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Integrated Water Cycle Management: "An Australian Perspective"

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Abstract: Integrated Management of Water Resources including stormwater and waterways is potentially one of the most influential factors in shaping our urban centres and our standards of liveability, now and in the future. Australia has a high water usage coupled with low and uncertain rainfall (Yencken and Wilkinson, 2000). Local governments in Australia are under enormous pressure to manage the significant future population growth in a sustainable manner. In order to be a sustainable and liveable region, local governments and the development industry need to work cooperatively to manage water resources and to protect natural assets. The traditional approach to managing water, at a government level, involves a number of departments looking after different water components. For example, at a Queensland State level, the Environmental Protection Authority (EPA) regulates water quality, while the Department of Natural Resources & Mines (DNRM) regulates water quantity. At a local government level the water authority provides supply and sewerage, while stormwater is managed by a different department and water sensitive urban design by another. Emerging ideology in the management of water supply is towards demand management. Demand management involves looking at efficient use of water through reducing losses, improving water usage efficiencies and source substitution. A holistic approach to demand management is through Integrated Water Cycle Management (IWCM). IWCM requires an integrated institutional approach to implement effectively. Water supply, sewerage and stormwater are the three key elements of IWCM, but are traditionally designed independently. In IWCM the three elements work together to derive sustainable water outcomes. As numerous disciplines are involved, a trans-disciplinary management approach is required to effectively implement IWCM. Urban stormwater and waterways health issues are generally managed separately by Local Governments through Total Management Planning (TMP) for Catchments and Waterways. This approach will serve to integrate water quality, catchment health, flood management and waterway corridor planning into a coordinated activity. However, stormwater at large is still treated as waste instead of considering it as a precious water resource. The obstacle in this integration is mainly due to institutional disintegration which could result in business conflicts for water utilities in balancing water selling and the broader impacts on waterways and the environment. Over the last ten (10) years a myriad of Acts, policies, plans and guidelines have been introduced by State and Federal Governments to mainly assist local governments and water authorities in managing water resources and the natural environment Environmental legislation is complex and often contains legal jargon, which can lack a clear direction and fail to consider actual resources.

Keywords: Integrated water management, Australia, sustainability, IWCM, trans-disciplinary management

1. INTEGRATED WATER CYCLE MANAGEMENT

1.1 History and Background

Water for urban purposes has traditionally developed over 150 to 200 years as a linear pathway of use and disposal of polluted waters. The applied engineering method has changed little over this period.

The idea behind IWCM is not new. However, the approach was initiated through water recycling and reclamation principles. The approach highlighted an integrated approach to water supply, sewage and solid waste disposal and recommended a need to control the conservation of water resources in rivers and streams and recharging aquifers.

Water reform has been occurring across Australia since 1994, under the Council of Australian Government's (CoAG) policy directions, through the National Competition Council, and now, the National Water Commission. Industry adjustment has occurred over the last eight (8) years, with

the support of the Federal and State Governments. The process has been driven by conditional tranche payments from the Federal to the State governments based on actual achievement of the reform packages. These payments have been passed through to water service providers on a similar basis of performance assessment.

In Queensland the major changes have occurred due to the introduction of the *Water Act 2000*, under the Department of Natural Resources and Mines (DNRM) administration. The principal focus has been on water service standards and planning. The Queensland Competition Authority (QCA) has been established and oversees pricing of water services under their terms-of-referral powers. QCA's principal foci have been on the economics of water service provision, full cost pricing and transparency of pricing mechanisms.

However, over the past decade the issues of environmental health, sustainability, water availability and water quality have emerged as significant political issues. The Council of Australian Governments (CoAG) came together in 1994 and agreed the *National Water Reform Framework.* This framework encompasses urban and rural water and wastewater industries. Its aim is to improve the efficiency and effectiveness of the provisions of water management.

1.2 The Drivers

The focus of the water industry is beginning to shift toward not only economic reforms by addressing externalities, but also to reforming how water is obtained and distributed. The natural environment is moving towards more prominence, including water resource preservation, efficiency of utilization and operations and discharges of used water. This is leading to changes to water cycle intervention and reformation in water management practices across Australia.

