Economics Work Package

EFFECT OF WATER SENSITIVE URBAN DESIGN SOLUTIONS AND GREEN SPACE ON PROPERTY VALUES: A LITERATURE REVIEW

Prepared by Sue Ira, Koru Environmental Consultants Ltd on behalf of Greater Wellington Regional Council

Te Awarua-o-Porirua Collaborative Modelling Project

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Report prepared for Greater Wellington Regional Council.

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EXECUTIVE SUMMARY

This report summarises a comprehensive, systematic review of national and international literature, focusing on the effect of water sensitive urban design (WSUD) solutions on house prices. Approximately 74 studies were investigated through the literature review, and those found to be directly relevant to the study are summarized in Table 1. Studies primarily used the Hedonic Pricing Method of evaluation for single family homes to assess the impact of green infrastructure (WSUD) and space on property values.

The literature shows a consistent increase in house prices in close proximity to green infrastructure/spaces world-wide, however, the quantum of this increase varies significantly between countries. Studies in the USA show an average increase in house prices of 3.05% for those houses in close proximity to green space; whilst studies in the UK and Europe show an average increase of 4.93%, Australia shows a 7.92% average increase and New Zealand studies demonstrate a 6.04% average increase (Table 2). Purchase and rental costs of apartments also increase in close proximity to open space.

The literature demonstrates that houses which border on green space have higher values than property which is further away. The effect of views, especially where water is involved, leads to the highest increase in property values. However, there is a clear trend that poor quality green areas lead to a decrease in property values. Other negative effects on property values include green areas located in areas of high crime rates. Furthermore, lack of on-going maintenance can cause property values to decrease in the long term.

The type of green infrastructure/ space also has a differential impact on property prices. Table 3 documents this variability and shows that larger-scale urban parks and natural areas tend to have a higher effect on house value than small-scale green areas.

The literature also provides a link between the benefit to private individuals from increased house values to benefits to councils resulting from increased rates collections. This increased income could assist in funding potential increased maintenance and improvement costs of WSUD in the long term. The literature showed a clear preference for a “user-pays” approach to ongoing funding of WSUD.

Whilst a number of general conclusions can be drawn from the literature, they tend to be very “site specific” and the lack of homogeneity around housing and green space means that the variables which affect house prices will interact differently for different places. The literature therefore provides us with a general direction of change in values, along with potential variability between locations as well as economic parameters which require assessment. The quantum of change to property prices should not be transferred other locations.

Based on these economic assessment parameters and the lessons learnt through the literature on HPM studies, an assessment of the effect of WSUD solutions on property prices could be undertaken in New Zealand. Ideally, locally-sourced case studies (i.e. within the Wellington Region) should be used.

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1. INTRODUCTION

1.1 Background

The purpose of the project is to collaboratively generate information and knowledge to support the Te Awarua-o-Porirua Whaitua Committee make recommendations for land and water management in the Whaitua. The project will produce modelling outputs and knowledge describing the current environmental, social, cultural and economic conditions in TAoP Whaitua, as well as potential future outcomes that might result under urban and rural land and water management scenarios.

This report forms part of the economic assessment work and is one component of the overall economics work brief that addresses the decision making needs of the Whaitua Committee. The focus of current stormwater and run-off management practice in the Porirua is largely on flood control and sedimentation, with the water transport aspect paramount. Alternative approaches to the uses of rainfall, the contaminants contained in stormwater and their sources have the potential to create diverse positive effects at multiple scales and across a number of dimensions. Changes to that focus may potentially impact the economic possibilities of water use, and urban-based effects on receiving waterbodies, which in turn may impact the extent of ecosystem services experienced by the community, with flow on effects for community wellbeing and liveability in the Porirua Whaitua.

A change in operational focus beyond water transport to intervention practices such as source control and treatment is considered alongside how rainfall may be utilised to take account of community preferences for the condition of the receiving waterbodies and uses of water. This "Water Sensitive Urban Design" (WSUD) approach will create costs over and above the existing flood control function currently funded as a collective good paid for by landowners through targeted rates, levies and charges. The additional costs may be borne as private costs, or increases to rates, levies and charges where mitigation solutions are provided as part of the collective good. However, a WSUD approach to stormwater management may also impact on regional GDP, employment, and household income and expenditures potentially induced by the stimulus of expenditure that the intervention practices in each scenario create. It can also influence house prices as a result of the increased "greening" of the city, enhanced liveability, improved aesthetics and associated benefits.

1.2 Purpose

The context for this literature review report is a collaborative decision-making project set in New Zealand's national freshwater management processes: the Te Awarua-o-Porirua Whaitua. As the Whaitua committee considers alternative scenarios of catchment stormwater management interventions, they wish to be understand the potential effects on property prices of WSUD practices. The review is not so much focused on a wider assessment of price formation in property markets in the presence of WSUD, but has been commissioned to develop, inform, and provide an evidential basis for narratives around house price effects. As such it is a preliminary exploration of these effects to inform

consideration of Wellington region or Porirua location specific hedonic analysis of property price effects.

This report documents the results of an international and national literature review of the effect of water sensitive design solutions on house prices. Additionally, it has investigated and summarized house price effects associated with, but not limited to, proximity to urban green corridors and spaces, wetlands, and parks, with a particular focus on New Zealand studies where possible.

2. METHODOLOGY

2.1 Literature Review Methodology

A comprehensive, systematic review of national and international literature, focusing on the effect of WSUD solutions on property prices and taxes, has been undertaken. The literature review was scoped on the basis of investigating the following key research objectives:

1. To describe the potential range and distribution (which classes of property are most likely to be affected) of property price effects that may arise across the Te Awarua-o-Porirua Whaitua in response to the stormwater, wastewater and urban design interventions defined for each of the project scenarios, with a particular focus on the effect of green solutions offered through a WSUD approach to water management.
2. To describe the potential range and distribution of location based property price effects that arise from proximity of properties to interventions, e.g., rain gardens, wetlands and green corridors.
3. To identify trends in the literature relating to the effect of water sensitive design solutions and green corridors on property prices which could be applicable to the design and management of water sensitive design solutions as well as the implementation of various land-use scenarios.

