Investigating International Best Practice in Stormwater Management

Winston Churchill Memorial Trust Fellowship 2022

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(Source: Mile High Flood District)

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Introduction

Aotearoa has a special affinity for water. We are an island nation, surrounded by rivers, lakes and the ocean. There is a plethora of activities Kiwis enjoy doing in or on the water. Holidays often revolve around the use of or being near a lake, the beach, or a river. For Māori, water (wai) is part of their identity and is the essence of life.

This special relationship New Zealanders have with water, and the need for improved water practices, has recently brought about national legislation including the National Policy Statement for Freshwater Management (NPSFM) and National Environmental Standards (NES) for Freshwater. These policy documents outline the need to better protect, value and enhance our water. They put weight on Te Mana o Te Wai, recognising that the water around us has a life force and identity. ***Te Mana o te Wai speaks to the aspirations of many Kiwis who want clean, bountiful rivers and lakes for the generations to come***. The legislation recognises that ***the mauri, mana, and health of each body of water should be the primary consideration before looking at using it for other purposes***[1].

With potential changes to how water infrastructure is managed, the wastewater, water supply and stormwater services will likely be delivered in the future by larger regional organisations. These organisations will have the capacity, and the legislative and societal drivers to improve water management practices across the country. With revenue sources significant enough to deliver efficient, consistent and world leading services.

Due to New Zealand's unique geographical features, and cultural and social desire for improved water practices, we have the potential to be world leaders in water mangement. To unlock this potential, we need to be open to better ways of doing things including being abreast of innovative and revolutionary thinking from around the world. Adoption of international best practice will be crucial in improving our resilience to climate change and the water quality of our waterbodies we enjoy and cherish.

I firmly believe that we can, and need to be, world leaders in the way we manage water and the environment. Our communities are demanding it and we are not alone in the challenges we face. Learning from rest of the world will be an important step to meet these challenges and expectations.

The fellowship gave me a unique opportunity to explore how leading countries and cities are meeting their water management challenges and investigate innovative solutions and thinking that can be adapted to the New Zealand environment for better water quantity and quality outcomes.

Kei te ora te wai, kei te ora te whenua, kei te ora te tangata

If the water is healthy, the land and the people are nourished

[1] Taken from https://ngaitahu.iwi.nz/our_stories/wai-ora/

Unique Practices

On my travels I experienced a number of perspectives and practices that are different to what is often implemented in New Zealand. These ranged in their effectiveness but are useful to learn from either way, so we can manage stormwater and freshwater in New Zealand better for the benefit of our communities and the environment.

I found the following practices enlightening and different to what we do:

- **Implementing smart asset management** (e.g. Internet of Things – IoT) is becoming common practice in the USA. As an example, retrofitting stormwater ponds to become 'Smart Ponds', with the ability to control water levels remotely (on a smartphone or website) leading to reduced downstream flooding, or improved water quality or stream erosion outcomes. New ponds installed with this capability have been shown to require a smaller footprint as well, which is gaining traction. Auckland, for instance has over 600 of these type of stormwater ponds and wetlands to manage which could benefit form such an approach.
- **Prevalence of green infrastructure** less common in New Zealand, specifically green roofs, but also 'climate roads' and tree pits. I found green roofs to be much more common overseas, likely due to our cities still being relatively small on the world stage (where space is a premium), but also due to the heat island effects in larger cities.

Figure 1: Cira Green, Philadelphia ('park in the sky') – green roof, urban park and 'roof top' bar (Source: greenroofs.com)

