TRANSITION TOWARDS WATER SENSITIVITY - DEFINING THE BUILDING BLOCKS

Damian Young, Morphum Environmental

Stu Farrant, Morphum Environmental

ABSTRACT

This paper investigates, defines and summarizes key elements and 'building blocks' necessary for cities to transition to water sensitivity, with a particular focus on the stormwater aspects of this spectrum, drawing on local project examples and overseas exemplars.

Many towns and cities across New Zealand are limited by issues around scale and resources (both financial and personnel) to achieve effective water sensitivity. This is compounded by the long held reliance on 'traditional' networks delivered with a singular focus on quantifiable service delivery measures typically governed by conveyance and flood mitigation. Water sensitivity offers a new paradigm in the design and implementation of public/private infrastructure which capitalizes on synergistic benefits through integrated solutions. These in turn provide increased levels of service which encapsulate a range of tangible and intangible benefits to Councils, communities, Iwi and receiving environments. This paper articulates the institutional processes, community understanding, technical guidance and functional delivery mechanisms required to support transition to water sensitivity.

International exemplars of cities which have successfully adopted water sensitivity as part of their approach to stormwater management will be identified and investigated. This will inform an understanding of the actions and drivers which have underpinned their transitional change and the barriers which they have overcome in this process. These experiences will be evaluated against recent domestic progress to better understand tangible and intangible impediments to change in the New Zealand context. This process will identify the 'building blocks' which support the effective paradigm shift towards water sensitivity as they relate to key stakeholders including Councils, utilities, iwi and private enterprise.

This process will give confidence to the subsequent prioritization of actions through a consistent and concise understanding of the locally relevant; governance issues, institutional barriers, community aspirations, ecological contexts and cultural considerations. These will in turn inform guidance on the required building blocks encompassing;

- Priority data procurement
- Institutional capacity building
- Local policy documents
- Regional collaboration

- Community understanding/education
- Multi-disciplined technical skill shortages

KEYWORDS

Water Sensitive Cities, Water Sensitivity, Integrated Stormwater Management,

PRESENTER PROFILE

Damian Young is a founding Director of Morphum Environmental and has specialized in integrated catchment planning from ecological assessment, detailed asset management through to regional water quality strategy.

Stu Farrant is a the Wellington and Southern Sector Manager of Morphum Environmental and has specialized in water sensitive design. He has project and design experience in both New Zealand and Australia having been involved in the authorship of both the current Melbourne Water Wetland Design Guidelines and draft Auckland Wetland guidelines.

1 SETTING THE SCENE

How we are going to transition from our current modern city model, being water supply cities with defined drainage systems, reticulated to provide a defined level of service. Typically with high grade potable water supplies, wastewater networks to service new and existing subdivisions and piped or channel conveyance networks designed to avoid the damaging effects of large storm events. To water sensitive cities where we have integrated water systems supported by a robust functioning business processes and a water sensitive culture encouraged and monitored by transparent city governance structures. Where our use and management of water is intrinsically linked to ecology, water quality and aesthetic experience?

It has to be about more than just, “am I going to get flooded” or is the footpath dry with no algal growth, from the weeping seep, resulting in discoloration or a public safety issue. These are relevant and important issues and should not be dismissed. Could or should it be about how we can design our landscapes to retain, treat and purify our surface runoff waters and take advantage of overland flow or perching groundwater to passively irrigate street trees which in turn might purify the air and aid to the landscape quality of our urban streetscapes.

Should or can cities practically achieve this shift in isolation or will it, or must it, be supported by central government to provide the resources, intellectual and policy support. What about the small and medium sized towns and municipalities, or regions with poor economic performance?

Our world faces many challenges and many of these are exemplified in the challenges of the cities. Climate change effects, urban pollution and high population rates all put pressure on water resources.

If we take the examples of Auckland or Melbourne we see that significant changes in design, requirements and specification have come from larger regional councils and in the example of ARC TP 10 Stormwater Management Guidelines for the Auckland Region 2003, have influenced requirements and design across New Zealand and has simply become a default position for areas without the resources to author and implement these kind of detailed guidelines. The successes are in fact all around us and in numerous ways the transition has begun. But what are the steps from here?

