OCCASIONAL PAPER 29

Urban water planning framework and guidelines

MARCH 2014

WATER SERVICES
ASSOCIATION OF AUSTRALIA

Overview of WSAA

The Water Services Association of Australia (WSAA) is the peak body that supports the Australian urban water industry.

Its members and associate members provide water and wastewater services to about 16 million Australians and many of Australia's largest industrial and commercial enterprises.

WSAA facilitates collaboration, knowledge sharing, networking and cooperation within the urban water industry. The collegiate approach of its members has led to industry-wide advances to national water issues.

WSAA can demonstrate success in the standardising industry performance monitoring and benchmarking, as well as many research outcomes of national significance. The Executive of the Association retain strong links with policy makers and legislative bodies and their influencers, to monitor emerging issues of importance. WSAA is regularly consulted and its advice sought by decision makers when developing strategic directions for the water industry.

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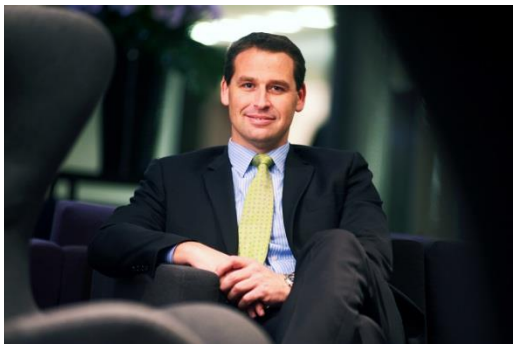
Foreword



The urban water sector is adopting a more outwardly focused approach to planning to reflect customer and community needs. The urban water planning framework, together with the companion WSAA Occasional Paper 30 *The role of the urban water industry in contributing to liveability,* supports this direction (WSAA, 2014b).

The urban water planning framework builds on and updates the previous WSAA 2005 framework (Erlanger and Neal, 2005).

Overall, the framework has shifted from being presented as a linear step-wise process to better reflecting the inter-dependent process of continual input and updates that occurs.

Of most importance in creating this framework, particularly in the context of resilience and liveability, is the need to include an influencing strategy for the external strategic environment. Also important is the need to broaden an organisation's vision to embrace new expectations particularly with regard to customer value.

These aspects recognise that good planning does not happen in a vacuum and form the first two phases of the framework. Influencing trends in the strategic environment at the front end of the planning process provides opportunities for better outcomes.

As time and land development processes progress closer to requiring a water service, fewer opportunities exist to deliver the most efficient, productive, reliable and resilient services to enrich a community.

Equally, ensuring a water service provider's vision reflects their strategic environment is paramount.

Hence, the urban water planning framework has three inter-dependent phases:

- *Phase 1* – influence the strategic environment
- *Phase 2* – broaden the organisational vision
- *Phase 3* – plan, implement, adapt and review.

The third phase includes detailed planning, implementing, adapting and reviewing.

The urban water planning framework and guidelines serve as a basis to broaden water service planning to embrace a role in contributing to multiple objectives as mandated by state governments and our customers.

It provides a basis for engagement with the land development industry, local government, planning agencies, regulators, communities and other infrastructure providers about the future of urban water servicing.

This is a critical step forward in improving the resilience of urban water services. It builds on the industry's critical role in providing essential water services to also enable healthier communities.

Adam Lovell, Executive Director, WSAA

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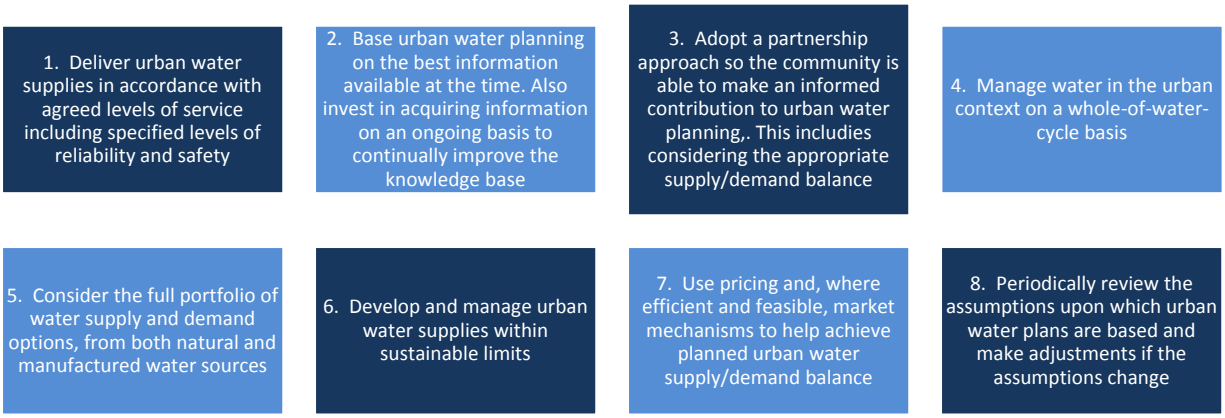
Purpose of this paper

The purpose of this paper is to provide an urban water planning framework that:

- addresses current challenges and embodies contextual changes (outlined below)
- includes community and customers' expectations
- builds on existing water planning skills and updates WSAA's 2005 water resource planning framework (Erlanger and Neal, 2005) to capture the extensive learnings in applying the framework
- responds to COAG's 2008 urban water planning principles (Figure 1)
- allows external stakeholders to gain an appreciation for and understanding of the complexities of urban water planning and the role they could play.

Figure 1: National Urban Water Planning Principles (COAG 2008)



Background

There are a range of emerging trends, expectations and opportunities that are shaping a new direction for the urban water industry including:

- resilience
- empowered customers, engaged communities and stakeholders
- liveability
- environmental sustainability
- commercial agility
- adaptive planning and risk
- integrating urban water planning with strategic land use planning.

This is summarised by WSAA's 2030 vision 'customer driven, enriching life' which focuses on the:

- emergent 'liveability' agenda, in concert with 'environmental sustainability'
- financial viability of the industry (working within the debt constraints of state governments, large debt and lower water use are contributing to some financial instability)
- impact of climate variability and particularly extreme events on future supply security
- recognition there will always be 'politics in water' but it is how we work with, and manage this reality, that will truly set us on the path to resilience (WSAA, 2013a).

Today the water services industry needs to be flexible and adaptive. It needs to cope with the vagaries of climate change while placing customer's front and centre of their businesses. Water service providers are seeking to realise the long term benefits in collaborating with stakeholders to find the best solution.

These changes are shaping a new approach to urban water planning.

Overview of the framework

WSAA released a national urban water planning framework in 2005 to guide best practice across different urban water utilities, local challenges and community preferences. The framework focused on achieving consistency in determining the current level of service and in undertaking a yield analysis (Erlanger and Neal, 2005).

WSAA is now updating this framework to more clearly capture:

- the broader context within which urban water planning occurs
- the role for communities and stakeholders in decision-making
- the broader objectives now included by the industry, including liveability.

The urban water sector is taking a more outwardly focused approach to planning to reflect customer and community needs. The urban water planning framework supports this direction.

Of most importance in creating this framework, particularly in the context of resilience and liveability, is the need to include an influencing strategy for the external strategic environment. Also important is the need to broaden an organisation's vision to embrace new expectations particularly with regard to customer value.

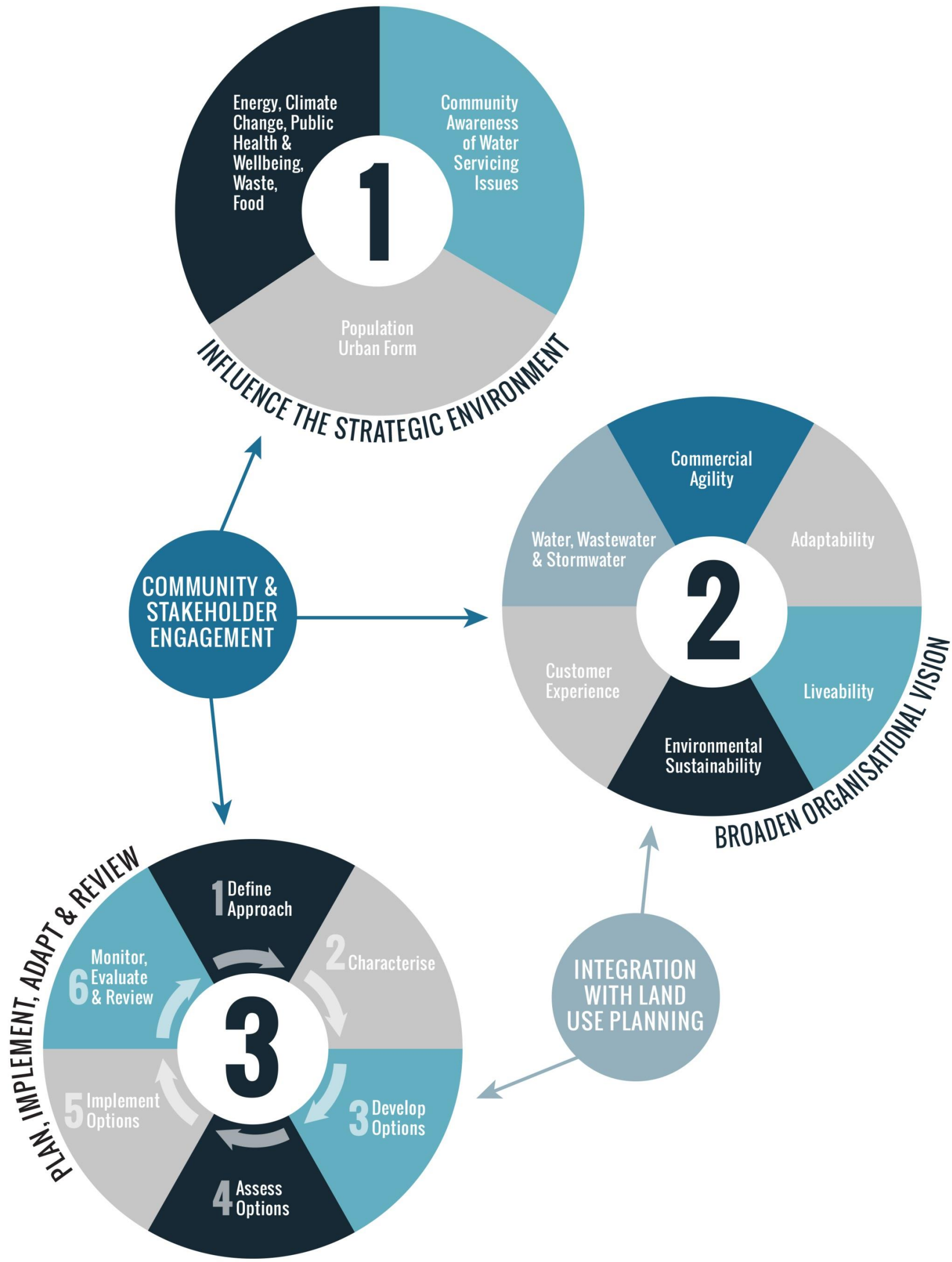
These aspects recognise that good planning does not happen in a vacuum and form the first two phases of the framework. Influencing trends in the strategic environment at the front end of the planning process provides opportunities for better outcomes. As time and land development processes progress ever closer to requiring a water service, fewer opportunities exist to deliver the most efficient, productive, reliable and resilient services to enrich a community.