Development of a "complete water cycle management approach" for urban communities has been an emerging position for water practitioners, water service providers and waterway administrators over the last five (5) to six (6) years, across Australia. It is a position that is being widely examined across States and has been growing in momentum over the last two (2) years, particularly in South Australia, Victoria, New South Wales and Queensland. Australia, with its dry climate and high variability of rainfall, is tending to take a leading-edge role in this new thinking. There are also considerable interests at the International level for a more complete understanding of the water cycle and the effects of human intervention in water use practices.

Improved water resource management is strongly influenced through social discourses, evidently brought about by the current drought and pressures on the environment, from water shortages and the quality of water discharged to waterways. The community desires improved environmental outcomes and improved water planning, to address the scenarios of climate change and climate variability predicted by CSIRO and other international scientific community members.

Undoubtedly, water remains a key ingredient for our urban and rural prosperity, for job generation and for the basic necessities of life. Thus, water has become a political imperative to act upon, for all levels of government in Australia. Major decisions on water resources have nearly always been an ideological decision, based upon political imperatives (e.g. Snowy Mountains Scheme, the Ord River Dam, Nathan Dam in Queensland).

Several factors have triggered the adoption of IWCM approach in Queensland to water planning:

- The Office of Urban Management (OUM) of the State Government has identified major growth centres in the next twenty (20) to thirty (30) years;
- The Regional Water Supply Strategy for South East Queensland;
- Growth pressure from industry and developers;
- The pressures from the environmental regulator (EPA) to plan for removal of effluent discharges to waterways;
- The increasing availability of effluent from wastewater treatment plants, potentially of high quality, has built momentum towards consideration of alternative approaches to water resource utilization;

- The pressures for strategic planning for water and wastewater services. Developers and the community expect assured pathways for sequenced development in emerging community areas.

1.3 Management Issues

As discussed above, some of the key drivers for adopting IWCM are the protection and enhancement of the natural assets in addition to using stormwater as a resource rather than regarding it as a waste.

Urban development had a dramatic effect on the hydrological cycle by altering the regime of water pathways in the natural environment. The results are more water directed to waterways and streams, and less water going into the ground directly. Either way there are permanent changes that can have detrimental effects to the natural ecology of the area. The adoption of good planning such as Water Sensitive Urban Design (WSUD) and integrated approaches can alleviate these effects.

The following figure shows the discipline areas and the diversity of management's issues that are connected to and impacted by the IWCM practices.

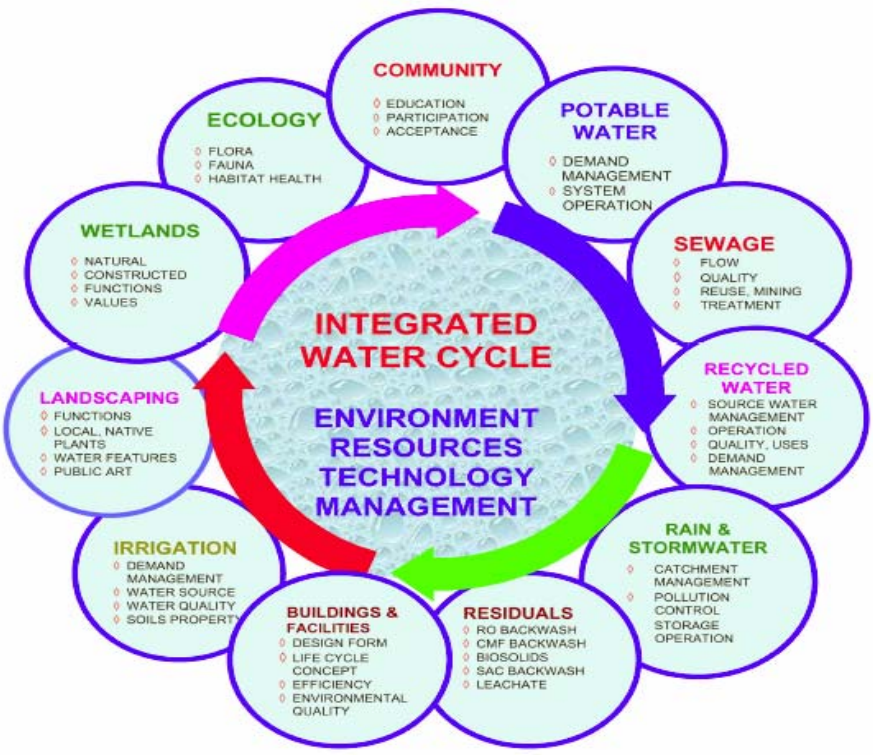

Figure 1. The Integrated Water Cycle
(Source: Listowski, 2003 cited in Radcliffe, 2004)

