WSUD CAN BE COST-EFFECTIVE AND LOW-MAINTENANCE, NOT TO MENTION ALL THE OTHER BENEFITS

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ABSTRACT (500 WORDS MAXIMUM)

At the 2018 Water NZ Stormwater Conference we introduced the 'Activating Water Sensitive Urban Design (WSUD)' research project, part of the Building Better Homes Towns and Cities National Science Challenge. We described the results of surveys and workshops with WSUD practitioners and set out a plan for a programme of research activities to support WSUD uptake. Twelve months on, this paper summarizes our progress across a wide ranging, but linked, suite of research to progress three main 'quick win' areas. Through focused case-studies we have investigated costs, assessed benefits and explored operations and maintenance requirements; these being leading themes expressed by practitioners in conversations on barriers to the adoption of WSUD.

We have found that WSUD can be a cost-effective alternative to conventional approaches to stormwater management. It can avoid some costs of building hard infrastructure and the hidden costs of deferred environmental remediation, while delivering better 'bang-for-buck' in removing stormwater contaminants. On the benefits side, we have demonstrated that the reasons for adopting WSUD can extend well beyond those of hydrological and water quality management, for instance by enhancing the terrestrial environment and contributing to the well-being of urban communities. In complementary research, the project has started to investigate how WSUD in Aotearoa values, recognizes, and provides for Te Ao Māori and how it could do better (described in a complementary paper at the present conference). We have developed the 'More Than Water' tool to help assessments of projects reflect the costs and benefits advantages of adopting WSUD approaches, for instance to support project planning and consultation.

We have found that problems around WSUD maintenance are linked to inadequate consideration at the design stage and inadequate recording of the location and condition of WSUD assets at 'handover', especially those in public spaces. Together, these have led to acceptance of defective devices and a lack of maintenance. Based on observations at our case-study locations, we have developed guidance on the design of low-maintenance WSUD and checklists for acceptance. In addition we have reviewed financial incentives employed overseas, finding that, while there is no 'silver bullet,' a tool box of approaches is available to incentivize the uptake of WSUD in New Zealand.

The research effort has been supported by continued conversations with WSUD stakeholders. These have included targeted discussions with the roading and asset maintenance sectors and engaging with Melbourne's WSUD community to learn from the experience of researchers and water managers there. A wide range of learnings from that City's transition appear to be relevant to New Zealand, with the importance of effective governance, leadership and collaboration at the top of the list.

The findings of our research are being delivered through workshops for NZ's WSUD community, including a workshop and linked site visit as part of this conference. Outputs

are also posted on the project web site. Looking beyond the current project, these outputs include an assessment of longer-term research needs to help WSUD in New Zealand to deliver outcomes that urban New Zealanders value.

KEYWORDS

Benefits, Cost-effectiveness, Low-maintenance, Water Sensitive Urban Design.

PRESENTER PROFILE

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1 INTRODUCTION

At the 2018 Water NZ Stormwater Conference we introduced the 'Activating Water Sensitive Urban Design (WSUD)' research project, part of the Building Better Homes Towns and Cities National Science Challenge. The project began in late 2017 with a "discovery phase" (Phase 1), which involved working with practitioners in workshops and via surveys to explore barriers to the adoption of WSUD in New Zealand. A wide range of barriers were identified, leading to recommendations for a programme of research (Phase 2) that could help address these barriers (Moores *et al*., 2018). Recognising the relatively limited duration of the project (approximately 18 months in total), the research design focused on the delivery of a series of 'quick wins' while also proposing the development of a longer-term research plan.

Over the past 12 months, Phase 2 of the project has focused on three 'core' research areas:

- Understanding the full lifecycle costs of WSUD;
- Characterizing, evaluating and demonstrating the full benefits of WSUD; and
- Providing guidance for low-maintenance-led design of WSUD.

Reflecting the very close links between these three themes, the research has been conducted as an integrated exercise, in which a range of methods have been used to investigate the topics concurrently. These methods have included field assessments, case studies, reviewing international literature and the development of tools and guidance material.

As well as these 'core' research activities, the project team have also sought to continue to build the NZ knowledge base through further discovery and dissemination activities. These have included visiting Melbourne to learn from the experience of practitioners and researchers on success factors in the implementation of WSUD in that city. The project has also started to investigate how WSUD in Aotearoa values, recognizes, and provides for Te Ao Māori and how it could do better (described in a complementary paper at the present conference; Afoa and Brockbank, 2019). Finally, the project has updated and made available information on financial methods for incentivizing WSUD.

This paper summarizes these various research activities and some of the key findings of each. Section 2 describes research that aims to help make the case for WSUD, summarizing research into the areas of costs and benefits that has culminated in the development of the 'More Than Water' assessment tool. Section 3 describes research that aims to help with the implementation of WSUD, including guidance on designing for low-maintenance and a review of options for incentivizing uptake of WSUD. Section 4 summarizes the project's continued discovery activities, in Melbourne and Aotearoa.

2 MAKING THE CASE FOR WSUD

2.1 COSTS

During the Phase 1 workshops, it became clear that a better understanding of the long-term maintenance and life cycle costs of WSUD in New Zealand was needed (Moores *et al*., 2018). A key component of the subsequent research has therefore been to better quantify maintenance costs via the collection of actual maintenance cost data for green infrastructure (GI) practices in New Zealand, as well as investigating how cost-effective WSUD is when compared with a conventional development approach (Ira and Simcock, 2019).

Cost data was collected from a total of 16 councils, consultants and contractors from around New Zealand. Existing life cycle cost models – COSTnz (Ira *et al*., 2009) and the Urban Planning that Sustains Waterbodies (UPSW) decision support tool (Ira *et al*., 2012) were used to model the life cycle costs of a variety of GI practices. The new data collected assisted with refining the cost and maintenance frequency data assumptions within the model, and the net present value life cycle costs shown in Figure 1 and Table 1 are representative of the most current indicative cost estimates for different practices in New Zealand. These life cycle costs will assist stormwater professionals in understanding the relative cost differences (based on a range of costs from low to high) between different green infrastructure solutions.

