THE $GREEN BENEFITS OF WATER SENSITIVE DESIGN

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ABSTRACT

An economic assessment of the ancillary benefits of Water Sensitive Urban Design (WSUD) leads to a more robust economic analysis when designing infrastructure. Among the benefits are:

- ✓ improved air quality;
- ✓ greater biodiversity.
- ✓ healthy watercourses;
- ✓ reduced flood risk;
- ✓ lower carbon emissions;
- ✓ reduced urban heat island effect;
- ✓ increase energy efficiency of buildings;
- ✓ increased property values;
- ✓ improved health and well-being;
- ✓ reduced crime and violence;
- ✓ increased economic performance, and
- ✓ inclusion of Te Mana o te Wai.

Each stakeholder within the development chain will value the above benefits differently. Understanding the needs of the stakeholder and monetising the ancillary benefits of WSUD, that directly affect stakeholders, can foster a willingness to pay the increased capital cost for the construction of WSUD within a project. Applying overseas methodology, and adapting the methodology into a New Zealand context, can yield reliable monetary values of the secondary advantages of WSUD.

This paper provides a basic accounting tool, based on international research and best practice, to assign a monetary value to the unrealized cost benefits of different types of WSUD. Worked examples demonstrate the overall monetary value of amenity, environmental outcomes, biodiversity, carbon reduction, flood prevention and overall livability.

The paper also outlines a matrix for identifying which ancillary economic values of WSUD will benefit specific stakeholders and beneficiaries. By relating the WSUD benefits to the stakeholders, the designer, at the start of the project, can develop WSUD appropriate to the stakeholders. Presenting tangible economic benefits of WSUD will allow for more informed decision making on both greenfield and brownfield projects, getting the most bang for the buck.

For example, a 5 ha greenfield private development requires flood storage and stormwater treatment. With roading there is space for 166 townhouses that would sell for $750,000 each. By constructing a 2 ha central park to act as a flood storage basin with a wetland for treatment, the infrastructure requirements for the development can be met, but the number of townhouses will be reduced. Global research shows that homes within 450 m of that park will sell for about 10% more than those with no park. Using 2 ha of the property for a WSUD flood storage park and building 100 homes, profits remain the same,

as the roading infrastructure costs are reduced and the sale price of the townhouses increases to $825,000 each. The flood basin park will not only reduce carbon emissions related to infrastructure construction but will also sequester carbon. Carbon credits, which have monetary value, are awarded for projects that store, avoid, or reduce greenhouse gas (GHG) emissions in the atmosphere.

If the 5 ha development were for Kāinga Ora, the largest landlord in New Zealand, the WSUD economic analysis would include:

- ✓ flood protection;
- ✓ energy efficiency;
- ✓ reduction in crime;
- ✓ improved health, and well-being

The tools presented herein, allows a practitioner to develop WSUD that meets the infrastructure requirements for development and demonstrates the economic benefits to stakeholders.

KEYWORDS

Water sensitive urban design, economic benefits, livability

PRESENTER PROFILE

After immigrating to New Zealand in 2006 Linda joined ACH Consulting. Achieving degrees in Chemistry, geology, and an advanced degree in oceanography / marine geophysics, she has worked for NASA, Woods Hole Oceanographic Institution, and the US Geological Survey. As scientist and engineer, she brings multidisciplinary experience to stormwater design.

1 INTRODUCTION

Everyone wants to live in clean, safe, resilient, and vibrant communities regardless of economic status. People want and need access to high quality greenspace for mental and physical well-being. Central government has stated a commitment to reducing carbon emissions as well as improving water quality of our coastal and inland waterways. All government departments are under stress to reduce costs. Private land developers want to maximize profits. Commercial entities want to attract the best employees and promote consumer spending. Territorial authorities want to save money on energy costs.

Cross disciplinary planning and the use of WSUD can:

- Improve water quality which increases recreational opportunities and tourism.
- Reduce flood risk to communities – The 2023 Auckland flooding cost the city 2 billion NZ$ in damages.
- Improve air quality – a single street tree removes an average of 90 g of particulate matter from the atmosphere/ year (Shakya, R., and Ahiablame, L. 2021) as well as reducing ground level ozone and other atmospheric pollutants.
- Reduce urban heat island effect leading to reduced energy consumption and less greenhouse gas emissions.
- Reduce combined sewer overflows – beach closures lead to reduced revenues for communities like Orewa which generates 30% of their income from beach tourism.
- Provide habitat for wildlife including bees, birds, and bats.

