WATER SENSITIVE DESIGN: A STRATEGIC APPROACH TO MANAGING STORMWATER IN AUCKLAND

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ABSTRACT

Water sensitive design (WSD) underpins the approach preferred by Auckland Council for the management of stormwater. The objectives, policies and rules of the Auckland Unitary Plan support this approach for both greenfield and brownfield developments. In turn, this approach supports the vision of the Auckland Plan – for transformational shifts and for Auckland to be the World's most liveable city.

WSD is the latest manifestation of an evolving story of stormwater management, from the combined sewers of early Auckland; through awareness of growing flooding problems; to catchment scale treatment of stormwater for quality purposes and now to the trans-disciplinary approach of WSD to managing urban stormwater.

Auckland Council's amalgamation has provided a unifying structure by which to provide better Local Government services in Auckland. The Government's emphasis on the delivery of integrated services for customers, underpinned by the Managing for Outcomes strategic management framework; and the expectation of leadership throughout organizations requires a strategic approach that is applied across all facets of service planning and delivery.

WSD is an outcome-focused approach to stormwater management. The outcomes identified by the community include healthy urban streams which provide natural and social capital, while serving as part of the stormwater network, improved water quality in our harbours and reversal of the degradation known in some estuaries. To achieve these outcomes in an intensifying and growing city, stormwater must be managed appropriately to minimize changes in hydrology and avoid transportation and deposition of contaminants to the streams and harbours, all of which can be achieved through the water sensitive design approach.

This paper will trace the evolution of stormwater management in Auckland; will show how strategic planning has been part of this process for the last 30 years, and how water sensitive design is the natural progression for stormwater management in Auckland and others of the World's most liveable cities.

KEYWORDS

Unitary Plan, Auckland Plan, Water Sensitive Design, Stormwater Strategic Planning

1 INTRODUCTION

In 2010, Auckland Council was created out of the amalgamation of 7 territorial authorities and 1 regional council. The amalgamation resulted from a Royal Enquiry, set up by the Government, to consider the bureaucratic challenges arising from the existing regime, particularly for infrastructure development, as Auckland continued to grow and develop. The Commission examined similar city bureaucracies around the world, and made recommendations. The final Auckland Council structure departed from that recommended, and created a single governing body, with 24 local boards.

The responsibility for the provision, operation and maintenance of the public stormwater network sits in the operational arm of Council – specifically in the Infrastructure and Environmental Services Department. A significant proportion of new public stormwater infrastructure is delivered as part of the subdivisional requirements on new development, and as such, it is important that Council provides clear direction to the development community about its expectations for the stormwater network.

2 AUCKLAND'S STRATEGIC FRAMEWORK

2.1 AUCKLAND PLAN AND STRATEGIES

The population of the Auckland region is predicted to grow from approximately 1.4 million in 2012 to 2.4 million by 2040. Most of this population growth will be accommodated within the existing urban area of Auckland, or in planned growth expansion areas.

