

Sustainability-Based Asset Management

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Water for a Healthy Country Flagship Report

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WATER SERVICES ASSOCIATION

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The Water for a Healthy Country Flagship aims to achieve a tenfold increase in the economic, social and environmental benefits from water by 2025. The work contained in this report has been undertaken by CSIRO with input from a range of anonymous water companies and individuals, the input of whom was obtained with the help of the Water Services Association of Australia (WSAA).

For more information about Water for a Healthy Country Flagship or the National Research Flagship Initiative visit www.csiro.au/org/HealthyCountry.html

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EXECUTIVE SUMMARY

As part of CSIRO's efforts to assist the Australian water sector to meet its asset management challenges, research has been undertaken into the role sustainability principles should play in asset management. The approach taken used in-depth interviews as a data collection tool, with a thematic approach to data analysis and interpretation.

An important aspect of this type of research is that a representative sample is not required. Instead, interviewees are sought with specific reference to their ability to provide insights into the research questions in hand. In this study, individuals from five water authorities located in three Australian states (Victoria, New South Wales and Western Australia) took part in the interviews. Auxiliary interviews were also undertaken with other stakeholders involved in the water sector, including industry associations (1 interview), consultants (1 interview) and regulators (2 interviews). In total, 25 interviews were undertaken.

Given the aims of this research were to elicit viewpoints on relatively specific issues, a questionnaire consisting of 13 standard questions was used as the basis for the interviews, split into three areas: 1) Understanding of terminology; 2) What is and isn't working with respect asset management and sustainability and 3) Research challenges. It should be noted that while the questionnaire provided some structure, the overall approach to the interviews allowed for exploration of other ideas and concepts that arose during discussions.

Interview Synthesis: Understanding of Terminology

A sophisticated definition of asset management was generally stated by interviewees. The definition of sustainability expressed was generally given in terms of a focus on environmental and social outcomes, or with explicit mention of the 'triple bottom line'.

The opinions expressed indicated that participating water authorities have a high level of commitment to sustainability, and are investing in various initiatives to raise awareness of sustainability issues and to embed new modes of thinking into decision-making. Another reoccurring theme was that there are strong links between asset management and sustainability in the water sector, and there is a strong expectation that asset management will play a significant role in achieving sustainability-related outcomes.

Interview Synthesis: What is and isn't working

Despite the high level of commitment to sustainability expressed in the interviews, the general feeling was that sustainability is not yet embedded in the day-to-day practices of the participating water authorities. While much effort has been expended to develop policies and raise awareness, the majority view was that sustainability is still a 'bolt on' consideration in many business processes and/or decisions (i.e. is not yet fully integrated into practice), and that legacy drivers like financial efficiency and regulated outcomes are often still overriding considerations.

Interviewees noted there were a range of approaches being used to measure and monitor the sustainability of asset management. However, the overall impression gained was that these measures were either not explicitly designed to assess sustainability or did not provide effective feedback on whether progress was being made.

In terms of asset management practices, the participating water authorities all appear to be expending most effort to integrate sustainability principles into the early stages of the asset management cycle (especially strategic planning approaches). Overall, the later stages of the asset management cycle (operations, maintenance, renewals, and disposal) do not yet appear to have been re-examined in the light of sustainability principles.

While the interviewees felt that the water sector has a history of delivering assets and service, as well as social and environmental outcomes, aligned with the needs of society, many felt that the upcoming challenge is that the solutions applied to yesterday's problems may not meet emerging challenges such as climate change, changing demographics, and a

carbon constrained future. Lack of information, appropriate tools and the need for broader systems knowledge were seen as some of the key barriers to achieving a more sustainable sector, as were the willingness to pay for sustainability, especially where the outputs of investment are less tangible to customers and other stakeholders. A range of societal and cultural issues were also noted as being barriers to advancing sustainability, including institutional and personal inertia with respect to the need for change.

While there was a mix of positive and negative comments in relation to the role of regulators in promoting sustainability, a number of interviewees expressed strong opinions that regulation is a barrier to the innovation needed to meet sustainability goals, although there was a general acceptance that where there is a regulatory need, it is relatively easier to obtain funding for capital investment to meet that need. Another common theme expressed was that regulation is focused too narrowly to allow sustainability to be achieved in some schemes.

Interview Synthesis: Research Challenges

The Table below indicates research areas for the development of sustainability-based asset management, listed in order of the total number of times these were mentioned across all interviews. This ordering can be considered indicative of the priorities given to research areas by the interviewees.

Indicative Priorities by Research Area

Research Area	Count
Understanding Sustainability & Asset Management	27
Asset and System Design	26
Decision Support Tools and Approaches	16
Social Research	15
Information and Knowledge	10
Technical Aspects of Asset Management	10
Innovation & Collaboration	9
Regulation & Governance	2

In terms of immediate research priorities, the preliminary recommendations presented in the Table below are made. It is also recommended that, where practical, research in the sustainability field needs to be applied rather than an academic exercise; i.e. project based; working with researchers to deliver an end product.

Preliminary Recommendations for Asset Management Research

Research Area	Research Recommendation
Regulation and Governance	<i>Considered outside the scope of research into SBAM</i>
Social Research	<ul style="list-style-type: none"> • Social research to help authorities determine where in their organisation conflicting social messages or perverse drivers are being generated that conflict with the overall sustainability goals. • Social research to determine effective change management strategies that can be used to embed sustainability into business as usual processes and practice. • Social research to understand the interactions between regulators and water authorities, so as to develop interactions that underpin rather than conflict with sustainability goals.

...continued

Research Area	Research Recommendation
Innovation & Collaboration	<ul style="list-style-type: none"> • Issues to do with knowledge sharing and piloting of technologies should be addressed at the national level. In particular, this could be facilitated by the development of a central repository for information on pilot schemes and case studies. • Sector wide databases of data required to undertake life cycle analysis (or similar) could also be developed. • Common terminology and definitions for both asset management and sustainability (agreed and adopted across Australia) would help encourage collaboration
Understanding Sustainability & Asset Management	<ul style="list-style-type: none"> • Specific aspects of asset management and sustainability need to be researched so as to develop a common understanding of issues • In particular, a greater understanding of the impact of climate change and reduction in water availability on existing and planned assets is needed • More generally, there is a sector-wide need to undertake analysis to identify the impacts existing and planned assets have on sustainability goals, with the view to mapping opportunities for change and identifying key points of leverage across the sector. • Research into the sustainability of current service levels would also facilitate authorities to understand sustainability.
Asset & System Design	<ul style="list-style-type: none"> • <i>Considered outside the scope of research into SBAM</i>
Decision Support Tools & Approaches	<ul style="list-style-type: none"> • Research the alignment of risk and sustainability frameworks; this should include the integration of externalities, external costs and welfare loss into analysis of risk and planning. • Research into developing an adaptive approach to performance management, including revisiting asset management and other KPIs from the perspective of sustainability • Research how to integrate the consideration of future options into rehabilitation planning tools (e.g. the concepts or philosophy that underpins real options analysis). • Research into the pragmatic application of sustainability assessment tools, to ensure that the level of detail of analysis undertaken is appropriate. • Develop new and existing asset management tools and approaches so they can consider wider sustainability issues. Tools should be designed to help embed new modes of thinking and sustainability practices. • Research the specification of common (sector wide) weightings to be applied in qualitative and subjective approaches
Information & Knowledge	<ul style="list-style-type: none"> • Produce template-type analysis for a range of planning and asset management options. Such analysis should be designed to help identify key areas of leverage (where change would deliver benefits and value) and to communicate the key points from this analysis so that the findings can be used to drive changes to practice and inform decision making. • Research into the development of data and information needed to underpin quantitative approaches, where such approaches are necessary.
Technical Aspects of Asset Management	<ul style="list-style-type: none"> • Undertake research to help develop asset management approaches (like condition assessment, monitoring, etc) and understand their role in sustainability.

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1. INTRODUCTION

1.1. Background

The supply of high quality potable water and removal of wastewater is an integral part of a healthy modern society, and the continuing supply of such services is central to the economic and social wellbeing of Australia. In urban areas, these services are delivered through a diverse range of physical assets, which have a high capital value and cost a significant amount to operate and maintain. For example, the Water Services Association of Australia (WSAA) note that the nominal book value (written down cost) of water and sewerage fixed assets in 2005/06 was \$53.5 billion, comprising 75,574 km of water mains and 70,851 km of sewerage mains and channels (WSAA, 2008; see figure 1-1 page 4). It should be noted that the replacement value of these assets is significantly more than this nominal book value.

Since the water sector is so capital-intensive, effective management of assets is a cornerstone of delivering service to customers and the environment. In reflection of this, the Australian urban water sector has expended significant effort to raise the standard of asset management. As a result, Australia is now recognised internationally as a leader in asset management (WSAA, 2008).

While acknowledging this achievement, there are emerging national and international trends that are today imposing new challenges. In particular, there is on-going drought in many parts of Australia. For example, according to Melbourne Water¹, the last decade has been the driest on record in Victoria, and river flows and reservoir levels are at all time lows. As such, water security is one of the biggest environmental challenges facing Australia as a country, especially with projected levels of population growth (Nowak, 2007). Changing community attitudes and increasing pressure on water resources are also influencing the way in which some communities are provided with water and wastewater services (e.g. Sharma *et al*, 2008), necessitating a change in the type and configuration of assets used to deliver this service and/or the way in which assets are operated and maintained into the future. At a global level, there are wider threats associated with climate change, population growth, damage to ecosystems and a carbon constrained future (due to reduction in oil reserves and attempts to curb greenhouse gas emissions).

This convergence of national and global trends is likely to have an increasing impact on the business environment within which Australian water authorities must operate. All these changes mean that existing asset management approaches need to evolve as well. At the same time, the sector must maintain and operate its existing asset stocks in an effective manner, and meeting these relative demands in a changing environment represents its own challenge.

As will be discussed more fully in Chapter 2, sustainability principles have the potential for allowing asset management and other business processes to be evolved so as to allow water authorities to meet the complex and competing demands placed upon them.

1.2. Focus of this Report

As part of CSIRO's efforts to assist the water sector to meet its asset management challenges, qualitative research has been undertaken into the role sustainability principles should play in asset management.

As part of this research, interviews have been undertaken with a range of industry professionals who provided insight into current industry sustainability and asset management

¹http://www.melbournewater.com.au/content/water/water_storages/water_storages.asp, accessed July 2008.

practices, as well as opinions on where there remain research gaps. Details of the interview design and analysis form the bulk of this report.

1.3. Relationship to Previous CSIRO Initiatives

In April 2006, CSIRO hosted an industry workshop entitled 'Asset Planning & Operations: Sustainable Asset Management in the Water & Gas Sectors'. The purpose of this workshop was to provide a forum in which asset managers could discuss sustainability issues, with the overall aim of identifying research needs for developing a 'sustainability-based approach to asset management'.

At the beginning of the workshop, the participants were asked to divide themselves into five groups and debate relevant concepts and issues, guided by a facilitator. As the workshop progressed, participants were encouraged to move from group to group to help broaden the discussions.

Results from this workshop are presented in Appendix I. In summary, the seminar identified a range of asset management issues that needed to be addressed, the top five being a need for:

1. Asset management tools that introduce science into decision making.
2. Predictive tools for utilising data.
3. A common asset management framework.
4. A common data framework, data definition and databases.
5. Accurate models to determine failure rates and modes.

These issues all reflected research needs for asset management itself, rather than addressing sustainability issues *per se*. Hence, at the time of the workshop it was concluded that there still remained a need to develop asset management approaches in order to provide 'sustained levels of service', rather than to address concepts relating to 'sustainable development' (see Chapter 2 for further discussion on such distinctions).

The research presented in this report represents an attempt to revisit the issues discussed in the 2006 workshop and to determine if the sector had moved on from the position identified.

1.4. Relationship to WSAA Asset Management Initiatives

At the time of writing, the WSAA asset management committee had produced a diagram that represented the 'asset management story' of the Australian water sector. The diagram, shown in Figure 1-1, illustrates the current position of the sector, as perceived by the committee, the position it aspires to, and the initiatives that must be put in place to achieve the desired state.

As can be seen from Figure 1-1, one feature of the desired state is to move to the position of being able to make 'sustainable asset management decisions' that balance economic, environmental, and social outcomes. The WSAA 'asset management story' also indicates that one of the strategies to get to this 'desired state' is to integrate sustainability principles into decision making frameworks.

While this research is aligned conceptually with the aims of the WSAA's asset management story, it is not formally linked into this WSAA initiative, although WSAA and some of its members actively engaged with the interview process detailed herein, so there are strong linkages in practical terms.

1.5. Report Structure

The report is intended as an industry resource document to help inform the future direction of asset management research undertaken within the Australian sector. To this end, the main body of this report presents the results from interviews designed to elicit current thinking with respect to the role of sustainability in asset management. Since the interviewer took an

active role in the interview process, it is considered important to present background information on both sustainability and asset management from the perspective of the interviewer.

With these aims and constraints in mind, the remainder of the report is structured in the following way:

- Chapter 2 outlines the conceptual relationship between asset management and sustainability principles.
- Chapter 3 presents results from the interviews. Summary responses to questions posed in the interviews are given sequentially along with some commentary, additional opinions and thoughts expressed in the interviews are then summarised. Details of the interviews are presented in Appendix IV and Appendix V.
- Chapter 4 summarises the research gaps and ideas identified through the interview process, along with some supporting discussions. Appendix VI details the explicit comments made in the interviews in relation to research needs, categorised in terms of research areas and themes.
- Finally, conclusions and recommendations are presented in Chapter 5.

The following Appendices are included for completeness:

- Appendix I: Presents summary results from the CSIRO workshop on sustainability-based asset management held in 2006.
- Appendix II: Presents an overview of changing paradigms that are driving the need for sustainability-based asset management.
- Appendix III: Details the questionnaire used as the basis of the interviews.
- Appendix IV: Details the opinions voiced and analysis of the answers to interview questions relating to 1) Understanding of terminology and 2) What is and isn't working with respect asset management and sustainability.
- Appendix V: Provides a summary of additional points made during the interviews.
- Appendix VI: Details the research ideas and/or drivers for research that were mentioned specifically in answering the last part of the interview questionnaire.

WSAA Asset Management Story – Built and Natural Assets

Urban water is an asset intensive industry. The nominal written down cost of water and sewerage fixed assets in 2005 / 06 was \$53.5 billion, comprising 75,574 km of water mains and 70,851 km of sewerage mains and channels. Management of this enormous asset base in a prudent, risk based cost effective manner is a critical strategic issue for the industry.



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Current State

Where are we now?

- Australia is recognised internationally as a leader in asset management.
- We benchmark against the WSAA Asset Management Framework.
- Asset management has momentum and has been recognised as a key industry priority by WSAA Members (2007 survey).
- We are starting to share knowledge better than before.
- Sustainable decisions are now a critical aspect of asset creation and management.

but ...

- There is a general perception by stakeholders that our assets are falling apart.
- The knowledgeable people in the asset management industry approaching retirement – and there is insufficient attention to succession planning and building capacity.
- Focus on innovative asset solutions is causing some problems for whole of life management.
- The water industry doesn't have a shared view on what asset management means.
- We aren't yet able to confirm that we are investing the right amount.
- We often duplicate effort because we don't network effectively.
- We don't have the understanding necessary to link asset decisions to customer and stakeholder satisfaction.
- About half of WSAA Members are less than satisfied with AM Committee offerings and communications (2007 survey).
- There is no consistent approach to how assets are valued.

and ...

- Asset management must address both short and long term issues.
- We don't publicise our successes.
- We also need to also consider natural assets like catchments.
- We don't fully understand what it will take to deliver water services into the future.
- Our delivery model is changing, and we may not yet understand all risks.
- Significant asset failures can damage our reputation.
- How well we manage our assets will have a significant impact on the future financial health of our businesses.
- We have an insufficient and inconsistent focus on OH&S.

SO...

How do we ensure that assets in the water industry are best able to meet the current and future needs for our customers?

Strategies

How do we get there?

Build awareness of our stakeholders and opinion leaders about asset management in the water industry.

Move our stakeholders and opinion leaders along a continuum of Awareness – Understanding – Support – Trust – Advocacy

Maximise the opportunities to share knowledge.

*Share what we know.
Identify and document best practice.
Identify gaps in knowledge.
Bridge the gap.
Celebrate and communicate our successes.*

Build asset management capacity and capability.

*Skills and competencies for roles in asset management.
Acquisition and maintenance of skills and competencies.
Promoting a consistent understanding of asset management across the water industry.*

Integrate sustainability principles into decision making frameworks.

Measures of Success

How do we measure our performance?

- Number of asset management workshops conducted for the water industry
- % of members who actively participate in networks and / or workshops
- % of members that indicate that they gained value from the networks / workshops.
- % of WSAA members who consider that asset related risks to their business are being better managed as a result of the work of the Asset Management Committee.
- Decision making frameworks (guidelines, procedures, codes etc):
 - developed for nominated generic asset classes (nominated annually).
 - No of members adopting the frameworks
- Aquamark
 - Increase in median score across all 7 asset management streams
 - Used to identify areas for focus on improvement
 - Areas identified for improvement drive business focus
- Knowledge Management
 - Number of "hits" and downloads" on the AM discussion forums.
 - members report KM initiatives are improving access to information which is resulting in better business decisions.
- Specific measures from the Engineers Australia Infrastructure Report Card.
 - Overall measure for potable water
 - Overall measure for wastewater
- Negative media stories on asset related issues – reducing trend.

Desired State

Where do we want to be?

Effective asset management throughout the water industry

Improved community confidence in the industry's management of its assets

- Community opinion leaders and Regulators have awareness, understanding and confidence in the way assets are being managed.
- Water industry is trusted as effective asset managers.
- We value customer service and understand how this links to the management of assets.
- We are responsive to changing community and customer expectations.
- Management of assets is based on risk and although incidents happen, they are competently managed and the number and impact is reducing.

Effective Knowledge Management

- Industry is building long-term capability – prepared for the new dynamic.
- We create an environment where an "enquiring mind" is valued and the full range of data is used to inform decision making.
- Existing asset management information is well documented and maintained.
- Knowledge on leading practices is effectively shared.
- We have convergence on contemporary practices (framework, tools).
- We have a shared understanding on what asset management means.
- Looking beyond the water industry – we share with and learn from others.

Sustainable Asset Management Decisions

- Effective decision making framework exists for each major asset class.
- Frameworks are flexible and adapt over time.
- Aquamark informs asset management processes.
- Safety and efficiency are key considerations in our asset management decisions.
- Our industry is successful in balancing economic, environmental and social outcomes.

Figure 1-1: The WSAA Asset Management Story

2. SUSTAINABILITY & ASSET MANAGEMENT

Chapter Summary

1. *The word ‘sustainability’ can be used simply to indicate the ability to continue to do something into the future. However, this research is concerned with the application of concepts that align with ‘sustainable development’.*
2. *Asset management is concerned with the management of assets over the long term to deliver affordable levels of service to customers and the environment. As such, asset management should be a key vehicle for delivering against sustainability objectives of a water authority.*
3. *In practice, asset management involves a range of activities undertaken at different temporal and spatial scales. The role of sustainability principles in each of these different asset management perspectives is outlined.*
4. *There is a possibility that sustainability policy of a water authority will be misaligned with the actions undertaken at the asset level, so there is an increasing need to ‘operationalise’ sustainability requirements in a way that asset managers can clearly understand and deliver against; this is the research challenge being addressed in this report.*

2.1. Introduction

As noted in Chapter 1, the infrastructure involved in delivery of water and wastewater services represent a significant national investment. Just as current generations have inherited assets from previous ones, future generations will inherit the cumulative impact of our current and on-going asset management decisions. From this perspective, it can be asserted that asset management is intimately linked to sustainability of the water sector, and asset management should therefore be a key vehicle for delivering sustainability goals of a water authority (Marlow, 2006; Allbee, 2005).

Sustainability is, however, a nebulous term that is currently used to mean a range of things. Nevertheless, asset managers are still increasingly being asked to deliver against high level ‘sustainability objectives’ of their water authority. To allow them to do this effectively, asset managers need to understand what is meant by the term and be able to see how their decisions link into related objectives. With these issues in mind, this Chapter provides some background material on the basic definitions of sustainability and asset management, and illustrates how sustainability and asset management are conceptually linked.

2.2. Sustainable Development & Sustainability

At a basic level, the terms ‘sustainable’ or ‘sustainability’ merely imply the ability to continue to do something indefinitely. A focus on a long term view is thus always implicit within any use, but after that the term can be (and is) used in a myriad of ways. For example, with respect to the water sector, ‘sustainable’ can be used to refer to the financial longevity required to deliver water services into the future (e.g. Gohier, 2005; Allbee, 2005). However, sustainability is often taken to mean much more than this, since it is (or is becoming) synonymous with the concept of ‘sustainable development’, a widely quoted definition of which is given in the report from the Brundtland Commission (WCED, 1987):

“Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

Throughout this report the terms ‘sustainability’ and ‘sustainable development’ will be used interchangeably; i.e. sustainability implies an intention to implement ‘sustainable development’ as defined by the Brundtland Commission report.

The terms of reference outlined in the Brundtland report had a very strong focus on environmental issues, explicitly couched within an anthropocentric viewpoint. Emphasis was also given to the role that the environment plays in underpinning economic and social development, considering the limitations imposed by the present state of technology, social organisation and the ability of the biosphere to absorb the effects of human activity. Similar concepts were later restated in the Millennium Ecosystem Assessment (MEA, 2005), and have been embodied in simple conceptual models such as that shown in Figure 2-1, which seek to illustrate the critical dependence of both human society and economic activity on the biosphere; i.e. that the natural environment provides a wide variety of essential ecosystem services, without which human society and the economy would collapse (e.g. Porritt, 2005).

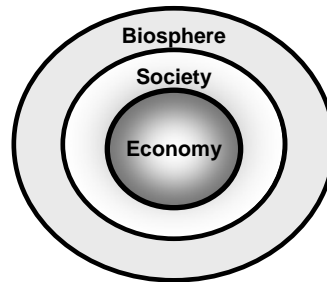


Figure 2-1: The Dependence of the Economy on Society and the Biosphere

2.2.1. Different Scales of Sustainability

According to the Chairman's forward, the Brundtland commission were asked to formulate 'a global agenda for change' (WCED, 1987; page 11). As such, the Brundtland definition of 'sustainable development' is explicitly global in scope, being concerned with the viability and productivity of the biosphere from the perspective of current and future generations. This scope makes the concept somewhat nebulous from a practical perspective, and defining what 'sustainable development' means at an operational level is a difficult and inherently fuzzy issue (e.g. Labuschagne *et al.*, 2005; Andriantiatsaholiniaina *et al.*, 2004). Hence, while the philosophy of 'sustainable development' is conceptually attractive to many people, there are inherent problems with putting the underlying concepts into practice (e.g. Pope *et al.*, 2004; Butler & Parkinson, 1997).

While the Brundtland definition was explicitly global in its intended scope, any attempt to adopt 'sustainable development' as a guiding principle requires action to be taken at a local level, so in practice a multi-scale view of sustainability is needed; hence the well known phrase 'think globally, act locally', coined for 'Local Agenda 21' of the International Council for Local Environmental Initiatives (ICLE, 2008). Kain (in Söderberg & Kärrman, 2003) provided an interesting insight by noting that sustainable development should be understood as defining a direction towards some preferred state, and that this 'preferred state' is always an empirical question that needs to be considered in relation to the local situation at hand. In practical terms, this is often achieved by working towards a variety of specific targets, e.g. certain kinds of system performance or states, assessed through a range of metrics.

2.2.2. Linkage between Sustainability and the 'Triple Bottom Line'

One approach used to measure and communicate the sustainability credentials of businesses is termed 'triple bottom line reporting', which arose from the concept of the triple bottom line (TBL). The term 'TBL' mirrors the use of the term 'the bottom line', which is used to refer to the traditional 'single bottom line' of financial performance (i.e. profitability). Advocates of the TBL concept argue that business continuity requires a broader focus than just financial performance alone, and that businesses need to give appropriate focus to social and environmental output measures (e.g. Elkington, 1998). Triple bottom line reporting was developed to provide a means of measuring business performance with this broader focus.

Having developed out of the need for public health and environmental improvements (e.g. Brown & Clarke, 2007), and with an increasing need to operate in a financially efficient

manner (e.g. Burn *et al.*, 2007), the water sector is intrinsically engaged with achieving financial, social and environmental outputs. Hence, triple bottom line reporting provides a good fit with the operations of a water authority, and the concept of sustainability is often couched in the language of the triple bottom line (e.g. Kenway *et al.*, 2006).

A distinction has to be made, however, because having a focus on financial, social and environmental output measures does not necessarily mean that a water authority is operating in a way that is aligned with sustainability concepts. For example, water authorities can operate under a demand and supply paradigm (i.e. building supply capacity to meet growing demand). Such operations still focus on triple bottom line outputs, but there has been increasing awareness that this approach is not sustainable and a change in paradigm is needed to encompass more demand-side controls (e.g. Pinkham, 1999).

While sustainability and TBL concepts may not be the same, the welfare of current and future generations explicitly requires a consideration of triple bottom line elements. As such, it can be asserted that a focus on triple bottom line outcomes is a necessary but not solely sufficient component of sustainability. The question then arises as to how sustainability in the water sector should be defined.

2.2.3. Sustainability in the Water Sector

A definition of sustainability that can be applied in the water sector has previously been proposed by ASCE/UNESCO (1998), who defined a sustainable water system as:

...one that is designed and managed to contribute fully to objectives of society, now and in the future, while maintaining ecological, environmental and hydrological integrity.

This definition integrates the concept of sustainable development with issues that are specific to the use of water resources, and also explicitly reflects the triple bottom line focus of the water sector. As such, the ASCE/UNESCO definition provides a reasonable basis from which to assess the sustainability of a water authority, especially from the perspective of its management of water resources. While the definition does not explicitly address the asset base used to deliver services to customers and the environment, these assets have a direct influence on both the extraction of water and the return of wastewater to the environment, and thus whether or not a water system is sustainable in the context of the ASCE/UNESCO definition. Hence, it is necessary to consider sustainable water systems not just in terms of water resources, but also from the perspective of the management of the physical assets used to deliver service.

2.3. Asset Management

Irrespective of any other sustainability requirements, the capital-intensive nature of the water sector requires that water authorities manage their physical assets effectively (Foley, 2005; Allbee, 2005). The business processes used to manage these assets is now commonly referred to as 'asset management'. The term 'asset management' is, however, still ill-defined and numerous definitions are in use (Causey, 2005; Marlow *et al.*, 2007). As noted by Marlow & Burn (2008), the following definition, modified from that given in the International Infrastructure Management Manual (IPWEA, 2006), encapsulates the main features of this emerging discipline:

"A combination of management, financial, economic, engineering and other practices applied to (physical) assets with the objective of maximizing the value derived from an asset stock over the whole life cycle, within the context of delivering appropriate levels of service to customers, communities and the environment, and at an acceptable level of risk."

It is important to note that this definition again reflects the triple bottom line focus of the water sector. In practice, however, the focus of asset management effort can vary significantly depending on where an individual organisation is in the development of its asset management frameworks. For example, as noted by Marlow *et al.* (2007), 'best practice' strategic asset management frameworks have evolved over time so as to shift the focus

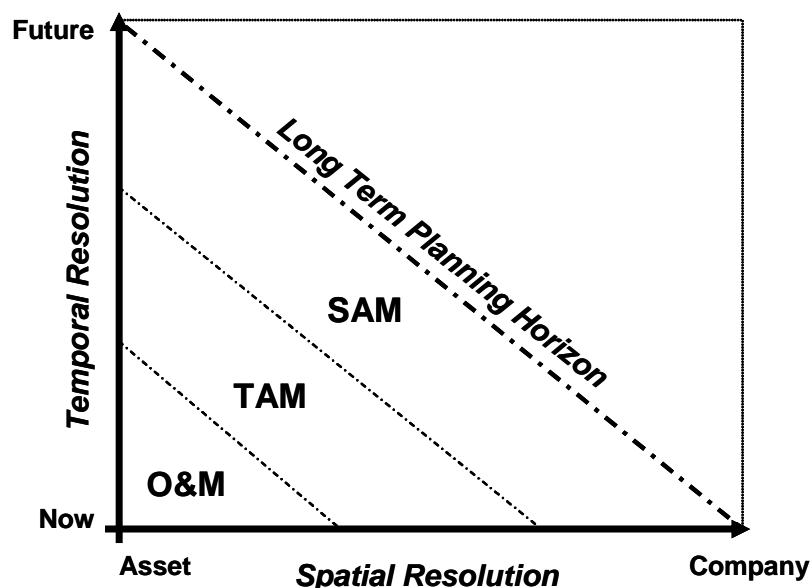
away from a purely asset-centric view, to one that considers explicitly the underlying purpose of owning and maintaining the asset portfolio; the generation of value through the provision of service.

