Greater Sydney Harbour catchment, past studies have identified stormwater pollutant loads as an important driver contributing to poor water quality in the Harbour. Pollutant loads are a factor of both quality (pollutant concentrations) and stormwater quantity (runoff volume).

Therefore, in this study, the focus is on diffuse stormwater pollution rather than management of stormwater flows, noting that measures that reduce the quantity of stormwater runoff (e.g., rainwater and stormwater harvesting) can reduce pollutant loads and therefore can also contribute to improvements in overall water quality in the harbour. For example, modelling undertaken for the PRCG's Masterplan (Jacobs, 2018) recommended the benefits of rainwater and stormwater harvesting to reduce pollutant loads. The Water Quality Improvement Plan recommends "stormwater harvesting is a key action available to reduce stormwater discharges to Sydney Harbour as well as reducing the pressure on the sewer system through infiltration of stormwater to the sewer system" (NSW Local Land Services, 2015, p. 53).

1.3 STUDY PURPOSE AND OBJECTIVES

Stage 2 of a CMP involves studies to identify, analyse and evaluate risks, vulnerabilities and opportunities, including refining the understanding of key management issues.

The overarching objective of Studies 1 and 2, as described in the SCCG's project brief (Sydney Coastal Councils Group, 2021) is to "enable councils, Sydney Water and relevant state agencies, to collaborate more effectively in the management of urban stormwater and marine litter and in so doing address community values and expectations". Specific objectives, as stated in the brief (Sydney Coastal Councils Group, 2021) ,were to:

- Identify, collect, and collate all existing information (i.e., models,

monitoring and reports) on Sydney Harbour relating to water quality for Sydney Harbour and its catchments

- Collect and collate data on community values for the Harbour and its tributaries
- Begin to apply the Risk Based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning (Dela-Cruz, Pik, & Wearne, 2017) to identify council and agency management needs
- Evaluate management options against environmental, social, and economic costs and benefits
- Prioritise management actions across the catchment at council and catchment scales
- Evaluate the implications of current practices for stormwater and marine litter management across the catchment and make recommendations for improvement.

Building from this, the first part of Stage 2, Study 1 (McAuley, Adams, & Davies, 2022) examined the current state of stormwater management across the Greater Sydney Harbour catchment. This identified three important interconnected factors that are constraining the capacity of stormwater and catchment managers to sustain and improve waterway health:

1. **Fragmented governance**, within which there is poor vertical (between state and local government) integration and horizonal (across state agencies and between councils) coordination.
2. **Inconsistent and inadequate funding** arrangements to effectively deliver on policy intent and operational needs.
3. **Collaborative efforts are constrained** as a consequence of the fragmented governance arrangements and funding gaps.

Furthermore, Study 1 found that these factors have resulted in a patchwork of different approaches to stormwater and catchment management across the catchment:

- **In the public domain**, while certain basic stormwater management measures are widespread, it is not clear how consistently these measures are undertaken and how they contribute to overall catchment outcomes. More complex activities requiring cross-boundary collaboration are not applied strategically, consistently nor in a coordinated manner.
- **In private development,** while consistent stormwater management objectives and stormwater quality treatment targets are included in most local planning policies, they are applied differently in each council depending on the type and scale of development. The lack of consistent objectives and targets in state planning policies is a notable gap, which erodes the effectiveness of local provisions. A significant and increasing proportion of local development is assessed under the Codes SEPP as complying development, in which there are no stormwater quality requirements. As such this development assessment category circumvents most of the outcomes achieved via water sensitive urban design controls. There is also a more fundamental question as to whether existing local planning provisions, typically contained within individual council DCPs, are effective in improving stormwater outcomes.
- **Sea level rise** will affect councils and Sydney Water in different ways, so it is not surprising that approaches vary. Councils that are exposed to greater impacts of sea level rise would prefer a coordinated approach to assessing the risks and a consistent approach to navigate the complex territory of imposing planning provisions to manage future risks.

In all these areas, local differences should be expected depending on local socio-political, environmental and organisational contexts. While recognising these differences there is considerable scope for council activities to be improved, collectively coordinated (e.g. to target specific sub-catchment outcomes that may cross local government boundaries) and made consistent to improve waterway health outcomes. Furthermore, the lack of consistent state policy and coordinated state agency action also erodes the effectiveness of coordination and consistency where development is proposed, planned, assessed by, built or maintained by a state agency or authority.

These findings from Study 1 have informed the direction of this study (Study 2). The main implication of these findings is that to meet the overarching objective of "[enabling] councils, Sydney Water and relevant state agencies, to collaborate more effectively in the management of urban stormwater and marine litter and in so doing address community values and expectations", the most important, high-priority needs are to address the governance, funding and collaboration constraints that pervade every aspect of stormwater and catchment management.

The NSW Coastal Management Manual guideline for Stage 2 (NSW Office of Environment and Heritage, 2019) is focused on enabling councils to complete a risk assessment, including an analysis and evaluation of risks and vulnerabilities, and commencing risk management activities. The emphasis is on physical risks (e.g., erosion, instability and inundation). The guideline indicates the need for detailed risk assessment in Stage 2, "if the first-pass risk assessment (Stage 1) identified complex issues, potentially high and unacceptable risks, significant uncertainty or complex management choices" (NSW Office of Environment and Heritage, 2019, p. 33).

Greater Sydney Harbour does indeed face these types of complexities, however, as demonstrated in Study 1, not only are these issues complex, but any attempt to address them is currently constrained by fragmented governance, inconsistent and inadequate funding and limited collaboration. Any attempt to improve the management of physical risks (i.e. to bring them under control or deal with the consequences) is continually drawn back to the needs to improve governance (formal and informal rules, procedures, and practices and decision making processes), funding (sustainable, equitable and fit-for purpose), and collaboration (between different parts of government and industry, academia and the community) to ensure not only that appropriate management measures are in place, but that intended outcomes are achievable.

Therefore, the Greater Sydney Harbour CMP is taking a different approach with its focus on "sustaining waterway health through improved coordination, consistency and leadership". Study 2 has maintained a focus on governance, funding and collaboration and the high-level objectives of:

- Identifying opportunities and constraints to coordinate stormwater and litter management with a more holistic and strategic, catchment-wide approach.
- Assessing management options to:
    - Align waterway health with community values
    - Plan for climate change and the risks of sea level rise in keeping with community expectations.

These objectives are shown in Figure 3, which illustrates how they align with the Study 1 findings. Throughout Studies 1 and 2, there has been a focus on the organisational issues (i.e., governance, funding, collaboration) alongside the physical management issues (i.e. waterway health, climate change and sea level rise).

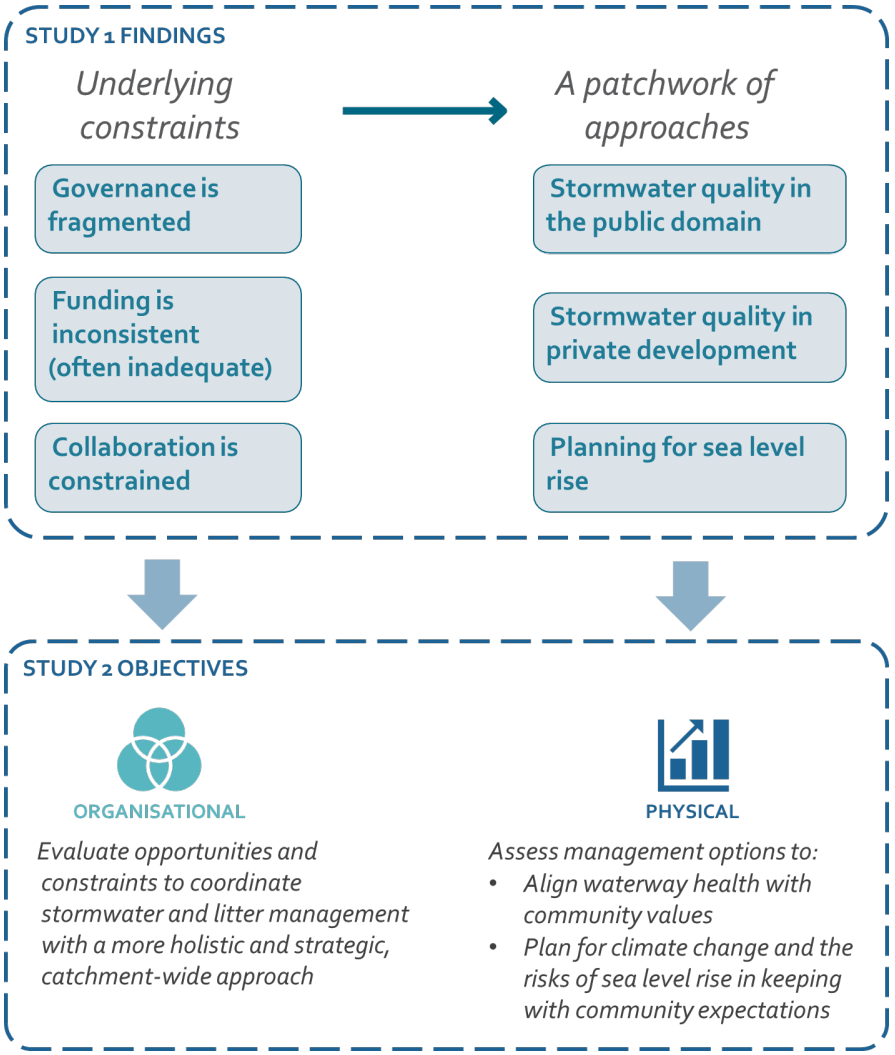


Figure 3: Summary of Study 1 findings and their relationship to Study 2 objectives

1.4 THIS REPORT

This report, the 'Greater Sydney Harbour Coastal Management Program Stage 2, Study 2: Catchment Management Options Study', has been organised as follows:

- Section 1 (this section) introduces the report, outlining its purpose and objectives and its context in relation to previous and concurrent work.
- Section 2 outlines the Study 2 method including stakeholder consultation, identification and assessment of management options.
- Sections 3 and 4 review important background information, forming a link between previous studies and the current work:
  - Section 3 reviews community values of Greater Sydney Harbour, which have been identified in previous studies and plans.
  - Section 4 reviews priority threats identified previously, providing an updated risk assessment for the high-priority threats which are the focus of Stage 2.
- Sections 5 and 6 examine management options from experts' and catchment managers' perspectives, considering what is needed to bridge the complex space between community aspirations and governments' planning and implementation in practice:
  - Section 5 focuses on aligning waterway health with community values.
  - Section 6 focuses on planning for climate change in keeping with community expectations.
- Sections 7 and 8 come back to higher-level features of an effective management framework:
  - Section 7 identifies the features of an effective management framework that would enable catchment managers to work more effectively towards community aspirations.
  - Section 8 presents a succinct set of recommendations for future management of Greater Sydney Harbour.

1.5 CONCURRENT STUDIES

Figure 1 showed two other components to Stage 2 of the GSHCMP:

- **Study 3** is focused on developing appropriate models for governance and sustainable funding. The Study 3 team has been examining national and international examples for insight and will make recommendations on appropriate governance and funding models for Greater Sydney Harbour.
- **Expert workshops** have sought the input from a wide range of academic, government and industry experts on how water quality, catchment actions and climate change should be managed more effectively in the Greater Sydney Harbour catchment.

Study 1 was commenced in December 2021 and finalised in August 2022 (McAuley, Adams, & Davies, 2022) and therefore its findings were able to inform other parts of Stage 2. Subsequently, Studies 2, 3 and the expert workshops have all been completed concurrently and are all due to be presented to the PMC in September 2022.

The lead author of this Study 2 report has attended all the expert workshops, and therefore as far as possible, findings from the expert workshops have been incorporated into the recommendations of Study 2.

Studies 2 and 3 have been prepared concurrently and there is some overlap in their subject matter, but their scope differs. Study 3 is looking at the options for establishing a new high-level form of governance and funding for Greater Sydney Harbour, incorporating fundamental governance principles (transparency, efficiency, equity, etc). Study 2 examines governance elements and some high-level management functions that could be incorporated into a new entity as well as councils and other stakeholders more broadly.

Following consideration by the PMC, SCCG will be preparing a report to government to synthesise the findings of all the Stage 2 studies and consolidate the recommendations.

2 STUDY METHOD

An overview of the Study 2 method is shown in Figure 4. This illustrates the two parallel parts to Study 2: addressing the physical environment including managing diffuse stormwater pollution and sea level rise; and the organisational elements inclusive of governance, funding, and collaboration. These elements align with the study's two main objectives as presented in Figure 3.

- Identifying opportunities and constraints to coordinate stormwater and litter management with a more holistic and strategic, catchment-wide approach.
- Assessing management options to:
    - Align waterway health with community values
    - Plan for climate change and the risks of sea level rise in keeping with community expectations.

The reason for separating these themes was principally due to the differing expertise and stakeholder input needed to address the key concerns and explore management options. This also reflects the complexity of urban catchment management. As identified in the Study 1 report: "Diffuse stormwater pollution is a complex problem, generated by various sources, and by its very nature needs a multi-faceted approach to address all its causes and impacts." (McAuley, Adams, & Davies, 2022, p. 42).

2.1 STAKEHOLDER CONSULTATION

The primary focus of engagement for Stage 2 Studies 1 and 2 have been with the 20 GSH councils and Sydney Water. This focus reflects the greater strategic and operational responsibilities of these organisations with respect to stormwater management, although noting that there are many others that have varying degrees of control, influence, or concern in the area.

Stakeholder consultation in Study 2 has included:

- A full-day workshop (12 July) including council stormwater working group and Sydney Water participants, to discuss future directions for catchment management. Outcomes of this workshop are written up in Appendix A. These outcomes were circulated as a draft at the end of July, giving all the invitees an opportunity to comment.
- Expert workshops (18 August, 2, 5 and 16 September) focused on water quality monitoring, catchment initiatives, climate change risks, and climate change implications. These workshops have been organised by Wave Consulting and are written up separately (Wave Consulting Australia, 2022).

In addition, during Study 2, SCCG has attended a workshop (11 August) on the NSW DPE's updated water quality objectives. This provided information about the State Government's proposed update to water quality objectives, based on research into community values.

The Project Management Committee (refer to Section 1.1) and Council Partners Group (comprising a senior representative from each of the 20 GSH councils) received briefings on the project on 17 and 30 August respectively, giving them the opportunity to comment on the study's approach and an initial draft set of recommendations, prior to the completion of the draft report.

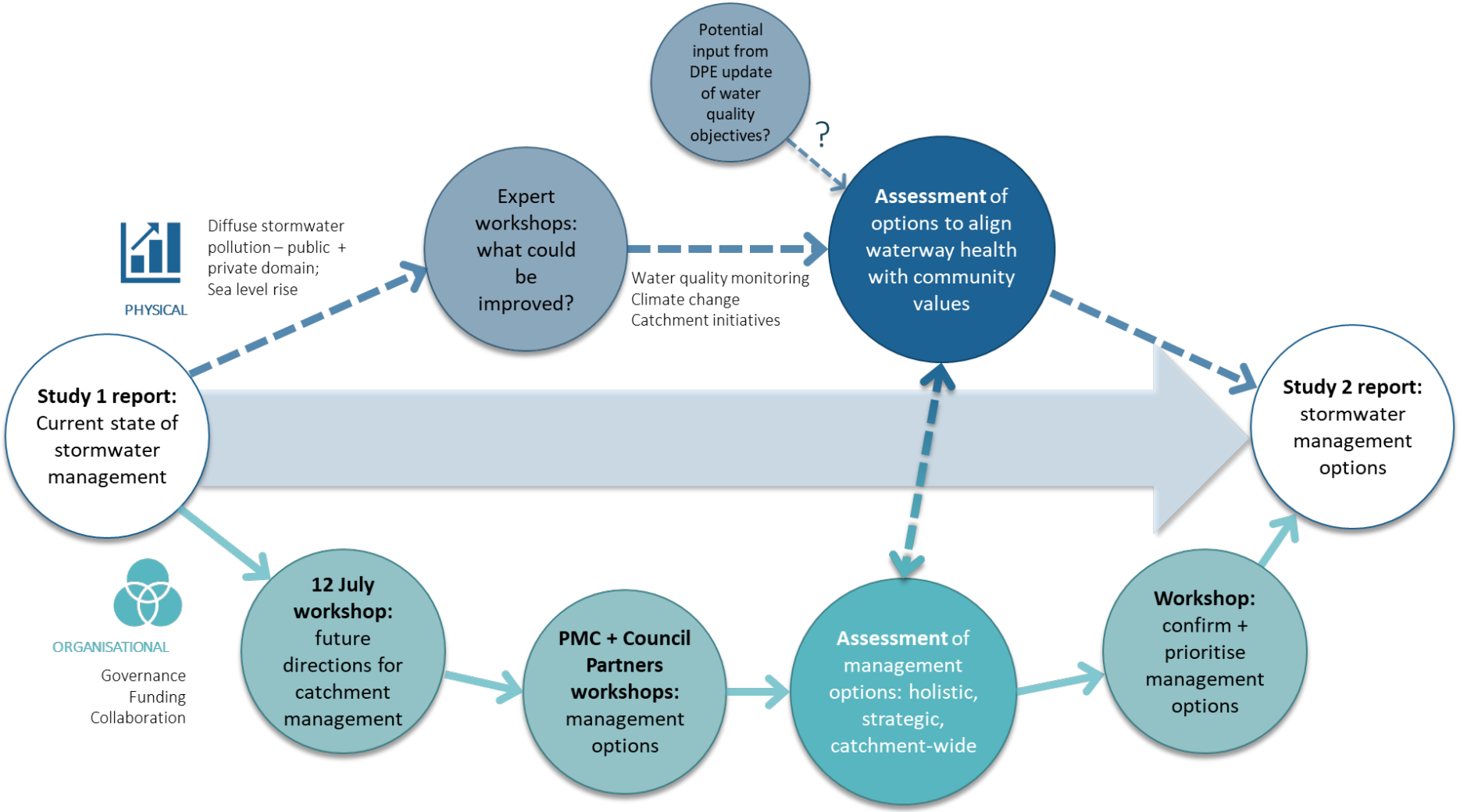


Figure 4: Study 2 method overview

2.2 ASSESSMENT OF MANAGEMENT OPTIONS

During Study 2, management options were considered from a range of different perspectives. Four main sources of ideas are outlined below. Findings were triangulated from each perspective to identify the key features that should be present in an effective management framework.

While each of these perspectives generated different ideas for the future management of Greater Sydney Harbour, they also identified common issues and a consistent message reinforcing the need for a holistic and strategic, catchment-wide approach.

Findings from each perspective were distilled to identify a set of six key features which should be included in an effective management framework. The study's recommendations have been organised in line with this framework.

2.2.1 Review of existing management frameworks and plans

This study is not the first to consider management options for Greater Sydney Harbour specifically or urban waterways in general, and therefore its starting point was to review what has been recommended in key publications and previous plans. This included:

- Recommended management frameworks, including the risk-based framework for considering waterway health (Dela-Cruz, Pik, & Wearne, 2017)
- Previous plans, including the Sydney Harbour Water Quality Improvement Plan (NSW Local Land Services, 2015) and the Parramatta River Masterplan (Parramatta River Catchment Group, 2018)

Existing management frameworks and previous plans were assessed in terms of the extent to which they have helped catchment managers with enabling either of the following two related outcomes:

- Aligning waterway health with community values (see Section 5)
- Planning for climate change and the risks of sea level rise in keeping with community expectations (see Section 6)

2.2.2 Expert workshops

At the expert workshops (over August-September), participants focused on specific management challenges (water quality monitoring, catchment initiatives, climate change risks, and climate change implications) and examined the gap between current management practices and approaches recommended by experts applying the best available science and best available management practices. Workshop participants discussed some of the reasons why this gap persists and how it could be addressed.

2.2.3 Catchment managers' workshop

At the 'future directions for catchment management' workshop (12 July), participants considered the fundamental constraints identified in Study 1 (fragmented governance, inconsistent and inadequate funding, and constraints on collaboration) and explored management options which could overcome these barriers.

2.2.4 Previous studies

Previous studies have also considered how to improve waterway and catchment management by improving frameworks for governance, funding and collaboration. Notably:

- The CRC for Water Sensitive Cities' 'Vision and transition strategy for a water sensitive Greater Sydney' (CRC for Water Sensitive Cities, 2018).
- The 'Parramatta River Waterway Governance Review' (Davies *et al*, 2017) prepared to inform the development of the Parramatta River Masterplan (Parramatta River Catchment Group, 2018).

3 COMMUNITY VALUES

The community places a high value on Sydney Harbour. The value of the Harbour takes many forms including environmental, social, cultural and economic. The community's values are well documented across many previous studies.

The GSHCMP Scoping Study (BMT, 2018) provides a recent summary of the Harbour's values and benefits. Eight common values and benefits for Sydney Harbour's coastal zone were identified in this study through stakeholder workshops and a literature review. These are listed in Table 1 (in the two left-hand columns).

Table 1 also shows (in subsequent columns) how values identified in other previous studies compare to those identified in the Scoping Study (BMT, 2018). Other previous studies include:

- The Parramatta River Masterplan (Parramatta River Catchment Group, 2018), which identified six core features of a living river based on community and stakeholder research.
- The Sydney Harbour CZMP Scoping Study (GHD, 2015), which identified eight community values based on a literature review and stakeholder engagement activities.
- The Sydney Harbour Water Quality Improvement Plan (NSW Local Land Services, 2015), which identified the Harbour's 'benefits' including environmental, social and economic benefits.
- The NSW water quality objectives (NSW Government, 2006).

