

# SPONGIFYING OUR CITIES - WHAT CAN WE LEARN FROM CHRISTCHURCH'S TWENTY YEAR "EXPERIMENT"

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## ABSTRACT

Sponge cities have emerged as a transformative urban planning concept in response to the growing challenges of climate change and urbanisation. The concept of sponge cities originated in China in the early 2000's, emphasising the need to rethink urban flood management, managing runoff through green infrastructure. Many parts of the globe have now been seeing the benefits of such an approach.

Sponge cities (or Low impact development, Water sensitive cities) aim to mimic the water-absorbing qualities of the natural environment, allowing cities to absorb, store, and utilise rainwater, reducing the risk of flooding and ensuring a sustainable water supply. The core principles include making space for water, giving room for rivers, enabling green infrastructure, and delivering at source / decentralised stormwater management systems (Mercier, 2023).

Christchurch, New Zealand, provides a compelling case study of sponge city principles in action. As a flat city built on significant wetland areas, managing surface water has always been a challenge. The city's recent history is marked by the devastating earthquakes of 2010 and 2011, which caused severe damage to its infrastructure.

Before the event, the city had embraced similar principles to a 'sponge city,' through the ground-breaking 1999 Waterways and Wetlands Natural Asset Management Strategy with its focus on a 'six-values' management approach. This put cultural, ecological, heritage, recreational and landscape values on equal footing with managing drainage. The Waterways, Wetland and Drainage Guide (WWDG) in 2003, created the design standard for all future infrastructure to deliver to.

The earthquakes enabled the accelerated uptake and application, with city planners and policymakers seizing the opportunity to rebuild with resilience in mind. The city has continued to invest in the restoration of its natural waterways and the creation of multifunctional green spaces, improving overall urban livability to help enhance flood resilience in areas that suffered from significant flooding events in 2014.

Christchurch's approach is uniquely embedded in its topography and cultural and post-European settlement history, as all approaches to sponge cities need to be. While in the west of the city high permeability soil allows for infiltration, the east has a high groundwater table, both requiring different approaches to coping with rainfall. Hillside areas require micro-storage, whereas large natural ponding areas are progressively being returned to their natural wetland 'sponge' state. Land use zoning and specific area plans have been used to protect these areas from development, forming a blueprint for how water will be managed as development occurs.

Christchurch's approach has not only planned for improved resilience to climate-related challenges but has also enhanced its environmental sustainability and quality of life for its residents. The case of Christchurch serves as an inspiring example of how innovative urban planning, from an initial idea and a group of champions can turn adversity into an opportunity to create a more sustainable, resilient, and livable city in the face of a changing climate and provides a benchmark for what is required of future urban transformations.

Amongst several significant lessons, a key enabling factor has been the tactical deployment of case studies to share exemplar visions for the community and elected members to enjoy. The value of champions (be they individuals or a group), is central to being successful in delivery across the catchment, selling the vision for the waterways and codifying the design needs for waterways into development outcomes.

Growing a network to support the planning and delivery of sponge cities across public/private enterprises enables bigger transitional moves to land and be successful as does 'well planned' recovery after natural disasters, allowing a community to significantly enhance overall flood resilience.

## **KEYWORDS**

**Sponge cities, flooding, waterways, Low Impact Design, Water Sensitive Urban Design, city wide strategy, resilience, communities, multi-benefits.**

## **1. INTRODUCTION**

Aotearoa New Zealand faces heightened risks from natural disasters like floods and cyclones due to climate change. A report by the Helen Clark Foundation and WSP suggests transforming urban areas into 'Sponge Cities' as a proactive strategy.

The current reliance on aging infrastructure falls short against increasing rainfall threats and continued urban expansion. Sponge Cities, inspired by ancient Chinese techniques, promote water harmony through innovative measures.

A **sponge city** is an urban area designed to mimic natural systems, that absorb, and storing rainwater (below or above ground) rather than letting it overwhelm drainage systems and core city functions. It uses blue / green infrastructure like parks, wetlands, and permeable pavements to slow down and capture water, reducing flood risks, improving water quality, and enhancing biodiversity. It encourages development away from areas with flood risk and acknowledges that the issue is sometimes about development in the wrong place, that cannot be mitigated without relocation. Essentially, it's about working with nature instead of against it to adapt cities to heavier rainfall and climate change impacts.

Whilst the term Sponge Cities has become more commonly known locally and globally, it is also being seen to be the missing part of how our cities have evolved in the past. It is important to recognise currently that many cities and catchments around Aotearoa have been applying smaller scale 'sponge city' applications / elements for many years at various scales.

This paper explores the key outputs from research work that sought to examine how Ōtautahi Christchurch has been successful in applying many of the sponge city elements for the past thirty years. This research enables us to share the complex

challenges that face Christchurch, many of which will resonate with cities and communities across the motu. The research identifies several key findings and lessons for cities and communities to build off and develop their unique place-based city and catchment sponge city approach.

We issue a wero / challenge for you to come to Ōtautahi, learn from the applications and importantly take it back to your city. In doing so, you can seize an opportunity to enhance your cities resilience to face the complex nature of the challenges ahead.