- **Stormwater charging** or tax (a separate rates bill) is standard practice in Philadelphia and Portland and is based on the percentage of the property that is impervious. This helps to educate and influence the behaviour of people to reduce stormwater effects (e.g. allowing more water soak naturally into the ground). This hasn't been implemented in New Zealand to date but may be an effective way to help increase and secure funding for stormwater management while preventing flooding and water quality issues, by changing behaviours.
- In Oslo combined (stormwater and wastewater in one pipe) **pipe renewals** are restricted to lining of the pipe rather than a full replacement. The reduction in the pipe capacity, from the liner, is offset by reduced stormwater entering the combined system, through the construction of green infrastructure to absorb water or by 'unlocking historic streams' to convey stormwater above ground. A driver for this was largely due to prohibitive costs associated with pipe renewals that involve replacing pipes by conventional excavation and relaying. This could be an alternative to the traditional stormwater pipe renewals to reduce costs and to 'green' our cities further.
- There is a big focus on **reducing the maintenance requirements of existing green infrastructure** in Philadelphia. Through strict development controls requiring onsite retention, thousands of private raingardens and green infrastructure have been created. Significant maintenance and compliance are now needed to ensure the systems achieve the intended benefits. We have a similar potential problem in some of our cities.
- Implementing **stream management corridors** in Denver (Figure 2) which gives room for the river or stream to flood and move over time, based on calculating the anticipated width that the stream or river needs. They use **development contributions to widen the streams** in preparation of increased flows from impervious development to both improve flood capacity and reduce the likelihood of widespread erosion, but also to create linear parks along the watercourses that everyone can enjoy.

Figure 2: Stream management corridor at Westerly Creek, Denver (Source: Mile High Flood District)

Key Learnings

After reflecting on the various perspectives, insights and experiences from my travels and interactions, that I was privileged to be part of, the key learnings from this trip include the need to:

1. **Understand the context of approaches** implemented elsewhere before adoption
2. **Focus on the prevention of issues** rather than relying on mitigation or adaption options
3. **Facilitate cross-organisation collaboration** for improved outcomes
4. **Recognise the importance of education and awareness** to unite people
5. **Connect people to water** so that it is rightly valued

These learnings were themes of the trip that repeatedly arose in discussions, field visits to projects and in problems that organisations were facing (e.g. the lack of funding to address issues). They are the culmination of thoughts and perspectives on how we can successfully effect change in our industry and practices in our country.

These learnings are outlined in further details in the subsequent sections.