The IWCM approach links better management of water quantities and qualities and the programmed tasks to improvement of environmental water quality for local governments.

Ultimately IWCM endeavours to develop new water service delivery solutions for emerging population growth areas and for the established water supply areas as well. IWCM manages water so that all components of the water cycle are considered such as:

- water supply
- sewerage
- stormwater
- rainwater
- recycled water

- reuse water and
- integrate alternate sources

The result is a minimised impact on water resources, other capital resources and users, linked to improved environmental outcomes for the waterways, streams, rivers and oceans.

IWCM holds the ability to close the loop on the traditional linear water management method. Historically, stormwater has been managed as a drainage problem rather than utilising it as a water resource. Stormwater management has the potential to play a pivotal role in achieving IWCM goals.

Up until 2002 little had been done to address and implement stormwater management strategies into IWCM. These strategies tended not to place an emphasis on utilising and harvesting stormwater as a resource. Instead, abatement measures tended to be focused towards developing new technologies, water recycling, dual reticulation, water saving devices and leak detection. In doing so, stormwater harvesting had comparatively minor attention as an alternative water source. The main barriers to this can be attributed to perceptions of cost, uncertainty of supply and water quality.

1.4 Institutional Arrangement and Governance

One of the critical issues in adopting and truly implementing the IWCM approach in managing water and other natural resources is the reshaping of institutional arrangements at various levels. In doing so, IWCM requires a trans-disciplinary approach to the management water resources.

Table 1 provides a snapshot summary of recent activities in the relevant State authorities in regards to organisational and policy initiatives.

2. STORMWATER MANAGEMENT

2.1 Background

In Australia, the responsibility of managing stormwater rests mainly with the local governments, whereas the State and Territory governments retain overall responsibility for land and water use planning and management (Environment Australia, 2002, p.28). Recently, the Commonwealth government has contributed to recycling projects such as *The Urban Stormwater Initiative*. Although this document is aimed towards conservation of natural resources, it does not recognise stormwater as a natural resource, nor does it go far enough to provide guidance on the opportunities to integrate stormwater for community use.

Local Governments in Australia are the primary managers for stormwater to ensure that adverse flooding, pollution of receiving waters and degradation of waterway corridors is minimised. This capacity is a reflection of the many critical roles Council plays in these areas.

Over the last ten (10) years a myriad of Acts, policies, plans and guidelines have been introduced by State and Federal Governments to mainly assist local government in managing stormwater and the natural environment. In a vast majority of cases, local authorities lack the resources or adequate structure to effectively administer Acts and other policies. Despite this, local governments continue to be pressured to implement and administer regulations. The policies and guidelines are often ambiguous and lack sufficient detail, providing only broad statements and concepts. Environmental legislation is complex and often contains legal jargon, with no clear explanations or definitions available. The following are some of the relevant legislations which govern stormwater management in Australia:

- Environmental Protection (Water) Policy 1997
- Water Act 2000
- Integrated Planning Act 1997

- Environmental Protection Act 1994
- Coastal Protection and Management Act 1995
- Vegetation Management Act 1999