In a similar vein, and assuming a growing commitment to sustainability (in line with the concept of sustainable development, as defined above), the next logical development is to focus on sustainability principles, and to develop sustainability-based asset management frameworks that deliver outcomes that are fully aligned with the concept of sustainable development across the asset life cycle (Marlow, 2006). At present, however, sustainability principles are not incorporated into guidelines relating to physical asset management such as the UK's PAS 55 (BSI, 2004) or the International Infrastructure Management Manual (IPWEA, 2006), and the concepts underlying a sustainability-based approach to asset management thus need to be developed.

The need to shift to asset management frameworks based on sustainability principles is being driven, at least in part, by the emerging challenges that the water sector currently has to respond to, as outlined previously in Section 1.1. These challenges mean that there is a driver towards re-evaluating many of the paradigms that have underpinned the design of systems and service provision in the past. For completeness, Appendix II presents a summary of these changing paradigms (modified from Kärman *et al.*, 2005) and the impact these may have on asset management.

2.3.1. Different Levels of Asset Management

In practice, the management of assets involves a range of activities undertaken at different spatial and temporal scales, and different terms are used to denote these various aspects, as illustrated graphically in Figure 2-2 (after Marlow & Burn, 2008). The degree to which 'asset management' can influence sustainability goals will thus depend on which aspect is being considered. Table 2-1 indicates some of the potential roles each level of asset management could play in meeting sustainability objectives.



Notes: O&M: Operations and Maintenance; TAM: Tactical Asset Management; SAM: Strategic Asset Management

Figure 2-2: Different Temporal and Spatial Scales of Asset Management.

It can be anticipated that strategic asset management, in conjunction with associated planning procedures, has the biggest scope for impacting sustainability objectives, because these activities are involved with the design and acquisition of new systems and assets. In contrast, TAM and O&M tends to be involved with existing assets and their influence on sustainability goals has to some degree already been set during the design and acquisition stages of the asset life cycle. Nevertheless, at any moment in time, it is the existing assets that actually deliver any economic, social and environmental outcomes. In addition, there

could be opportunities for making incremental changes to asset operation, maintenance and management that would have a significant impact on sustainability objectives when aggregated across existing asset stocks. This implies that the sustainability of asset management needs to be considered at each level, not just strategic planning.

Table 2-1: Sustainability Aspects of Different Levels of AM

Level of AM	Potential Role in Sustainability
SAM (planning for the future)	<p>Balancing the value proposition of future options against management of current assets.</p> <p>Ensuring appropriate access to services for the community and environment</p> <p>Analysing micro-scale (asset) contributions to macro-scale (regional and global) issues (e.g. water use and emissions)</p> <p>Reducing resource use, energy (including embodied energy) and water abstraction from the environment over the whole asset life cycle, including design for disposal/recycling.</p> <p>Implementing system reconfiguration where value-adding (noting, for example, improved resilience is more sustainable when compared to a more vulnerable system)</p> <p>Providing appropriate and sustainable levels of service that represent maximum value (minimise social and environmental harm; maximise social and environmental benefits)</p> <p>Ensuring appropriate capacity is maintained/delivered</p> <p>Identifying current knowledge gaps and opportunities for improvement (I.e. innovation and research).</p>
TAM (determining which assets are to be replaced and how)	<p>Targeting assets beneficial to replace</p> <p>Appropriate use of short-term repairs to manage cost and risk</p> <p>Provision of service at an acceptable level of risk</p> <p>Selection of replacement options with minimal disturbance and maximum benefit</p> <p>Minimise/remove replacement of assets which do not accrue benefit (i.e. reduce replacement of the wrong asset, at the wrong time, for the wrong reason)</p> <p>Identifying current knowledge gaps and opportunities for improvement (I.e. innovation and research).</p>
O&M (undertaking operations, maintenance and operational risk management)	<p>Driving out inefficiency; ensuring service provision is affordable</p> <p>Reduce travel time; reduce journeys of maintenance staff (optimise stores locations, depots etc., chunk work effectively)</p> <p>Achieving better service or asset life through appropriate levels of maintenance (the right amount maintenance, at right time)</p> <p>Minimising waste/use of materials etc. (managing spares, reduction, recycling, etc.)</p> <p>Getting maintenance right first time; minimise number of repeat failures and improving reliability.</p> <p>Mitigating consequence of failure through emergency response and other measures</p> <p>Reduce environmental impact (direct, such as disposal of oil and materials, recycling etc. indirect, quality of effluent, energy efficiency, etc.)</p> <p>Identifying current knowledge gaps and opportunities for improvement (I.e. innovation and research).</p>

2.3.2. Aligning Sustainability with Asset Management

The asset management process can be conceptualised in terms of an on-going cycle, as shown in Figure 2-3 (after Marlow *et al*, 2007). As illustrated, monitoring of asset performance (and level of service provided) throughout this cycle is undertaken with respect to targets and requirements. Setting these targets and requirements is, however, not part of the asset management cycle *per se*. Instead, they are set in relation to the strategic objectives of the Authority, which should in turn reflect the needs of all relevant stakeholders. Hence, if stakeholders require sustainability principles to be considered, the asset management cycle will be undertaken in light of these requirements. Conversely, assets can be managed to deliver non-sustainable goals if that is the requirement of stakeholders. The decision to operate in a more sustainable fashion is thus outside the scope of asset management, residing instead in the domain of environmental, socio-political, and business ethics (Marlow, 2006). Nevertheless, if adopted, many activities undertaken in light of sustainability goals will be subsequently directed through asset management. In this respect, asset management is a vehicle for delivering against sustainability objectives.

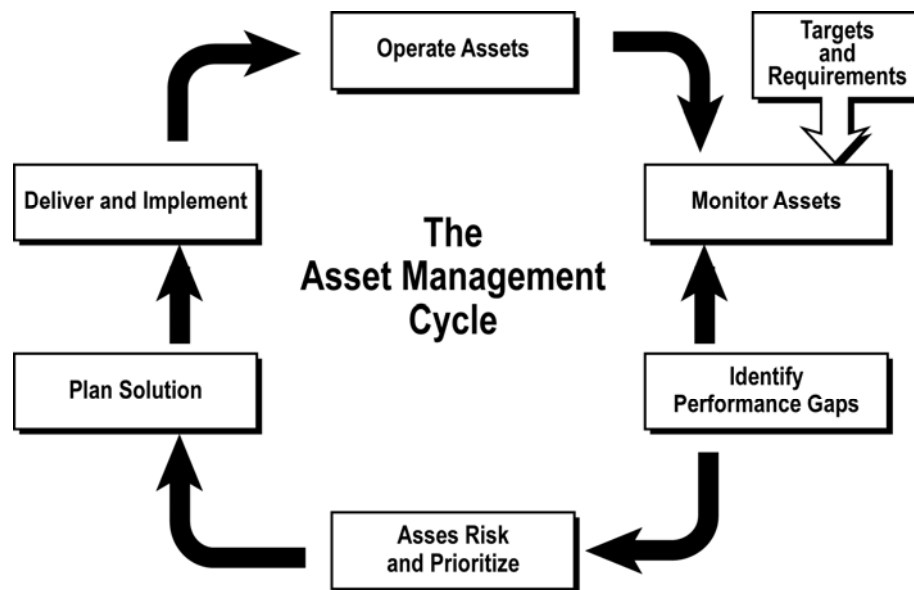


Figure 2-3: The Asset Management Cycle

2.3.3. Potential for Misalignment

The ability to deliver against sustainability targets presupposes that the sustainability policies of a water authority are translated into terms that are meaningful to asset managers. In practice, however, asset managers may not be able to see how their decisions link into sustainability objectives. One reason for this is that sustainability policy is generally concerned with a top down view of business outcomes, whereas asset management (especially operation, maintenance and tactical asset management) is explicitly concerned with management decisions at the asset (or asset cohort) level.

If appropriate business processes are not in place, the day to day requirement to manage assets could involve decisions that conflict with higher level sustainability policy objectives. For example, drivers such as the requirement to be cost effective, resource limitations, and the need to respond to failures in a timely fashion could all mean asset management decision making is sub-optimal from the perspective of higher level sustainability goals. At the same time, sustainability policy could potentially create a conflict with the demands of asset management; for example, by deflecting resources away from necessary maintenance activities and into capital delivery of new 'sustainable' schemes. Figure 2-4 illustrates the potential for such conflicts as a misalignment between the top-down and bottom-up processes of asset management and policy goals.

Since they are by nature involved with a higher level view of the asset stock, there is more scope to ensure sustainability is embedded in the processes used in strategic asset

management and planning. Nevertheless, to effectively deliver against its high level sustainability aspirations and asset management goals, a water authority needs to identify and rationalise any and all conflicts between asset management (at whatever level) and sustainability, whether they arise from the assets, management actions, decision making process, people or culture. Such issues are investigated in the remainder of this report.

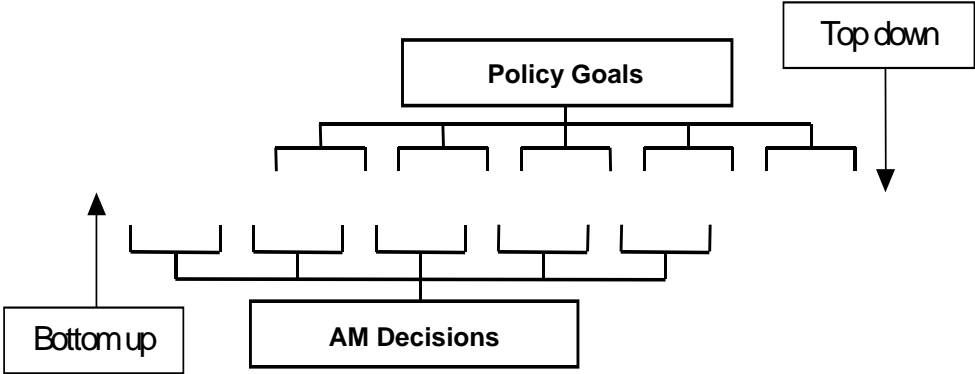


Figure 2-4: Misalignment between Sustainability Policy & Asset Management Decisions

3. INTERVIEW DESIGN AND RESULTS

Chapter Summary

1. *A series of interviews has been undertaken to assess where the Australian water sector is with respect to the development of its asset management philosophies and frameworks, and thereby identify the need for further research and development of sustainability-based asset management.*
2. *A total of 25 interviews were undertaken between January and July 2008*
3. *While the interviews were based on a standardised questionnaire, in practice a semi-structured approach was taken to allow concepts under discussion to be explored more fully.*
4. *The results from the interviews are presented and discussed. Where possible, the interview responses are categorised into themes and presented in summary graphs. Additional comments made in the interview are also documented*
5. *The following key points can be drawn from the interviews*
 - *While there appears to be a high level commitment to sustainability, there is still a need to embed sustainability into business as usual practices*
 - *Monitoring of assets and outcomes is not currently seen as driving sustainability in asset management*
 - *Interviewees feel the sector has got a lot of things right, but there are many challenges and barriers associated with changing drivers.*
 - *The role of regulators is seen as positive in some respects, but not with regard to meeting the need for innovation or driving changes in the way things are done.*
 - *Some individuals seem to have had a positive interaction with regulators, and pointed to the need to develop relationships between regulators and water authorities that are based on co-operation, rather than a more adversarial approach.*

3.1. Introduction

To assess where the Australian water sector is with respect to the development of its asset management philosophies, and thereby identify the need for further research and development of sustainability-based asset management frameworks, a series of interviews were undertaken with water sector professionals from various Australian water authorities and other stakeholder organisations. These interviews aimed to collate opinion on the role sustainability concepts currently play in asset management, the role sustainability should play in the future, what the key barriers are and where there is a need for research to help bridge the gaps. The design and delivery of the interviews, as well as the detailed findings are presented in this Chapter.

3.2. Interview Design and Application

The approach adopted in this research is consistent with qualitative research techniques using in-depth interviews as a data collection tool (e.g. Myers & Newman, 2008). An important aspect of this type of approach is that a representative sample is not required. Instead, interviewees are sought with specific reference to their ability to provide insights into the research questions.

As noted by Cohene & Easterbrook (2005), interviews have the potential to elicit a large amount of information and can be undertaken in a structured, semi-structured, or unstructured format (see also Broom, 2005). In structured interviews, interviewers ask a set of predefined questions. In contrast, semi-structured interviews are delivered in an exploratory and dynamic manner. In unstructured interviews, there is no pre-defined agenda, and interviewers may explore a range of issues with stakeholders. Given the aims of this research were to elicit viewpoints on relatively specific issues, a structured format was considered to be appropriate, but in practice it was necessary to introduce a semi-structured element to allow for exploration of ideas and concepts that arose during discussions.

3.2.1. Interview Protocol

To provide the structure to the interview process, a questionnaire was drafted and sent to various industry partners for comment; this review process led to the addition of two questions and rewording of some other questions. The finalised questionnaire (see Appendix III) was then circulated to potential collaborators with a request for participation in the interviews. A standardised interview protocol was also drafted and circulated to a range of CSIRO researchers and external stakeholders for comment.

After some refinement, the following protocol was adopted and communicated to all participants well in advance of the interviews:

1. All interviews were to be undertaken face-to-face.
2. Interviews were to be recorded (with permission of the interviewee) to allow detailed notes to be made outside of the interview.
3. A set of 13 standardised questions was to be used to provide structure to the interviews (see Appendix III). The questions were split into three groups:
 - Understanding of the terms 'asset management' and 'sustainability', and the link between the two (5 questions);
 - What is working and what isn't working with respect sustainability and asset management in the water sector (6 questions);
 - What are the remaining research challenges (2 questions).
4. In accordance with the wishes of the interviewee, the discussions were to be either:
 - Sequential; i.e. the questions were addressed sequentially; or
 - Non-sequential; i.e. the interviewee made general comments relating to the research context, with specific reference to questions as desired/necessary.

As noted above, a semi-structured aspect to the interviews was introduced because additional questions were asked by the interviewer to seek clarity on points made and/or to seek additional insight into the issues raised. This approach meant that the interviewer played an active role in the discussions. As such, the overall approach to the interviews can be construed as a co-learning process; i.e. the intent was to achieve a free exchange of opinion between both interviewer and interviewee, with explicit attempts made to discuss any apparent or actual differences in opinion or understanding of issues.

3.2.2. Interview Participation

Individuals from five water authorities located in three states (Victoria, New South Wales and Western Australia) took part in the interviews. The roles of the individuals who participated are summarised in Table 3-1. Auxiliary interviews were also undertaken with other stakeholders involved in the water sector, including industry associations (1 interview), consultants (1 interview) and regulators (2 interviews). These auxiliary interviews provided additional perspectives on issues under discussion. As shown in Table 3-1, 25 interviews were undertaken in total. It is noteworthy that three of the four non-sequential interviews were with 'other stakeholders'.

It should be noted that in selecting water authorities to participate in the research, no attempt was made to be representative of the overall Australian water sector. In fact, authorities were approached who were considered (by the researcher) to be actively engaged in the sustainability challenge, as well as undertaking relatively advanced approaches to asset management. Furthermore, since individuals volunteered to participate in the interviews, it can be anticipated that they represent a self-selecting sample of people actively engaged with (or at least having an active interest in) sustainability issues. While this selection procedure did not allow a representative view of the Australian sector to be obtained, the approach was deemed justifiable because the overall aim was to determine the research needs for developing sustainability-based asset management frameworks.

Table 3-1: Details of the Interviews

Role of interviewee	Number of interviews	Sequential	Non-Sequential
Senior managers (CEO, general managers)	4	3	1
Mid-level manager (asset management)	7	7	-
Mid-level manager (sustainability)	5	5	-
Other asset management role	2	2	-
Other sustainability role	3	3	-
Other stakeholders	4	1	3

3.2.3. Interview Delivery

As noted by Myers & Newman (2008), the qualitative interview is an excellent means of gathering data, but it is fraught with difficulties. The delivery of the interview was thus undertaken in such a way as to address potential problems associated with this research approach. For example, Myers & Newman note the following potential pitfalls associated with interview delivery:

1. The researcher is essentially asking the interviewee to answer (or to create an answer), often under time pressure.
2. The interview is a very artificial situation, since it involves a researcher talking to someone who is a complete stranger.
3. The researcher is also intrusive; the interviewer intrudes upon the social setting and potentially interferes with peoples' behaviour.

Issues with time pressure were addressed as far as is practicable by circulating the questionnaire to participants before the interviews, thereby allowing them the opportunity to prepare. In reality, most of the interviews were not overly time constrained, and there was sufficient time to complete all interviews in a natural (unhurried) manner, with the exception of one interview where the last two questions could not be addressed due to time constraints.

To address artificiality and intrusiveness, the interviewer gave some background information on his own experience and research interests at the start of the interview, along with an outline of the research project and approach being taken, and the role of CSIRO as a research provider. In general, the interviewee also provided background information on their role, experience and interest in the project. This process allowed the interviewer and interviewee to become comfortable with one another.

Following on from these preliminaries, the interviewer stated that the intention of the research was to produce an industry resource document to help inform the future direction of asset management research undertaken within the Australian sector, irrespective of who was to undertake the research. This point was made to emphasise that it was not a focus on CSIRO's future research *per se*. It was also noted that a draft of the report would be circulated to all participants prior to its publication. The interview protocol was then reviewed and confidentiality of information/opinion provided reiterated. The interviewer also sought permission to record the interview and determined whether a sequential or non-sequential

approach was preferred. In practice a sequential approach was encouraged where time allowed. All interviews were undertaken face-to-face and in private and took on average about 1 hour to complete (ranging from approximately 40 minutes to 1 hour 20 minutes).

3.2.4. Quality of Data

While every attempt was made to collate good quality data, as discussed in the previous section, it should still be appreciated that the interview is an artificial situation and views collated represent the opinions expressed at the time the interviews were conducted (interviews were undertaken between January and July 2008). It can be anticipated that the opinions reflect the experience of working within the Australian water sector, with differences in opinion being specifically informed by:

1. The differences in water sector governance at the state level;
2. Corporate objectives of the individual's company;
3. The role of the individual;
4. The personal response of the individual to the interviewer and/or interview process;
and
5. Any personal bias, whether conscious or unconscious.

With the later points in mind, it should again be noted that the interviewer actively engaged in the discussion of sustainability and asset management to try and elicit opinions and understand the view point of the interviewee.

3.2.5. Analysis of Interviews

As noted in the protocol given above, interviews were recorded with permission of the interviewee (all interviewees agreed to be recorded). To allow the responses to be analysed, the recording of each interview was then reviewed and detailed notes made of the answers given for each question. These notes are presented in Appendix IV.

Once detailed notes from all the interviews had been made, the answers were reviewed and a thematic approach to data analysis taken (e.g. Wang & Roulston, 2007); that is, responses were categorised according to common concepts or themes. The categorisations used for each question are described in the following sections, and were constructed with reference to the range of responses given, as well as the analyst's knowledge of issues under discussion. The allocation of individual responses to the various categories is shown explicitly in Appendix IV for completeness.

It should be noted that only interviews that followed a sequential format were analysed in this way, because it was not considered appropriate to assess non-sequential interviews on a common basis. In particular, it was not possible to determine if an issue had not been mentioned because it was not considered important, or because the issue did not come up in non-sequential discussions. The results from non-sequential interviews are, however, used to inform the discussion of more general issues given in Section 3.4 and Appendix V.

It should also be noted that, even for those interviews undertaken in a sequential fashion, in some cases the interviewee did not have a relevant opinion.

3.3. Interview Results (Questions 1 to 11)

Detailed notes made from the recording of the interviews are presented in Appendix IV and V, and the results of summary analysis of the interviews are presented in the following subsections, along with some supporting commentary.

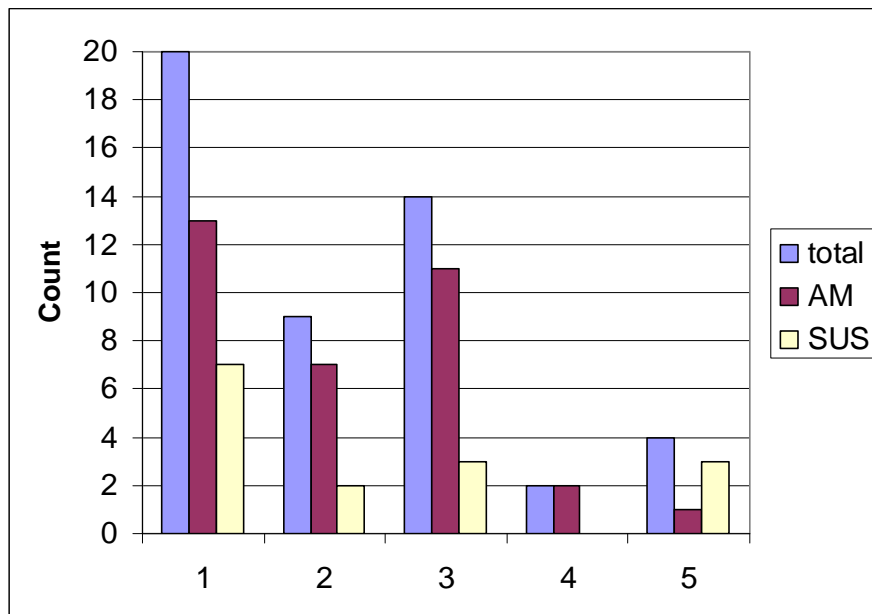
3.3.1. Question 1: Meaning of Asset Management

Q1. What does the term 'asset management' mean to you?

The responses to this question were reviewed to determine if the following aspects of asset management (presented in order of increasing sophistication) were mentioned:

1. **Managing physical assets** (cost and function of individual assets);
2. **Managing these assets in terms of levels of service provided;**
3. **Applying life cycle concepts to this management;**
4. **Applying risk based decision making;**
5. **Applying broader sustainability concepts;** i.e. triple bottom line and/or intergenerational considerations.

Figure 3-1 illustrates the results of this thematic analysis. With reference to Figure 3-1, it can be seen that all interviewees expressed the opinion that asset management was concerned with managing the cost and function of physical assets; four interviewees mentioned only this aspect. Life cycle concepts and service provision were also commonly referred to, especially by those with an asset management role.



NB: See main text for label definition. Number of interviews with explicit response to this question: 20 (13 interviewees in asset management roles, AM, 7 in sustainability roles, SUS).

The count indicates the number of interviewees who explicitly mentioned a particular aspect of asset management. Interviewees generally mentioned more than one aspect, so the total count is greater than the number of interviewees. For example, all interviewees mentioned that asset management was concerned with managing physical assets, so this aspect has a count of 20 (13 AM, 7 SUS) against it, but in general other aspects were mentioned as well.

Figure 3-1: Q1 Summary – Meaning of Asset Management

It is interesting to note that only two interviewees explicitly referred to risk in their definition of asset management, although answers to later questions showed that risk concepts are considered central to the application of asset management. It is also interesting to note that

only four interviewees referred to triple bottom line issues explicitly and of these only one was in an asset management role.

3.3.2. Question 2: Asset Management and Aging Assets

Q2. In practical terms, is 'asset management' within your organisation primarily concerned with aging assets?

In the author's experience, some individuals consider asset management to be expressly concerned with the management of ageing assets, and this question was therefore included to investigate the prevalence of this view.

It was clear from the answers given for question 1 that most interviewees considered asset management to be concerned with the life cycle of an asset, and this was confirmed by answers given to question 2. In fact, none of the interviewees expressed the opinion that asset management was concerned solely with ageing assets, and 12 interviewees (out of 19 who explicitly answered this question) specifically reiterated that asset management is a life cycle concept. The remaining interviewees indicating that asset management was concerned with existing assets, not just 'ageing' assets. Two interviewees made the distinction that much of the operational and maintenance effort is focused on ageing assets.

It is interesting to note that one interviewee indicated that ageing assets had been the focus of asset management in the past due to some high profile failures, but that ageing assets were now managed appropriately. The underlying message being that the focus of asset management changes according to the changing circumstance, business needs and priorities of the water authority.

3.3.3. Question 3: Meaning of Sustainability

Q3. What does the term 'sustainability' mean to you?

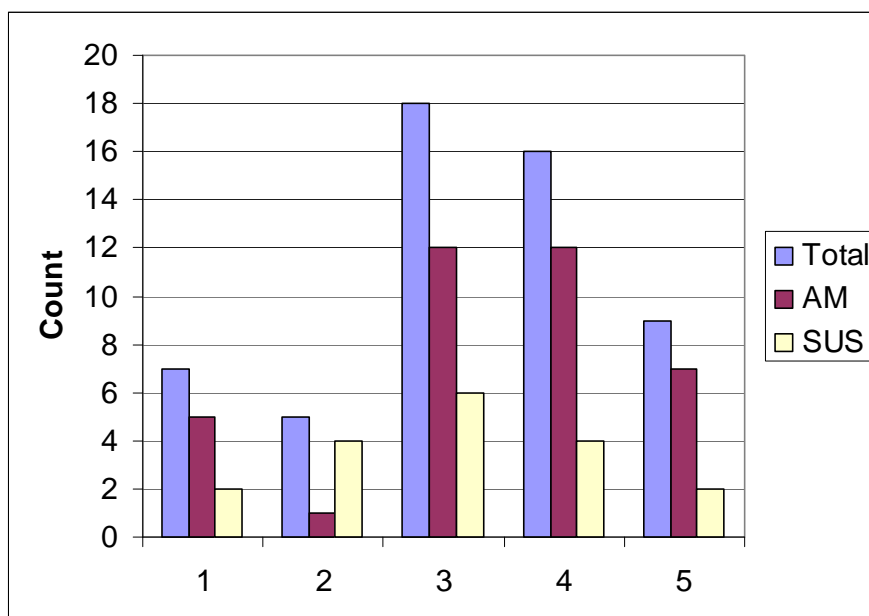
The responses to this question were reviewed to determine if the following aspects of sustainability were mentioned:

1. **Maintaining assets and service into the future;**
2. **Business sustainability (continuity);**
3. **Environmental outcomes;**
4. **Social outcomes;**
5. **Intergenerational equity.**

Figure 3-2 presents the results of this thematic analysis. Perhaps as would be expected, sustainability was considered by the majority of interviewees in terms of environmental and social outcomes. Interestingly, while some interviewees acknowledged explicitly the intergenerational aspects of sustainability, others expressed simply the need to take a longer term view of our actions. Since we do not know what future generations will want, this is perhaps a pragmatic interpretation of the need to consider intergenerational equity.

Seven interviewees noted that maintaining assets and service into the future is an important aspect of sustainability, although it is worth noting that none of the interviewees mentioned this aspect in isolation of other considerations.

It is interesting to note that four out of seven sustainability professionals referred to business sustainability (i.e. business continuity) directly in their response to this question, in contrast to just one asset manager overall. Of these, three worked at an authority where there had been an explicit initiative to communicate to staff that broader sustainability issues had to be set within a framework of overall business sustainability if they were to be delivered. It was stated during the interviews that the driver behind this initiative was related to the fact that individuals within the authority were more naturally inclined to focus on environmental sustainability, rather than business sustainability *per se*.