Note that the NSW water quality objectives are currently being updated by the NSW Department of Planning and Environment. SCCG representatives attended a workshop about this process, hosted by DPE in August 2022. Materials from this workshop indicate that DPE has identified the same four values in the Greater Sydney Harbour catchment that were established in 2006 (although the 2022 version uses words more relatable to the community):

- A place where fish, plans and animals live (aquatic ecosystems)
- A natural place to look, walk, relax, picnic or camp (visual amenity)
- A place to canoe, paddle or sail (secondary contact recreation)
- A place to swim and immerse yourself in water (primary contact recreation)

Participants at DPE's August workshop provided feedback on DPE's proposed values, spatial management units and draft water quality objectives and it is understood that this feedback is now being considered before the revised water quality objectives are finalised. Therefore, there may be some changes to DPE's characterisation of the community's values in the Greater Sydney Harbour catchment.

Even when DPE updates their picture of community values in the GSH catchment, previous studies indicate a quite consistent picture of community values (albeit with greater breadth and depth in some studies than others). Therefore, DPE's current work is unlikely to change this picture substantially.

Table 1: Values of Sydney Harbour identified in previous studies

Values and benefits of Sydney Harbour's coastal zone (BMT, 2018)		Features of a living river (Parramatta River Catchment Group, 2018)	'Community values' of Sydney Harbour (GHD, 2015)[1]	Benefits of Sydney Harbour (NSW Local Land Services, 2015)	Sydney Harbour and Parramatta River water quality objectives (NSW Government, 2006)
Value	Details				
Clean waters	Clean and healthy waters in Sydney Harbour and its waterway system are valued for the benefit it provides to the environment, community and economy.	Clean, clear water that is safe and supports life in the river.	Maintenance and improvement of high water quality	Environmental benefits include clean water	
Biodiversity: ecosystem value	Sydney Harbour and its foreshores are valued for the healthy and diverse marine, estuarine and terrestrial ecosystems they provide.	Healthy ecosystems in the river, the catchment and natural creeks.	Preservation of natural areas and threatened species	Environmental benefits including habitat, biodiversity, ecosystem services	Aquatic ecosystems
Geodiversity: form and process value	Sydney Harbour and its foreshores are valued for the diversity of geological features, landforms, landscapes and natural coastal and hydrological processes they provide.				
Amenity / recreation / participation value	Sydney Harbour has significant natural beauty, and provides opportunity for communities to access and use the harbour and its foreshores safely, and to live along-side a thriving waterway.	Ease of access through improved public transport and connected cycleways and walkways. Quality facilities for events, leisure, recreation and family fun.	Safe and healthy access to the harbour Maintenance or enhancement of Harbour views High quality outdoor experience Appreciation of low key/natural public areas	Social benefits include recreational activities (including swimming, boating, diving and fishing as well as activities on the foreshore), natural beauty, and views.	Visual amenity Secondary contact recreation Primary contact recreation

[1] Most of the 'community values' in the Sydney Harbour CZMP Scoping Study (GHD, 2015) are presented in terms of management objectives to maintain/enhance community values, rather than simply stating the values on their own.

Values and benefits of Sydney Harbour's coastal zone (BMT, 2018)		Features of a living river (Parramatta River Catchment Group, 2018)	'Community values' of Sydney Harbour (GHD, 2015)[1]	Benefits of Sydney Harbour (NSW Local Land Services, 2015)	Sydney Harbour and Parramatta River water quality objectives (NSW Government, 2006)
Value	Details				
Cultural value	Sydney Harbour is significant to Traditional Owners and to new settlers, both in terms of its ongoing importance to communities, but also because of the links to the original owners of the area, and the role the harbour has played in the history of Australia.	An engaged community that loves and cares for their waterways.	Preservation and appreciation of cultural heritage	Social benefits include heritage values.	
Education / scientific value	Sydney Harbour plays a strong role in education of people at all levels, and in multiple disciplines, it provides a place for ongoing scientific discovery and the generation of new knowledge.				
Economic value	Sydney Harbour has substantial economic value because of its natural capital. It makes a substantial contribution to the national, state, regional and local economies, including as a means of connecting people, supporting access to workers, and providing a conduit for services including communications and electricity.	Business opportunities enabling thriving local businesses due to the river's popularity.	Sustainable use and management of the harbour	Economic benefits include tourism and commercial shipping. Tourism is linked with recreational values.	
Symbolic value	Sydney Harbour is a symbol for Australia, it has global recognition and is a gateway to Australia for tourists and for new immigrants.			The Harbour's iconic structures and bays give Sydney its identity, beauty, tranquillity and serenity.	

Sydney's land use planning process is supportive of the community's values and benefits that were outlined in Table 1. The Greater Sydney Region Plan describes 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 Region Plan, A Metropolis of Three Cities, states that "Improving the health of waterways is essential to the sustainability and liveability of Greater Sydney" (Greater Sydney Commission, 2018, p. 149). This position is supported by objective 25 - "The coast and waterways are protected and healthier" (Greater Sydney Commission, 2018, p. 148). The strategies proposed under objective 25 align with the environmental, social, cultural and economic values 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.

Supporting Sydney's Regional Plan are five District Plans, four of which overlap the GSH catchment: the Central, Eastern, Northern and Southern District Plans[2]. Planning priorities in each of these include "Protecting and improving the health and enjoyment of the District's waterways". Each of these District Plans also includes a specific 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".

Local government has responded to the direction of the regional and district plans through their own strategic planning studies, the Local Strategic Planning Statements (LSPSs). These council-specific statements echo the value that their communities place on the harbor and broadly the natural environment Study 1 (McAuley, Adams, & Davies, 2022) found that 90% of GSH LSPSs include a local planning priority/objective that specifically mentions healthy, clean improved or enhanced waterways.

Local councils' Community Strategic Plans are also supportive of the community's values and benefits that were outlined in Table 1. Study 1 (McAuley, Adams, & Davies, 2022) found that 90% of GSH councils' Community Strategic Plans included waterway health or water quality as a high-level goal or priority.

Therefore, there is a continuity of values identified over time and from regional to local scale.

[2] Refer to https://greatercities.au/district-plans

4 PRIORITY THREATS

The CMP is focused on priority threats where the risks are more significant, there are gaps in current management and/or there is a likelihood of the hazard becoming problematic in the future.

The GSHCMP Scoping Study (BMT, 2018) identified a wide range of threats to Sydney Harbour's coastal zone through discussion with stakeholders, literature reviews (including MEMA Threat and Risk Assessments conducted for the Central Region) and advice from key experts. During the Scoping Study, 58 threats were initially identified that were subsequently distilled to 23. These related to the following issues:

- Land use intensification
- Resource use and conflict
- Public safety
- Natural hazards.

A 'first pass risk assessment' was completed in the Scoping Study for these 23 threats and following this, six 'priority threats' were identified to the Harbour, including urban stormwater discharge, marine debris, sewage discharge, disturbance of contaminated sediments, marine vessels and infrastructure, and climate change.

A subset of these was distilled to become the focus of Stage 2 and therefore are the focus of this study. These are:

- **Urban stormwater discharge** – in particular, the management of diffuse stormwater pollution.
- **Marine debris** – in particular, the management of land-based litter as a key source of marine debris.
- **Sewage discharge** – in particular, wet and dry weather overflows and leaks from the wastewater network.
- **Climate change** – in particular, sea level rise and its implications for:
    - Coastal and tidal inundation
    - Beach, estuary foreshore and bank erosion
    - Degraded / failing coastal protection structures (seawalls).

Table 2 reproduces the Scoping Study's summary of why each of these threats is important and how it affects community values (BMT, 2018, pp. 70-71). Table 3 reproduces the Scoping Study's characterisation of these threats as per the 'first pass risk assessment' (BMT, 2018, pp. 72-74).

Table 2: Scoping Study characterisation of the threats that are the focus of Stage 2 (BMT, 2018)

Threats	Why does it matter?	How does this affect communities?
Urban stormwater discharge and marine debris	The significant population and associated development in the catchment of Sydney Harbour results in substantial runoff of nutrients, sediment, contaminants, and marine debris (including micro plastics) into the harbour after rainfall events. This reduces the amenity, the water quality, and the ecosystem health of the harbour. In addition, this also causes damage to creeks and rivers due to increased water velocity.	Water pollution from stormwater discharge can impact amenity and therefore people's enjoyment and relationship (participation) with the estuaries environmental values (e.g. biodiversity and water quality). Stormwater pollution can also degrade/threaten tangible Aboriginal cultural heritage values (e.g. food sources, places of cultural significance). It also adds the cost of repairing damaged creek lines.
Sewage discharge	Being a low-lying asset that stretches from the Parramatta to the ocean, the harbour shoreline has been an ideal location for placement of sewerage. This means that many of the overflow points for sewers are close to the harbour. Overflows can cause substantial release of sewage into the harbour (pathogens, nutrients, oils, grease, contaminants, suspended solids). This has been rectified in many places but is still an issue during high rainfall conditions. Environmental impacts arise from combined stressors including nutrients, suspended sediments and toxic contaminants.	Water pollution from sewerage discharge can impact amenity and therefore people's enjoyment and relationship with the estuary environmental values (e.g. biodiversity and water quality). Water pollution occurring from sewerage discharges can also degrade/threaten tangible Aboriginal cultural heritage values (e.g. food sources, places of cultural significance).
Climate change	Climate change stressors such as sea level rise, increased temperatures and heavy rainfall events are expected to impact on the water chemistry (salinity, acidification), ecological health and functioning, and the physical (coastal, estuarine, and riverine) processes, dynamics, and form at an increasing rate over time.	Realisation of the physical environmental stressors of climate change will place pressure of the ecological functioning of the harbour, increase the prevalence of natural hazards (including coastal and flooding), and cause major disruption to the private sectors and governments operating with the coastal zone. Structural adjustments will occur in the economy. Environmental and economic changes in response to climate change will have implications for socialisation and sense of community.
Coastal and tidal inundation	Coastal and tidal inundation threaten low lying environmental assets not adapted to coastal processes. Landward migration of coastal wetlands will occur in response to sea level rise, where allowed to do so. Numerous foreshore structures (e.g. seawall) will form a barrier to wetland migration in areas.	Coastal and tidal inundation threatens low lying community use assets and infrastructure now. With increasing sea level rise, there is the potential for increased flooding of infrastructure and housing, loss of access to the foreshores and harbour, and a suite of other challenges (flooding of sewerage infrastructure, ground water intrusion). increased wave overtopping as a result of sea level rise will threaten public safety.
Beach, estuary foreshore and bank erosion/ recession	Erosion of harbour beaches, estuarine foreshore and river embankments is threat because it causes increased sedimentation in the waterway, and in a loss of foreshore biodiversity. Shoreline variability accretion has impacted seagrass meadows in some places. With sea level rise, erosion impacts will migrate landward.	Erosion is a threat to the built foreshore assets on private and crown land, foreshore access, and amenity values.
Degraded / failing coastal protection structures (seawalls)	Much of the edges of Sydney Harbour have been protected from erosion in some way. This has generally been ad-hoc and under no clear plan or design. There is no clarity about the risks associated with many of the sea-walls and of their longevity. Many are not suited to addressing the effects of climate change.	Sea-walls are expensive to build and need maintenance. likely that councils will not be able to afford more than ad-hoc repairs or upgrades, and that in the long-term the design and construction of more appropriate sea-walls will require engagement about options and priorities.

Table 3: Scoping Study risk screening assessment of the threats that are the focus of Stage 2 (BMT, 2018)

Potential threats/hazards	Existing management	Current residual risk	Likely future hazard direction	Hazard likely to become problematic in the future
Urban stormwater discharge	Yes (stormwater management plans, WQIP, licensing, education, legislation	Yes, its improving, but still not good enough. Benefits of WQIP will take time	Hazard increase in the future as population increases	Likely to be worse in bays
Sewage discharge (overflows/septics)	Yes (licensing conditions)	Yes (licensed discharges still occur)	Hazard increase in the future	Designated overflows under license agreements, also some areas where there is significant development and growth.
Coastal and tidal inundation	No	Yes	Increase	Yes, sea-level rise will lead to more inundation, which will threaten low lying development. Sea level rise also threatens high value saltmarsh habitats with no 'room to move'.
Beach, estuary foreshore and bank erosion/recession	Yes	Yes, some risk based management plans are in place, but not everywhere	Increase	Yes, will differ between natural and built environments. About 90% of Sydney Harbour is protected by some form of structure.
Degraded / failing coastal protection structures (seawalls)	Yes	Yes, there are controls but little knowledge of who owns sea-walls and they are generally repaired by councils when they fail.	Increase, as sea levels rise	Yes, aging infrastructure that is designed for lower sea-levels creates additional risk.

Key:

Existing risk under control, risk management in place and working and little change or improvement into the future

There is little risk or even if the risk is increasing there is little consequence to the harbour as a whole, or where the risk is located in a small area

There is current risk, management is not effective and there is residual risk, its likely to get worse in the future.

The scoping study screening risk assessment (Table 3) presents a simplified and limited picture of these complex issues. This study has returned to this assessment as a starting point for further analysis, noting a number of limitations of this approach, including:

- Risks are generalised across the catchment and not considered at a site by site or issues by issue basis where greater vulnerabilities may be present. This limitation reveals the importance of a detailed approach that can account for local issues.
- The characterisation of the adequacy of existing management measures and scale of residual risks has been questioned by stakeholders given the findings of other recent studies (e.g. the apparent characterisation of wastewater overflow management as 'under control' and of urban stormwater management as presenting 'little risk').
- Given significant uncertainties and unknowns in managing a complex system like Greater Sydney Harbour within a dynamic urban catchment and as the climate is changing, any attempt to characterise the likely direction, scale and significance of future hazards is fraught.
- Sydney Harbour has diverse values and stakeholders bring different perspectives. They have expressed different views on what constitutes a 'problematic' future risk.

Detailed risk assessment, typically undertaken as part of Stage 2 of a CMP as noted above, should engage with these issues and, as far as possible, overcome these limitations. This is discussed further in Section 5 in relation to waterway health and Section 6 in relation to climate change and sea level rise. Given the prevalence of uncertainties and unknowns, the following sections provide a more nuanced picture of the current state of understanding of each of the priority threats and management measures, highlighting four types of uncertainties:

1. In understanding the system: to what extent do catchment managers have access to reliable quantitative information on the current state of the Harbour, potential impacts of the threat and outcomes of different management scenarios?
2. In understanding solutions: how clearly do catchment managers understand what needs to be done to maintain the Harbour's values or meet the community's aspirational goals?
3. In implementation: to what extent do catchment managers have access to reliable evidence on the effectiveness of existing and recommended management measures?
4. In understanding future risks: to what extent do catchment managers have access to the information they need to assess future risks?

Note that uncertainties are inherent to the nature of these complex hazards and are never likely to be fully eliminated. However, uncertainties need to be understood and can be reduced with improved management.

Each section below is based on previous studies, information from Study 1, as well as further consultation with catchment managers and input from the expert workshops during Study 2.

4.1 URBAN STORMWATER DISCHARGE

Stormwater runoff has been consistently identified as a significant risk in previous studies. This includes the Sydney Harbour Water Quality Improvement Plan (NSW Local Land Services, 2015, p. 40), which identified four 'high to very high' risks, three of which were:

- Stormwater runoff (including nutrients and sediments)
- Lack of knowledge about the water pollution cycle (generation, transport and impact)
- Lack of enforcement, punishment and deterrents against inappropriate actions.

The Parramatta River Masterplan (Parramatta River Catchment Group, 2018) also identified stormwater runoff as a significant issue, with Step 5 focused on reducing runoff. Step 4 ('Standardise the standards') is also focused on addressing stormwater pollution.

Table 4 summarises uncertainties in the assessment and management of risks associated with urban stormwater discharge.

Table 4: Uncertainties related to urban stormwater discharge

Areas of uncertainty	Specific uncertainties related to urban stormwater discharge
System	Current monitoring does not provide a sufficient understanding of trends in underlying issues (e.g. poor water quality) and previous studies have been limited in their ability to link policy and management scenarios with water quality outcomes in the Harbour.
Solutions	There is a good understanding of the type of measures that can reduce pollutant loads at a site scale. Therefore, it is thought that contemporary stormwater treatment measures are the right approach, but that more investment is required. Yet it is not clear how much investment is required, nor where is best to invest. The catchment-scale effectiveness of current management actions is uncertain. Applied research is needed to explore the effectiveness (local to catchment scale) of planning, policy and management actions.
Implementation	In the private domain, impacts of development are only partially addressed in planning provisions and compliance has been identified as a gap. The long-term effectiveness of stormwater treatment systems in the private domain is largely unknown. In the public domain, stormwater management is inconsistent across the catchment, with funding a major constraint for most councils.
Future risks	Development in the catchment is understood to be increasing the impervious area and therefore increasing stormwater runoff and pollutant loads. This has been quantified in previous studies based on land use planning at the time of each study. It is not clear whether existing management approaches are sufficient to offset this impact or not. The potential impacts of climate change on stormwater discharge and water quality in the Harbour are only understood in general terms.

4.2 MARINE DEBRIS

Litter and marine debris have also been identified as threats in previous studies. The Sydney Harbour Water Quality Improvement Plan lists litter as a moderate threat to the Harbour (NSW Local Land Services, 2015).

The recent Greater Sydney Harbour Regional Litter Prevention Strategy (Parramatta River Catchment Group and Sydney Coastal Councils Group, 2022) notes 2021 community survey results identifying that 82% of respondents who stated that a problem in waterways. The strategy points out the large quantity of litter and debris removed from the catchment and Harbour each year, and the significant cost involved in this.

Marine debris is closely related to stormwater runoff, as urban stormwater runoff is a significant source of marine debris. Most marine debris is derived from land-based litter and in Australia, marine debris is concentrated around major cities and urban centres which suggests local sources within urban areas (Centre for International Economics, 2021).

Table 5 summarises uncertainties in the assessment and management of risks associated with marine debris.

Table 5: Uncertainties related to marine debris

Areas of uncertainty	Specific uncertainties related to marine debris
System	There is a good understanding at state level of the impacts of debris on marine ecosystems in general (NSW Department of Planning and Environment, 2022a), but specific impacts on Sydney Harbour are not understood in detail.
Solutions	SCCG and the PRCG have recently completed a Litter Prevention Strategy for the Greater Sydney Harbour Catchment (Parramatta River Catchment Group and Sydney Coastal Councils Group, 2022). This aims to establish a more strategic approach to prevention of land-based litter in the catchment. The new strategy provides local direction, and the State Government has also committed to relevant actions in the Waste and Sustainable Materials Strategy (NSW Department of Planning, Industry and Environment, 2021).
Implementation	Implementation of the litter prevention strategy is in its early days, and it is not yet clear how much impact it will have. EPA has recently commenced new measures of catchment-based litter (the Australian Litter Measure) and litter in estuaries (the Key Littered Items Study) (NSW Environment Protection Authority, 2022). Until there is a longer time series of data available from both measures, it is too early to identify trends or understand the success of management strategies.
Future risks	If there is increasing demand for recreational use of Sydney Harbour, the community are likely to perceive marine debris as an increasingly important issue due to its significant visual impact and 'yuck factor'. Microplastics (some of which are derived from marine debris) are also an emerging pollutant of concern.

4.3 SEWAGE DISCHARGE

The fourth 'high to very high' risk identified in the Sydney Harbour Water Quality Improvement Plan (NSW Local Land Services, 2015, p. 40), was sewage overflows.

In the Parramatta River Masterplan (Parramatta River Catchment Group, 2018), wastewater overflows were also identified as a significant threat to the vision of bringing back swimming, and Step 6 is focused on improving overflows.

While Sydney Water has a good understanding of sewage discharges and their management within existing, well-established frameworks, they are still perceived as a significant threat due to the substantial public health risk posed by wastewater pollution.

Note that sewage discharges in the catchment include:

- Wet weather overflows, which occur predominantly due to stormwater entering the wastewater system, via both infiltration and illegal connections, and overloading the capacity of the network. Wet weather overflows occur at controlled overflow points in the network.
- Dry weather overflows, which occur predominantly due to blockages/chokes in the wastewater network caused by tree roots and inappropriate disposal of solids in the wastewater system (Sydney Water, 2021). They may occur anywhere but are
- Dry weather leaks, which occur when wastewater leaks into stormwater drains and waterways during dry weather. Causes may include illegal connections and damaged infrastructure in the wastewater network.

Wet weather overflows are much higher magnitude than dry weather overflows or leaks, and are also more predictable and readily quantified.

Table 6 summarises uncertainties in the assessment and management of risks associated with sewage discharge.

Table 6: Uncertainties related to sewage discharge

Areas of uncertainty	Specific uncertainties related to sewage discharge
System	Sydney Water reports on wet and dry weather overflows each year, including the impact on designated swimming sites, but this provides a limited view of the impacts on Greater Sydney Harbour beyond a few specific sites. Modelling undertaken for the Parramatta River Masterplan (Jacobs, 2018) quantified the impact of various wet weather overflow scenarios on swimmability in the Harbour as a whole, in terms of *Enterococci* concentrations, but did not consider dry weather discharges.
Solutions	Sewage discharges are regulated under Environment Protection Licences issued by EPA. Regular reviews have the potential to encourage performance improvements over time. In the most recent review, a risk-based framework has been proposed to replace the previous frequency-based system, to better account for the impact of overflows on the environment.
Implementation	Sewer discharges will never be completely eliminated but ongoing management efforts are reducing the risks. Monitoring is in place so the effectiveness of management interventions can be assessed. However, stakeholders other than Sydney Water have a limited view of the management measures or their outcomes, and remain uncertain about whether the measures in place are sufficient to address the risk.
Future risks	If there is increasing demand for recreational use of Sydney Harbour, the significance of risk posed by sewage discharges could increase. Risks are also likely to increase with climate change, however there are risk management measures already being implemented to mitigate at least some of these climate-related risks (e.g. pumping stations are being modified to protect them from sea level rise).

4.4 CLIMATE CHANGE

Climate change has not been consistently identified as a threat in previous studies, for example the Sydney Harbour Water Quality Improvement Plan discusses climate change only briefly in terms of its potential impacts on stormflows, flooding, and biodiversity, but it does not identify it among the threats in Table 3 (NSW Local Land Services, 2015, p. 40).