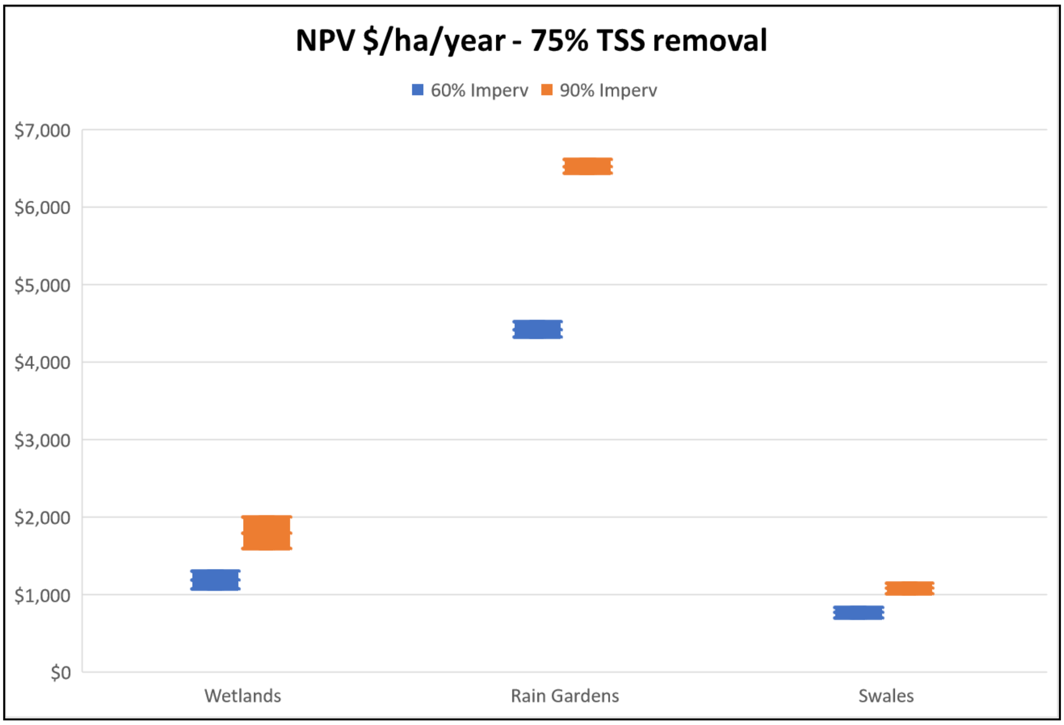

Figure 1: NPV $ per hectare per year life cycle costs for swales (which provide for water quality treatment and conveyance), rain gardens and wetlands

Table 1: Indicative life cycle cost estimates (NPV $\$/m_2/yr$) for green roofs[1], inert roofs[2], permeable paving and rain tanks

	Low estimate	High estimate
Green roofs	$269	$706
Inert roof	$162	$378
5000 litre rain tank	$358	$804
Permeable driveway	$11	$16
Concrete driveway	$9	$10

This work has been augmented by conducting a literature review to better understand international perspectives on the cost differential between WSUD and conventional approaches to stormwater management. The literature review highlighted that, in general, WSUD is a more cost-effective approach to land development than current conventional forms of development. On average, WSUD can result in 14% - 35% savings on site preparation and earthwork costs. Savings from reduced impervious areas and piping associated with a WSUD design can vary from 11% - 69%. While some studies (Rozis and Rahman, 2002; Water by Design, 2010; Lewis *et al.*, 2013) found that costs of creating or enhancing natural and landscaped areas can increase under a WSUD development, other studies have found landscaping costs to be neutral or less than conventional development approaches when the landscaping components are integrated with GI (USEPA, 2007 and ECONorthwest, 2007). The review highlighted that maintenance costs of green infrastructure practices are extremely variable, and that the quantum of cost is inextricably linked with GI design (Ira and Simcock, 2019). However, because our knowledge around maintenance costs is scant, a significant part of the cost research focussed on the investigation of activities (and associated costs) relating to GI maintenance. An overview of the findings of this work is discussed in Section 3.1.

Overall, this component of the research has highlighted that while cost information is highly variable and difficult to obtain in a form which is usable and transferable, significant savings can be realised via the avoided costs of WSUD during the development phase. A detailed investigation into the Kirimoko Park Development in Wanaka highlighted that the developer saved, on average, 22% over a conventional development approach by using a WSUD approach to site design and stormwater management. Findings from this research can help to overcome the limitations of economic costing models which have historically focussed on life cycle stormwater costs incurred by a public operator, rather than considering the full range of avoided costs and cost efficiency (see Figure 2). This need for a wider consideration of cost-related factors has been captured in the development of an integrated decision-making tool on costs and benefits of WSUD (discussed in Section 2.3).

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[1] Green roofs shown here are for *stormwater quantity control, so they are lightweight, 50-150 mm depth and 100-200 kg/m² not requiring concrete structure*