Table 1. State Structures

State	General Institutional Arrangement for Water
Queensland	Water, wastewater and stormwater services in Queensland are still provided by local governments where as water quality issues are still operated through the Queensland Environmental Protection Authority (EPA). However, the State government through the EPA has established the *Queensland Water Recycling Strategy*. Overall, the water resources planning rest with the Department of Natural Resources Mines and Energy (NRME) and is administered through the *Water Act 2000*.
New South Wales	From the late 1990s, NSW had a Stormwater Trust. The trust had an $87 million budget, and the assistance of the then NSW EPA, to assist local government develop stormwater management plans. The phase one plans, which were quality oriented, have largely been completed. In the last State budget, the trust was axed, and there is currently no direct State government stormwater funding. In 2004, the NSW government introduced new regulations for development in the State. Amongst other things, the BASIX (building sustainability index) regulation requires all new homes in the Sydney metropolitan area to consume 40% less water than an existing home The regulation was effective in Sydney from 1 July 2004 and will be effective in non-metropolitan NSW from 1 July 2005. The Basix regulation is administered by the NSW Department of Infrastructure, Planning and Natural Resources, but is backed by a whole of government approach. Recently, NSW Premier Bob Carr released a 25 year plan called "Meeting the Challenges – Securing Sydney's Water Future". The Plan, charts the governments course towards a sustainable and secure water system for the people of Sydney and the rivers they rely on over the next 25 years. Consistent with the NSW *Water Management Act 2000*, the plan makes a special allowance for water for the environment. The plan involves the involvement of many departments with a sub-committee including Planning Minister Craig Knowles, Environment Minister Bob Debus and Utilities Minister Frank Sartor driving the project. The NSW Department of Energy and Utilities (formerly the NSW Department of Land and Water Conservation) also has a program to fund Integrated Water Cycle Management Strategies for local water utilities that includes stormwater, sewerage and water supply.
Victoria	The Victorian Government has released a paper entitled *Securing our Water Future- Green Paper for discussion* (DSE 2003). The paper promoted greater use of rainwater tanks and the management of stormwater as a water resource rather then a drainage problem to be included as a substitution for potable water and for a 'third pipe' domestic application. Victoria has 19 water authorities and the Victorian EPA is responsible for setting environmental standards and regulates environmental performance.
South Australia	In South Australia the water and wastewater resources and services are operated through the Engineering and Water Supply Department. However the management of water resources management now falls within the jurisdiction of the Department of Water, Land and Biodiversity Conservation.
Western Australia	Water resources are the responsibility of the WA Water and Rivers Commission. The water and wastewater provision are the responsibility of the Western Australian Water Corporation.

Source: Redcliffe (2004)

2.2 Case Study

Management of stormwater and waterways could be one of the most influential factors in shaping our urban centres and our standard of liveability for now and in the future. This is supported by evidence collected from cities around the world.

This case study will provide insight into the potential impacts of stormwater and waterways management or mismanagement on the general living standard in urban centres. Waterways conditions and management practices will be discussed for two different cities namely the Gold Coast (Australia) and Bangalore (India), to illustrate how beneficial or devastating they can be.

Gold Coast

The Gold Coast is world famous for its beaches, waterways and hinterland areas, although it is also Australia's fastest growing major city. The City has a population of some 425, 418 people and is expected to have a total population of 514, 000 by 2011. In addition, tourists and day-visitors are estimated to add the equivalent of an extra 90,000 residents in a year. To accommodate extreme development pressure, around 300 hectares are being developed for urban use each year.

Some of the major pressures facing the City's stormwater and waterways are flooding, vegetation cover, riparian vegetation, acid asulfate soils, surface water quality, water resources and supply with significant shortage during recent drought.

The majority of catchment and waterways management activities are the responsibility of the Gold Coast City Council, however, these responsibilities are spread across most Directorates and amongst a number of functional areas within those departments.

This has resulted in uncoordinated activities with some duplication and potential gaps in the investigation and management of various catchment issues and the use of different goals.

High levels of investigation and best management practices have been followed for various issues (drainage, flooding, water quality, etc). However, the overall outcomes are not integrated and subsequently not readily applicable to managing catchments and waterways.

Bangalore

Bangalore is one of the fastest growing cities in India with a current estimated population of 5.8 million and covers an area of 225 km^2. The Bangalore City used to be known as the "Lakes City". As a result of recent and poorly controlled urban developments, the 262 lakes evident in 1960 have been reduced to a few polluted small waterbodies.

These waterways, in addition to their primary function as flood carriers, have initially provided the city with a green corridor and reasonable ecological and recreational values. However, currently most of the waterways are depleted. This is mainly due to pollution from wastewater discharge to the stormwater system.