Climate change studies have not consistently identified the range of risks posed by sea level rise, for example the NSW Estuary Tidal Inundation Exposure Assessment (NSW Office of Environment and Heritage , 2015) focuses on private properties exposed to climate change.

However, expert workshops held as part of the GSHCMP Stage 2 made it clear that climate change needs to be considered as a significant threat to a wide range of community values, due to the risks posed by sea level rise and its likely impacts on private property, public infrastructure, community values (e.g. public space) and natural values (e.g. coastal habitat). It will also have an impact on the hydrodynamics and physio-chemical processes that will have flow-on effects on water quality in the Harbour, as documented in the series "Climate change in estuaries: State of the science & guidelines for assessment" (UNSW Water Research Laboratory, 2019).

Table 7 summarises uncertainties in the assessment and management of risks associated with climate change.

Table 7: Uncertainties related to climate change

Areas of uncertainty	Specific uncertainties related to climate change
System	Previous studies assessing the risks of climate change have not considered the effects on the Harbour as a system, leaving significant gaps in understanding the risks. Previous studies: • Are either too large-scale to consider the Harbour in any detail, or too small-scale to consider the Harbour as a whole. • Do not consider all factors leading to increased inundation (e.g., the effects of a reduced drainage window and increased sedimentation on local floodplain drainage). • Stop short of assessing all the impacts of climate change and sea level rise, focusing on the frequency and magnitude of inundation.
Solutions	Management plans have not been developed. Affected properties have only been identified in some LGAs and few councils have set planning levels for private properties exposed to sea level rise. Most councils have reasonable data on their assets but have not considered how they will be impacted by sea level rise in any detail.
Implementation	The risks of climate change and sea level rise are only understood in general terms. Existing guidance lacks sufficient detail to provide a clear framework for councils to manage the risks of sea level rise.
Future risks	Hazards posed by climate change will increase over the coming decades. Climate change projections show that sea levels will continue to rise, even after global temperatures stabilise. Increasing inundation threatens low lying development, low-lying public assets, high value public open space and high value saltmarsh habitats with no 'room to move'. Climate change and sea level rise also poses a threat to water quality in the Harbour. Catchment managers currently lack the capacity to stay abreast of this evolving threat.

5 ALIGNING WATERWAY HEALTH WITH COMMUNITY VALUES

Urban stormwater discharge, marine debris and wastewater overflows have been identified as high-priority threats to the Harbour's values (Section 4). All of these have an impact on waterway health. Compounding these three threats, climate change is expected to exacerbate waterway health risks through impacts on rainfall and runoff (for example, a record wet year in 2022 has led to a decline in water quality at estuarine swimming sites at NSW in the 2021-22 reporting year (NSW Department of Planning and Environment, 2022b)), and higher sea levels that will alter water chemistry (salinity, acidification), ecological health and function, and through physical changes to the coastal, estuarine, and riverine systems. There is an urgent need for action when viewed through the multiple lenses, first the current threats then those emerging that are associated with climate change.

The call for action to meet community expectations for a cleaner Harbour is not new. Action is underway; however, progress has been limited by the governance complexities in urban water and catchment management. Previous studies (see Table 1) and the analysis of existing planning documents in Study 1 (McAuley, Adams, & Davies, 2022) have consistently revealed an alignment of concern for the health of the Harbour, yet barriers to effective action remain, with root causes linked to responsibility, accountability and funding.

Having achieved this waterway health and community values nexus, the next steps must disentangle and resolve the two core objectives of this study, that is how to improve the physical settings impacting urban water quality (e.g. diffuse stormwater pollution and climate change) and the governance arrangements, linked to accountability and funding.

Whether waterway health can be fully aligned with community values is an open question given the ubiquity of urban stormwater pollution, legacy contamination in Harbour sediments and contemporary pressures linked to development policy and practice. In this context, there are opportunities to position policy and practice change being led by the community to create a socio-political step change. Alternatively, change may be subject to the gravity of path dependency that seeks to avoid new and innovative approaches, that is often cloaked by a position of the cost to act and not the benefits of action.

5.1 IN THEORY: THE RISK-BASED FRAMEWORK HAS BEEN APPLIED

The NSW Coastal Management Toolkit provides several resources to support preparation of coastal management programs. The 'Risk-based Framework for considering waterway health outcomes in strategic land use planning decisions' (Risk-based Framework) is intended to help decision-makers understand interactions between their community's environmental values and uses of waterways, land-use pressures that impact them, and the management options available that help protect them. "The Framework allows decision-makers to determine management responses that meet waterway health outcomes which reflect the community's environmental values and uses of waterways" (Dela-Cruz, Pik, & Wearne, 2017). It sets out the process shown in Figure 5.

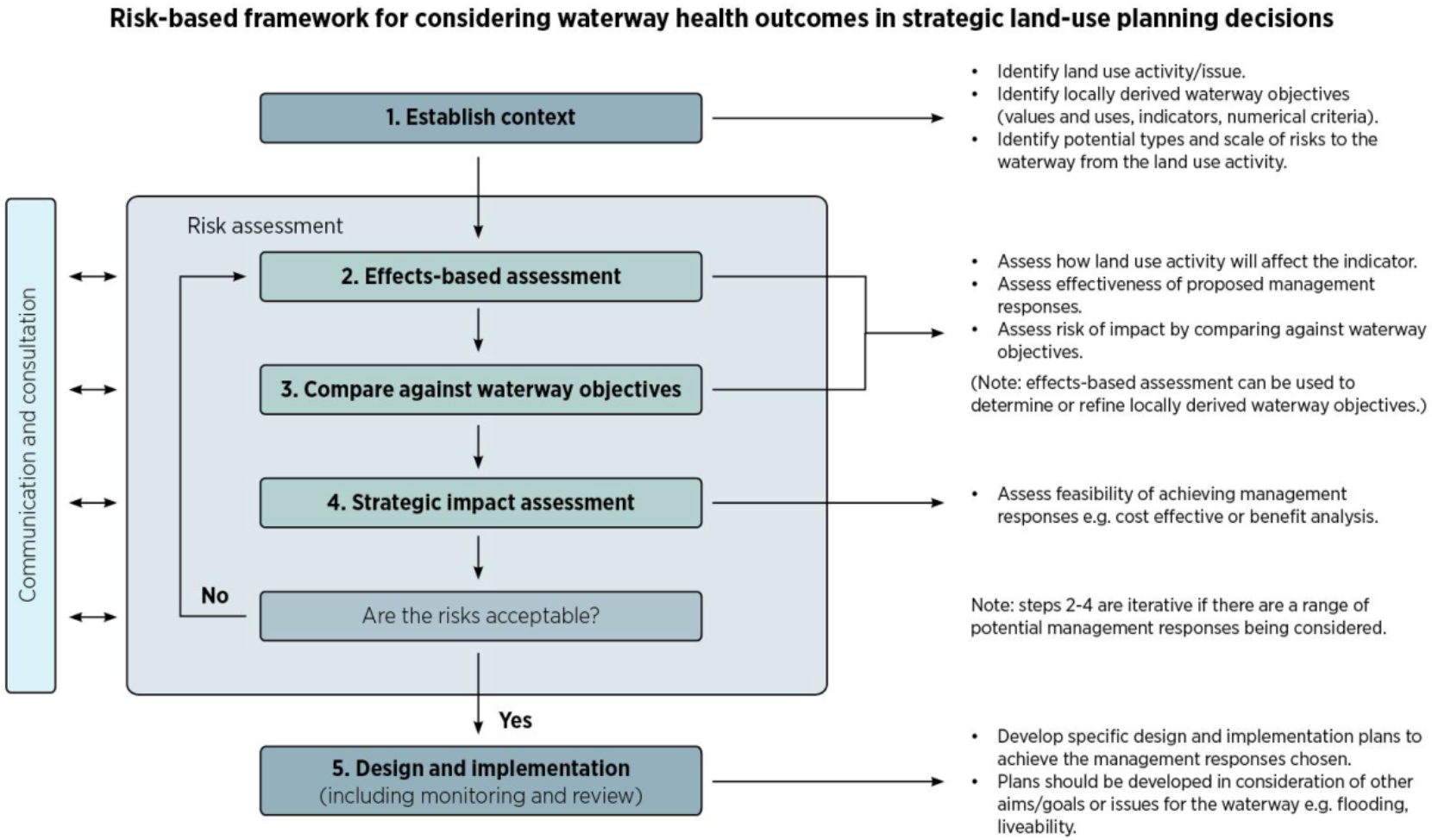


Figure 5: Risk-based Framework for considering waterway health outcomes in strategic land-use planning decisions (Dela-Cruz, Pik, & Wearne, 2017)

Note that there are strong similarities between the risk-based framework and the water quality management framework that was first introduced in the ANZECC guidelines in 2000 (ANZECC & ARMCANZ, 2000) and updated in the current version of these guidelines (ANZG, 2018). Therefore, previous studies prior to 2017 have applied very similar frameworks. The following sections (5.1.1 and 5.1.2) outline how the risk-based framework was applied in the Sydney Harbour Water Quality Improvement Plan (NSW Local Land Services, 2015) and the Parramatta River Masterplan (Parramatta River Catchment Group, 2018).

Application of the risk-based framework relies on significant data inputs, modelling effort and stakeholder engagement. Given the complexity of the system and the uncertainties discussed in Section 4, not all this uncertainty can be resolved, and some questions remain unanswered. Yet both these projects have advanced catchment managers' understanding of the Harbour and its catchment, informing the management initiatives in place and underway today.

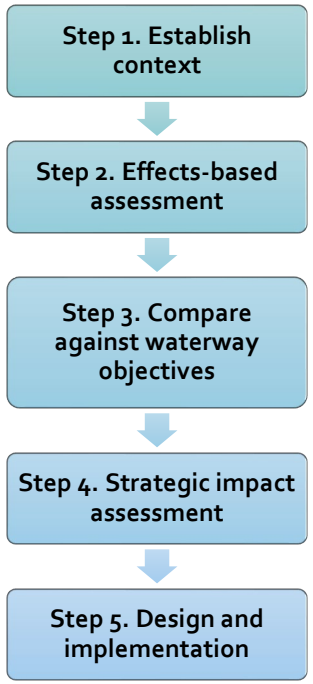
5.1.1 The Sydney Harbour Water Quality Improvement Plan

While previous Sydney Harbour Water Quality Improvement Plan (NSW Local Land Services, 2015) was completed before the NSW Government published guidance on the Risk-based Framework, it essentially applied the same process as shown in Figure 5. The plan stated that it was "developed to be consistent with the risk framework being designed and implemented... by the Marine Estate Management Authority (MEMA)" (NSW Local Land Services, 2015, p. 1). An outline of its main components, in line with the steps in the risk-based framework, is shown in Figure 6.

The Water Quality Improvement Plan took a broad approach and makes broad recommendations for implementation by multiple stakeholders, across a wide range of areas to improve management of stormwater pollution, wastewater overflows, contaminated sediments, and contaminated groundwater. Recommendations cover education, treatment, maintenance, enforcement, planning provisions, habitat restoration, and monitoring. It also makes recommendations for policy review, funding and coordination.

These broad recommendations were largely consistent with the direction of catchment management efforts already underway at the time, and served to reinforce the evidence supporting these directions in the local context. However, the benefits of action are also stated in broad terms (e.g., general alignment with values and stakeholder views) rather than identifying any specific outcomes. Therefore, the plan provided no tangible short-term targets, no compelling urgency to lift the level of action, and little confidence that long-term outcomes would be achievable.

Main steps in the risk-based framework:



How these steps were applied in the Sydney Harbour Water Quality Improvement Plan (NSW Local Land Services, 2015)**:**

1. It identified the benefits of Sydney Harbour and its tributaries, and assessed the threats and risks to these benefits.
2. It quantified how land use activity would affect key pollutants including Total Nitrogen (TN), Total Phosphorus (TP), Total Suspended Solids (TSS), *Enterococci* and faecal coliforms (however, it did not quantify the impact of pollutant loads on receiving water quality parameters such as turbidity, Cl-a, or other indicators of swimmability or ecological health).
3. It proposed a localised set of targets for pollutant load reductions required to protect the condition and values of the Harbour.
4. Assessment was based on modelling a range of management responses including WSUD in new development, WSUD retrofits, and a sewer overflow reduction program.
5. Management options were evaluated and the plan identifies high, moderate and low-priority recommendations. It also includes a plan for monitoring and review.

Figure 6: How the Sydney Harbour Water Quality Improvement Plan aligned with the risk-based framework

5.1.2 *The Parramatta River Masterplan*

In the development of the Parramatta River Masterplan (Parramatta River Catchment Group, 2018), the PRCG applied the Risk-based Framework, as shown in Figure 7. The Parramatta River Masterplan applied the framework with a specific focus on the objective of bringing back swimming to parts of the Parramatta River. Technical assessment was completed as part of the Water Quality Modelling Study (Jacobs, 2018).

The Parramatta River Masterplan (Parramatta River Catchment Group, 2018) offers guidance on clarifying the community's aspirations in a manner that is ambitious but specific enough to be achievable and to be clear what must be changed. The PRCG's approach suggests that even though it is very challenging to improve water quality across a large urban catchment, it is possible to take many practical steps to meet community expectations and shift social, policy and institutional norms to create cleaner urban waterways.

The creativity of the Parramatta River Masterplan (Parramatta River Catchment Group, 2018) to identify specific sites for swim activation, rather than a generic statement that all waterways and locations therein are to be swimmable, offers a new approach. In the past, catchment management plans have tended to articulate generic concerns, objectives and expectations. Most often these aspire to all urban waterways and sections therein being improved to some degree (refer to the Stage 1 report, McAuley, Adams and Davies 2022). Through identifying specific swim activation sites based on engaging with the community, technical studies, applying risk-based framework and this novel and site-specific approach is emerging as a successful template to align waterway health outcomes with community values. Moreover, this approach has emboldened several councils to identify, design and deliver swim sites that align with community values to a tangible outcome. In doing so, and in partnerships with state agencies, Sydney Water and others, it has enabled a revitalised focus on the value of and opportunities to have an immersive experience, to swim and play in the Harbour, rather than a more superficial view from the edge. The evidence of this impact can be seen in frequent media reports heralding the opening of swim activation sites (for example: Sydney Morning Herald, 2022) and therefore providing a consistent reminder to the community and government of this initiative.

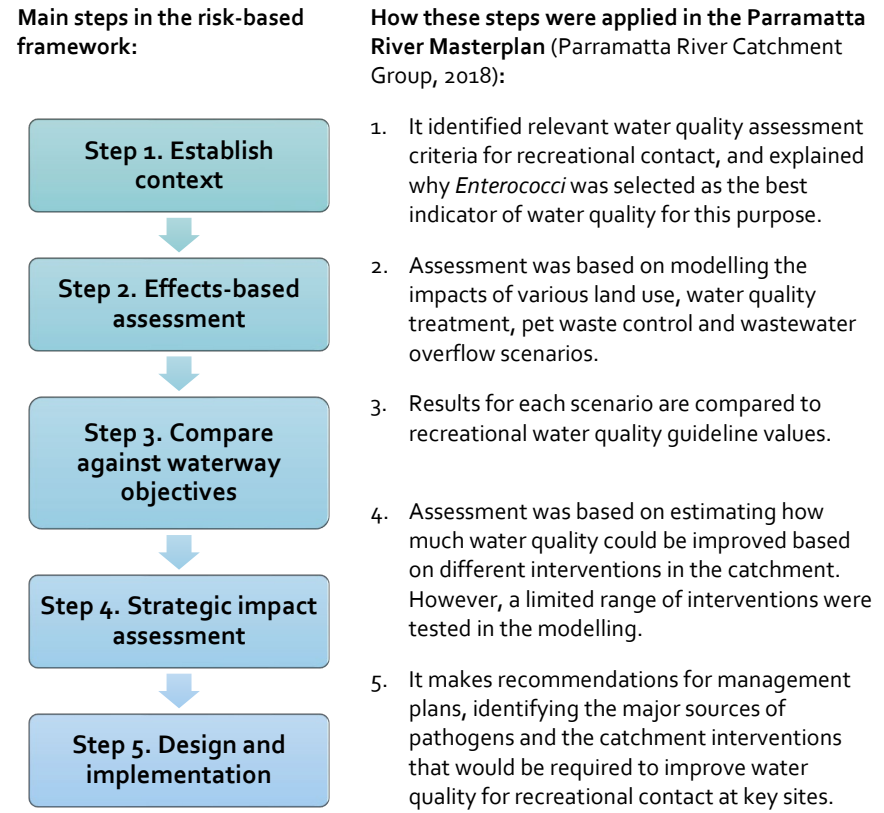


Figure 7: How the Parramatta River Masterplan aligned with the risk-based framework

5.2 IN PRACTICE: IMPLEMENTATION IS CONSTRAINED

Both the Sydney Harbour Water Quality Improvement Plan (NSW Local Land Services, 2015) and the Parramatta River Masterplan (Parramatta River Catchment Group, 2018) recommend action to reduce stormwater runoff and pollutant loads, and to reduce wastewater overflows into the Harbour. In doing so, these studies have sought to assign responsibilities to various authorities, notwithstanding these agencies remain captured by the path dependencies of insufficient funding, authority and accountability.

The following two sections review progress with the implementation of recommendations from both the Water Quality Improvement Plan and the Parramatta River Masterplan. Being broader in its approach, the Water Quality Improvement Plan includes a longer list of recommendations and below, only the high priority recommendations have been reviewed. The Parramatta River Masterplan includes just ten 'steps' focused on shorter-term action to 2025.

Comparing the two suggests that a more focused set of recommendations in the Parramatta River Masterplan may be one of the factors that has contributed to its success. Comparing the two also suggests that the success of the Parramatta River Masterplan is likely related to its governance arrangements - who has been assigned to take action, how they were engaged to take responsibility for implementation, and the role of the PRCG in maintaining a level of ongoing accountability to shared goals.

5.2.1 *The Sydney Harbour Water Quality Improvement Plan*

Sections 3 and 4 of this report showed that values, uses and threats to the Harbour have not changed since the Water Quality Improvement Plan was completed; therefore, its findings and recommendations remain valid. However, implementation has been a challenge.

Table 8 lists the high priority recommendations from the Water Quality Improvement Plan (NSW Local Land Services, 2015) and includes an assessment, based on the findings of Study 1, of what has been achieved against each of these recommendations in the last seven years since the plan was completed. A 'health check' against each recommendation identifies whether there has been an improvement, no change or worsening performance.[3]

This shows that improvements have been modest (at best) and inconsistent across the catchment thus unable to achieve the step change in management practices needed for catchment wide to site specific improvements in environmental condition. Some of the GSH councils have made improvements to land use planning provisions that are designed to address the impacts of future development. Sydney Water has introduced their Waterway Health Improvement Program and continued to implement wastewater overflow abatement programs, including a recent focus on the Parramatta River catchment. At the community level, education programs initiated in partnership with state and local government have been targeted towards changing individual normative behaviours, such as Get the Site Right.

[3] Note that the Water Quality Improvement Plan includes an evaluation framework (NSW Local Land Services, 2015, pp. 62-64) which was intended to enable evaluation of the plan's performance. This framework could also be applied to evaluate progress. Its list of measures is very similar to the list of recommendations reproduced in Table 5; however, the recommendations were more specific than the evaluation framework in terms of exactly what should be done and by whom, therefore the recommendations were used for the health check to provide a clearer picture of progress.

However, barriers remain. The Water Quality Improvement Plan has not been supported by improved governance or funding. There remains a lack of coordination, consistency, and leadership to implement its recommendations:

- In the past, Sydney Metropolitan Catchment Management Authority (2004-2011) and Greater Sydney Local Land Services (2011-2017) played a coordinating role. However, State government has not supported the implementation of the Water Quality Improvement Plan's recommendations. The restructure of Greater Sydney Local Land Services (GSLLS) in 2017 left a gap in the coordination of catchment management, which remains only partially filled by the efforts of PRCG and SCCG. Stormwater quality remains a weak point in state policies and planning instruments.
- Support for councils to build capacity and improve their catchment management practices has been provided in the past by the WSUD in Sydney Program (2002-2007), and briefly, the Splash Network (2016-2017). Other organisations such as PRCG have also played a role. However, NSW has consistently lacked the equivalent of Victoria's Clearwater program, South East Queensland's Healthy Waterways Partnership or South Australia's Water Sensitive SA.
- Across the catchment councils, progress on WSUD implementation in the public domain and as part of public infrastructure projects has been limited (notably managing runoff from roads).
- For households, schools and community organisations, programs and support is patchy and it is unknown whether actual behaviours have changed.

Reflecting on these limitations suggest the need for substantial reform and a step change in governance, funding, and capacity. This must be the precursor of change. The Sydney Harbour CMP should not repeat the process of the Water Quality Improvement Plan and reiterate the same recommendations, which would continue to offer support but are not sufficient in and of themselves to break through the barriers of policy and practice inertia.

5.2.2 The Parramatta River Masterplan

The PRCG has had more success with the implementation of their Masterplan. The reasons for this are likely to include being more focused on a tangible goal (which also strongly resonates with the community), having a more targeted set of just 10 actions in the Masterplan, establishing Sydney Water as the lead coordinating agency, and the PRCG's ongoing presence to support implementation.

The ten steps of the Masterplan, listed in Table 9, include a brief note on progress against each step. The first three steps are focused on activating swimming sites and this is probably where the most noticeable progress has been made.

Steps 4-6 are focused on improving water quality, and Steps 4 and 5 are particularly focused on areas where councils play a significant role. Under Steps 4 and 5, Sydney Water has been able to fund some key studies and coordinate activities required at a catchment scale to progress necessary planning work, therefore there has been progress on understanding what to do (e.g. research, planning, guidance). Implementation of Steps 4 and 5 still sits primarily with councils. Actions have made slow progress within the individual councils, for all the reasons outlined in Study 1. Sydney Water has made more substantial progress on Step 6.