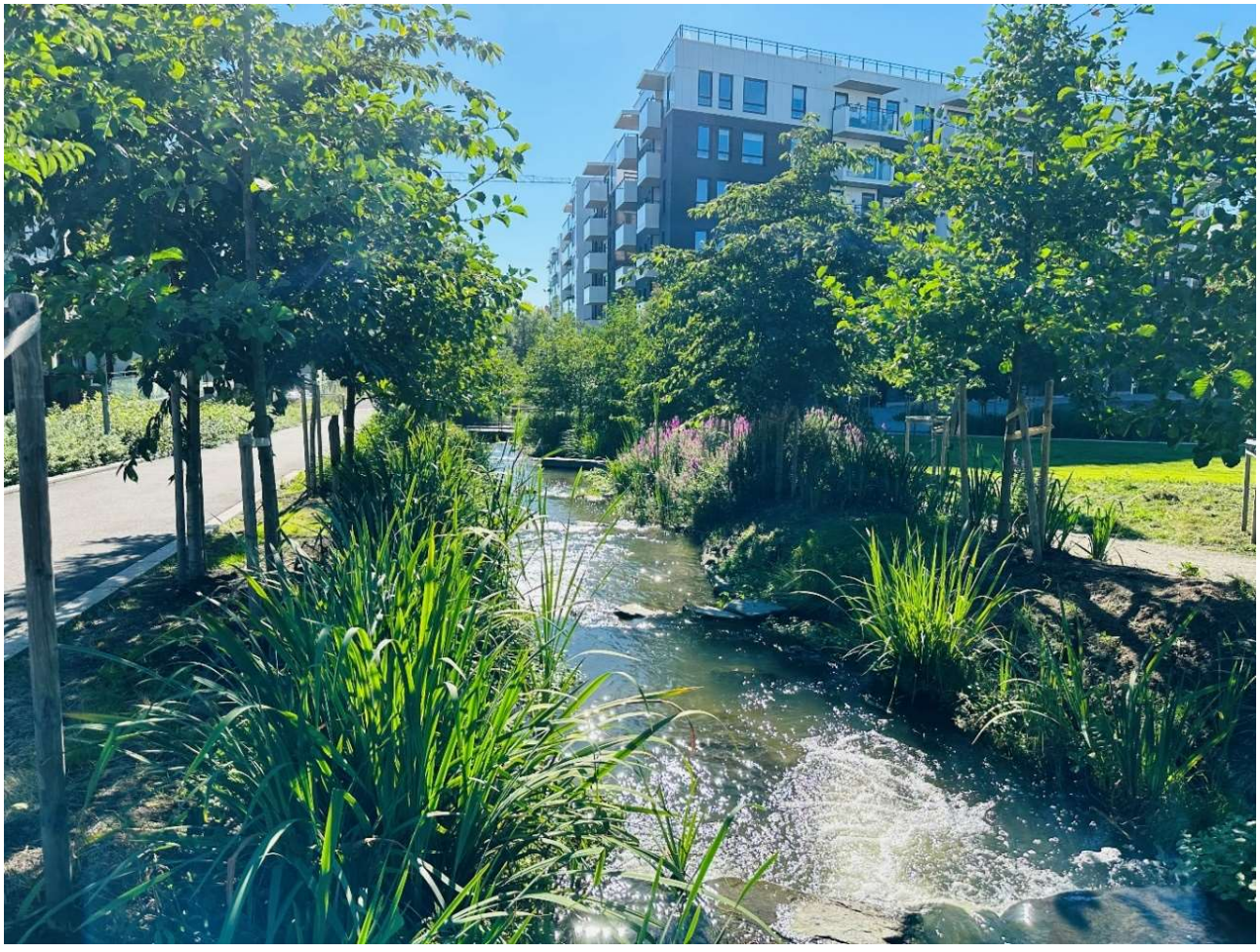

Figure 3: Daylighted stream adjacent to street conveying stormwater diverted from the combined wastewater-stormwater system in Oslo

1 Understand the context of implemented measures undertaken elsewhere before adoption locally

Cities and countries are facing similar challenges to New Zealand with regards to water management. New Zealand is not alone in its devastating flood events, urban development in floodplains and in the degradation of water quality and our environment. But we do have differences and these need to be well understood before considering the viability of adopting alternative international and even various approaches nationally.

Understanding the context is the first step in managing risk, and associated flood and environmental risks are no different. Every country, city, land, region, area is unique. We cannot blindly adopt a practice seen elsewhere whether overseas or in another part of New Zealand and expect that solution will suit. However, a more planned and considered approach will ensure sound management approaches are implemented successfully for the New Zealand environment.

Factors that are relevant to consider, with regards to stormwater management, are the location's climate, soils (e.g. permeability and erodibility), stormwater system, topography, nature of flooding, people and culture of the city or country etc. As an example, I witnessed some interesting stormwater management practices in Oslo, but upon further investigation, Oslo's 100yr 24hr average recurrence interval (ARI) storm event is predicted to be barely more than a third of the magnitude of Auckland's. As a result, their practices may be less effective considering Auckland's climate.

It is best to understand the drivers of certain management approaches – i.e. what led to their decision to approach it that way. Approaches may suit a city, region or country for different reasons but it is important to consider their drivers before considering appropriateness.

Furthermore, the context needs to be combined with a good understanding of what the 'problem' is. It is crucial that the problems we are facing on a micro and macro scale are well and correctly defined, to ensure that the appropriate solution is implemented. Flawed problem definition is the cause of a lot of the recurring issues we face. A theoretical example of this, is for someone to say "this house flooded due to water flowing overland" and they go on to say "due to an under-capacity stormwater pipe". Based on this version of the problem, the correct solution appears to be to upsize the stormwater pipe, to ensure that there is no overland flow and that the house doesn't flood. When in fact the real problem is that historically we consented a house in an overland flow path, or there is not an adequate overland flow path around the house to safely covey the flood water.

In summary, New Zealand is a unique country with varying landscapes and challenges. We need to define problems appropriately and consider the variability and differences of our country before adopting different stormwater management practices from around the world.

2 Focus on the prevention of issues rather than the reliance on mitigation or adaption options

We fall too easily into the trap of trying to mitigate the issues that we experience from urban or rural intensification. As practitioners the majority of our work is focusing on addressing the 'symptom' and not actually the underlying problem. We avoid trying to change the behaviour of people or a practice and put our effort into attempting to mitigate the resulting effects.