A desktop review of the literature was undertaken based on a number of key "search terms" used in internet searches within a number of scholary databases such as Google Scholar, EVRI, jstor.org and Science Direct. These terms included words such as: water sensitive design, green infrastructure, low impact design, sustainable urban drainage systems, open space, green space, property values/ prices, house values/ prices, economic analysis, hedonic pricing, market values, benefits transfer, willingness to pay.

2.2 Economic Valuation Methodologies

There are various statistical and assessment methodologies which are available to researchers to value environmental goods and services, as well as the benefits which accrue to communities and the market from these services. These methodologies generally fall into two distinct categories, namely (Rohani, 2013):

- revealed preference techniques: individuals reveal their willingness to pay for goods through market and surrogate market prices (market valuation); and
- stated preference techniques: individuals are asked directly what they are willing to pay for goods and services (i.e. non-market valuation).

Whilst this literature review has focused primarily on hedonic pricing of changes in property value (market valuation studies), willingness to pay (non-market valuation studies) and benefit transfer research is also included. A brief explanation of each of these economic valuation methods is provided below.

2.2.1 Hedonic Pricing

As taken directly from Rohani (2012, p.6):

'The Hedonic Price Method (HPM) is a revealed preference method of valuation. The hedonic price method of environmental valuation uses surrogate markets for placing a value on environmental quality. The real estate market is the most commonly used surrogate in

hedonic pricing of environmental values because it shows the willingness of the households to pay for a property.

Hedonic property models are predicated on the theory that the prices of heterogeneous goods reflect the component values of those goods' characteristics……..Households make their purchase decisions based on a number of structural, environmental and neighbourhood characteristics. Market price as the equilibrium price shows the value of property attributes. The HPM is a tool to separate out the environmental component of value from the observed market price and use that as a surrogate for the environmental value……..This method has been used extensively in the economics literature to measure the impact of a given resource, such as a beach, river, or lake on the value of locating properties close to the resource. This proximity consists of two separate benefits households derive from living close to the resource, namely access and views.'

2.2.2 Willingness to Pay

Willingness to pay is a contingent valuation or non-market valuation method where researchers ask respondents, through a structured review, what price that they would be willing to pay for environmental or market goods (Bastien, *et. al*., 2011).

2.2.3 Benefit Transfers

Undertaking "benefit transfers" is another economic methodology for determining the monetary benefit of environmental activities on the market-place. This method is used to estimate economic values by transferring data already obtained within completed studies from another location or context and undertaking a meta-analysis on the data to determine its relevance for the study site (Perino, *et. al.,* 2013).

2.3 Water Sensitive Urban Design and Green Space – A Complex Relationship Unraveled

Internationally there is extensive literature on the effect of green space on house values, and there is also wide-ranging literature on the economic benefits of water sensitive urban design (WSUD). It is therefore pertinent that any literature review on the effect of WSUD and green spaces on house prices clearly defines both the type of green space as well as the relevant WSUD practice(s) that this space could encompasses or is comparable to. A definition of WSUD and how these relate to different categories of green space is provided here.

WSUD is a design philosophy to water management which encompasses a range of solutions. The Wellington City Council WSUD manual (undated) similarly defines WSD as:

'*WSUD is an approach to water management in towns and cities that addresses both water quantity and water quality issues. WSUD draws upon the processes of natural systems and adapts these to suit urban environments. It integrates the processes inherent in water systems with the 'built environment' – buildings, infrastructure and landscapes*.'

Importantly, the Wellington City Council WSD manual (undated) acknowledges that the urban water system includes potable water, wastewater and stormwater which need to function as an integrated system.

The Wellington City Council WSD manual (undated) lists four overarching objectives of WSD, namely:

1. Protect or enhance the environmental, social and economic values of downstream environments
2. Reduce the frequency, duration and volume of stormwater runoff to mitigate the risks of nuisance flooding and moderate post-development flows to waterways
3. Reduce demand on potable water supply
4. Improve amenity in the urban environment.

Whilst WSUD is a philosophy about site design and development rather than just about managing stormwater at source, it has a high focus on the use of natural processes and vegetation to provide stormwater treatment, reduction and attenuation, as well as enhance the amenity and 'naturalness' of the urban environment. Common WSUD solutions include increased native/ green areas and reduced impervious surfaces, wetlands, rain gardens, swales, green roofs, rain tanks, infiltration and native bush replanting.

WSUD is known by many other terms in different parts of the world, namely low impact design, green infrastructure, sustainable urban drainage systems and water sensitive design. These terms are used interchangeably in the literature (and in this report), and whilst they may have a slightly different focus or objectives to WSUD in New Zealand, the majority of solutions are the same.

Due to the important focus of WSUD on using vegetation to mitigate effects of stormwater and wastewater discharges, urban green spaces become an integral part of a city's water infrastructure under a WSUD development scenario. It is for this reason that stormwater infrastructure in many countries is now called 'green infrastructure'. During the literature review, green spaces were therefore categorised as follows:

- **Large open spaces/ urban parks:** no formal stormwater mitigation but includes natural areas which reduces urban impervious area and increases evapotranspiration (regional parks, natural areas, local parks).
- **Small open spaces/ urban parks:** no formal stormwater mitigation but includes natural areas which reduces urban impervious area and increases evapotranspiration (small local parks; neighbourhood parks/ playgrounds).
- **Natural green open spaces/ corridors:** may include catchment-based formal stormwater mitigation such as ponds and wetlands, but also includes natural bush, riparian or woodland areas.
- **"At source" green areas:** majority of areas include formal stormwater mitigation solutions such as rain gardens, tree planters (including street trees), swales, green roofs.
- **Stream restoration areas:** includes green space where streams have been daylighted or restored and riparian vegetation planted.

Where possible, these categories of green space have been identified within this literature review.