[2] Such as a colour steel type (baked enamel) of roof or similar

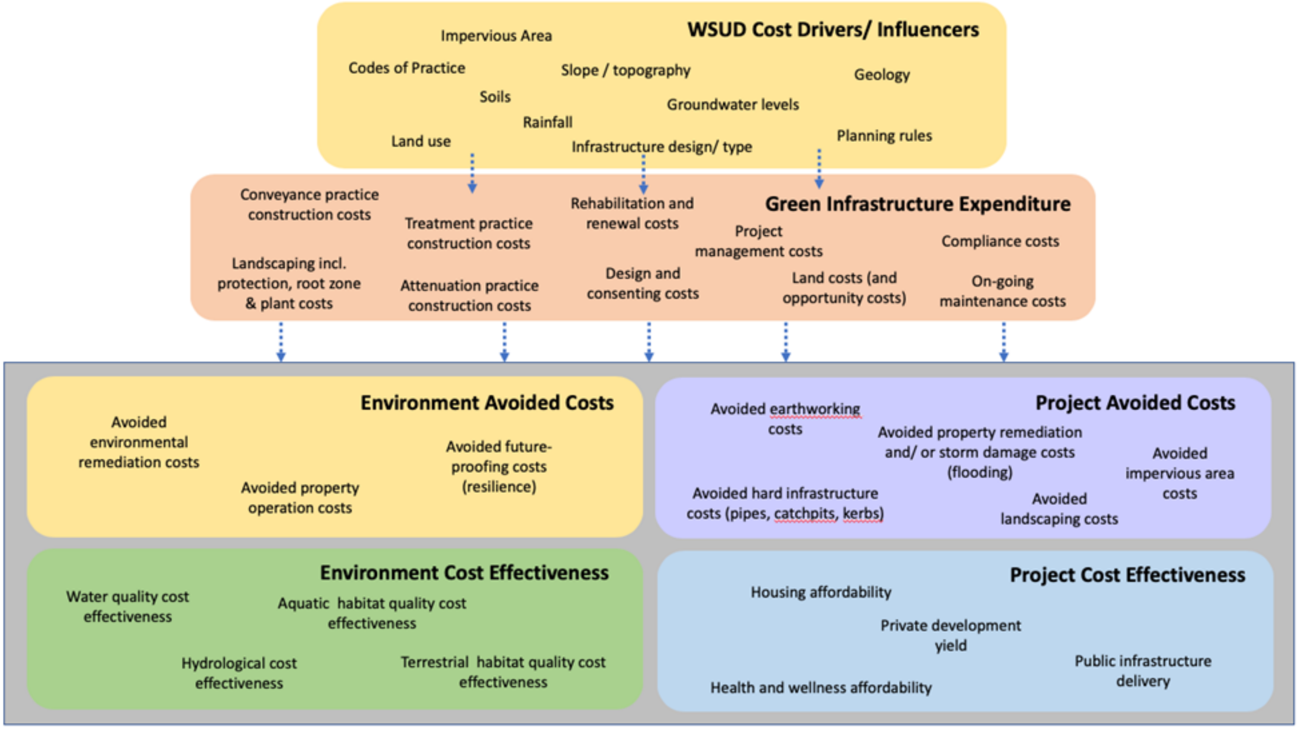


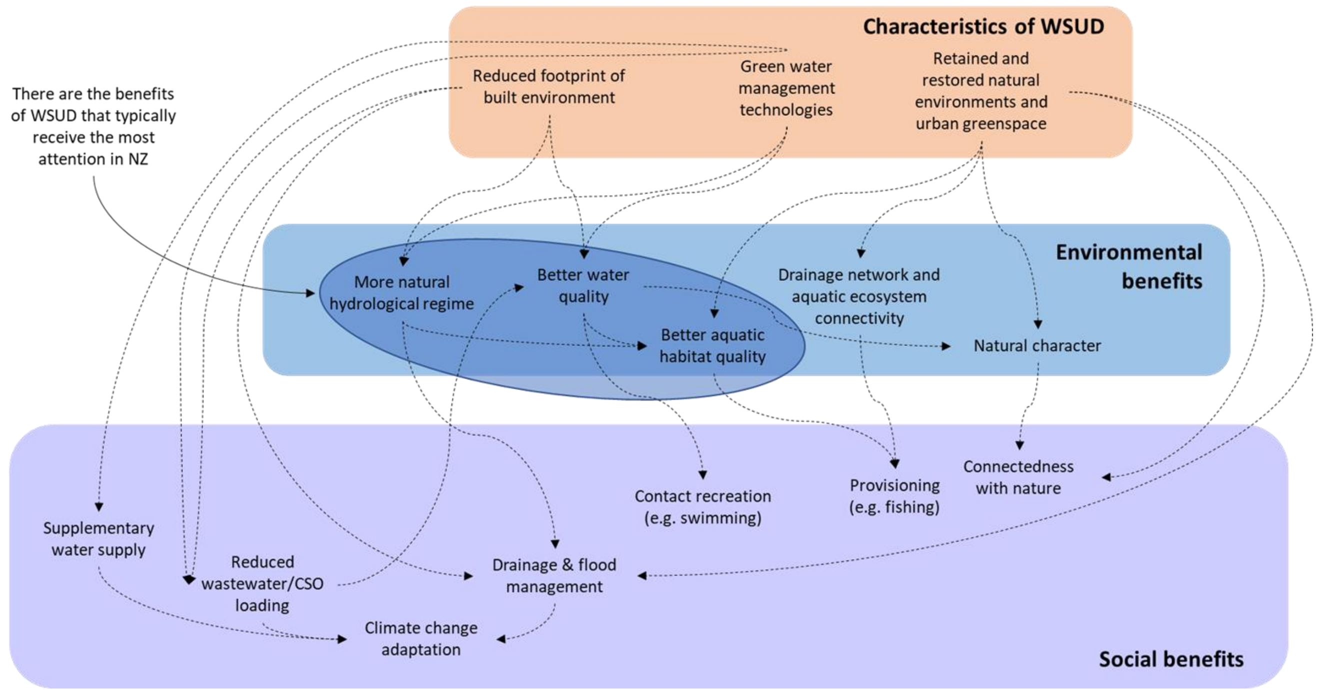
Figure 2: Cost-related factors relevant to assessments of the business case for WSUD

2.2 BENEFITS

The findings of Phase 1 of the project indicated that, without a better understanding of the full range of benefits of WSUD and ways to evaluate those benefits, making the business case for WSUD in New Zealand is likely to remain a significant challenge. Reflecting this need, one of the three core activities in Phase 2 of the project has been the development of guidance for characterizing, evaluating and demonstrating the full benefits of WSUD. This has involved reviewing international literature describing WSUD co-benefits and economic assessment methods and tools developed for WSUD practitioners overseas (Moores and Batstone, 2019).

The review found that the potential water-related benefits of WSUD, relative to conventional urban development approaches, are well documented. Typically, a successful WSUD project might be expected to deliver restored hydrology, improved water quality and healthier aquatic ecosystems (Figure 3). While there remain evidence gaps on the delivery of these outcomes, especially in New Zealand, monitoring and modelling methods for their assessment are well developed.