We struggle with implementing preventative measure, I believe, due to a few reasons:

- Prevention involves changing people's behaviour – which is often difficult to do and requires investment of time, money, and the skillset of trained individuals.
- It is often challenging to demonstrate the benefits of an implemented strategy or policy (both forward looking or retrospectively).
- There is a tendency to build physical infrastructure over implementing an effective strategy or policy.
- We are focused on how to address an individual problem at a location without stepping back to consider the collective issue or wider cumulative effects.

We have lured ourselves into a false sense of security thinking we have mitigated the effects, at least down to an acceptable level. However, as time goes on, we are realising that our practices are not effective enough, lead to unintended consequences, or there are things that we didn't understand well enough about our environment. An international example of this, which I discovered on my travels in the USA, is where a chemical compound found in car tyres, 6ppd, has recently been found to be toxic to salmon and other fish. When tires wear down through contact with roads, these particles are released and when it rains these particles are washed downstream to streams and other water bodies. This is a significant and emerging issue for the pacific northwest of the USA.

Figure 4: 6ppd-quinone – a toxic chemical found in tyres has been recently discovered to be deadly to coho salmon (Photo by Roger Tabor, US Fish and Wildlife)

3 Facilitate cross-organisation collaboration for improved outcomes

One of the barriers to improved water management practices, particularly in our cities in New Zealand, is the lack of integration and apparent disconnect between organisations. Naturally organisations are setup with a fixed vision and mandate, for them to focus their work on, however this vision is often narrow and specific to their own organisation and can lead to a 'silo' based mentality, with associated biases.

On my travels to Scandinavia, I noticed effective collaboration between entities and organisations. In Stockholm there were roading engineers constructing stormwater sensitive 'climate roads' and tree pits, in Copenhagen they had a hybrid team in charge of retrofitting their parks and reserves with water management in mind and in Oslo there were wastewater engineers implementing green infrastructure or stream daylighting to separate stormwater from the combined system, and ultimately reduce the treatable wastewater volume. Another example organisation silos can be broken down was In Stockholm, where the water organisation pays an employee to be based in the transport organisation to facilitate good outcomes.

Figure 5: Enghaveparken – Climate Park, Copenhagen (Source: State of Green)

Some thoughts on how we can have more effective cross-organisation collaboration:

- Formally tasking teams and organisations to collaborate
- Having a shared vision or outcome that multiple organisations are trying to achieve
- Seconding or having permanent staff in other organisations to promote collaboration
- Organise regular webinars with other teams, organisations and industries to share, educate and inspire

This seemed to at least partly explain Scandinavia's ability to have multiple organisations on the same page – to facilitate the integration of water management solutions in the city landscape. Cross-organisation 'pollination' and collaboration is critical to achieving better outcomes for the community and environment and something that we in New Zealand need to further encourage.