2 OBJECTIVES

This paper hopes to shed light on some of these questions, by investigating, the key elements and 'building blocks' necessary for cities to transition to water sensitivity, with a particular focus on the stormwater aspects of this spectrum, drawing on local project examples and overseas exemplars. The objectives of this paper can be summarized as follows:

- To present international exemplars,
- To describe how this transition might occur,
- Outline some of the tools which can be used,
- Detail the delivery mechanisms and the critical limiting factors,
- To articulate the institutional processes required.

3 THE INTERNATIONAL PERSPECTIVE

Internationally there has been an increasing move towards a more integrated, water sensitive approach to urban development and planning. This is manifest in a transition away from the traditional 'business as usual' approach to water management towards a more responsive network which embraces complexity as a means to deliver tangible environmental benefits whilst also creating a more resilient urban landscape. The drivers for this transitional change vary geographically and can range from historical sewer network deficiencies, ongoing flood management issues or particularly sensitive receiving environments. Regardless of the primary drivers which underpin this change, the move towards a more water sensitive approach can effectively and efficiently deliver on the full range of these challenges.

The following provides a brief summary of three international case studies where this shift towards water sensitivity has been made and some of the key defining facets which have supported this.

3.1 PORTLAND, USA

The City of Portland, Oregon provides another example of where water sensitivity has been applied across the urban fabric to provide ongoing environmental benefits. Approximately half of the cities sewers are combined with any rain induced surcharge contributing to significant pollution of the Willamette River. This is further compounded by other urban contaminants and prompted action. In response, since the early 1990s, the Bureau of Environmental Services (BES) has implemented a program that supports stringent regulation which was enacted whilst at the same time supporting education, urban ecology and amenity. Initially a stormwater management plan was documented which outlined how stormwater needed to be better managed across the City to reduce pollutants from the river discharges. The local government introduced strict codes mandating the integration of stormwater treatment elements in all new and redevelopment projects. A period of uncertainty and poor design outcomes led the Council create the Stormwater Policy Advisory Committee (SPAC) in 1996. This multi-disciplined group included technical representation from landscape architecture, architecture, engineering, institutional organisations, and the stormwater treatment industry, to provide input to the City on stormwater matters.

The SPAC collaboratively developed policy and regulation, which were developed into the city's stormwater management manual. This document (similar to Auckland's TP10) describes the requirements for stormwater management and specific WSUD design approaches.

In 2001 Portland saw the need for further internal coordination and targeted promotion of sustainable stormwater management systems and formed the Sustainable Infrastructure Committee. This committee represents a body of expertise within government who can to coordinate the roll out of programs and investigate innovative approaches to the city's water management. Following this initiative a more targeted Sustainable Stormwater Management Program was developed. This group monitors and tests the performance and design of

pilot WSUD projects and provides technical assistance to developers and designers who are incorporating stormwater measures into site designs. The program also facilitates community education and outreach programs and is focused on capacity building within the water industry.

Specific programs implemented by this program in Portland have included:

- Greenroof Program,
- Green Streets Program,
- Downspout Disconnection Program,
- Innovative Wet Weather Program.

Projects are well funded through a system of grants and cost sharing with the Portland Bureau of Environmental Services (BES), the Office of Sustainable Development and Federal Grants. In 2008, Portland's Mayor announced a budget of 50 million dollars over 5 years for the Grey to Green Initiative. This initiative is focused on specifically increasing the rate of green space in the city with a particular focus on integrated stormwater treatment assets. Up to 2013, over 17 ha of green roofs, 50,000 street trees and 920 green streets are in various stages of planning and delivery.

3.2 HAMBURG, GERMANY

The city of Hamburg provides a different example of transition where a strong and focused commitment has been well funded with intent to develop leading edge technical understanding and innovation. Similarly to London (and indeed many cities) Hamburg is located on the lower section of a significant river, the River Elbe, which is one of the largest in Central Europe. Downstream of many large (and industrial) towns the water quality within the river is largely governed by landuse well beyond the jurisdiction of Hamburg Wasser (Hamburg Water) who manage the city's water infrastructure. Since its inception the European Union (EU) has increasingly committed resources towards the betterment of the water resources in member states, in particular within the large watersheds which are unconstrained by political borders. This reflects an increasing interest by community stakeholders. Based on the EU wide opinion poll (Eurobarometer) recently found that almost half (47%) were concerned about water pollution. This increasing concern has been a stimulus for EU wide policy encapsulated within the EU Water Framework Directive. This directive deals with issues relating to water quality and ecological health of watersheds as well as large scale and complex flood management issues.