However, assessments of the benefits of WSUD that focus solely on these water-related outcomes are incomplete. Through the principles of working with nature and employing green technologies, WSUD has the potential to deliver a wide range of other co-benefits, in addition to those relating to water (Figure 3). Some of these are other (non-water) environmental benefits: for instance, the preservation of natural soils, microclimate moderation and terrestrial habitat provision. Others can be framed as social benefits, both water and non-water related. Water-related social benefits include the provision of supplementary water supplies and enhancement of opportunities for contact recreation. Non-water social benefits include public safety, property values and improved health and wellbeing deriving from the use of GI.



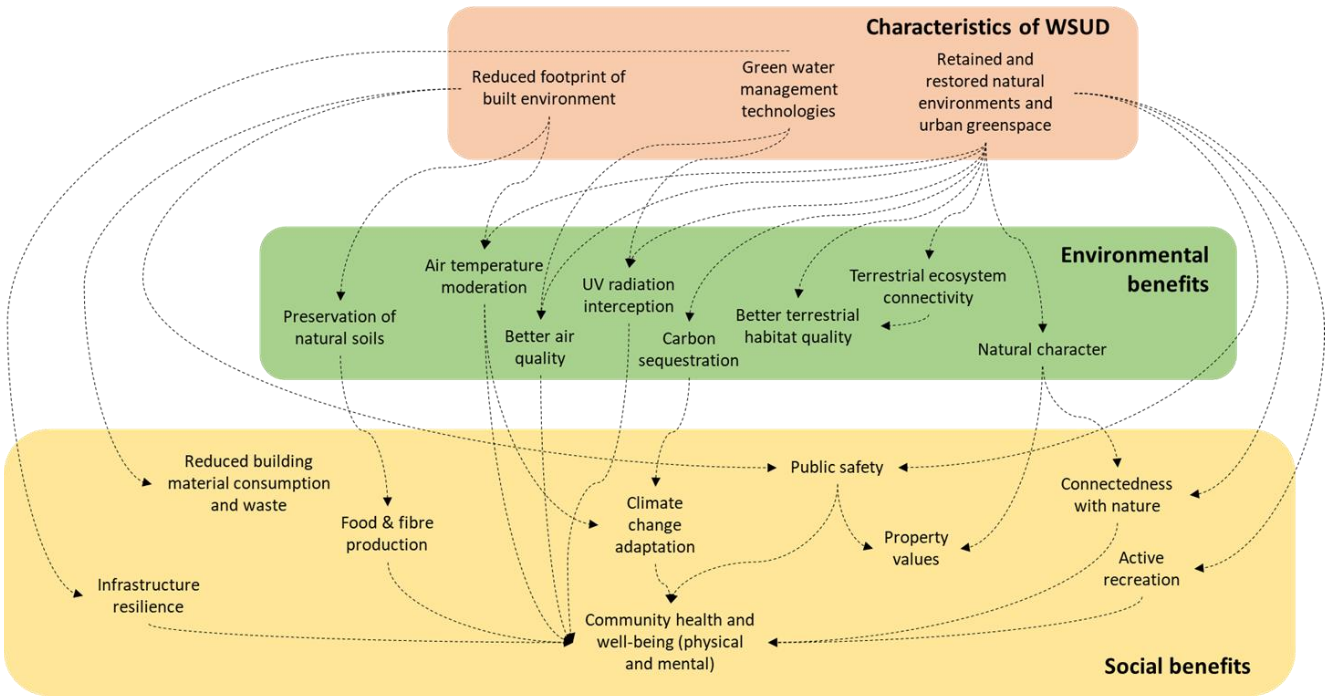


Figure 3: Examples of water (upper) and non-water (lower) environmental and social benefits of WSUD

A number of tools developed overseas provide for assessments of the benefits of WSUD. Spreadsheet-based tools such as the UK B£ST and a benefit-cost tool under development by the Cooperative Research Centre for Water Sensitive Cities (CRCWSC) in Australia draw on established methods from the field of environmental economics to infer estimates of economic benefits (expressed as dollars) associated with the GI's delivery of a wide range of water-related and co-benefits. Combined with information on infrastructure costs, these methods can be used in assessments of cost-benefit and cost-effectiveness of WSUD compared to conventional water management approaches.

However, these tools are not readily applicable in New Zealand without first addressing a number of cautionary considerations. These include: uncertainty in transferring economic valuations data from one jurisdiction to another; attitudes to the monetization of environmental outcomes; approaches to discounting and the general suitability of such methods for use in non-technical settings such as collaborative planning processes. While noting the potential to address these concerns by collaborating on the customization of an overseas tool for application in New Zealand, the review concluded there remained a more immediate need for a 'quick win' method by which practitioners can demonstrate and communicate the wide-ranging benefits (as well as costs) of WSUD projects to decision-makers, communities and stakeholders. As a result, the team has developed the 'More Than Water' assessment tool, described below.

Finally, the review noted the emergence of a growing body of research on the public health benefits of providing greener living environments. This is likely to provide a fruitful direction for the development of new assessment methods that better provide for a comprehensive assessment of the benefits of WSUD projects in New Zealand. Overseas, research has reported explicit linkages between the level of 'nature dose' and the incidence of physical and mental health conditions in urban areas (Cox *et al*., 2018). This has particular relevance for the New Zealand circumstance. A 2010 study by NZ Treasury (Holt, 2010) showed the direct (treatment) and indirect (lost productivity) cost of illness to the NZ economy through chronic illness of the order of 3.6 – 8.5% of GDP annually (between $5.4b – 12.8b). This astounding figure is generated through an estimated 1.3m of a total population of 4.8m being affected by chronic physical and mental health disorders. Even if only a fraction of these costs could be avoided by the provision of greener, healthier living environments, then there appears to be a strong case for recognising and attempting to assess this co-benefit of WSUD projects and for public health agencies to have a role as advocates and/or participants in the implementation of WSUD in New Zealand urban areas.