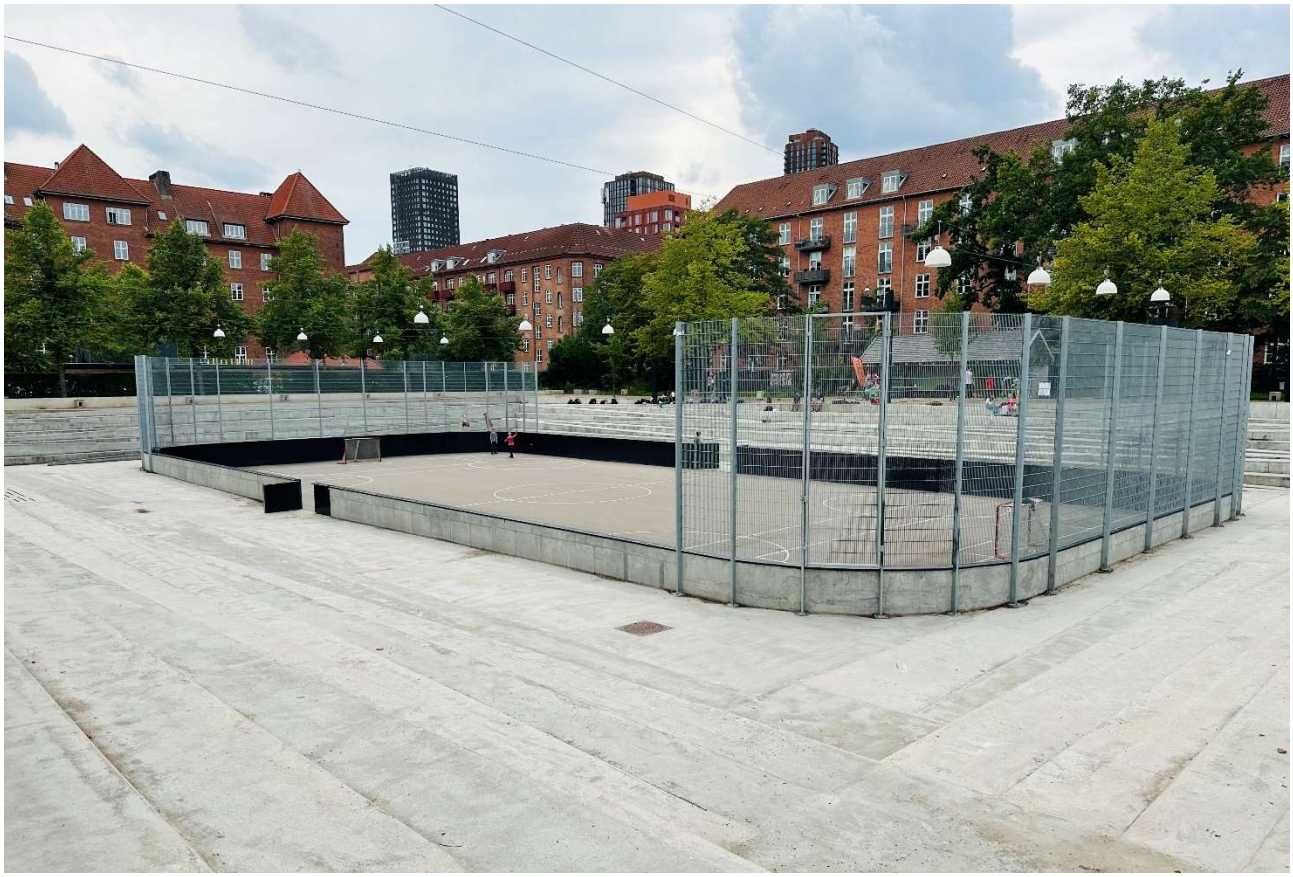

Figure 6: Sunken multi sports 'court' designed to temporarily store flood water as part of Enghaveparken, Copenhagen

4 Importance of education and awareness of the issues

One of the things that become evident through the course of my travels was the importance of educating and making people aware of the stormwater management issues. We need to focus on raising awareness, educating and increasing engagement in water issues in our communities, 'sister' organisations and politicians to get better traction.

Generally, people don't know where their water comes from, where it goes, what the issues are, or how to help. We need everyone to be onboard, not just those in the room. We tend to 'preach to the choir' but need for others to see the importance of the issues. Improved water literacy in the community will bring about better behaviours and practices associated with water management and help to secure funding of initiatives.

I believe it needs a targeted approach to all areas and levels of society from schools to the wider community, but also to politicians and the media. Recently 'water' has been given a lot of attention from the media in New Zealand, but there is still a long way to go to get the right messages across. We need more social scientists, teachers and marketers in our water industry.

Climate events are becoming more common but are still pretty rare. People easily forget about what previously happened and get complacent or are new to areas prone to flooding. In Ribe, in Denmark and Washington D.C. there were sculptures and monuments standing to visually remind people of the historic flood levels that occurred in the past.

Figure 7: Historic water marks in Washington D.C., USA (Source: Wayside Studio) and Ribe, Denmark

I visited the Klimatorium in Lemvig, Denmark. It's purpose to bring people together to discuss and address the climate challenges we face. The ground floor was dedicated to raising awareness of the issues through interactive exhibits demonstrating the climate challenges such as sea level rise, and coastal and stream erosion, as well as presenting some innovative solutions. The setup was similar to a science museum.