The result of this EU wide focus on water management has been an increased motivation to fund initiatives and innovations at a national, regional and local scale. In Germany combined funding from EU LIFE+ Programme, the German Federal Ministry of Education and Research (BMBF) and the Federal Ministry for Economic Affairs and Energy (BMWi) has enabled the city of Hamburg to forge an pathway towards innovative solutions to water management via a highly researched and resourced precinct scale pilot project. The *Hamburg Water Cycle* is a project which has been developed and is being piloted implemented at the new 15 ha Jenfelder Au development which is being constructed on a former military barracks to house 2,000 residents. The basis of the project is to cost effectively isolate the three waste water streams (namely stormwater, sewerage and greywater) and apply different water quality treatment approaches to each. Integrating bio-digesters and heat recovery into the process enables the nexus of water and energy to be optimized to provide further efficiencies. As a well-funded pilot, the Jenfelder Au site is intended as an incubator to support applied research into the technical components which can enhance the performance of the capture, treatment, reuse and controlled discharge of urban water. This research can then inform continuous improvement and enable the implementation of the overall integrated water (and energy) management approach across the city and indeed the whole EU.

In tandem with the Hamburg Water Cycle, the *RainInfraStructureAdaption* (RISA) project is another well funded (by the State Ministry of Urban Development and Environment of Hamburg) project being implemented by Hamburg Water. This project is focused on the flooding aspects of urban water management with an aim to develop responses to urban water management to avoid or mitigate flooding and water pollution from sewer surcharge. As with the Hamburg Water Cycle approach, RISA focuses on the identification of technological requirements and the creation of conditions that support innovations and forward-looking urban water management. The RISA structure includes technical working groups who collectively (and collaboratively) develop an understanding of the issues which must be addressed and the technologies which can support this. The specific working groups include;

- Urban drainage
- Urban and spatial planning
- Traffic planning
- River basin management

The overall stated goals for the city wide project are;

- Flood protection: risk assessment & flood prevention
- Water Protection: stormwater treatment & avoidance of pollution
- Near-natural water balance: every new building & reconstruction

3.3 LONDON, ENGLAND

As a particularly historical city, the urban center of London has been subject to significant change over a prolonged period. Located at the lower estuarine section of the Thames River, the city encompasses numerous smaller tributaries and rivulets which have been progressively covered over and piped. Historically these 'drains' were used to dispose of all of the city's waste resulting in ecological collapse in the waterways and significant human health issues.

More recently the city has developed alongside infrastructure modifications. The current city is serviced largely by a network of combined sewers which discharge to municipal water treatment plants prior to outfalls. As with most combined sewers the issue of capacity is an ongoing issue with significant rainfall events resulting in surcharge of mixed sewerage/stormwater into these relic tributaries and the river itself. In tandem with these water quality issues has been an increasing focus on significant and damaging flooding. Attributed to a mix of land use changes in the upper catchments and historical development on flood prone lower reaches, the risks of flooding have clear and communicable economic implications.

Responses to these urban challenges (whilst still in relative infancy) have demonstrated a well-intentioned attempt to take a more integrated approach. An initial focus solely on issues relating to flooding has dominated the water landscape. Implementation of flood detention ponds have been widely mandated in new growth areas with no clear policy directive in relation to water quality. At present, there is no mechanism to require water quality management to be delivered in new developments by local Councils or water companies. This results in a general apathy by developers with a focus on financial cost savings over innovation and environmental outcomes.

In the City of London, the water policy (4A.17 Water quality) states that; "*The Mayor will and boroughs should protect and improve water quality to ensure that the Blue Ribbon Network is healthy, attractive and offers a valuable series of habitats by:*

- *ensuring that adequate sewerage infrastructure capacity is available for developments*
- *refusing, or directing refusal of proposals that are likely to lead to a reduction in water quality*
- *using sustainable urban drainage systems to reduce the amount and intensity of urban run-off and pollution*

This nonspecific and non-binding policy is indicative of policy which lacks the technical rigor and/or quantifiable performance evaluation required to drive any meaningful action. The effectiveness and delivery of water sensitive design outcomes is therefore limited by a lack of clear and decisive policy and some inconsistencies with overall governance around any transitional change. The inability within local authorities to resolve challenges with the ownership and maintenance of stormwater treatment assets has also resulted in substandard performance due to unclear accountability.

More recently a research study and promotional campaign by the Construction Industry Research and Information Association (CIRIA) has driven momentum around water sensitive urban design across the UK and London in particular. This campaign has focused on the holistic definition of WSUD balanced with a stronger weighting towards flood mitigation.