NB: See main text for label definition. Number of interviews with explicit response to question: 20 (13 interviewees in asset management roles, AM, 7 in sustainability roles, SUS). As with Figure 3-1, the total count exceeds the number of interviewees.

Figure 3-2: Q3 Summary – Meaning of Sustainability

3.3.4. Question 4: Commitment to Sustainability

Q4. Does your organisation have a formal commitment to sustainability as a core business concept? If so, how is this expressed?

This question sought to gather opinion on whether or not water authorities are communicating an explicit commitment to sustainability as a core business concept. All interviewees indicated that their water authority had a formal commitment to sustainability, and this was written into corporate mission statements, goals and policies.

In the case of four of the five water authorities, at least one interviewee explicitly stated that high level corporate goals cascaded down through the business (e.g. divisional goals and project targets are linked into corporate goals). Individuals from the other water authority gave specific emphasis to an initiative to integrate sustainability into a decision making framework, which implies that sustainability objectives are similarly being implemented within business processes.

Various initiatives were mentioned that have been designed to raise awareness of corporate commitment to sustainability, including sustainability groups and steering groups. These initiatives focused on raising workforce consciousness with regards the internal activities of the company (e.g. office culture with regard waste and conservation).

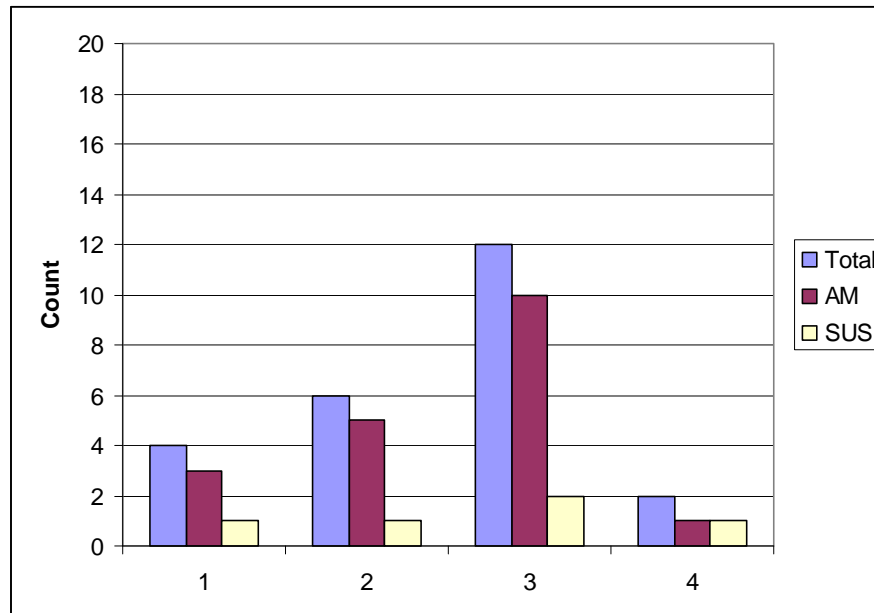
3.3.5. Question 5: Links between Sustainability and Asset Management

Q5. From the perspective of the water sector, where do you think the key links between asset management and sustainability are or should be?

In Chapter 2, it was asserted that it is necessary to consider sustainable water systems from the perspective of asset management. In analysing the response to this question, it was therefore interesting to consider the accuracy of this assertion from the perspective of those working within the sector. As shown in Figure 3-3, a number of themes were identified in the answers given, namely:

1. **Effectively no difference:** interviewees expressed the opinion that sustainability and asset management are essentially the same.

2. **Performance/impact:** the key links are either through the performance of the assets or the impact these assets and associated management activities have on triple bottom line output measures.
3. **Decision/Planning:** the key link is through the decision making and/or planning process.
4. **Long Life of asset:** the key link is through the long life of many of the assets



NB: See main text for label definition. Number of interviews with explicit response to question: 17 (13 interviewees in asset management roles, AM, 4 in sustainability roles, SUS). As with Figure 3-1, the total count exceeds the number of interviewees.

Figure 3-3: Q5 Summary – Links Between Sustainability and AM

As shown, four interviewees saw little or no distinction between asset management and sustainability, noting that the long term requirements of asset management are equivalent to sustainability, and that it is the assets themselves that deliver sustainability outcomes.

The majority response indicated that the link between asset management and sustainability was achieved in the way decision making was undertaken and, in particular, decision making within the various planning functions, especially strategic planning for service provision. Six interviewees also expressed the opinion that the performance and impacts of the individual assets and associated management activities are important links.

An interesting viewpoint noted by a person with a community engagement role that is not reflected in Figure 3-3, was that the key link between sustainability and asset management was making explicit the link between people and assets, and building mutually beneficial relationships with the community that offer long term benefits. This reflected the opinion that there is a growing need to engage with the community to deliver on business and industry targets for water conservation. These targets require the authority to build capacity within communities to encourage behavioural change.

Another interesting viewpoint not reflected in Figure 3-3, and somewhat more technical from the asset management perspective, was that the key link between asset management and sustainability should be through risk concepts. Risk is a fundamental principle in asset management; so if the link is made between risk and sustainability, it would also align sustainability with asset management. The interviewee noted that this approach (i.e. linking risk to sustainability concepts) would have the advantage that the addition of sustainability to current risk-based approaches would only add a few extra dimensions to the way decisions are already made. As such, a new ‘sustainability’ framework for asset management would not be required, which would simplify and promote its uptake.

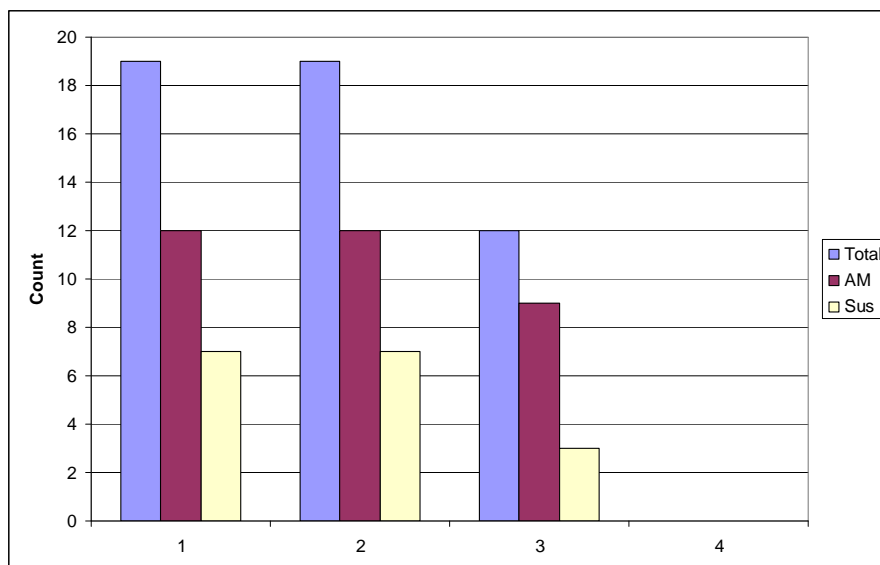
3.3.6. Question 6: Embedding Sustainability into Usual Practice

Q6. In your opinion, are the requirements of sustainability-related written policies and procedures embedded in day-to-day practices across your organisation and supply chain? Are they effective?

As noted earlier, the interviews indicated that the participating authorities have made an explicit commitment to sustainability, and this is reflected in corporate goals and mission statements. To be effective, however, policies have to be translated into day-to-day activities. For any new policy, it can thus be anticipated there is a process of embedding necessary changes into business as usual practice. Following a conceptual model outlined by one interviewee, this can be considered as a three stage process. The policy is first defined and formalised in writing. Awareness of the policy and its implications must then be raised through a range of initiatives. Finally, the policy must be embedded in day to day practices, ideally through some kind of formal change management process.

The responses to question 6 were thus assessed with respect to this simplified conceptual model; that is, policy definition/change, awareness-raising and embedding. A distinction also had to be made between those interviewees that indicated that sustainability had been embedded into at least one business function; for example, strategic planning of new schemes. As show in Figure 3-4, answers were therefore characterised according to the following themes:

1. **Policy definition**
2. **Awareness-raising**
3. **Partially embedded**; practices changed in some aspects of the business
4. **Fully embedded**; practices changed in all aspects of the business



NB: See main text for label definition. Number of interviews with explicit response to question: 19 (12 interviewees in asset management roles, AM, 7 in sustainability roles, SUS). As with Figure 3-1, the total count exceeds the number of interviewees.

Figure 3-4: Q6 Summary – Embedding Sustainability into Usual Practice

As can be seen from Figure 3-4, all interviewees felt that sustainability policy had been developed and there was awareness of the policy. However, only 12 interviewees considered that the policy had been embedded into some business function, and no interviewees felt the policy had been fully embedded across the business.

It is interesting to note that one interviewee indicated that the relevant question was not so much whether the policy had been embedded into business as usual practice, but whether the policy was effective. It was also noted by another interviewee that some sustainability

requirements have been carried out for a while under a different 'banner', and as a result these aspects are embedded into business as usual practice.

As well as addressing the effectiveness of policy within the water authority itself, question 6 refers to the supply chain. However, in general there was little opinion voiced over the sustainability credentials of the supply chain (only 5 interviewees expressed an opinion). This is perhaps not surprising, since individuals can be expected to focus on their own role and the sustainability policy of the water authority itself. In any case, the policy of one business can only be imposed on another through contractual requirements and purchasing decisions.

Where the supply chain was mentioned, it was noted that larger partners have similar commitments to sustainability as the water authorities and that management were aware of the importance of sustainability credentials of the supply chain.

Interestingly, it was also noted that the supply chain by its nature looked for ways to do things smarter and better where this relates to a competitive advantage or better profitability. The implication of this being that the supply chain will seek creative ways to meet the requirements of the water authority, especially where these are contractual or embedded into the contractor/product selection process in some other way. It was also noted that the supply chain is good at looking for 'best for project' solutions, but that it is up to the water authority to seek 'best for business' solutions.

3.3.7. Question 7: Measuring and Reporting Sustainability in AM

Q7. *How is the sustainability of asset management measured and reported in your organisation, and do the approaches used drive sustainability effectively?*

As with question 6, there were in essence two parts to question 7; the first addressed how sustainability is measured, and the second addressed if this approach is effective in driving sustainability. As shown in Figure 3-5, interviewees indicated that a range of measurement approaches were identified, namely:

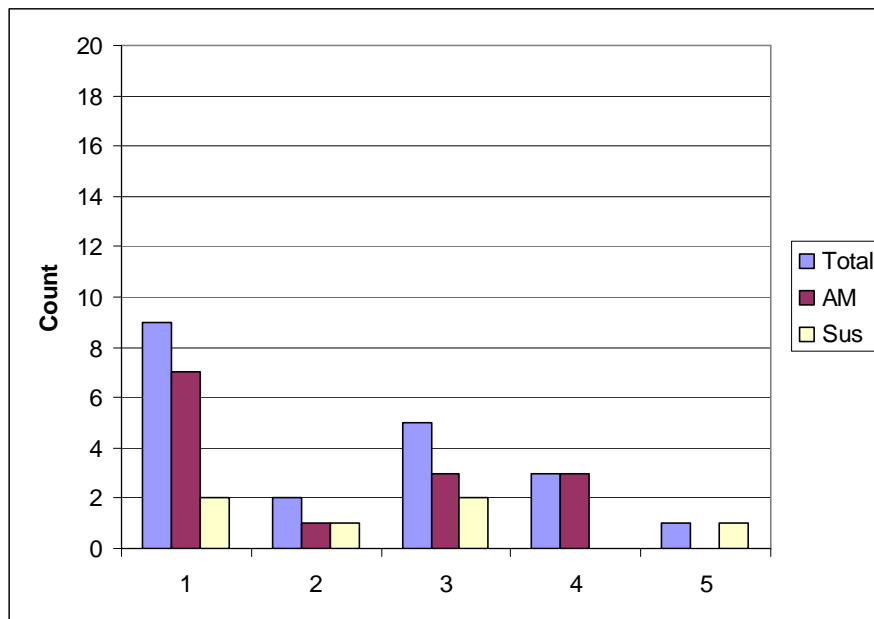
1. **Non-financial asset management Key Performance Indicators (KPIs).**
2. **Other KPIs** (environmental management system or social indicators).
3. **In post-implementation reviews** of assets and capital schemes.
4. **Corporate TBL reports.**
5. **Reporting in line with the Global Reporting Initiative (GRI).**

Only one of the interviewees did not consider sustainability was being measured or reported at all from an asset management perspective. However, it was also noted that forward planning included sustainability elements and that this would increase the sustainability of the asset stock over time. The implication of this comment seemed to be, however, that any such increase in sustainability is not being measured in practice once assets are built.

As indicated in Figure 3-5, a number of interviewees felt that non-financial asset management KPIs (bursts, chokes, floods, quality measures, etc.) could be used to measure the sustainability of asset management, although it was also noted that these measures had not been developed explicitly with wider sustainability issues in mind. Similarly, some interviewees felt that indicators involved in Environmental Management Systems (EMS) provided an equivalent measure. A range of business reports and plans that explicitly use these indicators were considered to be part of the reporting process.

Five interviewees indicated that sustainability was embedded in business cases and/or strategic planning approaches, and effectiveness was judged in a range of post-project implementation reviews and benefit realisation studies (reviews/studies undertaken after scheme construction to determine if the project went to plan and delivered the expected outputs). In a similar vein, one authority uses post-project audits to determine performance across a range of process-robustness and outcome measures. While this process is

undertaken at the end of the project, it is expected to drive changes in the way projects themselves are undertaken.



NB: See main text for label definition. Number of interviews with explicit response to question: 19 (13 interviewees in asset management roles, AM, 6 in sustainability roles, SUS). As with Figure 3-1, the total count exceeds the number of interviewees.

Figure 3-5: Q7 Summary – Measuring and Reporting Sustainability in AM

Some interviewees indicated that a TBL or sustainability report was produced that provided either a snapshot view of the water authorities sustainability-related performance and/or provided information on targets and progress towards those targets.

One interviewee indicated their Authority followed the GRI approach, but that the measurements used did not provide clear signals as to what should be done by asset managers (neither planning nor operations). An interviewee from another Authority noted that GRI approach was being considered.

The issue of effectiveness was explicitly addressed by only 5 of the interviewees, and only two answered positively. Furthermore, both appeared to be speaking in a somewhat narrow sense, since they indicated that measurement of asset management outputs informed business sustainability.

3.3.8. Question 8: Sustainability Tools & Techniques Used

Q8. *What techniques does your organisation apply to the quest for more sustainable solutions to the asset life cycle (e.g. using sustainability principles to guide thinking; life cycle analysis; advanced cost-benefit analysis; others)?*

This question was asked to determine the range of tools and techniques being used and to elicit opinion on their use and application. As shown in Figure 3-6, the results for this question are summarised in terms of the following themes:

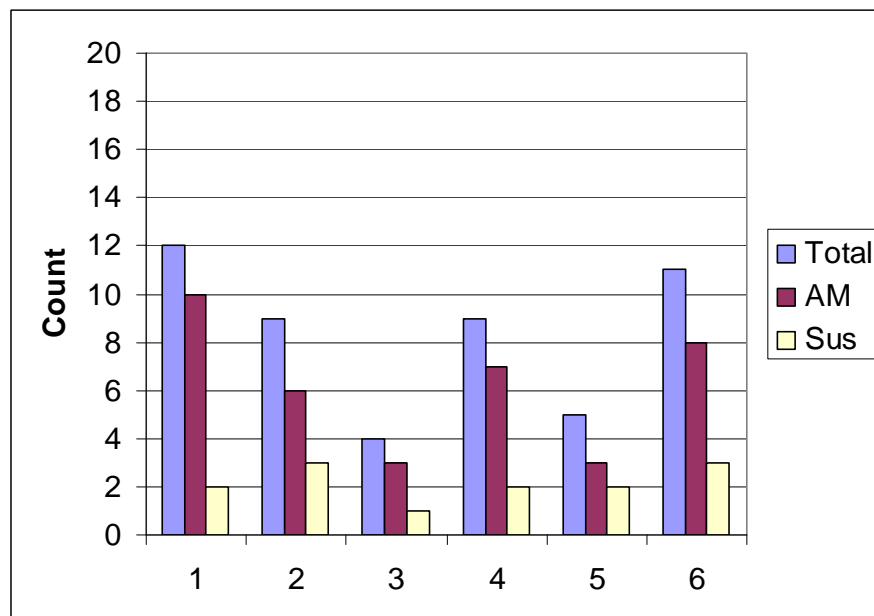
1. **Financial analysis approaches;** including cost-benefit/NPV, and life cycle costing type analysis.
2. **Formal life cycle analysis (LCA) approaches.**
3. **Risk analysis approaches;** a general consideration of risk in the decision making, as well as the use of formal risk analysis techniques, including quantitative risk analysis, FMECA, HAZOP, etc.
4. **Multi-criteria/TBL assessment approaches.**

5. **Stakeholder engagement tools**; including engagement with regulators, communities and councils.
6. **Sustainability frameworks**; i.e. planning frameworks that are coached within the context of sustainability outputs and outcomes.

In terms of financial analysis, the degree to which external costs and externalities are considered seemed to vary. One interviewee indicated that there was a need to put dollar values on externalities (social and environmental impacts), though the level of quantification needed will vary depending on the context of the decision.

One interviewee indicated that formal LCA was an important tool in their Authority, though another interviewee from the same company indicated that LCA was not yet applied to later stages of the asset management challenge; for example, consideration of rehabilitation options to extend asset life.

It is interesting to note that only four interviewees explicitly referred to the use of risk analysis approaches, which is surprising given the importance of risk concepts to asset management. It should be noted, however, that risk issues are captured to a degree in the consideration of financial modelling discussed above.



NB: See main text for label definition. Number of interviews with explicit response to question: 17 (11 interviewees in asset management roles, AM, 6 in sustainability roles, SUS). As with Figure 3-1, the total count exceeds the number of interviewees.

Figure 3-6: Q8 Summary – Sustainability Tools & Techniques Used

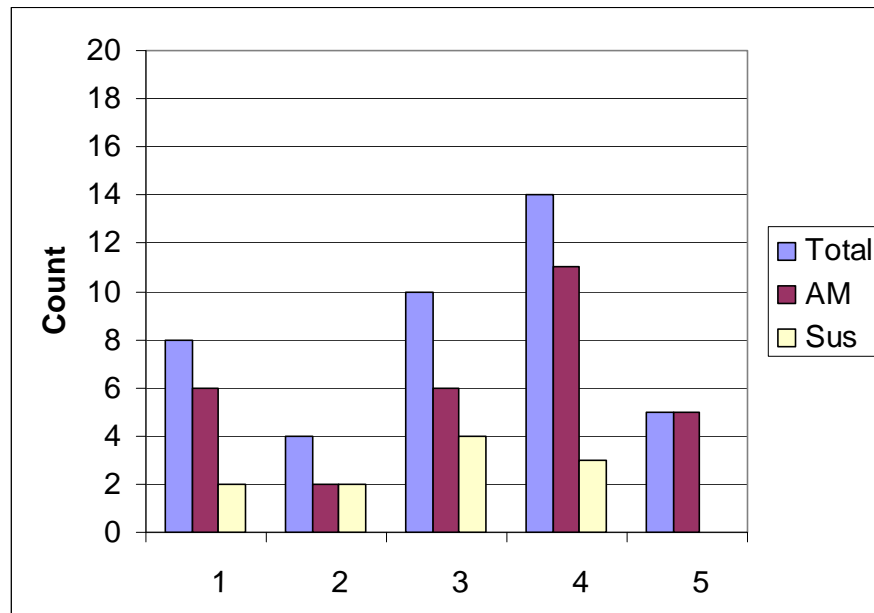
A range of tools for engaging with stakeholders were mentioned, ranging from community consultation exercises through to more formal willingness to pay and choice modelling techniques. It should be noted that community consultation and engagement was considered by a number of interviewees to be an area that was not being addressed well.

3.3.9. Question 9: Successes and Remaining Challenges

Q9. *From your view of asset management within the water sector, what have we already got right from a sustainability perspective and what are the remaining challenges?*

In answering this question, interviewees indicated aspects of asset management they considered the sector already has right from the perspective of sustainability. As shown in Figure 3-7, in analysing the positive aspect of the responses, the answers given were categorised in terms of the following themes:

1. **Assets and systems.**
2. **Provision of service;** i.e. a record of providing service to customers and the environment, consistent with existing requirements.
3. **A commitment to sustainability.**
4. **General approach;** to asset management, which contributes to sustainability outcomes.
5. **Approaches to analysis;** and the tools required to support the analysis.



NB: See main text for label definition. Number of interviews with explicit response to question: 17 (11 interviewees in asset management roles, AM, 6 in sustainability roles, SUS). As with Figure 3-1, the total count exceeds the number of interviewees.

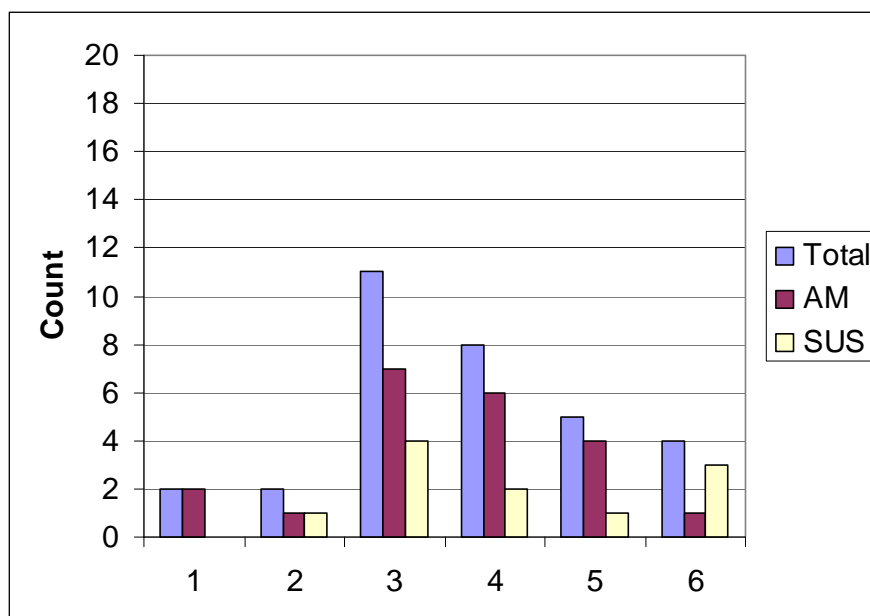
Figure 3-7: Q9 Summary – Perceived Asset Management Successes

A number of interviewees indicated the resilience of existing assets and systems was a positive contribution to sustainability goals. Some interviewees also noted that the level of service provided to customers and the environment were a positive contribution.

A majority of interviewees indicated that the sector had made a strong start with respect to the sustainability journey and that this was reflected in the level of commitment shown by water authorities. Comments were also made to the effect that while the water sector has made a good start, there are areas where lack of knowledge and understanding is still an issue. Five asset managers indicated that the sector has developed a range of the asset management tools and approaches necessary for the consideration of sustainability.

Question 9 also asked the interviewees to consider what the remaining challenges are. As summarised in Figure 3-8, responses were categorised in terms of the following themes:

1. **Willingness to pay;** the willingness of customers and/or the water authority to fund sustainability improvements.
2. **Integrated water cycle;** the need to be able to manage the water cycle in an integrated fashion.
3. **Knowledge and understanding;** of how asset management impacts sustainability issues, as well as the need to understand sustainability to a greater degree.
4. **Data, information and tools;** to support better decision making.
5. **Cultural aspects;** either within the water authority or in the community.
6. **Drought and climate.**



NB: See main text for label definition. Number of interviews with explicit response to question: 17 (11 AM, 6 SUS). As with Figure 3-1, the total count exceeds the number of interviewees.

Figure 3-8: Q9 Summary – Perceived Remaining Challenges

As shown in Figure 3-8, two of the interviewees felt that a key issue was the willingness to pay for sustainability, especially where outputs are less tangible to customers and stakeholders (note, however, eight interviewees saw willingness to pay as a barrier, rather than merely a challenge, see Figure 3-9).

The majority view was that understanding asset management tradeoffs and solutions and the impact of these on sustainability, as well as gaining a greater understanding of sustainability in broader system terms, remains a challenge. For the most part, such comments were made with respect to the water sector itself, though one interviewee did note that the challenge was also to get this knowledge and understanding of sustainability communicated to the community.

Eight interviewees indicated that data, information and tools needed to evolve to allow better decision making. In particular, better data and information on sustainability issues are required and there is a need to move away from subjective to more quantified assessments where this is possible. This latter issue requires a range of tools to be available and used on a routine basis. One interviewee also noted that knowledge retention and sharing was an issue that had to be addressed, especially given the ageing workforce.

Five interviewees expressed opinions that the remaining challenges were more to do with people than assets; for example, translating high level objectives into action on the ground and changing the way people think and act. One individual in a sustainability role noted that the culture of the water sector is itself a challenge, as there is still no commitment to zero net environmental and social harm, and instead a pervading commitment to business as usual practices based on compliance with what are currently socially acceptable impacts.

Surprisingly, the issue of drought and climate change were mentioned as a key challenge either directly (drought and/or climate change were explicitly stated as a challenge) or indirectly (the impacts of drought and climate change were noted in discussions of upcoming challenges) by only four interviewees. Interestingly, one individual noted that, in their opinion, one of the remaining challenges is that people are still talking about drought and not climate change (i.e. permanent changes to water availability).

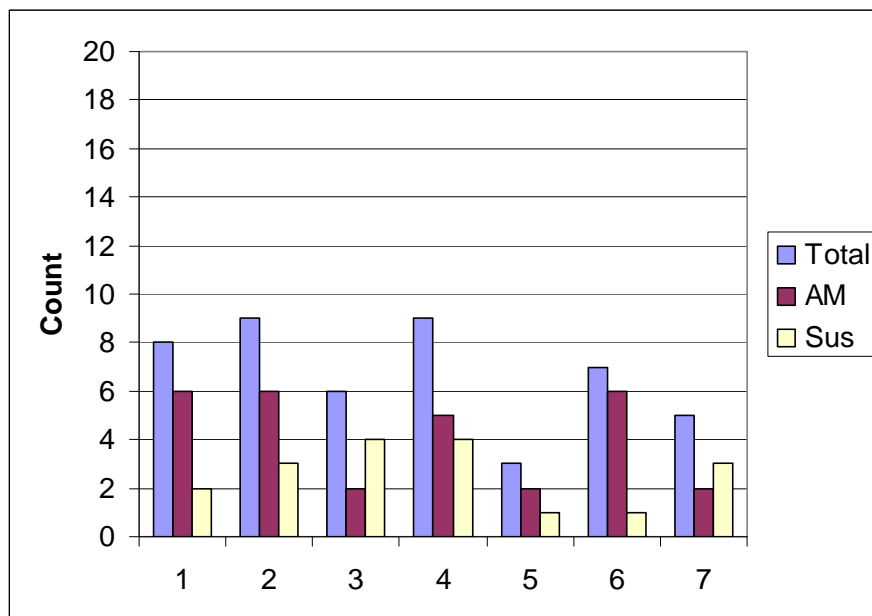
3.3.10. Question 10: Barriers to Sustainability

Q10. From your view of asset management within the water sector, what do you consider are the most significant barriers to advancing sustainability?

In conjunction with question 9, question 10 was asked to gather opinions relating to any barriers and/or challenges to advancing sustainability. Whereas question 9 was focused on asset management, question 10 was phrased to refer only to sustainability. In addition to this change in emphasis, the expectation was that the reference to 'barriers' in this question (as opposed to 'challenges' referred to in Question 9) would focus interviewees on aspects that were considered more intractable. In practice, however, some interviewees again referred to issues they considered to be 'challenges, rather than barriers.