2.3 WSUD ASSESSMENT TOOL

In combination, the research activities described in Sections 2.1 and 2.2 above have demonstrated that conventional assessments of the costs and benefits of WSUD are incomplete. These findings prompted the research team to develop a 'quick win' method by which practitioners can take account of the wider-ranging benefit and cost considerations that might otherwise be excluded from a business-case assessment of a WSUD project. The name of the resulting 'More Than Water' (MTW) assessment tool reflects the notion that WSUD can deliver multiple co-benefits and cost-related advantages, in addition to more familiar considerations associated with management of the hydrological and water quality effects of urban development.

The tool employs a qualitative assessment method that is easy to use and provides graphic demonstration of benefits and cost outcomes and how these might vary under different scenarios (Moores *et al*., 2019). It is suited to screening level assessments and communication processes that involve both the technically-familiar and lay audiences. Use of MTW involves making assessments of the level and importance of a series of benefits and costs criteria, along with the reliability of the assessment, drawing on guidance information provided with the tool. While assessments can rely on expert judgement, they can also be informed by the results of supporting analyses, such as hydrological modelling and life cycle cost calculations, where these are available. MTW represents each of these three aspects (level, importance, reliability) through differences in the length, width and colour intensity of sectors of a circle representing each benefit or cost criterion (Figure 4).

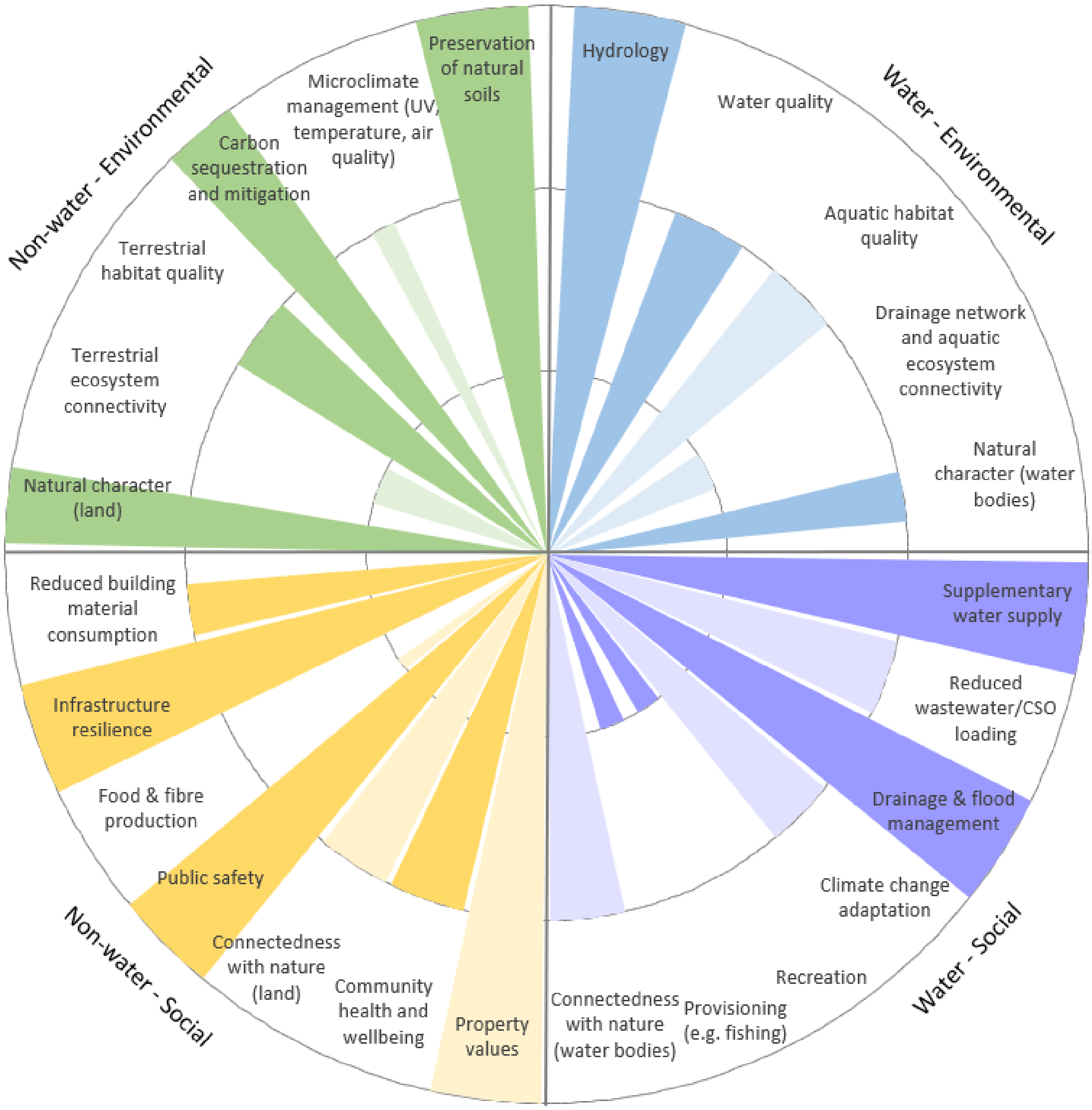


Figure 4: MTW tool: output of an illustrative assessment of WSUD benefits.

Typically, use of the tool will involve comparing an assessment of the benefits and costs of a WSUD project with those of some alternative, such as a 'business as usual' scenario employing conventional development practices. This approach has been demonstrated through the application of the MTW tool in three case studies: Kirimoko Park residential subdivision, the AMETI transport project and Talbot Park Community Renewal project. In all three cases, the use of the tool demonstrated that a WSUD approach delivers a greater range and level of benefits and performs better across a range of cost outcomes (Figure 5).

The current version of MTW is not considered the end-product. As a next step, the real-world utility of MTW should be assessed by practitioners trialing the use of the tool in WSUD projects, providing feedback for further development of the tool and underlying assessment methods. The tool and supporting guidance is available on the Activating WSUD website.