Steps 7-10 are focused on broader involvement and here, there has been a range of activities underway. Councils are involved; however, these activities could be scaled up if councils had greater capacity to support them.

The success of the PRCG's Masterplan supports the case for Sydney Water – as a statutory State Owned Corporation with clear revenue pathways and extensive asset ownership – to continue to take a role in catchment management.

Table 8: High priority recommendations of the Sydney Harbour Water Quality Improvement Plan (NSW Local Land Services, 2015) and progress on their implementation

Recommendations from the WQIP – high priority actions	Progress on implementation of each action, based on Study 1 findings	Health check*
Business to incorporate WSUD into any redesign or redevelopment of commercial building sites – e.g. biofiltration systems for carpark runoff	Stormwater quality treatment is included in the private domain when required under planning provisions. Relevant provisions are included in 76% of DCPs currently in force in the catchment, generally applicable to larger-scale commercial sites (typically, to sites greater than 1-2,000 m²).	
Households, schools and community organisations to take actions on their own properties that support the load reduction targets for the catchment. These might include things like installing: rainwater tanks, permeable paving, rain gardens (small household scale bioretention systems).	There is no measurement of the extent of action in this area.	
Councils to: - Seek opportunities to incorporate WSUD principles and stormwater harvesting in asset renewal programs for their own stormwater infrastructure.	Study 1 showed that currently, across the 20 GSH councils: - 65% are installing new treatment systems when opportunities arise, however only 30% have strategic plans in place to guide this process. the other 35% operate opportunistically.	
- Incorporate maintenance of WSUD such as GPTs, wetlands and biofiltration systems in their works plans and ensure devices are maintained on a regular basis.	- Over recent years, councils have been focused on improving asset management across all asset classes, including information on asset condition, current value, remaining life, and renewal cost as well as information on ongoing maintenance schedules and costs. At least 50% of GSH councils have recently audited their GPTs.	
- Provide training to staff who are involved in the maintenance and on-ground works e.g. operational staff so they understand how WSUD works and potential impacts of their actions on water quality.	- GSH councils have noted that it is still hard to overcome internal barriers to collaboration, however the root cause is unlikely to be a lack of training per se.	
- Include the stormwater/WSUD clause developed by the GSLLS into the LGA's Local Environment Plan (LEP).	- As LEPs are updated, an increasing number include a stormwater quality/WSUD clause, however there are still many that do not. Study 1 found that only 32% of current LEPs have comprehensive objectives or consent considerations relating to improving stormwater quality.	
- Prepare or update the LGA's Development Control Plan(s) to include WSUD and the stormwater pollutant load reduction and flow control targets identified in the Plan.	- As DCPs are updated, an increasing number include stormwater quality/WSUD provisions. Study 1 found that relevant provisions are included in 76% of DCPs currently in force in the catchment	
- Ensure new or renewed local council infrastructure (i.e. roads, drainage, car parks, footpaths, bike paths, etc.) is designed from a WSUD perspective and meets the stormwater pollutant load reduction targets, to minimise impacts on waterways.	- WSUD is not routinely integrated into most local council infrastructure projects. In Study 1, some of the GSH councils explained that it is still challenging to collaborate across internal boundaries, particularly when resources are constrained. 35% of GSH councils are not installing any new WSUD systems at all, while another 25% are	

Recommendations from the WQIP – high priority actions	Progress on implementation of each action, based on Study 1 findings	Health check*
	installing them opportunistically. 30% have a more systematic approach with strategic plans in place for at least certain parts of the LGA.	
- Engage with and support local communities implementing actions consistent with the Sydney Harbour WQIP.	- Some councils have programs in place to support households, schools and community organisations to take action on diffuse stormwater pollution, however there are only 50% of councils with education campaigns, 40% who offer community capacity building events and 20% with incentives available to the community to reduce pollutant loads (e.g. rainwater tank rebates).	
Sydney Water to: - Continue improving sewer overflow performance through the catchment and identifying and managing illegal connections.	Sydney Water has an ongoing program to improve wet-weather sewer overflow performance, as well as a program to detect and reduce dry weather leakage. Sydney Water is currently working with the EPA to prioritise wet weather overflow abatement works in the Parramatta River catchment.	
- Seek opportunities to incorporate WSUD principles and stormwater harvesting in asset renewal programs for their own stormwater infrastructure.	Sydney Water has a Waterway Health Improvement Program (WHIP) with funding allocated to stormwater treatment projects.	
State Government to: - Incorporate WSUD in BASIX, DCP and LEP guidelines, growth plans and other policy and planning instruments.	While WSUD objectives may be included in planning instruments for specific precincts (e.g. Wentworth Point), they have not been systematically included in the LEP Standard Instrument, in BASIX, or in any other SEPPs.	
- Review the level of fines and other regulatory instruments used to enforce water quality requirements (such as for removal of vegetation or use and maintenance of erosion and sediment controls on building sites) to ensure they are adequate to ensure compliance.	There has been no change to fines or regulatory instruments.	
- Provide funding and support to local government to implement recommendations of the WQIP.	There has been no funding or support for implementing the WQIP's recommendations. Study 1 found that funding has become more constrained for councils in the time since the WQIP was completed.	
- Incorporate the stormwater load reduction targets proposed in the Plan into regional planning policies.	Regional planning policies (e.g. the Greater Sydney Region Plan and District Plans) include general goals and objectives related to healthy waterways, but no specific targets.	
- Ensure any new government policies or plans developed for, or that will have an impact on, the Sydney Harbour catchment are consistent with the objectives of Plan.	There is a new Environment SEPP currently in draft, which consolidates several former plans including the Sydney Harbour REP. However, it does not include any substantial updates, and as the Sydney Harbour REP predates the WQIP by 10 years, it is not consistent with the WQIP. Other State planning instruments also lack provisions for stormwater quality -the Codes SEPP is a notable gap, due to its impact on the Sydney Harbour catchment.	

Recommendations from the WQIP – high priority actions	Progress on implementation of each action, based on Study 1 findings	Health check*
- Ensure the use of the Sydney Harbour CAPER DSS to model the impacts of large scale projects proposed in the Sydney Harbour catchment before allocating funding or giving approval.	The CAPER DSS tool does not appear to have been applied to any large scale or other projects since the WQIP was completed.	
- Ensure the GSLLS has the funding to continue to support the implementation of the Plan and to maintain and update the Sydney Harbour CAPER DSS and other catchment and estuary models developed.	After the WQIP was completed, Greater Sydney Local Land Services (GSLLS) was restructured, and their programs no longer include catchment and estuary planning.	
- Ensure Sydney Water continue to improve the sewer overflow performance throughout the catchment.	Sydney Water's wastewater Environment Protection Licences (EPLs) are reviewed each 4 years. In the most recent review, a risk-based framework has been proposed to replace the previous frequency-based system, to better account for the impact of overflows on the environment.	
Federal Government to: - Provide funding programs to support coordination of actions between Local and State Government and to encourage implementation and ongoing maintenance of WSUD. - Ensure all environmental grants or funding allocated in the Sydney Harbour Catchment are consistent with and/or supports the implementation of this Plan. - Continue to fund water quality improvement devices in the Sydney Harbour catchment that are consistent with this Plan.	The Federal government's Environment Restoration Fund has 'Protecting and restoring Australia's coastal rivers and waterways' as one of its current priorities, however this program is not currently funding any projects in the Greater Sydney Harbour catchment.	
All government to set up and adequately fund a program or initiative to coordinate management actions in the Sydney Harbour catchment and assist MEMA in the management of threats to the Harbour. This should facilitate collaboration between Local Government, State Government, Sydney Water and key business interests.	No such program or initiative has been established. The gap has been partially filled by the PRCG (particularly since the Parramatta River Masterplan was completed) and the SCCG's coordination of the current CMP, however adequate funding remains a persistent challenge.	

* Key:

 improving no or very little change  worsening

Table 9: Progress on implementation of the Parramatta River Masterplan (Parramatta River Catchment Group, 2018)

The ten steps in the Parramatta River Masterplan (Parramatta River Catchment Group, 2018)	Progress on implementation (selected highlights), as reported by the PRCG at their Masterplan Dashboard
1. **Get swimming** (at existing swim sites)	Visitor data and user preference surveys completed at existing swimming sites, for insight into the planning of future sites.
2. **Keep watch** (put a Riverwatch water monitoring program in place)	Substantial progress on microbial monitoring, chemical assessment and human health risk assessment for priority swimming sites. Predictive models are being established to support the program.
3. **Create new swimming spots** (three new ones by 2025)	Concept designs and community engagement completed for 3 sites. Bayview Park detailed design and construction has been completed and this swim site is due to open in November 2022.
4. **Standardise the standards** (consistent policies and practices across councils)	Recommendations paper published in 2021, providing guidance to councils to update their planning provisions. A pilot of the blue-green index tool has been initiated in Camellia.
5. **Reduce runoff** (and in doing so, reduce stormwater pollution)	A Stormwater Subcommittee has been meeting regularly and a workplan established, focusing on developing sustainable stormwater management plans and foreshore litter prevention. An audit of private WSUD systems has been completed with recommendations incorporated into a workplan, and a research report has been completed on microbial hazards in urban stormwater and their removal through WSUD.
6. **Improve overflows** (from the wastewater system)	Sydney Water has been working with the EPA to prioritise wet weather overflow abatement works in the Parramatta River catchment. Works include inflow reduction, infiltration reduction and rectification of illegal connections on private property.
7. **Involve the community** (giving everyone a role)	Activities include Get the Site Right, Love Your Waterways campaign, Riverkeeper network, Riverfest and other community events.
8. **Bring in nature** (maintain, improve, and create new habitats for native species)	A Biodiversity Subcommittee has met on several occasions and a workplan established, focusing on the five iconic species identified in the Masterplan. Talks and webinars have been held for council staff and the community. A citizen science program is being developed.
9. **Report back regularly** (track progress)	The Masterplan Dashboard is updated regularly with details on progress against each step.
10. **Create clear leadership** (Sydney Water to lead a collaborative effort)	Governance arrangements have been established. An Aboriginal Leadership: Community Engagement Report has been completed and has been followed up by other actions focused on Aboriginal engagement, storytelling and design.

5.3 THE GAP BETWEEN PLANNING AND IMPLEMENTATION

Previous plans have identified what needs to be done to improve the health of the Harbour and enhance community values, however implementation has been a persistent challenge.

Sydney has a long history of catchment management initiatives as outlined in the Stage 1 report (McAuley, Adams, & Davies, 2022). There are a number of repetitive and common themes that have persisted impacting their success. The Stage 1 report identified these underlying constraints falling to fragmented governance, insufficient and inadequate funding and constraints to collaboration.

Other previous studies have identified similar issues. For example, a discussion paper prepared for the 2021 'franc' conference (Thomas, Prodanovic, Zhang, & Jamali, 2021) presented a set of policy, funding, capacity building and collaboration issues which are summarised in Table 10. The CRC for Water Sensitive Cities characterised the progress of Sydney's transition to a water sensitive city as being "risk of stagnation if critical enabling conditions are not established" (CRC for Water Sensitive Cities, 2018, p. 26). The CRC defines six phases to transition, and characterises Sydney's current progress as spanning phases 2 (issue definition), 3 (shared understanding and issue agreement) and 4 (knowledge dissemination). They characterise Sydney as not yet displaying any sign of the factors that characterise phases 5 (policy and practice diffusion) or 6 (embedding new practice) (CRC for Water Sensitive Cities, 2018).

These persistent issues serve to constrain the implementation of catchment management initiatives. For example, the biggest gap in the implementation of Water Quality Improvement Plan recommendations (Table 8) has been the absence of funding and support for Greater Sydney Local Land Services and local government to implement recommendations of the plan. Progress remains flat in many other areas.

Table 10: Issues raised in the Franc conference discussion paper (Thomas, Prodanovic, Zhang, & Jamali, 2021)

Themes	Issues raised
Policy issues	No over-arching statewide commitment to sustainable urban water management Fragmented policy Unclear / poorly resolved lines of authority and responsibility Weak policy and impotent regulatory instruments
Funding issues	No funding programs dedicated to transitioning urban water management practice No viable funding mechanism for the ongoing operation and management of WSUD Infrastructure WSUD funding is opportunistic rather than strategically planned to optimize the benefits
Capacity building	No formal capacity building mechanism Lack of state-sanctioned guidelines and standards No state-based formal technical support to local government
Collaborations	Disparity of understanding and acceptance of WSUD across and within different stakeholder groups No formal collaborations 'hub' Active resistance [from developers and in some instances, state government] Short-lived and poorly conceived collaborations Legal barriers

Successful examples demonstrate that well-targeted action is effective, although care is needed when aspiring to replicate these initiatives due to socio-political and environmental differences:

- Focused management actions have proven effective at reducing point source pollution, managing high-risk activities (e.g., management of erosion and sediment from construction activities), and addressing key contaminants of concern (e.g., litter has been targeted with the installation of more than 1,500 gross pollutant traps across the catchment).
- The PRCG has made demonstrable progress towards opening new swimming sites in the Parramatta River, invigorating a renewed focus on the value of urban waterways to the community.
- Examples such as Little Stringybark Creek demonstrate the potential for thorough source control to improve ecosystem health in downstream waterways, with demonstrated success in smaller catchments with relatively low-density development (Walsh, et al., 2022).

Compared to these examples, improving the overall health of the Harbour is a more complex, longer-term and larger-scale challenge. Important questions remain to be answered regarding the specific outcomes to be targeted, the specific actions and investment required to achieve these outcomes. In a complex system, uncertainty may prevail, but given what is already known, stakeholders could still identify many ways in which management could be improved, and therefore where they could reasonably expect improved outcomes to follow.

5.3.1 The experts' perspectives

Two expert workshops were undertaken that sought to identify where and how to align waterway health with community values:

- One on water quality monitoring, to discuss the context, evidence base, science, and the opportunity for a permanent whole-of-catchment core monitoring program for Greater Sydney Harbour.
- One on 'catchment initiatives' for improving waterway health, focused particularly on addressing diffuse stormwater pollution.

Expert workshop outcomes are written up in a separate report (Wave Consulting Australia, 2022).

Across both workshops, we heard that current management efforts are not misplaced, however, different organisations are working on different parts of the problem. Figure 8 illustrates four layers of complexity that were discussed at the workshops. These reflect many of the classic features of a 'wicked problem' including: multiple competing objectives, multiple causes, interconnectedness straddling organisational and disciplinary boundaries, those that created the problem are also seeking to solve it, there are no right or wrong solutions, and it is difficult to evaluate alternatives (given the complexity).

Faced with all these layers of complexity, a fragmented effort is not sufficient. To align waterway health with community values, it will take a **consistent, coordinated** effort across the catchment, across multiple objectives and issues and over a long period of time.

Participants at the 'catchment initiatives' workshop also raised the issue that as we pursue more aspirational goals and more intensive catchment management efforts are required, there is a need for more decentralised action, with more diverse participants involved. **Coordination**, **leadership** and **collaboration** become increasingly important.

Figure 8: Layers of complexity in aligning waterway health with community values

5.3.2 The catchment managers' perspectives

Study 1 identified the need to address gaps in governance, constrained funding and barriers to collaboration. The catchment managers' workshop on the 12 July identified the following specific reasons why governance, funding and collaboration are such persistent challenges:

- **There is low alignment with residents' or councils' priorities**. Individual local political priorities tend to drive a focus on more short-term, tangible, reportable outcomes to the community. Despite the efforts of the integrated planning and reporting reforms to local government that recognise the diversity of functions of local government and their need to prioritise actions based on community values, there remains a focus on traditional council business (roads, rubbish, infrastructure) as the overriding priorities. Within these, some priorities conflict with water quality improvement such as the continued delivery grey over green infrastructure.
- **Water quality/waterway health issues have low visibility** (other than litter) and there is poor understanding of the magnitude or causes of water quality problems. Water quality and waterway health problems seem distant to most residents of urban catchments, and compete with other priorities for attention. Even for those in close proximity to waterways, it has hard to see how individual actions or the even action at LGA scale would influence the state of waterways.
- **There is a lack of evidence for investment** – both to demonstrate where investment is most effective and whether investment is effective overall in improving water quality/waterway health. There is also a secondary challenge with who pays/who benefits.
- **There are limits to revenue** that councils can raise due to rate capping, the fixed nature of the stormwater levy, and other constraints on council revenue.
- **The high cost of action** to improve waterway health, particularly in highly constrained urbanised catchments.
- **It's a tragedy of the commons** – instead of each land holder doing their share, the problem is left to government to manage in the public domain, where in fact catchment management is a community-government coupled responsibility.

Working within these constraints, catchment mangers (i.e., currently primarily local government) are ill-equipped to address the layers of complexity identified in Figure 8 by themselves. Past projects and programs that have grappled with these complexities have relied on state-based organisations (e.g. Sydney Metropolitan CMA, GSLLS) or catchment groups (e.g. PRCG). Working with PRCG, Sydney Water has taken on a role overseeing complex technical pieces of work such as the modelling for the PRCG Masterplan.

Figure 9 summarises findings from the 12 July workshop, as they relate to the layers of complexity identified in Figure 8. Stepping down through each layer, councils' capacity constraints become more pronounced.

Workshop participants discussed how to address these constraints, identifying the following needs:

- State government **leadership** to address matters of regional significance and establish the business case for regional investment in environmental and liveability outcomes.
- **Coordination** of a more systematic approach to knowledge-building, and management action, including the application of systems thinking.
- More effective **collaboration,** not just between different parts of government but also with research organisations and community, and not just focused on short-term projects but sustaining a focus on holistic, long-term goals.
- Stronger **governance** arrangements, which ensure a **consistent** approach, and enable an **adaptive** approach.

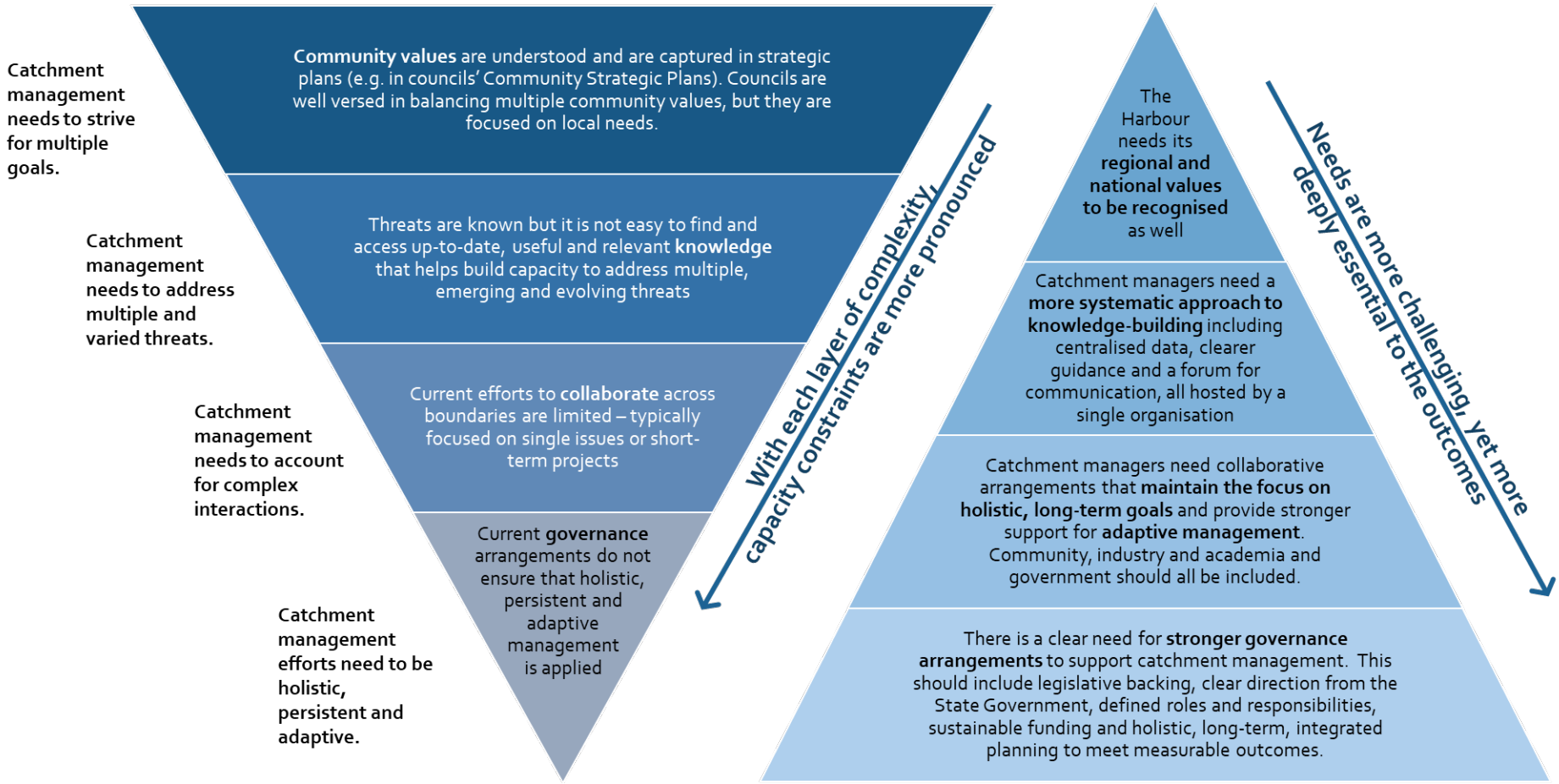


Figure 9: Challenges (left) and needs (right) in aligning waterway health with community values

6 PLANNING FOR CLIMATE CHANGE IN KEEPING WITH COMMUNITY EXPECTATIONS

Climate change, and particularly sea level rise, is identified as a high priority threat in Section 4, and is an area in which there is a clear and urgent need to improve management practices to address current and future risks (refer to Section 4.4).