3. RESULTS

Approximately 74 studies were investigated through the literature review. Those found to be directly relevant to the study are summarized in Table 1, with further information from each report being included in Appendix A. Table 1 summarises each paper according to several key criteria which were developed to ensure that the project research objectives (Section 2.1) were met. These criteria include:

- Country, city or region;
- Geographical and topographical considerations (e.g. topography, catchment form, soils, rainfall);
- Stormwater design objectives (e.g. water quality, water quantity, stream protection or volume reduction mitigations);
- WSUD practices (e.g. rain gardens, swales, wetlands, ponds, rain tanks, permeable paving, green roofs, riparian planting, parks, natural bush areas);
- Land-use (e.g. residential, commercial, industrial, rural-residential, rural – related to the type of property analysed in the study along with the property dataset);
- Development context (e.g. brownfields or greenfields development);
- Valuation approach (e.g. hedonic pricing, benefit transfer, willingness to pay);
- Study period;
- Unit of analysis used (e.g. % or $ change in house price);
- Magnitude/ range of effect (i.e. range and or distribution of properties and their proximity to green space);
- Percentage change in house price;
- Additional economic information/ comments (e.g. including information on revenues, taxes, implementation, benefits).

Table 1 Literature review summary

Case Study Details	Jurisdiction		Geography/ Topography	Stormwater Design	WSUD practices	Landuse	Development Context	Property Price Information						Additional Economic Information/ Incentives/ Other Comments
	Country	City/ Region	(including criteria such as topography, catchment form, soils, rainfall)	Objectives (water quality, quantity, volume control)	Rain gardens, swales, wetlands, ponds, rain tanks, permeable paving, green roofs, riparian planting, parks, natural bush areas	Residential, commercial, industrial, rural-residential, rural	Brownfields, greenfields, single retrofit	Valuation Approach	Study Period (years)	Unit of Analysis	$ change in house price	Magnitude/ Range of effect	% change in house price	
CRC for Water Sensitive Cities. 2016. Enhancing the Economic Evaluation of WSUD	Australia	South Australia	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	information presented here briefly summarises the Polyakov et al and Rossetti studies. No new studies presented.
Daniels, P., Porter, M., Bodsworth, P. and Coleman, S. (2012). Externalities in Sustainable Regional Water Strategies: A Compendium of Externality Impacts and Valuations. Urban Water Security Research Alliance Technical Report No. 42.	Australia	Queensland	N/A	N/A	Rain tanks; wetlands; restored streams; water	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3 - 13% (California) - restored streams; 17% (Melbourne) - wetlands; 28% (US): properties within 300m of water.	Report summarizing economic valuation of economic externalities. Hedonic pricing studies using Hedonic pricing (direct use values): o homes near restored streams had higher prices than similar homes on unrestored streams, California (Streiner and Loomis (1995): 3 – 13% o Properties with frontage onto a constructed wetland in Melbourne attracted a higher price than average block price (Lloyd (2001):- 17% o price of a house located within 300m of any body of water raises (US Dept of Housing and Urban Development (1991): 28% o Residential housing with open water frontage in Brisbane (Campbell (2001): - 80%
Iftekhar, M.S, Urich, C., Schilizzi, S. and Deletic, A. 2016. Effectiveness of incentives to promote adoption of water sensitive urban design: A case study on rain water harvesting tanks. International Congress on Environmental Modelling and Software. Paper 64. h p://scholarsarchive.byu.edu/iemssconference /2016/Stream-D/64	Australia	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Not Relevant.
Jones, R. N., Symons, J. and Young, C. K. 2015. Assessing the Economic Value of Green Infrastructure: Green Paper. Climate Change Working Paper No. 24. Victoria Institute of Strategic Economic Studies, Victoria University, Melbourne.	Australia	Melbourne	N/A	N/A	N/A	N/A	N/A	life cycle analysis and discounting		N/A	N/A	N/A	N/A	The main differences between green infrastructure and conventional infrastructure are: o The high proportion of intrinsic value to total value. o A large contribution to social and environmental values rather than conventional economic o values. o The relatively low substitutability of some assets. o The biological aspect of growing assets, goods and services. o Its long-lived nature and maintenance of value over long time periods. General narrative around valuing assets and green infrastructure as well as social
Landcom. Undated. Water Sensitive Urban Design: Book 3 - Case Studies	Australia	Sydney: Renwick and The Ponds (greenfields); Prince Henry Hospital and Victoria Park (retrofits)	N/A	N/A	Variety of WSUD devices (rain gardens, swales, wetlands, rain tanks, stream restoration)	Variety of landuses (residential and commercial)	Greenfields & retrofit	N/A	N/A	N/A	N/A	N/A	N/A	No economic information.
Pandit, R., Polyakov, M., Tapsuwan, S. and Moran, T. (2013). The effect of street trees on property value in Perth, Western Australia, *Landscape and Urban Planning* 110, 134-142.	Australia	Perth	Not stated but significant amenity areas (Swan River, the sea, parks) - likely to be river sand soils and reasonably flat.	N/A	Street trees - broad-leaves and palms (could be a proxy for tree pits or rain gardens)	primarily residential but also some commercial and industrial areas. Single family homes only of <2ha	brownfields	Hedonic Pricing	2006	$ increase in median house prices for single family homes.		not specified.	4.27% for broadleaf trees located in public space	Type of tree and location of that tree is an important consideration. No increase was found for palm trees, regardless of their location. Only those broadleaf trees located within public space led to an increase in property values.
Pannell, D. Undated. Presentation summarising the A.1 research for the Water Sensitive Cities Programme (also includes some CRC fact sheets).	Australia	Perth	N/A	N/A	Rain tanks	N/A	N/A	Non-market Value			$18,000 - rain tanks.			Presentation showing results of above studies. Also documents a study in Perth on rain tanks, but no details provided. Also provides data on value of benefits and cost benefit analyses
Polyakov, M., Fogarty, J., Zhang, F., Pandit, P. and Pannell, D.J. 2017. The value of restoring urban drains to living streams	Australia	Perth	Highly modified drain and surrounding areas - reasonably flat area with river sand soils	Yes (nutrients)	Riparian planting and open space - 320m of restoration of the main drain.	Single family houses only (but study area does include commercial and industrial areas).	Brownfields	Hedonic Pricing	1990 - 2013	$ increase in house prices		200m from restoration area	4.70%	Important to consider the following aspects: o temporal aspect of the restoration project o Fixed spatial effects o fixed distance of 200m o Existence of repeat sales in the study database o Functional form of the hedonic model o Omitted variables • Following the restoration project the allowable dollar return to the water utility increases by $500,000 0.056 1⁄4 $28,000. • Paper also includes a cost benefits analysis.