As shown in Figure 3-9, in analysing the responses to these questions, the answers given were categorised in terms of the following themes:

1. **Funding:** in essence the willingness or ability to pay for sustainability.
2. **Value proposition:** the ability to demonstrate the benefits of sustainability initiatives.
3. **Cultural:** relating to the culture within the water sector or wider cultural issues in society.
4. **Governance:** aspects of governance of the water sector.
5. **Political:** in essence, the impact of political realities on sustainability.
6. **Tools and understanding:** required to determine or justify sustainable solutions.
7. **Climate change.**



NB: See main text for label definition. Number of interviews with explicit response to question: 20 (13 interviewees in asset management roles, AM, 7 in sustainability roles, SUS). As with Figure 3-1, the total count exceeds the number of interviewees.

Figure 3-9: Q10 Summary – Barriers to Sustainability

Only one interviewee stated the opinion that there were no significant barriers to sustainability, although they also noted that there was still a need to prioritise effort to get the biggest return.

Funding of sustainability schemes was mentioned by nine interviewees as being a barrier. For example, one interviewee noted that the biggest barrier to sustainability is the amount of money that would be required, especially given there is not always sufficient funding to undertake operations and maintenance on existing assets. In a related issues, a number of

interviewees indicated that one of the biggest barriers (or challenges) was getting the balance between benefit and costs right, since it always possible to be “more green”, but there was still a need to consider cost, benefits and affordability issues. One interviewee linked this explicitly with the difficulty of assessing the benefits of sustainability.

A range of cultural issues were referred to in the interviews as presenting key barriers to sustainability. One interviewee noted that the cultural challenge of having to bring the whole community on the “journey of sustainability”. Other interviewees made reference to cultural issues associated with trying to assess inter-generational needs.

As well as noting societal issues, some interviewees expressed the opinion that there are a range of people and cultural issues to address within the water sector itself. For example, since age profiles show that there will be significant losses of knowledge as people leave the sector over the next 5-8 year period, there is a growing need to ensure the right people with the skills are brought into the sector. Another interviewee noted that sustainability is about people’s minds and the way industry professionals currently think about issues is a barrier to sustainability (for example, considering short-term costs as a key driver in decision making).

Nine interviewees mentioned barriers that can be linked to the current governance structure of the water sector. For example, one interviewee noted that the current governance of the water sector does not facilitate integrated management of the water cycle. Institutional barriers and issues were also noted in many of the interviews (though not necessarily in response to this question).

Three interviewees indicated explicitly that there are significant political barriers to achieving sustainability. For example, the opinion was expressed that governments are influenced by lobby groups, which can result in perverse decisions, when considered from the perspective of sustainability. Similarly, another interviewee noted that “political grandstanding” can mean that decision making is driven by political considerations rather than scientific or technical ones.

Seven interviewees indicated that a key barrier was having appropriate tools, information, data and knowledge, and the need to obtain a broader understanding of sustainability issues and impacts of the different options available. One interviewee noted that this was more an issue of getting tools that are acceptable to a range of stakeholders, especially since there is currently much cynicism about the ability to manipulate model parameters and assumptions (hence, more direct/numerical relationships between factors that go into the models would be useful). A number of interviewees also referred to the lack of clear/tangible sustainability goals as a key barrier. One interviewee noted that this issue was compounded by the lack of agreed definitions for sustainability and that the vague notion of sustainability means that having a focused conversation is often clouded by a diversity of views and philosophical positions.

Climate change issues were referred to explicitly by only five interviewees as being a barrier to sustainability of asset management. Surprisingly, only one interviewee noted that scarce water resources are a key barrier. That being said, issues relating to climate change and water scarcity were mentioned throughout many of the interviews.

3.3.11. Question 11: Role of Regulation in Promoting Sustainability

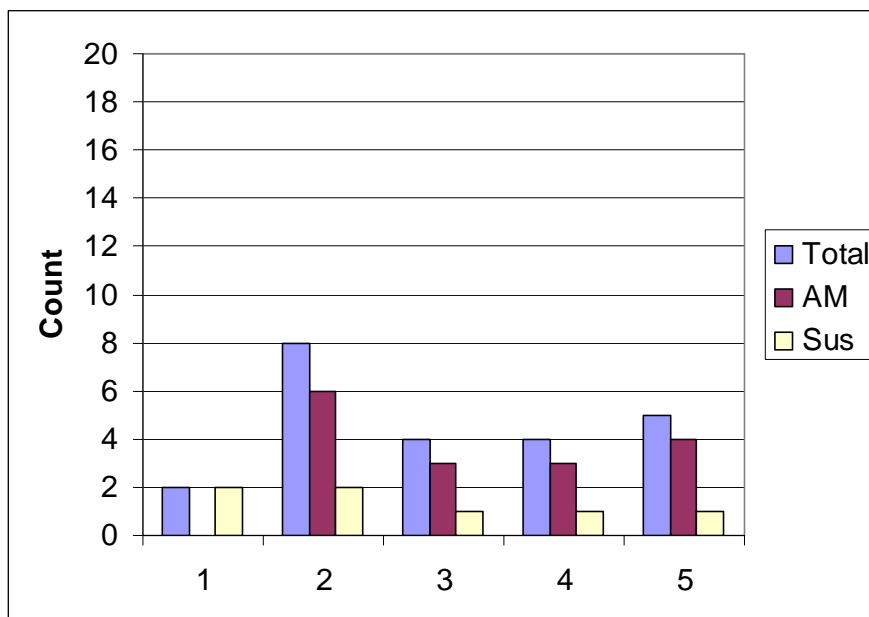
<p>Q11. Does current regulation of the sector promote or hinder the attainment of sustainability goals?</p>
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The water sector of Australia is highly regulated, and the decisions of water authorities must be made with reference to the requirements of various regulatory bodies. In practice, these regulators therefore have a significant influence on the triple bottom outcomes delivered by water authorities. It was thus of interest to determine if interviewees felt that regulators promoted or hindered attainment of regulatory goals. As shown in Figure 3-10, in analysing the responses to these questions, the opinions given were categorised in terms of the following themes:

1. **Not relevant:** regulation was not an issue.

2. **Hinders:** regulation hinders sustainability.
3. **Can hinder:** regulation can hinder sustainability (expressed in negative terms).
4. **Can promote:** regulation can promote sustainability (expressed in positive terms).
5. **Promotes:** regulation promotes sustainability.

One interviewee expressed the opinion that regulation is not relevant to the sustainability question, because it is focused only on compliance. As a business, the relevant question for a water authority was whether there is a need to go above and beyond compliance with regulations, and what level of commitment should be made to non-core service provision. In a similar vein, another interviewee noted regulation is focused on legacy issues, rather than the emerging sustainability challenge.



NB: See main text for label definition. Number of interviews with explicit response to question: 19 (13 interviewees in asset management roles, AM, 6 in sustainability roles, SUS). As with Figure 3-1, the total count exceeds the number of interviewees.

Figure 3-10: Q11 Summary – Role of Regulation in Promoting Sustainability

Overall, a small majority (12) of interviewees felt that regulators do or can hinder the attainment of sustainability goals. This opinion seemed to be related to the fact that regulators are required to have a narrower focus than is needed to promote sustainability. For example, one interviewee indicated that while the sector is required to provide good service to customers, meet legislation and to manage budgets, there is no requirement to minimise environmental footprint. This drives water authorities to be cost efficient rather than 'sustainable'. Another interviewee noted that there is no sustainability framework around the way regulations are set, and regulators are very risk averse with respect to the issues they are regulating.

Another key concern expressed by those with a negative view of regulation was related to innovation. A number of interviewees expressed the opinion that regulations do not promote sustainability because they are too conservative, hinder innovation and tend to drive traditional behaviour, such as a 'big is beautiful' solution to water quality. It was also noted that the pace of regulation is much slower than the pace of change/innovation in the sector.

A significant minority of interviewees (9) indicated that regulation can or does promote sustainability. A number of interviewees referred to the fact that regulations lock-in sustainability aspects, so it is easier to get funding for schemes where there exists a regulatory requirement. It was also noted, however, that some elements of sustainability are not regulated, and water authorities tend to address only those issues that are regulated (for example, social-environmental tradeoffs are not supported through regulations).

It is interesting to note that those that expressed a more positive attitude to regulators appeared to have the experience of working directly with the regulator to determine what needed to be done. Those who expressed a more negative attitude seemed to be drawing on previous experience of regulators placing barriers in the way of innovation or the attainment of 'more holistic' sustainability goals. There was some suggestion that this difference was to a degree an issue related to scale; more positive interactions with regulators being associated with setting overall strategy and more negative interactions being associated with specific schemes, interventions and/or technologies.

3.4. Other Issues Raised

As noted previously, a range of opinions were expressed in interviews that, while interesting and relevant to the overall research focus, were not considered relevant to the specific question under discussion at the time they were mentioned, or arose in interviews undertaken in a non-sequential format. The interested reader is referred to the detailed notes of these opinions given in Appendix V, which cover a range of issues, namely:

1. **Definitions and Understanding of Sustainability**; including the need to have collective agreement on terminology and definitions, and the need to adopt an adaptive strategy to deal with uncertainty in future needs.
2. **Social Aspects of Sustainability**; including the need to address community participation and engagement to understand and/or promote social acceptance of solutions, moving away from the application of an expert model. Also the need to understand issues like the impact of desalination and use of grey water systems on customer attitudes and actions.
3. **Generational Issues**; including the need to address inter-generational differences with respect to expectations of service and sustainability issues, and the need to consider water sector assets as part of the inheritance passed on to future generations.
4. **Governance and Regulators**; including the need to move away from governance frameworks and approaches that are aligned with the needs of the past, rather than the future, the need to ensure innovation is promoted rather than hindered such that the most sustainable solution can be adopted (when assessed across a broad rather than narrow range of drivers), and the need to ensure that long term strategies are not compromised by short term political expedience. The need to build co-operative relationships with regulators was also mentioned.
5. **Regulation**; including the need to have high level sustainability targets attributed explicitly to organisations.
6. **Sustainability in asset management**; including the need to consider the impact of sustainability and changing drivers on asset design and selection, the role of sustainability at each level of asset management (strategic, tactical and operational), and the need to get more from existing assets where this is desirable from a sustainability perspective.
7. **Embedding sustainability into business as usual**; including the need to integrate sustainability into 'upfront thinking' rather than as a bolt on consideration, and the need to facilitate a change in mindset, as well as a change in asset management practices.
8. **Traditional Assets**; including the need to build in sustainability into the management of existing assets, including options for renewal/rehabilitation and considering options for transitioning to alternative asset configurations rather than just adopting like for like replacement. The need to understand the impact of changing environmental and climatic conditions on assets (e.g. low flows, greater levels of blockages and bursts, changes in peak demand etc.) and the need to adapt asset management to these changes were also mentioned.

9. ***Innovative/decentralised solutions***; including the need to identify where these assets deliver value, the need to work out how these assets will be managed and by whom (water authorities, community management models, other technical service providers), the need to understand tradeoffs and risk involved with adoption of novel schemes, and the need to address issues of standardisation/diversification of assets and the impacts on management capacity, service and risk.
10. ***Tools and Knowledge***; including the need for more quantitative analytical approaches, rather than a reliance on qualitative/subjective assessments that can be 'massaged'.
11. ***Financial Modelling***; including the need to address underlying assumptions that have underpinned financial modelling in the past, the need to monetise impacts and benefits, and the need to adopt appropriate discount rates for elements of natural capital like soil and biodiversity.

4. RESEARCH NEEDS

Chapter Summary

1. *A range of ideas and drivers for research expressed in the interviews are summarised in this Chapter and detailed in Appendix V.*
2. *The results were analysed by categorising the responses in terms of research areas and themes.*
3. *A synopsis is given of those research areas that are considered to be relevant to the development of asset management frameworks, including:*
 - *Embedding sustainability into asset management through development of performance management systems and social research.*
 - *Research to address the cultural issues of change management and sustainability.*
 - *Research and development to promote collaboration and information sharing.*
 - *Understanding asset management and sustainability through fundamental and applied research.*
 - *Developing decision support tools and approaches, including research to formalise the link between risk and sustainability.*
4. *For many of the research areas a transdisciplinary approach is needed; i.e. project based research undertaken between researchers and industry professionals, working across disciplinary boundaries, with broad dissemination of information and findings to the sector as a whole.*

4.1. Introduction

As noted previously, the overall purpose of the interviews was to identify areas for research that will help the sector in its development of sustainability-based asset management frameworks. To this end, two questions were asked in relation to research needs, namely:

Q12. *In your opinion, what research is needed to manage our existing assets in a more sustainable way?*

Q13. *In your opinion, what research is needed to manage new emerging technologies and approaches to service provision (e.g. decentralised service provision) in a more sustainable way?*

Two separate questions were asked because it is assumed that the sector will need modified approaches to manage both its existing assets and new emerging technologies. In practice, however, interviewees tended to talk about research issues in general, rather than separating issues in the way suggested by the two questions. As such, in analysing the responses, no distinction has been made between the answer to question 12 or 13.

4.2. Thematic Analysis

As with other questions, the comments made by interviewees were categorised in terms of general research areas and underlying themes. Appendix VI gives the details of the comments made by interviewees and the categorisations used; Table 4-1 summarises the responses in terms of the research areas and themes determined during the analysis. An

attempt has been made to list the areas and themes in order from more strategic considerations, through tactical to more operational ones.

Table 4-1: Summary of Research Needs Expressed in the Interviews

Research Area	Theme	Count
Regulation & Governance	Markets	2
Social Research	Customers & community	8
	Cultural issues	7
Innovation & Collaboration	Innovation	3
	Collaboration	3
	Pilots	3
Understanding Sustainability & Asset Management	Risk	1
	Climate change	10
	Evaluation of alternatives	10
	Existing assets	6
Asset & System Design	Urban form	4
	Integrated systems	4
	Recycling/reuse (water)	4
	Recycling/reuse (solids)	2
	Decentralisation	4
	Treatment technologies	3
	Sewerage	5
Decision Support Tools & Approaches	Decision making	1
	Economic analysis	5
	AM Models/tools	10
Information & Knowledge	Data and Information	3
	Knowledge sharing	5
	Corporate knowledge	2
Technical Aspects of Asset Management	Asset life/failure	7
	Monitoring technologies	3

While the counts given in Table 4-1 are indicative of the interviewee's responses to question 12 & 13, it is considered important not to over-interpret these results, not least because there are artefacts introduced by the way individual ideas have been allocated to themes. For example, when the answers to all questions are considered in combination, it is clear that improving decision making is a critical aspect of improving sustainability, both in asset management and more broadly. However, only one comment was counted as being an explicit indication of the need to undertake research into decision making. At the same time, it is clear that many aspects of decision making underpin other research themes mentioned.

The count given to each theme should also not be considered indicative of the value that would be generated by undertaking associated research. For example, while the need to link risk and sustainability was only mentioned once, this is a strong research idea as it would help to embed sustainability into current asset management frameworks.

Given the difficulty with interpreting results at the level of individual ideas and even themes, Table 4-2 indicates the specific research areas (higher groupings of themes, as categorised by the analyst) in order of the total count allocated to the research area across all interviews. This ordering can be considered indicative of the priorities given to research areas by the interviewees.

Even at this level of aggregation, there are some issues with interpretation. For example, while there were strong opinions expressed throughout the interviews as to the need for changes to governance and regulation of the sector, this was not reflected in explicit responses to questions 12 or 13. To some degree this reflects the asset-centric focus of the questions, and also is perhaps reflective of the fact that governance issues are outside the day to day scope and control of the interviewee's responsibilities.

Table 4-2: Indicative Priorities by Research Area

Research Area	Count
Understanding Sustainability & Asset Management	27
Asset and System Design	26
Decision Support Tools and Approaches	16
Social Research	15
Information and Knowledge	10
Technical Aspects of Asset Management	10
Innovation & Collaboration	9
Regulation & Governance	2

4.3. Synthesis of Research Needs

The overall objective of this research project was to identify areas for research that will facilitate the Australian sector to develop its ‘sustainability-based asset management’ frameworks. In practice some of the research ideas identified were related to issues that are outside the scope of an asset management framework. In particular, while issues related to governance and regulation, urban form, asset technology development and system design are important from a broader sustainability perspective, they are not directly related to the development of the sector’s asset management frameworks.

With this issue in mind, the following discussion provides a synthesis of the research needs specifically in relation to asset management frameworks, as perceived by the analyst, drawing on the results of the interviews. Further work to determine research priorities from the perspective of the industry is, however, needed.

4.3.1. Suggested Research Approach

One sustainability professional expressed a strong opinion that research in the sustainability field needs to be applied rather than an academic exercise; i.e. project based; working with researchers to deliver an end product. This is because hypothetical outcomes do not have to address ‘real world’ issues of implementation, including stakeholder and other process-related problems, which only become apparent when a new approach or intervention is actually tried/trialled. Among other things, this suggests a transdisciplinary approach (e.g. Walter *et al.* 2007) is needed for many of the research ideas outlined below; i.e. project based research undertaken between researchers and industry professionals, working across disciplinary boundaries, with broad dissemination of information and findings to the sector as a whole.

4.3.2. Embedding Sustainability into Business as Usual

As noted previously, there is a need to move away from the consideration of sustainability as a ‘bolt-on issue’, to where sustainability considerations form a seamless part of a water authority’s business. Research is thus needed into the technical, social and cultural aspects of this challenge, as well as the change management processes required to embed sustainability into ‘business as usual’ practices. It is important to note that well-designed asset management tools and frameworks will facilitate this, not only by providing an appropriate analytical framework, but also by helping to change the underlying cognitive and decision-making processes of users.

A research task that would help embed sustainability into ‘business as usual’ practices is to re-examine the performance management systems used for asset management and, in particular, develop key performance indicators (KPIs) for sustainability that allow water authorities to easily assess progress/outcomes from one year to the next. As noted by one of the interviewees, pragmatic indicators would ideally be developed that give signals akin to those used in the monitoring of health (consider for example, the fact that high level health outcomes are quite complex, but easily measurable indicators like weight, cholesterol, ‘pulse rate at rest’ can be used as a proxy to give meaningful feedback).

Given the complexity of the water sector and issues being addressed by sustainability initiatives, it is perhaps pragmatic to accept that an adaptive management approach must be taken, and to design performance management systems with this in mind. In this context, an adaptive system implies having appropriate metrics to measure the effectiveness of policy, procedures and practices, with appropriate feedback mechanisms in place to modify, refine or change parts of the business as necessary.

4.3.3. Cultural Issues

Overall, achieving better sustainability outcomes requires appropriate signals to be sent that modify individual and collective actions and thought processes across all organisations that make up the water sector. Research techniques drawn from the social and management sciences provide would help address these issues; for example, by determining what drives an individual's or group's actions, where the points of leverage are and thus encourage engagement with the 'sustainability journey'. Interactions between different business units within water authorities, and between the water authority and its stakeholders (especially regulators), also needs to be considered, again potentially through the application of techniques from the social sciences.

Another key research area for promoting sustainability would be to study the interaction and interface between human, financial and technical aspects of systems and processes, with the intention of limiting or removing any actions that are counter to overall sustainability goals. In particular, research should be undertaken to help authority's identify the source of perverse incentives/drivers that arise due to short-term business and other pressures.

4.3.4. Collaboration & Information Sharing

While developing new asset technologies is outside the scope of asset management frameworks, there is clearly a need for more collaboration with respect to evaluating and piloting new technologies and approaches. An important element would be to share risks and costs appropriately, and disseminate findings so as to avoid duplicated effort and promote sector-wide consensus on options. This could be facilitated by the development of a central repository for information on pilot schemes and case studies.

Development of a common terminology and definitions for both asset management and sustainability across Australia would also be useful in promoting collaboration.

There also appears to be a need for further development of pooled data and information required to underpin sustainability analysis. For example, sector wide databases of data required to undertake life cycle analysis could be developed.

4.3.5. Understanding Asset Management & Sustainability

Since, lack of information, appropriate tools and the need for broader systems knowledge were seen as some of the key barriers to achieving a more sustainable sector, there is a need to undertake fundamental research into these areas. For example, a greater understanding of the impact of climate change and reduction in water availability on existing and planned assets is needed to determine the impact of reduced flows in water pipes and sewers. Research into the role embedded energy should play in asset management decision making is also required.

More generally, there is a sector-wide need to undertake template-type analysis to identify the impacts existing and planned assets have on sustainability goals. The impacts could be expressed in terms of footprints, resource inputs or triple bottom line outputs. The analysis should be undertaken with the intention of mapping opportunities for change and identifying key points of leverage across the sector.

Connected in with the previous issue, is the need to consider the role of sustainability in managing existing assets. In particular, there is a need to understand the impact of current assets on sustainability goals, with a view to identifying opportunities for making incremental changes that will deliver significant benefit across an existing asset stock. There is also a need to develop tools and approaches for tailoring the rehabilitation technique selected for a given asset and context.

4.3.6. Service Levels and Sustainability

Definitions of asset management are normally couched in terms of service provision, and there is a general consensus that improved service is a desirable goal, especially for such issues as drinking water, effluent quality and other environmental impacts. From a sustainability perspective, however, there is a need to consider the appropriateness of service levels provided to the community and the environment, judged in terms of the overall value (benefits net of costs) accrued.

While it may be a contentious issue, the ultimate extension of this argument is that service standards should be tailored to the predominant economic, community and environmental circumstances, which may imply at least the potential for specifying lower level of service standards, rather than driving service to ever improving levels. Some of the key issues to be addressed from a service perspective are detailed in Table 4-3:

Table 4-3: The Sustainability of Service Levels

Outstanding question	Considerations
What is a sustainable level of service and what effects this decision	Environmental impact Community impact Financial considerations (affordability, value for money) Broader economic factors (e.g. flow on effects) Social acceptance Political acceptance Technological soundness, including risk, vulnerability, resilience (e.g. resilience to natural disasters)
What is a sustainable way of service provisions	What is this now and how might future technological innovations change this How will community expectations change this How will political factors change How uncertain/certain is all this, and what should we do about the uncertainty.

4.3.7. Decision Support

The need to integrate sustainability into asset management decision making and decision support tools was a common theme throughout the interviews. Overall, there is a desire to have pragmatic sustainability-based tools (and/or ways to use these tools) that help embed sustainability principles into all business and asset management processes (rather than treating them as a bolt-on consideration).

One of the key issues to be addressed is thus to integrate sustainability considerations into asset management decision making tools. A significant step forward would be to address the assumptions and approaches used in financial analysis tools and to widen the scope of issues taken into consideration; for example, integrating externalities and external costs into economic analysis, and the development of appropriate discount rates that reflect sustainability issues.

While some interviewees expressed a desire for more quantitative techniques to be applied, there was also clearly a need for the development of pragmatic approaches as well. One way of bridging these somewhat conflicting demands would be to undertake, document and disseminated template-type analysis for a range of planning and asset management options. Such analysis should be designed to help identify key areas of leverage (where change would deliver benefits and value) and to communicate the key points from this analysis. The key findings could then be used to drive changes in practice and inform decision making without necessitating the analysis to be undertaken in each case.

Research is also required into the pragmatic application of sustainability assessment tools, to ensure that the level of detail of analysis undertaken is appropriate. Where less sophisticated approaches like subjective ranking is to be used, it would be desirable to reach a sector wide consensus on the relative importance (weighting) of different issues, with due regard given to local circumstances.

At present there is a tendency to adopt like for like replacement for many assets, especially pipe assets, rather than consider if there is an opportunity to defer investment in a given asset and subsequently replace a group of assets with a different configuration. The ability to consider options into the future should therefore be investigated and integrated into rehabilitation planning tools (e.g. using the concepts or philosophy that underpin real options analysis).

4.3.8. Aligning Risk & Sustainability

Given the importance of risk management frameworks to asset management, one means of integrating sustainability into 'business as usual' processes is to ensure risk and sustainability concepts and analysis are fully aligned. Further research into this issue should therefore be undertaken.

As noted by Marlow (2006), sustainability principles can be incorporated into risk assessments through a more comprehensive treatment of failure consequences. Categories of consequence to consider include health and safety impacts, environmental impacts, social impacts, public relation impacts, direct costs, and direct third party losses. There is also a need to widen the scope of risk assessments to cover other domains outside the technical/engineering system, including public health, human-technology interface, ecological, socioeconomic, cultural and political domains.

5. CONCLUSIONS & RECOMMENDATIONS

5.1. Conclusions

The interviews indicated that the participating water authorities have made a strong commitment to sustainability, and this is being expressed in a range of initiatives intended to deliver benefits across the triple bottom line. The opinions expressed suggest, however, that there is a need to facilitate change processes and to embed sustainability into business as usual practices, as well as to consolidate gains and point the way for future developments through targeted research and cross-sector action.

The interviews also indicated that, within the participating water authorities, a significant focus is currently being given to the integration of sustainability principles into strategic planning. The impact of this effort on overall sustainability outcomes will depend on how much growth is occurring (e.g. the relative investment in new assets compared to the modern equivalent value of existing assets), as well as the inherent sustainability of that growth.

Addressing assets in the middle and end of their life cycle still remains a challenge, and less emphasis is currently being given to this aspect of sustainability. In fact, there was at least some indication that funding of maintenance functions may be at risk due to the pressure to invest in the sustainability of new developments and/or the development of alternative water supplies. While this issue requires further research, it is worth noting that the development of sustainability-based asset management frameworks requires both sustainability and asset management to be considered simultaneously. A corner stone of asset management is getting maintenance right to ensure assets achieve their optimum economic life, not least because an asset that continues to provide service does not require additional resources or funds to be diverted from other endeavours. Any move to reduce maintenance budgets without solid justification must therefore be considered as potentially counter productive, both in terms of asset management and wider sustainability outcomes.

Given the need for societal change in the face of key drivers like climate change, population growth and globalisation, it is important that the water sector continues to investigate the role of sustainability within asset management as a holistic discipline, and not just focus on planning functions. It is, however, acknowledged that significant value will be gained from integrating sustainability principles into strategic planning, especially for areas where high levels of new developments are occurring (judged in terms of the investment in new assets compared to the value of the existing asset stock).

A key issue in any consideration of sustainability remains the need to ensure that corporate and political rhetoric is translated into on-ground solutions and initiatives. In particular, there is a need to develop appropriate regulatory and governance frameworks that enable innovation and take a holistic view of sustainability. An improved and holistic approach to asset and business performance assessment/management would also play a role, especially if these help address wider cultural issues relating to people's engagement with the sustainability challenge. It can be anticipated that to develop a positive culture, signals and feedback on sustainability should, were possible, be provided as positive reinforcements (i.e. reward and recognition) rather than negative ones (i.e. penalties). Furthermore, given the need for individual engagement in the challenge, it can be inferred there is also a requirement for organisations to create an enabling environment, where individuals have the space to make their own decisions on how best to contribute to sustainability goals. To help in this, there is also a need for a clear and consistent expression of corporate and political intent with respect sustainability objectives.

5.2. Recommendations

In terms of immediate research priorities for the development of sustainability-based asset management, the preliminary recommendations presented in Table 5-1 are made. Where practical, research in the sustainability field needs to be applied rather than an academic exercise; i.e. project based; working with researchers to deliver an end product.