Despite an increasingly consistent picture of the likely future trajectory of sea level rise, increasing knowledge of its likely impacts, and lived experience of extreme water levels during king tides and other events, planning for sea level rise around Greater Sydney Harbour has been limited to date.

As with the challenge of improving waterway health (Section 5), planning for sea level rise is a complex problem that local councils are ill-equipped to address individually. It spans global to local issues, interconnected and evolving risks, and requires a range of expertise. Councils are clear that state leadership and a collaborative effort is required, yet there have been significant barriers to leadership and collaboration which have stymied progress.

6.1 IN THEORY: GUIDELINES AND RISK ASSESSMENTS HAVE BEEN PUBLISHED

There have been several guidelines published, aiming to assist councils (and others) in planning for sea level rise. These include:

- A 2007 guideline for to assist councils considering climate change in floodplain risk management: 'Practical Consideration of Climate Change' (NSW Department of Environment and Climate Change, 2007)
- A 2010 guideline from NSW Government: 'Coastal Risk Management Guide: Incorporating sea level rise benchmarks in coastal risk assessments' (NSW Department of Environment, Climate Change and Water, 2010)
- A 2012 series of publications by SCCG and CSIRO, 'Mapping & Responding to Coastal Inundation' (various authors, 2012)
- A 2013 report 'A Multi-Criteria Analysis of Coastal Adaptation Options for Local Government' (Preston, et al., 2013)
- Engineers Australia 'Guidelines for Responding to the Effects of Climate Change in Coastal and Ocean Engineering' (National Committee on Coastal and Ocean Engineering , 2017)
- UNSW Water Research Laboratory's 'Climate change in estuaries – State of the science and framework for assessment' series of guidelines (Heimbuber, et al., 2019)

Furthermore, there have been multiple national and state-based studies characterising the risks of climate change and sea level rise, including:

- A 2008 'Fort Denison Sea Level Rise Vulnerability Study' (Watson & Lord, Fort Denison Sea Level Rise Vulnerability Study, 2008)
- A 2009 report 'A Snapshot of Future Sea Levels: Photographing the King Tide' (NSW Department of Environment, Climate Change and Water, 2009)
- 'Climate change risks to Australia's coasts: a first pass national

assessment' (Australian Government Department of Climate Change, 2009)

- NSW Estuary Tidal Inundation Exposure Assessment (NSW Office of Environment and Heritage 2015)
- CoastAdapt 'Sea-level rise and climate change Information Manual' (Siebentritt, 2016)
- A 2016 report: 'Sea Level Rise Science and Synthesis for NSW' (Glamore, Rahman, Cox, Church, & Monselesan, 2016)
- A 2018 journal article outlining an approach to assessing future tidal inundation in estuaries, focused on NSW (Hanslow, Morris, Foulsham, & et al, 2018)
- A 2022 journal article outlining the determination of extreme still water levels for Sydney Harbour (Watson, 2022)

It is notable the number of guidelines and studies, the range of authors/publishers and the shift from earlier publications more focused on guidance to local government, to more recent publications more focused on the science. The scientific knowledge of sea level rise will continue to evolve and so these recent publications address a real need, but there is also a need to update the guidance to local government, including providing more specific guidance on conducting risk assessment, scenario planning and risk management for sea level rise.

Beyond guidelines and studies, local government staff responsible for managing flooding/coastal hazards have said that they do not have capacity to engage with detailed studies and need more practical assistance with sea level rise assessment.

6.2 IN PRACTICE: LOCAL PLANNING HAS STALLED

Study 1 (McAuley, Adams, & Davies, 2022) found that of the twelve councils with Sydney Harbour foreshores:

- Only three of the current Community Strategic Plans mention coastal hazards. Where coastal hazards do feature in Community Strategic Plans, only one mentions sea level rise explicitly as a future challenge.
- Eight of the twelve foreshore councils already have or are currently preparing a resilience or climate change adaptation strategy. Those that address sea level rise identify the range of risks in broad qualitative terms.

Within the GSH councils, there has been limited progress with sea level rise assessment, setting planning levels for new development and planning for impacts on public assets. Progress to date is summarised in Table 11.

6.3 THE GAP BETWEEN PLANNING AND IMPLEMENTATION

6.3.1 The experts' perspectives

Two expert workshops were undertaken that sought to identify where and how to plan for climate change and sea level rise in keeping with the latest science:

- One with the purpose to identify practical climate risk assessment methods, using latest state-of-knowledge, for consistent application across the Greater Sydney Harbour catchment.
- One with the purpose to consider the implications of climate change, SLR and flooding on the coastal zone and waterway health.

Expert workshop outcomes are written up in a separate report (Wave Consulting Australia, 2022).

These workshops outlined how climate change and sea level rise risk assessment methods need to account for a range of complex factors and interactions, as listed in Figure 11. This mirrors the picture shown in Figure 8 – both catchment management and climate change call for engagement with multiple layers of complexity.

Table 11: Current progress on planning for sea level rise in the 20 GSH councils

Planning steps	Progress in the GSH councils (based on Study 1 investigations)
Assessment of future sea levels	• Woollahra Council has recently completed a detailed assessment as part of the Eastern Beaches CMP (BMT, 2021) • Northern Beaches Council is currently extending a basic Estuary Planning Level (EPL) assessment to the Harbour catchment • Inner West (former Leichhardt) completed a simple EPL study in 2010 • The City of Sydney includes a high level assessment in their Climate Change Adaptation Plan (based on data from SCCG) • Elsewhere, flood studies may include assessment of sea level rise scenarios [4]
Planning levels for new development	• Only Inner West Council (for the former Leichhardt area) and Woollahra Council include Sydney Harbour EPLs within their LEP and DCP. Woollahra Council has made a recent updated based on the BMT (2021) study. • Elsewhere, flood planning levels may account for some degree of sea level rise. [4]
Planning for public assets	• Northern Beaches Council refer to 'AdaptRoads Analysis' (Climate Risk, 2017) • Woollahra Council has commenced planning using data from the BMT (2021) study • Elsewhere, Climate Change Adaptation Plans identify high-level risks but do not include detailed planning.
Planning for impacts on public space	• Sea level rise may be considered in site-specific or project-specific plans

Experts and catchment managers agreed that sea level rise vulnerability assessment needs to be undertaken for the Harbour as a whole, as it needs to be considered as a system. Experts emphasised the need to consider all the interconnected factors contributing to higher sea levels, including the hydrodynamics of the Harbour, and the best way to do this would be in a single integrated assessment for the Harbour. Experts also noted the need to plan for sea level rise before its impacts become severe, while there are still opportunities to involve the community in planning and consider options that take longer to implement.

A complete assessment of sea level rise vulnerability should consider all the components shown in Figure 10, and this will require input from both a Harbour-scale perspective and local council perspective:

- Exposure assessment (i.e. mapping of the frequency and extent of future inundation risk) is beyond the capacity of individual councils and should be undertaken for the Harbour as a whole as part of the CMP. However, councils are best placed to identify specific assets exposed to sea level rise.
- Sensitivity assessment (i.e. to understand the type and extent of changes that could occur) will require both Harbour-scale analysis of the dynamics of coastal systems and local knowledge of details such as the physical nature of the shoreline and low-lying drainage systems.
- Adaptive capacity (e.g. the ability of private landowners and public asset managers to adjust their behaviour) may vary from place to place and will require local consideration, but would also be well-informed by a Harbour-scale study.

[4] Flood Studies, and Floodplain Risk Management Studies and Plans should consider sea level rise in accordance with AR&R Book 6 (Ball, et al., 2019), Engineers Australia's "Guidelines for Responding to the Effects of Climate Change in Coastal and Ocean Engineering" (National Committee on Coastal and Ocean Engineering , 2017) and the NSW Government's floodplain risk management guideline on 'practical consideration of climate change' (NSW Department of Environment and Climate Change, 2007). However not all foreshore areas are covered by floodplain management planning.

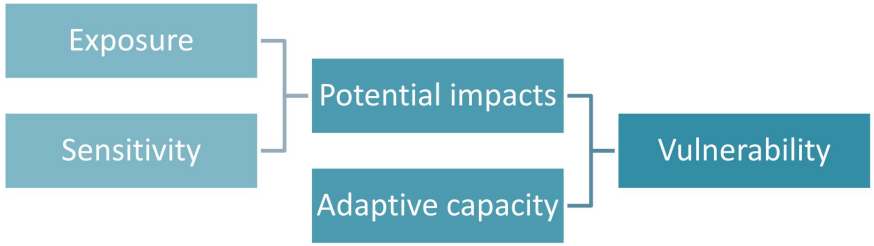


Figure 10: Components of vulnerability (NSW Office of Environment and Heritage, 2019, p. 34)

After vulnerability assessment, councils will then need to consider management options for both private land and public assets. This is typically undertaken as part of a CMP Stage 3, which recommends consideration of five broad categories of potential strategic approaches: alert (watch and wait), avoid future impact, active intervention, planning for change and emergency response. Different types of assets, with differing levels of vulnerability, are likely to require different strategic approaches. This provides a starting point for identifying and assessing specific management options. Applying this process will also require local knowledge, but should be undertaken within a consistent framework, including a set of options and an assessment process. Such a framework could be developed for the catchment as a whole and informed by state-level guidance.

6.3.2 The catchment managers' perspectives

Several councils have made it clear that they would like the GSHCMP to include a sea level rise assessment, as they see this as their key opportunity to complete this study in collaboration with others. A **coordinated** approach will enable a more comprehensive and detailed assessment to be completed. In general, land on the southern side of the Harbour is more exposed than land on the northern side, and therefore sea level rise assessment is a higher priority for those councils who are more exposed.

For those councils where sea level rise assessment is a priority, there are two main areas where councils have indicated they have more pressing concerns:

- To establish planning provisions for development exposed to sea level rise. Here, they would prefer to apply a **consistent** approach with other councils (as is the case with floodplain management planning).
- Where they are planning asset renewals and infrastructure upgrades in the coastal zone, and should consider how to build for future **adaptation** to sea level rise.

Councils' assets vulnerable to sea level rise include natural assets, open space and built assets such as seawalls, drainage structures, roads and paths. More frequent inundation is likely to lead to impacts on the health of natural systems (e.g. loss of salt marsh areas), reduced amenity of open space (e.g. loss of beaches, more frequent inundation of foreshore parks; impacts on boating infrastructure), and increased maintenance needs (e.g. where stormwater drainage systems, roads, paths, etc. are inundated more frequently). In some parts of the Harbour, the impacts of storm surge also need to be considered. Some assets may need to be modified to minimise impacts. This is a concern for councils already struggling to fund essential maintenance and renewals of existing assets, and highlights the need for councils to have access to adequate **funding** as they face increasing costs.

Note that Sydney Water has completed more detailed planning for sea level rise, so that they could implement plans to modify their highest-risk wastewater pumping stations, which are vulnerable to impacts of inundation. Councils' assets are different and more diverse than Sydney Water's pumping stations, so Sydney Water's planning approach for pumping stations is unlikely to be directly applicable to council assets. However, ideally councils and Sydney Water can use a consistent planning framework for their various types of exposed assets.

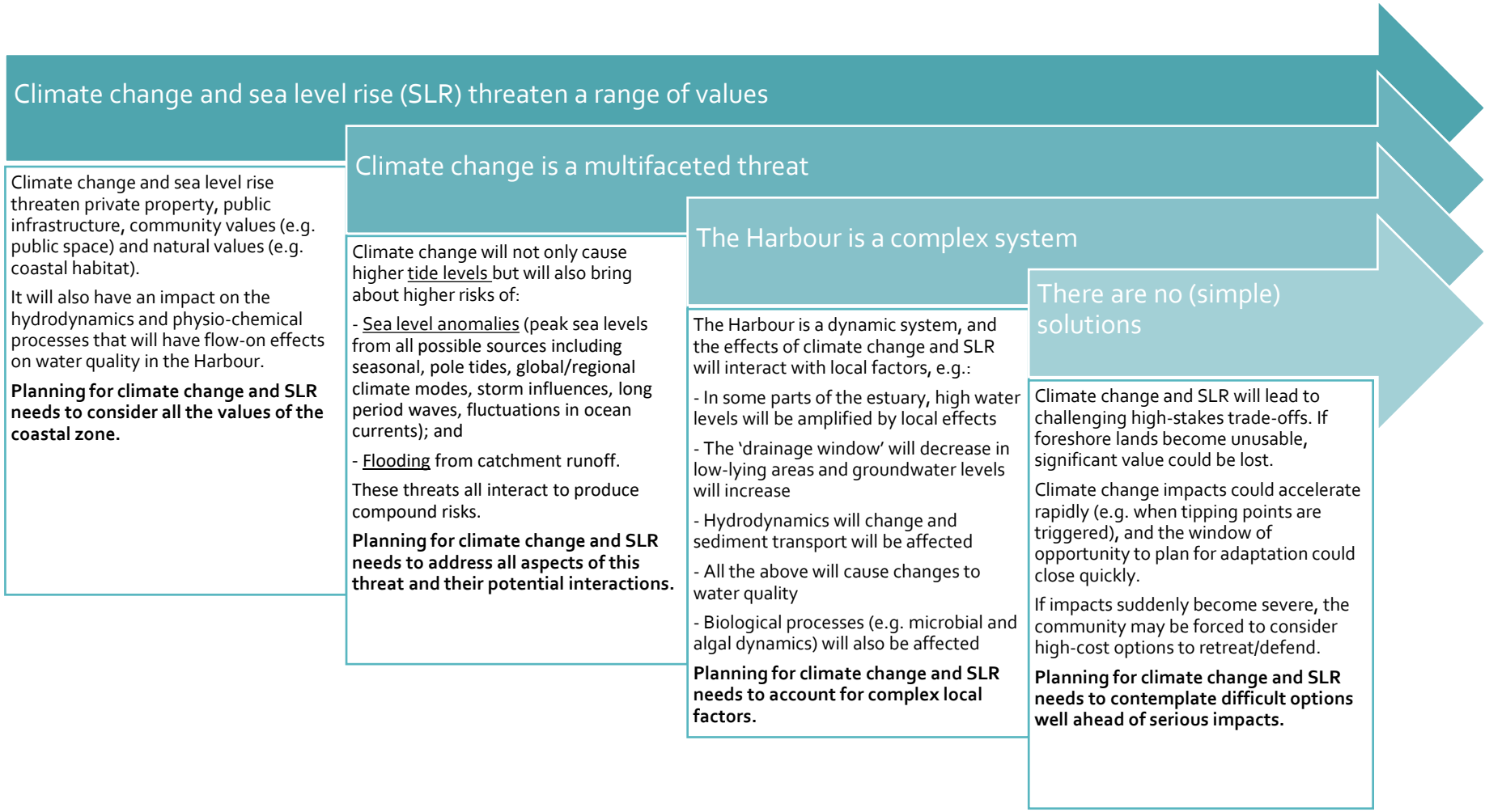


Figure 11: Layers of complexity in planning for sea level rise in keeping with community expectations

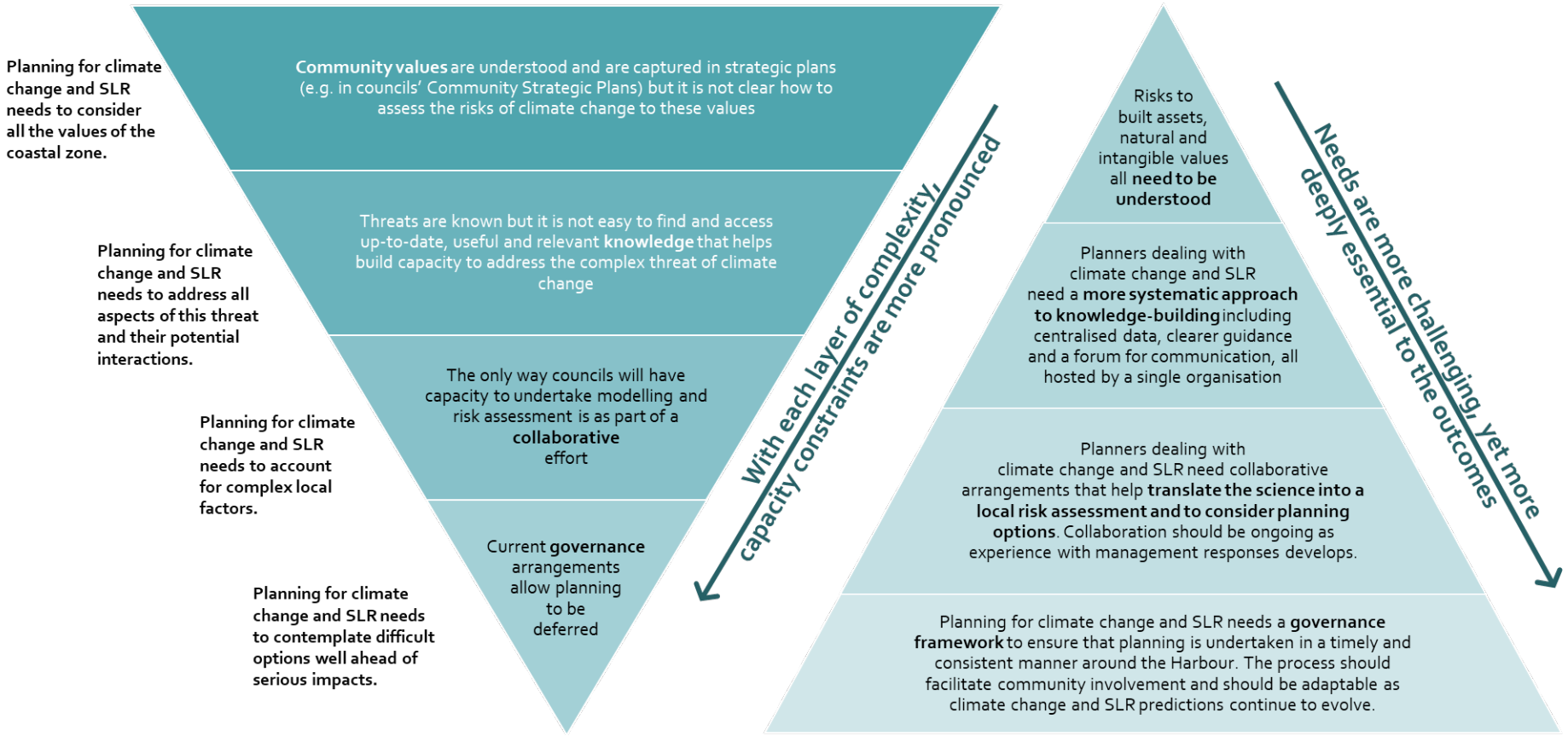


Figure 12: Challenges (left) and needs (right) in planning for sea level rise in keeping with community expectations

7 FEATURES OF AN EFFECTIVE MANAGEMENT FRAMEWORK

At the workshop on 12 July, participants agreed that a new management framework is important for Greater Sydney Harbour, with features including:

- A stronger, more consistent, coordinated and cohesive approach
- A better funded, better supported and more efficient approach
- A longer-term and more integrated approach - integrating (rather than competing) physical, social, Indigenous, commercial, environmental sustainability objectives
- Continuous improvement linked to measurable outcomes
- More accountability.

The management framework should address the fundamental issues identified in Study 1 (McAuley, Adams, & Davies, 2022) and shown in Figure 13:

- Governance that ensures improved vertical integration and horizontal coordination
- Funding that is adequate and equitable across the catchment
- Collaboration that addresses shared responsibilities and enables different organisations to work across boundaries to achieve long-term, holistic outcomes that enhance community values

It also needs to address the needs identified in Sections 5 and 6, including improved **coordination**, **consistency**, and **leadership**. These features have emerged as a consistent theme of the GSHCMP Stage 2 and were reinforced by stakeholder consultation during Study 2.

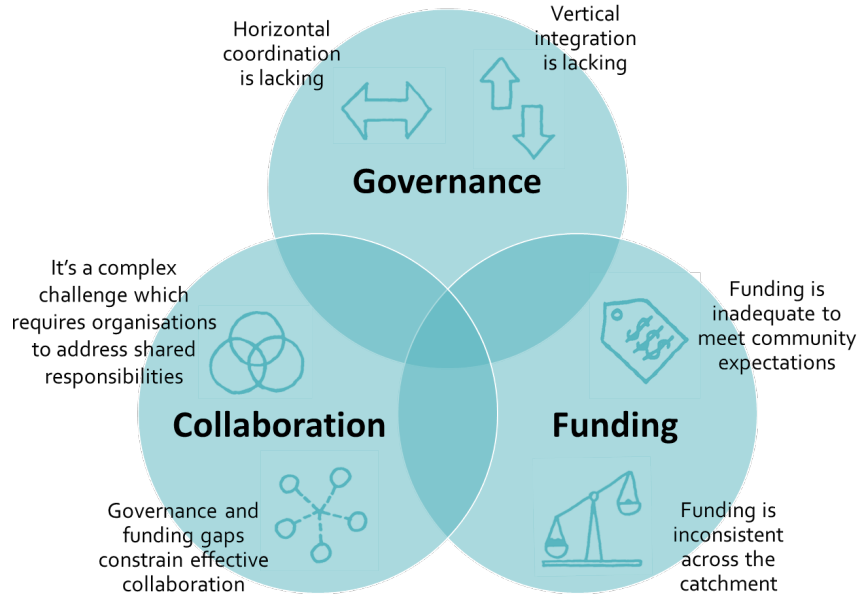


Figure 13: Interconnected constraints identified in Study 1 (McAuley, Adams, & Davies, 2022)

Sections 5 and 6 identified some other important features required in a management framework that is fit to enable:

- Aligning waterway health with community values
- Planning for climate change and the risks of sea level rise in keeping with community expectations

In particular, **collaboration** and **adaptation** came up repeatedly as being required to manage such complex challenges. These two features also emerged as important features at the 12 July workshop – for example, see Appendix A, p.22:

- More inclusivity, enabling more effective **collaboration** not just between different parts of government but also with research organisations and community.
- More iterative and **adaptive** approaches that enable innovation and a Caring for Country approach. The concept of 'triple-loop learning' is relevant here (Johannessen, et al., 2019).