This increased profile and community interest has prompted Thames Water, the utility which is mandated with the delivery of London's three waters infrastructure, to progress the issue of water sensitivity across greater London. The Greenstreets@Counters Creek project is an ambitious pilot study retrofitting a number of WSUD elements into a range of streetscapes and communities in Central London. These are being designed to manage surface water runoff whilst also creating greener urban spaces to increase amenity within the city. The intent is to reduce the incidence of flooding and sewer overflows into the Counters Creek waterway. It is hoped that the findings from this project will inform the industry on how best to overcome the relevant technical and stakeholder challenges and will ensure that the wider social benefits of WSUD are realised. These social benefits are fundamental to the project due to laws which give Thames Water no legislative powers to install WSUD assets within the streetscape. Therefore a process of consultative engagement has underpinned the roll out.

4 NEW ZEALAND DRIVERS FOR WATER SENSITIVITY

New Zealand is a country which has long been defined by water. Extensive inland mountain ranges, which stretch almost the entire length of the country, delineate east and west coast catchments, providing the source of numerous large and small waterways which in turn support a wide range of alluvial processes. A myriad of meso and macro scale forces continue to respond to our physical geology and induce change in the landscape. Tectonic forces, climatic variability, sediment transport, coastal processes and soil properties are all dynamically linked with our water cycle and the feedback loops which these sustain. Over the geological timescale, it is water which has provided our now productive alluvial plains, coastal outwash fans, protected inlets and deep river gorges and it is water which continues to sustain our towns, cities, industry and rural economy.

As with most populated nations, New Zealand's early settlement patterns were pre-determined by a relationship with water. Early Maori settlers relied on rivers, coastal estuaries and wetlands as valuable food sources and correspondingly established pa and kainga in close proximity to areas of abundant coastal and freshwater protein. This early reliance on these aquatic systems, and their life supporting capacities, underpinned the Maori's understanding of these complex ecosystems and the importance of their preservation for future generations. Adherence to the practice and principles of kaitiakitanga supported the Maori belief in the life giving forces of water referred to as 'Mauri' and underpinned a number of traditional approaches to water management which would now be regarded as sustainable resource management. Protocols such as not allowing human effluent into waterways, maintaining water within its 'natural' catchment and enforcing rahui (temporary moratoriums on food collection) on overfished areas reflected this appreciation of the importance of these dynamic systems for a range of ecosystem services. This close connection with water is perhaps best captured by the tribes of Whanganui and their saying, 'Ko au te awa. Ko te awa ko au' (I am the river. The river is me).

With the arrival of European settlers in the 18th and 19th centuries this human reliance on water was increasingly exploited. Again, the strategic importance of harbours, navigable waterways and well watered pastures defined the establishment of our towns and cities as well as the landuse of our primary industries. In particular extensive clearance of the dominant lowland forests, draining of the abundant wetlands and containment of our once dynamic rivers resulted in dramatic impacts on our natural waterways. The deforestation rates experienced in New Zealand are considered to be the highest experienced anywhere in the world with approximately 14% of the countries landmass (equivalent to the current National Park estate) cleared in the 10 years from 1885 to open up areas for development and provide timber for housing and industry. At the same time we also drained approximately 90% of wetlands to support the primary industries on which New Zealand's economy became reliant. The combined impact of this on the hydrology, nutrient cycling, water chemistry, temperatures and sedimentation would have been rapid and pronounced.

On a more urban context the construction of numerous large dams for water supply and hydroelectricity, disposal of untreated human effluent, reliance on waterways as drainage conduits and the introduction of exotic sport fish species such as trout has resulted in the widespread degradation of our streams, rivers, lakes, estuaries and coastal environments. This degradation is ongoing with continued stressors from both urban and rural landuse. Anthropogenic pollutants such as heavy metals, hydrocarbons, industrial wastes and litter continue to be discharged to our waterways with aging wastewater infrastructure also contributing untreated sewerage

through surcharge, cross connections and exfiltration. Urban growth continues to increase imperviousness within catchments and our ongoing reliance on motor vehicles (and hence roads) provides a sustained source of water borne pollutants with toxic (often lethal) impacts on aquatic biota. In tandem with these landuse impacts associated with our urban centers, there are also ongoing significant impacts due to extractions from surface and groundwater for municipal water supplies (as well as rural irrigation). These extractions, which often only service non-potable water demands, further deplete our waterways of their natural flow characteristics often extending the ecological impacts further into the upper catchments above our population centres.