Case Study Details	Jurisdiction		Geography/ Topography	Stormwater Design	WSUD practices	Landuse	Development Context	Property Price Information						Additional Economic Information/ Incentives/ Other Comments
	Country	City/ Region	(including criteria such as topography, catchment form, soils, rainfall)	Objectives (water quality, quantity, volume control)	Rain gardens, swales, wetlands, ponds, rain tanks, permeable paving, green roofs, riparian planting, parks, natural bush areas	Residential, commercial, industrial, rural-residential, rural	Brownfields, greenfields, single retrofit	Valuation Approach	Study Period (years)	Unit of Analysis	$ change in house price	Magnitude/ Range of effect	% change in house price	
Polyakov, M., Iftekhar, S., and Fogarty, J. 2013 The amenity value of water sensitive urban infrastructures: A case study on rain gardens. Poster Presentation	Australia	Sydney	Not stated	Water quality and flood control	Rain gardens	Single family homes only	Retrofit of 41 raingardens into existing brownfields intersections.	Hedonic Pricing	2008 - 2014	$ increase in median house prices for single family homes.	$36,000 - 54,000	within 50 and 50 - 100m	Within 50m = 6% and 50 - 100m = 4%	Comparing the effect of intersection with rain-gardens with the effect of street trees estimated by Pandit et al (2013): o Effect of an intersection with rain-gardens within 50 m of the house is comparable to the effect of 1.5 trees on the street verge next to the house o Effect of an intersection with rain-gardens between 50 and 100 m from the house is comparable to the effect of 1 tree on the street verge next to the house
Rossetti. 2013. Valuation of Australia's Green Infrastructure: Hedonic Pricing Model using the Enhanced Vegetation Index. Monash University Thesis.	Australia	nation-wide	N/A	Enhanced Vegetation Index (EVI) as a proxy for green infrastructure	Enhanced Vegetation Index (EVI) as a proxy for green infrastructure (trees and vegetation; parkland areas)	Yes - houses only. Apartments excluded.	Not stated but assumed to be brownfields.	Hedonic Pricing	2009 - 2010	$ increase in house values and prices	AUD$32,139 - $57,991	Not specified.	study showed that a one standard deviation increase in EVI leads to an 8.62% increase in house prices using year fixed effects. 15.57% increase using state-year fixed effects	Increase in property values as a result of the presence of street trees. - uses Enhanced Vegetation Index (EVI) as a proxy for green infrastructure. Georgia, USA - 4.5% increase which had a subsequent effect of increasing tax revenue for the city by roughly 0.46% (Anderson & Cordell, 1988). Economic/ health benefits by reducing severity of heat waves, improves air quality.
Taylor, A. 2005. Guidelines for evaluating the financial, ecological and social aspects of urban stormwater management measuresto improve waterway health. CRC Technical Report 05/11	Australia	nation-wide	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Not relevant - cost focus.
Water by Design. 2010. A Business Case for Best Practic Urban Stormwater Management: Case Studies	Australia	SE Queensland			Variety of WSUD devices (rain gardens, swales, wetlands, rain tanks, stream	Variety of landuses (residential and commercial)	Greenfields	N/A	N/A	N/A	N/A	N/A	N/A	Case studies only provide cost data, no benefits assessment.
City of Portland Environmental Services. 2008. Cost Benefit Evaluation of Ecoroofs. 42 pp.	Canada	Vancouver, BC	Higher rainfall than Wellington region	volume reduction	ecoroof	Hotel	brownfields	Market prices	2008	$ net benefit	$80 more per night for a room than comparable	specific to the building	N/A	The report also provides costs and net benefits to the private propoerty owner as a result of onetime and ongoing reduction in stormwater management fees, avoided stormwater management facility costs, reduced cooling and heating costs, avoided roof replacement costs, and reduced HVAC equipment sizing costs.
Panduro, T.E and Veie, K.L. 2013. Classification and valuation of urban green spaces - a hedonic price valuation. Working Paper 2013:4. De Økonomiske Råds. ISSN 0907-2977	Denmark	Aalborg	Geographically quite different from Porirua.	N/A	Lakes, open space, nature, church yards, buffer zones	Residential (both apartments and single family homes investigated) - 12,928 transactions	brownfields	Hedonic Pricing	2000 - 2007	% change in property price	N/A	ranges from 100m to 500m from the green space	7% increase for houses with lake views; 6% increase for apartments with lake views. (distance not specified for 'views') 2.7% (100m) increase for houses adjacent to parks down to 0.9% 500m away 2.1% (100m) increase for apartments adjacent to parks down to 0.7% 500m away.	Percentage change in apartment and house prices associated with various types of green space and varying distances. Likely that "Lakes" are the most applicable to WSUD (similar to wetlands/ ponds). Also parks. Price changes related more to view of the lakeand amenity value of the green space was NB. Green buffer spaces may also be applicable, but these related to buffers between residential and industrial areas and had a negative impact on property prices due to the surrounding "industrial" landuses.
Zhou Q., Panduro T E., Thorsen B J., Arnbjerg-Nielsen K. 2013. Adaption to Extreme Rainfall with Open Urban Drainage System: An Integrated Hydrological Cost-Benefit Analysis. Environmental Management (2013) 51:586–601 DOI 10.1007/s00267-012-0010-8.	Denmark	Aarhus (Risskov)	Geographically quite different from Porirua. Paper noted that Risskov is one of the wealthiest residential areas in Aarhus with high property value.	Adaptation for climate change	Infiltration; lakes - green areas with trees; green areas (no trees and lakes)	Residential (Apartments not considered, only single family housing: 12,339 properties)	brownfields	Hedonic Pricing	2000 - April 2010	% increase in house price	N/A	100m increments	0.6% decrease in property price for each 100m away from a green area (lake and trees); 0.01% for each additional green ha; access to lakes: 1% increase in distance to a lake will reduce property value by 1.7% urban green areas not including lakes and trees - negative effect on house	Assessment of adaptation of drainage systems for climate change and extreme flood events as well as hedonic valuation model to capture economic gains and losses more water bodies in green areas.
Aecom & Severn Trent Water. 2013. The Ripple Effect - Building resilience of urban water systems to climate change. Technical Report: The Case for Birmingham and Coventry	England	Coventry and Birmingham (Water Sensitive Southern Gateway)			roadway SuDS (raingardens/ swales/ trees); lakes, stream daylighting	commercial and residential areas but costs relate to residential houses	brownfields	Market prices	2013	£ increase in house prices & uplift in rent.	See comments	Not specified. (no data provided to support property price and rent increases)	ave 7%	Increasing in value of the 500 residential properties in the area and 2,600 new dwellings. Also looked at uplift in rent. • Daylighting the River Sherbourne: average 24.2% uplift in rent value (riverside property is more valuable) • Stoney Road green SuDS street retrofit: the uplift in resale value for a property on a tree-lined street equates to an average of 7% • Water sensitive Southern Gateway (Birmingham): 20% increase in green space would leave to increased residential house values by over 29 million pounds for the planned 2,6000 new and existing residential properties.
City of London Corporation. 2013. Green Spaces: The benefits for London. Report by BOP Consulting for the City of London Corporation	England	London (evidence from different cities)		N/A	Urban parks	Residential housing (although the paper does include information on businesses - see comments)	brownfields	Market prices	2005, 2007 and 2010	Increase in property values for houses located within 600m of an urban park		Within 600m of a park	Within 600m = 1.9% - 2.9% Edge of a park = 19% "nearby" a park = 6% (Netherlands) and a view of a park = 8%	Business property: some publications cited here point towards a positive correlation between green spaces and businesses location decisions, particularly small businesses. Overall though there is little evidence of the effect of green spaces on businesses' decision to locate in a certain area. • Survey results from 2009 show that only 4% of businesses and 3% of City executives agreed that "more parks, open space, gardens" are a way to improve the City as a place to do business, and only 13% of workers identified "more parks, open space, gardens" as a priority to improve the City as a place to work. NB to draw a differentiation between the benefits that people attribute to having green space close to where employees live vs close to where they work.