## **2. CONTEXT**

As Aotearoa New Zealand determines its response to an uncertain climate future, it is imperative that we evolve both traditional and innovative approaches that enhance the resilience of our assets, our businesses, and our communities. As such, four key themes emerge if we are to embrace sponge cities approaches:

- Move away from "fighting" water through conventional drainage systems and working collaboratively across urban environments and asset owners. Recognising water is a valuable resource, distributed use and replenishing groundwater helps us to adapt to future climates.
- Prioritise nature, including the restoration and creation of urban green spaces. Parks, wetlands, and green roofs to support the four community well-beings<sup>1</sup> and enhance our urban areas to make them more livable.
- Involving communities in understanding and recognising the value of nature-based solutions. This will lead to designs that are accepted, embraced, and nurtured, fostering a sense of ownership and collective responsibility.
- Celebrate what is unique about NZ and embed Mātauranga Māori (the accumulated knowledge of generations), and tikanga Māori (customary practices), into our approaches. They provide guidance on living in harmony with the natural world, informing sustainable water management strategies.

Flooding is a constant issue that faces many of our urban areas across Aotearoa. It is our most common natural hazard threat. The threat is growing as our population grows with more and denser urban areas, further exacerbated with the looming threat of adverse effects of climate change. These impacts are already being felt in Aotearoa New Zealand, as intensification challenges the performance of our existing urban infrastructure, reducing the capacity available for shifts in rainfall patterns and extreme weather events.

Allied to this, is the growing threat of rising sea levels, it is clear the urgency for action has never been greater for many of our towns and cities. All this highlights the pressing need for adaptation measures, outlining the current and projected consequences of inaction. Notably, the following demonstrate the broad nature and complexity of what is facing us as we seek to enhance the overall resilience across the motu (taken from Mercier, 2023):

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<sup>1</sup> Local Government Act (2002) introduces the four community wellbeing and the role of Local Authorities to play a broad role in promoting the social, economic, environmental, and cultural well-being of their communities, taking a sustainable development approach.

- Extreme rainfall events are projected to intensify in some areas of New Zealand (primarily western and southern regions).
- Our assets are ageing and have been challenged by historic and current levels of growth. These are regularly being found to not be ready for rainfall increases.
- Our cities are becoming less green and losing trees through urban intensification.
- We need to house more people if our population continues to grow.
- Flooding causes impacts, these will grow in some regions (primarily the western and southern parts of the country).
- Māori face unique challenges due to their cultural connection to at-risk landscapes and traditional knowledge systems.

We are rapidly realising that our natural ecosystems are essential for our well-being, providing a variety of services like clean water, natural cooling, air quality regulation, food production, mental wellbeing, and recreation. However, climate change could disrupt these ecosystems in a multitude of ways including changing rainfall patterns. Degraded and isolated ecosystems are likely to be more vulnerable to climate change.

Nature based approaches can help to make our overall ecosystem more resilient to climate change and ensure that they continue to provide the services that people need (more commonly referred to as Nature Based Solutions (NbS)). These solutions seek not only to withstand climate impacts but to thrive in concert with the ecosystems that sustain us.

NbS are defined by the IUCN (International Union for the Conservation of Nature) as being "Actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits." Opperman et al., 2021 identifies that NbS interventions:

- Addresses a societal challenge (such as flooding, drought, water quality degradation)
- Use ecosystems to address the challenge (protection, management, or restoration)
- Deliver simultaneous benefits to people (human well-being) & biodiversity (net gain).

Because NbS projects often involve protection or restoration of ecosystems, there is often cross over with conservation projects. A critical distinction between NbS and nature conservation is that, although NbS activities protect or restore ecosystems, that protection or restoration is not the main purpose of the investment (Opperman et al., 2021). A societal function is usually the main delivery outcome, such as enhancing the overall resilience of our communities and urban landscapes by reducing people's risk from floods.



Figure 1 – Nature Based Solution examples (taken from the World Bank website)

### 3. WHAT ARE SPONGE CITIES?

Mercier (2023), reports that the term 'sponge city' was coined by a landscape architect, Dr Yu Kongjian in 2003, inspired by traditional approaches used by Chinese farmers over the past 2,000 years. The farmers regulated water through the wet and dry seasons by setting aside 20% of their cultivated land for ponds. Taking this approach into the urban landscape, would enable whole cities to turn to have a network of 'blue' and 'green' nature-based infrastructure to soak up and store water in green open spaces allowing our waterways to 'breathe' in times of high flows, minimising the impact on the socio-economic fabric of our urban areas.

Section 1 incorporated a definition of Sponge Cities, with it being clear that we are not talking only about absorbing water (as is commonly thought with the title) but incorporates room/space for the natural rhythms of water to come and go safely, minimising the socio-economic and cultural impacts to people and the built environment. The concept is also about helping communities to prepare for a largely accepted future where cities and towns may need to adapt to an uncertain future climate. They are intended to enhance cities and ecosystems, through restoring and promoting biodiversity, supporting cities to become more resilient to climate change and natural hazard disasters.

This practice will help reverse the trend in urban development of the past with a reduction in urban green spaces and tree cover. Morgenroth, J (2022) identified that "Wellington has the greatest canopy cover, with 30.61%, while Auckland has 18% canopy cover and Christchurch has 13.56%", noting that Auckland and Christchurch tree canopy cover levels are significantly below the averages for the specific biome the cities are located within. One of many reasons as to why these numbers are shown in Figures 2 & 3 below.