- Reduce crime – crime costs NZ 11 billion/year. For every 1% increase in high quality green space there is a 1.2% reduction in violent crime and a 1.3% reduction in property crime (Venter, Z. S. et al. 2022).
- Increase physical activity improving physical health.
- Improve metal health.
- Provide a sense of community.
- Increase property values.
- Provide green jobs.

With all the potential benefits WSUD should be installed in every green field development and retrofitted to infill and brownfields development. Here in NZ WSUD is not the standard for stormwater management. A large part of the barriers to the widescale uptake of WSUD is perception.

Territorial authorities are best suited to promote the large-scale uptake of WSUD yet there are a number of barriers standing in the way. Decision makers who determine how money is spent for infrastructure often perceive WSUD as an emerging technology with unknown performance outcomes. There is also a perception that WSUD is more expensive than traditional grey pipe systems both in terms of CAPEX (capital expenditure) and OPEX (operational costs). While this is true for the capital costs for green roofs and permeable paving, the long-term cost benefit analysis often cancels out the increased costs. Other barriers include regulatory problems where codes of practice conflict with WSUD principles and a lack of resources in terms of staff capacity.

Developers also resist the implementation of WSUD believing it to be expensive to install and uses up valuable land. Promoting the uptake of WSUD with developers requires a cross discipline approach. Demonstrating that WSUD can be incorporated at the design phase development as opposed to superimposed on top of it as an afterthought. Well implemented WSUD can increase property value while reducing infrastructure costs. In terms of New Zealand's largest residential landlord, Kainga Ora demonstrating the WSUD can improve communities becomes essential in getting the government agency to adopt WSUD.

WSUD can even provide fiscal benefits to single house sites and free up otherwise undevelopable land for development.

2 BENEFITS OF EACH WSUD ASSET

There are a numerous of ancillary benefits provided by WSUD. Table 1 presents types of WSUD asset and the potential benefit.

Table 1 Benefits of various WSUD assets

	Rain gardens	Swales	Street Trees	Permeable paving	Green Roofs	Flood Basin Parks	Wetlands	Rain Tanks
Reduction of Urban Heat Island Effect	√	√	√	√	√	√	√	
Improved Air Quality	√	√	√		√	√	√	
Lower Carbon Emission		√			√			
Increased Energy Efficiency					√			√
Reduced Flood Risk	√	√				√	√	√
Reduction of Sewer Overflows	√	√	√		√	√	√	√
Healthy Water Courses	√	√	√		√	√	√	
Greater Biodiversity	√	√	√		√	√	√	
Increased Property Values	√		√			√	√	
Improved health and well-being	√		√			√	√	
Reduced crime and violence			√			√	√	
Increased economic performance	√		√		√	√	√	
Inclusion of Te Mana o te Wai	√	√				√	√	
Educational Opportunities	√				√	√	√	

2.1 REDUCTION OF URBAN HEAT ISLAND EFFECT

Where the urban landscape has replaced trees and vegetation with concrete and asphalt the thermal properties of the landscape have been altered. The surfaces within the built environment absorb heat causing surface temperatures to rise. During the summer months the city of Los Angeles is 2.75 ºC warmer than the surrounding more vegetated areas (Shakya, R., and Ahiablame, L. 2021). Green roofs, trees, rain gardens, vegetated swales, wetlands, and flood basin parks lower the ambient air temperature through evapotranspiration and shading. The City of Toronto Canada estimates that a widespread use of green roofs in the city could lower the air temperature in the city by as much as 5º C (Shakya, R., and Ahiablame, L. 2021). The lowering of temperature has a knock-on effect as it reduces the instances of heat related health effects as well as reducing the energy usage for the cooling of buildings. The reduction of the urban heat island effect caused by the built environment will become vital in the face of climate change and the increased urbanization of the human population.

2.2 IMPROVED AIR QUALITY

Urban areas suffer from poor air quality due to emission of nitrogen dioxide (NO_2), sulfur dioxide (SO_2), ground level ozone (O_3) and particulate matter 10 μg/m (PM_{10}). The sources of these emissions are from industry, transport, and domestic activities. Poor air quality leads to worsening of existing respiratory conditions such as bronchitis and asthma. The NZ Ministry for the Environment states that poor air quality leads to an increase in school absences, days off work and hospital admissions. Internationally there is an established correlation between poor air quality and mortality rates. Further to this lower income communities air disproportionately exposed to poor air quality (Rentschler, J. and Leonova, N. 2023) The pollutant removal rate of street trees, green roofs and rain garden are included in Table 2.