Figure 8: Interactive exhibits at the Klimatorium in Lemvig, Denmark

At the Denver aquarium there is a flash flooding simulator, demonstrating the power and speed that water can have, bringing this type of flooding to life for people. At the West Tennessee River Basin Authority they have tools to demonstrate the effect of channel straightening on peak flows, velocities and timings, and the subsequent stream erosion.

Figure 9: Dynamic education tools at the West Tennessee River Basin Authority

To bring about effective change in New Zealand, I believe we need to invest more in demonstrating the challenges we face to the community, bringing our challenges and issues to life.

5 Value of 'connecting' people to water

A key theme that came through the meetings and site visits was the value of connecting people to water. I believe if water is absent, dirty or unclean it will eventually not be an important part of people's lives, but if people see and interact with water they are more likely to value and appreciate it.

Historically, we've piped stormwater – effectively hiding it below ground. With this approach in a normal rain event stormwater is captured by gutters or catchpits and drained away in pipes never to be seen again. However, when an extreme storm event occurs people are often surprised to see water flowing overland, but this is exactly what will occur when the pipes cannot take the flow (they are typically not designed to do this). This reliance on the piped infrastructure is not helping address fundamental issues of understanding. Our communities need to be more 'in tune' with the climate as this will help everyone to be on the same page as to the issues and appropriate management approaches.

In Copenhagen, Oslo and Denver in particular, there were many great examples of projects and practices with a focus on people interacting with water. Projects that introduced stepping stones for people to walk down and across streams, for people to swim and dive into the ocean and streams daylighted adjacent to footpaths and streets for people to hear, see and experience nature.