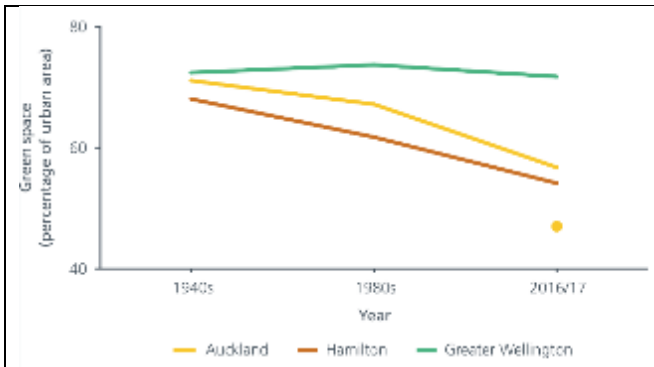


Figure 2 – The declining trend in green space across three cities since the 1940’s (PCE, 2023).



Figure 3 – Comparing the intensity of suburbs 1940’s development (Mt Roskill) on the left to 2010’s (Flat Bush), taken from PCE (2023).

The name ‘sponge cities’ has caught the public’s imagination following recent flooding events, with a range of applications already delivered nationally. Across the motu, applications include the small scale (streetscapes and neighbourhoods) through to more catchment wide solutions. Sponge city applications across several Chinese cities have shown impressive results:

- Jinan – high risk flooding areas reduced by 45 % for the 1 in 50-year rainfall event, through creating above-ground storage.
- Wuhan – reduced flooding, sequester CO<sub>2</sub>, and reduced temperatures in the city.
- Shangyu District, Shaoxing - installation of 45,000m<sup>2</sup> of permeable pavements and landscaped waterbodies has allowed for 87% of typical annual rainfall (by volume) to be captured rather than directed to stormwater networks – double that captured previously – reducing flooding impacts across the 2.8 km<sup>2</sup> district.

Applying a unique sponge cities framework for Aotearoa approach offers a systemic approach for all those that work across urban environments to enhance resilience against climate change by fundamentally shifting how we manage urban water for the benefit of the waterway, the communities, as well as maintaining business continuity and protecting assets.

Several key opportunities emerge from transforming our approach to living with water (under a sponge city framework) as opposed to the more ‘traditional’ stormwater management approaches, namely:

- Flood mitigation: Absorption and flood storage reduces peak flows, slowing runoff protects infrastructure assets, people, and the receiving water environments.
- Water quality improvement: Natural filtration removes pollutants, reducing treatment needs.
- Infrastructure longevity: Reduced stress extends life, lowers maintenance costs.
- Additional benefits: Increased biodiversity, improved human health, reduced urban heat island effect, groundwater/stream flow recharge.

There are several challenges associated with these potential solutions, including:

- Context – it is important to acknowledge / adapt thinking for each catchment and local setting – as these applications are not one size fits all requiring trans-disciplinary thinking and community / mana whenua involvement.
- Retrofitting nature-based solutions into existing urban areas is challenging and complex, due to a web of existing services, multiple land uses and land ownership.
- Initial investment: Implementing nature-based solutions can sometimes be costly at first, but evidence points to widescale and longer-term benefits accruing.
- Data limitations: Long-term performance data may be scarce.
- Integration: Combining traditional & green infrastructure requires early planning. Pro-active spatial and strategic infrastructure planning is critical to success. A long-term vision is essential.

Overall, sponge cities offer a proactive approach to climate change adaptation for infrastructure asset managers. By integrating nature-based solutions with traditional infrastructure, you can enhance the resilience of urban systems to withstand future challenges, provide environmental benefits, and enhance quality of life for residents.

Several recent applications typify this shift, including Greenslade Reserve, Northcote, Auckland that was completed a mere 4 months prior to the devastating Auckland Anniversary floods of the 27<sup>th</sup> of January 2023 (See Figure 4 below). Christchurch has similar applications across the city, such as the Edmunds Sports Park in the Bells Creek catchment, which has not been so severely tested to date.



The Helen Clark Foundation report (Mercier, 2023) shares several further case studies and is a recommended read that offers valuable insights, empowering asset managers to adopt sponge city thinking and realise the value of nature-based approaches for effective climate adaptation planning.

## 4. SHARING THE CHRISTCHURCH LABORATORY

### 4.1 EXEMPLARY VISIONS, DESIGNS & IMPLEMENTATION

About the same time as Sponge Cities was entering the global lexicon thanks to Professor Yu Kongjian, a small but visionary water unit in the Christchurch City Council was already changing their approaches. The unit were investing in smaller scale applications to shift waterways infrastructure investment away from 'getting rid of the water' efficiently to seeking to integrate water into the urban landforms to create more ancillary benefits to the traditional drainage only focus.

Figures 5 – 10 show the planning, visions, and implementation across a series of projects and locations throughout the city over the past 20 years.



*Figure 5 Papanui Stream in Erica Reserve – before (1999) and after naturalisation of the timber lined drains (in 2010) reproduced from updated WWDG (2010).*



*Figure 6. New subdivision stormwater outcomes - Wigram Skies development, 2012<sup>2</sup>.*

<sup>2</sup> Images sourced from <https://www.ccc.govt.nz/assets/Documents/Environment/Water/Avon-River-Catchment-Vision-Values.pdf>





Figure 7. Te Papa Ōtākaro – integrating green infrastructure and making space for the river (2015 – 2017) (Photos Credit – Liam Foster 2018).



Figure 8. Te Oranga Waikura, Bells Creek catchment flood storage<sup>3</sup> (2017).



Figure 9. Urban Creek Catchment Visions for blue/green networks (WSP Opus 2018).



Figure 10 Stream naturalisation and inclusion of floating wetlands within the No.1 Drain, 2019<sup>2</sup>.