Table 2 Pollutant uptake of WSUD

	NO_2	SO_2	O_3	PM_{10}
Medium Street Tree (McPherson et al, 2002)	77 g	31 g	122 g	132 g
Green Roof per 100 m^2 (US EPA 2014)	232 g	198 g	449 g	65 g
Rain garden & other green streetscapes per m^2 (Shakya, R., and Ahiablame, L. 2021)	64 g	55 g	124 g	18 g

2.3 LOWER CARBON EMISSION & INCREASED ENERGY EFFICIENCY

The manufacturing and transporting of reinforced concrete pipes result in 17.17 kg CO_2 emissions for every meter of 225 mm diameter pipe. Every 1 m deep manhole generates 177 kg of CO_2 emissions in production and transport. Based on size and thickness, the standard stormwater catchpit creates 75 kg of CO_2 emissions (Concrete Pipeline Systems Association, 2010).

WSUD helps in lower carbon emissions in a number of ways. The installation of swales, rain gardens and wetlands to convey stormwater reduces CO_2 emissions. Grasses and trees which make up WSUD help to sequester CO_2. Large parks, street trees and green roofs reduce the ambient air temperature during the summer month reducing the energy demands for cooling. Further to this, green roofs make buildings more energy efficient acting as an insulation barrier. The plants reduce the solar energy reaching the roof and evapotranspiration cools the roof resulting in cooler temperatures within the building. One study showed that the widescale installation of green roofs in Brisbane could reduce CO_2 emissions by 100,000 tonnes per year, which would be the same as removing 909,880 cars from Australian roads (Anwar, M. et al. 2020).

2.4 REDUCED FLOOD RISK AND SEWER OVERFLOWS

Recent Auckland flood events have cost 2 billion dollars in damages, the cost is the equivalent of $1,226 for every resident of Auckland. The flooding has made people and politicians aware of a need to reduce flood risks and become resilient in the face of climate change. WSUD can mitigate the increased runoff rate and volume resulting from urban intensification. Creating blue green parks that are designed to flood in extreme rainfall events can act as extended detention. Conveying water overground through restored stream and roadside swales will make the urban environment less reliant on the piped network. Planting stands of trees reduces runoff velocity, and volume, increases the time of concentration, as well as supports infiltration into the soil. Managing stormwater runoff

on site or within smaller sub catchments reduces the burden on aging infrastructure. Changing the view of stormwater from a liability to an asset will require a paradigm shift.

Flooding also contributes to overflows of untreated sewage discharging into the waters surrounding Auckland. Overflows occur in wet from stormwater entering the sewer system through aging pipes and the combines sewer network area of the city being overwhelmed. The overflows result in beaches being closed to swimming. The closure of beaches has an economic impact on communities like Ōrewa that receives 30% of its retail income from beach attendance.

2.5 HEALTHY WATER COURSES

Vegetated swales, rain gardens and wetlands remove TSS, microplastics, gross pollutants, nutrients, and heavy metals upstream of the receiving environment. The upstream filtration of stormwater runoff protects and can even retore natural waters. Many freshwater aquatic species are threatened in New Zealand due to the loss and degradation of habitat.

Detaining and retaining water in smaller storm events through rain gardens, wetlands and detention devices protects the stream banks from erosion. Protecting the stream banks allows the streams to better convey water and further protects habitat from degradation.

2.6 GREATER BIODIVERSITY

WSUD provides habitat to all kinds of organisms. The 2.73 ha green roof at the Jabob Javits Convention Center in NYC is home to 29 species of birds, 5 species of bats, 80,000 honeybees, other arthropods, and soil microbes. Inland constructed wetlands can provide habitat for mudfish, grazing bird, and nationally important plant species. Flood basin parks can similarly provide habitat for a variety of terrestrial species. Even street trees provide an opportunity to create habitat for native birds and insects.

2.7 INCREASED PROPERTY VALUES

There is an abundance of research which demonstrates that property values are higher in vegetated neighborhoods. The value of houses on streets with swales and rain gardens and green streets in Seattle are 3% - 5% higher than those without (USEPA 2013). Houses constructed near a park, which can include WSUD, have an increased value of between 8% - 19% (RICS 2007). Even commercial property value can be increased by 15% near open spaces (Silvennoinen S., et al. 2017). Another study showed that within a 500 m buffer zone of a park house prices increased by 5.4% for every 100 m closer to the park that house was situated. A study from Philadelphia found properties close to green surface infrastructure increased in value by more than 10%.