Case Study Details	Jurisdiction		Geography/ Topography	Stormwater Design	WSUD practices	Landuse	Development Context	Property Price Information						Additional Economic Information/ Incentives/ Other Comments
	Country	City/ Region	(including criteria such as topography, catchment form, soils, rainfall)	Objectives (water quality, quantity, volume control)	Rain gardens, swales, wetlands, ponds, rain tanks, permeable paving, green roofs, riparian planting, parks, natural bush areas	Residential, commercial, industrial, rural-residential, rural	Brownfields, greenfields, single retrofit	Valuation Approach	Study Period (years)	Unit of Analysis	$ change in house price	Magnitude/ Range of effect	% change in house price	
Mell, I., Kenskin, B., Hehl-Lange, S. and Henneberry, J. 2012. Valuing Attractive Landscapes in the Urban Economy: A Contingent Valuation of Green Investments in The Wicker Riverside, Sheffield. Level II Report (Action 4.2)	England	Manchester	Highly urbansed environment, large river frontage	flood management	trees, green open space areas	Residential, commercial and mixed use - survey of 510 people	brownfields	Stated preference (WTP)	2012	WTP for 3 different development scenarios - differing level of "greenness"	£4.27 and £10.81 (Blonk Street) and £3.87 to £29.21 (Nursery Street)	N/ A		• green issues such as naturalness, pollution, flood mitigation and access to nature are important influences on WTP • respondents appear to be WTP more rent or mortgage interest for investments that provide additional or sustained ecological benefits and that provide or enhance the visible greenery of the urban environment • scenarios most preferred had areas of green space and lots of trees (when visually compared with other scenarios) • across all income ranges, the greener investment options were preferred to the VALUE investment • Summarises positive and negative influences on WTP: most prominent positive factors were that investments improved the attractiveness for greener options & that they made the area look more natural. Most negative influences include economic factors – can't afford to pay more for it or already paying too much in rent/ mortgage • Residents, business owners, employees, commuters and different users are all WTP for green investments if they provide functional, natural and attractive urban spaces.
Gensler Urban Land Institue. 2011. Open space: an asset without a champion?	Europe		N/ A	N/ A	open space	Commercial urban areas	brownfields	Survey - willingness to pay	2011	% willing to pay		"close proximity" (not defined	N/ A	95% of respondents believe that open space adds value to commercial property and would be prepared to pay at least 3% to be in close proximity to it. WTP more to be close to high quality open space - respondents asserted that this could be harvested to relieve the fiscal burden of developing and maintaining open spaces. There should be a public private split/ partnership for funding open space.
Kolbe, J and Wustemann, H. 2014. Estimating the value of urban green space: A hedonic pricing analysis of the housing market in Cologne, Germany. Acta Universitatis Lodziensis. Folia Oeconomica 5 (307), 2014.	Germany	Cologne	Highly urbanised/ modified environment.	N/ A	Open space - parks, forests (at least 30% tree coverage at 5m height), farmland (semi-natural areas/ wtlands) and fallowland	Residential - apartments (85,046 transactions)	brownfields	Hedonic Pricing	1995 - 2002	% change in property price and % increase in urban park area		Not always specified, but infers a 500m buffer of green space	1% increase in urban parks (500m buffer) equates to 0.1% increase in apartment prices. 1% increase in fallow land equates to -1.46% decrease in apartment prices and a -0.18% decrease for farmland.	Since the effects of environmental variables on housing prices, in contrast to intrinsic variables, are often very small, the accuracy of the environmental variables used in the hedonic price function plays an important role. NOTE: fallow land/ poor quality open space impacts negatively on prices.
Botanic Gardens of South Australia. Undated. Gr een Infrastructure Evidence Base (Chapter 5 - Economic Benefits) http://gievidencebase.botanicgardens.sa.gov.au/contents/1030	International	Philedalphia + other US cities.	N/ A	N/ A	Street trees	N/ A	N/ A	Hedonic Pricing	N/ A	N/ A	N/ A	N/ A	1.9%, 3 - 5%, 7% and 9% (in relation to street trees)	General overview of TEV method and focus on one section on Hedonic pricing. Includes information from studies referenced here. A few studies from the US not included in this literature review have also shown increases in house values as a result of street trees.
Konijnendijk, C. C., Annerstedt, M., Nielsen, A. B., & Maruthaveeran, S. (2013). Benefits of urban parks: a systematic review. A report for IPFRA. IFPRA.	International		N/ A	N/ A	N/ A	N/ A	N/ A	Hedonic Pricing	N/ A	N/ A	N/ A	N/ A	N/ A	Detailed and methodical literature review relating to the benefit of parks on property prices. Majority of studies examined used hedonic pricing, some used willingness to pay and meta analysis. Generally found an Increase in property prices as a result to proximity to a green space. The paper found that there is moderate to strong evidence that urban parks have a positive impact on the value of nearby property (houses, apartments, land), although it is important to keep the limitations of the hedonic pricing methods – applied in the large majority of the studies - in mind. Parks have a greater impact on property values than other types of green spaces. The positive impact relates to both possibilities for recreational use and views over the parks. Positive impacts increase with proximity to the park and drops quite rapidly with increasing distance to the park. Negative impacts on price relate to crime levels in the neighbourhood, as well as lighting and noise.
Zhang, F and Fogarty, J. 2016. Nonmarket valuation of water sensitivie cities: current knowledge and issues	International		N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	3 - 5% (USA)	General report around non-market valuation techniques and literature for the 3 waters and groundwater. • Farber (1992) estimated that the costs of the environmental risk caused by both point and nonpoint source pollution in the USA could be as high as 2.7 percent of GDP. • Property value changes in the USA following urban stream restoration measures, including flood protection measures, are calculated in Streiner and Loomis (1995). The authors found that flood damage reductions and stream stabilizations together can add around 3 to 5 % to the value of properties (parameters of the study are not defined but hedonic pricing was used). • Although no specific monetary values were reported, Bartosova et al. (2000) found increases in food risks could decrease the value of residential properties within the 100-year floodplain in Wisconsin, USA. • The hedonic price method is used in Harrison et al. (2001) to estimate the housing discount for homes in the 100- year flood plain. The data for the study relate to the period 1980-97 and are for Alachua County in Florida, USA. The discount for being in the 100-year flood plain was found to be around $3,000. The authors also note that the net present value of the additional insurance premiums associated with a home on the 100-year flood plain are more than the discount in the capital price of a home on the flood plain. • Overview includes information on quantifying recreational benefits from improved water quality (pg 33).