<sup>3</sup> Images sourced from <https://hail.to/sara-templeton/publication/hVS4sMY/article/RzYZJjc>





Figure 11 Images of Te Kuru Wetland system, part of SWAP delivery (Photos credit – Mark Groves 2024).

## 4.2 SHIFTING FOCUS FROM HISTORICAL APPROACHES

This mahi and research resulted in codifying guidance / standards for delivery of natural waterways, with the publication of the WWDG (CCC, 2003). The research concluded that natural-based interventions (natural treatment) could not only be cheaper in the long run but more importantly enable a wider range of ‘values’ to be realised (as shown below in Figure 12).

This shift introduced a new approach, that has become known as the ‘six values’ framework, where interventions sought to deliver enhancements for other values – Amenity, Cultural, Heritage, Landscape, Recreation as well as perform the key Drainage function required.

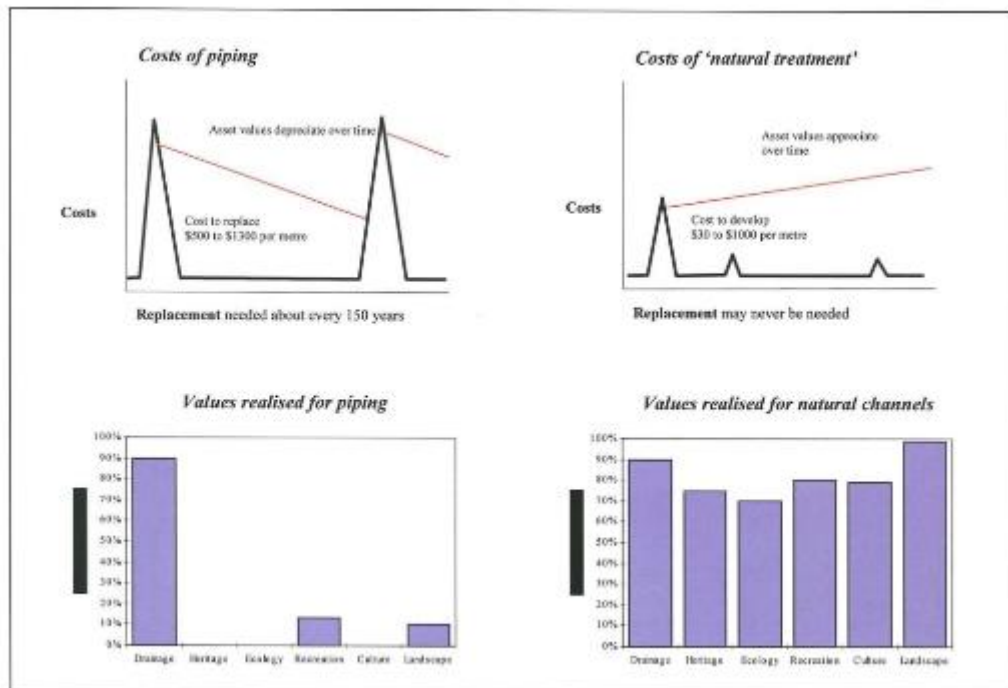


Figure 12 – Simplified image of the thinking that shifted the way surface waters are managed in Ōtautahi Christchurch in the latter part of the 20th Century (CCC, 1999)

### 4.3 THE CHRISTCHURCH SETTING & CONTEXT

Generally considered too wet for permanent settlement by Ngāi Tahu, European settlement of Ōtautahi Christchurch proceeded despite the extensive wetlands and channels throughout the area. While there were pockets of dryer grassland and forest, Christchurch is essentially founded on wetlands.

The 1856 Black Map is a survey plan that shows the original land formation, vegetation, waterways, and wetlands of Christchurch at the time of European settlement (a modified version is shown overleaf in Figure 13). It is a useful indicator of the natural drainage and vegetation types that existed prior to urbanisation. It also often explains why some areas are particularly vulnerable to flooding.

Furthermore, the main title of the history of the Christchurch Drainage Board (CDB) is 'Swamp to City' (Wilson, 1989). This too hints at the floodplain management issues faced in Christchurch, where relatively flat swampy land was drained to allow urban development. As the 'swamp' dried out the sediments consolidated requiring ongoing maintenance to keep waterways flowing, with 'dredgings' placed on the banks creating localised challenges for flow.

There are many lined channels throughout parts of Christchurch, where the only function served is drainage. Urban development now often relies on these.