Equally, ensuring a water service provider's vision reflects their strategic environment is paramount.

Hence, the urban water planning framework has three inter-dependent phases:

- *Phase 1* – influence the strategic environment
- *Phase 2* – broaden the organisational vision
- *Phase 3* – plan, implement, adapt and review (Figure 2).

Figure 2: The urban water planning framework

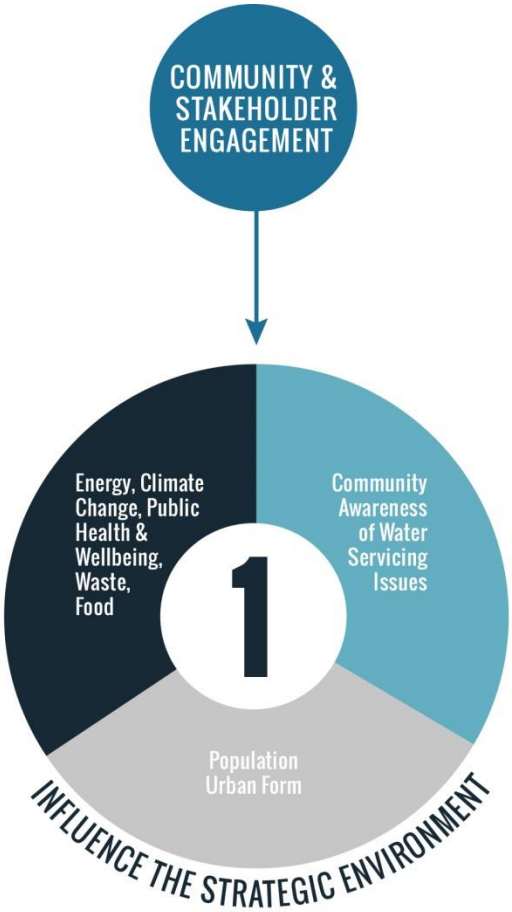


Phase 1 – Influence the strategic environment

The emerging environment for water utilities is more heterogeneous and is likely to remain so. The level of service targeted by an individual utility will reflect both customer demands for water delivered to private homes, businesses and institutions as well as demand for water to support liveability.

Outcomes for natural systems may be factored into the 'service outcomes' pursued by water service providers. Decisions made by other stakeholders, particularly in the urban planning process, are likely to pose both constraints and opportunities for water service providers. This is as the interface between the urban form and water services becomes more complex.

In this environment, water service providers will need to move from simply understanding, monitoring and being aware of the external environment, to actively influencing it, noting both long and short term trends, as well as identifying potential for disruptive events. Water service providers are encouraged to revisit their role in public policy formation and contemplate opportunities to leverage their technical and community knowledge to support effective outcomes in the public interest.



Urban form

A number of states are currently reviewing their land use planning systems and strategies, including:

- A *New Planning System for NSW* – White Paper (NSW Government, 2013a) this proposes a greater focus on strategic planning (particularly long term), enforced through light handed regulation
- *Plan Melbourne - Metropolitan Planning Strategy* (Victorian Government, 2013) will guide the development of the city through to 2050 and provides an ideal opportunity to align urban water plans with land use planning.

These reviews offer the urban water sector the opportunity to influence the strategic land use planning process; particularly through:

- informing debate around the socio-political environment
- informing policy for the planning system
- informing strategic plans themselves. For example WSAA has started influencing this through recent submissions on both of the above reviews.

The Socio-political environment

The objectives in state-based land planning and water services statutes should support the better integration of urban land and water planning.

Where possible, water businesses should influence legislation and regulation to reflect the need to integrate urban water services with land planning, protect the water cycle and share the responsibility for planning, growth and management of urban water between communities, governments and businesses.

For example the new *NSW Planning System (NSW Government, 2013a*) proposes the following objectives:

- the coordination, planning, delivery and integration of infrastructure and services in strategic planning and growth management
- the effective management of agricultural and water resources
- the sharing of responsibility for planning and growth management between all levels of government.

The Victorian Government is currently reviewing the *Water Act 1989* to ensure the Act reflects sound water cycle management principles and establishes the right governance and incentive arrangements for water authorities to adopt an integrated, innovative approach.

Water businesses can influence strategic plans for states, cities, regions and towns to address urban water servicing issues. Examples include:

- *NSW 2021 (NSW Government, 2013b)*, a 10 year plan to guide decision-making and to deliver on community priorities
- South Australia's *Strategic Plan* (SA Government, 2013), which outlines the community's visions and goals
- Western Australia's *State Planning Strategy* (WA Government 2013), which sets out a vision for the state to be diverse, liveable, connected and collaborative.

Urban policy

Land planning in most states is guided by a series of strategic planning policies (SPPs).

However, Queensland is proposing to collapse a myriad of SPPs into one SPP that covers a number of themes. These include:

- housing and liveable communities (amenity and community wellbeing, and land development and housing supply)
- economic growth, environment and heritage (biodiversity, coastal environment and healthy waters)
- hazards and safety, and transport and infrastructure (state infrastructure and services, water supply catchments and infrastructure).

NSW proposes to cover a small number of core planning issues of significance to the state with their reduced number of SPPs.

Western Australia has SPPs that guide land planning interfaces with water resources and protecting water quality outcomes.

Water businesses are encouraged to review draft SPPs and ensure they reflect the principles of integrated water management. This would support the creation of strong, healthy and liveable communities where the natural environment is protected.

Urban plans

City, regional and local plans are generally a primary outcome of land use planning processes in Australia.

For example, new plans for NSW include regional growth plans, sub-regional delivery plans and local plans. The regional growth plans and sub-regional delivery plans will identify city or region shapers to deliver

transformational change and policies relevant to that region (all underpinned by a detailed evidence base). The local plans will provide a statutory framework for developing and using land in a local government area. Other new plans, called growth infrastructure plans are the first of their type in Australia. They will inform the development of these plans. They will include contestability assessments to involve the private sector earlier in the planning process.

In Victoria, recent changes to the Statement of Obligations under the *Water Industry Act 1994* require Victorian water authorities to work with the Office of Living Victoria to (in accordance with any written guidelines issued by the Minister) develop:

- an integrated water cycle strategy that identifies the best mix of measures to achieve a set or prescribed objectives in the Statement of Obligations, and ensuring these measures 'consider opportunities that support liveable and sustainable cities and towns through the delivery of benefits across the urban water cycle. This includes approaches to align the funding of benefits with the organisation responsible for their delivery'
- integrated water cycle plans for regions across Melbourne as well as preparing precinct structure plan submissions (metropolitan water corporations only)
- consult with local government, the Growth Areas Authority, the Department for Planning and Community Development and relevant developers and builders.

Water businesses have a role to influence regional planning strategies to realise the full potential to integrate land and water outcomes. Water is a key 'enabler' of liveability.

Engaging with communities

Engaging with the community on where its water comes from, how sewage is managed, and the value of water usually happens during a drought.

For example, in response to the *Millennium Drought* there were many programs on educating the community about how to use less water. What also became important was the need to talk with the community about the urban water cycle and how new opportunities could be explored. These included:

- wastewater recycling
- desalination
- stormwater reuse
- replenishing drinking water sources with highly treated wastewater i.e. potable reuse.

This led to two collaborative research projects between Australia and the United States of America on how presentation of water reuse in the context of the urban water cycle can positively impact acceptance of potable reuse (Callaway *et al*., 2012). These research projects found that '*no amount of statistics can overcome the stigma if the public is first introduced to the subject as a linear progression from wastewater to drinking water, without the contextual understanding about water's use and reuse in the world today. This research suggests that one pathway to acceptance is to create new understanding, experiences, and images that expand on and broaden people's perspectives. Such an approach might help people make sustainable, informed decisions based on knowledge of water reuse's benefits*' (Callaway *et al*., 2012).

Stewardship of the urban water cycle

Across Australia, new sources of water have transformed the urban water cycle to improve the industry's resilience to climate variability. Many of these sources are now owned or managed privately. This reflects a trend for more decentralised sources (such as rainwater or local groundwater) to complement traditional centralised approaches (such as dams). With new water sources, new industry participants and new business models, the challenge is to make the industry function reliably, efficiently and productively. No single entity owns and maintains the entire urban water cycle.

Urban water utilities are well placed to provide an overview of changes to the overall system, ensuring supply demand balance and network resilience. This is particularly complex with stormwater use as utilities, government agencies and local councils all have a role ownership, control and management.

Other issues and responses

WSAA and its members have contributed significantly to public policy around climate change, given the impact on our industry. WSAA and its members have also established a relationship with UNSW's Healthy Built Environment's program and the Cooperative Research Centres for Low Carbon Living and Water Sensitive Cities to better integrate urban water in the built environment.