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CIRIA. 2013. Demonstrating the multiple benefits of SuDS – A business case (Phase 2). CIRIA Research Project RP993	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Comprehensive literature review on the economic benefits of SuDS as well as an investigation of implementation and funding alternatives. Much of the literature from the study is included in this review and has been examined "more in-depth" through this Porirua review (with respect to property pricing). Interesting as Brandon and Ando (2012) cited as stated that the benefits to property prices are benign since SuDS reduces construction costs which offsets increased property prices for the buyer.
DEFRA. Local Environmental Quality: Valuing the neighbourhood in which we live	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Stated preference	N/A	Improvement in quiet areas	N/A	N/A	N/A	Willingnes to pay for an improvement in quiet areas of one point on a ten point scale. Not able to obtain a copy of the report - sourced through the BeST review.
Bicknell, K.B. and Gan, C.. 1997. The Value of Waterway Enhancement in Christchurch - A Preliminary Analysis	New Zealand	Christchurch	Flat topography and relatively low rainfall region.	Stream enhancement	stream daylighting and restoration	Residential homes (detail not specified but infered to be single land homes). Very small dataset - approx 50 homes	brownfields	simplified hedonic pricing model	1997	Total $ house value		Adjacent to stream vs across the road; within the same block as the stream vs outside the block (distance not specified)	15.71% - improved value for properties adjacent to the stream 6.2% - improved value to properties in the same block as the stream.	• A simplified regression model is specified, where sales price is hypothesised to be a function of house-specific characteristics, and proximity to the waterway (regression equation on page 14 of the paper). • Limited housing characteristics (floor area and section size) used due to data limitations – may introduce specification bias, but floor area seems to be the most significant explanatory variable in larger models.
Flat Bush WSUD catchment development (https://www.nzgeo.com/stories/no-swimming/)	New Zealand	Manukau, Auckland	Hilly terrain with short stream catchments and clay soils. Similar rainfall.	Water quality, stream protection and flood control	Ponds, rain gardens, bush revegetation		Greenfields	N/A	N/A	N/A	N/A	N/A	N/A	Similar approach to Long Bay, but more consistent with the "improved" scenarios for Porirua. Could also be a good example for analysis.
Fleming, D., Grimes,A., Lebreton, L., Maré, D. and Nunns, P. 2017. Valuing Sunshine. Motu Working Paper 17-13	New Zealand	Wellington	Equivalent to Porirua	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	per hour of sunshine	2.4% increase in property prices per hour of sunshine	Sunlight study in Wellington which relates an increase in property prices per hour of sunlight. Not relevant to this literature, but includes some additional references for open space hedonic studies which have now been included.
Kerr, G. and Sharp, B 2003. Transfer of choice model benefits: a case study of stream mitigation. Occasional Paper No. 4. ISSN 1447-6975	New Zealand	Auckland (North Shore & south Auckland)	Hilly terrain with short stream catchments and clay soils. Similar rainfall.	Payment for stream restoration	Stream restoration	Generally in residential areas but not explicitly stated.	Greenfields	Choice modelling and benefits transfer	2003	$ worth of natural stream attributes for off-set mitigation	N/A	N/A	N/A	Not directly relevant to property prices, but includes information on freshwater attributes which are deemed important to 2 very different socio-economic and cultural groups in Auckland. Details of study are included in the word summary.
Long Bay WSUD catchment development http://www.aucklanddesignmanual.co.nz/project-type/infrastructure/technical-guidance/wsd#/project-type/infrastructure/technical-guidance/wsd/case-studies/street_long_bay_auckland	New Zealand	Long Bay, Auckland	Hilly terrain with short stream catchments and clay soils. Similar rainfall.	Water quality, stream protection and flood control	Wetlands, swales, rain tanks, permeable paving rain gardens, riparian planting - is most likely the largest and most comprehensive WSUD development in NZ at present.	Long Bay encompasses 162 ha and includes a village centre, 2500 houses and 28 ha of parks and areas given over to heritage protection. The development also has direct access to two existing schools. The site is part of a sensitive and valued natural landscape which includes the Long Bay Regional Park, and the wider Long Bay – Okura Marine Reserve. The coastline and beach form the eastern edge of the development. The site is bisected by Vaughan's Creek, and the Awaruku Stream forms the boundary between the new community and the existing Torbay suburbs.	Greenfields	N/A	N/A	N/A	N/A	N/A	N/A	No economic information included, but could be an excellent example for an Auckland based hedonic study into property prices affected by WSUD. Could compare it to the neighbouring catchment, Torbay, which has similar densities, views and amenities. Age of housing/ type of housing may be a significant explanatory variable. Long Bay is the most likely comparable example in NZ of what urban and rural residential greenfields development in Porirua could be like under a WSUD scenario. (high income area)
Nunns, P., Allpress, J and Balderston, K (2016). How do Aucklanders value their parks? A hedonic analysis of the impact of proximity to open space on residential property values. Auckland Council technical report, TR2016/031	New Zealand	Auckland	Hilly terrain with short stream catchments and clay soils. Similar rainfall.	No stormwater objectives (amenity study)	Parkland/ open space	Residential areas - single family homes + apartments	brownfields	Hedonic Pricing	2016	Total $ house value		Within 500m of a park	Based on an apartment of $500k: apartments 500m away nearest RP is 13.7% less and local park is 16.4% less than those close to the parks.	Only hedonic pricing study of park/ open space in NZ. Does include a small literature review of international literature - most of the studies already captured here. Study found that there was only a positive effect on property prices close to parks for apartments. No signifcant difference for houses. • analysis suggests that almost all residential property sales in Auckland are close to parks. Over 95% of property sales are within 500 metres of at least one local or neighbourhood park, and there are only 306 property sales that were further than one kilometre from the nearest park – therefore, compared to other cities, Auckland may just have few places that aren't close to parks. THerefore need to treat international studies with caution as the urban form may be different from NZ cities which have a high number of parks.