An increasing scientific understanding of the impacts of human mismanagement on waterways and receiving environments has occurred in recent decades since the 1950's. This has highlighted the importance of the complex biological processes which flourish in a functioning ecosystem and the fragility to these from our 'traditional' approaches to water management. These biological impacts have been extensively covered in literature and are not elaborated on here. In New Zealand, the Treaty of Waitangi has established a legal platform for the recognition of the Maori value set towards water management and the environment. This recognition is enshrined in the Resource Management Act which is explicit in the importance of respecting the cultural significance of water to iwi and mana whenua. This cultural value set is also increasingly being embraced by non-Maori as a way to articulate the importance of mitigating the impacts of our urban land uses on the natural environment. Community awareness of urban biodiversity and relic waterways is compounded by an increasing appreciation of the benefits of recreating in nature and the realization of the often harmful human health risks associated with degraded water quality. This in turn underpins progressive legislative tools which are being developed to better manage our water resources. Interpretations, by Regional Councils and Territorial Authorities, of the National Policy Statement on Freshwater are increasing the impetus to modify our approach to water management with defined intent to not just maintain the status quo but to actively alleviate the legacy of past mismanagement. When we cast our thoughts towards the future, it is clear that climate change and the uncertainty associated with this introduce a different level of complexity with water management, in particular for urbanized centers. Projected increases in peak temperatures, prolonged dry spells and less frequent but more intense rainfall events must all be factored in our planning for future water management.

The adoption of a more water sensitive approach to how we design and deliver water services (across all streams) provides a pragmatic and efficient way to maintain (or improve) existing levels of service with a reduced toll on the environmental and social capital on which we depend for prosperity. With an increasing realization of the economic importance of community health and wellbeing, recognition of the cultural values of water and an appreciation of role of ecosystem services in providing a resilient and sustainable niche for humanity the rationale for water sensitivity is compelling. Mitigating of the urban heat island effect through maintaining water in the landscape, protecting receiving environments through appropriate levels of water quality/quantity treatment, integrating flood mitigation with town planning, providing fit for purpose alternative water sources for non-potable demands and reflecting the relic hydrology of the land through a reconnection with lost waterways can all deliver ongoing tangible and intangible benefits.

5 SUMMARY OF LIMITING FACTORS

If, through the transition to water sensitivity a targeted approach to identify limiting factors and similar to a risk approach, define and implement enabling solutions are undertaken, the limitations of policy or institutional function can in themselves form part of the process to transition. Some of the critical limiting factors in the transition to and implementation of water sensitivity are considered to be the following:

- Poor understanding of the benefits particularly some of the less tangible aesthetic or ecological ones.
- Lack of Geographic Information System (GIS) resource availability,
- Limited in-house modelling technical knowledge. This results in difficulties in model scoping, survey, design and quality assurance procedures. Experience has shown a large variability in the quality and usefulness of modelling outputs.
- Lack of robust discourse with National planning processes,

- Life Cycle Data Management (lack of processes to plan data capture and house data in a useable manner) and its subsequent use to support project initiatives and report on successes to stakeholders,
- Limited asset data information for the largest town and cities (connectivity, levels, validation) resulting in opportunities being difficult to locate or implement without substantial cost,
- Planned integration with other stakeholders (other council departments) with the intent to agree on scope of the planning work, recommendations and mutual implications and alignment of proposed works.
- Receiving environment information and availability,
- Human resource capacity and skills,
- Consulting and contracting communities not been equipped to provide or construct ideal solutions,
- Limited information sharing between councils and/or regional groups.
- Lack of technical standards for the identification, design and maintenance of water sensitive technologies.

6 TRANSITIONAL TOOLKIT

6.1 POLICY AND STANDARDS

Water policy must be targeted to deliver on water sensitive outcomes. Without the correct level of targeted policy, provided at the national level, the trickle-down effect on regional initiatives and directives is often sporadic. Additionally, the resources needed to effectively implement policy and the supporting technical standards to deliver on policy objectives are critical limiting factors.