Following the stakeholder consultation workshops, upon reflection, one more important element was identified that had been present in the discussion but not brought to the foreground: **creativity**. Participants had identified ideas including:

- A need to 'do things differently', rather than simply replicating practices that work elsewhere
- Communities of practice focused on delivering outcomes in specific projects/program areas
- More proactive approaches that accentuate the positives.
- Support for innovation

Often, these ideas were accompanied by comments along the lines that 'we don't know exactly what this looks like', suggesting the need for a creative approach. Workshop participants also identified a risk that centralised management could limit collaboration, innovation, and creative approaches. Positive examples of creativity in existing management approaches include:

- The idea of directly connecting the community to the Harbour through specific and multiple swim activation sites, serving as the catalyst for institutional and community change
- Sydney Water's Urban Plunge project and Innovation Festival
- Community initiative such as the 'Lollipop Ladies', raising awareness of litter in the Parramatta River.

Figure 14 therefore identifies six key features that should be included in an improved management framework:

- **Leadership**: a strategic approach
- **Creativity**: to encourage innovation and a proactive approach
- **Collaboration**: including broad involvement of community, academics, and others
- **Adaptation**: to cope with uncertainty, learn by doing, and build knowledge
- **Coordination**: of a holistic approach to the catchment and estuary
- **Consistency**: a catchment-wide approach that can be sustained for the long-term.

In and of themselves these elements are not innovative. Rather, we have sought to emphasise the value of their integration and in particular the need for creative responses in which small and coordinated actions can leverage success.

At the 12 July workshop, participants explored centralised/formal, decentralised/organic and hybrid management models, and there was significant interest in the hybrid model, but difficulty articulating its features or benefits. The framework presented in Figure 14 provides a set of 'hybrid' management features, which combine features typical of a centralised, formal approach (coordination, consistency and leadership) with features typical of a decentralised, organic approach (creativity, collaboration and adaptation).

Figure 14: Features of an improved management framework

7.1 ALIGNMENT WITH COUNCILS' NEEDS

Participants in the 12 July workshop were in favour of robust governance arrangements including:

- **Clear direction from the State Government**, with parameters/KPIs defined, and clarity over the 'services' provided by regional organisations
- **Clear roles and responsibilities**, potentially including status in legislation, authority to act, or involvement of an authority who can drive results.
- **A clear, long-term program** including planning and implementation over an extended period of many years.
- **Measurable outcomes** including a clear return on investment [calculating the return on investment would be a challenge, given the tangible, intangible, direct and indirect benefits of many catchment based initiatives]
- **Accountabilities** defined around a clear set of defined goals, with responsibilities for implementation, operation and maintenance.
- **Coordination** by an overall catchment entity who can promote collaborative relationships.

These features are consistent with the approach to delivering other important outcomes that rely on action across state and local government. For example, floodplain management planning is coordinated by State Government under the Floodplain Management Program, including technical and financial support, policy and guidelines. The NSW Government's Flood Prone Land Policy clearly defines roles and responsibilities. Local implementation within this framework has resulted in a reasonably consistent approach to floodplain management across the state.

Workshop participants also identified several other positive features of existing arrangements, which should also be emphasised in future management, including:

- Shared vision, common goals and collaborative plans
- Forums for working together
- Informal relationships, direct relationships with specific organisations (Sydney Water was mentioned) and direct relationships with individuals.

Table 12 organises input from workshop participants into the six features of the framework in Figure 14.

Table 12: Features of an effective management framework and their alignment with both councils' needs and previous CRCWSC recommendations

Features	Councils' (and other catchment managers') needs – as identified at the 12 July workshop
Leadership 	Establish clear leadership, including: • A state-based authority such as an agency of government with authority over other departments and involvement in directing and mediating results, a Ministerial priority, links to legislation for catchment management. • A clear, long-term program including planning and implementation over an extended period of many years. The CMP could play this role if it continues to take a catchment-wide approach and remains well-supported through planning and implementation. • Accountabilities defined around a clear set of defined goals, with responsibilities for implementation, operation and maintenance. • Collaborative involvement of all relevant parties, all levels of government and key stakeholders working together. • Support for innovation. • Independence from political or developer influence.
Creativity 	Support creative approaches including: • 'Doing things differently', rather than simply replicating practices that work elsewhere • Communities of practice focused on delivering outcomes in specific projects/program areas • More proactive approaches that accentuate the positives. • Support for innovation
Collaboration 	Maintain and enhance the positive features of existing collaborative arrangements: • Shared vision, common goals and collaborative plans. • Forums for bringing everyone together • Stakeholder and community support • Technical capacity and knowledge sharing role • Fostering formal and informal, direct and indirect relationships.

Features	Councils' (and other catchment managers') needs – as identified at the 12 July workshop
Adaptation 	Foster adaptive management including: • A more systematic approach to knowledge building • A more iterative approach • Stronger community collaboration • Communities of practice focused on delivering outcomes in specific projects/program areas. • Stronger research partnerships (an ingredient largely missing in NSW but with greater presence in other states - e.g. Water Sensitive Cities' partnerships with universities in other states).
Coordination 	Establish a governance framework that includes: • Clear direction from the State Government, including defined performance indicators, measurable outcomes, and links to regional goals. • Clearly defined roles and responsibilities, potentially including status in legislation, authority to act, or involvement of an authority who can drive results. This should include an improved allocation of responsibilities at local, catchment and state level. • A clear nexus between the outcome, the activity, the asset, and the funding. • A rigorous approach around where, when to monitor and what for, including standard parameters/targets, consistent monitoring framework and reporting requirements, with benchmarking/comparison to agreed baseline/s. • Mandatory reporting requirements to ensure transparency, link investment with performance measures and measure progress towards outcomes. • Oversight and support by a catchment-based organisation such as a trust.
Consistency 	Provide support to catchment managers to maintain a consistent effort, across the catchment and over time: • An improved stormwater levy, which should be legislated, permanent, specifically linked to waterway health, set to rise with CPI, and applicable to all properties evenly across the catchment. Funding should be able to support whole project life cycles, including investigations, design, construction, maintenance and monitoring as well as education, engagement, enforcement. • Sustainable funding, including direct, ongoing funding with a reasonable level of certainty. Funding should be sufficient to maintain key roles and fund longer term programs (e.g. at least 5 years). • More rigorous planning controls applied at appropriate scale (e.g. catchment based targets).

7.2 ALIGNMENT WITH PREVIOUS RECOMMENDATIONS

The elements shown in Figure 14 and features outlined in Table 12 align well with previous recommendations. The CRC for Water Sensitive Cities' "Vision and Transition Strategy for a Water Sensitive Greater Sydney" (CRC for Water Sensitive Cities, 2018) was based on a series of workshops with 51 participants from water, planning, environment and development in Greater Sydney. Prior to the Greater Sydney Harbour CMP, this was the most recent and thorough effort to plan for improved catchment management in Sydney. The CRC recommended five overarching strategies to advance Sydney's water sensitive transition, aligned reasonably well with five of the six features identified above:

I. Create formal and informal networks for driving Sydney's water sensitive city agenda to support a collaborative, flexible and integrated governance approach [collaboration].

II. Embed Sydney's water sensitive city vision in organisational policies, plans and strategies [consistency].

III. Establish a cross-organisational framework that enables and drives an integrated and strategic approach for managing the whole water cycle [coordination].

IV. Increase knowledge about the social, technical and design solutions that are not yet sufficiently developed to deliver the full scope of Sydney's water sensitive city vision [adaptation].

V. Identify and establish pathways for implementing water sensitive solutions through innovation and investment [leadership].

Creativity does not feature in the CRC's high-level principles, however it does feature within the more detailed recommendations below each of these principles, including:

- Design and implementation of urban spaces and infrastructure systems that are multi-functional
- A compelling narrative that links the benefits of the water sensitive city to organisational priorities and a broader city vision.
- Demonstrating innovation at scale
- Innovative solutions across social, technical and design domains

8 RECOMMENDATIONS

Sections 5 and 6 of this document identified that improving waterway health and planning for climate change involve layers of complexity that are inadequately addressed by current management approaches.

To address governance and funding gaps, **coordination, consistency and leadership** are vital. However, they are not likely to be sufficient to address the complex challenges facing Sydney Harbour today. A well-balanced approach should also be built to foster **creativity, collaboration and adaptation**.

Table 13 presents 12 specific recommendations, organised around these six proposed features of an improved management framework. Under each of these 12 high-level recommendations are 1-4 sub-recommendations, which provide more detail.

Table 13 suggests roles for catchment groups (e.g. PRCG and SCCG), state agencies, and a 'formal, catchment-based' organisation which would take on roles including management functions (driving program implementation) as well as technical functions (e.g. monitoring, capacity building). This type of organisation is missing from current arrangements, but has existed previously (e.g. the Upper Parramatta River Catchment Trust and the Sydney Metropolitan Catchment Management Authority). Similar organisations exist in other jurisdictions (e.g. Healthy Land and Water in South-East Queensland). It is also possible that existing organisations could take on these roles (e.g. Sydney Water is already working in this role to some degree in implementing the Parramatta River Masterplan). The Study 3 report is considering these options.

Note that while Table 13 indicates that responsibilities are best placed in one of these three specific types of organisation, the six high-level features from Figure 14 could be applied across each of these organisation types, as well as within local government, to varying degrees and in different ways. For example, creativity and innovation are best supported by organisations that have a high degree of capability and expertise, are open to innovation and can invest in the expertise of their staff and partners over time. However, all organisations have some degree of capacity to adopt creative approaches.

Table 13 does not assign priorities to each recommendation, as these are not to be considered as actions to be completed but as measures which will require ongoing attention. It is relevant to consider the potential impact of each recommendation, both on its own and together with others, as some have greater potential for transformative effect if implemented in concert. For example:

- Recommendation 2 (an entity with authority to drive program implementation) has the potential to strengthen all the other recommendations. Its effect would be greatest if it is supported by recommendation 1 (developing the program).
- Recommendation 11 (whole of catchment-based funding models) would be a crucial enabler with significant impact, particularly when combined with recommendation 9 (accountability and transparency).
- Recommendations 7 (iterative and adaptive approach) and 8 (systematic approach to knowledge sharing and technical capacity building) would be strengthened by recommendation 10 (core monitoring program).
- The creativity and collaboration recommendations (Nos 3-6) are complementary.

Table 13: Recommendations

Management framework features	Specific recommendations	Where responsibilities are best placed		
		Decentralised, organic (e.g. catchment group)	Formal, catchment-based (e.g. catchment trust)	Formal, centralised (e.g. state agency)
Leadership 	**1. Develop a clear, long-term program (e.g. the CMP) that takes a catchment-wide approach, is well-supported by stakeholders, and includes planning and implementation over an extended period of many years** 1.1. Adopt a shared plan for Greater Sydney Harbour's future management that provides clear direction including - A compelling narrative that links the benefits of a healthy Sydney Harbour to organisational priorities and a broader city vision. - Defined performance indicators and measurable outcomes, including clear short-term milestones and long-term goals. 1.2. Develop a cross-agency implementation program for improving the health of Greater Sydney Harbour and its catchment, including: - Clearly defined roles and responsibilities, including improved allocation of responsibilities at local, catchment and state level. - A plan for phased delivery with shared responsibilities tied to specific and accountable actions. - A process for the program to be managed adaptively. - Collaborative involvement of all relevant parties, all levels of government and key stakeholders working together. - A strategic cross-organisational approach to driving innovation and investment in water sensitive solutions.		Potential role for a new organisation	
	2. Provide an existing or new entity with authority to drive program implementation 2.1. Establish the principles by which this entity should operate, including: - Accountabilities defined around a clear set of defined goals. - Responsibilities for coordinating implementation, operation and maintenance. - Collaborative involvement of all relevant parties, all levels of government and key stakeholders - Independence from political or developer influence. 2.2. Ensure this entity has the capacity to support all the recommendations below, including a long-term presence.		Potential role for a new organisation	

Management framework features	Specific recommendations	Where responsibilities are best placed		
		Decentralised, organic (e.g. catchment group)	Formal, catchment-based (e.g. catchment trust)	Formal, centralised (e.g. state agency)
Creativity 	**3. Create a culture within institutions that fosters innovation and experimentation as a deliberate process** 3.1. Build innovation and experimentation into everyday practices: - Actively support lateral/ outside the square thinking in the design and delivery of programs and projects - Encourage team members to challenge the status quo - Share and socialise experiments and innovation as part of routine team meetings, updates, e. 3.2. Establish specific opportunities to focus on innovation, including forums that encourage creative ideas (e.g. innovation days).	Creativity should be driven at all levels		
	4. Foster a culture of creativity across traditional boundaries 4.1. Bring multiple perspectives to the process of developing ideas, delivering projects and making decisions: - At the ideas stage, allow space for divergent thinking before converging on preferred options. - Establish multi-disciplinary teams who can challenge the constraints inherent in the perspectives of individual disciplines. - Embed multiple objectives into decision making, including wellbeing, liveability and environmental health.			
Collaboration 	**5. Develop collaborative partnerships between government, academia, industry, and community** 5.1. Develop collaborative plans for specific projects/initiatives, i.e., focused on delivering short-term outcomes in specific projects/program areas. 5.2. Foster formal and informal, direct and indirect relationships across boundaries, i.e., build longer-term partnerships. - Create opportunities that bring stakeholders together for a range of purposes, formal and informal. - Build 'communities of practice' across organisational boundaries. - Include staff at multiple levels in different organisations.	Catchment groups are already playing a key role		

Management framework features	Specific recommendations	Where responsibilities are best placed		
		Decentralised, organic (e.g. catchment group)	Formal, catchment-based (e.g. catchment trust)	Formal, centralised (e.g. state agency)
	6. Foster shared ownership of urban waterways 6.1. Incorporate diverse representation on working groups, committees, boards, etc. 6.2. Prioritise projects and initiatives that foster shared ownership. 6.3. Seek opportunities to involve multiple stakeholders in delivery of projects and initiatives.			
Adaptation 	**7. Implement a more iterative and adaptive approach to catchment management** 7.1. Undertake pilot-scale testing and demonstrations of solutions to help prove concepts, highlight benefits and build capability. 7.2. Develop knowledge of solutions to support decision-making and guide implementation. 7.3. Explore and integrate new approaches, including incorporating Aboriginal knowledge and values into water planning and decision-making, water stewardship practices, solutions for increasing resilience.	Catchment groups are already developing some of these practices		
	8. Develop a more systematic approach to knowledge sharing and technical capacity building 8.1. Provide independent and up-to-date evidence-based policy and best practice guidelines, which provide state and local governments with fit-for-purpose guidance on urban water and catchment management knowledge relevant to Greater Sydney Harbour. 8.2. Complete a comprehensive estuary planning level study to provide a more complete picture of sea level rise risks around the Harbour. 8.3. Undertake independent evaluation of the effectiveness of current WSUD policies and practices (such as street sweeping and natural treatment systems) is needed to determine if these approaches can deliver cost-effective outcomes at various scales. 8.4. Coordinate education and regulation programs across state and local government to maximise their impact and shift social norms and behaviours. This should include ongoing education programs for households, inclusive of Owners Corporations in Strata and Community title land, on how and why to maintain WSUD features is required to ensure these systems meet their water quality design outcomes.		Potential role for a new organisation	

Management framework features	Specific recommendations	Where responsibilities are best placed		
		Decentralised, organic (e.g. catchment group)	Formal, catchment-based (e.g. catchment trust)	Formal, centralised (e.g. state agency)
Coordination 	**9. Build accountability for catchment management and transparency into funding, planning and reporting mechanisms** 9.1. Ensure vertical policy alignment and consistency within the integrated planning reporting framework that explicitly responds to community expectations and desire for improved waterway health outcomes for Sydney Harbour. 9.2. Ensure that waterway health goals and policy outcomes include measures to provide transparency of actions and that these are made accountable to specific agencies with respect to their impact. 9.3. Implement standard financial reporting mechanisms for state and local government with respect to expenditure on water quality and quantity and catchment-based programs.			This will need to be implemented by the State Government including involvement of DPE, OLG
	10. Establish a permanent whole-of-catchment core monitoring program for Greater Sydney Harbour 10.1. Establish a monitoring program[5] for Greater Sydney Harbour, including: - Integrated catchment & waterway health monitoring, evaluation and reporting program - Indicators of long-term ecosystem health, short-term public health, pollution investigation, environmental awareness & behaviour change, catchment management effectiveness. - Reporting and open-access data useful for catchment managers, decision-makers, researchers, community. 10.2. Coordinate how councils and agencies audit and report on their stormwater treatment and harvesting infrastructure to ensure consistency and enable a measure of stormwater treatment effectiveness across the catchment as a whole.		Potential role for a new organisation	

[5] Note that this has been identified as a priority in the Greater Sydney Water Strategy (NSW Department of Planning and Environment, 2022c) under Action 4.1 Maintain and Improve Ecosystem Health - Scope a water quality and river health monitoring governance framework for Greater Sydney's waterways, including assessment of existing data in relation to WQOs within 3 years. Responsibility: DPE—EHG, DPE—Water, and Sydney Water supported by councils and EPA

Management framework features	Specific recommendations	Where responsibilities are best placed		
		Decentralised, organic (e.g. catchment group)	Formal, catchment-based (e.g. catchment trust)	Formal, centralised (e.g. state agency)
Consistency 	**11. Establish new whole of catchment-based funding models to ensure diffuse stormwater pollution can be addressed in line with community and government expectations** 11.1. Establish a new whole of catchment-based funding model, including: - Legislation to ensure that funding is permanent, specifically linked to waterway health, set to rise with CPI, and applicable to all properties evenly across the catchment. - Sufficient funding to maintain key roles and fund long term programs (e.g. 5+ years). - Mechanisms to provide funding for whole. project life cycles, including investigations, design, construction, maintenance and monitoring as well as education, engagement, enforcement. - New funding models designed to deliver coordinated and scaffolded catchment-based priorities. 11.2. Support liveability outcomes by setting clear metrics and liveability service levels that must be met via price-regulated entities in so far as these support healthy waterway outcomes. 11.3. Review the existing rules governing the application and use of other funds by councils, specifically the use of Stormwater management Service Charge and Environmental Special Rates, to enable their coordinated use to deliver stormwater water quality and quantity outcomes sought by the community and state and local government plans and policies.			New funding models will need to be established by the State Government including involvement of IPART, DPE, EPA, OLG and Treasury as well as Sydney Water
	12. Improve consistency in the planning system 12.1. The goal of improving and sustaining the health of Greater Sydney Harbour is to be consistently included within all relevant strategic and operational plans of state and local government. 12.2. Ensure vertical policy alignment and consistency between state regional and district plans to local strategic planning statements and individual council LEPs that explicitly state the goals for improved waterway health outcomes for Sydney Harbour 12.3. Standardise stormwater quality planning provisions and implement across all development types across the catchment. 12.4. State and local governments must take a consistent approach to planning for sea level rise and coastal inundation that is integrated with floodplain management planning and informs both: - Strategic asset management programs for stormwater drainage, foreshores, coastal and estuarine infrastructure. - Strategic planning for city plans, district plans, LSPS', LEPs, housing strategies and other local council strategies.			This will need to be led by DPE

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APPENDIX A WORKSHOP OUTCOMES: FUTURE DIRECTIONS FOR CATCHMENT MANAGEMENT

GREATER SYDNEY HARBOUR COASTAL MANAGEMENT PROGRAM
Stage 2 investigation for integrated stormwater discharge and waterway health management

Workshop outcomes: future directions for catchment management

October 2022

Civille

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Contents

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Stage 2 Investigation into Stormwater Management

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Introduction

A workshop was held on 12 July 2022 to invite input from councils and Sydney Water on their perspectives on future management of the Greater Sydney Harbour catchment.

The workshop was facilitated by Peter Davies of Macquarie University, Alexa McAuley and Phil Adams of Civille. It included 27 in-person attendees and 4 online, representing:

- 14 of the 20 participating catchment councils
- Sydney Water
- Sydney Coastal Councils Group (SCCG)
- Parramatta River Catchment Group (PRCG)
- Department of Planning and Environment (DPE)

Prior to the workshop, a survey was sent out to invitees with some initial questions. This received 17 responses, which were used to inform the workshop content.

The workshop aimed to address the following questions about the management of the Greater Sydney Harbour catchment:

- What is already going well and should be maintained?
- What needs to be improved or strengthened?
- What is missing? and needed to achieve the Coastal Management Plan (CMP) vision of "Improving and sustaining waterway health through improved coordination, consistency and leadership."

The workshop included four main parts, as shown in Figure 1. This summary of workshop outcomes is also organised into the same four parts.