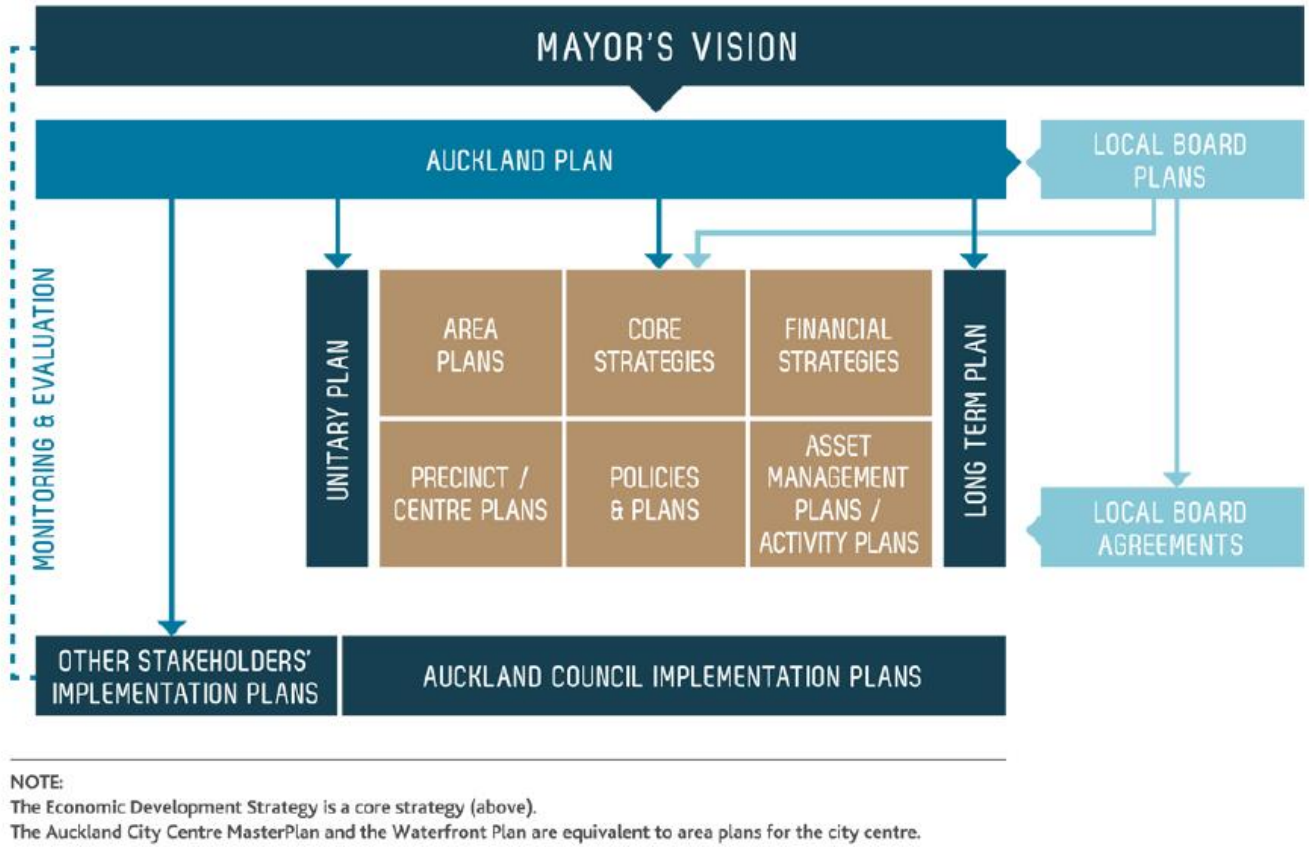

Figure 1: Auckland's Strategic Framework

Auckland Council's Strategic Framework (Figure 1) includes the Mayor's Vision, the Auckland Plan, and a carefully orchestrated set of plans and strategies which will guide development and economic decisions in the City through this 30 year time period. The Auckland Plan is the spatial plan which sets in place the high level aspirational outcomes, transformational shifts, and development strategy which are necessary in order to achieve the Mayor's vision.