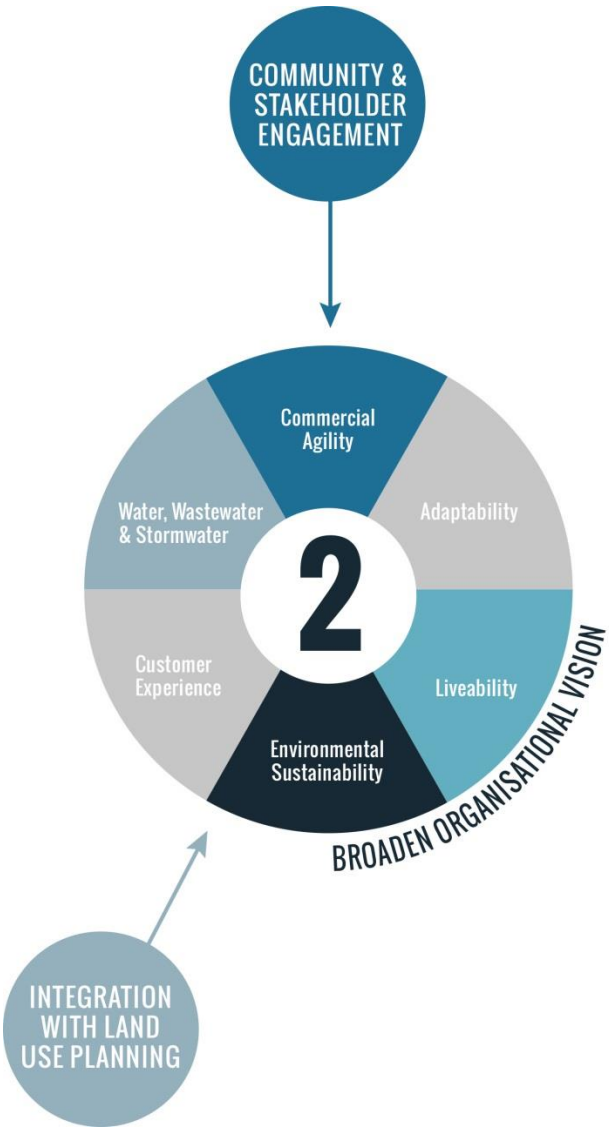
Also, with constraints on public borrowing capacity shaping government decisions around infrastructure investments, new models for financing and operating assets are becoming more attractive across infrastructure classes.

Stakeholder preferences for diversity in the supply chain are influencing approaches to service delivery with some state and territory jurisdictions actively seeking opportunities for greater private sector involvement in delivery.

Finally, the institutional and legislative arrangements established by governments vary between jurisdictions and are frequently under review. Changing institutional boundaries and responsibilities require water service providers to respond to these changes. Legislative reforms underwrite the expansion or contraction of organisational vision and purpose.

Phase 2 – Broaden the vision

An organisation should establish their breadth of vision and mandate in the urban water sector to inform their planning process in delivering customer value.



Adopting objectives associated with each of the domains outlined below, and the emphasis placed on these objectives, depends on a range of factors common to most water service businesses. While the vision should extend across all areas in which an organisation functions, establishing this vision has particular relevance to the planning process.

Community engagement influences decision making, irrespective of the chosen objectives. Also critical during the implementation phase, is engagement with the broader urban planning sector to ensure integration between strategic land use planning and urban water planning.

Customer experience

The urban water sector provides one of the most essential services to society. The industry wants to be recognised by customers as trusted, efficient and valued service providers. We will continue to improve efficiency and productivity while delivering the services that customer's value. We will not lose sight of the need to keep delivering great core services. The industry also views the 'environment' as a customer of its services.

WSAA surveys show that customers see the urban water industry as conservative, trustworthy and reliable. The industry is also seen as slow to change and somewhat compliance driven. Our aim is that customers'

values and willingness to pay for services determine how services are delivered and what trade-offs are made between risk, reliability and affordability. We expect this will drive the industry to provide a greater range of services and more choices for customers.

Water businesses are encouraged to work with customers to determine what they value and why, and to consider what benefits, if any, may come from customer segmentation work. WSAA recently compiled some information to form a picture of customer expectations (Figure 3).

Further, there are generally three customer segments:

- Disengaged (45% of customers) – (given various names – 'unconvinced', 'uninvolved', 'disempowered', 'basic need', 'so what'). This segment is not interested in involvement with the water companies unless they are impacted by circumstances that directly affect their expectations.
- Price-centric (12% of customers) – (given various names – 'price control', 'leave it for later'). This segment could be interested in involvement with water companies in the future, but at this time they have other priorities, particularly keeping bills low.
- Positive (43% of customers) – (given various names – 'respectful', 'future focus', 'social conscience', 'efficient usage'). This segment is very interested in water and they are already taking steps to save water and are environmentally aware.

Figure 3: Urban water utility customer expectations of their water service provider (WSAA meta-analysis)

ALWAYS	MOSTLY
• Safe clean drinking water • Efficient sewerage service • Fix and maintain infrastructure • Water with acceptable look and taste	• Set customer water use targets • Correct billing • Water management advice • Proactive leak detection • Protection of waterways
SOMETIMES	**NEVER**
• Estimate water use for customers so they can lower their bills • Advice on water restrictions • Provide water usage comparisons • Sell new water related products or services • Include recycled water in supply	• Provide customer usage data to a third party • Sell new water related products and services or diversify into new markets for profit – at the expense of ensuring essential water service provision

For further details on customer value and innovation refer to WSAA's position paper 'Using Water Wisely' (WSAA, 2013b).

Water, wastewater and stormwater

Key objectives of the urban water sector include:

- a secure supply of safe drinking water
- safe collection and treatment of wastewater before returning it to the water cycle
- safe removal of stormwater to protect the public and property.

Liveability

Liveability describes the attributes that make a city or region enjoyable to live in. Social, economic and environmental sustainability are essential foundations. However, liveability also addresses:

- amenity
- human preferences towards certain places
- services
- a sense of social connection and belonging.

For further details on liveability refer to WSAA's Occasional Paper 30 *The role of the urban water industry in contributing to liveability* (WSAA, 2014b).

The urban water industry's contribution to liveability differs with each city and region, and over different timeframes. As liveability is also highly context specific and subjective, it is likely to differ from place to place and community to community. It is essential that water utilities engage with their customers to determine their values and preferences on liveability in their community, and ensure the proposed water solutions are appropriate.

Key objectives include:

- reliable and resilient water services support passive and active recreation, provide amenity and reduce the urban heat island effect
- customer affordability and choice underpins resilient homes and gardens
- shared responsibilities and resources across the planning and development, health and environmental sectors distribute benefits and costs.

Adaptability

This domain emphasises resilience in the urban water system, arising from the increasing volatility and unpredictability of the climate system.

Key objectives include:

- a resilient and diverse portfolio of options to meet demand, weighted by risk
- assets are temporary or have multiple uses and functions over their long lives
- planning approach is updated as technology evolves.

Environmental sustainability

This domain acknowledges the potential for water service providers to impact (and be impacted by) changes to natural capital.

All water service businesses are required to comply with environmental regulation. There is capacity for organisations to move 'beyond compliance', when aligned with stakeholder and community objectives.

Key objectives include:

- protect and improve (where necessary) ecosystems and their services
- minimise carbon emissions, and energy and resource consumption; optimise resource reuse opportunities.

Commercial agility

This domain responds to calls for a leaner sector, making more efficient use of financial and economic resources, and drawing on the skills and strengths of both the public and private sectors.

Key objectives include:

- water businesses innovate and experiment along the value chain for the benefit of customers
- third party participants are actively encouraged to produce a more diverse business environment.

Phase 3 – Plan, implement, adapt & review

The final part of this paper includes elements from above and the practical experiences of water service businesses, to describe the process of planning, implementing, adapting and reviewing. This acknowledges the continuing significance of core tasks: water service providers will continue to be responsible for providing water, wastewater and stormwater services.

The *6 Steps* are general in nature, reflecting the diverse circumstances, scales and objectives for contemporary water service businesses. Rather than specifying the sequence of analytic tasks, the *6 Steps* bundle tasks into broad categories, as in reality tasks occur in parallel rather than sequentially. Good practice sees an exchange of data and methodological approaches between each key step of analysis to generate a coherent body of knowledge for making decisions.

Similarly, planning processes are rarely linear, and involve multiple feedback loops. The *6 Steps* note the importance of evaluating knowledge and assumptions underpinning the process, to ensure new information is consistently integrated into decision making. Individual users can assess where a feedback loop occurs.

For the third phase, WSAA has developed 11 core elements related to the six key steps in the wheel above (Table 1).

Table 1: 6 Steps and 11 core elements of Phase 3 with a focus on planning, implementing, adapting and reviewing

Key step	Core elements
Define approach	1. Define an approach to planning that includes an opportunity for a diverse range of stakeholders to come together and ask "What is the problem we are trying to solve?" 2. Establish a clear and agreed set of urban water servicing objectives between urban water planners, land use planners, communities and customers, and economic, health, water and environmental regulators. 3. Develop a stakeholder and community engagement strategy which aims to maintain open and transparent lines of communication between all parties to the planning process, including around key decision-making points.
Characterise	4. Adopt a 'systems' approach to planning for and managing urban water services. That is, plan for, and manage water services in the urban context on a whole of water cycle basis and within the context of land use planning (particularly capital city and regional), waste management, and energy and food production.
Develop options	5. Identify (and regularly update as conditions change) flexible portfolios of water servicing options at a variety of scales (on site, local and region/city).
Assess options	6. Assess the merits of all options for a particular area and identify for each option the associated funding models including the identification of who benefits and who pays for each option. 7. Quantify environmental, economic and social costs and benefits of options using a model agreed to by economic regulators.
Implement	8. Develop an investment strategy – a set of policy rules and instructions as to the sequence in which the types of options are chosen, the thresholds and triggers for new options, predecessors and constraints for some options, and the constraints of the system. 9. Ensure the implementation plans include agreement/s on responsibility for ongoing management, operation and maintenance of all options.
Monitor, evaluate and review	10. Publish periodically a water outlook that contains information on: • the amount of water currently available • a forward storage/capacity outlook for the coming year under a range of plausible climate scenarios • whether agreed levels of service will be able to be met under these scenarios and if not what actions will be taken to improve system performance so that these agreed levels of service can be met (i.e. what triggers, if any, need invoking). 11. Comprehensively review and update the plan every five years.

STEP 1: Define approach

Core elements

Define a planning approach to include an opportunity for a diverse range of stakeholders to come together and ask "What is the problem we are trying to solve?"

Establish a clear and agreed set of urban water servicing objectives between urban water planners, land use planners, communities and customers, and economic, health, water and environmental regulators.

Develop a stakeholder and community engagement strategy.

Key outcomes

- Clear purpose with an agreed set of urban water servicing objectives
- A stakeholder and community engagement processes from the outset that maintains open and transparent communication between all parties to the planning process and key decision-making points.

At the start of the planning process, the planning team should form and establish the overall approach. This includes identifying the objectives and key stakeholders for the planning exercise. This is before setting out a broad 'plan of attack', including a plan to gather necessary information and analysis to engage stakeholders.

Community and stakeholder engagement

Stakeholder and community engagement is a key consideration in planning given its potential to empower and contribute to maintenance of the 'social contract.' Water businesses need to move towards the 'empower' end of the IPA2 Public Participation Spectrum (Appendix 1). The spectrum assists in selecting the level of participation that defines the public's role in any community engagement program. In this framework, differing levels of participation are legitimate depending on the goals, time frames, resources and levels of concern in the decision to be made. Users should select tools that are fit for their purpose. For complex problems, engaging the community will require community learning so they can effectively participation.