The NZ National Policy Statement on Freshwater goes someway to provide guidance, to councils across New Zealand, to set minimum standards for freshwater quality. However, in many ways this guidance has not been able to cater for the fundamental landuse pressures by which water quality is generally degraded. Water quality is intrinsically connected to the activities on the land. If, for example, the surface of a catchment has changed from mixed scrubland too intensive urban subdivisions the effect on water quality are profound and the consequential effect on ecosystem health being equally profound. Although the Resource Management Act 1991, in the New Zealand context, has provision for an assessment of environmental effects to be conducted related such activities. Many of the effects are either poorly understood, as a consequence of permitted activity rules, or cumulative (death by a thousand cuts) and so are ineffectively mitigated.

To be effective, policy associated with water sensitivity, should aim to control landuse activity and/or development, to encourage design alternatives that facilitate development outcomes while supporting water sensitive design outcomes and ultimately result in built infrastructure that is water sensitive. There is a complex relationship between the various design standards that dictate how metropolitan areas are built. From roading to parks it’s the thread of water sensitivity woven into these standards which can result in integrated design outcomes. It is more than just having standard guidelines for wetland treatment systems.

Even when policy can be established that enshrines the values, goals and objectives of water sensitivity, high quality technical guidance for the design and management of the required infrastructure is required. Auckland is currently involved in the crystallization of the numerous planning elements that form the Auckland Unitary Plan. The supporting technical stormwater standards are complex and various. This example underpins the pressure smaller cities and regions might have in developing their own set of, essentially bespoke, standards.

The sharing of high quality methods, standards or tools can act to encourage the uptake of water sensitive principles and the adoption of policy. Identification of technological requirements and the creation of conditions

that support innovations and integrated urban water management is fundamentally supported by sound policy and high quality technical standards.

Based on the intent to increase the quality of policy and standards to deliver water sensitive outcomes, the following building blocks/actions are proposed;

- That the National Policy Statement Freshwater be amended to include provision to support the management of stormwater discharges through the use of water sensitive technologies,
- That a set of national design standards for water sensitive technologies are developed, which are flexible enough to cator for the various design conditions in the New Zealand context,
- A national working group is established to investigate and report on the capacity of the regions to deliver on the Freshwater Policy Statement and to implement water sensitive initiatives.
- That the link between landuse and water policy is more fully investigated as the current planning framework in most Regions of New Zealand allows for the incremental degradation of receiving environment quality.

6.2 DATA AND INFORMATION

In many instances, in New Zealand, there is a lack of perceived need in terms water sensitivity unless severe water stress or pollution is a key pressing driver. In Australia water usage and awareness of water stress has typically increased and reduced respectively as water resources become available after drought. In Auckland in 1993 a lack of water resources resulted in heightened public awareness about water use and conservation. The response was to retrofit rain tanks and to change personal behavior. In consideration of these examples and acknowledging that water quality issues which might affect creeks and streams with complex ecologies are abstract, well-crafted scientific communication about the state of our receiving water to the public at large is essential to garnish support for the capital spend required on enabling infrastructure. Internet websites that tap and present telemetry data from water quality sensors or networks is a key delivery tool for transparent stakeholder engagement. It's all about the data!

We live in newly data rich environment where everything from our fridge's to toasters can store, analyze and send information via the global information network the World Wide Web. At the personal level, in the palm of our hands we carry extremely powerful technology, in the form of smart phones, which can be used to accurately locate ourselves through GPS, take high resolution panoramic images and record and store our daily motion in steps and distance. On a corporate scale our telco, water and transport networks are run in real-time with sensors, telemetry and enhanced neural network technologies.

With this as a background, the rich vortex of data, the transition to water sensitivity can be more effectively achieved through smart focused collection, analyses and sharing of vital data about water use, foot printing and quality. Particularly when trialing new technologies or design types data about cost and performance is a) often not collected but is b) crucial to encourage greater up take of best practice. Typically the cost of, for example, water quality performance data of a treatment device such as a wetland or proprietary filter, is high and thus not often collected.

Based on the intent to support a robust fit for purpose data and information collection and sharing systems in the water sector the following building blocks are proposed;

- Single platform GIS systems with a customised interface that takes into account user profiles necessary to support collaboration e.g. consenting teams having full access to environmental data-sets.
- The design and implementation of standardized data structures and analytical testing procedures,

- Procedures for the capture, maintenance and analysis of data, sharing of results and generation of customised tools in the most efficient way.

- Internet websites that present telemetry data from water quality sensors or networks as a key communication delivery tool to support transparent stakeholder engagement.

- Customize apps to be used by the community to inform them about local water sensitive design installations as they navigate through the urban landscape.