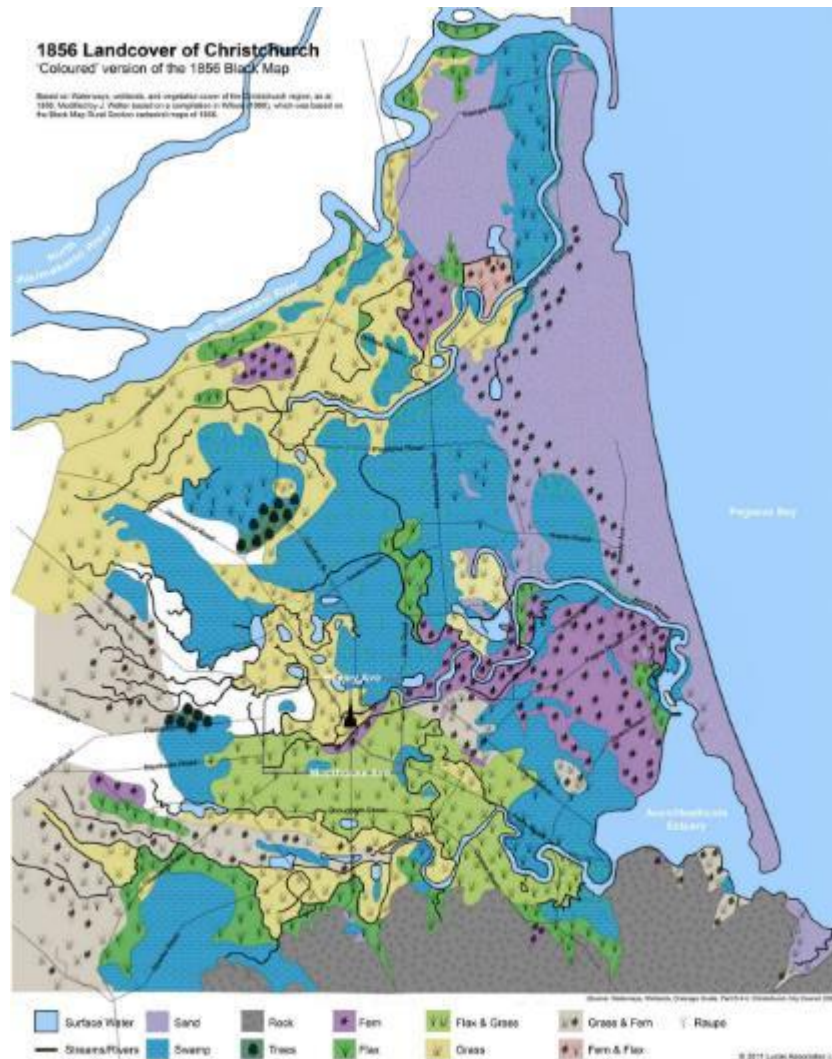


Figure 13 – Modified Black Map showing waterways, swamps, & vegetation cover for Christchurch<sup>4</sup>.

Being so flat, the changes from the Canterbury Earthquake Sequence, urban intensification and a changing climate have meant that flood vulnerabilities are quickly exposed. Water quality is affected with the spring-fed streams / waterways of Christchurch now degraded through their straightening, presence of hard banks, reduction in riparian vegetation, and growing prevalence of urban contaminants.

While the origins of urban Christchurch were largely thanks to the works of European settlers draining the swamp (Wilson, 1989) to enable urban development and protect the new city from flooding, things started to change during the 1990's. Colin Meurk described this 'revolution' in his foreword for *The Christchurch Waterways Story* (Watts, 2011) "...a group of innovative engineers appeared, blinking as they emerged from their piped surrounds into the sunlight. This band of big thinkers embarked on the creative mission of freeing the city of its linear manicured mind set and instead introduced serpentine tussock-clad riverbanks, havens for native wildlife. Importantly, they implemented a multi-value approach to water planning in the city and for a while the concept, the indigenous plants and the wildlife flourished."

<sup>4</sup> Modified by J Walter based on Wilson (1989). Image sourced from <http://www.lucas-associates.co.nz/assets/ChCh-Historical-Maps/1856-CHCH-MapColoured.pdf> on 24<sup>th</sup> March 2024



The Waterways and Wetlands Natural Asset Management Strategy (CCC, 1999) is as revolutionary now as it was 25 years ago. It is worth repeating the introduction in full as it is not out of place in contemporary sponge city approach document:

*"Recently the Council decided to take a values-based approach to the management of the natural and physical resources that make up Christchurch's system of waterways, wetlands, and drainage. This approach has a two-fold benefit. Not only does it satisfy the Council's responsibility to maintain its assets in good condition and budget accordingly, but it also provides a means by which the Council delivers on the resource management objectives and policies contained within its City Plan.*

*Examples now exist of how the Council's values-based approach has worked in practice. These include Corser's Stream, a naturalised waterway that links the Avon River & Travis Wetland as a green corridor with pedestrian access and which was less costly than the original piping scheme; Janet Stewart Reserve which is a Stewart family bequest to the people of Christchurch that has become a celebration of waterways and wetlands beside the Styx River; the wet-pond associated with the Wigram Retention Basin which ... traps contaminants from an industrial catchment, but also provides a wonderful habitat for birds and plants adding life to the landscape.*

*Planned with imagination and sensitivity along with community consultation, waterways and wetlands can do much to enrich Christchurch. The challenge is to progress from the past thinking of responding to needs only with engineering solutions, to one in which an investment is made in forethought and sustainability.*

*By understanding the natural processes linking land and water we are much more able to bring to life the values important to our community. These values have been specifically identified as ecology, landscape, recreation, heritage, culture, and drainage.*

*The preparation of the strategy in consultation with elected representatives and Tangata Whenua is the beginning of a long process of realising the values in a way that is sustainable for present and future generations. Its success depends on full participation of the key partners and the interest and support of the key stakeholders identified in the strategy.*

*It is intended that this document be the foundation for a strategy that will continue to be developed through ongoing consultation and monitoring of progress."*

This strategy has formed the basis on which Christchurch has turned from drainage alone to a more integrated approach to surface water management. There have been successes, failures, and everything in between in the intervening 25 years, but there is a deeply ingrained focus on multi-value outcomes wherever possible. This approach also informed the WWDG, CCC's stormwater design guide, where the six values approach to stormwater management was codified in an 'engineering' guide.