Defining the problem and objectives

Considering feedback loops within the proposed process is critical in this early period. At this stage it is important for a diverse range of stakeholders to come together and ask 'What is the problem we are really trying to solve here?' This is a critical question that can open up the process to more options and a greater probability of creating a resilient future. Often it can result in:

- developing systems maps
- identifying new stakeholders and networks/clusters of people/organisations
- establishing a unity of purpose
- establishing a broader, more dynamic and relevant set of ideas, tools and approaches.

The draft planning objectives should arise directly from the organisational vision and objectives from *Phase 2* of the planning framework. Consulting with customers, community and stakeholders on the draft objectives is critical. Depending on the scale and nature of the planning exercise, tailoring these broad objectives specifically to the planning exercise in question is a good idea. For example:

- commercial agility
  - minimise impacts to water prices and associated cost of living
  - facilitate faster release of land
- environmental
  - improve waterway health
  - improve or project ecologically significant species of flora and fauna
  - minimise carbon emissions
  - enhance sustainable use of groundwater systems
- liveability
  - provide reliable supply of water for public open space, recreational reserves, ecological corridors, additional landscaping which enhance amenity of precincts
  - mitigate impacts associated with the urban heat island effect
  - minimise flooding risk and impacts
- adaptability
  - provide a service strategy that is resilient to trends and shocks.

It is important to link assessment criteria clearly to agreed objectives, and describe desired performance levels in specific and measurable terms.

Aligning the process with strategic land use planning

In addition to the interface with the community, the expanded scope for the urban water sector suggests a strong integration with the land use planning system. WSAA's 2030 Vision (WSAA, 2013a) recognises the importance of a customer focused industry which contributes to liveable communities where water services deliver broad economic, environmental and social benefits to everyone.

> *Australia's cities top the liveability stakes. However, as they become more complex water must be in the front row of planning. Greater integration of urban water services planning with strategic land use planning at the beginning of the process is essential to deliver services that meet multiple objectives including improving liveability and urban design. A strategic approach to planning early on keeps open the maximum number of options for servicing a community to achieve the best scale, delivery model and development timeframes.*

An understanding of the land use planning system is needed to constructively integrate urban water and land use planning.

Plan and document process

Having determined objectives and stakeholders, the planning team should document a sequence of actions, including requirements for analysis and internal and external stakeholder engagement. As part of this process, identify potential triggers for feedback loops or additional stakeholder engagement.

Tools (Appendix 1)

- Planning and 'problem definition' workshops
- IAP2's Public Participation Spectrum

STEP 2: Characterise

Core elements

Adopt a 'systems' approach to planning for and managing urban water services. That is, plan for, and manage water services in the urban context on a whole of water cycle basis and within the context of land use planning (particularly capital city and regional), waste management, and energy and food production.

Key outcomes

- Demonstrated community and stakeholder support for planning objectives, and increased community understanding of system
- Spatially enabled characterisation of the system, incorporating water, wastewater and stormwater, and other objectives as identified above
- An understanding of the natural environment and its relationship to the built environment (existing and planned).

Prior to considering future planning options, the planning team should establish a clear context as a benchmark against which to identify objectives and evaluate performance. System characterisation helps inform both the existing conditions and expected impacts that shape the options available to continue to meet service and community requirements.

Characterisation of the system involves:

- assembling system data to help inform issues, risks and opportunities
- assessing system influences – including both trends (gradual changes) and shocks (step changes)
- describing scenario paths, including combinations of the variables identified as influencing the system (including climate change risks)
- considering supply - demand balance
- revisiting issues, risks and opportunities based on the information collected
- setting planning objectives based on the scenarios identified.

The system context is not limited to the demand for water resources, but may be characterised by a wide range of factors. For example, for an organisation that has adopted a broader liveability or sustainability mandate, understanding the broader features of the existing and planned urban environment may be a feature of this stage.

Therefore, of critical importance at this stage is the collation of data.

Assemble data about the system

Including additional domains into the planning process requires a far broader range of considerations than a traditional water supply and demand analysis. Widening the planning focus may significantly increase the potential issues, opportunities and options that could be included in the planning assessment. To give focus to the analysis, a preliminary assessment of the system characteristics is required.

As the range of objectives increases, so too does the volume of data to be analysed. GIS can be a powerful tool for harnessing large amounts of data and understanding the spatial relevance of key issues that may influence project objectives and options selection. The ability to 'layer' information can provide an efficient method of identifying inter-dependencies and spatial opportunities and constraints.

Depending on the project scale and information availability, give consideration to mapping or collating the following information over the full planning horizon:

- physical context: the fixed (and evolving) characteristics of the system, including natural features, water resources, built and urban form, and land use
- demographics: the community profile, including population density and distribution and the resulting demand for potable and non-potable water. The planning team could also consider factors that could affect usage rates and capacity for engagement
- environment: the environmental context, including ecosystem and waterway health, areas of significance, climate data
- liveability: accessibility to local and regional destinations including public open space, recreation facilities and centres of activity, the quality of these destinations and the climatic comfort and/or risks urban areas have (such as flooding and urban heat island effect).

Understanding the asset profiles of water, wastewater and stormwater systems is a critical part of characterising the physical system. This is because system capacity and condition can contribute to shaping future opportunities and constraints.

When understood in the overall context of the catchment, this information can assist in uncovering integrated strategies and solutions that could contribute to 'closing the loop' and matching local sources of demand and supply. For example, avoiding a major augmentation to a sewer at capacity could justify implementin decentralised treatment that provides a new recycled water resource. Considering the systems collectively, rather than in isolation, assists with identifying synergistic opportunities, such as the use of an abandoned sewer for the storage or conveyance of stormwater.

Where an organisation has data collated through telemetry or other collection arrangements, profiling capacity use across both time and space within a system or network can provide powerful insights into constraints and opportunities. Using GIS data can assist in interpreting this information and understanding its implications.

Understanding the environmental and social context is equally important to a holistic analysis that seeks to align service provision with the natural water cycle. An understanding of the current status of the factors contributing to environmental sustainability and liveability allow us to identify both challenges and opportunities for improvement.

Once identified, key opportunities, issues or constraints may initiate a feedback loop. The opportunities, issues and constrains should be reviewed for alignment with the previously identified objectives, and adjustments made if necessary.

Assemble data on external drivers

External drivers, control over which is limited, test the resilience of water service provision most dramatically. These factors influence any or all elements of the system and are most clearly illustrated with the examples of population growth and climate change. They may also include other major impacts such as major changes to the prevailing financial or political context. Importantly, these impacts may manifest either as trends over time, or potentially as shocks, such as a sudden and unexpected step-change.

Successful planning will account for this range of potential outcomes. Systems planning must retain the flexibility to adjust to better information as it becomes available. A range of scenarios should also be consider so decisions occur on an informed and timely basis.

Given the uncertainty attributed to future conditions, considering a range of potential scenario paths can ensure flexibility and robustness in the planning process. Identifying scenario paths, each comprised of different combinations of the potential range of outcomes identified for the external drivers, captures a range of possible future outcomes. The ability of the system to respond to these scenarios, and to continue to meet objectives, drives the options identified to meet any shortfall.

The Australian Government's scientific body, the CSIRO, regularly updates projections of potential climate change impacts across the country. In the country's south-east this is complemented by reports by the South East Australian Climate Initiative (SEACI), which reflects on recent climate trends to continually refine future climate projections.

For example, population change projections, though potentially negative, typically reflect an expectation that the customer base will grow at a given rate over the planning horizon. Clearly the further along that horizon the rate is projected, the greater the associated uncertainty. However, in some instances predictions of sustained population growth can represent a substantial change over the planning period.

Similarly, variability in climate conditions, both naturally occurring and as a potential impact of climate change, can influence demand (such as contributing to higher demand during sustained hot weather). These are particularly material for supply-side considerations of yield and levels of service objectives. The impact of these climatic changes on the urban heat island effect may also be significant.

Water balance and system analysis

To complement the characterisation of the study area and to inform options selection, developing a water balance can broadly articulate the available supply and demand characteristics for the study area. It may be intuitive to break the study area into sub-catchments or precincts, dependent on the outcomes of the spatial variability of supplies and demands.

A demand analysis is fundamental at an appropriate level of detail, consistent with the scale and complexity of the study. The analysis should account for the scenario paths identified to represent the range of potential future demands.

Analysing the extent, timing and water quality requirements of demand across different sectors can assist in framing the water supply-demand balance.

Identifying major water users may contribute to a better characterisation of demand, particularly where there are large demands (such as industrial or agricultural) that could potentially be met with non-potable resources.

Utilising GIS as a platform for identifying demand requirements can help begin to make the spatial connections between demand profiles and supply resources. When including liveability, consider options that may also increase demands (particularly for non-potable water) to deliver additional benefits such as supporting increases in open space, landscaping or improvements to eco-system health.

The principles of yield estimation practice should be adopted in assessing the current and future reliability of supply for the system under each scenario path. This will lead to identifying the risk of supply shortfalls and other 'gaps' in providing levels of service (e.g. frequency, severity and duration of shortfall periods.

Identify a wide range of water supply sources including some that are yet to be used. For each establish a reliability profile, typically as an ability to meet a given demand for a certain proportion of the time. Understanding the relative reliability of each supply source and their inter-dependencies can then help to shape options for future supply 'portfolios'.

Tools (Appendix 1)

- Demand: GIS, Regression analysis, Urban Developer, SSIM, Precinct Tool
- Supply: REALM, IQQM, SOURCE Catchments, MUSIC, urban developer
- GIS for spatial data mapping

STEP 3: Develop options

Core elements

Identify (and regularly update as conditions change) flexible portfolios of water servicing options at a variety of scales (on site, local and region/city).

Key outcomes

- Options function across planning 'silos' and cover the continuum from the water supply through to the water sensitive city
- Spatial dimension of options is considered
- Relationships between individual options are examined and optimised
- Trade-offs between options are understood
- Communities and stakeholders feel they have contributed to *Step 3*
- Funding models, including identification of who benefits and who pays for each option.

A broader organisational vision tangibly increases both the objectives of the planning study and also the suite of options available to water managers to meet these objectives. In this *Step 3*, the issues, opportunities and constraints identified in *Step 2* and the vision and objectives agreed in *Step 1* are analysed to identify and develop a portfolio of options 'clusters'. The options clusters acknowledge the interactions between the traditional water management silos of water, sewerage and stormwater and with the introduction of liveability, also incorporate land use planning options.

The key output of this section is a discrete set of options or clusters; developed to a level of detail that enables input into the *Step 4* assess options process. In this *Step*, determine the appetite by stakeholders for third party involvement in the delivery of water solutions. Third party involvement is generally essential where an organisation's vision heavily emphasises commercial agility.