6.3 INSTITUTIONAL CAPACITY BUILDING

Multi-department and organisational collaboration is essential to meet objectives and outcomes and share benefits. There are of course a number of barriers to this sort of collaboration as it is often secondary to the goals and drivers of the individual departments or organisations. In particular project implementation and performance targets will generally not include any targets or measures for positive results generated through interdepartmental collaboration related to environmental outcomes.

University research is key to inform continuous improvement in design and application. The students who are benefit from this practically focused education are then well equipped and enabled to implement integrated water management approach across a city or country.

The integration of information through Geographical Information Systems (GIS) and documented management systems can allow multi-department/organizational collaborations to flourish. Under a total watershed management approach that includes infrastructure, such as roads, wastewater/water supply and multiple land uses, it is possible to combine visions and resources to achieve more sustainable results.

Investment in human resources is vital in the delivery of any complex project in particular when multi-stakeholder synergy is required. Vital to this is the retention of well trained staff that has access appropriate tools. This results in staff being in much better position to support each other and to provide a robust sounding board for their outside resources to deliver high quality outputs. Institutional process is under pinned by well delivered human resource management that takes into account the wider objectives of the parent organisation. Any institutional success to deliver on water sensitive objectives or indeed stormwater best practice, which may in itself be business as unusual, will typically consider the technical skills and thought leadership vital to this end.

Based on the intent to support institutional capacity in the water sector the following building blocks/actions are proposed;

- A national task force encourage multi-department and organisational collaboration.

- A structured organisational process that provides for procedural changes to be initiated from findings and experience of the learning of other related sectors.

- Involve the contracting community in the trailing of new products and methods in a pilot process to access the body of practical knowledge they are the keepers of.

- Appoint water sensitive champions across organisational departments.

- A free national level GIS platform to design and test water sensitive technologies.

6.4 COMMUNITY EDUCATION/UNDERSTANDING

Community understanding of the issue of water management is surprisingly low. Recent surveys in the Porirua Harbour catchment found that as much as 70% of respondents across a range of demographics believed that water drained to roadside sumps was somehow treated prior to discharge into the Porirua Harbour. This result typifies the current level of community engagement in seemingly mundane facets of urban life such as urban water management. Similarly the level of appreciation of the relic eco-hydrology of our towns and cities is considered very low with few knowing the alignment of the long lost historical streams and fewer still being

aware that they are still essentially in existence albeit in large diameter underground culverts. In recent years communities have made significant advancement in understanding around litter, recycling, vehicle and home fire related air pollution and urban biodiversity but are still divorced from the issues of water management. It is generally only with the onset of droughts that people are compelled (through costly campaigns) to restrict wasteful water use practices with a general lack of comprehension of where the mains water is sourced from and what the environmental impact of this is. Likewise, little thought is typically given to the fate of urban pollutants such as heavy metals, nutrients and hydrocarbons whilst at the same time as a population we are quick to celebrate our coastal waters, lakes and rivers. Activities such as on street car washing, irrigation with mains water and unmetered residential water use are increasingly being phased out supported by extensive education and communication programs.

Education can be a powerful tool to drive change. Through an increased understanding of the natural water cycle, and the impacts of the traditional engineering approach to the management of it in an urbanized context, the community can make informed decisions on what values they attribute to the preservation of ecological values within the system. These can then be balanced against the economic costs and benefits of implementing water sensitivity at a range of scales/complexities to determine the preferred approach to future management. This in turn then needs to feed back to the decision makers to ensure that they are making strategic decisions which are genuinely reflective of the communities wants and needs. This process is essentially what is being facilitated through the Whaitua process in the Wellington Region at present.

Based on the intent to increase community understanding of water sensitivity through education, the following building blocks are proposed;

- Document and promote a clear understanding of the natural aquatic ecosystems which existed prior to European arrival.
- Reference relic waterways and features in the urban landscape through public art, interpretive signage, publicity and education programs.
- Document and promote a clear understanding of the cultural value of local waterways to Tangata Whenua and communicate the relationship which they had with specific ecological niches
- Develop and support community/school education programs and community science to engage members of the public in the issue of water management. These should be coordinated at a national level for consistency and to enable meaningful use of collected data.
- Launch nationwide education program around increasing the communities understanding of how the stormwater network functions and the ecological impacts of actions such as street side car washing.
- Educate and promote (supported with appropriate financial assistance) a move away from mains water use for non-potable water uses such as irrigation and toilet flushing. Convey message beyond just ‘reservoirs are low so time to conserve water’.