2.8 IMPROVED HEALTH & WELL-BEING

Effectively managed stormwater can provide a healthier environment for people. WSUD reduces heat island effect and captures air pollutants, positively impacting health. Larger WSUD assets provide opportunities for exercise and recreational activities which improves physical health and mental well-being. WSUD can also include urban gardens providing an opportunity to grow food as well as provide recreation. These types of activities lead to better overall health of a population. In a country that has a public health care system improved health and well-being can reduce healthcare costs.

2.9 REDUCED CRIME & VIOLENCE

Urban environments increase overall stress levels contributing to depression and mental illness which can result in violent behaviour (Shepley, M. et al 2019). There is evidence that higher ambient air temperatures lead to heightened aggression (Gamble, J.L.; Hess, J.J. 2013).

Greener urban areas are associated with sustained mental health improvements (Alcock, et al. 2014) and interaction with nature can promote the ability to make better choices. Incorporating a visual connection to water into the design creates a positive effect and is considered restorative (White, et al. 2010).

WSUD incorporates well maintained green spaces including parks, street trees and rain gardens. All of these provide a walkable environment, increasing social interactions and reinforcing a sense of community. The WSUD can also contribute to a sense of civic pride and inclusion. Parks, wetlands, green roofs, rain gardens, and street trees reduce the ambient temperature thus reducing aggressive behaviours that contribute to violent crime and domestic disturbances. As previously stated, NZ spends 11 billion/year. For every 1% increase in high quality green space there is a 1.2% reduction in violent crime and a 1.3% reduction in property crime (Venter, Z. S. et al. 2022). This level of reduction has a significant economic benefit to the NZ government.

2.10 INCREASED ECONOMIC PERFORMANCE

Well executed WSUD provides aesthetically pleasing streetscapes. In a commercial district this leads to shoppers staying longer and greater spending. Workers want to be in areas with open spaces, good air quality and clean water where nearby recreational activities are available. According to the USEPA these environments result in a happier, more productive work force.

2.11 INCLUSION OF TE MANA O TE WAI

Te Mana o te Wai acknowledges that protecting the health of water protects the health of the environment and that restoring the balance preserves the wider community. Putting the health and well-being of water and freshwater ecosystems above the needs of the people will allow communities to continue to have social, economic, and cultural well-being for future generations.

The inclusion of the Māori values as part of the WSUD process provides for values that appear non-monetary but provide for the well-being of people. There is increased social harmony with the inclusion of Te Mana o te Wai as it is a vehicle for cross cultural understanding. It enhances civic engagement across cultures, promoting democracy and social capital. The inclusion of all groups reduces social stresses and has a positive impact on mental health.

2.12 EDUCATIONAL OPPORTUNITIES

Teaching the next generation the value of water is critical to New Zealand's Future. The Jacob Javits Convention Centre in NYC is a good example of the potential educational opportunities that can be provided by WSUD. The green roof provides educational programs including STEM, nature photography and urban ecology. The green roof also acts as a living laboratory used by Columbia University, Drexel University and Cooper Union Institute for Sustainable Design.

Smaller waterway restoration projects constructed wetlands and flood basin parks can also provide many unique educational opportunities from primary school to university level. It will take a paradigm shift not only in how we view stormwater but how we perceive educational value.

3 WHO WILL PAY FOR ALL THIS COOL STUFF?

Greater uptake of WSUD is dependent on targeting the designs for the steak holders on a project. For example, designing WSUD for a large civic building can target energy efficiency, reduction of urban heat island effect, inclusion of Te Mana o te Wai and educational opportunities. A private housing development will seek to increase property values and gain carbon credits, which can have a monetary value on big developments. Kianga Ora is a government department whose mission is to build better brighter homes, communities and lives would seek to include WSUD that reduces urban heat island effect, reduces crime, improves air quality, and improves overall health thus creating savings across government departments.

Table 3 below presents an assessment of what ancillary WSUD benefits will positively impact individual stake holders. Using Table 1 and Table 3 together will allow the designer to target the WSUD assets to the stake holder, creating greater uptake by demonstrating economic advantages.

Table 3 Beneficiaries of WSUD by steak holder and project type.