Table 5-1: Preliminary Recommendations for Research into SBAM

Research Area	Research Recommendation
Regulation and Governance	<i>Considered outside the scope of research into SBAM</i>
Social Research	<ul style="list-style-type: none"> • Social research to help authorities determine where in their organisation conflicting social messages or perverse drivers are being generated that conflict with the overall sustainability goals. • Social research to determine effective change management strategies that can be used to embed sustainability into business as usual processes and practice. • Social research to understand the interactions between regulators and water authorities, so as to develop interactions that underpin rather than conflict with sustainability goals.
Innovation & Collaboration	<ul style="list-style-type: none"> • Issues to do with knowledge sharing and piloting of technologies should be addressed at the national level. • In particular, this could be facilitated by the development of a central repository for information on pilot schemes and case studies. • Sector wide databases of data required to undertake life cycle analysis (or similar) could also be developed. • Common terminology and definitions for both asset management and sustainability be agreed and adopted across Australia would help encourage collaboration
Understanding Sustainability & Asset Management	<ul style="list-style-type: none"> • Specific aspects of asset management and sustainability need to be researched so as to develop a common understanding of issues • In particular, a greater understanding of the impact of climate change and reduction in water availability on existing and planned assets is needed • More generally, there is a sector-wide need to undertake analysis to identify the impacts existing and planned assets have on sustainability goals, with the view to mapping opportunities for change and identifying key points of leverage across the sector. • Research into the sustainability of current service levels would also facilitate authorities to understand sustainability.
Asset & System Design	<ul style="list-style-type: none"> • Considered outside the scope of research into SBAM
Decision Support Tools & Approaches	<ul style="list-style-type: none"> • Research the alignment of risk and sustainability frameworks; this should include the integration of externalities, external costs and welfare loss into analysis of risk and planning. • Research into developing an adaptive approach to performance management, including revisiting KPIs from the perspective of sustainability • Research how to integrate the consideration of future options into rehabilitation planning tools (e.g. the concepts or philosophy that underpins real options analysis). • Research into the pragmatic application of sustainability assessment tools, to ensure that the level of detail of analysis undertaken is appropriate. • Develop new and existing asset management tools and approaches so they can consider wider sustainability issues. Tools should be designed to help embed new modes of thinking and sustainability practices. • Research the specification of common (sector wide) weightings to be applied in qualitative and subjective approaches

Research Area	Research Recommendation
Information & Knowledge	<ul style="list-style-type: none"> • Produce template-type analysis for a range of planning and asset management options. Such analysis should be designed to help identify key areas of leverage (where change would deliver benefits and value) and to communicate the key points from this analysis so that the findings can be used to drive changes to practice and inform decision making. • Research into the development of data and information needed to underpin quantitative approaches, where such approaches are necessary.
Technical Aspects of Asset Management	<ul style="list-style-type: none"> • Undertake research to help develop asset management approaches (like condition assessment, monitoring, etc) and understand their role in sustainability.

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APPENDIX I: RESULTS FROM 2006 CSIRO WORKSHOP

As part of the development of this research area, CSIRO held a workshop in 2006 to investigate the conceptual link between sustainability and asset management. 30 participants took part in the workshop, categorised (by themselves) as:

- 15 Industry professionals
- 2 Consultants
- 13 Researchers

At the start of the workshop, the participants were asked to divide themselves into five groups and debate concepts and issues, guided by the facilitator. As the workshop progressed, participants were encouraged to move from group to group to help broaden the discussions.

The concepts and ideas for each of the discussion areas were mapped out to aid in the identification of key issues. Initially efforts focused on mapping of the current situation regarding the treatment of sustainability within asset management. An attempt was then made to map out the ideal scenario. The research challenges to get to this ideal scenario were then identified and prioritised using a voting system; the prioritised research challenges are summarised in Table A1.

Table A1: Key issues identified and results of subsequent importance vote

ID	Options	I&C	R	T
1	Asset management tools that introduce science into decision making	9	7	16
2	Predictive tools for utilising data	5	5	10
3	Common asset management framework/similar methodologies	7	2	9
4	Common data framework, data definition and databases	5	4	9
5	Accurate models to determine failure rates and modes	5	4	9
6	Understanding how business, risk and AM models fit to sustainability	7	1	8
7	Options for extending the life of assets	4	4	8
8	Research into true cost of water - internalising externalities	3	4	7
9	Compilation of best practice in SAM	5	1	6
10	Quantification of social/environmental components and importance	2	4	6
11	What tools currently exist or are being developed	3	3	6
12	Define what data is currently available (knowledge management)	1	5	6
13	Common vocabulary and communication lines across sectors	2	3	5
14	Assessment of sensitivity of service levels to SAM	4	0	4
15	Utilisation of technologies in case studies	2	2	4
16	Clearly defined sustainability policy	3	1	4
17	Understanding characteristics of stakeholders	1	2	3

Key: I&C: Participant linked to Industry and their Consultants

R: Participant linked to Research organisation

T: Total

Following the workshop, the issues raised in the meeting were categorised according to underlying issues, as presented in Table A2. Table A2 therefore summarises the key points relating to the current and ideal situation, as determined by the workshop participants.

Table A2: Results from the 2006 CSIRO Workshop on SBAM

Issue	Current Situation	Ideal Situation
Definition	The definition of sustainability will shift; implementing 'sustainable' solutions will thus be a challenge (what is sustainable today, might not be sustainable tomorrow)	Clear definition of sustainability (scope and accountability), allowing for evolution of this definition (what sustainability 'is' changes as our understanding grows): <ul style="list-style-type: none"> ▪ Understood by all (& communicated effectively) ▪ Definition includes resources and assets
Focus	Only elements of sustainability are currently drivers in regulation and risk management	Sustainability is encapsulated in regulation (regulation drives sustainability), embodied in service levels and considered in risk assessment/management
Awareness	Awareness of sustainability is not good across stakeholders, including customers	Full awareness of issues and common understanding of accountabilities is achieved
Customer expectations	Customer expectations will shift	Customer expectations would be understood and 'guided'
Institutions	There are misaligned drivers between public and private institutions; no clear accountabilities	Drivers would align with sustainability principles
Corporate alignment	Different business functions have different drivers; financial drivers are, in reality, key drivers in decision making	A framework exists for aligning different corporate elements (all business functions align, without conflicting drivers)
Asset stock	We have aging infrastructure and variable asset stock. Potentially large waves (peaks) of expenditure (due to changing 'quality' regulations, as well as cohorts of pipes /assets reaching the end of their lives)	'Backlog' in investment would be removed; investment profiles would be smoothed; quality requirements would be consistent over time and aligned with sustainability principles
Budgets	Budget limits are a real issue	Budgets would not be an issue (a more realistic cost of water services is required)
Investment cycle	Technology and budget cycles are out of phase (concept of sunk investment using outmoded technology)	Economic analysis would consider the value of maintaining options (Real Options); modular systems would be used to facilitate expansion and modification
Planning horizon	There is still a short term reactive approach to renewal planning	Long term planning horizons would be used, with appropriate weight given to future benefits

Issue	Current Situation	Ideal Situation
Decision making	Poor understanding of long term impact of decisions	Full understanding of the implications of actions/decisions <ul style="list-style-type: none"> ▪ Better prediction of growth/demand
Asset management	Various frameworks with non-uniform implementation; sustainability not considered	Uniform framework for asset management (considering sustainability issues) that is cross-sector.
AM tools and approaches	Outmoded design concepts remain used Various tools are currently used that could be developed further; for example, LCA	Design standards follow technology and innovation closely: <ul style="list-style-type: none"> ▪ Predict accurately future resource demands ▪ Advances in technology ▪ Intelligent tools Tools would be developed based on scientific principles, good understanding of systems and good data
Performance requirements	Variable performance standards, based in part on historical practice that could be outmoded/unjustified	Uniform performance standards (across the sector, based on real information not just historical practice): <ul style="list-style-type: none"> ▪ Common definitions of performance ▪ Facilitated through standard benchmarking
Resource use	There are changing patterns of resource use that impact on asset design and operation (e.g. impact on sewer flows if more recycling implemented)	Asset design would account for changing patterns of resource use
Data and knowledge	Data and knowledge is a real issue <ul style="list-style-type: none"> ▪ Quality of data ▪ Sustainability of knowledge into the future; knowledge management issues Non-integrated data and information systems	Perfect (sufficient) data and information: <ul style="list-style-type: none"> ▪ Accurate life cycle cost ▪ Uniform data models Fully integrated management systems (data, information) Effective knowledge management
Technology	There is a lack of detection technologies	Cost-effective detection technologies would be available

APPENDIX II: CHANGING WATER SECTOR PARADIGMS

As noted in the main report, various paradigms that have underpinned service provision in the past are currently being reconsidered within the water sector, which could have an impact on asset management.

To help illustrate this and building on the work undertaken by Kärman (2005) and Pinkham (1999), Table A3 indicates various aspects of the water sector, and the old and emerging paradigms associated with each. The potential impacts that these changing paradigms may have on asset management are also noted.

Table A3: Changing Paradigms in the Water Sector

<i>Aspect</i>	<i>Old paradigm</i>	<i>Emerging paradigm</i>	<i>Influence on asset management</i>
<u>Human waste</u>	Nuisance (harmful pathogens)	Resource (nutrients)	Change in asset configuration, impact on asset deterioration of new conveyed fluids; new asset types
<u>Stormwater/used water</u>	Nuisance (remove quickly)	Resource (alternate water source, should be retained and allowed to infiltrate where possible)	Change in asset configuration and capacity requirements; new asset types
<u>Demand & Supply</u>	Build supply capacity to meet growing demand	Manage demand in line with resource (supply) limits	Reduced flows in sewers, increased effluent concentration, change in asset configuration, impact on asset deterioration
<u>Quality</u>	Treat all to drinking quality; environmental compliance	Supply water fit for purpose/use; environmental stewardship	Change in asset configuration, impact on asset deterioration of new conveyed fluids; new asset types; different levels of risk and risk management demands; maintenance issues and complexity
<u>Cycle</u>	Once through	Reuse, reclaim, recycle	Change in asset configuration, impact on asset deterioration of new conveyed fluids; new asset types with associated management issues
<u>Treatment infrastructure</u>	'Grey' – i.e. unnatural, engineered systems	Include use of natural ecosystem services to transport, store and purify water	Need to invest in and manage green assets in proportion role and value-added;
<u>Scale</u>	Centralised: bigger is better (economies of scale)	Decentralised is an option (diseconomies of scale); avoidance of inter-basin transfers	Change in asset configuration; new asset types; new asset management and asset ownership models
<u>Diversity</u>	Standardise: limit complexity	Allow diverse solutions, determined by local needs and situations	Change in asset configuration; new asset types; Increased complexity for maintenance; new asset management and ownership models required to deal with diversity
<u>Integration (physical)</u>	Water, stormwater, sewage separated physically	Distinctions are blurred because 'waste' (nutrients and water) is reused not discharged	Change in asset configuration, impact on asset deterioration of new conveyed fluids; new asset types; increased complexity for maintenance and asset management

<i>Aspect</i>	<i>Old paradigm</i>	<i>Emerging paradigm</i>	<i>Influence on asset management</i>
<u>Integration (institutional)</u>	Water, stormwater and sewage managed by different authorities and departments, under different budgets; silo thinking prevails	All phases of urban water cycle managed in coordination, allowing physical integration and reuse; co-ordinated management prevails	Increased complexity for planning, maintenance and asset management
<u>Public participation</u>	Public relations exercise – public and other stakeholders are approached when final choice is made; paternalistic approach taken resulting in weak social connections	Active engagement of stakeholders in collaborative search for mutually beneficial solutions; participatory approaches taken resulting in social resilience	Potential issues with short-termism, focus on emotive issues, rather than value, cost of decision making increases

APPENDIX III: INTERVIEW QUESTIONNAIRE

Your interpretation of 'asset management' and 'sustainability'

- Q1. What does the term 'asset management' mean to you?
- Q2. In practical terms, is 'asset management' within your organisation primarily concerned with aging assets?
- Q3. What does the term 'sustainability' mean to you?
- Q4. Does your organisation have a formal commitment to sustainability as a core business concept? If so, how is this expressed?
- Q5. From the perspective of the water sector, where do you think the key links between asset management and sustainability are or should be?

What is working and what isn't?

- Q6. In your opinion, are the requirements of sustainability-related written policies and procedures embedded in day-to-day practices across your organisation and supply chain? Are they effective?
- Q7. How is the sustainability of asset management measured and reported in your organisation, and do the approaches used drive sustainability effectively?
- Q8. What techniques does your organisation apply to the quest for more sustainable solutions to the asset life cycle (e.g. using sustainability principles to guide thinking; life cycle analysis; advanced cost-benefit analysis; others)?
- Q9. From your view of asset management within the water sector, what have we already got right from a sustainability perspective and what are the remaining challenges?
- Q10. From your view of asset management within the water sector, what do you consider are the most significant barriers to advancing sustainability?
- Q11. Does current regulation of the sector promote or hinder the attainment of sustainability goals?

Where are the biggest research gaps?

- Q12. In your opinion, what research is needed to manage our *existing* assets in a more sustainable way?
- Q13. In your opinion, what research is needed to manage new emerging technologies and approaches to service provision (e.g. decentralised service provision) in a more sustainable way?

APPENDIX IV: RESPONSES TO INTERVIEW QUESTIONS

Question 1: Asset Managers

	Managing assets	Levels of service	Life cycle concepts	Risk	TBL
PAS 55 and other definitions are legitimate and how AM is described in a formal way, but it all boils down to applying knowledge and common sense to managing assets; we all own assets (cars, houses) and we know how to manage them from our own experience	1				
Asset management means having an understanding of life expectancy of assets; and the ways to minimise costs associated with extending life and disposing of them.	1		1		
Asset management is more inward looking; it is about asset stewardship across the asset life cycle. There is an asset management focus once you have a clear picture of service provision.	1	1	1		
Asset management is about managing the life cycle of assets to meet customer/stakeholder objectives at an acceptable risk	1	1	1	1	
Asset management concerns the total life cycle of the asset, from cradle to grave... it's about having the right asset, right size, at the right time.	1		1		
Asset management is the cradle to grave management of assets	1		1		
Asset management is about the full asset life cycle, its not just existing assets; its new assets for growth, design standards as well as O&M. The asset management policy and manual is set around the full asset life cycle (planning through to disposal).	1		1		
Asset management is about the whole life cycle of a particular assets; concept through to renewal and disposal, though never that much disposal in water industry assets. Some long life assets are managed in perpetuity; maintaining the working value of these assets is one of the responsibilities of a water authority. It is an integrated network concept; not stand-alone assets... you need to take a systems view. Asset management is about stewardship of assets for the customers perspective, but also stewardship from the perspective of the community and environment	1	1	1		1
Asset management is about the whole asset life cycles... the objective is getting the assets to perform over their life, providing maximum benefits to customers, and meeting other stakeholder requirements. Covers the spectrum from having enough assets to meet demands; so provision/creation of assets is an aspect, through getting maintenance strategies in place and making tradeoffs involved with replacement/maintenance and repair	1	1	1		
Asset Management is about having the right assets, at the right time, in the right shape to do the job. It requires whole of life management of assets, including assessing the need & capacity gap, addressing the gap by creating assets, enhancing assets, or getting assets to perform as they should be. Overall, asset management is also about ensuring services are provided by assets appropriately, so asset management is about being able to do this forever at minimum whole life cost; all in the context of an acceptable level risk; asset management is about doing everything you must to achieve these goals	1	1	1	1	
Definition of AM; management of assets over their life cycle, from planning to disposal; managing assets to get optimal life, while maintaining levels of service.	1	1	1		
Asset management is about whole of life management of assets, from cradle to grave; tends to think in terms of infrastructure assets, not fleets or IT	1		1		
Formal definitions of asset management apply, but there was an attempt to reduce these to something more meaningful; AM formal definitions related to having the right infrastructure assets to deliver service... but this was reduced to having the right asset, at the right time, keeping in the right shape, and making sure they can do the right job... Asset management broadly considers information systems, culture and people, as well as the assets, but need to be mindful of the wider business need/environment	1	1			

Question 1: Sustainability Role

	Managing assets	Levels of service	Life cycle concepts	Risk	TBL
Asset management is linked strongly with customer service; need to maintain the asset so as to perform its function over its life	1	1	1		
At the highest level, asset management ensures assets continue to do what they are meant to do, while ensuring stakeholders are happy, they are affordable, and provide the right outcomes. Asset management is about justifying the life and the use of the assets; it is about providing robust cases for investment. Asset management is whole of life cycle but broader than the 'concrete'; it requires consideration of service provision in a way that community expects it to be supplied. Part of the community is our regulator(s)	1	1	1		1
Asset management is about maintenance of infrastructure; ensuring assets are running well and keeping up with demand	1				
Asset management is about pipes and pumps	1				
As a core idea, asset management is about infrastructure for water and sewerage systems; asset replacement and renewal; and some of the innovation programs that are related to assets. It is about physical assets, so includes shared space in which communities might operate; ensuring aesthetic requirements of the community are met (so green assets; wet lands, biodiversity sites)	1				
Asset management is about pipes and pumps, making sure looking after the maintenance, future planning, and delivery of assets to support future generations	1				1
Asset management means a holistic view of the asset life cycle; from identifying the need right through to decommissioning. More broadly, it is involves dealing with externalities, for example, defining the social-permission space from process through to outcome. Increasingly it is about the need to design in environmental benefit and not net incremental harm; business excellence is about getting all these things right simultaneously	1		1		1

Question 2: Asset Managers

AM is not so much about ageing assets, but assets that are not performing, which is dominated by ageing assets; more about service, but very much about existing assets
O&M is a key part of asset management
Asset management is definitely not just about ageing assets; need to consider all business objectives and identify needs, both in terms of current assets and future requirements and capabilities; identify what needs to be done; where are the gaps now and in the future
No: asset management is a key player in the construction of new assets. Need to consider its management in the conception and asset creation phases; considering corrosion, maintenance, access issues etc.
Not primarily concerned with ageing assets; this was a primary concern in the mid 1990s driven by a number of sewer collapses and high profile failures (ageing assets are now managed, so not the primary concern; now driven by water shortage issues
Asset management is absolutely not about ageing assets, it is about the full life cycle; there is an asset management committee that look at the whole life cycle; greenfield, developers, etc
From a capital spend perspective, no, because ageing assets are only a small part of asset management. There is only a small portion of the capital budget spent on renewals, whilst a large portion is spent on growth, compliance (bringing asset up to modern day service standards), and meeting changing service/quality standards (e.g. level of floods that must be catered for by dams). From an O&M perspective, asset management is strongly about ageing assets. Sustainability of this from an asset management perspective, is related to the question of when do you stop investing in maintenance and undertake renewal/replacement instead? This is a sustainability decision because it has an impact on resources, communities and customers.
Asset management is not about ageing assets; though ageing assets are a significant issue
No, asset management is about the whole asset life, so ageing assets are just one issue. Much bigger spend is on growth, SDB, changing demands and quality requirements and efficiency are all bigger drivers
AM is not primarily about old assets; the AM division is primarily focused on exiting assets. However, on the capital side, planning and acquisition are a big focus, but done in different divisions
No, ageing assets are not a great concern.
AM is not about ageing assets, it is about the full life cycle of the assets; it is about capability management; monitoring tracking performance against demands... considering that there is a 7-10 year lead time for new water resources to be brought on line. AM is about keeping assets in the right shape, but getting the right assets at the right time (acquisition) is important... it is whole of asset life cycle.

Question 2: Sustainability Role

No answer
Ageing is a part of the issue.
Asset management is not just about ageing assets; 70% of population growth over the next 30 years is, however, within brownfield development. Ageing assets are thus a particular factor; e.g. with respect to available capacity and demand
Asset management is not about aging assets; also about getting the most out of newer technologies as much as older ones. Part of the challenge is aging assets (i.e. replacement of deteriorating), but it is really about getting the most of existing assets however old.
No, its about existing assets and innovation; looking ahead, not just about fixing assets; being pro rather than reactive
Asset management is not just about aging assets; in the 2015 strategy it is recognised that there are areas of focus like asset management, but there is also the need to have a broader perspective and consider how to provide more tailored water solutions for customers; which may or may not involve assets
Asset management is not primarily about ageing assets; its as much about looking to the future; it is a life cycle focus
Asset management is not just about ageing assets, as the thrust of activity is on asset creation and network extension

Q3: Asset Managers

	Maintaining assets/service	Business sustainability	Environmental outcomes	Social outcomes	Intergenerational equity
Sustainability is about intergenerational equity; each generation should be leaving the world behind in a better shape (baby boomers have been a bad thing, very material period of history). Sustainable has a strict meaning; meeting needs now without compromising the ability to meet future needs, but has tended to be broadened into TBL realms, implying sustainability across a number of dimensions.			1	1	1
Previously (5 years ago) sustainability meant managing environmental impacts; these days, economists have hijacked the term; it now is about economic issues. There is certainly a TLB element now; what is the best you can do and continue to do without causing damage.			1	1	
Sustainability is a broader outward looking approach than asset management; since it requires consideration of stakeholders and the environment. Sustainability is the provision of services to improve quality of life for customers and stakeholders; there is an intergenerational aspect, and also a social good and environmental aspect.	1		1	1	1
Sustainability; it is a TBL concept and also about sustained service	1		1	1	
Sustainability is a process a journey, rather than a specific thing, whereby what you do shouldn't detrimentally effect future generations. It considers social and environmental aspects, but also technical/engineering aspects; can it be maintained into the future, so maintenance, corrosion, accessibility, ability to build over or near by assets or easements, etc. are all aspects of sustainability.			1	1	1
Sustainability is about meeting the needs of current and future generations; leaving the world in a better way... of course, the key challenge is to define what is 'better'					1
Sustainability is TBL with a long-term perspective; you can do TBL with a short-term perspective, but it is not necessarily sustainable. Sustainability is how to get a win-win across the three elements of TBL. Sustainability is couched in terms of providing water services to meet today's needs without compromising the ability of future generations to meet their own needs			1	1	
Sustainability is an evolving term; had a TBL tenant to it in the first place, but is being expanded to cover issues like retention of staff, stewardship of assets, financial viability to remind everyone that there is a need to cross-check what we are trying to resolve and why (should we replace or do something in a different way)		1	1	1	
Sustainability is one of the frameworks within which to asset management frameworks are embedded; this ensures asset management can continue in a sustainable manner. It is about stakeholders; communities, future generations, and the environment... a TBL focus. Governance is an important aspect of sustainability; we need to ensure we behave like custodians of the assets; they are not our assets, we are looking after them for a while. We need to consider future generations and their ability to make decisions. There are wider equity issues about current generations as well.	1		1	1	1
Sustainability means ensuring something can happen forever; the formal/dictionary definition of sustainability. It is couched in terms of balancing TBL outcomes with the future in mind... it is about understanding what will prevent us doing things into the future, be it economic, environmental/resource use or social constraints. With respect to the definition of sustainability in terms of service provision, there is an increasing need to recognise risks that prevent things being done into the future; running out of oil, running out of water, GHG issues, etc. These are all new issues that weren't considered in the past	1		1	1	
Sustainability is a process you can carry on indefinitely; for example, if a bore field is managed in a sustainable manner, a certain amount of water can be taken out forever. There is generally an economic, social and environmental aspect to sustainability	1		1	1	

	Maintaining assets/service	Business sustainability	Environmental outcomes	Social outcomes	Intergenerational equity
Sustainability; whatever activities are undertaken, e.g. building of assets or management of assets, don't detract from society or the environment and future generations; making sure there is no net loss			1	1	1
Sustainability is about leaving the planet in a better shape, it is about inter-generational equity, taking a long term views on achieving acceptable outcomes. It is about a whole of system, whole life assessment of issues with a long term view			1	1	1

Q3: Sustainability Role

	Maintaining assets/service	Business sustainability	Environmental outcomes	Social outcomes	Intergenerational equity
Sustainability from a philosophical point of view tends to imply environmental sustainability; providing service within the carrying capacity of the natural environment.	1		1		
Sustainability as a business is meeting corporate goals, as embedded in the water act and our operating license	1	1			
Sustainability is about economic, environmental and social responsibility, now and into the future; it is also about business sustainability; part of which is to have a TBL perspective		1	1	1	1
At its broadest, sustainability is about everything the authority does; policies, processes, about allocating resources, training, managing funds, culture etc. It's about creating a sustainable organisation. Environmental factors are still important, as is taking a long-term view about impacts tomorrow... the environment is a large part, because assets etc. have an impact on the environment and there is a need to reduce the footprint overall		1	1		
Sustainability is about short-long term solutions that take into account TBL factors. Concerns management of water resource, but also how the authority engages locally to achieve longer-term objectives through shared ownership of problems and solutions. Social aspects of sustainability are possible the most underdeveloped of this equation; comfortable in the environment space now.			1	1	
Sustainability is looking after current and future generations; it is not just environmental sustainability, it requires a robust business; to be a good business you need to take into account broader issues; it is about taking into account all perspectives, not just financial, and not just environmental sustainability. It is beyond TBL; you need to take into account broader aspects of a business and how they are interlinked. Culturally, sustainability is about being green; so the challenge is to shift this focus to one that is truly TBL		1	1	1	1
Sustainability means that the business pays for all environmental and social harm arising from its operations; it doesn't leave residual environmental harm as a consequence of doing business... this can mean using environmental offsets or compensation in the social space. Moving into positive stewardship is the inspirational aim; the ecological footprint is too big, so all sectors need to address this imbalance			1	1	

Q4: Asset Managers

<p>There is absolutely a formal commitment to sustainability; we undertake LCA when planning new developments, but this is not done for advice for renewals (asset management) though this is on the agenda. We are looking to minimise its environmental footprint; energy use, waste to land fill, etc, there is an expectation that we will do that as individuals and take this through right up to the largest projects</p>
<p>There is a formal commitment to sustainability. It is embedded in the sustainability planning manual and thus the strategic approach to planning. Key sustainability goals are linked to corporate goals, which are cascaded down into divisional goals. Projects are also assessed in relation to these goals. So there is a link between corporate goals, sustainability goals and project goals</p>
<p>Commitment to sustainability is through core business objectives that are embedded into programs and activities. There are general requirements for sustainability in the operating licence; there is a requirement for 'sustainable decision making', though this is not defined</p>
<p>Yes: Sustainability principles are endorsed by the executive and cascaded down through the organisation. Targets are set, and we are measured against those targets... shows how well doing against targets. Various initiatives on-going initiatives are undertaken to raise the profile of sustainability. There is a sustainability group (3 people)</p>
<p>Sustainability principles are outlined in the corporate plan; the essence of the whole business. It is however more driven by the decision making process and the conversations that need to take place to get things done</p>
<p>Sustainability is high up on the agenda. There is a sustainability policy, there is a sustainability steering group looking at how sustainability principles can be incorporated into day to day activities, not just asset management... right across the organisation</p>
<p>There is a formal commitment to sustainability, but it is a journey and people are at various points with this. Sustainability underpins decision making and thinking processes (this is the goal, it needs to be something that forms part of the thinking process, not something that needs to be referenced in a book from time to time) and is embodied in corporate goals. Sustainability in terms of a sustainable business will pick up all TBL issues (sustainability in the context of green), but include staff, technology, innovation, etc.</p>
<p>Sustainability is written into corporate plans and mission statements... sustainability starts with the board and senior management and is intended to infiltrate through to all activities; Sustainability has a high profile, in terms of all aspects of the business.</p>
<p>There is a formal commitment to sustainability, expressed in the corporate purpose statement. There is a sustainability principles document, which includes a sustainability framework. There are endeavours to embed sustainability into business practices, starting with planning; how can planning be done on the basis of sustainability. The corporate risk framework also embodies sustainability</p>
<p>We do have a formal commitment through the sustainability group; objectives and rules for sustainability have been generated from the corporate level, and it is now about flowing these down to the rest of the organisation. This is done better in some parts than in others; e.g. in planning, high level principles have been translated into guidelines for individual projects, but not necessarily so well done in other parts of the organisation. The vision statement also includes sustainability</p>
<p>There is formal commitment to sustainability expressed in terms of the sustainability principles; these focus on both outcomes and processes</p>
<p>There is a formal commitment to sustainability in the purpose statement. We consider ourselves to be in the 'forever' business, and are trying to embed sustainability thinking into the approaches taken. There is a sustainability wheel with 6 dimensions; TBL, ethical, stakeholder and governance. These structure aspirations, starting from preventing environmental harm or protection health through to enhancement across the TBL (enhancing ecological resilience, enhancing community, and adding economic value).</p>