#### **4.4 WHAT HAS ALL THIS RESULTED IN.**

The implementation across Ōtautahi Christchurch is the best evidence of the success of the shift in the way that the Land Drainage Unit transformed, several of these are shared below with several captured in Figures 5 to 11 above:

- **South-West Area Plan<sup>5</sup> (SWAP)** - The 2009 document provides a framework for managing urban and business growth for part of Christchurch. The plan is based on a blue-green network that puts the management of surface water (including stormwater treatment, floodplain management and waterway restoration) at the heart of the framework (Figure 14). This allowed for the plan to incorporate the key elements of nature-based solutions the sufficient space to be successful, prior to development occurring. Te Kuru, described below, is an outcome from this plan.

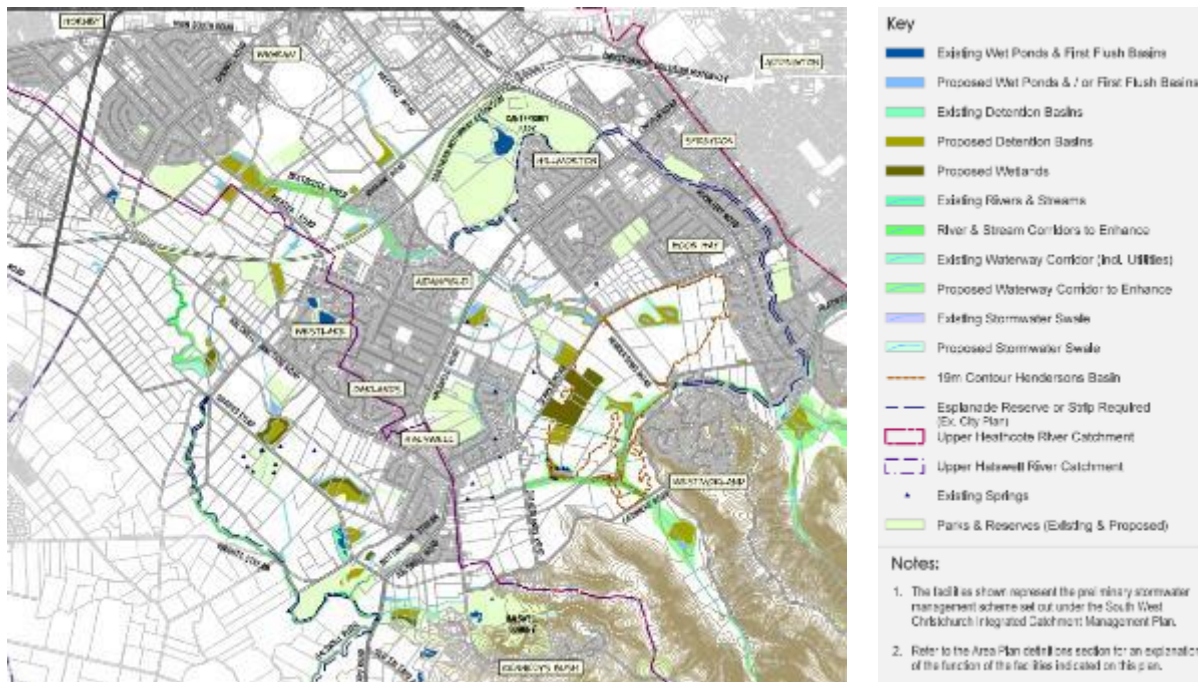


Figure 14 – A snip of the SWAP 'blueprint' showing the planning of an extensive blue-green network<sup>6</sup>

In effect, the plan allowed this area to develop as a sponge city. As evidence of the success of planning ahead around water, on a like-for-like comparison with 1991 development, water levels during a current climate 2% AEP event have dropped by nearly 400 mm in the main Heathcote River channel just downstream of the area covered by the plan, despite all the development in one of the fastest growing areas of Christchurch.

- **Wigram East Retention Basin** (Figure 17) – The 'original' six values project, construction began in 1993 with a vision for combining a wet pond for treatment and flood detention with restoration of wetland and forest planting in an area that lacked this original habitat. 30 years on it is now a site of ecological significance with a high diversity of bird species (visiting or resident). This provides an example of the long-term impact of allowing space for water.
- **Flockton Basin and Dudley Creek Catchment** – A \$50m flood scheme consisting of creek widening and naturalisation alongside a flood bypass structure, completed prior to 2017 supports flood mitigation for over six hundred properties that had an increased vulnerability/risk to flooding due to the Canterbury Earthquake Sequence of 2011/12. The scheme allowed for enhanced natural

<sup>5</sup> <https://ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/area-plans/south-west-area-plan>

<sup>6</sup> <https://ccc.govt.nz/assets/Documents/The-Council/Plans-Strategies-Policies-Bylaws/Plans/area-plans/south-west/SWAPFinalPlan1-southwest.pdf>

habitats along the creek corridor to support native taonga species, such as Tuna and other freshwater native species thrive, whilst also delivering a connectivity along the length of the creek in the form of new footpath allowing the communities to connect with the awa and have segregated, active, and accessible modes of transport.

- **Bells Creek catchment area** – A \$19 million land drainage scheme has reduced the flood risk for dozens of properties in the Woolston and Linwood area and created lasting legacies for the community. *"The flood mitigation work that has been done over the past two years in the Bells Creek catchment area has reduced the number of properties at risk of floor level flooding in a one-in-50-year event from thirty-three to one. An additional eighty-eight properties also benefit from significantly lower flood risk. But what is really great about this land drainage scheme is the benefits that we have been able to bring to the community as a whole through providing new recreational and ecological spaces such as the Te Oranga Waikura Urban Forest"* (Keith Davison, Land Drainage Manager for Christchurch City Council 2019)

Thousands of native trees and plants have been planted in the forest, which sits off Ferry Road and covers 2.75 hectares. The forest, which is open to the public, acts as a storage basin in heavy rain events, reducing the frequency and severity of flooding in the surrounding area.