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Project Twin Streams	New Zealand	Auckland (Oratia, Waikumete, Opanuku, Pixie and Swanson	Hilly terrain with short stream catchments and clay soils. Similar rainfall.	Water quality, stream protection and flood control	property purchase and stream restoration/ riparian planting	residential area	brownfields	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	No economic information available but potentially similar to Christchurch restoration study, plus factor in reduced flood risk to surrounding properties (Sharp study).
Rohani, M. 2012. Impact of Hauraki Gulf amenity on the land price of neighbourhood properties. An empirical Hedonic Pricing Method case study North Shore, Auckland Auckland Council Working Paper 2012/001	New Zealand	Auckland (North Shore)	Hilly terrain with short stream catchments and clay soils. Similar rainfall.	No stormwater objectives (coastal views)	Hauraki Gulf views	Residential homes - single land value for 8500 homes	brownfields	Hedonic Pricing	2011	mean land values			50% higher for wide coastal views; 43% higher for coastal property.	Not directly relevant to WSUD - prices skewed by coastal views rather than native wetlands, trees, WSUD, etc. Important parameter when calculating distance from an "amenity" to use network access distance rather than linear distance.
Rohani, M. 2013. Freshwater Values Framework. A Review of Water Valuation Methods Utilised within Total Economic Valuation. Auckland Council working report, WR2013/001	New Zealand	nation-wide	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	Discussion on different types of economic valuation methods, including hedonic pricing. No specific (new) details or case studies presented.
Samarasinghe, O and Sharp, B. 2010. Flood prone risk and amenity values: a spatial hedonic analysis. The Australian Journal of Agricultural and Resource Economics, 54, pp. 457–475	New Zealand	Auckland (North Shore)	Hilly terrain with short stream catchments and clay soils. Similar rainfall.	Flooding	No remediation - cost of property in flood prone land	residential houses - 2241 sales	brownfields	Hedonic Pricing	2006	% change in property price	$32,300 - $11,850 lower inside a floodplain	within and outside of floodplain	6.2% lower if a property is sold before the flood maps are available. 2.3% lower than a house outside a floodplain if the maps are available to the public.	Estimated that 3% of houses are effected by floodplains. Results show that the sale price of a residential property situated within a flood prone area is significantly lower than a comparable property located outside. Moreover, we find that the discount associated with location in flood prone area is dependent on whether publicly available flood plain maps were available at the time of sale. Our results show that the discount associated with the location in a flood risk zone is lowered by the release of additional public information provided by the flood plain maps. - landscape quality was not found to impact property prices. - water views commanded approximately 28% more than properties without appreciable views - slight to moderate water views were estimated to be 4% - 10%. - property prices appear to fall with distance from local parks, but not statistically
Shaver, E., 2009. Low Impact Design Versus Conventional Development: Literature Review of Developer-related Costs and Profit Margins. Prepared by Aqua Terra International Ltd. for Auckland Regional Council. Auckland Regional Council Technical Report 2009/045.	New Zealand	Auckland	Hilly terrain with short stream catchments and clay soils. Similar rainfall.	Water quality, stream protection and flood control	Range of WSUD solutions (wetlands, rain gardens, swales, etc)	residential developments	Greenfields	Gross realisation	No date specified but original case study done in 2000s	% change in gross realisation of profit for the developer.	N/ A	N/ A	Heron Point: 39% conventional; 38% WSUD (cost neutral) Palm Heights: 26% conventional; 18% WSUD (WSUD more expensive) Wainoi Downs: 15% conventional; 23% WSUD (WSUD less expensive)	3 case studies and full details provided in TR2009/045. Al residential greenfields developments.
Bastien, N., Arthur, S. and McLoughlin, M..J. 2011. Valuing amenity: public perceptions of sustainable drainage systems ponds. 12th International Conference on Urban Drainage, Porto Algre/ Brazil, 11-16 September 2011	Scotland	Edinburgh	Undulating and 680mm ave annual rainfall; large stream systems	flooding and water quality treatment	ponds	residential - 400 questionnaires for 5 separate pond catchments. 107 questionnaires completed.	brownfields	Stated preference (survey) - willingness to pay	2009	£ per month per dwelling for the residents (average for all sites and the NPV of a 2400m3 pond capable of draining a 20 hectare	N/ A	5 minutes walk of a pond	N/ A	Weighted average willingness to pay of £18.71/ month, privately or council maintained ponds are clearly outranking Scottish Water owned ponds, reaching a weighted average willingness to pay of £5.62/ month. For all the locations combined, an average £10.95 per month per dwelling for the residents living in close proximity to ponds has been established. Residents have identified wildlife as the most important benefit, and this impact on their potential willingness to pay. This finding underlines the need to use treatment trains before runoff is discharged to a pond to manage runoff quantity and quality efficiently, and thus maximise wildlife and amenity potential
EFTEC. 2013. Green Infrastructure's contribution to economic growth: a review: A Final Report for Defra and Natural England. Defra Project Code: WC0820	Scotland	UK and USA case study sites	Very large scale cities and projects (New York, Philedalphia, Manchester)	N/ A	Green Infrastructure (as defined as greening of the city - trees, parks, etc). Literature relates to very large scale parks and stream restoration studies. Scale is not applicable to Porirua situation.	Residential and commercial	brownfields	Market prices	N/ A	Increase in council tax receipts, increase in employee numbers, increase in rateable value from business, % increase in property values and number of vistors.	N/ A	N/ A	N/ A	Contribution of park improvement to economic growth. Creation of an elevated urban public park - increase in property values and number of visitors. Excellent article for understanding different economic benefits of large scale urban greening, but not direcly applicable to the Porirua situation. General "conclusions" are relevant and included in the summary document.
Building natural value for sustainable economic development: The Green Infrastructure Toolkit – User Guide (Section 5 Land and Property Values). Undated.	UK	Nation-wide		N/ A	urban parks	Residential, but does include information on commercial properties	brownfields	Other	2008 onwards	£ increase in house prices per ha per year and % uplift in property prices.				References studies already documented as part of the Forest Research (2010) report. Note that this is a user-manual for a GI toolbox of methods – can be used to determine the value of environmental improvements and work out the expected benefit from an uplift in house values (Appendix 1 case study). Calculator for determining property values/ changes at this link: http://www.greeninfrastructurenw.co.uk/html/index.php?page=projects&GreenInfrastructureValuationToolkit=true
Costs and Benefits of Sustainable Drainage Systems. For Committee on Climate Change. Final report 9X1055	UK	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	Market prices	N/ A	reduced risk of flooding	N/ A	N/ A	N/ A	Nets benefit of SuDs to new developments as a result of the reduced risk of flooding. Not able to obtain a copy of the report - sourced through the BeST review.