Q4: Sustainability Role

Originally a top down approach was taken; the environmental strategy was put into policy. In the second attempt, the executive defined strategic objectives and managers tried to determine what success would look like and how this could be delivered.
Formal commitment to sustainability is embodied in the corporate goals
There is a formal commitment; expressed in terms of a strategy map, which required sustainability principles to become embedded into business practices (this is signed off the board)
There is a formal commitment to sustainability; this is expressed in the decision making framework, which is being piloted across the organisation... it is used for a range of decisions (including salary increases); and designed to look at problems better upfront and extending the range of options considered (not jumping to a solution)
Formal commitment in terms of sustainability policy and principles; piloting of sustainability decision making framework; sustainability standing committee; (committees involve middle and lower management in strategic direction setting)... sustainability can be intangible and the standing committee provides a forum for discussion
There is a formal commitment to sustainability in the form of policies and sustainability principles; sustainability standing committee; sustainability is increasingly being incorporated into decision making at board level... needs consideration of broader issues, not just financial ones.
There is a formal commitment to sustainability, but it is still being communicated; there has been a significant shift over the last few months where the board and exec have coalesced on this. This commitment is expressed through the purpose statement of the water authority and in the business principles. There are 18 business principles and 3 outcome spaces; TBL: 3 outcome spaces prevent harm, conserve value, and then create value. There is also behavioural governance for ethical behaviours... outcome spaces compliance with the law through to moving beyond compliance. There is also stakeholder engagement: consultation through to an attempt at co-design; community participation in informed dialogue. The final element is good governance, like financial systems and other management systems. We are asking people to consider their part of the business and determine how this intersects with these principles and attempt to design out any pathology they discover... and to support them in this endeavour

Question 5: Asset Managers

	Effectively, no difference	Performance and impact of assets	Decision making/planning functions	Long life assets
Links are probably in the planning and investigation type functions, which have been areas in water service providers that have been cut back and neglected; low level staffing compared to before. Planning as a whole; asset creation and also in operations and maintenance.		1	1	
AM team should be evaluating the environmental impact of different materials, and should be evaluating the impacts of remedial measures and maintenance practices to identify the least damaging approach. AM needs to be providing Planners advice on WLC		1	1	
The key link between AM and sustainability is through the strategic planning, which sets the servicing strategy for an area. The transition between strategic (determining how to provide water services, water sources, effluent disposal, where to site STP) and detailed planning (how many pumping stations, configuration of STP, and pipeline routes etc) provides the link; the endpoint being the design and delivery of the assets themselves.			1	
Sustainability and asset management are more or less the same thing; objectives of asset management are on-going from a TBL perspective, therefore around sustainability outcomes; assets deliver sustainable outcomes. Asset management is a whole of organisation process; there are different slices that can be taken... a technical asset management view or a sustainability principle focus, but these are really just different views of the same thing	1			
Key link is through the process put in place to support decision making, which drives consideration of sustainability issues. Biggest impact on sustainability is available at the design phase; this sets the achievable sustainability envelope; you can do worse, but not really any better. Need to consider life cycle impacts and costs; might be cheaper to build pumping stations, but gravity will be more sustainable over the long term.			1	
Links are throughout the whole asset life cycle: Planning; if too small, or don't take energy into account, won't be sustainable. Routing and impact of pipelines is also a consideration. Maintenance; disposal of oil, pumping efficiency related to O&M, disposal of materials and assets. Most benefit is realised in planning and design for new assets; once locked into a design, little you can do to make it more efficient and thus sustainable, though plenty can be done to make it less so.		1	1	
Sustainability needs to be a core principle of asset management and needs to be built into the decision-making and thinking going around asset management practices. Long-term requirements of asset management are equivalent to sustainability	1		1	
Key links are in the impact of asset management activities: used to open trench everything, but increasing pressures on the perspective that this is not the way to go from the perspective of natural habitat, aboriginal heritage, backyards, impact on the environment and communities. Water sector is an energy consuming business; from a project evaluation perspective, need to consider energy in the decision making process; e.g. whether to use green assets, buying offset or working through the design for lower energy consumption/high efficiency		1	1	
Key link are around how we undertake decision making for asset management; involves taking into account TBL in replacement and growth strategies; another dimension behind the whole of life aspects of asset management. Sustainability is a formal part of any business case for any activity; the larger the investment, the more effort is put in to sustainability aspects. Routine decisions have developed over the years and incorporate notions of sustainability and are embedded in quality system documentation, which forms part of the process for making these decisions			1	

	Effectively, no difference	Performance and impact of assets	Decision making/planning functions	Long life assets
Everything done in the asset management space has ramifications to sustainability in terms of an impact on environment, community, using resources or \$s etc. to do anything. There are sustainability elements in each part of the asset life cycle. In terms of where the key links should be, it should be between risk and sustainability; risk is a fundamental principle in asset management; so if you can get the link between risk and sustainability, it aligns with asset management. Adding in sustainability to risk adds a few extra dimensions to the way decisions are already made, so it is not a new framework. If you try and bring in a separate sustainability framework, it could cause issues; how do you compare the two... key link is thus to mesh risk and sustainability	1			
The key links are through the whole asset life cycle; e.g.: Planning : very clear sustainability principles, when developing plans; look at TBL aspects to come up with the solution... there is an assessment across these considerations. Acquire : need to design and construct assets that are aligned with the principles, but also need specific things built in at this stage; e.g. focus on construction noise, site management to prevent pollution etc. O&M : the weakest area; don't see a lot of sustainable processes; there are sustainability principles in maintenance standards to a certain degree... but possibly not applied on the ground in any case. Disposal is not done very well at all. If new assets are built on top of the old, this has to be done, otherwise the asset are just left there in a poor state; there are lots of such assets; it needs special funding to address and can't be built into the capital project... so it doesn't get done		1	1	
Asset management starts from a business need with existing assets, the key to sustainability is that it needs to be dealt with early in asset planning or asset upgrades. Further down the life cycle of the asset (acquisition and O&M), the less options you have			1	
The link between asset management and sustainability is getting the desired service outcomes for optimum cost, recognising the long life nature of assets; recognising a short term focus on costs is sub-optimal. This requires a WL analysis. There are obvious links between energy and water; there are tensions because lots of the solutions people see as desirable are energy intensive; e.g. treating WW for reuse... which requires a trade off against energy. Getting understanding of these tradeoffs will be key. Will more and more go to looking at embedded energy. There is also a need to take account of the indirect costs of solutions to the community				1

Question 5: Sustainability Role

	Effectively, no difference	Performance and impact of assets	Decision making/planning functions	Long life assets
A key link between AM and sustainability is that the asset choices have a long impact due to the long lives (80-90 years), and also have an impact on available options into the future. The assets lock in, say, 80% of the space an individual has to be more sustainable, so asset planning is important.			1	1
Key links are making sure that service provision is aligned with the quality required by customers; quality and quantity/demand now and into the future... key links are thus through service standards and service provision		1		
Key links are the cultural/thinking aspects... planning an asset management project, how to bring sustainability into thinking; broader thinking taking into account future needs and all relevant considerations through each phase of the project. Planning in terms of new assets; financial, economic, social costs and benefits; what is the best solution. Design stage sets the envelope for sustainability; we can always be worse, but never better than the design allows. So this is the big win ticket from the perspective of the life cycle; but small numbers in terms of overall assets... where are the incremental changes that will provide large benefits across existing assets			1	
It is fundamentally obvious; the entire asset life cycle should be aligned with the idea of creation of benefit and prevention of harm. Sustainability should be rigorously applied to every step of the asset management cycle; maintenance shouldn't leave bits of sharp metal or dispose of things inappropriately. Sustainability should be a core concept of business; into which all other aspects should flow. A cohering idea, which should create a more coherent view of the business.	1			

Question 6: Asset Managers

	Policy	Awareness	Partially embedded	Fully embedded	Supply chain not mentioned	Partially cascaded to supply chain	Fully cascaded to supply chain
We have got the easy 'gets', but not embracing sustainability as a wholly integrated approach; probably because it is so complex. Sustainable credentials are in place where they are obvious; e.g. asset creation; we also require contractors to have well founded environmental management plans for silt, soil disposal, etc.	1	1	1		1		
Sustainability is embedded in the strategic planning approach; every strategic project over the last couple of years has been based around the sustainability planning approach, which has been refined as a result (only been working on the approach for the last three years; the planning manual has been tested on a few projects; 4 or 5). The concept of sustainability doesn't need to cascade further down than this; at the detailed planning phase you are dealing with the defined servicing strategy, which has been defined through consideration of sustainability and signed off by stakeholders. The fact that sustainability concepts are dealt with at the strategic planning phase allows the detailed planning phase to focus more on asset management considerations (robustness of assets).	1	1	1		1		
Not sure if principles are applied at a practical level; this could be a cultural or behavioural aspect, but could also be about the tools we have... have we really got the tools to use on the ground that build in sustainability in a meaningful and useable manner (putting in practical links that reinforce sustainability principles that individuals are aware of); e.g. do cost-benefit tools reinforce sustainability principles when it comes to making asset management decisions. It is as much about making the process effective and efficient. Supply chain; to a degree, but perhaps depends on size. Small suppliers perhaps only need an understanding of principles and some simple things that they should do, but a lot of the stuff is done though big partners, and these face similar challenges	1	1				1	
Policies and procedures are effective; but it is not a static state; there is a process of building on improvements	1	1	1		1		
Requirements do translate into day-to-day practice; but it is hard to know if they are effective, since sustainability involved a significant amount of value judgements: biggest challenge is how much are we prepared to pay; what is the WTP of our customers?	1	1	1		1		
Sustainability principles are embedded; the question is... are they effective? People are thinking along the right lines, but often bring in sustainability issues to late; so the challenge is to get sustainability considered at the appropriate time? Supply chain; not done much work at all... say with product, LCA, there has been some academic studies, but it is not embedded into the decision making process	1	1	1		1		
It is early days for getting policies embedded into action; the sustainability framework is relatively new, it represents a lot of written guidance and there is a long way to go before it becomes part of the way individuals automatically think, though a lot of sustainability issues were all ready being done, and so are embedded. Supply chain; part of the supply chain is doing things smarter/better... not sure if this translates to using a sustainability framework	1	1	1			1	
Aspects of sustainability have been thought through and are part of the documentation of procedures; largely effective... but still in early stages of determining how to bring sustainability into decision making; still in infancy about understanding the way we can incorporate sustainability principles into decision making and making tradeoffs, what to do now and into the future in terms of these tradeoffs. Often sustainability principles catch up with people's thinking about a project or issue; they are not always embedded in initial stages of thinking; need to ensure we have the sustainability tools that align more closely with the way people work; readily useable frameworks.	1	1			1		

	Policy	Awareness	Partially embedded	Fully embedded	Supply chain not mentioned	Partially cascaded to supply chain	Fully cascaded to supply chain
At present, sustainability is a bolt on process working in parallel to legacy approaches, so it is not as effective as it could be; so not embedded in the day to day... seen as a separate process to the process that is currently embedded; sustainability is still in the mind, but it is not the central driver. In planning, high level thinking is good, but there is still a disconnect on the ground; planners are endeavouring to apply, but financial considerations are still prevailing when looking at planning options; the traditional framework is still prevailing. In acquisition; lots of sustainability issues are captured by the regulatory approvals process... project timelines have been blown out to a number of years, while issues are addressed; heritage surveys, archaeological surveys, clearing permits, environmental reviews, etc. The consultation process is also being blown out. Operation and maintenance is very much driven by the efficiency side of the TBL triangle. Renewals; is getting back into planning, so probably better at sustainability in planning	1	1			1		
This varies across the organisation: In planning, sustainability principles are well documented and followed. Other areas, it is not there, but the sustainability aspects are still looked at. For example, the operational area; sustainability issues are considered, but there is not a very robust framework applied across the top of these areas. Things may be maintained in the best way, but without necessarily taking into account acceptable social and environmental aspects; these issues might be considered, and not applied uniformly. Not sure about the supply chain; expects the alliance might be quite good	1	1	1			1	
Sustainability principles are not embedded in day-to-day practice; they are really at the high level process and policies. There is a project in the asset-creation process to embed into day-to-day practice, and in the front end of planning they use sustainability principles and it is used in project management in the benchmarking approach; but not embedded yet day to day other than in these two areas	1	1	1		1		
We are certainly working hard to embed written policies and procedures, but they are not working perfectly now. There are tensions and robust debates over solutions proposed and the short term cost and long term benefits. Sustainability translates into practice in some way, but we are still on a journey, so things aren't perfect. Through the supply chain: there are all the usual tensions in the alliance. There is an attempt to find a best for project outcome, but we also push for a best for business outcome. Seeking a best for business view requires a WL perspective and also a view on standardisation (example of pumps given in terms of selecting cheap but high maintenance and standardising to reduce inventory costs). There is a debate over procurement/technical standards; are we gold plating or are they appropriate?	1	1	1			1	

Question 6: Sustainability Role

	Policy	Awareness	Partially embedded	Fully embedded	Supply chain not mentioned	Partially cascaded to supply chain	Fully cascaded to supply chain
Sustainability is embedded in the day to day activities though sustainability indicators (certainly in planning side), but not so much in the supply chain. In day-to-day on-going management activities it varies; e.g. sustainability is embedded in construction projects (an Environmental Management System approach is taken) and the impacts of discharges. In management activities it is about meeting a series of numbers; it is about meeting an output, not necessarily about whether the outcome is the best. However, in the process of talking/negotiating with regulators, outcomes are considered	1	1	1		1		
Sustainability is a relatively new concept for most staff to grasp, so it is not embedded... but lots of work done on developing policy and procedures; e.g. the sustainability framework. Not sure supply chain considerations are embedded, though management are aware of the overall importance of sustainability, so would try and make sure that any decision was in line with sustainability requirements	1	1					
Suspect that sustainability is not embedded into everything; this is a perception... principles have not been rolled out across the organisation fully	1	1			1		
Still at the piloting stage, the sustainability decision making framework tool is trying to get people to slow down and not jump to solutions; and as part of this process to consider sustainability issues. This is similar to issues like behavioural change with regard water consumption; it requires a real mental shift for all employees, and it is just the beginning of this journey	1	1			1		
Awareness has been raised, but sustainability is not yet as embedded into day to day practices. Supply chain not so much; O&M is still an issue of lowest cost, but this drives innovation	1	1					
Partially embedded; we are on a journey; sustainability requirements are increasingly effective, but high staff turnover is still an issue (difficult to keep everyone on the same page). There is an increasingly strong corporate commitment to sustainability, and this should generate improvement, but for this to happen there is also a need for the exec and board to be intellectually clear and articulate a consistent message	1	1	1		1		

Question 7: Asset Managers

	Not measured	Non-Financial KPIs	Other environment or social indicators	Post-implementation reviews	Sustainability/TBL reporting	GRI reporting	Effective	Not effective	No response
National performance report has elements of sustainability in it, but it is not explicit in terms of a group of metrics. Industry could be thinking about it, but more likely to be from the government		1							1
Sustainability isn't measured from an asset management perspective (should know what life cycle costs, but apart from rules of thumb, this hasn't been done). Forward planning does consider the sustainability of the asset stock. With work for forward planning, the company is going to be increasing the sustainability of its stock. Existing assets, work hasn't been done because there are no spectacular gains; potentially a lot of work for little gain... hard to get resources to do as there is no potential shine factor; no glamour. AM: is under quite tight economic strain; maintenance programs go first. It's a bit esoteric to talk about minimising the environmental impact for a program that keeps getting axed every year. Energies go into getting an AM program up, not getting it optimised in terms of sustainability.	1							1	
Sustainability is embedded in business missions for projects. It is assessed in post-implementation reviews and benefits realisation studies				1					1
Sustainability objectives are set and then measured through plans and feedback loops. Measurement and reporting is achieved through the planning cycle; area plans; sustainable product and service (future demands and service provision across the range of services); asset plans; state of asset reports... how do I create, operate and maintain to deliver the required outcomes... both plans are tied to the business plan. There are other sustainability reports; KPI indicators are selected out of a sustainability framework, a sustainability report provides a snapshot of the planning process. These are not an end in themselves; they provide a vehicle for communication about progress				1	1				1
There is a sustainability report and various things are measured against targets, and information presented on trends.					1				1
All asset management KPIs link to sustainability, because asset management is explicitly linked to sustainability		1							1
Sustainability is not measured, so not effective. Because performance measures are short-term, all you can do is look at what the long-term view of asset management, given the targets set for the next few years. The focus is still on meeting the short-term targets without necessarily any reference to why the target was set; what is the long-term view of asset management given these targets? There is the hope that short-term targets have been set with sustainability in mind; for some this is true, but some are political. Having a 5-year goals for a water plan, or showing an improvement in service does not necessarily equate to being sustainable. a. Decision was made 3-4 years ago to move to a TBL report instead of an annual report; some trends going in now, but still more of a snapshot.					1			1	
Asset management measures are measures of asset management sustainability; non-financial KPIs (condition of assets; frequency, duration, severity of bursts, interruptions, blockages, response to issues, is bow wave of renewals happening, etc.). These asset management KPIs do drive sustainability in the context of a sustainable business, because they are related to customer needs, environmental impacts, cost, etc. If these KPIs are degrading it is an indication you are not a sustainable water business. There is also measurement in terms of business cases for renewals or new service strategies; business cases represent written material that relates to sustainability		1					1		

	Not measured	Non-Financial KPIs	Other environment or social indicators	Post-implementation reviews	Sustainability/TBL reporting	GRI reporting	Effective	Not effective	No response
Asset management KPIs have a sustainability focus; but these can be addressed by bolt on aspects. Measures of GHG emissions are fairly effective at making people focus, since they have to talk about net GHG outcomes in comparison of options when projects go for approval; largely driven by a GHG KPI. A lot of other KPIs are more of a compliance activity; a lot are set by talking to stakeholders; so sustainability is embedded in the way the targets are set; they are effective way of focusing asset management effort		1					1		
We measure and report risk, so to the extent that risk reflects sustainability principles, the sustainability of asset management is measured. Individual elements of sustainability are also picked up through reporting against environmental licenses and objectives; e.g. discharge and odour KPIs		1							1
Sustainability of asset management is measured in a range of ways: Planning: no measurement as such, it uses the sustainability principles, but they don't measure at the end of the year what has been done. Operational and maintenance: KPIs exist that reflect customer and environmental factors, but not measured under a sustainability framework; these KPIs are however developed under a different umbrella, not a sustainability framework. If you went through the asset management KPIs you could extract various TBL measures for customers, environment and costs, but this is not brought out in practice		1							1
A benchmarking program; benchmarking the effectiveness over asset delivery across 44 measures, in 6 benchmarking categories (TBL, governance, stakeholders and ethics). This has been applied to a selection of 40-60 projects over the last year, it is a scoring procedure based on self-assessment with third party validation. It runs from very poor, poor, business as usual, best practice, outstanding practice; these are all defined for each measure. It is starting to drive change in behaviour beyond a focus on time and cost, and is pitched at the project management and director level. The process is undertaken right at the end of the project; it addresses how the project went... not upfront, but then the sustainability principles are being included in the front end				1					1
Traditional indicators of asset performance are lag indicators, and fairly removed from driving sustainability thinking. We have adopted GHG emissions, measuring energy aspects. Also a sustainability consciousness index, used to communicate how people are thinking in the sustainability space. There is a sophisticated process for assessing new projects against a sustainability wheel in the planning phase. The asset management space is struggling with how to assess and measure sustainability		1	1						1

Question 7: Sustainability Role

	Not measured	Non-Financial KPIs	Other environment or social indicators	Post-implementation reviews	Sustainability/TBL reporting	GRI reporting	Effective	Not effective	No response
Follow global reporting initiative, which is done well, but there is not a 'direct line of sight' giving signals as to what should be done; there is no real measure of how well a planner is doing this year compared to last... similarly not there for operations either; how sustainable are the assets put in last year, how effective is operations?						1		1	
Environmental Management System has sustainability indicators within it which articulate the corporate goals (since corporate goals are very general, they need to be translated into something more tangible)			1						1
Sustainability of asset management is measured through the quality of product; e.g. effluent and water quality measures		1							1
Sustainability of asset management is measured through corporate KPIs; leaks, bursts, WQ etc. The annual report to government has the three TBL elements in... the way TBL reporting was approached was to have three headings, and at the end of the financial year go through a process of slotting initiatives under one of the three headings. This approach doesn't show progress; it is about compliance. A sustainability report has been suggested that is more about day to day tracking. The fact it would have an impact on how things were measured day to day was seen as an issue in some quarters; there is a desire to keep it as an end of year thing, as people can't see why all the data collection would be worth it.		1							1
When the assets are planned, there is a need to take sustainability into consideration; KPIs are developed and these are used to assess success... not sure how well this goes into the future. WSAA KPIs are sustainability driven to an extent, as they are about reducing impact on the environment and communities. Started to look at GRI in terms of sustainability reporting; need to select/develop measures that are appropriate and are transparent; still a reporting level though, not used on an operational basis; the operational ones are the WSAA KPIs				1					1
Measuring sustainability is a work in progress; there is fairly rigorous outcome reporting. All vehicles of asset delivery (capital creation) are measured through a process of self assessment aligned with business principles. It is an auditable process... evidence based... it is both process robustness measures and outcome orientated (e.g. number of significant injuries and how advanced is the safety culture, measured on well defined 10 point scale)				1					1

Question 8: Asset Managers

	Financial analysis	LCA	Risk Analysis	MCA/TBL assessments	Stakeholder engagement	Sustainability frameworks
Uses advanced cost-benefit analysis; using a range of stats/models to evaluate the best way forward. Analysis of life cycle is lacking; have calculations in terms of end of life, but don't have capacity to calculate extensions to life... except as a way of avoiding rehabilitation costs. The real question for maintenance is; how many rehabs are avoided; does what you are doing extend the asset life, and is that cost effective.	1					
Techniques used include economic tools like life cycle analysis; cost benefit – NPV; but it is broader, like forecasting/trending demands and gaps out to 30 years, so you are scanning for customer stakeholder demands.	1	1				1
TBL assessments; MCA approach and tick box; NPV and gateway assessments (by regulators). LCA done to a degree, but an area for improvement. Public consultation is done; lot is done through councils who already have community groups or committees set up. Communications people do a lot of surveys done on issue like SDB. Risk assessment also done using a TBL approach; using a matrix type approach.	1	1	1	1	1	1
TBL assessment guidelines, try to balance all options across TBL measures. \$s is done using NPV looking at capital, maintenance, operations, and risk costs (i.e. reliability of options; try and put a \$ to risk). In the design stage use techniques like HAZOP/HAZIDS to refine and improve design.	1		1	1		
Have used LCA, sustainability framework, cost-benefit analysis, MCA; question is how complex. Need to put \$ values on externalities (social and environmental impacts) and try to quantify as much as possible; the level of quantification needed will vary; the more quantification the better you will understand the issues, but if it is a simple decision, no need to quantify... qualitative often good enough. Choice modelling is generally done at the time of water plans; ask about value of improving service standards; pretty basic, gives an indication of where money should be spent, but not sure customers really know what the benefits will be	1	1		1	1	1
WTP of customers is an important part of determining where to operate. From an efficiency and allocation perspective, NPV models are used to look at economic tradeoffs; lots about NPCs... need to prioritise where to spend. Tools to consider the different cost elements involved; externalities, intangibles for service strategy; capital v O&M cost; NPV will pick up some of these issues, whereas the sustainability decision framework will pick up others.	1				1	1
Life cycle analysis is a fundamental part of financial analysis that is done. MCA approaches (spider web tool that looks at weighted scoring of customer impact, community, environment, and financial aspects); this is a neat way to communicate TBL effects of a particular project or options for a project (to the board). Sustainability principles make people articulate issues in approvals/business cases, reports, briefings etc.; taking a quantitative approach when possible, but often qualitative; but is formalised in a document and the process of review picks up whether there is any substance to the qualitative aspects		1		1		1
Sustainability principles are being applied in planning and across the business to guide thinking. LCA; not looking at elements such as embodied energy; i.e. not doing a formal LCA. NPV: life cycle of assets, but no \$ value for carbon, but decisions are not just made on NPV, options are selected by considering other benefits not just the highest NPV	1					1

	Financial analysis	LCA	Risk Analysis	MCA/TBL assessments	Stakeholder engagement	Sustainability frameworks
Sustainability principles, LCA and CBA are all used. A TBL approach is used in planning, based on a matrix type evaluation of issues; i.e. there is an analytical process to come up with the most sustainable solution. It is a qualitative rating type approach, plotted on a sustainability wheel to give an assessment of the most sustainable option. Life cycle costing is done, but as a rule we don't monetise social and environmental issues, though this is being looked at in a pilot project. Tried to do this in the asset management space, but not with great success... used risk assessment approach, costs to repair, impact of customers and cost, cost of damage to environment.	1	1		1		1
Do select assets on a 50yr net present value (life cycle costs); primarily economic; the social and environmental aspects are picked up, but quantification of these is a new endeavour. Projects to look at more quantitative TBL analysis are showing that some decisions are optimum economically, but not from a TBL perspective; looking to apply a more holistic approach that the financial analysis previously used, but only at pilot stage. Planning do a less quantitative analysis for planning options, but generally decision making is based on financial analysis, and whatever the regulators impose on top. Are applying LCA to large WWTP to calculate its footprint, but not done in planning in a really robust manner	1	1		1		
We use WL costing, RCM type techniques in analysis; life cycle costing is undertaken. Sustainability wheel is used for projects; seek to achieve desired outcomes in the 6 categories of sustainability; we are seeking not to make tradeoffs across the 6 categories; or at least seeking minimum outcome across all areas for a project to be considered viable. Looking at WSAA sustainability work; water, health, environment committee and the asset management committee. Historically, financial considerations win out, so turning impacts into \$s is important.	1		1	1		1

Question 8: Sustainability Role

	Financial analysis	LCA	Risk Analysis	MCA/TBL assessments	Stakeholder engagement	Sustainability frameworks
LCA is a big part of the tool set. Risk-cost analysis has been considered, especially when using something new. Community cost assessment. Stakeholder engagement tools (council, environmental regulator). Financial tools like NPV and C-B. Community engagement; moved from marketing an engineering solution.		1	1		1	
WSAA sustainability planning framework						1
One of the main techniques used is the sustainability framework; start with stakeholders across project life cycle, identify options available, filter options... the framework has been piloted on a few test projects and accepted by the board						1
Community consultation tools; to define spaces... putting some limitation on where the authority wants to make a difference (in the community or environment). There is a sustainability form that is completed when there is a new supplier. Stakeholder consultation is more to do with assets; there is a project, and support is needed from local residence for it; this is not as wide as some of the community engagement activities referred to above					1	
Sustainability framework; decision making framework; MCA tool (spider web approach, using principles of sustainability to assess options against criteria; subjective tool, not as robust as it could be); LCA done but fairly limited; NPV/NPC, intending to look at financial tools more closely	1	1		1		1
Sustainability principles are used and we are beginning to apply advanced CBA; there has been some dabbling with LCA, but to immature to say it is being used. There are two critical components in driving better sustainable outcomes; Design in sustainability for options (consciously design in benefit and consciously design out harm) and making a choice on the basis of sustainability criteria (at the planning stage, you might come up with a range of options that meet the business principles, but there is a need to select the best one	1	1		1		