The recent growth has mainly been accommodated by the significant increase in urban density in the built-up areas. This urban growth has not been guided by strong strategic planning or development control measures to minimise the impacts on existing infrastructures on the surrounding environment, and in particular on the stormwater system.

The system is characterized by wide spread flooding, significant sediment and erosion problems, drainage encroachments and filling in the floodplain, and the main sewer pipes are located in the drainage channels. As a result, stormwater flows in the sewer pipe during floods and the sewerage flows into the open channel during the dry periods.

Figure 2. The Good and the Ugly.

Stormwater management responsibilities are spread across a number of separate state government departments as follow:

- Bangalore Water Supply and Sewerage Board (BWSSB)
- BMP, CMCs and TMC Municipalities
- State Pollution Control Board and the Central Pollution Control Board
- Karnataka Forest Department
- Bangalore Agenda Task Force
- Bangalore Metropolitan Regional Development Authority
- Bangalore Development Authority

The following comparison (Table 2) highlights some of the key issues and management practices that have impacted on both systems**:**

3. LINKING STORMWATER MANAGEMENT WITH INTEGRATED WATER CYCLE MANAGEMENT (IWCM)

Collection of rainwater from hard surfaces in urban areas has effectively become an alternate source of water to dam supplies. Ways to harvest and treat stormwater include the installation of rainwater tanks and the storage and recovery of stormwater through constructed wetlands/lakes or aquifers. The latter has not had much attention in Australia (besides SA); however, the implementation of rainwater tanks has seen renewed interest lately.

The application of best practice in Water Sensitive Urban Design (WSUD) can only reduce the effects that the urban population has on the hydrological cycle. IWCM regards stormwater as a resource rather than conveying runoff as fast as possible away from urban areas. The traditional conveyance approach results in externalities downstream. WSUD implements a sustainable management tool by improving stormwater runoff. WSUD seeks to offer an alternative to the traditional stormwater conveyance approach by mitigating the changes to the natural water balance through the reuse of water (retention) and temporary storage (detention) of stormwater runoff (Victorian Stormwater Committee, 1999).

Rainwater tanks are a water source control measure under water sensitive urban design principles and applications, particularly for rain events of a low to moderate impact. After South Australia, Queensland has the second highest usage of rainwater tanks with 18 percent of households using rainwater tanks and of this 15 percent use rainwater as the main source of drinking water (Australian Bureau of Statistics, 1994-2001). Historical regulatory constraints in States (such as NSW) that have recently been lessened, may explain the relatively lower level of usage of tanks in some states.

Accumulation of water in rainwater tanks has a completely different hydrograph to the accumulation pattern in open dam storages. Even in drought years, it is anticipated that rainwater tanks will still provide an effective storage due to the lack of losses that is normally seen in natural

systems (infiltration and evaporation). Figure 3 schematically illustrates in a perceived drought year (<600mm rainfall) there will be considerable volumes of water collected from the hard surfaces of roofs into the rainwater tank (RWT), where in the same period there will be near zero accumulation of water in dams. Therefore, as part of the water supply system, rainwater tanks potentially have a complementary role in accumulation of water for urban use.

Table 2. Management issues for Cold Coast and Bangalore

Management Issues	Gold Coast	Bangalore
Environmental regulation and regional commitment	High level legislative requirements, Waterway partnerships.	Environmental legislation exists, however, no enforcement, separate authorities.
Planning and development control	Well advanced in term of planning schemes, policies, codes, etc.	Basic city plan exist, no priority for waterways, planning and development control authorities are separate from local and state government authorities which manage Stormwater quantity and quality. Almost no referral mechanism exists.
Institutional Arrangement	Most of the waterways management activities are the responsibility of the Gold Coast City Council, however, these responsibilities are spread across most Directorates. Some coordination exists.	Waterway management responsibilities are spread across a large number of Government departments with very little coordination.
Best Practice Guidelines	Well advanced including; Development Manual , Stormwater guidelines, etc.	An almost complete absence of best practice guidelines for managing Stormwater related issues.
Community awareness and involvement	Significant community interests, expectations and involvement.	Lack of awareness and interest, with minor exceptions from relatively new corporate bodies.
Development pressures	Significant developments, however, mainly in the low land areas. More than half of the catchment areas for major waterways are in the hinterland with little development. The tidal regime provides a cleaning mechanism for the low sections of the waterways.	Significant industrial development driven by external investments. Tent cities are located in the waterways and floodplain. High density development covers the entire catchment for major waterways. No exchange with tidal regime to flush the waterway systems.