	Civic Building	Commercial Development	Council / Govt Project	Private Housing Development	Kianga Ora Development	Single House Site
Reduction of Urban Heat Island Effect	√	√	√	√	√	
Improved Air Quality	√	√	√	√	√	
Lower Carbon Emission	√	√	√	√		
Increased Energy Efficiency	√	√	√		√	√
Reduced Flood Risk	√	√	√	√	√	√
Reduction of Sewer Overflows			√			
Healthy Water Courses			√	√	√	
Greater Biodiversity			√			
Increased Property Values		√		√		√
Improved health and well-being	√		√		√	
Reduced crime and violence	√		√		√	
Increased economic performance	√	√				
Inclusion of Te Mana o te Wai	√		√		√	
Educational Opportunities	√		√		√	

4 WHAT IS IT WORTH

Determining the dollar value for each of the benefits and describing a unit is difficult. Some items like carbon emissions reduction have a dollar value that changes as do energy costs which vary around the country. Other values like reduction in health care and reduction in crime are tangential and require statistical analysis that is beyond the scope of this paper to accurately assess. However, values taken from overseas research have been included in Table 4 to allow WSUD to present a robust business case to stake holders when presenting various WSUD asset options.

Table 4 Dollar values for WSUD secondary benefits.

	Civic Building	Commercial Development	Council / Govt Project	Private Housing Development	Kianga Ora Development	Single House Site
Reduction of Urban Heat Island Effect	$1.4 million/ha/50 years		Street trees, wetlands and green space can take time to demonstrate health and social benefits. This figure represents a decrease in healthcare costs and increased social benefits. (adapted from Johnson et al. 2021)			
Improved Air Quality	$16,975 tonne/year		Total health benefits resulting from improved air quality. (adapted from Horton et al. 2019)			
Lower Carbon Emission	$55.00 / tonne		Carbon price as of April 2024. Carbon credits can be gained through the construction of 2 ha of green space and other monetary benefits can be gained through lowering carbon emissions on a project.			
Increased Energy Efficiency	$16.00/1% decrease/100 m^2		Based on BRANZ energy uses and current retail kWh costs. A green roof can reduce electricity consumption by 13.65% on 1000 m^2 building the energy savings are $2,185/year.			
Reduced Flood Risk	$3,093 / year/ household		Reducing the flood risk from events greater than the 10-year storm to events greater than the 100-year storm weighted annual average damage savings estimates based on probability (adapted from Horton et al. 2019).			
Reduction of Sewer Overflows	$33,000/overflow		Based on lost revenue from recreational fishing, swimming and food gathering resulting from red water conditions and based on the cost estimates of the larger events. There is significant statistical analysis that needs to be undertaken here.			
Healthy Water Courses	$55,000 km/year		The improvement of water quality in rivers, lakes and streams increases recreational opportunities, improves fisheries, and improves coastal waters. Bank stabilisation and water channel improvements allow for better conveyance of runoff in storm events (adapted from Horton et al. 2019)			
Greater Biodiversity	$240 /ha/year		Increase biodiversity helps support NZ biodiversity targets and restores natural capital. Greater biodiversity improves recreational opportunities and contributes to a sense of well-being. (adapted from Horton et al. 2019)			
Increased Property Values	10% Residential 3-15% Commercial		Based on RICS 2007 and others. There seems to be global agreement around 10%.			

Improved health and well-being	local green space $38.00 / visit View of greenery $317/person/yr.	These figures are based on increased emotional well-being and increased physical activity reducing health care costs and costs associated with depression and mental health. (adapted from Horton et al. 2019)
Reduced crime and violence	$1,644 /100 households/ 1% addition of greenery	Based on the per person crime rate of NZ as published by the word band the 1.2% reduction in crime for every 1% of greenery added as predicted by Venter, Z. S. et al. (2022)
Increased economic performance	57% increase in retail sales Increased employee productivity and reduced absenteeism	Based on the Center for Neighborhood Technology (CNT) and American Rivers (2010). There is a global acceptance of better employee outcomes where an office building incorporates green infrastructure. The percentages vary widely based on the quality of that infrastructure and the type of employment.
Inclusion of Te Mana o te Wai	$ unknown	Embedding Indigenous knowledge in WSUD creates engagement and fosters democracy and understanding. Placing a dollar value on this is problematic. However, the NZ government has committed to the inclusion of Mana o te Wai. This category should be considered a requirement for the relevant stake holders identified in Table 3.
Educational Opportunities	$42.00 per educational trip	This is an estimate of the educational benefits provided by trips which include lessons about nature, catchments, flooding and WSUD. (adapted from Mourato et al. 2010)

The values presented in Table 4 are a preliminary assessment. More in-depth statistical analysis may become available over time. Additionally, values adapted from overseas may require further adjustment for applicability to New Zealand. However, without a starting point for placing monetary value on the secondary benefits of WSUD it is difficult to make a robust business case when the perception is that WSUD has greater CAPEX and OPEX costs.