Under these circumstances, identifying and engaging with potential third party investors or operators may be appropriate at this stage. Benefits of early involvement may include diverse technological and commercial thinking about service options, as well as stronger appreciation by the water service organisations of the constraints and priorities of public or private sector contributors.

Identify individual options

Options identification should embrace all options that address both the full breadth of study objectives and different scales that are applicable to the planning study: allotment, precinct or region. With regards to liveability this may include some non-water related options such as:

- increased quantity and/or quality of open space – this may include improvements to existing assets from a recreational, thermal performance, facility-provision or providing new assets where none previously existed
- sale of land earmarked for water assets – this may include providing opportunity for commercial or social activities where a need existed or improving the interface with assets that have a recreational purpose
- stormwater management – this may consider the water needs of existing or future planned open space assets and flood management that considers the opportunities assets could create from a liveability perspective
- resource recovery – this may include capture and treatment of sewage and stormwater for the purposes of reuse, energy production or nutrient recovery within urban areas rather than treatment and disposal.

Develop portfolio options and investment strategies

Given the variability in the scale and benefits of options, one option alone will rarely meet the broad objectives of a planning study, which seeks to incorporate liveability. Combinations or portfolios of options are required to meet the full breadth of study objectives. With the endless permutations and combinations of option clusters, a scenario approach to developing discrete 'investment strategies' is one method recently proposed by Mukheibir *et al.* (2012). Under this methodology, each investment strategy has a theme to guide the rationale for combining options.

Examples of themed investment strategies

An "efficient investment" themed investment strategy may focus on utilising existing infrastructure and minimising capital investment. This may include: a strong focus on water efficiency, using intelligent networks to drive assets harder, linking assets across systems, utilising abandoned or under capacity assets, private sector provision of services, delaying staging to align with new development.

A "proactive sustainability" themed investment strategy which prioritises recovery of resources above a purely least cost approach may include: a local wastewater treatment plant, co-generation, co-digestion of solids, productive roof top gardens, ecological corridors and use of all water generated on site for either potable or non-potable uses.

A "proactive liveability" themed strategy may include dispersed stormwater management to provide open space in strategic locations, the provision of non-potable supplies to support 'greening' of the study area. This is the approach taken by City West Water in developing their "Greening the West" strategy.

Planners must consider how these options link together. For example, there may be insufficient demand to reuse all of the available recycled water and stormwater, or available storage may exist. The options for each investment strategy should therefore have a complementary fit.

The level of development of options will ultimately depend on the intent of the planning study. For example, a more strategic study may require broad scale options assessed at a high level of detail. While preparing a detailed servicing strategy may require a level of conceptual or functional design to thoroughly explore costs and risks. As a minimum, the options must be assessable against each of the determined assessment criteria.

In a traditional water supply and demand planning study, the primary benefits of options related to levels of service is determined via water resources modeling (as outlined in WSAA's 2005 Framework for Urban Water Resource Planning (Erlanger and Neal, 2005). When incorporating liveability considerations, additional modelling is required to determine the performance of each option against the multiple planning objectives. Depending on the scale of the planning study, additional modelling of options may include:

- flood modelling
- water quality
- biodiversity
- visual amenity, safety and security, service accessibility (for example, recreation facility useability)
- urban heat island effect
- nutrient loads
- hydraulic modelling of networks
- optimisation across a range of objectives.

For large scale planning studies, modeling multiple scenarios to articulate the impact of the previously identified trends and shocks is important.

Tools (Appendix 1)

- Modelling packages such as MUSIC, TuFlow, InfoWorks, SOURCE Catchments, Wathnet, REALM, PURRS
- Geospatial sustainability tools such as SSIM, Precinct Tool

STEP 4: Assess options

Core elements

Assess the merits of all options for a particular area. Identify for each option the associated funding models, including who benefits and who pays for each option.

Quantify environmental, economic and social costs and benefits of options using a model agreed to by economic regulators.

Key outcomes

- Options assessed by criteria consistent with overall vision
- Assessment considers both net benefits and the distribution of benefits, and includes qualitative and quantitative methods
- Risk and resilience transparently articulated and addressed in options assessment.

Capital intensive infrastructure, such as pipes, pumps and treatment plants, which have relatively long useful lives, dominate the sector. As a result, urban water planning decisions can have long lasting consequences for customers and public finances. As cities expand, centrally planned water and wastewater networks are exposed to potentially higher operational costs to transport water and wastewater around the network. This explains the need to identify the range (short and long term) of costs and benefits associated with each option.

Qualitative analysis

The first part of the *Step 4* is to put further 'meat on the bones' of the identified options. To do this first articulate in qualitative terms the expected benefits, impacts, risks and timing under each of the options. Then assess each for the extent to which it delivers the desired outcomes established in *Phase 2*. At this point, the team should develop an evaluation framework which includes the planning objectives.

Two traditional approaches to undertake these qualitative assessments are Scenario Planning and Multi-Criteria Analysis. Both bring the advantage of allowing options assessment where rigorous (and often costly) identification of costs and benefits has not been undertaken. By applying these multi-perspective filters, water cycle planners can often determine which options performed poorly in meeting the overarching vision. It can also determine those that have 'fatal flaws', without dedicating considerable resources to undertake full quantitative analysis of each identified option.

Through the qualitative analysis process it is important to identify the widest range of costs and benefits associated with the option. This assists in establishing the logical framework for the detailed analysis in *Step 5*.

Quantitative analysis

There are a range of approaches to undertaking quantitative analysis of urban water cycle options. However, cost-benefit analysis (CBA) is typically the approach preferred by central decision makers such as Treasury and Finance departments. Increasingly, senior managers of water authorities require rigorous cost benefit analysis of urban water cycle planning options.

Economic CBA specifically addresses marginal changes in social welfare brought about by an investment proposal through assessing the costs and benefits that result from the investment, relative to a do nothing/status quo case.

Benefits and costs are expressed in monetary terms and included into the CBA using a discounted cash flow analysis. The expected timing of benefits and costs is assessed to enable these to be converted into today's dollars using an appropriate discount rate.

This enables projects that have different investment profiles (i.e. capital costs, investment lives, timing of benefits etc.) to be compared on a common basis; on their Net Present Values (NPVs) and Benefit Cost Ratios (BCRs).

The general tasks for a CBA include:

- identify the objectives of the analysis
- identify and describe the status quo and intervention options
- quantify the marginal costs and benefits of options relative to the status quo
- undertake discounted cash flow analysis and calculate economic decision rules such as Net Present Value and Benefit Cost Ratio to inform selection of the preferred option
- test the sensitivity of results to changes in uncertain inputs and assumptions.

The first and second tasks of a CBA are addressed during *Phases 1 and 2* (respectively) of this water cycle planning framework. The remaining three tasks are addressed in this Step 4 of the framework.

When quantifying the marginal costs and benefits of each option planners should take particular care to address the following five considerations in order to capture the widest range of relevant costs and benefits.

1. Identify preferred options (s)

Ideally all costs and benefits of the proposed options identified during the qualitative assessment will be quantified in monetary terms. This enables CBA to be undertaken for each option against the specified base case. This will permit the costs and benefits to be included into a discounted cash flow analysis. Treasury and finance departments in most Australian jurisdictions have issued detailed guidance for this task.

The outputs of the discounted cash flow analysis are typically the Net Present Value and Benefit Cost Ratio for each of the proposed options. Both metrics are useful to inform planning decisions. However the metrics should not be the sole determinant of whether a particular option is preferred. Decision makers should take into account the entire suite of analysis encapsulated in *Step 4*.

2. Sensitivity analysis

The results of the CBA will be a useful guide to decision makers regarding which of the options should be preferred. Prior to making the final decision, it is useful to test the sensitivity of each option to significant changes in the assumptions that underpinned the economic analysis. The urban water cycle is typically sensitive to:

- changes in population growth and settlement patterns
- variability in rainfall across all relevant catchments
- structural change in the economy (particularly decline in sectors of the economy that consume significant quantities of potable water)
- broader regulatory or pricing changes that impact urban water consumption.

Robust sensitivity analysis can assist water planners to eliminate or amend those options, which are unable to withstand extreme variations.

3. Identify whole of life cycle costs, including externalities

Establishing the costs of urban water cycle infrastructure has traditionally been a relatively straightforward task. This is as a result of the physical nature of much of the infrastructure and the established capacity of the sector in costing engineering conceptual plans. What has become more apparent is the timeframe over which those costs have been assessed has been shorter than the useful lives of much of that infrastructure. This may have 'under cooked' the operational costs associated with the additional infrastructure.

A related challenge in quantifying life cycle costs has been the tendency to draw a relatively narrow geographic boundary for the economic analysis. Historically, analysts have focused on those costs and benefits directly related to the incremental change in the network from an investment. For example, supplying a new greenfield development with water cycle services has typically been assessed by drawing a tight geographic boundary around the greenfield site and quantifying the additional infrastructure costs, any change in the local network capacity required and the additional financial flows that would arise from developer contributions and ultimately end customers.

However, in some circumstances it is important to capture the incremental impact on the entire network. This is particularly relevant where the new investment would require water and wastewater to be transported significant distances. It is also important to quantify, to the extent possible, the external costs (known as externalities) borne by third parties who do not directly use the asset or service, such as impacts on urban waterways from increased stormwater flows. The urban water sector as a whole has invested in research and analysis over the past decade to improve estimates (expressed in monetary terms) of 'typical' externalities

associated with the urban water cycle. Where possible, planners should seek to include robust estimates of externalities in CBAs.

In evaluating options in relation to these broader impacts (Plant *et al*.,2012) have set out a process to include the values and benefits from ecosystem services into project appraisal. Similarly, Water Corporation used an Advanced Cost Benefit Analysis (Socio Environment Tool), which monetises costs and benefits which would normally remain unquantified (Atkins 2012). To assist in decision making, Sydney Water developed a Cost of Carbon Abatement Tool, which calculates the levelised cost per tonne of emissions reduced over a given period for individual initiatives.

Quantifying the benefits of environmental sustainability is an important process, which unlocks the potential for more effective collaboration with third parties. In particular, the ability to identify benefits from improved or sustained environmental performance, as well as the distribution of those benefits, is essential if a business case for third party financial contributions is to be established.

Water Corporation's Social Environmental Tool (SET)

Water Corporation has invested in the development of the Social and Environmental Tool (SET), which has been designed to estimate the social and environmental costs and benefits of water cycle planning decisions. The outputs from the tool are typically combined with traditional financial analysis of infrastructure options to provide a relatively more rounded view of the costs and benefits associated with water cycle planning.