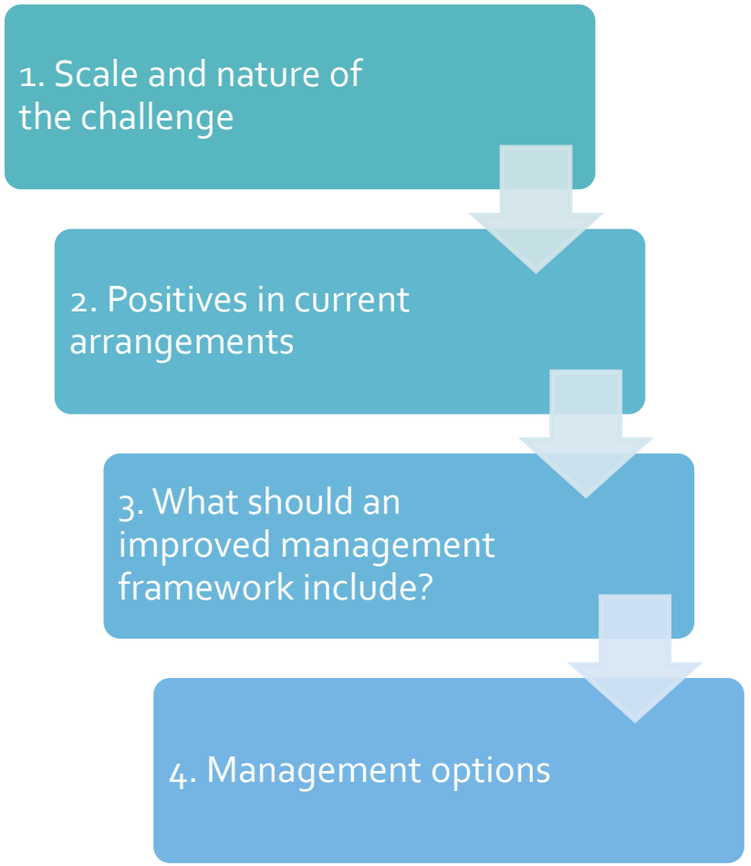

Figure 1: Workshop content

Context: Stage 2 of the CMP

The Greater Sydney Harbour Coastal Management Plan (CMP) vision is ***"Improving and sustaining waterway health through improved coordination, consistency and leadership."***

It aims to tackle significant, complex challenges to improve the management of the Harbour and its catchment.

Stage 1 of the CMP identified priority threats to the Harbour, which include urban stormwater discharge, marine debris (much of which is derived from land-based sources and transported via urban stormwater) and climate change.

Stage 2 of the CMP is approaching these challenges from multiple angles, as shown in Figure 2. Studies 1 and 2 are focused on the councils and Sydney Water, who are the main stormwater managers in the catchment. Study 3 is looking at interstate and international examples of governance and funding for urban catchments, and the expert workshops will bring in the perspective of technical experts.

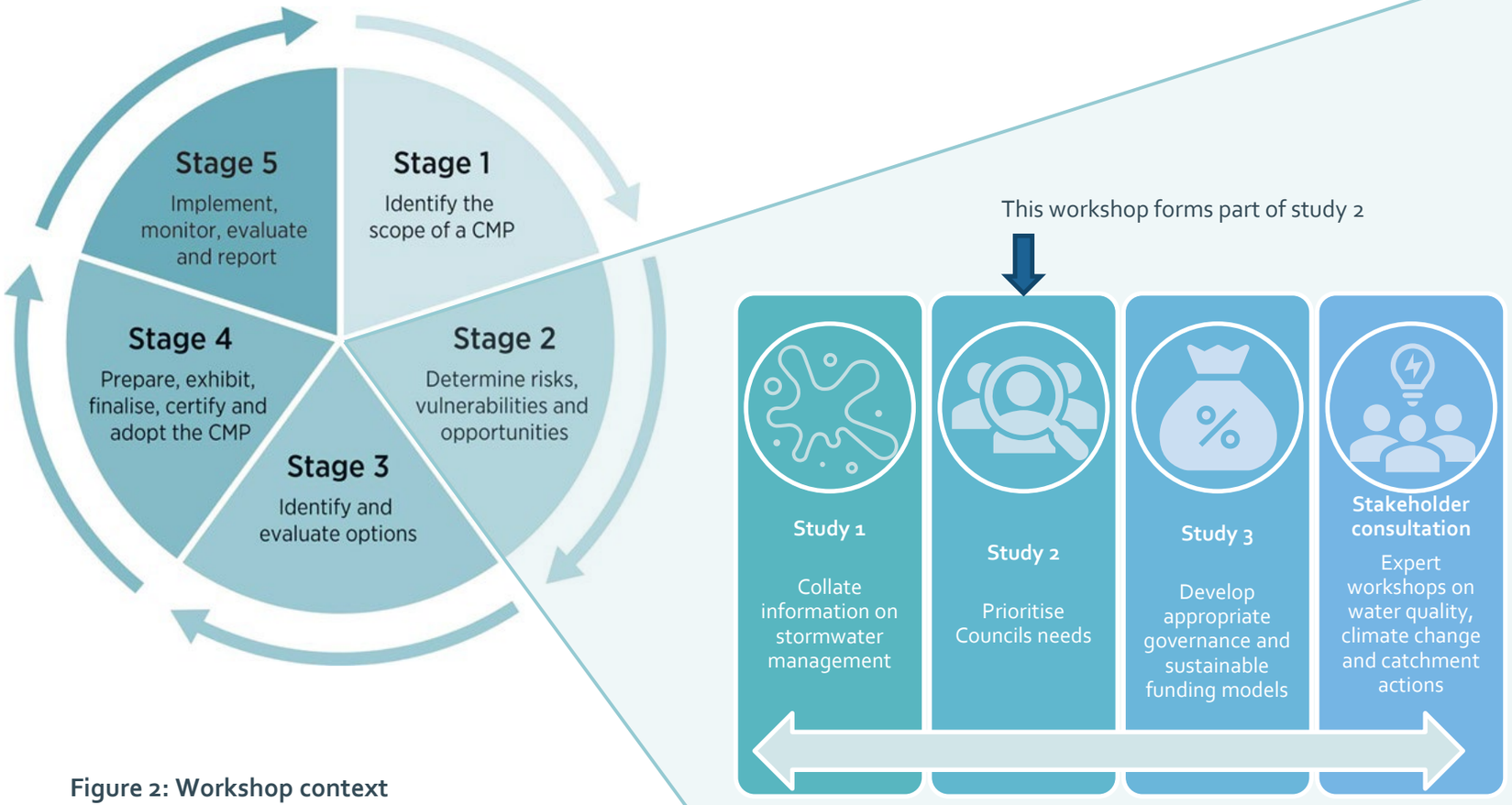

Figure 2: Workshop context

Background: Study 1 findings

Study 1 found that underlying challenges with governance, funding and collaboration are leading to a patchwork of approaches to stormwater quality management across the catchment:

- **Governance** is fragmented, so while community aspirations are recognised in high level plans, each organisation has made their own commitments in line with their own priorities, within a scope they can achieve. The overall effectiveness of fragmented actions is unclear.
- **Funding** is generally constrained, but is unevenly collected across the catchment, and more constrained in some organisations than others. There is also generally a lack of transparency about where and how funds are spent, with a wide range of activities contributing to stormwater management, but all reported separately and often mixed up with other related activities.
- **Collaboration** is highly valued, but also operates in a constrained environment. While collaborative efforts are present, it remains challenging to achieve sustained commitment to collaborative efforts across silos and across organisational boundaries.

Study 1 (final draft, p.22) stated:

> *"There are significant actions underway across the catchment to address diffuse stormwater pollution. However, the actions are not coordinated nor integrated within a whole of catchment nor overarching urban water governance framework.*
>
> *"Significant gaps exist between high-level objectives (outcomes) and how funding, programs and activities (commitments) are implemented.*
>
> *"There is a lack of coordination within organisations (horizontal) and between (vertical) levels of government. This reveals a degree of porosity of responsibilities and accountabilities at the institutional level, despite community aspirations for better waterway outcomes."*

Therefore, the workshop explored how existing and potential future management frameworks could address these issues of horizontal and vertical integration, as well as the related issues of funding and collaboration.

Figure 3 illustrates how responsibilities are currently split across different levels of government. Workshop participants were asked to consider scale and responsibility when exploring management options.

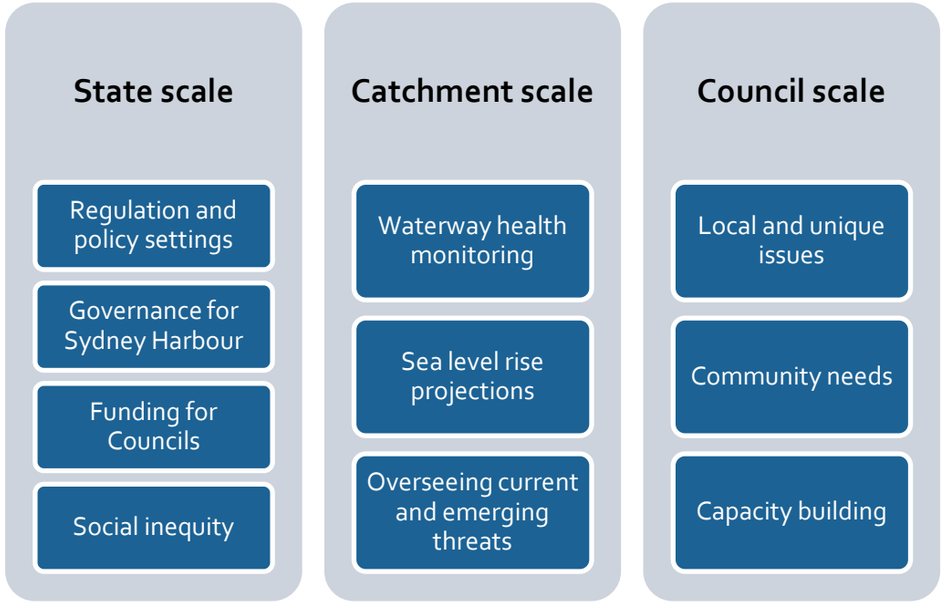

Figure 3: Scale and responsibility

Part 1
Scale and nature of the challenge

Scale of the challenge

Workshop participants agreed that their (collective) current management practices are only "somewhat" (56%) or "moderately" (44%) supporting the CMP vision, indicating significant room for improvement (Figure 4).

Most of the reasons that participants gave for their response (11/25 responses) were linked to **gaps in governance**:

- Lack of state government leadership
- No overall coordinator/manager for waterways
- Lack of ownership
- Lack of coordination
- Lack of consistency (particularly between councils and state government)
- Contradictory objectives
- Strategies not aligned
- A general lack of formal governance arrangements.

Two comments mentioned funding, one of these related to how funding is allocated and prioritised (i.e. this could also be considered a governance issue).

There were 4 comments that mentioned the positive nature of current collaborative efforts including the CMP itself, however this was somewhat tempered, with one mentioning that support and capacity to share is limited and another that it is 'still early days'. This reinforces the findings of Study 1; that collaboration is taking place but is limited in what it can currently achieve. There were also several responses in the pre-workshop survey that noted collaboration is present but it's difficult to coordinate on a catchment scale.

Several participants also gave reasons that were more about the scale and nature of the physical challenges we must address to improve and sustain waterway health, including:

- The backlog of works needed, particularly in 'older' catchments
- No matter how well we address stormwater pollution, if we don't address legacy sediments the water quality west of the bridge will always be a big problem.
- Complexity of issue/multifaceted solutions needed
- Challenges capturing sediment and chemical pollution
- Maintenance challenges, both public and private
- [Currently we are] undertaking a minimum requirement approach rather than a proactive one to "improve" status quo
- Unknown whether 'best practice' can deliver improvement

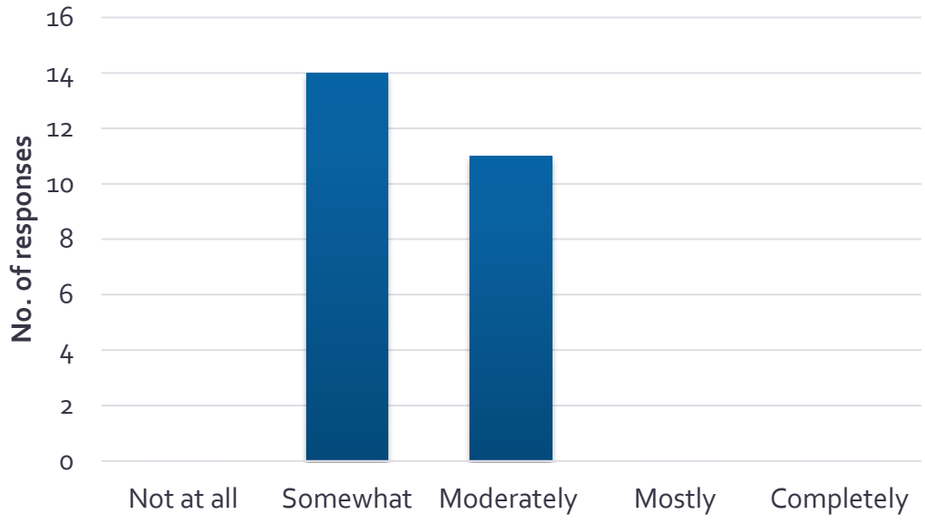

Figure 4: To what extent do you think our (collective) current management practices are supporting the CMP vision?

Nature of the challenge

Responses to the pre-workshop survey ranked funding and vertical integration as the greatest challenges for improving the governance, funding and capacity for management of the Greater Sydney Harbour catchment, as shown in Table 1.

In the workshop, competing priorities also emerged clearly as a major challenge, which hinders vertical integration, hinders horizonal coordination and keeps funding at the top of the list of related challenges.

Poor understanding of the problem and lack of evidence for investment also emerged as important issues.

In the workshop, the top reasons participants gave for **why funding remains at the top of the list** of challenges can be summarised as:

1. **There is low alignment with residents' or councils' priorities**. Political forces tend to drive a focus on more short-term, tangible, reportable outcomes to the community. Traditional council business (roads, rubbish, infrastructure) is seen as higher priority. Some priorities conflict with water quality improvement.
2. **Water quality/waterway health issues have low visibility** (other than litter) and there is poor understanding of the magnitude or causes of water quality problems.
3. **There is a lack of evidence for investment** – both to demonstrate where investment is most effective and whether investment is effective overall in improving water quality/waterway health. There is also a secondary challenge with who pays/who benefits.
4. **There are limits to revenue** that councils can raise due to rate capping, the fixed nature of the stormwater levy, and other constraints on council revenue.
5. **The high cost of action** to improve waterway health, particularly in highly constrained urbanised catchments.
6. **It's a tragedy of the commons** – instead of each land holder doing their share, the problem is left to government to manage in the public domain.

Table 1: Pre-workshop survey results, ranking the biggest challenges for improving the governance, funding and capacity for management of the Greater Sydney Harbour catchment

Average ranking	Challenges
2	Funding (whether for staff, projects, O&M or other resources)
3	Vertical integration - between different levels of government
4	Organisational commitment to relevant goals and objectives
4	Clarifying the goals and objectives
4	Horizontal co-ordination - between different organisations
5	Working across internal organisational boundaries
5	Relevant and accessible guidance and tools

Nature of the challenge

Based on participants' input at the workshop, the **top factors hindering vertical integration** of catchment management for Sydney Harbour can be summarised as:

1. **Governance in general,** including the lack of structure or accountability, 'too many cooks' all working on their own priorities with limited coordination,
2. **Competing and inconsistent priorities,** including a focus on short-term and more 'visible' priorities, differing priorities among different organisations, and changing priorities with changing governments.
3. **Poor understanding of the problem** – waterway health is an intangible value, the need for investment is not clear, the important role of councils is not valued.
4. **Politics is a complicating factor,** both for natural resources in general and Sydney Harbour in particular, as a prominent, iconic waterway.
5. **Lack of state government leadership** on waterway health, with fragmented responsibilities in state agencies and a lack of clear guidance.
6. **Lack of resources,** with grants insufficient to fill the gap and not enough focus on skills or capacity building.
7. **Lack of communication** in general.

Based on participants' input at the workshop, the **top factors hindering horizontal collaboration** between organisations across the catchment can be summarised as:

1. **Competing priorities,** with short-term local issues prioritised, changing political agendas and a lack of focus or interest from key stakeholders.
2. **Limited funding** and therefore limited resources (time, staff, money for projects or maintenance).
3. **Gaps in governance,** including challenges working across boundaries without higher-level policy settings.
4. **Poor coordination,** with challenges even knowing who to speak to.
5. **Lack of responsibility/accountability** for waterway health.

Figure 5 illustrates how several of the challenges identified in relation to funding, vertical integration and horizontal collaboration are interlinked.

Figure 5: Interconnected challenges

Part 2
Positive features of current arrangements

Positives in current arrangements

In the pre-workshop survey, respondents indicated that they currently find the following collaborative networks valuable:

- SCCG and other Regional Organisations of Councils (ROCs)
- PRCG and other catchment groups
- Neighbouring councils
- Water Sensitive Cities Australia (formerly the CRC for Water Sensitive Cities)
- Stormwater NSW.

Catchment Management Authorities (e.g. the Sydney Metropolitan CMA) were also mentioned although they are no longer operating.

Positive features of these networks were identified as:

- Sharing information, ideas, experience
- Working together
- Joint projects
- Translating research into application
- Getting state agencies, community and political support on board
- Gathering momentum
- Combining resources to focus thinking
- Advocacy as a united force.

During the workshop, participants were asked to list important factors contributing to **positive horizontal collaborations** between organisations across the catchment. The top factors listed were:

1. **Shared vision, common goals and collaborative plans** were identified as an important ingredient.
2. **Catchment groups** were identified as important forums for bringing everyone together, however it was noted that 'all need to be actively involved' and these groups work best with widespread stakeholder support and technical capacity. PRCG was identified as a strong example.
3. **Other relationships** were mentioned as important, including informal relationships, direct relationships with specific organisations (Sydney Water was mentioned) and direct relationships with individuals.
4. **Funding, knowledge, internal organisational factors and community support** were also mentioned as important enabling factors.

During the workshop, participants were asked to list important factors working to support the **vertical integration** of catchment management for Sydney Harbour. The top factors listed were:

1. **Positive practices** such as opportunities for networking, workshops, events, communication and collaboration.
2. **Supporting factors** such as grant funding, technical support from the State Government, capacity building, and successful projects building a track record.
3. **The Greater Sydney Harbour CMP** was mentioned several times as a positive factor, however one comment noted that 'we are doing catchment management through a coastal management program as no catchment management program exists'.
4. **Other NSW Government agencies/programs** were also mentioned including Coastal reforms, MEMA, GSWS.
5. **State-led urban planning** was mentioned as it includes high aspirations for water quality and water management in general.

A deeper view of current arrangements

A World Café style discussion was held to discuss how existing collaborative networks are supporting three types of outcomes:

1. Knowledge of catchment issues and management responses
2. Development of individual organisations' strategies, policies, plans and projects
3. Stronger governance arrangements for waterway health

Figure 6 lists a few examples of the type of outcomes that belong in each of these areas.

Outcomes of the discussion are summarised on the following pages.

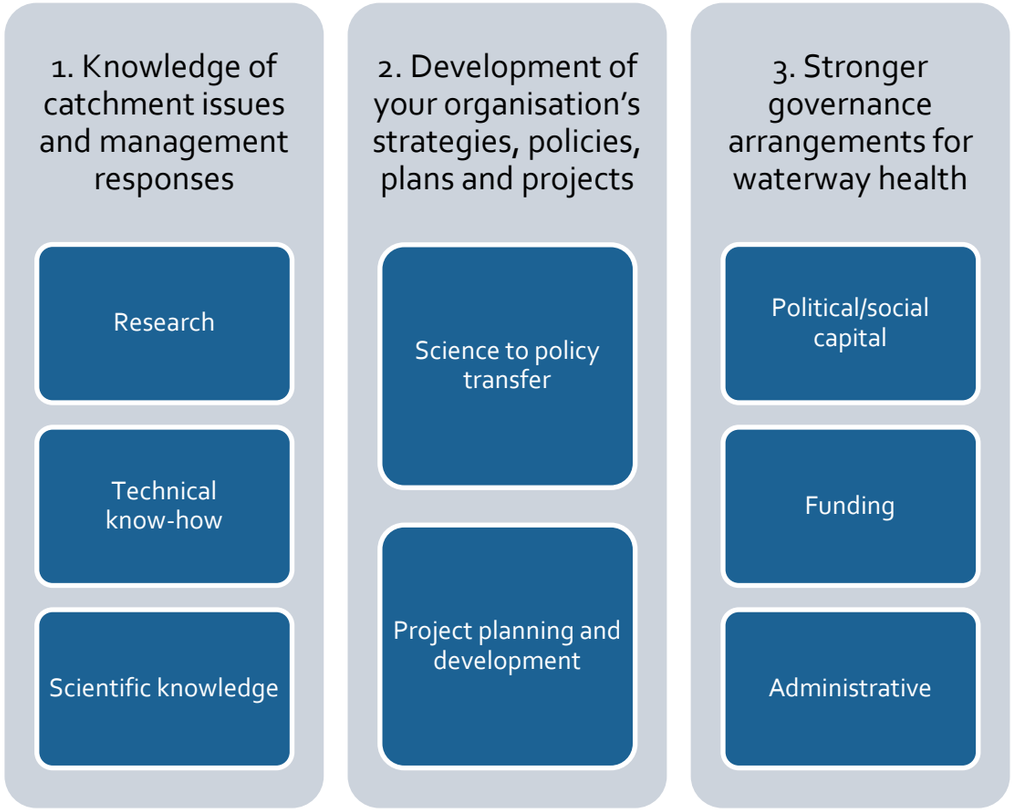

Figure 6: Workshop participants were asked to consider how existing collaborative networks support this set of outcomes

Supporting knowledge outcomes

What's working

Organisations like SCCG, PRCG and Stormwater NSW create opportunities for knowledge sharing. They achieve this with their meetings, presentations, conferences, and networking events.

The PRCG provides several examples of knowledge sharing via different means:

- The Stormwater Committee has a focus on knowledge sharing, capacity building, technical advice
- Projects create knowledge, e.g. reviewing policy.
- PRCG has a dashboard on its website to share progress on masterplan implementation.
- Through PRCG, Sydney Water has become a knowledge broker – working across multiple PRCG councils

Beyond these groups, other existing means of knowledge sharing include:

- Other conferences (e.g. IPWEA, WASA, SWNSW, CGSA)
- Peer to peer learning from practitioners
- Good consultants
- The CRC for Water Sensitive Cities
- NSW spatial data
- Australian Water School – capacity building

Challenges

Workshop participants talked about how knowledge is 'democratised' but this doesn't necessarily make it easy to find and access knowledge. They noted that current networks are limited by:

- Reliance on individuals – if staff leave, it leaves a void in knowledge. Rebuilding knowledge of new staff is a challenge. Identifying knowledge owners and ensuring their skills are transferred is critical.
- Reliance on small organisations (such as catchment groups) with limited funds.
- There is no single forum for all across Sydney (or even across the Greater Sydney Harbour catchment) to share information. The former "Splash" network was valued, with several participants noting that it worked well while it lasted (Sydney Water disbanded it due to lack of funding and other priorities).
- Different organisations take their own approaches depending on their capacity and local priorities.
- Individuals find they have insufficient time to understand research.
- Too much overlapping information, tools and guidelines that dilutes not strengthens knowledge.