Research undertaken by Coombes indicated that a rainwater harvesting system having a storage capacity around 3 – 5 kL per household, would provide a significant benefits close to diminishing returns for stormwater retention/detention and main water in Brisbane. This potentially would equate to a mains water saving of around 90 – 110kL per annum for an average household (Coombes and Kuczera, 2003).

Indoor use of stormwater in the form of rainwater tanks can be used alongside water saving appliances to reduce the demand on the potable water supply system while the demand can be reduced in the garden & public open space by using stormwater in conjunction with treated grey water & recycled water for irrigation and water sensitive designed gardens.

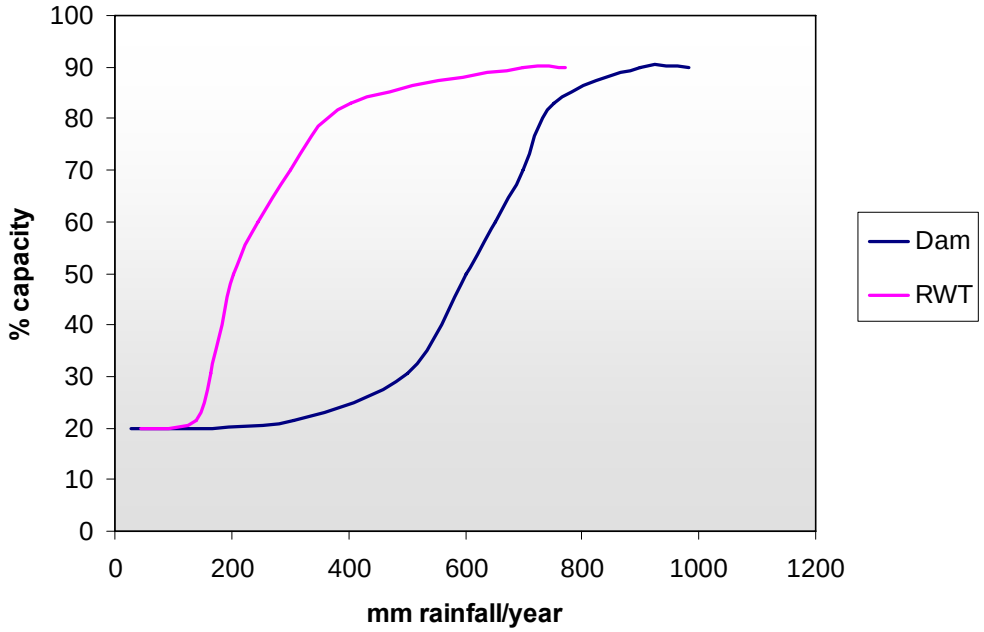

Figure 3. Accumulation of Water Reservoirs (for illustration purposes only).

Examples of how stormwater is being used as a resource in Integrated Water Cycle Management plans are:

- A new development in St Kilda, Melbourne, is collecting the first flush stormwater, treating it via wetlands and combining it with treated greywater for sub-surface irrigation and toilet flushing across the development. Not only will this reduce demand on potable water but also reduce the pollutants associated with the first flush entering Port Phillip Bay.
- In West End, Brisbane, street trees are to be irrigated through stormwater collected in road gully inlets and unit blocks are to have rainwater tanks.
- Some Local Councils in South Australia have been very innovative in stormwater management. For example the Corporation of the City of Salisbury have established thirty-six (36) wetlands and subsequently adopted Aquifer Storage Recovery (ASR) for wetland treated water. The stormwater is being treated in bird-proofed reed bed ponds and used for local industry and horticulture. Excess treated stormwater is stored in an aquifer and used during periods of drought. Initially the project was to use the treated stormwater for its parks and gardens. However, a recent joint venture has proposed to store and treat stormwater on Parafield Airport which will potentially provide over 1GL/year to be used by, Australia's largest wool processor, G.H Michell & Sons Australia Pty Ltd (Radcliffe, 2004).