The basis of SET is a database that contains monetised values for social and environmental outcomes. The values have been sourced from comprehensive and on-going literature reviews and knowledge that is contained within Water Corporation.

An Excel based user interface allows planners to select values that are relevant to the particular circumstances of the water cycle planning option. The tool then estimates the Net Present Value of the social and environmental values. This allows the planner to combine financial cost estimates with the outputs of the SET to arrive at a robust economic cost-benefit analysis of the options being investigated. The SET also allows sensitivity analysis to be undertaken.

4. Identify direct use benefits, including deferral or displacement of planned capital expenditure

Direct use benefits are typically those benefits closely linked to the use of urban water cycle infrastructure. Benefits include:

- the value of deferring or avoiding infrastructure augmentation altogether as a result of the water cycle planning decision
- avoided network operating costs
- the value of potable water savings from the use of relatively more efficient water use appliances.

5. Identify indirect and non-use benefits, including benefits of liveability

Indirect use benefits result from a change in the impact of the urban water cycle on third parties that do not directly use the infrastructure. Examples include:

- reduced flood damage
- improved water way health
- a reduction in the impacts of urban heat from an increase in functioning green spaces.

Many indirect use benefits are the economic manifestation of the liveability objectives for urban water cycle planning.

Non-use benefits recognise that a person may derive a benefit from the outcomes of urban water cycle planning, even though that person may not directly use the urban water product or service. For example, if a change to urban water cycle management results in restoration of a particular wetland or stream, a person may place a value on that outcome even if they never visit the wetland.

Tools (Appendix 1)

- Scenario Planning
- Multi-Criteria Analysis
- Cost Benefit Analysis
- Sensitivity analysis

STEP 5: Implement

Core elements

Develop an investment strategy – a set of policy rules and instructions as to the sequence in which the types of options are chosen, the thresholds and triggers for new options, predecessors and constraints for some options, and the constraints of the system.

Ensure implementation plans include agreement/s on responsibility for ongoing management, operation and maintenance of all options.

Key outcomes

- Prioritisation and sequencing of investments, including triggers
- Dynamic options portfolio regularly updated
- Procurement strategy (including potential for third party involvement)
- Identification of funding sources
- Agreement/s on responsibility for ongoing management, operation and maintenance of options.

Prioritisation of options for investment will occur within the portfolio and will also be part of the broader investment prioritisation process for the service provider. Options may include a combination of operating (e.g. demand management) and capital solutions (e.g. new or upgraded infrastructure).

Regulated water service providers are subject to a regulatory investment cycle (3 – 5 years) and need to satisfy regulatory tests to support expenditure (e.g. obligation, prudency, deliverability). Prioritisation and sequencing will also be dependent on external drivers – in particular, investments related to capacity and growth will be subject to the location and rate of development. This requires an adaptive and flexible approach with triggers for investment.

The procurement strategy should maximise customer value and business efficiency. The water service provider, developer, or private service provider may deliver infrastructure. Funding sources could include regulated revenue (customer fixed and variable charges), developer contributions, government funding (grants or community service obligations) and private investment for contestable schemes.

Options portfolio – implementation readiness and research

Step 4 may have generated a number of options across the water cycle. Prior to option prioritisation, a readiness assessment categorises options based on 'readiness' for implementation. The feasibility and cost-effectiveness of options can change over time and should be progressed and monitored as required. The options below are not exhaustive but indicative of some of the considerations (Figure 4).

Figure 4: Considerations for undertaking assessment of option readiness

Portfolio of options	Implementation Readiness	Research and Development
– Water efficiency – Water sources – Water treatment – Distribution & transfer – Recycling – Wastewater treatment – Wastewater discharge – Stormwater quantity – Stormwater quality	– Data availability – Technical feasibility – Community and customer acceptance – Cost confidence	– Data monitoring – Technology review – Pilot trial – Feasibility assessment – Market research – Community and customer engagement – Cost monitoring

Define strategy – prioritisation and plan development

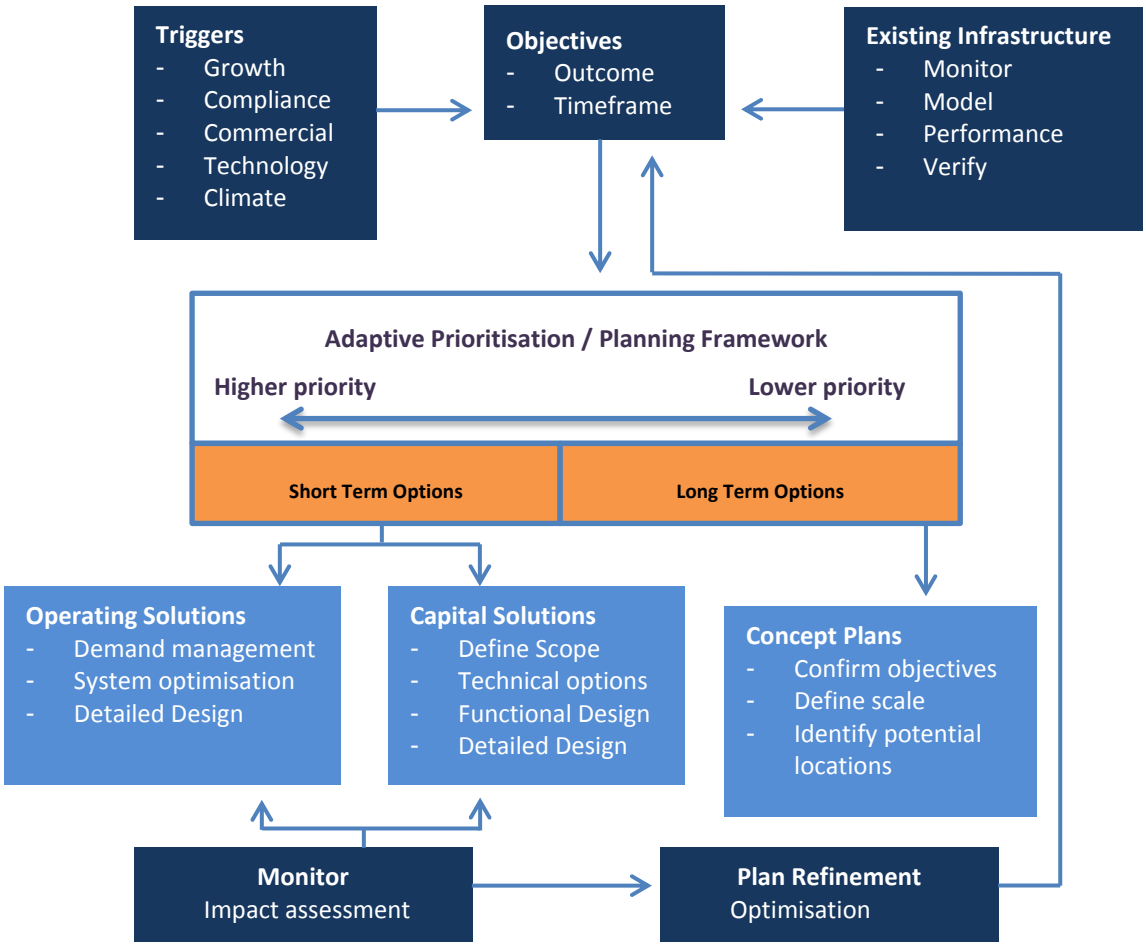
Prioritising options for investment will occur within the portfolio and will also be part of the broader investment prioritisation process for the service provider. The plan objectives should define the outcome and timeframe. The timing of implementation will depend on the performance of existing infrastructure and triggers for investment relating to the objectives. Triggers for investment may include one or a combination of drivers including:

- growth (demand, development, storage, loads)
- compliance (operating and environment license)
- commercial (efficiency, revenue opportunities)
- technology (development, trials, cost-effectiveness)
- climate trends (drought, flood, fire) (Figure 5).

The risk and consequence of not meeting objectives, the value of investment and value of opportunities influences the prioritisation of options.

Develop more detailed planning of operating and capital solutions for short term priorities and high level concept plans for long term priorities. The adaptive framework allows for priorities and options to be adjusted and refined based on monitoring of implemented options and triggers.

Figure 5: Integrating triggers with a portfolio approach (Source: AECOM)



Verification of costs and benefits

A number of assumptions made during the *Step 4* can provide the basis for establishing a data collection framework to support the assessment of realised options against planned objectives. Objectively measuring and testing the costs and benefits of realised options against the original assumptions must be done as part of a Post Implementation Review or Benefits Realisation process. Most utilities have an established Post Implementation Review Process. The Victorian Gateway review process also includes some useful guidelines for evaluating benefits realisation (VDTF 2009).

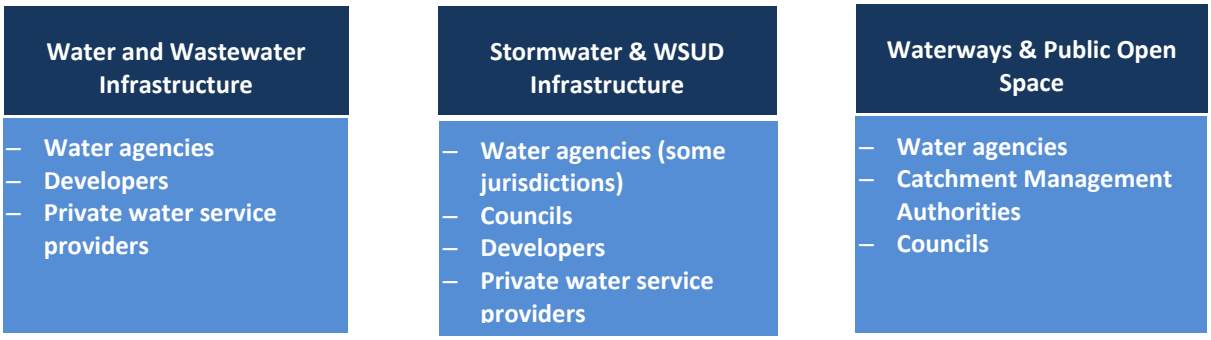
If there are any material changes between the assumed and realised costs and benefits, reflect these in the review of portfolio priorities and future planning assumptions.

Project delivery – procurement and funding

Project Delivery options for procurement and funding have evolved in the water sector over the last decade. This reflects the trend towards increased private sector involvement and the broader range of agencies and stakeholders involved in integrated water management and liveability solutions.

Depending on the portfolio of options, a range of stakeholders may be involved in project delivery for different parts of the water cycle. Stakeholders will need to agree who has primary responsibility for leading the project delivery and procurement and how to achieve this (Figure 6).