5 WORKED EXAMPLE

5.1 CIVIC BUILDING

A new convention and exhibition centre in Wellington has a designed roof area of 5,500 m^2. Taking the 13.65% energy reduction that would be provided by a green roof, the energy costs of the building are reduced by $12,012 year. The green roof also provides removal 0.052 tonnes of air borne pollutants in a heavily urbanized setting. The improved air quality has a value of $881/year. There is also a yearly value of $132 for increased biodiversity. The 5,500 m^2 would also have the ability to retain 5.2 million litres of water annually reducing the burden on Wellington's infrastructure. Over the 50-year building life the green roof would generate $770,000 value in the reduction of urban heat island effects.

Over the 50-year design life of the building green roof will generate $1.42 million secondary benefits. The 50-year itemized benefits from the green roof are as follows:

- $600,000 in energy saved at current prices.
- $44,050 worth of air borne pollutant removal.
- $6,600 biodiversity values.
- $770,000 value in the reduction of urban heat island effects.

While these numbers may seem high, they are comparable with large green roofed buildings elsewhere in the world.

5.2 PUBLIC HOUSING DEVELOPMENT

Where there is 5 ha of land available for a public housing development the housing density can be 36 units/ha including roads and parks. If 108 street trees were included as part of the stormwater management for the development those 108 street trees would provide the following ancillary benefits:

- 0.039 tonnes of air pollutant uptake per year generating air quality improvements wort $662 per year.
- Crime and violence reduction of $1,775 per year based on the trees creating 1% of green space.

If the development were to include 1 km of 2 m wide roadside bioretention swales capable of conveying the runoff from the 1 in 100 year storm the ancillary benefits added would be:

- 0.522 tonnes of air pollutant uptake per year generating air quality improvements wort $8,860.95 per year.
- An additional crime and violence reduction of $7,100 per year based on the bioswales creating 4% of green space.
- Reduced flood risk values at $334,044 per year.
- A 20 tonne reduction kg CO_2 emissions due to a reduced pipe network

Creating a 1 ha flood basin park at the centre of the development with a stormwater treatment wetland in the development would reduce the housing yield but would create greater liveability and increase the positive benefits to the community.

- 2.61 tonnes of air pollutant uptake per year generating air quality improvements wort $44,304.75 per year.
- An additional crime and violence reduction of $35,510 per year based on the park creating an additional 20% of green space.
- Improved health and well-being valued at $669,429 based on 292 residents visiting the park once a week and 100 residents having direct view of the park.

In the above public housing development, the WSUD generates 1.1 million dollars' worth of ancillary benefits. If the WSUD assets were well maintained over the 50 year building design life the 108 house development represents 55 million dollars in benefits. Much of these benefits would translate into the New Zealand government savings across health care and criminal justice. There are other savings here as the street tress and bioswale would serve to calm traffic and reduce the urban heat island effect.

6 CONCLUSIONS

The implementation of WSUD has the potential to bring about numerous benefits, including improving water quality, reducing flood risk, enhancing air quality, lowering carbon emissions, increasing property values, fostering biodiversity, promoting physical and mental health, reducing crime, boosting economic performance, and aligning with Māori values. However, the widespread uptake of WSUD in New Zealand faces barriers such as the perception of higher costs compared to traditional stormwater management systems, conflicting regulatory codes, and resistance from developers. To overcome these barriers,

a cross-disciplinary approach is needed to demonstrate the long-term cost benefits and multiple advantages of WSUD.

Using the table 1, 3 and 4 presented herein allows the practitioner to customise designs to appeal to different stakeholders based on economic advantages. Placing a monetary value on the secondary benefits of WSUD will help in creating a robust business case for its adoption. Ultimately, the incorporation of WSUD has the potential to bring significant secondary benefits to the community, and its widespread implementation could lead to positive environmental, economic, and social outcomes.

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