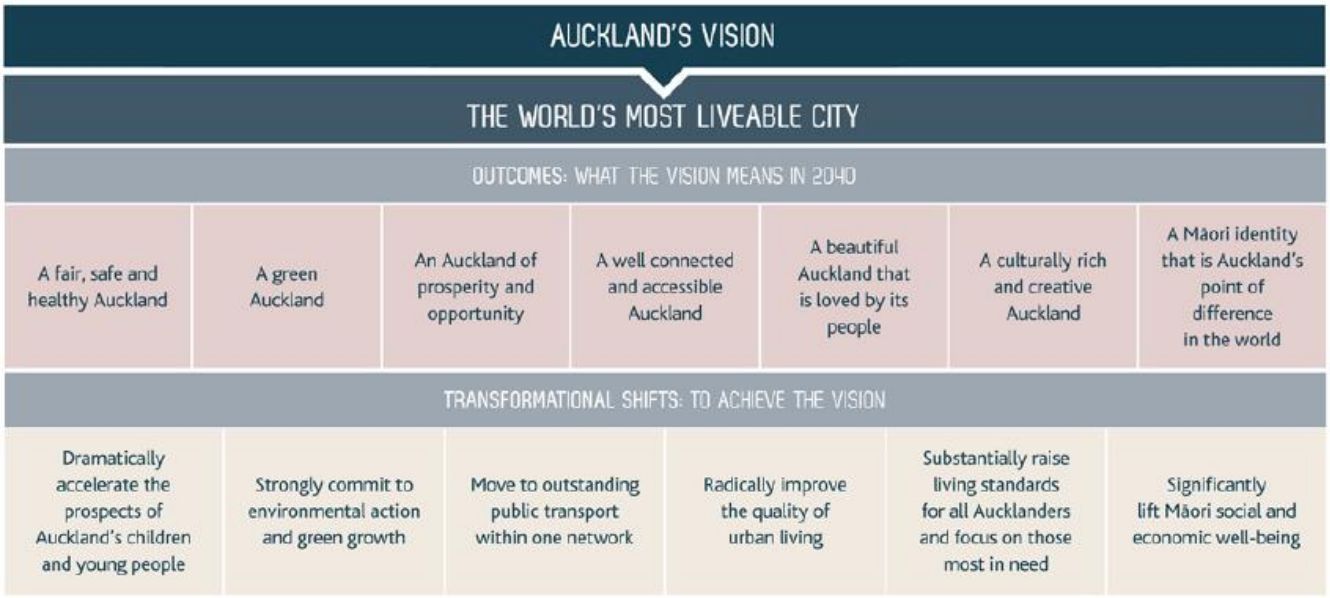

Figure 2: Vision, Outcomes and Transformation Shifts, Auckland Plan

Of key importance to the management of the stormwater network are the Outcomes of 'a fair, safe and healthy Auckland' and 'a green Auckland'. The transformational shift of strongly committing to environmental actions and green growth provides the mandate to manage the stormwater effects of growth and development in a way which provides for better environmental outcomes than were achieved in the past. The development strategy (Figure 3) which acknowledges that people and nature are inseparable points to the inherent wisdom of living with nature, and will provide us with a pathway to achieve integrated built and natural form and character in Auckland. The strategy of plan, deliver and maintain quality infrastructure is fundamental to the stormwater network. The use of a water sensitive design approach provides the strategies and tools to deliver on these Plan ideals. Although identified separately, the special character attributable to Auckland's strong Maori identity requires that all actions appropriately allow for Maori values and participation.

As seen in Figure 1, the Auckland Unitary Plan, required under the Resource Management Act, is one of the key tools for implementation available to the Council. Objectives, policies and rules support the outcomes sought by the Auckland Plan, and include requirements that will help to achieve the water sensitive design approach to stormwater management.