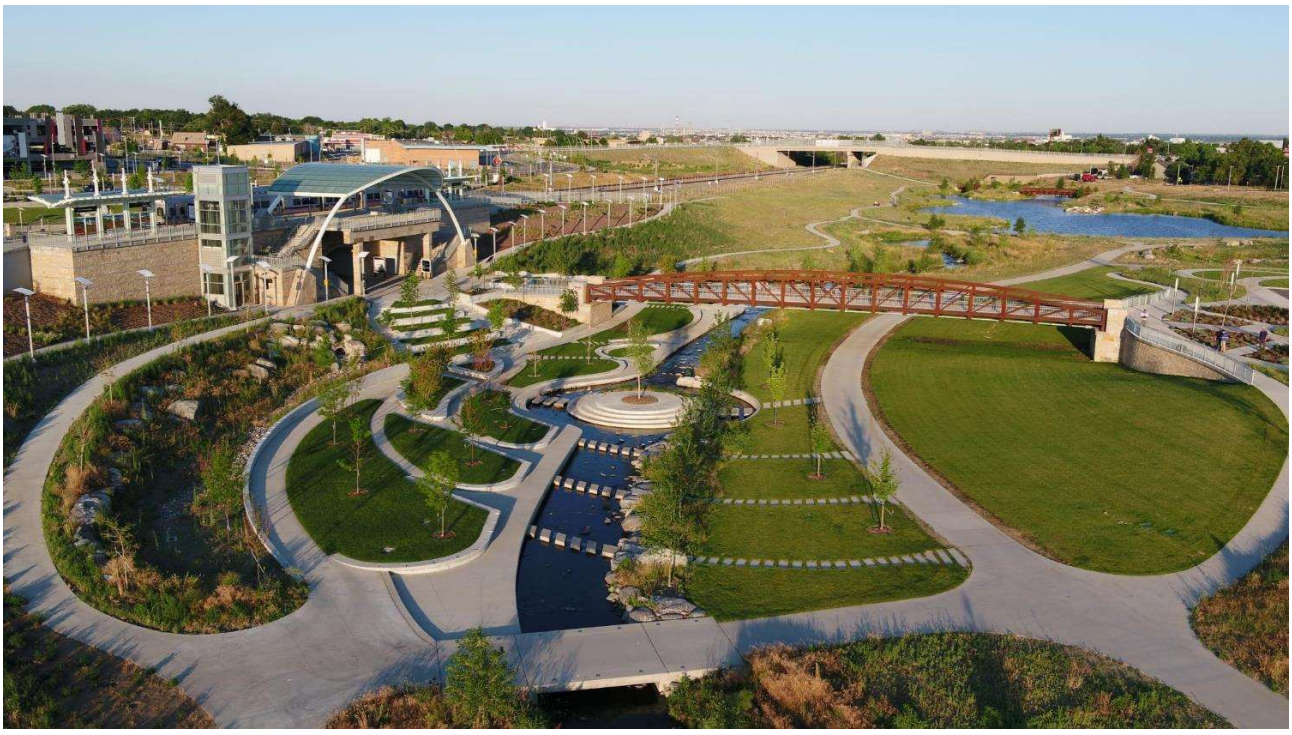

Figure 10: Westminster Station Park, Denver (Source: Mile high Flood District)

In Denver they have introduced online, engineered water parks, including rapids and standing waves for rafting and surfing. It doesn't need to be as designed as those examples but the principle, in terms of connecting people to water, so it's rightly valued in society is still applies.

Figure 11: River Run Park Denver (Source: Endless Waves)

We need to develop spaces for people to play, celebrate and interact with water. We have good examples in our waterfront areas, but we could be doing a lot more. Concerns over safety often prevail and provide barriers to re-connection to our water bodies which is so critically to better management and outcomes.

Dissemination

At the time of writing this report I have shared my learnings through:

- Presentation to Auckland Council in February 2024
- Presentation to Wellington Water in March 2024
- Article published in the Water New Zealand magazine in March 2024
- Individual conversations with industry professionals

In the next 6 months I have scheduled to share my learnings via:

- Presentation to Tauranga City Council in April 2024
- Presentation to Ministry for the Environment in April 2024
- Paper and presentation at the Water New Zealand Stormwater Conference in May 2024
- Article on stream restoration in the Water New Zealand magazine in July 2024

In my current role I also have the opportunity to directly apply my learnings to projects I work on, particularly in the Auckland area. Specifically, I can influence how Auckland rebuilds from the damaging floods in January 2023, giving insight into similar examples implemented in Scandinavia and the USA, and learnings from historic stream practices in the USA.