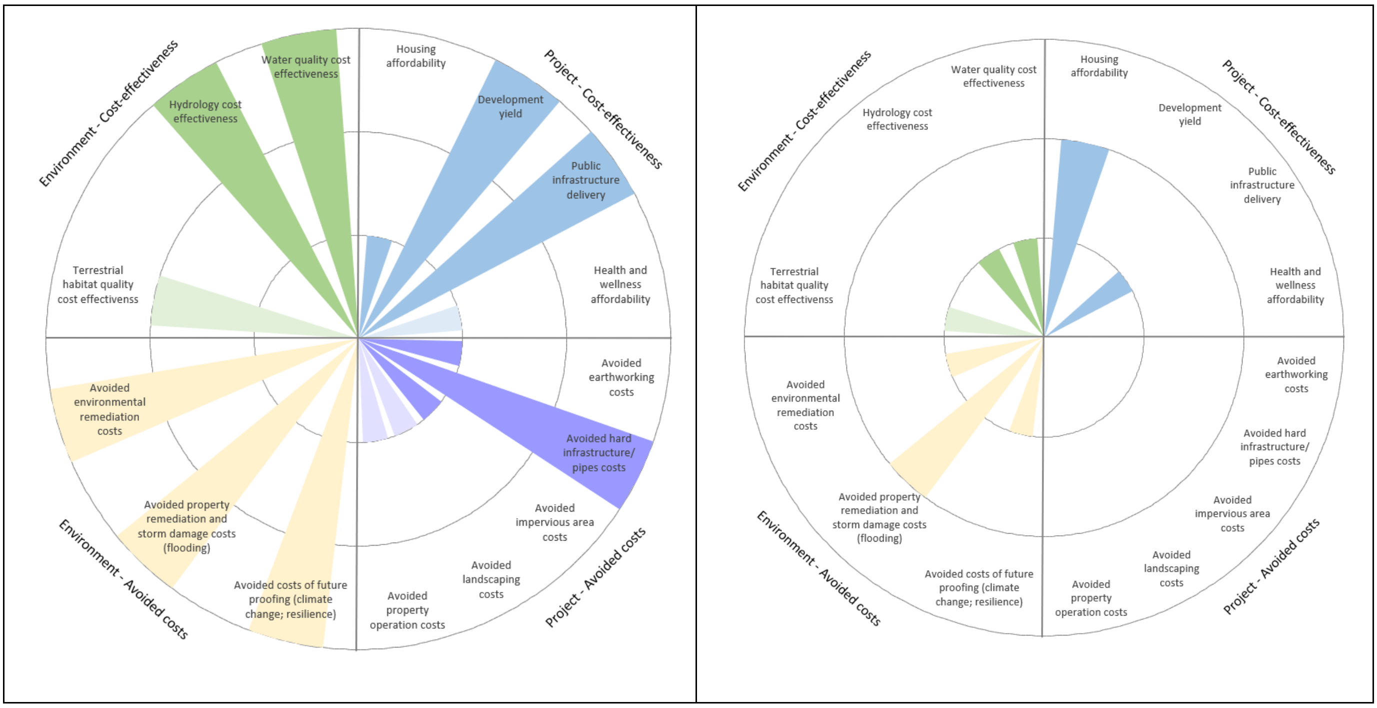


Figure 5: MTW output showing assessed costs for Kirimoko Stage 2 as constructed (left) and hypothetical 'business as usual' alternative (right).

3 HELPING THE IMPLEMENTATION OF WSUD

3.1 DESIGNING FOR LOW-MAINTENANCE

The project's third core research activity has addressed another leading barrier identified in Phase 1, the perception of WSUD as a high-maintenance alternative to conventional stormwater management. Because this research activity has focused on functional and operational aspects of WSUD that influence maintenance effort, it has been intricately linked with the cost-related research described in Section 2.1.

As part of this component of the research, summary tables of the likely maintenance activities, frequencies (based on expert advice as well as ARC, 2003; NZTA, 2010 and Healy *et al*., 2010) and costs for the different GI practices have been developed (Ira and Simcock, 2019). The maintenance tables for wetlands, rain gardens, swales and green roofs include three models reflecting differences in maintenance frequency to meet different objectives:

- Amenity – this approach focusses on high frequency maintenance to ensure devices are aesthetically pleasing all year round as well as functional from a stormwater perspective. This type of maintenance is likely to occur in areas which have high public amenity values (e.g. Wynyard Quarter in Auckland , Waitangi Park in Wellington, etc.);

- Functional – this approach focusses on undertaking landscaping maintenance during the growing seasons, coupled with the optimum level of drainage maintenance to ensure that the drainage function of the practice is not compromised through lack of ongoing maintenance.

- Bare minimum– this approach focusses on doing the absolute minimum amount of maintenance each year, whilst still allowing for some compromised level of functioning of the practice. Weed infestation and plant die-off is likely to occur.

This three-fold approach acknowledges that the two key drivers of maintenance costs are the frequency of the maintenance and the unit cost of the activity. While the bare minimum approach provides for the lowest maintenance frequency, the unit rates for this level of maintenance are higher than those for the amenity and functional levels. The reason for this is that it takes a maintenance person longer to weed, remove litter, landscape and maintain vegetation every 6 months than if they were doing it monthly or bi-monthly, as the level of weed infestation and sediment /litter accumulation is likely to be far greater. The 'bare minimum' also has a higher risk of much more expensive remedial works being required. As a result of these various influences on maintenance costs, the 'bare minimum' approach can be less cost-effective then the 'functional' approach (see Figure 6 for raingardens).