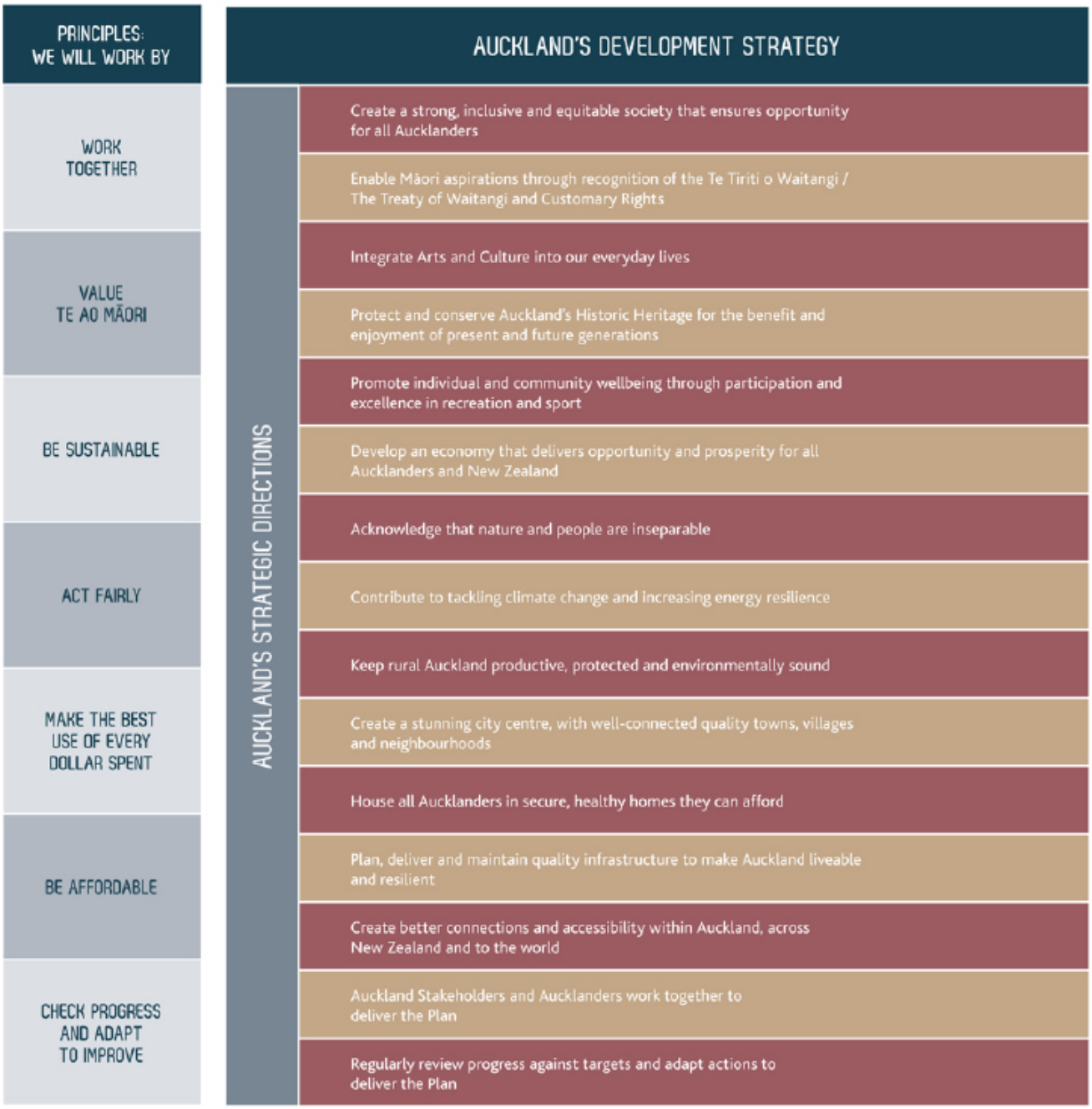

Figure 3: Development Strategy and Principals

2.2 STRATEGIC MANAGEMENT AS AN INSTRUMENT OF CHANGE

Strategic management in the public sector dates from the 1980's. The changes in bureaucracy that occurred during the 1980s, part of the New Era of Public Management, were aimed at making central and local government more efficient. Part of this change was the recognition that government services were overly bureaucratic – appearing to operate for the sake of procedures rather than for the sake of the people they were supposed to be serving. Strategic management, which had been used for many decades in the private sector, was seen as being useful for the public sector – especially in driving towards outcomes for society (Nutt and Backoff, 1987).

Strategic management is the process of setting goals, objectives and actions to achieve a set of desired outcomes. It is essentially about change – setting goals which will provide

a different outcome from the current state, and identifying actions which are required to achieve that changed state. Often, these actions are about changing the expectations and behaviours of the people involved. It follows a process of planning, resourcing, implementation, monitoring and evaluation – and ideally as the cycle repeats, improvements are made which will lead to the achievement of outcomes both effectively and efficiently.

In 2001, 'Managing for Outcomes' (MFO) was introduced in NZ, with the aim of having the Public Service achieve a "more strategic and outcomes focused approach to management and reporting" (Steering Group for MFO, 2003). It was anticipated that this would lead to a more responsive public service, able to deliver the outcomes that the Government was trying to achieve. While this was aimed more at the central government agencies, it was also introduced to local government through instruments such as the inclusion of the four well-beings in the Local Government Act 2002.

In the years since the introduction of strategic management to the public sector, there has been an inherent contradiction – that which runs between being efficient versus being effective (Gallop, 2006). Efficiency is about measuring the success of government departments, and is usually achieved by setting KPIs, which are often set as outputs. However, effectiveness is about achieving the desired outcomes for the community being served, and it is harder to measure public value and public good outcomes than KPI outputs. Often effectiveness has been lost for the sake of efficiency. Gallop (2006) suggests that a new era of strategic management is required – one that accommodates the increasing complexity, the joined-up responses that are needed, and the collaboration that will be required to resolve increasingly complex problems of sustainability.

It can be seen that the development of the Auckland Strategic Framework, and as a key instrument, the Auckland Plan, has set up the strategic direction for Auckland and Aucklanders to follow if Auckland really is to be the 'world's most liveable city'. It appears to deliver this new approach described by Gallop – accepting the increasing complexity of issues as Auckland grows, and setting the framework for joined-up collaborative responses.