What's missing

Workshop participants discussed the need for more systematic and inclusive approaches to building knowledge of catchment issues and management responses.

A more systematic approach could include:

- A web-based platform where councils upload data to a centralised database (e.g. similar to Resilience NSW re flood data, Sydney City resilience data)
- Centralised information on who to contact, past and current projects
- Online forums to share expertise
- Some effort to merge existing guidelines and tools together to provide clearer guidance and simplify implementation

A more inclusive approach could extend beyond catchment groups/existing regional organisations, but it was unclear exactly who should be included. It was observed that a group needs to be formed around common issues.

The opportunity was also identified for stronger research partnerships as an ingredient largely missing in NSW but with greater presence in other states (e.g. Water Sensitive Cities' partnerships with universities in other states).

Supporting strategies, policies, plans and projects

What's working

Currently there is strong collaboration in specific areas, including:

- Collaborative projects including the current CMPs
- Issue-based collaboration, such as Get the Site Right, involving multiple levels of government including local councils, PRCG and EPA.
- As needed/issue-based collaboration between councils and Sydney Water
- Neighbouring councils often work together on specific projects, or simply provide examples that others follow
- PRCG provides technical advice and support with a range of initiatives related to the Parramatta River Masterplan
- Several councils mentioned support from the NSW Department of Planning and Environment (DPE) with floodplain management
- Northern Beaches Council also mentioned DPE's support with application of the Risk Based Framework
- The former CRC for Water Sensitive Cities (now Water Sensitive Cities Australia) is important for certain councils (e.g. Hornsby, Ku ring gai) and Sydney Water
- Mosman Council mentioned Beachwatch but noted it is less collaborative than it used to be

Challenges

A challenge with current collaborative efforts is that they are often focused on specific needs rather than holistic longer-term goals, therefore:

- Each organisation is involved in different collaborations in line with their own objectives
- As is the case within organisations, collaborative efforts can occur in silos focused on specific issues
- Collaborative efforts are often short-term, focused on specific projects. Progress is lost when organisations are restructured and priorities change
- Projects are reliant on grant-funding, which tends to support 'business as usual' projects only, rather than supporting innovation [suggesting that grant programs and capacities of councils to accept funding emphasise low risk and conventional catchment approaches that may not achieve the step change required]
- Sometimes the priorities of different programs and projects are competing or overlapping, resulting in duplication, inefficiency and unnecessary complexity (this CMP and previous work of the PRCG were suggested as an example).

One person noted that internal groups that focus on water management issues/opportunities (across council) as a positive example of collaboration with broader objectives, but these groups can lack coordination/action without the focus of specific projects.

What's missing

Tentative ideas included:

- An integrated state agency focused on waterways
- One specific government agency who councils can speak to regarding water quality, and seek guidance (i.e. something more formal than the former Splash network. It was noted tat this works better in floodplain management, which is seen as more of a priority).
- Standardised documents and processes
- Guidelines to assist councils in what they would like to achieve through CMP

There was also discussion about the need to do things differently, rather than simply replicating practices that might work for floodplain management, but are less suited to the challenges of waterway health. For example, we should consider:

- A more iterative approach (adaptive management)
- Stronger community collaboration
- Establishing communities of practice focused on delivering outcomes in specific projects/program areas. Get the Site Right is a good example. Another could be focused on private WSUD assets and their compliance.

Supporting stronger governance arrangements

What's working

The PRCG has brought Sydney Water and councils together, focused on:

- A shared vision and common goals
- Collaborative joint decision-making process that were established from the beginning [of the Masterplan]
- An aspect of waterway health that the broader community can visualise/understand.

The PRCG and SCCG are both effective advocates for waterway health, they have state government connections beyond their individual members.

Challenges

There are significant hurdles for current collaborative networks trying to support stronger governance arrangements:

- While there are several collaborative groups present, there is no consistency across the Greater Sydney Harbour catchment around how people collaborate, therefore a unified voice is lacking.
- It is difficult for small, volunteer-based and poorly resourced groups (catchment groups, ROCs, Stormwater NSW, etc.) to provide the outcomes we need to drive long lasting change.
- Within councils, waterway health can easily become lost amongst other competing priorities.
- In State Government, there are many different portfolios and government ministers involved.
- State and local government are disconnected.
- State government tap into collaborative networks and expertise opportunistically and not as a sustained source of knowledge and practice.
- There is currently a lack of understanding of what is required for swimmability. So for example, there is government funding for swimming sites, but not for a catchment management approach to improve water quality.
- Grant funding is not sustainable – it comes with an administrative burden, and it doesn't suit all projects or initiatives.

What's missing

The following high-level principles emerged from discussions:

- There needs to be a shared direction that is:
  - Shared by stakeholders/councils even if they are not involved in catchment groups
  - Locally relevant
  - Apolitical.
- Water management should be integrated (drinking water/wastewater/stormwater).
- Planning needs to be holistic and long-term.
- Sustainable funding is required. Annual member contributions may be politically driven but a sustainable funding model can overcome inconsistencies in commitment.
- Catchment management needs to be covered in legislation (currently it falls between the lines, not included in the CM Act).

There was an observation that current approaches emphasise manging risks and reducing vulnerability to hazards, i.e. he focus is avoiding the negatives rather than accentuating the positives. Arguably, this suggests a need for more proactive approaches.

Part 3
What do we need an improved management framework to include?

Need for a new approach

A consistent theme from past consultation is that Sydney Harbour catchment needs a better management framework to coordinate the actions of multiple organisations, to drive an integrated and strategic approach to managing the catchment.

Workshop participants agreed that it is very important (63%) or important (33%) to improve the management framework for Greater Sydney Harbour (Figure 7).

When participants gave reasons for their responses to this question, most of the responses a significant number (17/24 responses) mentioned how improved management should lead to better results, via factors including:

- A stronger, more consistent, coordinated and cohesive approach
- A better funded, better supported and more efficient approach
- A longer-term and more integrated approach - integrating (rather than competing) physical, social, Indigenous, commercial, environmental sustainability objectives
- Continuous improvement linked to measurable outcomes
- More accountability.

These reflect many of the missing elements identified in the previous world café discussion.

Several other comments (5/24) focused on the importance of improved management because healthy waterways are fundamentally important to our future, Sydney Harbour is iconic, and we have established strong aspirations in high-level planning documents.

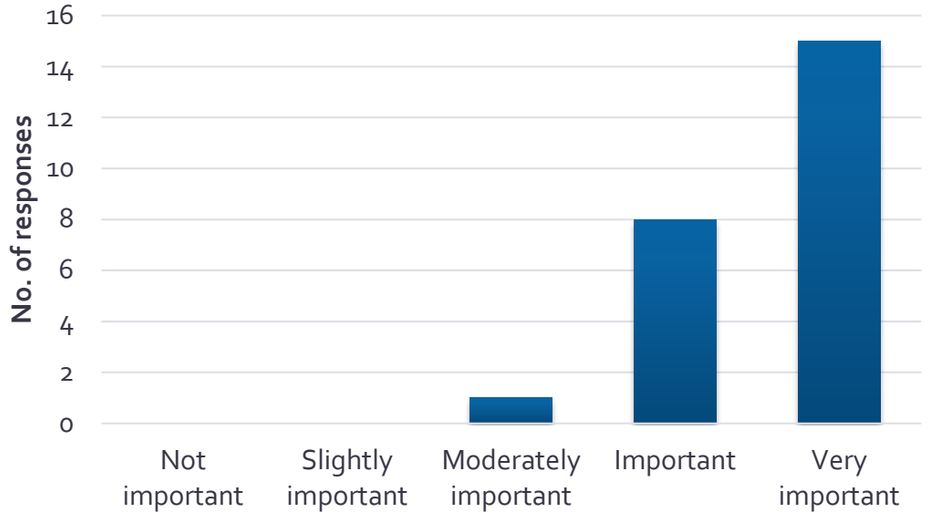

Figure 7: How important is it to improve the management framework for Greater Sydney Harbour?

Improving the management framework

An initial discussion about improving the management framework for Greater Sydney Harbour was focused on four questions:

1. *How could the coordination role of organisations like PRCG and SCCG be improved?*
2. *What would a more consistent funding model look like?*
3. *What would a more consistent approach to planning, monitoring and reporting look like?*
4. *What would effective leadership look like?*

To improve the **coordination** role of organisations like PRCG and SCCG, participants saw a need for:

- **Clear roles and responsibilities** to be defined, potentially including status in legislation, authority to act, or involvement of an authority who can drive results.
- **Sustainable funding**, including direct, ongoing funding that is not just based on membership fees and not subject to annual uncertainty. Funding should be sufficient to maintain key roles and fund longer term programs (e.g. at least 5 years).
- **Clear direction from the State Government**, with parameters/KPIs defined, and clarity over the 'services' provided by regional organisations
- **Measurable outcomes** including a clear return on investment [calculating the return on investment would be a challenge, given the tangible, intangible, direct and indirect benefits of many catchment based initiatives]
- **More formal links to the State Government**, including more involvement from DPE and a link to regional deliverables and outcomes
- **Taking on some responsibilities normally left to councils**, this would make sure that councils are not pushed to over-commit but assisted to achieve local and regional outcomes.

Participants imagined that a more consistent funding model could include:

- **An improved stormwater levy**, which should be legislated, permanent, specifically linked to water quality, set to rise with CPI, and applicable to all properties evenly across the catchment. This would provide certainty - a known quantity of funding that could be planned for each year (with flexibility about exact timing). It should be tied to mandatory reporting requirements to ensure transparency in how it is spent.
- **Funding for whole project life cycles**, including investigations, design, construction, maintenance and monitoring.
- **A connection to performance measures**, including potential bonus funding to drive innovation.
- **Managed by a trust** (similar to the former Upper Parramatta River Catchment Trust or Hawkesbury-Nepean Catchment Management Trust).

Improving the management framework

Workshop participants indicated that a more consistent approach to planning, monitoring and reporting should include more rigorous planning controls (e.g. consistent/catchment based DCP targets) as well as a **rigorous approach** around where, when to monitor and what for, including standard parameters/targets, consistent monitoring framework and reporting requirements, with benchmarking/comparison to agreed baseline/s.

There were diverse views about who should be responsible for monitoring and reporting:

- Some saw a role for **State Government** to establish the framework, objectives and performance metrics, publish a monitoring dashboard and define the parameters to report against.
- Some saw a role for a **catchment coordinator** to be responsible for monitoring and reporting at catchment scale, with advice from technical experts.
- Some imagined monitoring could be **decentralised** but coordinated via an information sharing portal, where data would be publicly available.

There were some comments calling for formal reporting on the implementation of the CMP.

Workshop participants imagined that more effective leadership should include:

- **A clear, long-term program** to implement a well-supported plan (e.g. the CMP) over an extended period of many years.
- **Accountabilities** defined around a clear set of defined goals, with responsibilities for implementation, operation and maintenance.
- **Coordination** by an overall catchment entity who can promote collaborative relationships.
- **State-based authority** such as an agency of government with authority over other departments and involvement in directing and mediating results, a Ministerial priority, links to legislation for catchment management.
- **Collaborative involvement** of all relevant parties, all levels of government and key stakeholders working together.
- Support for **innovation**.
- **Independence** from political or developer influence.

Part 4
Management options

Features of an effective management framework

In 2018 the CRC for Water Sensitive Cities developed a "Vision and Transition Strategy for a Water Sensitive Greater Sydney", based on a series of workshops with 51 participants from water, planning, environment and development in Greater Sydney.

The CRC recommended five overarching strategies to advance Sydney's water sensitive transition:

I. Create formal and informal networks for driving Sydney's water sensitive city agenda to support a collaborative, flexible and integrated governance approach.

II. Embed Sydney's water sensitive city vision in organisational policies, plans and strategies.

III. Establish a cross-organisational framework that enables and drives an integrated and strategic approach for managing the whole water cycle.

IV. Increase knowledge about the social, technical and design solutions that are not yet sufficiently developed to deliver the full scope of Sydney's water sensitive city vision.

V. Identify and establish pathways for implementing water sensitive solutions through innovation and investment.

Based on these five strategies and the specific elements recommended under each of them, an initial set of features important in an effective management framework was devised – refer to Table 2. In the pre-workshop survey, respondents were asked to identify the relative importance of each of these features. There was strong agreement that each of the features is essential or very important.

Survey respondents were also asked to identify any other features that were missing from the list. Other features that were mentioned were:

- Community engagement (4 comments), including a coordinated education approach, community and government working together, and acknowledging the cultural importance of water.
- State leadership and support (2 comments), including agency involvement, supportive land use planning and a funding model that enables effective action.
- Designing with Country (1 comment).

Table 2: Pre-workshop survey results – important features of an effective management framework

Essential	Very important	Somewhat important	
11	4	2	Holistic (state-level) policy for the Harbour catchment
9	8	0	Agreed objectives, standards and targets
9	7	1	Clearer roles and responsibilities
9	7	1	Governance arrangements that keep everyone accountable
9	6	2	Clearer vision and direction for Sydney Harbour
7	7	3	Single, consistent funding mechanism
1	13	3	Consistent approaches in different organisations

Three hypothetical models

The discussions in sessions 1-3 highlighted the need for more formal, top-down and systematic management practices including legislative arrangements, state government leadership, clear objectives, targets and monitoring protocols, clear responsibilities and accountabilities backed by sustainable funding.

There was also a thread of ideas throughout sessions 1-3 about arrangements that identified the value of:

- More inclusivity, enabling more effective collaboration not just between different parts of government but also with research organisations and community.
- More iterative and adaptive approaches that enable innovation and a Caring for Country approach.

A second World Café style discussion was held to discuss the advantages and disadvantages of the following options:

1. A decentralised and 'organic' management model (as in the PRCG or SCCG)
2. A centralised and top-down management model (for example, in the same way that EPA licenses point source pollution)
3. A hybrid management model (the former Upper Parramatta River Catchment Trust and Hawkesbury Nepean Catchment Management Trust are examples).

Indicative features of each of these are listed in Figure 8.

These three hypothetical models were selected for discussion because they represent one spectrum of options, organised around familiar concepts. These three models were used to prompt discussion about the features of different management options, without attempting to capture all possible models or identify the best model.

Outcomes of the discussion are summarised on the following pages. Note that where participants have identified advantages and disadvantages of each option, these should be read as *potential* advantages/ disadvantages, given that the models are hypothetical and there are many unknowns about how each might function. Where participants discussed the unknowns, these have been identified.

Where participants have identified advantages and disadvantages, this also highlights the features which need to be considered with care in the design of any future management model, to ensure that the advantages are realised and disadvantages minimised.

As noted in Figure 2, the purpose of Study 3 is to develop appropriate governance and sustainable funding models and therefore the findings of this workshop should inform Study 3 (which is being undertaken by a separate consultant).

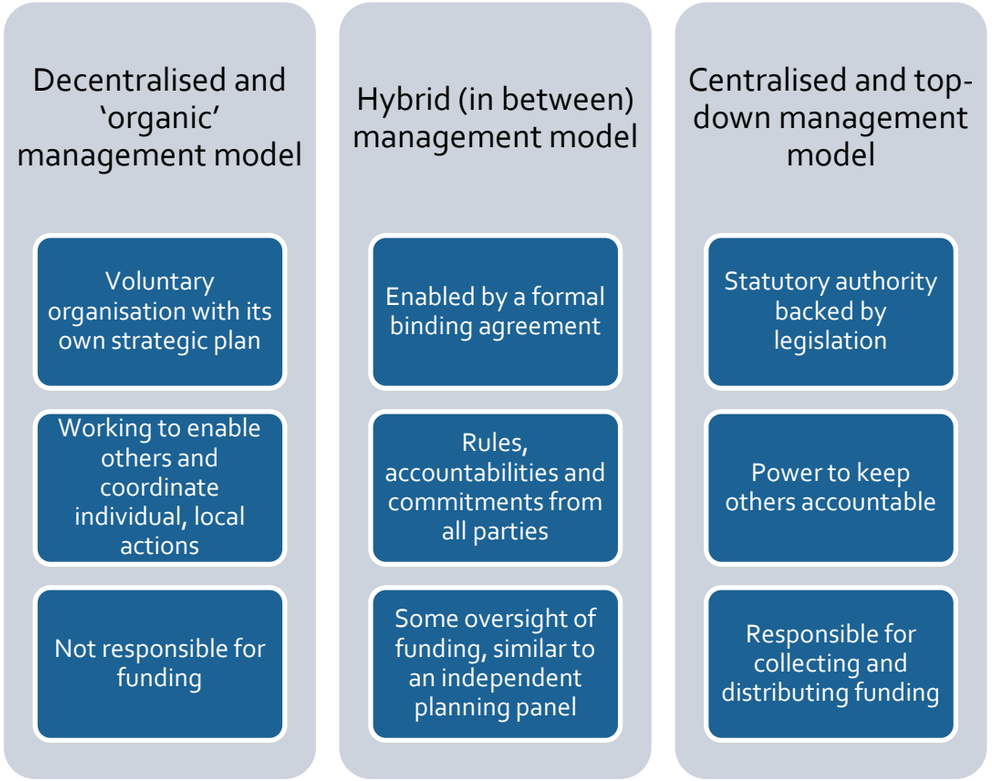

Figure 8: Workshop participants were asked to consider three hypothetical management models

Decentralised management

Potential advantages

A more local approach:

- Tailored to local context and local priorities
- Enabling local representation / participation and engagement
- Fostering local decision-making and ownership of outcomes
- Able to develop local knowledge
- Able to build a sense of local responsibility and involvement
- Closer to community and more responsive to community needs

A more flexible approach

- Greater independence from state government and less vulnerable to (state) political forces
- More flexibility to choose what money is spent on
- More able to work as an advocate 'up' to state government on the local to catchment issues of importance

Potential disadvantages

Limited ability to raise revenue

- Existing groups are largely reliant on member funding
- Currently, PRCG is ineligible for some funding (e.g. Commonwealth grants) as it is not an incorporated association (SCCG is an incorporated association and therefore this is not necessarily a fixed limitation of this model).

No formal authority or power

- Lack of authority when there are conflicting/ competing views – require third party to resolve + implementation
- Ability to engage state gov can vary depending on catchment/organisational objectives
- Lack of power to challenge established institutional arrangements

Instability

- Membership is voluntary and vulnerable. Stakeholders can leave at any time; this could affect long-term outcomes.
- [there could also be instability linked to individual council politics and administrations.]

Inefficiencies

- Duplication of effort, e.g. councils in multiple groups
- Less cost effective when doing things differently
- Lack of an overarching guiding framework
- Competition between catchment groups for limited resources
- Key councils may benefit without making a fair contribution

Complexity

- Complex network/relationships
- Each local council still works towards their own priorities, the approach is not necessarily consistent or fully coordinated

Unknowns/unresolved questions

This group did not discuss unknowns, their assumption being that this is the governance structure that exists presently, therefore it is well-known. What was not discussed in any detail was how the existing arrangements might be modified (e.g. to improve access to funding) while retaining key features of a decentralised approach.

Hybrid management

Potential advantages

Potential ability to achieve 'best of both worlds', e.g.:

- More connected to community while at the same time connected to state
- Able to collect and distribute revenue while remaining apolitical
- Potential to be fully focused at catchment scale, rather than dealing so closely with competing state and local priorities
- Potential to take on more defined roles and responsibilities while also remaining flexible in approach
- Potential to operate strategically as well as being grounded at operational level

Potential disadvantages

This group didn't explore any disadvantages as part of their discussion.

Unknowns/unresolved questions

- What is the appropriate scale? E.g. whole of Greater Sydney Harbour or smaller subcatchments?
- What is the right scope? E.g. integrated water management or waterway health focus?
- Binding agreement hard to implement in practice

This group also noted some examples worth further exploration:

- Birrarung Council for the Yarra River
- Greater Cities Commission
- Planning panels

Centralised management

Potential advantages

- Ability to establish a clearer vision with supporting policy and funding system.
- Greater productivity, consistency, certainty and control of outcomes.
- Clearer responsibility for raising revenue, decision-making, allocating funding, accountability for outcomes.
- Should enable simpler monitoring and reporting.
- Efficiency – faster decision-making, more streamlined projects, more efficient spending.
- Avoid local tensions over competing priorities, and work more effectively across local boundaries.
- Greater authority and recognition of the entity (e.g. statutory body), with ability to enforce/regulate via statutory powers.
- Power/authority to provide clear direction, negotiate conflict, establish defined objectives, targets, parameters others have to meet, guidelines to follow.
- Expectation that a centralised body could attract Commonwealth funding – e.g. as did the Queensland Healthy Waterways Program.
- Stability [however, past examples may suggest otherwise].

Potential disadvantages

- Centralised management could limit collaboration, innovation, creative approaches.
- A less flexible approach with the potential to be heavy handed or lead to inertia
- Local issues may be ignored and local approaches undervalued
- Less connected to local community
- Vulnerability to state government political + administrative changes (noting the history of former CMAs)

Unknowns/unresolved questions

- What is the appropriate scale? E.g. whole of Greater Sydney Harbour or smaller subcatchments?
- Which outcomes could be improved with centralised management?
- How would a centralised organisation manage reputational risks connected with project outcomes - this may affect the viability of the organisation