- **Upper Heathcote Basin System** - The scheme has enabled over one hundred homes to be removed from habitable floor flooding for the design event, whilst improving the overall flood exposure to many more homes and businesses along the lower Heathcote River corridor. This area has been flooded on multiple occasions in the past decade. The basins helped to avoid habitable floor flooding for the June 2021 and July 2022 storm events. Events that were of similar magnitude or bigger to previous events that had resulted in riverine flooding along the Heathcote (March 2014 and July 2017)<sup>7</sup>.
  - **Cashmere-Worsley Valley** (Figure 16), Ngā Puna Wai in Wigram, and Curlett wetland basins – Three separate basins adding over 650,000m<sup>3</sup> of flood water storage, creating new habitats and recreation areas as well as supporting treatment of urban and rural land runoff. A key benefit to continue enhancing the water quality of the Heathcote River system (one of the poorest quality urban water systems in Christchurch).
  - **Te Kuru Wetland System** – A 109-hectare network of basins and wetlands hold more than one million cubic metres of flood water in a big rain event, reducing the risk of flooding downstream and enhancing the quality of runoff from existing and new areas of the city. This was a key piece of strategic infrastructure identified in the SWAP (CCC, 2009). Creating over ten kilometres of new recreational paths and large areas of Rongoā gardens to support Te Aō Māori traditions were additional benefits from this 'sponge city' approach.

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<sup>7</sup> Taken from <https://insidegovernment.co.nz/citys-stormwater-investment-pays-off/>





Figure 15 – Wigram East retention basin with a view towards the basin outlet structure (WWDG, 2009)



Figure 16 – Cashmere Valley retention basin without and with flooding (P. Christensen).

## 5. KA MUA, KA MURI – LOOKING BACK AT THE LESSONS FROM THE 'LABORATORY' TO LEAP FORWARD.


Over the past thirty years of planning, designing, consulting, constructing, and maintaining these nature-based solutions, through the earthquakes and recovery, many challenges have emerged to their delivery. These challenges have been overcome to dramatically enhance the flood resilience across several parts of the city.

With the lens of looking back to look / leap forward and support other communities, cities, and catchments, we can now take these key lessons below to stand on the shoulders of Ōtautahi Christchurch's innovative approaches.

The thinking in 1999 was very much aligned to the more modern lexicon of "sponge city" thinking. By mimicking a natural sponge and creating space for waterways, these techniques aim to improve flood resilience, enhance urban liveability, and elevate water quality. Examining Christchurch's experience provides crucial insights for other cities with nine key lessons shared below in Figure 17.




## 9 Key lessons learnt from Ōtautahi Christchurch's innovative approaches to creating a sponge city




**Strong vision & Leadership**

It is clear from looking back at the growth of the Christchurch applications that strong, consistent, and visionary leadership were critical to the way that the city has evolved. Developing a clear understanding of the challenges, the city championed the concept, fostering buy-in from stakeholders and securing resources.



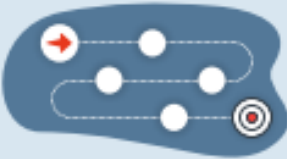
**Success is easier in Greenfields**

Retrofit is harder and more expensive. Less opportunities until major shocks like earthquakes and floods.




**Pilot Projects and Learning**

Early investment in "easy win" projects served as valuable learning experiences. These exemplar studies followed the mantra of "start small, learn along the way but do the best scheme possible". This allowed for refinement of techniques, identification of potential challenges (like litter management in rain gardens), and demonstration of the benefits to the public.




**Strategic Vision and Planning**

Establishing a long-term vision with clearly defined goals and a comprehensive plan was crucial. This roadmap guided decision-making, ensured project alignment, and facilitated resource allocation.




**Collaboration is Key**

Effective partnerships between government agencies, private entities, and the community were fundamental. Collaborative efforts promoted knowledge sharing, maximized resource utilisation, and fostered a sense of shared ownership.




**Maximising Outcomes: The Six Values**

Christchurch's approach focused on achieving multiple benefits. Beyond flood resilience, the city prioritised enhancing urban aesthetics, improving air quality, promoting biodiversity, and creating recreational spaces. This holistic strategy, encompassing the "six values" of sponge cities, provided a well-rounded and sustainable solution.




**Life-Cycle Considerations**

Recognising the long-term implications of implementing a sponge city approach was essential. Funding strategies were developed to cover not just initial construction but also ongoing maintenance and operation.



**Community Engagement**

Public participation and education were crucial for successful implementation and long-term success. Engaging the community fostered a sense of ownership, encouraged responsible behaviour (like proper litter disposal), and ensured the ongoing upkeep of these vital assets.



**Localised Implementation**

Christchurch recognised the importance of adapting a green infrastructure and "sponge city" approach that is specific to the location and context. Considering its flat landscape and high groundwater table, the city prioritised solutions beyond traditional pipes and urban drains, to more natural based solutions that have included rain gardens, bioswales and wetlands that are all more suitable for the local geology.

Figure 17 – Nine lessons learnt from the Ōtautahi Christchurch 'Living Laboratory' for transitioning urban areas to more 'sponge city' thinking.