3 AUCKLAND'S STORMWATER MANAGEMENT

3.1 WATER SENSITIVE DESIGN

Water sensitive design in its widest sense is about developing urban land in a way which allows for recognition of the hydrological cycle, and seeks to minimize the impacts which arise from changes to catchment hydrology in response to urbanization.

As a concept, WSD recognises that a trans-disciplinary approach to urban development will allow opportunities for integration of land use and water management, for using water as a resource, and for working with nature to enhance ecology and ecosystem services in urban areas. It is Auckland Council's preferred approach to both greenfield and brownfield development as it provides for avoiding or minimising the adverse effects of stormwater on receiving environments of streams and the coast.

A definition of water sensitive design is provided in the Proposed Auckland Unitary Plan (PAUP) as:

An approach to freshwater management. It is applied to land use planning and development at complementary scales including region, catchment, development and site. Water sensitive design seeks to protect and enhance natural freshwater systems,

sustainably manage water resources and mimic natural processes to achieve enhanced outcomes for ecosystems and our communities.

Water sensitive design approaches:

- *Utilise and maintain, enhance or restore natural freshwater systems*
- *Minimise hydrological changes to, and the adverse effects of land use development on natural freshwater systems*
- *Mimic natural processes and minimise the requirement for hard constructed infrastructure to manage stormwater runoff*
- *Maintain, enhance or restore amenity, open space and other community and cultural values.*

The decisions made now about urban development will have a significant influence on what Auckland will look like in 50 years. Auckland Council is championing a design-led City, one in which people and nature are linked, where environmental action is supported, and where the natural capital of Auckland, including our streams and harbours, is valued for its contribution to the liveability for Aucklanders. WSD contributes to this design-led approach by requiring consideration of streams and catchments when designing stormwater management into development.

3.2 HISTORY OF AUCKLAND STORMWATER

3.2.1 WATER QUANTITY

Prior to the Resource Management Act (RMA, 1991), stormwater discharges and catchment management were legislated under the Water and Soil Conservation Act 1967, and managed by the Auckland Regional Water Board (ARWB). In urban Auckland, this was focussed on the potential flooding effects of stormwater discharges, and the need therefore for good drainage, and a catchment-wide understanding of flooding.

With the development of computerised hydrological and hydraulic modelling in the late 1970s and early 80s, it was possible to model and quantify flooding on a catchment scale. Changes in design rainfall, in land use in the catchment, and in the configuration of the flood plain could all be modelled and quantified. While the calculations had always been known and applied, the manual method was long and time consuming, and so calculating flood plains, and the changes associated with changing parameters, was limited to critical locations. At the time, it was accepted that stormwater derived from impervious surfaces would be efficiently discharged via a piped system or channel to the nearest outlet – either into a stream or into the coast. Therefore the usual expectation in using the modelling was to help understand how any flooding which affected houses could be 'fixed.'

Where flooding was identified, both statutory and structural options were investigated. Structural options included consideration of upper catchment storage basins where flooding was in the lower catchment, removal of houses, bunding around groups of houses, widening of open channels, or other site specific solutions.

Even where rural land was zoned for future urban development, catchment modelling was carried out to define the flood plain area that would be required, assuming the entire catchment developed, and using a design factor for impervious area coverage under maximum probable development scenarios. In some council's, the floodplain was then set aside and could be zoned as flood management area.

This process of gathering information, running the models, understanding the outputs, and describing a set of actions for structural or non-structural solutions is part of the strategic planning cycle. The monitoring of the actions, and the evaluation of how well they address the goals have typically been left to the regulatory sections of the (legacy) regional council. This is true of New Zealand councils in general, and improvements in integrating regulatory and operational responsibilities for evaluating outcomes is a current focus for central and local government agencies. The re-focusing of WSD provides the ideal opportunity to define more clearly the outcomes that should be measured – both in terms of Plan delivery and in environmental results.