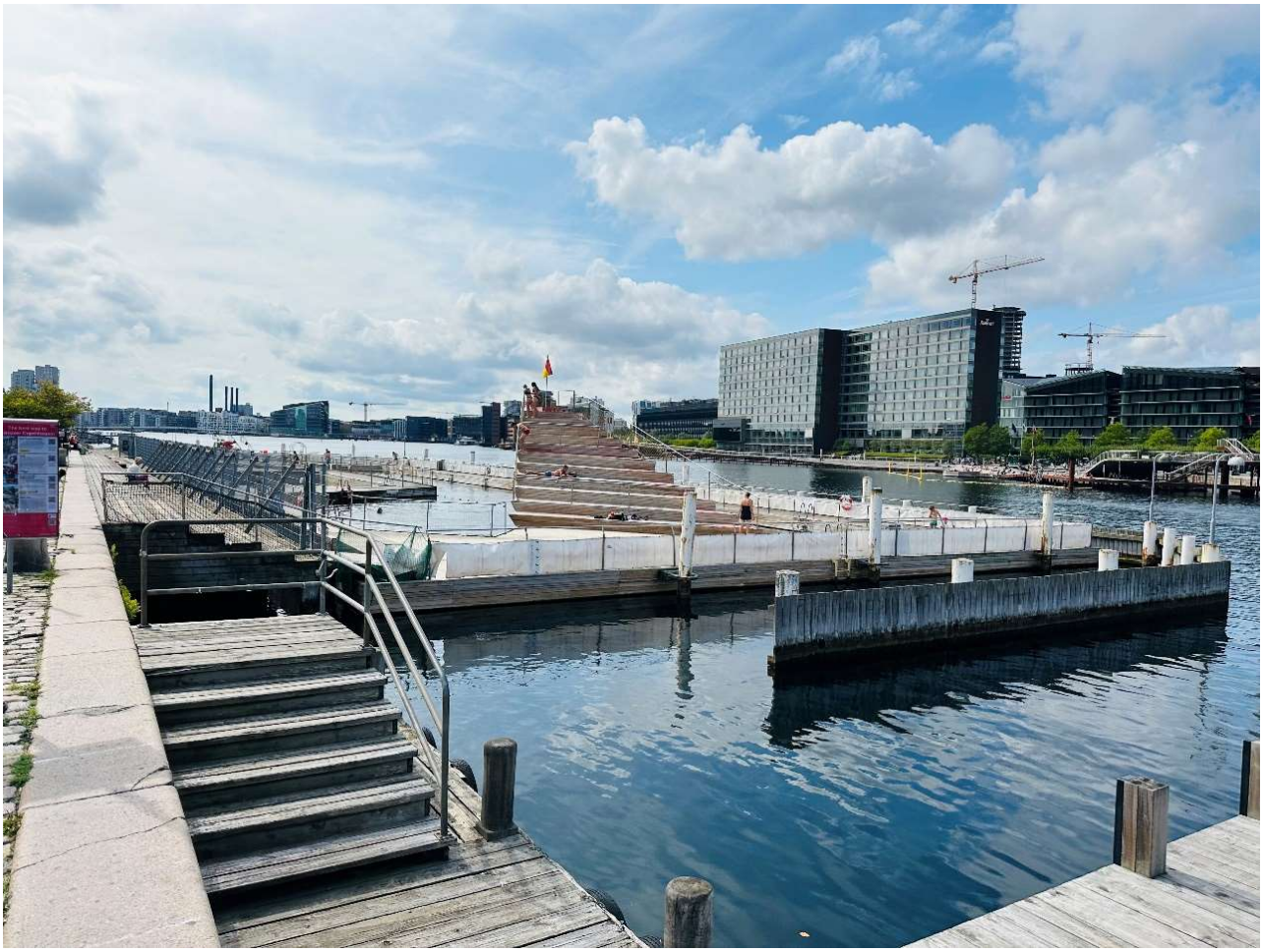

Figure 12: Copenhagen waterfront

Acknowledgements

I'd like to acknowledge all those people that helped to make this fellowship a success, namely those that generously gave up their time to meet with me and show me their challenges and projects, to those that helped with the connections and itinerary, to WSP for supporting me to be able to take the opportunity, to my referees and those that helped with my application and lastly to the Winston Churchill Memorial Trust Fellowship for providing with this incredible opportunity.

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Conclusions

Overall, this fellowship has been a transformative journey, equipping me with the perspectives needed to make a meaningful contribution to the stormwater industry in New Zealand. Through this experience I hope to inspire others to think differently about how we approach managing stormwater. I have shared my experiences back in New Zealand through conversations, presentations and articles and my hope is that with enough exposure the industry can pivot to a different approach and focus.

As recent destructive flood events have demonstrated, there is a need for improved practices in how we manage flood risk in the country. With our lakes, streams and rivers currently suffering from increased contaminants from agriculture, forestry and urban development, we need to change how we do things if we are to expect the water quality that we desire in our freshwater and coastal waterbodies. With aging infrastructure and a lack of investment we need a significant increase in funding alongside doing things smarter.

Armed with the learnings, lessons and best practice from around the world and combined with local indigenous knowledge, we can respond to our current challenges with fresh perspectives and renewed zeal to ensure this country remains a great place to live and to visit.

My recommendations for the water industry of New Zealand align with the key fellowship learnings. We need to embrace international practices and learnings while at the same time:

1. **Understanding the context of approaches** elsewhere before adoption
2. **Focusing on the prevention of issues** rather than relying on mitigation or adaption options
3. **Facilitating cross-organisation collaboration** for improved outcomes
4. **Recognising the importance of education and awareness** to unite people
5. **Connecting people to water** so that it is rightly valued

I am grateful for the opportunity that the Winston Churchill Memorial Trust has provided me for this fellowship and wish to thank them for their confidence and investment.