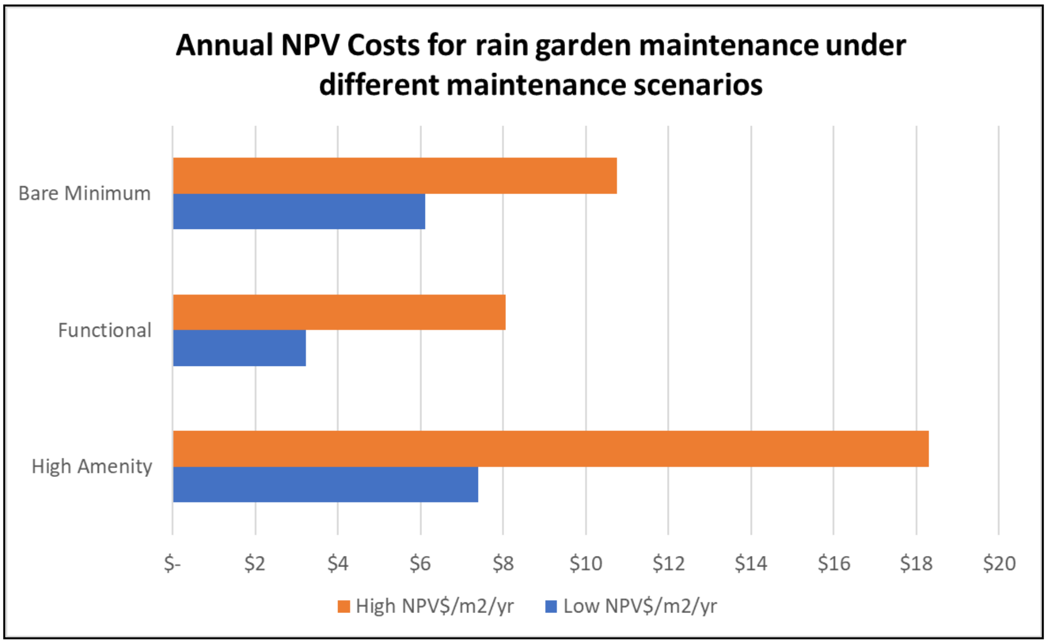


Figure 6: Annual Net Present Value (NPV/m^2/yr) costs of rain garden maintenance activities

As part of the research, we have developed factsheets summarising the key factors which influence maintenance costs, along with tips for on-going maintenance. We have also produced assessment and hand-over checklists to identify the most common design features that are linked to efficient, less frequent maintenance. Conversely, they also identify features and defects in design or construction that inflate maintenance costs. These can include: siting devices in locations that requires traffic controls to maintain inlets or vegetation; device shapes that maximise plant stress or damage from adjacent activities; inlets that are prone to blocking; and plants that block inlets. The checklists aim to help reduce the number of defective devices that are accepted by Councils.

This investigation of maintenance aspects of WSUD was strongly informed by site visits conducted as part of the Activating WSUD project's three case studies. One of these, the Housing NZ Talbot Park Community Regeneration project, noted the value of a local person who was responsible for maintaining public spaces, including rain gardens, for the first 2 years. This appreciation of the wider value of maintenance activities is in keeping with parts of North America where GI maintenance (particularly along roads and in public parks – rain gardens, swales, tree pits) has been recognised as making a positive contribution, providing jobs for local people and strengthening social cohesion.

3.2 FUNDING AND INCENTIVISING UPTAKE

It has long been acknowledged in New Zealand that there are significant challenges in securing funds for stormwater operators to address the cost of maintaining desired levels of service, and for planning for future growth while meeting community aspirations to maintain or enhance the quality of the environment (Ira, 2012; Landcare Research, 2005). Across New Zealand, the estimated cost of renewing the three waters network (wastewater, potable water and stormwater assets) is in the order of $30 billion to $50 billion over the next 15 years (National Infrastructure Unit, 2015). Local Government New Zealand has identified that property rates (the primary funding mechanism for stormwater infrastructure across New Zealand) are not the best and only tool to address the funding challenges which are facing local authorities (National Council of Local Government NZ, 2015).

Building on previous studies (Ira, 2012; Landcare Research, 2005), a literature review has been conducted to identify alternative funding options options that are or could be used in New Zealand under the Local Government Act 2002 and Local Government Rating Act (Ira, 2019). Table 2 summarises some of the options. The review also investigated how where and how successfully these mechanisms have been applied in cities around the world. The review found that application of a runoff-based stormwater fee is a common means of funding stormwater services in the United States, Canada, United Kingdom and Europe. Additionally, many of the cities within these localities also include incentive-based fee credits/savings to promote behaviour change and incentivise the use of green infrastructure. The "Cap and Trade" approach (i.e. a quantity-based market instrument that restricts the total allowable level of emission, allocates this level among individuals as allowances, and permits the transfer of these allowances through free trade (Ira, 2012) is also commonly used in the United States.

Table 2 Summary of funding options (adapted from Landcare Research, 2005)

Funding of capital works only	Funding of capital or operation works	Other available funding mechanisms
• Borrowing (loans or bonds) • Vested asset or financial contributions • Development contributions	• Allocations and grants (e.g. from national roading charge revenues) • Regional sales tax • General rate based on property value • Uniform annual general charge • Targeted rates (these could be based on, for example, land area, impervious area or hydrological contribution) • Fees and charges • Penalties	• Voluntary offset credit and incentive schemes (e.g. reduction of fees to encourage behaviour change • Negotiated agreements • Cap and Trade approach (i.e. creation of an economic market via water quality trading) • Public private partnerships

What is clear from the research (Ira, 2019) is that there is no silver bullet which can solve the funding gap facing councils and network operators in New Zealand. Rather, a toolbox approach to funding is needed. Landcare Research (2005, p.6) identified that any funding strategy should be based on five guiding principles:

1. **Sufficiency:** The need to secure adequate funds to renew existing infrastructure, improve service levels consistent with public priorities, and provide for growth.

2. **Certainty:** The need to ensure that sufficient funds will be available when required.

3. **Equity:** The principle of exacerbator (polluter) pays, i.e. those that generate additional demand for stormwater services (e.g. in relation to the extent of impervious surfaces connected to the stormwater network) should significantly contribute to its provision. This includes commercial properties, road users and developers.

4. **Efficiency:** The principle that a funding mechanism should provide incentives for behaviour consistent with the goal of reducing stormwater volumes and contaminant to levels that achieve the desired environmental and social outcomes.