3.2.2 WATER QUALITY

During the late 1980s, there was increasing awareness of the impacts of cities on waterways. Chesapeake Bay, in Virginia on the eastern coast of the US is a classic story of the realisation that the whole embayment had "died" and the awareness of the need to clean up the catchment. The issues there were largely related to heavy industrial discharges, and wastewater discharges for which there were low performance standards as well as combined sewer overflows. In Auckland, while combined sewers were a problem in the older parts of Auckland, the enclosed nature of our harbours, and their value as fisheries nurseries was recognised as providing potential for increasing water and sediment quality problems.

In Auckland, attention was turned to the effects of development on the Upper Waitemata and Manukau Harbours (ARC, 1990). These studies showed the effects of sediment as a contaminant in itself, but also the contribution of general urban runoff to poor water and sediment quality. Subsequent studies were initiated to monitor water and sediment quality in both harbours, and some locations remain part of the long-term monitoring programme in Auckland. It was clear from this monitoring that urban land use causes adverse effects.

This preliminary work was all part of the early learnings of the then ARC's urban stormwater quality programme, directed at understanding and managing the known water quality impacts. At the same time, an economic valuation report was prepared, to give an understanding of the value of the harbours to Auckland (Auckland Council TP93, 1991). It values the benefits to Auckland arising from amenity, commercial and recreational opportunities, including the flow-on benefits and intangibles, and reported a resultant $442million annually (CPI adjusted to 2013 NZ$700million).

For Auckland Regional Council, the change to the RMA and its focus on avoiding, remedying or mitigating adverse effects on the natural environment, provided regulatory support for managing contaminants in stormwater, which was clearly necessary given the increasing information about the adverse effects of stormwater discharges. The opportunity to use a best practicable option (BPO) approach to stormwater discharges (rather than a water quality standard approach) ultimately formed the basis for the approach taken in TP10 (Auckland Council TP10, 1992.) The basis for TP10 was that detention, and slow release, would provide time for settlement of soil particles. This meant that sediment, a contaminant itself, as well as other contaminants attached to it would be removed from stormwater. Cost curves showing cost (and size) of device against sediment quantity removal indicated that the justifiable proportion of sediment to be removed was 75%.

Once TP10 was published, provided that a developer complied with the design guidance in TP10, they would generally be granted consent. This could include treatment devices such as raingardens, swales, sand filters, ponds or wetlands. Often the cheapest option for large scale development was the use of ponds or wetlands at the catchment scale.

TP10 became the 'default' best practicable option, and also the default for 'low impact design'.

3.2.3 THE GROWING BODY OF KNOWLEDGE

From 1990 until amalgamation in 2010, there was a considerable body of knowledge built up largely due to the on-going collection of scientific information and evidence – a large amount of which was funded by the ARC, but some of which was contributed by Landcare and NIWA with research funding from national programmes or funds. This included water and sediment quality monitoring, coastal benthic monitoring, in-stream macroinvertebrate sampling; it included monitoring of installed wetlands, swales and raingardens – typically stormwater quality in to the device vs water quality out of the device; it included the five year Low Impact and Urban Design for Development programme, carried out jointly by the University of Auckland and Landcare Research, which investigated governance, implementation and monitoring issues along with the physical science and technology.

Studies carried out with on-line wetlands showed that they had significant impacts on catchment ecology. In addition to issues of fish passage through the wetlands, there were problems with elevated temperature at the outlet, ducks contributing to faecal matter and high biological oxygen demand. In addition, it was realised that the construction of a wetland causes damage to the stream – although both provide ecological habitat, they are different habitats and ecology; and a wetland habitat effectively results in loss of stream habitat.

As a result of increasing understanding of the physical effects of stormwater runoff, particularly on stream erosion and health, the second edition of TP10, published in 2003, included a requirement to attenuate rainfall volume on-site – 34.5 mm across the site's impervious surface. This was intended to reduce peak flows, and therefore reduce the potential for erosion in the receiving stream environment. This was the first time that flow requirements had been imposed in Auckland because of the impact of changing flows on the stream geomorphology and associated ecological effects, rather than as a control on contaminants or for flood attenuation. These requirements were generally applied at a development scale.

Again, with evidence and increasing understanding, it was realised that this approach actually extended the length of time for which flow rates were in the 6 months-2 year AEP flow range owing to the slow release requirements set out in TP10. This range of flow rates is actually the erosive, channel forming flow rate due to its frequent occurrence.