Figure 6: Stakeholder interests in project delivery



The opportunities to improve value in the procurement strategy include staging and bundling of investments, procurement method, third party investment and supply chain efficiency. These choices will be influenced by the scale and timing of investment options.

Similarly shared responsibility for delivery will usually be associated with shared responsibility for funding. Sources of funding may include:

- water agencies - regulated revenue (customer fixed and variable charges)
- developers - developer contributions or handover assets
- councils - rates
- government - grants or community service obligations
- private water services providers - private investment recovered through customer charges for contestable schemes.

There is a strong risk of sub-optimal outcomes if institutional barriers to cooperative funding and regulatory certainty undermine integrated solutions.

STEP 6: Monitor, evaluate and review

Core elements

Publish periodically a water outlook that contains information on:

- the amount of water currently available
- a forward storage/capacity outlook for the coming year under a range of plausible climate scenarios
- whether agreed levels of service will be able to be met under these scenarios and if not what actions will be taken to improve system performance so that these agreed levels of service can be met (i.e. what triggers, if any, need invoking).

Comprehensively review and update the plan every five years.

Key outcomes

- Understanding of the actual costs and benefits of water servicing objectives and initiatives
- Feedback of key learnings (including the need for adaptive management) into the overall planning process.

This Step encompasses the ongoing review of the strategic environment and triggers derived from the analysis in the earlier *steps* of *Phase 3* and reviews whether planning objectives and expected benefits and costs have materialised. A good evaluation process starts by asking good questions: are we doing the right thing? Are we doing it the right way? Are their better ways of achieving results?

Within the domains of sustainability and liveability, the industry is trialing a variety of options and new technologies. Monitoring and evaluation presents the opportunity to test the effectiveness of these approaches. The cost-effectiveness of new technology generally improves over time, with experience and economies of scale. Equally environmental and liveability outcomes can be harder to measure empirically.

Element of an effective monitoring, evaluation and review process

The Australian Government, Department of Prime Minister and Cabinet, published a Monitoring, Review and Evaluation Toolkit in 2013 (DPMC, 2013) that summarises the key elements of an effective monitoring, review and evaluation process. In summary these include:

- define objectives and outcomes: Clearly defined objectives and outcomes and what evidence will be needed to demonstrate success at the outset
- report to others: Reporting information must be targeted for specific audiences and incorporated into governance arrangements to enhance transparency and accountability
- involve stakeholders: Engaging relevant stakeholders through an open process that allows stakeholders access to information increases credibility
- monitor progress: Successful monitoring delivers timely and relevant information that allows you to track progress towards outcomes and make adjustments to implementation arrangements as necessary. Implementation planning must define the data to be collected and the method to be used
- review regularly: Factor in reviews as part of your planning process to assess progress of implementation at critical milestones in response to specific issues. Findings and recommendations of reviews can improve implementation
- evaluate the outcomes: Planning for evaluation should identify and map baseline information as well as ensure that ongoing access to consistent data sources will be available through monitoring over the life of the initiative. Focus on asking the good questions – credibility is enhanced through sound evidence, professional and ethical standards and the degree of independence of the evaluator.

Adaptive implementation

The options portfolio needs constant monitoring and action to improve 'readiness' (e.g. data availability, technical feasibility, community acceptance, cost confidence). Also required is constant monitoring of triggers for investment which could include; growth, compliance, commercial, technology or climate outcomes. Changes in the readiness of options or triggers could alter the priority and level of planned investment. An adaptive strategy should have the flexibility to adjust where required.

Tools (Appendix 1)

- Post Implementation Review
- Benefits Realisation

Conclusion

The urban water industry will continue to implement this framework and improve it over time. WSAA will support the efforts of urban water utilities with complementary implementation activities including:

- Penetration of the Occasional Paper into business areas responsible for planning within urban water utilities
- Specific targeting of smaller and regional urban water utilities in circulation, and appropriate knowledge adoption
- Stakeholder engagement through one on one briefings, working with the local WSAA members as required
- Academic and industry wide presentations.

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Appendix 1 – Implementation tools

Benefits realisation

Benefits realisation management (BRM) (also benefits management or benefits realisation) is one of the many ways of managing how time and resources are invested into making changes that people want to see happen. The idea behind BRM is that an investment is only successful if the benefits stakeholders were hoping to get are actually realised (actually happen). A generic BRM process will:

- identify the investment outcomes
- define benefit measures for each outcome
- collect current benefit measure data to have a quantitative basis for decision making
- agree a tailored BRM approach for this investment
- plan the new or changed capabilities necessary to realize the benefits
- plan the investments needed to make the changes necessary to create or change the capabilities
- optimize the plan to reduce waste and have acceptable levels of resource, risk, cost, quality and time
- implement the plan
- review the impact of the plan implementation on the Benefit Measures and use insights to improve
- on completion of the plan, ensure BRM continues to sustain the capabilities and realisation of benefits.

http://en.wikipedia.org/wiki/Benefits_realisation_management

Cost benefit analysis

Cost–benefit analysis (CBA), sometimes called benefit–cost analysis (BCA), is a systematic process for calculating and comparing benefits and costs of a project, decision or government policy.

CBA has two purposes:

- to determine if it is a sound investment/decision (justification/feasibility),
- to provide a basis for comparing projects. It involves comparing the total expected cost of each option against the total expected benefits, to see whether the benefits outweigh the costs, and by how much.

CBA is related to, but distinct from cost-effectiveness analysis. In CBA, benefits and costs are expressed in monetary terms, and are adjusted for the time value of money, so that all flows of benefits and flows of project costs over time (which tend to occur at different points in time) are expressed on a common basis in terms of their "net present value."

http://en.wikipedia.org/wiki/Cost%E2%80%93benefit_analysis

GIS for spatial data mapping

A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data. The acronym GIS is sometimes used for geographical information science or geospatial information studies to refer to the academic discipline or career of working with geographic information systems and is a large domain within the broader academic discipline of Geoinformatics.

A GIS can be thought of as a system that provides spatial data entry, management, retrieval, analysis, and visualisation functions. The implementation of a GIS is often driven by jurisdictional (such as a city), purpose, or application requirements. Generally, a GIS implementation may be custom-designed for an organisation. Hence, a GIS deployment developed for an application, jurisdiction, enterprise, or purpose may not be necessarily interoperable or compatible with a GIS that has been developed for some other application, jurisdiction, enterprise, or purpose. What goes beyond a GIS is a spatial data infrastructure, a concept that has no such restrictive boundaries.

http://en.wikipedia.org/wiki/Geographic_information_system

IAP2's Public Participation Spectrum

IAP2's Public Participation Spectrum is designed to assist with the selection of the level of participation that defines the public's role in any community engagement program. In this framework, differing levels of participation are legitimate depending on the goals, time frames, resources and levels of concern in the decision to be made. Users should select tools that are fit for their purpose. For complex problems, engaging the community will necessarily require community learning to allow their effective participation.

IAP2's Public Participation Spectrum

	Inform	Consult	Involve	Collaborate	Empower
Public Participation Goal	To provide the public with balanced and objective information to assist them in understanding the problems, alternatives and/or solutions	To obtain public feedback on analysis, alternatives, and/or decision	To work directly with the public throughout the process to ensure that public issues and concerns are consistently understood and considered	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution	To place final decision making in the hands of the public
Promise to the Public	We will keep you informed	We will keep you informed, listen to and acknowledge your concerns and provide feedback on how public input influenced the decision.	We will work with you to ensure that your concerns and issues are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision	We will look to you for direct advice and innovation in formulating solutions and incorporate your advice and recommendation s to the maximum extent possible	We will implement what you decide
Example tools	Fact sheet Websites Open House	Public comment Focus groups Surveys Public meetings	Workshops Deliberative polling	Citizen advisory committee Consensus-building Participatory DM	Citizens juries Ballots Delegated decisions

InfoWorks

InfoWorks WS provides a comprehensive model management solution that will enable analysis and management of distribution network models more efficiently and accurately than ever before. InfoWorks WS may be configured as a component of a corporate modeling solution or as a stand-alone desktop application.

The combination of a fast relational database, powerful hydraulic engine and spatial analysis tools, provides a single, flexible water supply network modeling application that excels in both steady-state and extended period dynamic simulations.

http://www.innovyze.com/products/infoworks_ws/

MUSIC

As an aid to decision-making, MUSIC predicts the performance of stormwater quality management systems. It is intended to help organisations plan and design (at a conceptual level) appropriate urban stormwater management systems for their catchments. MUSIC is an easy to use modelling tool for both simple and highly complex urban stormwater systems using water sensitive urban design. It can simulate urban stormwater systems ranging from a suburban block up to a whole suburb or town (0.01 km2 to 100km2). The time scale can start at 6 minutes and stretch up to 24 hours.

http://www.ewater.com.au/products/ewater-toolkit/urban-tools/music/

Multi-Criteria Decision Analysis

Multi-Criteria Decision Analysis, or MCDA, is a valuable tool that we can apply to many complex decisions. It is most applicable to solving problems that are characterized as a choice among alternatives. It has all the characteristics of a useful decision support tool; it helps us focus on what is important, is logical and consistent, and is easy to use.

At its core MCDA is useful for:

- dividing the decision into smaller, more understandable parts
- analyzing each part
- integrating the parts to produce a meaningful solution.

When used for group decision making, MCDA helps groups talk about their decision opportunity (the problem to be solved) in a way that allows them to consider the values that each views as important. It also provides a unique ability for people to consider and talk about complex trade-offs among alternatives. In effect, it helps people think, re-think, query, adjust, decide, rethink some more, test, adjust, and finally decide.

http://en.wikipedia.org/wiki/Multiple-criteria_decision_analysis

Precinct tool

Developed by Kinesis, and licensed by government land development agencies, developers and utilities across Australia, CCAP Precinct is the industry standard for resource consumption analysis, infrastructure and sustainability design at the precinct scale. CCAP Precinct is enabled with comprehensive data sets, allowing instant analysis throughout Australia. Backed up by highly experienced and motivated staff, CCAP Precinct provides Water Utilities with an evidence base to:

- undertake consistent and transparent resource, infrastructure and sustainability analysis across all demand management and network augmentation projects
- set quantified and implementable sustainability targets across all new developments and precinct wide retrofit programs
- make informed decisions early in the planning and development process, bringing forward discussions with planning authorities and developers regarding servicing needs by 2 to 3 years
- save significant time and money on sustainability consultant analysis.