6.5 MULTI-DISCIPLINE TECHNICAL SKILLS

Solutions and technical innovations which deliver meaningful improvements with water sensitivity require a diverse and multi-disciplined skillset. The integration of climate science, hydrologic modelling, technical engineering, ecology, urban design, landscape architecture and art is needed to develop solutions which adequately consider the synergistic potential of all constituent parts. Currently this integration does not occur at a deep and substantive level. Often sub-standard WSUD projects are delivered without the technical input of specialist engineering and likewise they are often delivered without the considered input of more design orientated professionals. In both instances the outcomes of the projects will fail to meet expectations. This is currently manifest as poorly designed WSUD assets which are poor performers with limited functionality or conversely over engineered systems which detract from the public realm and offer little to engage the community in the issue of water management.

The process to facilitate this multi-disciplined team approach should in theory be straight forward. Involvement by and consultation with a range of technical and non-technical parties should occur as a matter of course.

Timing is a critical component whereby delayed engagement will often result in limited flexibility to adopt design responses due to preconceived decisions which have already been made. This issue of timing often arises out of a general lack of understanding with regards to other disciplines or constraints around expectations of cost and delivery timeframes.

Based on the intent to support a culture of multi-disciplined culture in the water sector the following building blocks are proposed;

- Establish collaboration at the tertiary education stage through coordinated cross faculty (including multiple institutions where necessary) input to course work.
- Foster culture of collaboration within new graduates through coordinated cross faculty project work involving input from external technical experts.
- Establish nationally standardized capacity building programs which target a range of professional disciplines on the principles and practice of water sensitive design.
- Introduce multi-disciplined streams and keynote presentations within industry conference programs (Water, Landscape Architecture, Social sciences, Urban design etc.) to expand the scope and breadth from existing limited focus.
- Champion benefits of multidiscipline approach to projects and communicate to clients at the outset of projects.

6.6 FRAMEWORK OF INNOVATION

As with most processes involving change, innovation is a key instrument to underpin success. Innovation is typically viewed as a technical paradigm related to tangible objects. In the case of water sensitivity however, this innovation needs to encompass not only the 'on ground' technologies but also the broader social, cultural and institutional environments which must support effective implementation. The historical status quo of Councils and/or service utilities being solely vested with the powers to plan, design, construct and manage water assets in isolation from the broader environmental and social contexts is changing. This change in itself is an innovation and offers a promising divergence towards more integrated outcomes. As with any innovation, these dynamic developments in the water industry need to be recognized as a learning experience with a view to continued improvement. As such learnings must be recorded, acted on and revisited to test for validity. The current position with many stormwater management initiatives where assets are constructed, fail to perform as intended and are then outcast as failures is neither efficient use of investment or conducive to a process of continued improvement. Similarly larger scale integrated water management strategies which encompass multiple strands of stormwater, wastewater and mains water must be monitored and routinely appraised to ensure that an informed understanding of what works and what doesn't is attained.

A particularly topical example of this is the current work being undertaken in the Wellington Region to define water management objectives and targets on a whole of catchment basis through a collaborative planning approach. This process is being led by Greater Wellington Regional Council (GWRC) and will feed into the Regional Plan which will provide directives tailored for the respective catchments or 'Whaitua'. These catchments are being subject to extensive scientific, social and cultural interrogation through a prolonged analysis phase which is intended to transparently capture the priorities, aspirations and expectations of the community within the Whaitua through well informed consultation. This in effect will establish service limits and water management targets which are developed from the bottom up rather than top down. This approach is similar to that employed in Canterbury and is being closely watched by other regions as an example of innovation from which to learn and apply elsewhere.

Based on the intent to support a culture of innovation in the water sector the following building blocks are proposed;

- Create an atmosphere which is supportive of calculated risks (with due consideration of repercussions of failure) in testing new approaches to water management in pilot scale projects.
- Develop a connected network of Council stakeholders across the country as a forum to discuss latest innovative projects and provide feedback and learnings as a result of these.

- Create a central database of New Zealand research and pilot projects covering all facets of water sensitivity
- Investigate the body of existing international research with integrated water and water sensitive design.
- Plan pilot projects which are locally specific rather than generic.

ACKNOWLEDGEMENTS

We would like to acknowledge all our fellow colleagues and members of the public who are actively involved in the transition to water sensitivity.

REFERENCES