Question 9 (Positive): Asset Managers

	Asset and systems	Provision of service	Commitment to sustainability	General approach	Analysis and tools
One of the things that was right from the start was using gravity as much as possible in the supply. Exploit gravity as much as possible. In more recent times, trying to address the balance in the water cycle, which is still part of an ongoing journey, but we know what we need to do in the urban water area; re-use, harvesting (but note that from a sustainability perspective, we need to consider the carbon, nutrient and water cycle)	1				
There is a good understanding of the relationship between the steps within asset management and service; knowledge of the impacts interventions/programs will have in terms of effect on customers. We are also optimise pumping rates very well	1			1	
The water sector has made a good start, but sustainability is a journey; a continuum and there are probably quite a few things where 'we don't know what we don't know'.				1	
We have a basic understanding of sustainability that allows us to roll principles down to a scheme level. So basically the intent and some of the tools are there			1	1	1
What we have got right is the process; the mindset of sustainability is now embedded and sustainability principles are very visible (on top of meeting agendas, on screen savers), with processes and procedures in place.			1	1	
We are using a TBL approach and not just looking at the \$s side. We are trying to make more complex decisions, taking into account more factors; but then not everything can be measured			1	1	1
What we have right is getting sustainability into decision making as best we can with the tools we have available				1	1
What we have right is that there is a good understanding of the importance of assets to the business; some of the tools (NPV), and investment in decision-making, tools and technology/innovation. Also, 100 year old assets are still going; so we have maintenance of assets ok. Regulatory processes in terms of the environmental regulator. Moving to contracting out and getting things done from a least cost perspective; creating alliances etc to generate better outcomes for customers	1			1	1
We have right tools like PARMS and other asset management techniques have facilitated progress; as such, have the balance right between replacement and maintenance as a result. At a general community level, are making the right decisions; service is improving, so have this right	1			1	1
What we have right; fairly solid social agenda; providing services to sustain life; clean water and sewerage systems. The sector understand this responsibility, and the need to embody 'rock solid' water quality (and similar) as a fundamental social obligation. The fundamentals of wastewater are also right, in terms of reliable service removing waste etc. Direct operations are achieved with minimum impact on the environment, within the constraints of what society is willing to invest; we have minimised energy to the point where it is cost-effective	1	1	1		
What have we got right; we do sustainability well for major projects... including community consultation and assessment of environmental impact/issues, looking to solve these.			1	1	
High level frameworks appear to be fairly robust				1	
We have a track record of operating a business for > 100yrs, delivering service to customers and the community. We have a wealth of experience that intuitively leads people towards making decisions that are optimum for parameters they are using, traditionally this is from a service and cost perspective, but the space is now being expanded into environmental and social outcomes	1	1	1	1	

Question 9 (Positive): Sustainability Role

	Asset and systems	Provision of service	Commitment to sustainability	General understanding/approach	Analysis and tools
Have identified what the key impacts, key drivers and points of leverage for sustainability and were the key points of leverage are.				1	
Lots of things are right; do provide reliable services with few disruptions that impact communities (example quoted of a large diameter pipe that failed in the southern part of Sydney for 4-5 weeks with no community impact; conclusion; in-built back ups may look very expensive but necessary from the perspective of reliability and resilience; gold plating is justified)	1	1			
As an organisation, well aware of the importance of sustainability; becoming more aware of what impacts might be on customers and the environment, and what it means economically to be more sustainable			1	1	
In terms of physical assets, the organisation believes we have done well and are successful part of the water sector	1				
What we have right is having the overarching policies and principles in place,			1		
Fundamentally, the water industry is about sustainability; looking after public health and the environment. There is a strong sustainability ethos in the water sector, much more so than from a commercial company. Raised awareness around sustainability issues and linking these to good business outcomes; customers are requiring a level of service, but more and more require an understanding of water issues and solutions for these issue, and a growing expectation that water authorities should be visible, not working in the background; this is generating the need for cultural change			1	1	
What we have right is a strong commitment to the sustainable management of water resources; though sustainable yield is concept that might not be viable any longer. There has also been a strong commitment to engineering excellence and public service (in terms of safe product); these are good underpinnings that need to be respected and maintained... we are coming from a strong place; we aren't making plastic toys or land mines... it is fundamentally a good sector		1	1		

Question 9 (Negative): Asset Managers

	WTP	Integrated approaches	Knowledge & understanding	Data, information and tools	Cultural aspects	Drought and climate
The assets we put in place are part of the inheritance we will pass on. One issue is that much of the inheritance we have was paid for out of the public purse for public good; now with new assets, it is user pays... too much economic rationalism; community should fund these things for younger generations; as it was built for us as a community, it should be built for them	1					
Challenges; greater capacity to analyse extension of life, working more closely with growth teams to prevent assets being built from inappropriate materials				1		
We need better knowledge and tools: a few tools are used regularly, but there are a broader range of tools that could be used, but some are more difficult on a project basis (easy; energy usage; more difficult; waterway impact). Things that can't be measured or calculated are taken into account with qualitative assessments in conjunction with stakeholders; but how good are these in reality (they don't capture interactions)?				1		
The strategy is to be sustainable; the remaining challenges are how are we going to achieve this, to determine what tools are needed and to develop them. In a wider context, the challenges are knowledge sharing, decision frameworks, tools, people, culture, capability of staff and retention of that capability (the latter is necessary for sustainable asset management). Knowledge transfer is a key issue; people now start from a higher knowledge base, but given the aging workforce we need frameworks for knowledge transfer to maintain capacity/capability (one question is; is learning gained through meeting a challenge; if so, once a challenge is met, how do we continue to instill the knowledge in others?)			1	1	1	
What is needed is more refinement, more knowledge, more understanding... understanding of impacts and what the right solution is.			1			
Remaining challenge is data and information; there are a lot of value judgements, and this is inevitable given the type of issue under consideration, some will focus on social views (jobs), others financial \$s, while others the environment, but we need better information from which to assess sustainability			1	1		
Bigger picture is how you integrate with other community decisions. We are looking at centralised/decentralised treatment systems, but from a true sustainability perspective you might consider transport... this will influence whether you will have a centralised or decentralised community; also is the development sustainable in wider context; should it be done at all. Take a new development; an Authority can make a decision whether or not to service it in one way or another, but the decision to build the development in the first is the issue in hand with respect to sustainability; transport considerations, cheap land, whatever are key issues. The issue for the water authority is more often about, given you have to do something; what is the most sustainable approach... not should we be doing this!		1				
Challenges include the externalities issues; methods to put a value on externalities; this is factored into decision-making, but should it be reflected in pricing? Another challenge is to update data and decision tools to keep them current and refine them...as a business, water authorities have obligations and targets for things like per capita demand, recycled water targets, etc.; but have we got enough data, information etc. to make decisions on these issues in the absence of obligations? Challenges are also about ageing people; how to make sure data and knowledge gets retained and transferred; how to sustain corporate knowledge. Made worse by contracting out.			1	1		
Challenges are coming out of a changing environment; climate, water resource issues, etc. How will these effect storm flows, bursts, blockages... what will be the impact of changing community habits driven by water shortages on assets. What are the tradeoffs between environmental standards given flows in streams are dropping; less dilution; again, influence on assets.			1			1

	WTP	Integrated approaches	Knowledge & understanding	Data, information and tools	Cultural aspects	Drought and climate
While the authority accepts and understands environmental responsibility; but not really gone beyond regulations. However, the sector has not been dragged along, it has kept up willingly. The real challenge is to be driven by a true understanding of sustainability and getting customers to be prepared to pay for that; it is also to deliver sustainability outcomes without significant financial impact	1		1			
Day-to-day, don't put in the same amount of effort; money is channelled into big projects, so the day-to-day stuff suffers (e.g. valve maintenance). Planning on whatever scale is done better					1	
The challenge is to translate these high level frameworks into meaningful objectives and a vision, and then articulate to people that challenge in a clear manner; e.g. carbon neutral by 20XX; what does that mean? Need to embed principles into front-end and through processes					1	
While we have the technical aspects of maintenance engineering right, but we need better theoretical grounding in degradation curves, failure modes, etc... more engineering understanding, less gut feel. We perhaps don't have a wealth of experience in these wider environmental and social spaces, and the people experienced in getting the more traditional outcomes are also long in the tooth, so there is also a need to capture this knowledge into corporate decision making processes. Have focused on getting sustainability into the planning side of asset management, especially for water resource use. Getting sustainability into the maintenance side of things remains a challenge; deterioration, modes of failure, etc. Need to avoid just dropping in the term environment or sustainability to 'green wash' issues			1	1	1	

Question 9 (Negative): Sustainability Role

	WTP	Integrated approaches	Knowledge & understanding	Data, information and tools	Cultural aspects	Drought and climate
Need a more holistic view of the water cycle and how asset management fits into sustainability, both temporally and spatially. Given a service issue like a burst, what should be done? We need to go up scale; but we haven't had the ability to do that spatially or in time and ask how things can be done differently...		1	1			
Remaining challenges; supply chain, embedded energy, a real understanding of carbon instead of taking energy as a proxy (this might be correct, but it is not known); climate change and impact on day to day operations (including emergency response) and planning			1			1
Remaining challenge is educating public on what sustainability means in the water sector and what can be done			1			
The remaining challenge is to embed these into day to day practice; the remaining challenges are cultural aspects, these will define how fast we can move forward; it is more about people than assets				1		
Challenges; have always been focused on financial aspects and efficiency; need to break costs down into elements and understand tradeoffs (environmental/social benefits versus cost)... need to determine how far down the sustainability road should we go; what is the cost and business benefit for investment in sustainability. There is still an opinion driven aspect to costing environmental decisions; should you maintain biodiversity or plant a pine tree forest for carbon offsetting (benefits of gaining GHG offsets versus something less tangible). Big challenge remains drought and climate; the physical sustainability of what we do; how we manage water and sewers when there isn't much water, or a larger variability in flows/demands.			1	1		1
What we have wrong is that people are still talking about drought, not climate change; there is still no commitment to zero environmental and social harm; there is still a strong commitment to business as usual... the idea that the environment is an impediment and it is about compliance with socially acceptable impacts. There is still an obsession with cost, instead of the value proposition... what is the solution that will deliver the highest long term value					1	1

Question 10: Asset Managers

	Funding	Value proposition	Cultural	Governance	Political	Tools and understanding	Climate change
Key challenge is the political barrier; there is a lot of talk, but governments are influenced by lobby groups, which results in perverse decisions based on politics, not sustainability. Climate change issues will also be a challenge, in terms of the political part and water utilities and the way they are managed. The cultural challenge is to bring everyone on the journey of sustainability; the whole community needs to be brought along at the same time. A key challenge is that developers have to fund infrastructure; market driven does not necessarily lead to sustainable solutions. Community should pay; there may be arguments from the perspective of health costs; more sustainable environments equate to lower costs; benefit to community.	1		1	1	1		1
One of the key barriers is the vulnerability of the maintenance budget.	1						
Most significant barriers are our knowledge and tools. We have a sustainability division devoted to pursuing more sustainable processes						1	
There are no significant barriers, except we need to be able to prioritise what we do to get the biggest bang for the buck and biggest return for your effort (trading off across all activities, R&D, asset projects, understanding customer preferences, etc.). Big question is getting the balance right; how do we trade off one area against another... this is often a political decision; not everything can be done scientifically.		1				1	
Biggest challenge is getting the benefit-cost side right; always possible to be more green but at what cost, but who is going to pay and is it worth it? What are the tradeoffs against generations? Another challenge is to refine tools, information, data and knowledge, become more aware and get a broader understanding of issues and impacts. Another key challenge is getting the right people with the skills that are needed. Also age profile shows that there is a large chunk of people to be lost over 5-8 year period; need to have the stay in the industry.		1				1	
Biggest barrier is what communities and water authorities are prepared to pay to fund sustainability, especially in light of the money needed to address water security issues and when initiatives don't stack up financially	1	1					
Boundaries that are in place that relate to integrated water cycle; a water authority is the service provider, the plan talks about multi-services, but the authority doesn't control the headworks, or within customer properties. Institutional barriers are thus a problem; these are starting to be broken down with 3rd pipe and alternative sewer systems which break down barriers relating to the customer fence.				1			
The most significant barrier is cost; the regulator assesses against need, then efficiency of solution and then delivery (time, skills, etc.); sustainability is about the need and there is a requirement to demonstrate that need; this is easy with an obligation and also easier when you have worked through a strategy (in terms of getting sign-off/acceptance from boards and regulators).	1			1			
The most significant barriers are getting tools that are readily acceptable; everyone is saying the right words, but there is still a lack of understanding about how to apply tools... there is much cynicism that you can manipulate the tools parameters and assumptions to get the answer you think is right (more direct/numerical relationships between factors that go into the models would be useful). We also need to understand how risk interfaces with sustainability; risk is about uncertainty; all activities have an uncertainty component and are thus risky; we need to marry ideas about risk imposed and sustainability. When you look at sustainability issues, you need to be comfortable about the level of risk you take on... What is the right level of risk to achieve sustainability; how do we assess performance and risk in the context of sustainability... is it by spills or consequence of spills?						1	
The biggest barriers are creating a new framework for decision making other than \$s, or embodying the wider issues into \$s... putting a \$ value on things and getting the community to accept that. There is also a need for a combined holistic vision.		1		1		1	

	Funding	Value proposition	Cultural	Governance	Political	Tools and understanding	Climate change
The biggest barrier is the amount of money to spend; there isn't the \$s to undertake operations and maintenance in a sustainable manner; for example, disposal of assets; the money is not there... lots of money gets channelled to new assets, and the old assets get left. As such, there is not enough money being spent on existing assets, so we won't get the optimum life from them. AM doesn't have near enough resources to make it sustainable; day to day activities outside the city have moved from proactive to more reactive. So to be sustainable you need more \$s and more people in these areas.	1	1					
Main barrier is cost impact; there is more scrutiny from the Treasury, due to increase in investment, growth and climate change. Where more sustainable solutions are proposed, there is a need to get treasury and the economic regulator on board. Getting regulatory authorities aligned with sustainability is (ironically) a significant barrier	1	1		1			
Some barriers hinge around the vague notion of sustainability... the term means so many things to many people... having a focused conversation is clouded by a diversity of views and philosophical positions on what sustainability means. We need clarity on objectives and measures. Other barriers are a common understanding of the technical issues and language. Lots of asset managers come from a background of hands on experience, but are not grounded in AM or sustainability theory; things are learnt on the job. Other barriers; climate change and politics; political grandstanding can mean the opportunity is lost for technical aspects to drive decision making; other things start to drive the decision making. The Industry needs to engage with politicians and policy makers about what sustainability means from a water perspective; what makes sense			1		1	1	1

Question 10: Sustainability Role

	Funding	Value proposition	Cultural	Governance	Political	Tools and understanding	Climate change
One of the key barriers is that there isn't a high level goal. There is a lack of clear requirements and accountability within which the sector can operate. Another key gap is that regulation is always lagging and not driving the right process; acts and legislation is therefore for a different purpose; not sustainability.				1			1
Lack of information and understanding is a key issue; what will be the impact of climate change; if temperature increase, by how much; if rainfall is to decrease, by how much; similarly with extreme events... how big and where? What is the role of embodied energy; what does a carbon constrained future mean... when the price of power is high, will it effect water use; should there be pricing of water in accordance with time of use (time of year, time of day), like there is with energy? Where will customer expectations around service delivery go? They are different now to 30 years ago; values and behaviours have changed... how will they change in the future? How do we manage generational changes; young people demand information in way older generations didn't... how will this be addressed? How will we manage water conservation if and when the drought ends	1		1				1
Most significant barrier is funding to change infrastructure if deemed not as sustainable as it could be	1	1					
Scarce water resources are a key barrier; we don't have answers to the challenge of supply security... there are also cultural issues to consider, there is a NIMBY issue. The state government's review of the water sector has been limited, and a broader perspective needs to be taken (not just the Melbourne retailers). Vested interests in governments and influencing governments (community, different sectors, etc) have an impact, and these are a challenge to a more sustainable sector			1	1	1		1
A significant barrier is the need for a new cultural consciousness; need to invest more research programs from community relationship perspectives; there isn't one big homogenous community, so there is a need to understand who the community are and what they want. There is an opinion that the sector is doing what is being asked of it and doing it well, so why should it move beyond its cost services. To answer this, we need to understand what communities want and communicate what the impacts of things are		1	1			1	
One of the significant barriers is how to cost things; how do you cost environmental benefit and degradation; need sustainability accounting standards; some kind of framework is needed... this needs to go down to the nitty gritty of selecting projects; providing a format within which to make decisions internally within an organisation; given this sort of project, we cost environmental impacts in this way, etc. A key issue is having transparency; exec want to remove all judgement and provide consistent decision making; but this will never happen. Instead, there a need for transparency, to provide as much information as possible to allow a valid decision to be reached, and an audit trail... sustainability is a soft issue; this is a barrier... it needs to be made into something not soft; something that must be delivered.		1		1			
Sustainability is about people's minds; what is required is a transitional shift in thinking; e.g. taking the waste out of wastewater... i.e. not talking about wastewater, but thinking of sources of energy, water and nutrients. The way people think about things is also a barrier; they are still considering short-term costs. The biggest barriers are psychological largely, and perhaps one of moral courage; the water authorities are under state ownership, and while there is a duty of care to make shifts, there is also timidity in this. We perhaps need to do less of some things, and also to get rid of waste (in human endeavour terms); if we converted the waste into value, we would be better off. Technology is important, but it is largely a people issue; getting people to think differently and be open to opportunities and synergies.			1	1			

Q11: Asset Managers

	Not relevant	Hinders	Can hinder	Can promote	Promotes
Regulators can be allies if truly independent; but the question is how independent is the process				1	
Regulation probably hinders attainment of sustainability; there are poorly defined KPIs in terms of outcomes. There is a requirement to provide good service to customers, meet legislation and to manage budgets. Don't have a requirement to minimise environmental footprint, so things are done to where they are cost-neutral and then breaks down.		1			
Sustainability principles are embedded in our act and operational license, so regulation is not a barrier. Given that sustainability is a combination of TBL perspectives, it needs to be a balance between social, environmental and economic factors. Regulation is about promoting sustainability but there are fairly strong financial constraints					1
Regulation lock-in sustainability requirements, so it is easier to get funding so in this context regulations allow things to be done (you have the funds to deliver things).					1
Regulation helps... proposals that address sustainability issues are not thrown out by the economic regulator. The environmental regulator hasn't been a barrier; need to get them to understand the constraints we are working under; there's not a limitless supply of funds and resources; We can't do everything. If you show them you have a plan and are working to it, the environmental regulator is happy.					1
Some regulations actually promote sustainability; if you have a regulatory hook to hang something off, it is easier to get funding through; if not it is harder to get it through the ESC even if it were 'more sustainable'. Social and environmental good projects could be hard... but then the financial side is also important to sustainability, as someone has to pay and their limited budgets			1	1	
Regulations don't promote sustainability; this comes back to conservatism; if new solutions, product or service, lots of regulations to overcome to get these on-line; this comes back to precautionary principle... but regulators go overboard on this; you have to show no increase in risk to the nth degree; everyone is protecting their own backs			1		
Regulations can promote or hinder; pace of regulation is much slower than the pace of change/innovation in the sector. Environmental regulation might, for example, encourage recycling, but act as a policeman for the use of recycling... this double barrel role can make things more difficult. However, when there is an obligation, it is easier to get the right kind of investment to meet the goal. Regulations can tend to be confused; regulating input, outputs and outcomes at the same time, whereas an outcome driven regulatory framework could allow more efficient solutions to be sought; leaving the business to find the right mix to match its customer base, assets, etc.			1	1	
Some of the regulators don't promote sustainability; regulators are very risk averse with respect the issues they are regulating; there is also disjointed regulation; it appears there is no sustainability framework around the way regulations are set in the water sector		1			
Regulation creates opposing forces; economic regulation hinders as it is very much focused on efficiency. The economic regulator will accept other regulations, but won't embrace/countenance/enable investment in broader sustainability goals. Environment, water resources, safety, water quality regulation all promote sustainability in a way, driving towards the right sort of outcome, but how is this implemented. The regulations tend to drive traditional behaviour, such as a big is beautiful solution to water quality (reflected that it is not the regulation, but the response to regulation is the issue). Some elements of sustainability are poor cousins; not regulated, so don't get driven... you always lean to what is regulated; e.g. the disadvantaged in the community; other regulations drive things in another direction and can't afford to think about that sort of thing		1			1
Regulations hinder; the most sustainable solution may not be the cheapest; is the money available for more sustainable solutions? We don't set out own budgets; but make a bid and there is a tendency for regulators to trim back budgets, as a result we don't build things that should be built, and don't undertake operation and maintenance in an appropriate manner. Then again, we still make a huge profit each year, which goes to government... water is far too cheap; and the economic regulator sets prices		1			

	Not relevant	Hinders	Can hinder	Can promote	Promotes
Regulation hinders; environmental protection act is too environmentally focused, needs to be more holistic. Could be that there are social-environmental trade offs (social impact), but this is not supported through regulations. We try and consider this, but there is really a need for advanced economic analysis to consider best value proposition		1			
There is room for regulation in driving thinking and sustainability: unfortunately, most regulators have a fairly simplistic view of their role and how the industry should be regulated; can drive overly prescriptive regulations, not driving desired outcomes. Regulations can be driven by non-industry people, and can lead to naïve approaches that don't drive sustainable outcomes. Across Australia, the government is focused on the East coast and the Murray-Darling, and this drives a certain policy approach that is applied across Australia, but may not be appropriate for other parts of the country. We need to understand the interplay between regulation and legal requirements; individuals have personal liability that drives inappropriate outcomes; spending \$100 millions to reduce discharges... thinking that is driven by prosecution risk, even though money can be better spent elsewhere. Regulation in this context is a very blunt tool. More value could be realised by taking a sophisticated view of issues.		1			

Q11: Sustainability Role

	Not relevant	Hinders	Can hinder	Can promote	Promotes
At present, there are conflicting requirements; legal and governance frameworks are legacy issues. Innovation is not driven by regulation.	1		1		
Regulation does not hinder except where you are not sure what the regulation will be (e.g. carbon trading), but you do need to work with the Regulator rather than against them. Guidelines are all risk based and this helps to convince regulators and part of this is working through consultation with stakeholders. It is not written regulation that is not a problem if you can show outcomes; regulators are conservative not prescriptive. Relationships with regulators are important, and there is a high level interaction with our management team and regulators that helps smooth issues by the time it gets to an individual officer.					1
There is a stand off between the commonwealth and the state re management of water; while there is now a national agreement, it shows that political cycles have an impact, even if intentions are good; political considerations are not always tied to rationality and there is short-termism		1			
Regulation is about compliance; the question is do we need to go above and beyond there core services and compliance with regulations; what level of commitment is there to non-core service provision. Even environmental work is about compliance; the business hasn't reconciled what commitment it wants to make outside of the core-business offerings	1				
In some ways regulation is helpful; being a monopoly run by the government, there is some space to deal with sustainability issues that wouldn't be available to a purely commercial business, but governments have a shorter timeframe and there are difficulties getting across the longer term view. There are also sometimes policies to be followed that cause real difficulties with respect to sustainability. Big issue is that there are some many parts of the water industry; this is confusing in the mind of consumers; this poses a significant challenge from the perspective of sustainability. Water as a whole resource should be managed as a whole resource; in some ways there is a need for more centralisation in regulation, especially if this improves flexibility and adaptability. We need institutions that can meet the challenges of today and tomorrow; not yesterday and today.				1	
Regulation hinders broadly; on the environmental side, there is often the dilemma of having zero discharge requirements to water courses; the regulator has a strong commitment to ideals, without any pragmatism or consideration of outcomes, and the application of an 'over'-precautionary principle. For example, spending millions on overflow abatements that will achieve little or nothing in terms of Nitrogen)... with the amount of money being spent, could probably fix all the fugitive emissions and fix the problem. There is a disjoint between the concepts of environmental protection and environmental value. Health: there is also an application of the over-precautionary principle; but then there is a good relationship with the regulator. Economic; has a very narrow view; not taking a broad economic view including natural and social capital to the extent it should driving minimalist decisions... bringing things down to a price. Societal issues; unaccountability of regulators is a real problem... even if there is a real need for environmental protection		1			

APPENDIX V: ADDITIONAL ISSUES DISCUSSED

The following notes were made from responses that were not directly linked to questions under discussion, but reflect opinions relevant to the overall research aims.

Definitions and Understanding of Sustainability

1. Achieving sustainably is a degree more difficult because there is no collective agreement on what sustainability actually means; if you talk about sustainability, but can't anchor it in targets for GHG, water (changed every water plan), nutrients and give accountability for these, it is more difficult to progress; what do you tell individuals to do? We therefore need clear definitions of what 'sustainability' actually means in terms of a water authority's operations.
2. Sustainability is incremental by its very nature. We are currently reviewing our sewage strategy, and trying to formulate an adaptive strategy; all you can do is consider various future scenarios, and pick a path that is flexible and not locked-in; but there are still people that want a 50-year master plan of what the system will look like, but that's not going to happen.
3. There is a lot of disorganised thinking in the sustainability space. One of the problems is that the standard engineering solution has delivered good outcomes, in terms of public good, water services, public health and to an extent environmental aspect. It is hard to shake this paradigm if things are changing and they are... what is threatening us now is that all the assumptions that underpin the business model we apply are all varying at once in hostile ways... energy cost, drying climate, staff retention difficulties, physical cost of infrastructure going up, etc
4. Public service is embedded in the water sector, and economic rationalism has been a strong focus, so it is these new environmental aspects that present the new challenge... there has been an assumption that resources will be there forever... which simply reflects societies demands, but now there is a need to be ahead of these demands and recognise what is not sustainable and respond to new challenges.
5. Overall, we need to understand what is the trade-off between the environment and the amount of investment and community impacts? Should we put more emphasis on protecting customers or waterways

Social Aspects of Sustainability

1. Social issues are nebulous and must be addressed through participation and interactions with stakeholders. Expert panels can be provided to allow some independent advice to be given to communities.
2. Our real risk today is not so much in terms of the environment but in the social acceptance of solutions. Social side of issues is a risk; how to approach communities, how to compare options.
3. The industry recognises that there is a need to be incrementally better at community consultation. However, an expert model is generally being applied, rather than a participatory one, though aware of difference between marketing solutions and education. Before would spend 5 years trying to determine the best solution and then market it to the community; now, trying to understand why the solution was picked (applying a learning model), what influenced the decision and get that across to the community. On the other hand, on-going interactions have given a better understanding of who the community is.
4. There are some political issues with respect water conservation v desalination; will desalination plants change public perception of issues; are we going to remain credible in their requirement for conservation strategies when the desalination plant comes on line, especially considering the amount of wastewater being pumped down the outfall.

Generational Issues

1. The next generation will have a different approach; and be more amenable to sustainability as it will be part of their culture
2. Lots of demographic issues to do with generations; especially for older generations who have delivered what has been asked, and can't perhaps see the intangible nature of the new challenges, or why we shouldn't deliver what has been delivered in the past... in the same way as the past.
3. Assets provided can have a very long life spanning 7-8 generations, so there is a need to consider the long term interactions between assets and the environment.
4. Built and natural asset stocks are a part of the inter-generational inheritance; AM crosses the boundaries of generations; asset life can be infinite in effect barring natural catastrophe. The assets we put in place are part of the inheritance we will pass on. One issue is that much of the inheritance we have was paid for out of the public purse for public good; now with new assets, it is user pays... too much economic rationalism; community should fund these things for younger generations; as it was built for us as a community, it should be built for them.
5. New infrastructure choices is perhaps more sustainable than in the past, but renewals are less so. There is no real evidence that people are looking at a region and planning for something else. The question is, what benefits would be accrued, and do we, as a society, value the step towards different infrastructure configurations in a way that will allow this option; do we consider the duty to pass on a more robust and sustainable configuration of infrastructure a key and affordable issue, or are we to let future generations pay for that as well?

Governance and Regulators

1. Currently, the governance framework is still aligned with a 19-century culture; issues are dealt with in silos, addressing service in the way it was first envisaged (public health, drainage, safe disposal, etc.). Now we need a one-stop-shop that meets the needs of today and being capable of transforming to meet the days of tomorrow.
2. Key gap is the need for regulatory support rather than impediment. A smart developer can kill the need for innovation; the state government is not taking a lead on issues... regulations are ad hoc and not well thought out, driven by niche interests not sustainability... it is not just innovation that is needed, it is the space for innovation.
3. Planning and decision making can be over-ridden by political expediency; e.g. the desalination plant; triggers for non-rainfall dependent solution. The strategy was made in a dispassionate way, but then over-ridden; no matter how well things have been planned, there is always the possibility that short-term political gain could drive decision-making.
4. As a sector, we should not be as close to the government as we are. Urban water shouldn't be privatised; shareholders shouldn't be government, but should have community representatives to decouple from the political cycle and remove ministerial interference.
5. Our environmental regulator is under resourced, and can act more like a policeman than an enabler, which in turn can compromise speed of innovation. The environmental regulator is set up to meet the demands of yesterday; we need regulation that enables service to be provided for tomorrow, not yesterday.
6. The environmental regulator can be more of a barrier than a facilitator and can demand the same treatment standards from novel solutions, which are not practical and prevent them from being implemented; standard performance requirements or quality standards can drive solutions to be less sustainable.
7. The environmental regulator has it in their regulation that they must take into account total community costs when they set parameters, but when you come to arguing through issues, they take a hard line on their regulations and don't look at tradeoffs. For example, more

sustainable recycling could be achieved in one area, but only with some impact on an already degraded water courses; the environmental regulator takes a hard line view on the waterway health, not considering overall tradeoffs or benefits... looking at the background objectives for the waterway, which were based on pre-settlement quality. This meant recycling became impractical and ended up pumping effluent out of the catchment, with GHG effects.