At a minimum, each project analysed in CCAP Precinct can provide the following information:

- total water, stormwater, sewer treatment and water pumping energy requirements needed for development applications
- calculate water reduction from demand side efficiency, rainwater, stormwater and recycled water infrastructure
- size and cost building and precinct level water infrastructure
- test the sensitivity of infrastructure performance under the future climate variation (rainfall, evaporation and temperature) and price volatility
- stormwater pollutant load analysis
- links energy, water, stormwater, transport and embodied energy modules, ensuring changes in precinct design effect end use demands, material requirements and surface runoff
- up-to-date tariffs, capital and maintenance costs for precinct sustainability strategies and infrastructure
- household operating costs (energy, water and transport operating costs per household per year)
- comparisons with metropolitan and “business as usual” averages
- unlimited variations of analysis and reporting for the life of each project.

http://www.kinesis.org/tools

Post Implementation Review

'Completing a project' is not the same thing as ending the project management process. Simply finishing doesn't ensure that the organization benefits from the project's outcome. For example, after completing a year-long project to establish a new quality management process for your organisation, you want to make sure that what you set out to do was actually achieved. Your objective wasn't to simply deliver a process – but rather, to deliver the process that addresses the specific business need you intended to meet. This is the real measure of success. To make the most of the benefits that the project can deliver, however, you also need to check to see if further improvements will deliver still greater benefit.

You need to ensure that the lessons learned during the project are not forgotten. You can more effectively design and execute future projects when you take advantage of lessons learned through experience of previous projects. So how can you properly measure a project's success, and work toward continuous improvement?

This is where the process of Post-Implementation Review (PIR) is helpful. It helps you answer the following key questions:

- did the project fully solve the problem that it was designed to address?
- can we take things further, and deliver even bigger benefits?
- what lessons did we learn that we can apply to future projects?

http://www.mindtools.com/pages/article/newPPM_74.htm

PURRS

The PURRS (Probabilistic Urban Rainwater and wastewater Reuse Simulator) (Coombes, 2002) model was utilised to continuously simulate demand management (water saving devices) and the performance of rainwater harvesting and wastewater reuse to explore the reductions in rainwater tank demand, wastewater discharges and stormwater runoff that occur at an allotment-scale.

http://www.icms.com.au/udmandwsud/abstract/87.htm

REALM and IQQM

Hydrologists, river managers and modellers advise on how different policy, past actions or climate change scenarios affect the use and distribution of water in regulated river systems. In the Australian context, this typically involves using software packages that model regulated river systems include Integrated Quantity Quality Model (IQQM) and Resource Allocation Model (REALM). In Australia, these are the most popular software tools which government departments use extensively in the eastern states.

http://www.mssanz.org.au/modsim09/I11/penton.pdf

Regression analysis

Regression analysis is widely used for prediction and forecasting, where its use has substantial overlap with the field of machine learning. Regression analysis is also used to understand which among the independent variables are related to the dependent variable, and to explore the forms of these relationships. In restricted circumstances, regression analysis can be used to infer causal relationships between the independent and dependent variables. However this can lead to illusions or false relationships, so caution is advisable; for example, correlation does not imply causation.

Many techniques for carrying out regression analysis have been developed. Familiar methods such as linear regression and ordinary least squares regression are parametric, in that the regression function is defined in terms of a finite number of unknown parameters that are estimated from the data. Non-parametric regression refers to techniques that allow the regression function to lie in a specified set of functions, which may be infinite-dimensional.

http://en.wikipedia.org/wiki/Regression_analysis

Scenario planning

Scenario planning, also called scenario thinking or scenario analysis, is a strategic planning method that some organizations use to make flexible long-term plans. It is in large part an adaptation and generalization of classic methods used by military intelligence.

The original method was that a group of analysts would generate simulation games for policy makers. The games combine known facts about the future, such as demographics, geography, military, political, industrial information, and mineral reserves, with plausible alternative social, technical, economic, environmental, educational, political and aesthetic (STEEEPA) trends which are key driving forces.

In business applications, the emphasis on gaming the behavior of opponents was reduced (shifting more toward a game against nature). At Royal Dutch/Shell for example, scenario planning was viewed as changing mindsets about the exogenous part of the world, prior to formulating specific strategies.

Scenario planning may involve aspects of systems thinking, specifically the recognition that many factors may combine in complex ways to create sometime surprising futures (due to non-linear feedback loops). The method also allows the inclusion of factors that are difficult to formalize, such as novel insights about the future, deep shifts in values, unprecedented regulations or inventions. Systems thinking, used in conjunction with scenario planning, leads to plausible scenario story lines because the causal relationship between factors can be demonstrated. In these cases when scenario planning is integrated with a systems thinking approach to scenario development, it is sometimes referred to as structural dynamics.

http://en.wikipedia.org/wiki/Scenario_planning

Sensitivity analysis

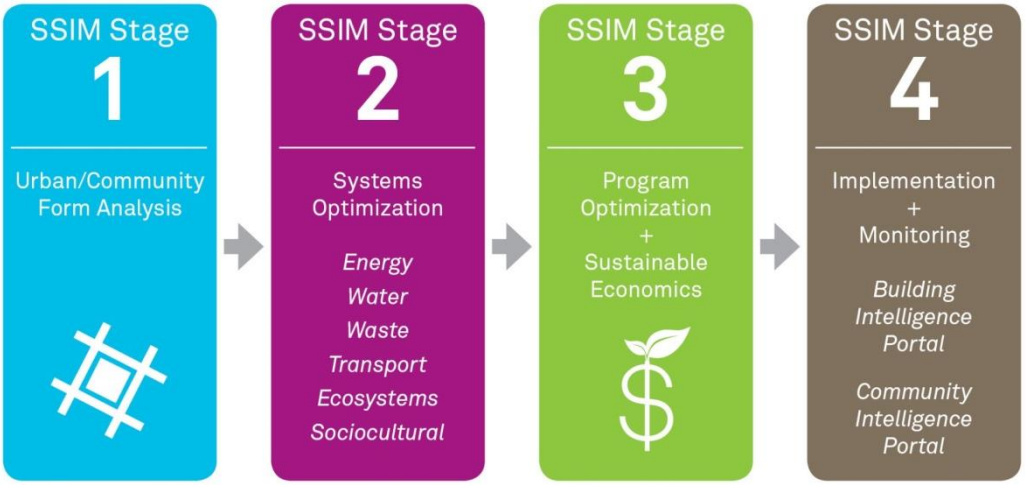
A technique used to determine how different values of an independent variable will impact a particular dependent variable under a given set of assumptions. This technique is used within specific boundaries that will depend on one or more input variables, such as the effect that changes in interest rates will have on a bond's price. Sensitivity analysis is a way to predict the outcome of a decision if a situation turns out to be different compared to the key prediction(s).

It is very useful when attempting to determine the impact the actual outcome of a particular variable will have if it differs from what was previously assumed. By creating a given set of scenarios, the analyst can determine how changes in one variable(s) will impact the target variable.

http://en.wikipedia.org/wiki/Sensitivity_analysis

SSIM

This tool developed by AECOM enables you to evaluate the sustainability merits of alternative urban form and system solutions, using evidence based and transparent assessment. Application: decision making support tool, GIS based visual multi criteria analysis, easy to communicate, qualitative and quantitative factors, and relevant through the development cycle.



http://www.aecom.com/News/Sustainability/_news/AECOM+advances+Sustainable+Systems+Integration+Model+(SSIM%E2%84%A2)+process+globally

Source

An Australian-wide collaboration effort backed by the Commonwealth Government — is built to meet the myriad climatic, geographic, water policy and governance settings across the country. Australia's first national river basin scale water modelling system, it represents a substantial step forward in managing our water resources.

The Source modelling platform allows users to build on, rather than replace existing models. It has been developed to take a holistic approach to water management including human and ecological impacts. This includes integrating policy, addressing water savings and sharing for a whole river and connected groundwater systems including cities, agricultural and environmental demands. As such it will boost the capability of managers to use robust and defensible science to give advice to policy and decision makers.

http://www.ewater.com.au/products/ewater-source/

TuFlow

TUFLOW Products is a suite of advanced numerical engines and supporting tools for simulating free-surface water flow for urban waterways, rivers, floodplains, estuaries and coastlines. The TUFLOW engines are technically superior and are industry leaders in solving all the necessary physical processes using 1D, 2D and 3D solutions. The approach to developing the TUFLOW engines is grounded on two philosophies:

- develop numerical engines through collaborative efforts with universities and research organisations to ensure they are scientifically of a high standard and are thoroughly benchmarked
- design software for the rigorous demands of consulting and to interface with third party products. This makes TUFLOW Products useful, efficient, flexible and highly suited to the workplace.

http://www.tuflow.com/

Urban Developer

Urban Developer is the latest urban water modelling product from eWater and augments the market leading WSUD product, MUSIC. Urban Developer offers game-changing capability to rigorously model the whole urban water cycle for successful Integrated Urban Water Management (IUWM).

For the first time, users can make decisions based on all elements of the urban water cycle (stormwater, wastewater and potable water) to consider a wide range of potential management options including reuse, alternative supply sources and water efficient appliances. Urban Developer is a decision-support tool, based on the best available science which allows consistent cost benefit assessment of IUWM on a case-by-case, and scenario-by-scenario basis.

Urban Developer allows users to improve understanding and management of the various impacts of urban water management options from the lot to the suburb scale. It allows performance assessment of integrated urban water management options across the entire urban water cycle.

It allows users to achieve savings of:

- water- by developing and evaluating integrated strategies that promote more efficient use of water resources
- money- by streamlining the design process, finding innovative solutions and costing them, and reducing wastage (with water reuse options and fit-for-demand water infrastructure)
- time- by streamlining the design process.

http://www.ewater.com.au/products/ewater-toolkit/urban-tools/urban-developer/

WATNET

WATNET is a tool designed to optimize the pipes size in drinking water network. WATNET considers the objective of cost reduction. Maximal and minimal acceptable pressures and velocities are also taken in consideration in the proposed problem formulation, as hydraulic constraints.

In order to resolve the optimization problem, WATNET uses a Genetic Algorith (GA). It ensures a linkage with the EPANET (Rossman, 2000) software to read data related to the hydraulic network. This capability is used to evaluate solutions for the problem by computing flows, velocities and pressures in the studied drinking water network, and then the objective and fitness functions.

The user of WATNET has the task to prepare a network file using EPANET and to export the network to the format "*.inp". They must also choose the weights of the optimization criteria and the AG parameters. As output, WATNET displays the results of multiple AG runs and propose for the user the best one saved in the EPANET network file "*.inp", that can be imported in EPANET to analyse the optimal design computed by WATNET.

https://sites.google.com/site/drissamnouiri/watnet-software