5. **Acceptability:** The likelihood that the recommended strategy would be politically acceptable.

The main premise behind any funding strategy is that of "polluter-pays". A key funding principle should be that whilst the whole community may benefit from stormwater infrastructure, the people who generate the effect should be required to pay to mitigate it. Furthermore, the international experience clearly demonstrates that effective implementation of WSUD requires that the funding strategy encompass fee credits and/ or programme incentives to assist in creating behavioural change within the community and increase awareness of stormwater effects.

4 CONTINUED DISCOVERY

4.1 MELBOURNE STUDY TOUR

Members of the project team visited Melbourne in late November 2018 to learn about the WSUD characteristics (what), activating factors (why) and implementation approaches (how) that have delivered successful WSUD projects in Australian cities. The team met with researchers and practitioners from a wide range of disciplines as well as seeing many examples of the practical application of WSUD through the city. Meetings held at the CRCWSC, based at Monash University, and Melbourne Water, the city's principal three-waters agency, covered a wide range of topics, including:

- The development of benefit-cost assessment methods and tools;

- Strategies for transitioning to water sensitive cities;

- Understanding social influences on community engagement and uptake of water sensitive behaviours.

- An incentives scheme for promoting WSUD uptake by local councils (The Living Rivers programme[3]);
- Stormwater strategic planning and regulatory activities, including ongoing challenges facing WSUD implementation across Melbourne; and
- Capacity building in Melbourne's water management sector (delivered by a dedicated team: Clearwater[4]).

In addition, the team were taken by Melbourne University researchers on a tour of the Little Stringybark Creek catchment, the location of a long-established research project to investigate stream response to the retrofitting of WSUD devices (Walsh *et al*., 2015).

While important to note the difference in context between Melbourne and NZ, with WSUD in Melbourne primarily driven by a need for drought security, the project team reported on a range of success factors that may be influential in activating uptake in New Zealand (Activating WSUD, 2018). These include: the importance of engaged leadership the highest levels of public agencies; collaborative and co-ordinated approaches between agencies; the use of incentives schemes; and a significant effort in industry engagement and capacity building.

Despite widespread success in the implementation of WSUD, the team also found that Melbourne continues to face a number of challenges, some of which New Zealand practitioners will be familiar with. They include an aversion to WSUD among sectors of the development community and some local councils and problems with the consenting regime. Melbourne researchers are also investigating issues around the social equity of WSUD, recognising that the market appeal of WSUD gives the potential to result in locale gentrification and its uneven implementation among different socio-economic groups.

4.2 TE AO MĀORI AND WSUD

The Activating WSUD project has also started to investigate how WSUD in Aotearoa values, recognizes, and provides for Te Ao Māori, and how it could do better. This component of the research has involved a comprehensive review, described in detail in a complementary conference paper (Afoa and Brockbank, 2019). The authors have found that the principles of WSUD mirror Te Ao Māori – rather than trying to integrate Te Ao Māori, they stress the need to recognise that WSUD and its intended outcomes already draw upon fundamental Māori values – for example: whakapapa, whanaungatanga, kaitiakitanga, manaakitanga, and mātauranga māori.

Building on this work, the project team is investigating ways to make consideration of Te Ao Māori values an inclusive part of any assessment through the on-going development of the MTW tool described above.

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[3] https://www.melbournewater.com.au/community-and-education/apply-funding/living-rivers-funding

[4] https://www.clearwatervic.com.au/

5 CONCLUSIONS

5.1 SUMMARY

The Activating WSUD research project has investigated cost, benefit and operational aspects of WSUD implementation in New Zealand. We have developed life-cycle cost models for a range of WSUD devices and gained a better understanding of how a wider consideration of cost-related factors, such as avoided costs, informs a better comparison of WSUD with business-as-usual approaches to development. We have also shown how the benefits of WSUD can go far beyond conventional considerations of hydrology and water quality, extending into terrestrial and social domains. These alternative ways of understanding the costs and benefits of WSUD have been captured in the More Than Water Assessment tool, aimed at helping at least screening-level assessments of the value of WSUD projects for stakeholders with a wide range of numerical and technical competencies.

The project has also developed guidance on operations-led design and construction that impact maintenance costs, focusing on actions that result in 'Zero Additional Cost' or inflation of costs over and above costs of maintaining common conventional landscapes. It has also reviewed alternative funding options for incentivising the uptake of WSUD in New Zealand, finding that, while there is no 'silver bullet,' a tool box approach is available to incentivize the uptake of WSUD in New Zealand.

Finally, the research team has continued to learn from the experience of other WSUD researchers and practitioners, both in New Zealand and overseas, and has begun to explore how WSUD in Aotearoa does, and can better, recognise and provide for Te Ao Māori values.

5.2 NEXT STEPS

The findings of the project are being delivered through workshops for NZ's WSUD community of practice, including a workshop and linked site visit as part of this conference. The outputs described in this paper are also posted on the project web site. In addition, the project team will also deliver an assessment of longer-term research needs to continue the journey of activating WSUD in New Zealand. Feedback from WSUD practitioners will be sought at our workshops on what these further needs are. In advance of that feedback, we make the following recommendations for further research to build on the work delivered by the current Activating WSUD project:

- Assessing the role of WSUD/GI in climate change adaptation and/or mitigation;
- Updating of the existing COSTnz model to make it freely available to the NZ stormwater community;
- Investigating decision-makers' requirements and attitudes towards methods that involve the monetization of benefits.
- Further refinement of the assessment criteria within the MTW assessment tool, based on feedback from its application to assess real-world WSUD projects;
- Assessing the potential to customize cost-benefit tools developed overseas for use in New Zealand;
- Assessing the potential for public health economics to contribute to a more comprehensive assessment of the benefits of WSUD;

- Investigating the role of large trees and soil amendments in general landscaping areas to contribute to stormwater mitigation and wider benefits;

- Ground-truthing the maintenance model framework described in Section 3.1;

- Working with the local government sector to further investigate appropriate incentives and funding policies and mechanisms to support WSUD implementation across regional areas of New Zealand.

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