3.2.4 EXAMPLE DEVELOPMENTS

During the 20+ years since 1990, the major catchment-wide developments at Flat Bush and Long Bay have provided lessons as they have evolved through the planning and consenting processes and are now well through the construction phase. Flat Bush was identified during the early 1970s as an area for future development. As development spread outwards towards this area during the 1980s and 1990s a catchment management approach was taken to identify flood and water quality management requirements, based on the accepted philosophy of the time. The urbanization of Long Bay began as a legal challenge to the Regional Policy Statement setting of Metropolitan Urban Limits in 1996, and following the Environment Court decision, went on to develop as a structure plan process.

Both case-studies provide examples of good planning processes, with people committed to good urban development and stormwater management outcomes. It is valuable to

understand where these developments provide examples of good water sensitive design elements and, where compromises have been made, to understand the drivers for this.

Flat Bush

The legacy Manukau City Council made a decision in the 1990s to take a strong lead in the strategic planning for this catchment. The process began in 1997 and the variation to the District Plan was adopted in January 2006. In keeping with the principles of the Regional Policy Statement and the Regional Growth Strategy, protection and enhancement of waterways and use of low impact stormwater management were an important focus, as stormwater was identified as the most significant issue for development. The process was driven by a strong catchment management philosophy, with the structure planning progressing alongside as an integral part of the process.

The low impact design approach allowed for different treatments depending on the residential density, and consisted of a mix of discharge of stormwater to ground, use of permeable paving and swales alongside roads to provide stormwater treatment. Up to 50 ponds were provided for, and while it was intended that stream corridors would enable sensitive areas to be protected and biodiversity would be enhanced, these ponds were planned to be constructed on the stream network, as on-line ponds. They would also provide recreational and amenity functions by providing a strong natural element while meeting stormwater flood and quality management objectives.

As this was the first large scale application of low impact design in Auckland, the council pre-empted concerns that on-site devices would not be maintained over time, that they would be removed or changed so that they no longer functioned, and that Council would have no control over compliance requirements on the individual site owners. As a prudent planning measure, the larger scale catchment devices, for both flow and quality control, were designed to cater for the entire contributing catchment as if there were no other measures in the catchment. However, this meant there was less incentive for developers to take up further development of low impact design principles. The exception to this was the Regis Park subdivision, which is now recognised as an exemplar for Auckland in on-site or near-source mitigation for flow and quality effects. Some work is underway to monitor the changes in stream health due to the on-site mitigation measures.

It was during the late 1990s and early 2000s that the effects of on-line wetlands or ponds were realised – the two major effects being that they effectively destroyed the stream ecology, and that during times of low flows, the water heated up, causing adverse effects downstream due to increased water temperatures.

Flat Bush is a good example of the parallel structure plan and catchment management planning process, low impact principles were provided for, the amenity value for the area is very high – beautiful parks, 'green finger' corridors with walking tracks, and the urban layout has achieved relatively high density. The social aspects of the low impact design seem to have worked well, including the layout of public streets between houses and the wetland / park areas which provides easy access to the parks for the public and not just the nearby home owners. From a stream health point of view, the Regis Park subdivision provides the best opportunity for good stream ecology.

Long Bay

The Environment Court decision of 1996 required that the sensitive natural environment be protected while allowing development. The legacy North Shore City Council (NSCC) took a two staged approach to the development of the structure plan. Already in 1999

they had included principles for future development in Long Bay, but the more detailed structure plan process resulted in setting the main objectives and policies in 2001 followed by the detailed formal structure plan, including rules and methods and a timetable for the staged release of the land, which was notified in 2004.

NSCC were keen to integrate transport, community facilities and amenities, urban design and water management in the development. While the structure plan process had a focus on integrating matters, catchment management planning provided the core stream and stormwater management technical details.

The Long Bay area available for development fell across two catchments – Vaughan's Stream and the Awaruku Stream. The integrated catchment planning process was the vehicle for identifying the values of the streams, and the opportunities for low impact stormwater management principles to be applied in accordance with these values. NSCC split the area into two parts, essentially capturing the upper catchment, more sensitive stream environments in Part A, and the lower catchments in Part B. The level of protection, development densities and methods for mitigation were tailored to the relative sensitivities and values of these two Parts.