## 6. RECOMMENDATIONS

As Christchurch continues to evolve and adapt to the lessons learnt and with the benefit of nearly thirty years of approaching stormwater management differently, the journey continues. To support others to commence or enhance their programmes for transitioning our urban environments to become more sponge-like, there are several key recommendations that emerge from our laboratory, grouped into the three distinct phases of application and implementation.

**Initiating the Movement: Seeding the Groundwork** - The journey towards sponge cities implementation begins with taking calculated steps over many years and long-term plan sequences. Christchurch's laboratory approach shows the value of ***implementing targeted, visible pilot projects*** across manageable areas and using these to determine their value across the city. As these projects become commonplace across the city, public expectations changed as they start to ***experience the benefits of having access to areas of recreation and amenity***, supporting health and wellbeing improvements for the community. These initial efforts, such as riparian planting, stream restoration, swales, tree pits and rain gardens established in public open spaces and corridors, allowed for ***refinement of techniques before large-scale implementation***.

***Identifying and engaging champions*** across both the local council and a series of waterway groups has been another crucial step, enabling larger implementation to be followed by ongoing river care and maintenance activities. Their knowledge, passion, and influence can significantly drive project implementation and secure ongoing support. Furthermore, fostering a ***sense of community ownership is essential***. Focusing on a single catchment area at a time allows for targeted engagement with residents. Workshops, information sessions, and citizen science projects can be implemented to cultivate understanding and encourage active participation.

**Building Knowledge and Momentum** - ***Investing in research is vital*** for building a strong foundation for green infrastructure implementation. By allocating resources to conduct research on their specific needs and ***potential benefits within the city's unique context***, valuable data can be obtained to inform decision-making and secure broader support from stakeholders.

Concurrently, ***developing a long-term vision for the city that incorporates blue / green infrastructure*** across all catchments is crucial. This vision should consider future climate projections and potential opportunities for broader environmental benefits, such as improved air quality and increased biodiversity.

**Scaling Up and Ensuring Long-Term Sustainability** - Securing funding for large-scale implementation is a critical step. ***Exploring innovative funding models*** such as public-private partnerships, stormwater utility fees, and green bonds demonstrates a commitment to long-term project sustainability.

As projects mature, ***continuous investment is essential***. These investments not only support the ongoing implementation and maintenance of this green infrastructure but also serve as a platform for sharing success stories. Effectively ***communicating the positive outcomes of the exemplar projects*** attracts further funding and maintains public support, fostering a cycle of continuous improvement.

By following this generalised roadmap and incorporating the key recommendations from the Lessons Learnt section, cities across Aotearoa can embark on a successful journey towards implementing green infrastructure as part of a wider coordinated plan for sponge cities implementation.

Remember, starting small, building knowledge, and securing long-term investment are the cornerstones of achieving a citywide transformation, leading to a more sustainable and resilient future.

## **7. CONCLUSIONS**

Christchurch, New Zealand, stands as a leading example of a city that was already actively transitioning towards a "sponge city" ideal. Over the past three decades, the city has transformed its stormwater management strategy, prioritising a form of nature-based solutions. This journey offers invaluable lessons for other urban areas grappling with the realities of climate change and the need for increased resilience.

Christchurch's success underscores the critical role of strong leadership and a clearly defined vision. By championing the concept of the 'six values' and fostering stakeholder buy-in, the city fostered a culture of innovation and pro-active adaptation. Furthermore, the laboratory shares the importance of adapting to the context with specific implementation being key. Christchurch recognised the limitations of traditional drainage systems for managing flooding with its unique geological setting and embraced alternative solutions like rain gardens, giving waterways space, wetlands, and attenuation basins.

The city's commitment to learning through pilot projects and continuous refinement of techniques further exemplifies its dedication to long-term success. The development of a comprehensive strategic plan, with codified guidance provides a roadmap for decision-making, ensuring project alignment and efficient resource allocation.

Collaboration across all sectors – government, private entities, and the community – proved essential for knowledge sharing, maximising outputs through efficient resource utilisation. All of which fosters a sense of shared ownership and pride in the city and the outcomes left for future generations.

Christchurch's approach extended beyond mere flood resilience. By prioritising multiple benefits – enhanced aesthetics, improved air quality, and increased biodiversity – the city embraced a holistic "six values" strategy, ensuring not only a sustainable solution but also a more livable urban environment. The long-term implications were carefully considered, with funding strategies encompassing not just initial construction but also ongoing maintenance.

Public participation and education were recognised as cornerstones of successful implementation. By fostering a sense of community ownership and encouraging responsible behaviour, the city is seeking to ensure the long term and ongoing care and protection of these vital assets.

While Christchurch is not yet a fully realised sponge city, its exemplary applications across various catchments demonstrate noteworthy progress on this path. The city's commitment to upholding the principles outlined in WWDC ensures continued focus on delivering these multi-value outcomes.

It is important to acknowledge that sponge cities, while demonstrably increasing urban resilience, cannot guarantee entirely flood-free environments. However, Christchurch's ongoing efforts serve as a powerful testament to the potential of this approach. Moving forward, the city should maintain its aspirational approach, setting a vision for each major catchment's transformation into a fully integrated urban waterway system.

By incorporating the lessons learned from this real-world laboratory – targeted pilot projects, knowledge-building research, long-term visioning, innovative funding models, and continuous investment – urban environments around the world can embark on a similar journey to a more sustainable and resilient future in the face of climate change. Christchurch's ongoing evolution serves as a beacon of hope, not just for its own transformation, but for the potential it unlocks in cities everywhere.

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