4. CONCLUSIONS

There is currently significant good will and support at all level of governments, communities and industries for an integrated approach to water resources planning. This support and awareness has been generated through recent droughts, urban development pressure and environmental awareness. The water industry practitioners have moved forward in terms of their technical approach to embrace the philosophy of Integrated Water Cycle Management, Total Catchment Planning, and other approaches of the management of water and environmental assets.

In order to implement these changes the traditional intergovernmental barriers need to be broken down and an holistic integrated institutional approach to departmental divisions needs to be established. A trans-disciplinary organisational structure will enable these traditional barriers to be overcome and enable water resources to be managed in a sustainable manner for future generations.

Normally the water and sewerage business is grouped separately to the waterways business in local governments. Recognition of this aspect is one of the key elements in the adoption of an

integrated approach. An in-depth discussion of these organizational political influences would be most useful.

It is apparent that the waterway and water services organizations are limited in their linkage. A rethink of organizational structures and relationships may be necessary to realize the benefits of the IWCM approach. However, under a planned organizational change scenario and matrix organizational structure, desired outcomes can be achieved.

The Bangalore and Gold Coast examples highlight that the management of stormwater and waterways could be some of the most influential factors in shaping our urban centres and our standard of liveability for now and in the future. On the one hand the potential devastation of an entire city that results from mismanagement of stormwater and waterways. On the other hand, the Gold Coast waterways are still one of the main attractions of the city.

The strategy to move forward may vary significantly in its actions between the Gold Coast and Bangalore. However, the fundamental best practice approach to stormwater management remains the same.

Our professional associations are divided along similar lines of interests to the governments and institutions. However, the time has come for these associations to take a leadership role and integrate between themselves to form a comprehensive representation for the water resources and stormwater industries. After all ... it's all water!

REFERENCES

Australian Standard AS/NZS 4360:1999 – Risk Management

BCC Healthy Waterways Committee, (2000), SEQRWQMS

BCC, (1999), Urban Stormwater Management Strategy

Coombes PJ & Kuczera (2003) 'Analysis of the Performance of Rainwater Tanks in Australian Capitol Cities, 28th International Hydrology and Water Resources Symposium, The Institute of Engineers, Wollongong, NSW.

CRC for Catchment Hydrology, (1995), A Review of Urban Stormwater Quality Processes

Environment Australia (2002), Introduction to Urban Stormwater Management in Australia, Commonwealth Australia, Canberra.

EPA, Model Urban Stormwater Management Plan Guidelines

Gold Coast City Council (2003), Egis Consulting, Total Management Plan For Catchment and Waterways

QLD Govt, (1991), Integrated Catchment Management - A Strategy for achieving the sustainable and balanced use of land and water

Radcliffe JC (2004), Water Recycling in Australia: A review undertaken by the Australian Academy of Technological Sciences and Engineering, Australian Academy of Technological Sciences and Engineering, Victoria.

Roberts A & Wolley R (2005), Caloundra City Council; Strategic Review of Rainwater Tanks – Stage 1, JWP, Brisbane.

Roberts A & Wolley R (2005), Caloundra City Council; Strategic Review of Rainwater Tanks – Stage 2, JWP, Brisbane.

SEQRSG, (2000), Strategic Guide to Natural Resource Management in SE Qld

SKM, EGIS &BCE for AusAID, Stormwater Strategy Overview Report for Bangalore (2001), India

Victorian Stormwater Committee (1999), Urban Stormwater: Best Practice Environmental Guidelines, Victorian Stormwater Committee, CSIRO.

Woolley R. (2004), Integrated Urban Water Management for the Ripley Valley; Project Plan, JWP, Brisbane.

Woolley R. (2004), Ipswich Water: Integrated Urban Water Management Project Plan, JWP, Brisbane.

Yencken, D. & D. Wilkinson (2000), Resetting the Compass: Australia's Journey Towards Sustainability, CSIRO Publishing, Collingwood.