The use of financial modelling for four scenarios of infrastructure, environmental and development controls was an interesting approach – and showed that a full low impact design approach would most likely be unacceptable to the market. The modelling showed how the costs would fall to different parties (Council, developer or private owner) for each scenario.

As with Flat Bush, the newness of this concept meant that NSCC stepped back from full low impact design implementation. Integration of raingardens into the streets has allowed for treatment of the road stormwater for quality purposes, and contributes to a pleasant streetscape and the general amenity of the suburbs. The planning process was well integrated across the land use and stormwater aspects, and main streams have been kept open with the layout of the subdivision designed to assist with this. Long term monitoring will provide an understanding of the value of this approach – both in terms of the social benefits as well as the ecological and amenity benefits.

4 A WATER SENSITIVE FUTURE

Strategic stormwater management in Auckland, until now, has essentially been managed through provisions of the RMA and the regional and district plans. The RMA is focused on minimizing adverse effects of activities, however, outcomes need to be framed for desired positive aspects, not simply in terms of the effects to be avoided. With amalgamation, and drivers under the LGA, Auckland has developed a spatial plan, a strategic framework, which provides for the weaving together of the LGA, RMA and other relevant legislation and regulation to deliver the positive outcomes aspired to by Aucklanders. This evolution of learning, and changing practice to allow for the lessons learnt, is strategic management in practice.

This opens the door for water sensitive design to be considered in the widest possible sense, as Auckland grows, develops and redevelops. Even within the confines of the RMA, in the writing of a unitary district / regional plan, there is room to integrate land use management with stormwater design, in addition to continuing requirements to manage the effects of the discharge. Management of the land via regulation allows opportunities to achieve the four principles set out in the PAUP definition of WSD – to keep natural freshwater systems, to minimize the effects of hydrological changes, to use natural systems where possible rather than hard engineered infrastructure and to

recognize the contribution that green infrastructure stormwater management systems can contribute to amenity, ecosystem services and cultural wellbeing.

It is also important to take into account global drivers in the changing fields of urban design and growth, which includes a growing understanding of human well-being in cities, and the provision of ecosystem services as defined by the Millennium Ecosystem Assessment (MEA, 2005, included in Directive 7.1 of the Auckland Plan). The next challenge will be to fully understand the value of ecosystem services as benefits in Auckland, to truly safeguard Auckland's natural capital, including harbour water quality, so that a liveable city really can be achieved. This will include getting better at accounting for the long-term benefits and finding ways of incentivizing developers rather than simply applying regulatory requirements.

5 CONCLUSIONS

The amalgamation of the legacy Auckland councils into one Council has provided an opportunity for the development of a single strategic framework for Auckland. The Auckland Plan sets out the vision and goals, and the use of water sensitive design as an approach to development has the potential to contribute towards those goals by contributing to the transformational shifts identified in the Plan.

For the last 30 years, the legacy councils have worked on improving stormwater quality, with the adverse effects of changes in hydrology being catered for since 2003. The refocusing on water sensitive design, including the consideration of site layout to avoid piping of streams, provides a more holistic approach to stormwater management, and a real chance to improve the outcomes for water quality and our urban environment. These shifts will help to achieve the vision of being the world's most liveable city.

The examples of catchment scale development in both Flat Bush and Long Bay, provide the opportunity to learn lessons from the integrated structure plan and catchment planning processes and the implementation of water sensitive design principles. On-going monitoring and evaluation of the social and environmental outcomes arising from these developments will provide valuable information.

Auckland is growing. With the improved knowledge and evidence about the effects of stormwater on urban streams and coastal waters, and growing awareness of the non-stormwater benefits of ecosystems, water sensitive design provides a holistic and strategic approach to improving stormwater management outcomes even while increasing urban growth. Hence, it has become Auckland's preferred approach to urban development and redevelopment.

ACKNOWLEDGEMENTS

This paper is a statement in time – setting down the story of Auckland stormwater for the last 30 years, and describing the framework in place which will take Auckland's stormwater forward. We would like to acknowledge that there have been, and still are, many dedicated professionals involved across the disciplines of ecological and water quality sciences, planning, engineering, land development, urban designers, etc. Many people have made up the jigsaw puzzle of knowledge and experience that has delivered us to this place in time.

We thank you all for your work and wisdom to date, and ask that you remain dedicated to learning, teaching and practicing in the water sensitive future of Auckland.

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