8. A nutrient trading scheme could allow better outcomes to be realised, but the environmental regulator culturally has a problem with this kind of trade off.
9. Either/or aspects of regulation drive perverse outcomes (e.g. if a customer is given the choice either to have a rainwater tank, grey water or solar hot water heating; best environmental outcome is solar, but why the choice; all should be required, but if chose one, should be solar heating... do incentives or vested interests mean this is the case)
10. A vexatious dilemma; to try and engage with regulators and get them in a co-designing space; engagement with the regulator to get best outcomes is a problem, as they are not interested in the economic aspects of sustainability; and have very powerful legislation. There are also hostile views and mistrust... the problem is, from a water utilities point of view, enough things go wrong in terms of asset failures or bad project management to create an undertow of mistrust, which leads to a pathological loop of mistrust, informed by bad events. It is critical that this loop is cracked, but it needs to be done on the basis of ethical principled win-win engagement; but how do you get the other side to engage when they have the power?
11. Need to consider the relationship between water authorities and regulators, and also where in an organisation or supply chain policies and intent break down. Noting both are important... also that the two things aren't separate; you can have a high level agreement with a regulator that breaks down because there isn't the structure in place to deliver it.
12. Human aspects are important; smart, ethical people are being lost; and if regulators can only employ graduates, the regulations will be applied 'simplistically'... because they don't have the knowledge or experience base to consider things more holistically.
13. In areas with declining rural communities there is still a presumption of no discharge to streams, so very large capital cost to address this issue and no economic benefit from the water or nutrients.
14. In the past, we have put forward a proposal to be able to discharge to a creek, but didn't think this was the best thing to do... perhaps growing a crop or creating an artificial wetland would be better.
15. Infill sewerage policy to replace septic sewers; again in rural areas with declining populations, there is the issue of physical and economic sustainability of doing this.

Regulation

1. Need high level targets and then goals attributed to organisations; people want to achieve a better outcome; so how can they be facilitated to do this. At present, there are conflicting requirements; legal and governance frameworks are legacy issues. Change is not driven by regulation. Anyone doing anything different has to put in a lot of effort. Often project specific; standards are developed as we go on for e.g. grey water, stormwater reuse; not done holistically, not driven by government departments; driven by others.
2. The water industry is conservative and this is compounded by the regulators; any attempt to try anything new means hitting a brick wall with one regulator or another.
3. Regulations that bound the water industry are conservative; given the long term nature of assets and impacts that can be generated, this is probably fair enough, but we should be looking for more pilot plant type work, where you can try innovation out under controlled conditions and having a way out should it fail

4. One issue is that many of the regulations are not quantified; so someone can do nothing and be technically complying, and someone else could do lots and be equally complying. This does leave things open to allow the company to engage with customers and stakeholders to determine a way forward

Sustainability of the Water Sector

1. Sustainability of society; water sector can be sustainable, but if the world keeps going the way it is, nothing will be sustainable... the water industry is in the unique position of being able to model how we can be sustainable, but issues like population growth, resource depletion and GHG all have to be dealt with. All the sector can do is model how these issues can be dealt with. We are a little island striving for sustainability in an island of unsustainability
2. We need to consider social, environmental and financial constraints in service level setting; perhaps pay people for bad service to allow more pressing issues to be targeted or to allow interventions that are more subtle; i.e. run pipes of an area down till you have the choice to do something better, and pay folk in the interim.

Sustainability in asset management

1. Sustainability in asset management is concerned with the legacy we leave and part of that is the asset stock and the ability of the asset stock to meet society's needs in the future. It is also about running assets; what does it cost to run an asset... energy, waste materials left over, water use. Materials are also important; is one material better compared to another in terms of holistic impact; trading longer life off against environmental contaminants, embodied energy, raw material extraction, waste products, water use etc. There is also an aspect of location; climate change may mean a lot of our assets need to be rebuilt in the future because they are vulnerable to sea level rise; should we consider asset sites from this perspective?
2. The link between sustainability and asset management is different depending on the phase of planning and delivery;
 - o Strategic planning phase; sustainability is a guiding theme for deriving strategy for sustainable provision of water services
 - o Detailed planning: focus is on lease cost, reliable and robust assets; a more asset management focus.
 - o Strategic planning focuses on assets that improve quality of life.
 - o Intergenerational issues are built into the corporate definition of sustainability
3. There is a tangible link between the strategy and the on-ground assets, and thus between sustainability principles and the assets delivered. However, strategy doesn't specify assets; just where water of different qualities will come from, where wastewater will go etc.
4. Sustainability in asset management requires we move beyond tangible components to more intangible components; e.g. what are the intangible costs of failures to stakeholders, communities and the environment; and build these into a framework for decision making (currently \$s are treated well, intangibles less so).
5. In general, construction costs are huge compared to material cost for many projects. In a way, you are selecting a material and making a design that will protect that investment... planning for first rehabilitation, planning for future growth.
6. Our high level AM process starts with corporate vision, assets are operated and maintained, they are monitored with respect to condition, performance and risk, which eventually goes into the analyse/treat phase. Traditionally, the fall back position was capital solutions; now trying to encourage first looking if there is a maintenance or operational solution, including looping back to the start and considering the levels of service required, with an eye to possibly changing performance standards is this is an acceptable solution. Only when other opportunities have been exhausted will a capital solution be considered as the right solution. This is a

sustainability thing because AM is about getting more from assets, minimising whole life cost through operations and maintenance is important, especially because money for capital solutions is tight... because capital solutions are expensive and depreciation is the big killer (depreciation costs are a major line item in the financial reports), so the more you can do without the need for capital interventions, the better.

Embedding sustainability into business as usual

1. We started 3-4 years ago with sustainability policy, implemented through a basic MCA that has to be incorporated into decision making (business cases); good starting point, but a tick-box approach taken when writing the case; retrofitting sustainability into a decision making process rather than upfront thinking about a broader range of options. The effort now is to address this and make it an upfront process to come up with a broad range of options as possible.
2. We are moving to the point where you plan/think first about the outcomes that are required. This is a big change, but it is an attempt to move to a process where sustainability is considered as an after thought. Asset planners were in the past seen to try and skew the results of the planning process to meet with their expectations (what they thought was best going in). Now there is acceptance that there will be a more robust solution; it gets the planners what they need (a plan that will be accepted and not need to be changed). So in summary, the Planning process is seen as starting from the right end, rather than being a tick-box approach used to justify the outputs that planners consider should be delivered.
3. The sustainability framework is natural for some and pointless and unnatural for others; so there is a need to lead some people, prevent/require action, and thereby encourage participation. People have different mandates; KPIs are different across the business, since time is money, big question is... is consideration of sustainability slowing things down or helping. If an individual thinks their line management expects them to carry on working as before, then this will happen. In amongst conflicting messages, people will make up their own minds and do what they think is right, given their incentives and/or understanding of their role.
4. There is also a link into operations and maintenance; changing work practices, we have the knowledge to make improvement, but the challenge is to change people's perceptions, work practices and views. O&M have incrementally smaller opportunities for improving sustainability, but there will still be some there. Sustainability is top down and bottom up issue; turn it into a challenge; grass roots will generate a lot of ideas.
5. It is attitudes and mindsets that are important, and the best way to change those is to give people the space in which to make their own decisions, and provide the right signals.

Traditional Assets

1. While there is a life cycle focus, it is not clear that this is yet considering options for exiting assets; there is a focus on just replacement or rehabilitation. From a sustainability perspective, you can look at like-for-like intervention for an individual asset or small group of assets and try and select the most sustainable option, or you can consider non-like-for-like across a bigger group of assets, or a larger area.
2. The question is; should we maintain exiting assets into the future? We have addressed sustainability of Greenfield sites (70% of growth) and the backlog in assets like septic tanks principle activity centres (30% of growth) are now being addressed. However, with respect to existing infrastructure that has failed, the approach is more likely to be like-for-like interventions. So in summary, sustainability is being addressed in terms of new assets, but not necessarily in terms of old ones, but then the customer is not interested in the assets, just the service, so there may not be social driver for change.
3. There are a whole range of issues to do with the design of assets; peaking factors are changing; forecasting where these will go, will effect investment in pipe systems and design... for example, WQ impacts of low flows (no scouring velocities) and increase in sediment deposition (though community is more tolerant of poor quality water due to the drought?)

4. On the sewer side, there are equivalent issues; will there be an increase in root penetration due to drought impacts; increased increase of spills; we expect some pipes will increase in the rate of deterioration, but this is a gut feeling (there is no data on what will be the most effective pipe material). We need to adapt the way we prioritise proactive maintenance in sewer systems to minimise risk in the face of these changes. Storm flows into sewers; argument that we should allow sewers to spill more often due to increased dilution factors?

Innovative/decentralised solutions

1. The process of design is very site specific, so transitioning or innovation must be considered on a site-by-site basis; distance from infrastructure is a key consideration. Where there is an opportunity to link into existing infrastructure, this is often the smallest footprint. Where there isn't this opportunity, decentralised solutions will be better. In more general terms, capacity is being built in sustainability assessments using a range of tools, taking into account case specific factors.
2. Commercial providers of innovative systems would perhaps prefer for water authorities to manage novel solutions; examples in the city where these innovations cause headaches.
3. There is an expectation that innovative approaches to service provision will provide new business opportunities (what will something cost, who will pay, what is an annual fee a water authority needs to charge, is this a viable solution)
4. In area service plans, it is very hard to compete with the expansion of potable water and wastewater networks for the provision of services.
5. Decentralised solutions don't stack up against use of existing systems, both in terms of money and in terms of energy use; lots of small pumps means high power implications. One of the key limiting factors for greenfield site was that there couldn't be any dry weather discharge to receiving waters; this means you have to network the provision of services; pumping from a few places is better than pumping from a lot of places with inefficient pumps.
6. Small closed systems are perhaps sustainable and low cost if you get them right, but can be a high cost and risk for providing basic service. There is a health risk if not managed properly, so there is still an attitude that 'big is beautiful' from the perspective of risk and financial outcomes, even though small is perhaps better from a sustainability perspective.
7. There is a need to standardise decentralised solutions to allow them to be maintained and managed without increasing the cost; perhaps having communities manage them. Filter example given, where people have filters put in but don't maintain them... to the detriment of their water quality and in opposition to their intentions. Cost of service contract is an issue, as is technical capacity of the householder. Managing decentralised solutions through a water company will cost a lot, but there is risk if this is not done... this is a challenge.
8. Standardisation is at present done through big assets, not through the smaller assets. There are financial pressures to drive out differences, to achieve more homogeneity. Innovation is a tendency to increase variability, and only a small part of the business, so it can be considered a distraction. Need to move away from where innovation is driven by individual proponents with no standardisation. Inherently the challenge is how to move a company that is swamped with the demands of managing its current form, to have the time to think about how to move to another form. Pressures of efficiency tend to drive out the differences and push in the other direction to sustainable and novel solutions.
9. Innovation is being undertaken at the fringe. Self sufficient communities might be a better sustainable solution. We have pressures that oppose these types of developments. Challenge is to plan for the future in a more sustainable way with other industries and urban planners to shape urban form.

Tools and Knowledge

1. LCA has been a big step forward; this has allowed analysis of options to move away from qualitative assessments to quantitative and more rigorous assessments. Capacity is being built in this area, including a database of energy, nutrients, and transport costs. TBL/MCA can be massaged because there is a lot of subjectivity involved; LCA provides a more rigorous framework. LCA considerations are driven by nutrients, green house gas and water use; these are an order of magnitude higher in importance than other issues.
2. We have spent time and effort using LCA on a particular project... the analysis was dominated by power consumption (because of the number of sewer pumping stations) and there was a feeling that the company could have come up with the same answers on the back of an envelope. It is a learning process though; there were learnings from going through the analysis.
3. The sector needs to apply the 80:20 rule... to capture the essence of the analysis. What do we get from initial analysis and what do we get from better analysis; this will dictate when to use it. Short-cuts need to be developed.
4. Current tools are good in a relative sense; interventions are judged from the base case of the centralised option. Tools available can do this well without need for recourse to subjectivity embedded in TBL assessment or MCA.
5. Decisions are made on the best available information; given different information, a different decision might have been made.

Financial Modelling

1. Financial modelling does not recognise or model the value proposition. Financial modelling includes some primitive assumptions that are wrong. For example, some projects have been forced through that have a strong negative NPV, but now have a massively positive benefit due to changing perceptions of value.
2. We need to monetise key elements, like carbon cost, biodiversity cost, social blight costs, social and environmental benefit.
3. We should apply low zero discount rate for biodiversity, or soils, things that will go into the future. Hence, you apply different discount rates to different elements of the issue and different asset classes.

APPENDIX VI: RESEARCH AREAS, THEMES AND IDEAS

The following Tables present the notes made from answers to questions 12 and 13, which related to the research needs for addressing sustainability-based asset management. As noted in the main section of the report, the comments made by interviewers were categorised in terms of general research areas and underlying themes; the interviewee's comments on research needs are also given for completeness.

Research Area: Regulation & Governance

<i>Theme</i>	<i>Comment on research need</i>
Markets	Investigate the use of a nutrient offset scheme as a potential way of least cost approach to achieving reductions in nutrients
	Water markets; how do we use water in a more sustainable manner, and any impact on asset stocks.

Research Area: Social Research

<i>Theme</i>	<i>Comment on research need</i>
Customers & community	Address customer acceptance of recycled water
	Market research on customer acceptability of new products or services; e.g. taste testing of desalination water.
	There is a need to understand issues like the impact of desalination and use of grey water systems on customer attitudes and actions
	There is a need to manage customers; need to understand customers to make sure a project succeeds.
	More community and customer research and consultation programs are needed; education elements are underestimated in terms of new service provision issues; education shouldn't happen at the point of change to get a community on board; it should occur ahead of change and will deliver benefits if it is done that way.
	Tools, approaches; when where and how to do community engagement.
	One issue with decentralisation is community acceptance... especially with respect NIMBY (dealing with assets and also waste) and also cheaper sources of water (bore v recycled).
	Practice change in terms of community engagement; is also important... having early discussions with community, to capture knowledge of the local environment and also to gather opinion on potential solutions... this was suggested to planners, who felt challenged by this... as if it challenged their professional capacity. Trying to encourage this process, a social scientist has been put into the planning group
Cultural issues	There is a need to define what a successful organisation is; what do we have to do to become a successful organisation of the future to deliver sustainable solutions; what are the institutional arrangements, what are the cultural aspects, and aspects of corporate and individual behaviour.
	How do you make organisations to be adaptable; perhaps given the rate of change is this a new challenge.
	In terms of structure of the sector and culture; culture is a big gap; this is the area for the greatest improvement. We need to work out how we can work in independent organisations in a collective manner.
	Cultural aspects of decision making need to be researched
	A research gap is the change aspects relating to culture and simply process change (project concepts, development through implementation to mainstream adoption); changing processes is a key issue (change is about unfreeze-change-freeze).
	Sustainability managers can be off to one side; so need to understand what is stopping an individual from changing, and what is stopping a sustainability manager from facilitating that change, to break down barriers.
	Sustainability needs to become part of the culture; which is not easy to achieve; it is a long-term goal, things are needed to support this change and reinforce behaviours; rewards and incentives

Research Area: Innovation & Collaboration

Innovation	Should be allowance for incentivising developers to try new things. Every time we get an opportunity we should grasp it. There are lots of intangible benefits, so it is worth doing it.
	Need mechanisms to reward innovation to allow people to adopt them; need case studies to show how they can be used and make these acceptable.
	Need to ensure we have accountability right and determine what is the best technologies and best combination of technologies.
Collaboration	Innovation requires collaboration and people find this approach constructive.
	Important thing is to promote collaboration to avoid duplication of effort. Information as power is an old notion and it just doesn't work from a sustainability perspective; you can hold power for a short time, but it won't last
	Need to get everyone doing sustainability in the sector... not just the big water companies.
Pilots	Taking new technologies and using them effectively; translating them into the water sector.
	Need to have pilot studies with access to data and information.
	Need more speculative opportunity assessments; e.g. use of algal products to reclaim nutrients and get rid of gaseous wastes by putting them through the waste stream... perhaps even get something from bio diesel.

Research Area: Understanding Sustainability & Asset Management

Theme	Comment on research need
Risk	We need to align risk and sustainability frameworks; sustainability can then be rolled down to all levels of the business, because the risk basis is already all pervading.
Climate change	Impacts of climate change are important; lots work on water resources, but what about periodic inundation of assets... treatment plants in low levels, there could be major impacts on these assets.
	Impact of climate change on asset management and sustainability
	We need to understand how much water are people using; is it only less on average, or are the peaks lower or higher; what is the impact on sewer flows
	Need to understand what technologies reduce carbon emissions, and need research to support new technology.
	One of the biggest issues is climate change; drying climate, less stream flow, ground water is dropping but we are still taking water for supply from ground water; is the science there?
	Links between energy and water are also important; how to insulate water cycle from energy... is this through decentralisation or renewable energy?
	Big challenge in Brisbane, Adelaide and Melbourne will be to move from traditional water sources; less dams, less ground water, this leaves technology based solutions, but desalination has high energy costs, and recycling is similarly treatment intensive, which equates to high GHG emission
	Embedded energy is a key issue in asset management; how to trade off operational energy use (e.g. pumping using short pipes) against the use of energy for producing pipes (long lengths of pipe, gravity fed).
	Information on embodied energy to allow tradeoffs to be made
Embedded energy for pipe materials and systems configuration is also important	
Evaluation of alternatives	Sustainability guidelines; i.e. where are the low hanging fruit; what should we do now; get those things embedded.
	Where are the multipliers; the things that have small impacts, but can be replicated across lots of assets to have a large impact.
	What are the best solutions for each water company; consider the differences in climate, landscape and society.
	At a high level, strategic opportunity mapping; look at the inputs and outputs for systems, especially wastewater, and see what opportunities are thrown up... probably plant or system specific, but could be more generic...

Theme	Comment on research need
	Need to understand what the impact of lots of little pumps will be.
	Need to understand the spatial foot print of assets (i.e. land use); this can be reduced by advanced compact assets, but what does this mean to support... how does it impact complexity and support of the assets.
	Footprint analysis for existing plant; to see which assets are impacting outcomes more than others, which would provide support for decision making to minimise this (note; perhaps also protect the budgets required for operations and maintenance). This needs to be across asset categories and within asset categories for asset managers and for processes for process engineers... it can show unexpected things. For example, one process, SBR, the emissions of nitrogen gasses NOX had a higher impact on the environment in terms of carbon equivalents than the power used. Energy was always related to cost in the past, so the process selection was driven by energy, but since the GHG impacts are bigger in other ways, this wouldn't have come out.
	We need better information on the alternatives; it may not be sustainable to use ground water supplies, or get rid of water to the oceans.
	Alternative water supplies; dams, bores, tanks, grey water, 3 rd pipe; what is the impact into the future; need more information.
	Understanding the details of our assumptions; determine if there is a difference between belief and outcomes. For example; is grey water a good thing; it is expensive and there is some anecdotal evidence that some customers may bypass watering restrictions by leaving their taps running to feed the grey water system. We need analysis of real impact based on forensic investigation of issues
Existing assets	Tying sustainability into the whole asset management cycle and not just planning and design. Different aspects of sustainability that map onto different parts of the asset management cycle; e.g. guidance on sustainability in O&M
	What technologies should we use for rehab; where is trenchless a better solution; should it be banned under roads etc... is trenching safer? What is the more sustainable way; which is the better way?
	Alternative rehab techniques and impact of technique used on on-going management issues; how to maintain tanks without emptying; cleaning pipes without flushing; technology for inspection without drain down.
	We do need to consider activities that can be done a more sustainable fashion; e.g. trenchless technologies, which address disruption, refurbishment of pipes to increase capacity and avoid replacement.
	Sustainability of interventions; repair, renovation; what is the life span, are there issues that should be considered.
	Understanding how passive assets interact with other assets, e.g. people digging and interaction with power lines.

Research Area: Asset and System Design

Theme	Comment on research need
Urban form	More fundamental research about the urban form society will accept moving forward; infill within the existing urban footprint, or linear development (sprawl 5km from coast) as an alternative.
	Alternative shapes for the future; in terms of community, with overall sustainability in mind and with water services provision as a part of the design; you can't do these things in isolation.
	Consider urban consolidation and look for opportunities to reduce load on infrastructure and close the loop (e.g. commercial-swimming pools; high rise buildings etc all give opportunities for novel solutions)
	How to interface with urban consolidation: driven by public transport or transport systems; employment opportunities, utilities are at the very edge; this reflects the proportional investment and social impacts, but it implies that the water sector is constrained by land use planning, should be closely involved in it.

Theme	Comment on research need
Integrated systems	There is a need for an integrated water cycle view of design. This will involve new servicing strategies that require us to understand impacts on existing infrastructure or changes (peak flows for sewers and water mains; i.e. the impact of changes on underlying design standards for traditional types of assets)
	Penetrating influence beyond the meter will become important; in the energy sector, they are using efficient products and using household infrastructure to facilitate power generation; are there analogous things on the water side, e.g. how to manage stormwater; moving beyond the meter... How do communities become engaged in the water cycle in a management context (equivalent to using household infrastructure to generate energy)
	Integration of water cycle; at least retrofitting into redevelopment; then moving into general residential areas.
	Linkages between building and water will be an important aspect of research.
Recycling/reuse (water)	Re-examine decision to close small sewer treatment plants in light of the impact on our ability to recycle (decentralisation considered from the aspect of local sewer treatment plants, rather than emerging technologies).
	Traditionally, centralised Sewer treatment plants have been specified; but as we move to water recycling, do plants need to be where the water will be reused...
	Need to revisit industrial waste management and the influence on quality of sewage; and correspondingly potential for recycling of water.
	WWT needs to be geared towards recycling; the cost of high quality WW for aquifer recharge is high at \$4/KL; this is 4xcost for desalination with renewable energy; the cost needs to be driven down.
Recycling/reuse (solids)	Biosolids; emergent technologies to maximise recycle use; pathogen free, reduce cost of transport, produce recyclable biogas.
	Lots of things you can do with biosolids; project on-going to value add them... can't put on soils but there is a product that can be used which are being looked into.
Decentralisation	Need to be able to have case studies with substance that show under what circumstances smaller decentralised solutions are better, or where connection into networks is better.
	The key challenge for decentralisation is how to achieve and still deliver acceptable outcomes and cost.
	In general, we need to reduce the cost of technical solutions that are considered more sustainable, but are currently too expensive.
	Decentralisation: energy costs of centralised systems are becoming more problematic.
Treatment technologies	Research into treatment and pumping technologies.
	Energy usage and management for pumping and treatment; the way we design pumping stations, design, operation, management and monitoring, refurbishment to minimise energy
	Water treatment technology; new emerging products utilised at the household level; low cost approaches to removing risk from rain water tank use
Sewerage	Using dilution to deal with planned overflows may not be an option in the future; so there is a need to consider point of discharge treatment for overflows.
	Initiating in-line treatment within sewers.
	Effluent discharge; we can treat things to extremely high levels; but it costs a lot of money... is this overkill... is there an argument for modifying standards to get same outcome for less cost.
	In asset terms, need to address leaking gravity sewers; achieve wastewater systems without rainfall impacts is a key issue with respect sustainability.
	Understanding why there are still storm impacts on sewers; why in new systems. What is wrong with the design and construction?

Research Area: Decision Support Tools and Approaches

Theme	Comment on research need
Decision making	Decision making frameworks; embracing sustainability in existing frameworks; improved decision making enables other things. We can muck around with what we do at the asset level, like lining pipes; but this is bottom of the trough stuff... the big thing is changing the way we make decisions, as this enables other things.
Economic analysis	NPV and discount rates; current financial analysis favours delaying capital spend, and doesn't value benefits in the future. Short-term financial models don't map onto sustainable principles. For long-lead items, how should they be considered in financial models? We need to both represent externalities and external costs in \$s on the one hand, and drive down the costs (internal and external) on the other through innovation. Need to apply thorough cost-benefit analysis. If making decisions on replacing an asset; there is a need to put values on impacts to determine if we should invest. Need tools to look at these tradeoffs better. There is a need to broaden the definition of service to cover such intangibles as aesthetic use of water, environmental protection, etc and illustrate the tradeoffs involved, so individuals will be better placed to determine what their actual social preferences are.
AM Models/tools	Decision making tools and data for tradeoffs and efficient levels of spend. Need to build in more sustainability into our existing models. Tools are needed for determining what is the best way to service a community; which asset configuration is best? Develop a suit of tools (like PARMs) that people can have confidence in; these tools are an inter-generational legacy too; as we become more sophisticated, we hand on that capacity to future generation as a set of management tools. Need tools at a lower level; methodology to compare options... tools available don't address sustainability very well. We are currently limited by predictive models of ecosystems Tools that allow better analysis of impacts of the way assets are currently operating: New tools are needed, but there is still the question of how we use the existing tools... Less academic tools or tool use; how do we use tools to come up with quick results; appropriate level of detail is a key issue. Pragmatic tools use; e.g. LCA, can't justify its use on all projects and you shouldn't need to, but general guidelines and principles could be gleaned from detailed case studies and applied. Also need for models to help assess options given different scenarios; make decisions about how far down the sustainability road it is worth going. Tools are needed to support decision-making and present information to regulators to allow innovation such as decentralisation

Research Area: Data, Information and Knowledge

Theme	Comment on research need
Data and Information	There is still a need to have up-to-date data, and have the capacity to interpret that data Managing the overkill of data; managing emails, systems, etc and the like... occupies a lot of time. Remaining challenge is data and information; we need better information from which to assess sustainability as there are a lot of value judgements, though this is inevitable given the type of issue under consideration.
Knowledge sharing	More information is needed on alternatives; more dissemination of issues. Knowing what has been done before and what has been trialled etc. Ensuring that we do build on experience; if we don't we are not making progress as quickly as we could be; this is a real issue in the journey. Avoid starting from first principles in each company, reinventing the wheel. Need a central repository of information across Australia

Theme	Comment on research need
	Shared guidance and information on how to manage new technologies
	Undertake industry wide research as it creates opportunity and critical mass for industry and creates the opportunity for innovation to be possible.
Corporate knowledge	Retention of corporate knowledge is an issue
	The WSAA asset management committee are also considering knowledge management, knowledge sharing, training and development, building a workforce for the future.

Research Area: Technical Aspects of Asset Management

Theme	Comment on research need
Asset life/failure	How to extend the life of sewer assets; corrosion, odour treatment
	Buried assets remain the bigger challenge; understanding their modes of failure, the interactions with the environment... the impact of construction defects on later life and performance.
	Understanding the relationships between renewals and maintenance.
	Need to understand the long term behaviour of some new technologies (pipe materials, pipe systems, configurations, connections, fittings), including behaviour under climate change (e.g. wetting/drying of soils)
	Condition assessment; understanding what drives corrosion
	A suit of research is needed about understanding modes of failure, buried pipe condition, etc.
	For existing assets; research into condition of assets, understanding where assets are at.
Monitoring technologies	Monitoring performance of existing and new infrastructure from a sustainability perspective; simple drivers and indicators are a key need; to provide signals and allow tradeoffs to be made and determine how companies are going from one year to the next.
	Remote monitoring technology; being able to measure more accurately and remotely, and how this is integrated into smart decision making systems. There is an issue with potentially dumbing down operators; an unanticipated consequence of smarter assets; we need to take advantage of technology, without losing the added value from operators.
	New emerging technologies for monitoring and understanding leakage from trunk mains.



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