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Forest Research. 2010. Benefits of Green Infrastructure. Report by Forest Research. Forest Research, Farnham.	UK	Various		N/A	urban parks, urban woodland areas, general open space	Residential	brownfields and greenfields	Market prices/ various		increase in property values as a result of the presence of trees. WtP per annum. £ increase in housing transcations for 500-700 new residential propoerties and increase in downstream property values per ha.			15 - 25% increase in total value of property (depends on size, condition, location and species rating); 18% increase (North West England) - equates to views of natural landscapes within cities; 111% increase in Glasgow - urban regeneration of a run-down area using GI; 11.3% increase - properties adjacent to a park; 7.3% increase - properties in close proximity to a park.	Increase in property value due to tree planting. Increase in property value due to an increase of 20% in woodland cover. Increase in property value due to tree planting. Enhanced average house prices and the total value of property transactions Mainly a literature review of other studies. Report also includes information on local economic regeneration as a benefit of GI. Glasgow Green project increased yield in council tax by 47% as a result of the regeneration stimulated by the renewals, new housing and GI. Report acknowledges that it is an ongoing struggle to fund capital for GI works as well as find a sustainable source of revenue for ongoing maintenance. On-going maintenance NB as otherwise in the long-term property prices could decrease as the green asset falls into 'disrepair' and becomes similar to "fallow land". (SI observation)
Gibbons, S., Mourato, S. and Resende, G.M. 2014. The Amenity Value of English Nature: A Hedonic Price Approach. Environmental and Resource Economics, 57 (2). pp. 175-196. ISSN 0924-6460	UK	Nation-wide		N/A	all types of open space, include freshwater, wetlands and floodplains	Residential - 1 million housing transactions across England.	brownfields	Hedonic pricing	1996 - 2008	£ change in house value & % change in house value.		1% point increase in share of land cover	0.36% increase in house prices (freshwater, wetlands and floodplains)	Increase in house prices as a result of a chnages to proximity to rivers, nature reserves, coast, environmental amenities, etc. Very comprehensive study - key finding (Table 4) from this work is that environmental amenities are highly valued by home-owners and have a substantial impact on housing prices. Noted that property values adjacent to 'bare-land' decreased in value.
Naumann, S., Davis M., Kaphengst T., Pieterse, M. and Rayment, M. 2011. Design, implementation and cost elements of Green Infrastructure projects. Final report to the European Commission, DG Environment, Contract no. 070307/2010/577182/ETU/F.1, Ecologic institute and GHK Consulting	UK	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	General discussion around benefits of green infrastructure but doesn't go into detail on effects on property prices. • Report provides useful recommendations for policy action at a national, local and regional level to support implementation, these include: o Create an overarching and supporting framework at a national level o Provide financing and explore potential financing instruments o Promote networking, monitoring and research Table 21 (page 75) provides a framework for assessment benefits of green infrastructure projects.
Perino, G., Andrews, B, Kontoleon, A and Bateman, I. 2013. The Value of Urban Green Space in Britain: A Methodological Framework for Spatially Referenced Benefit Transfer	UK	Aberdeen, Bristol, Norwich, Sheffield and Glasgow case study cities - results aggregated for all cities	N/A	N/A	varying types of open green space (recreational, natural, gardens, etc)	Households	brownfields and greenfields (projected development scenarios over the next 50 years based on meta-analysis of existing data	benefit transfer	2010 (modelled changes for up to 2060)	£ value change and change in income between 2010 and 2060 (in 2010 pounds)	N/A	N/A	N/A	Per household and aggregate valuation Estimates for each scenario both with and without distributional weights. The analysis presents a methodology for estimating the spatial distribution of gains and losses arising from well specified policy changes. It therefore provides an important tool for the analysis of policies varying the amount, location and accessibility of urban greenspace. Study documents a number of caveats/ limitations of the study - summarised in the summary document.
Saraev V. 2012. Economic benefits of greenspace - A critical assessment of evidence of net economic benefits. Forestry Commission. ISBN 978-0-85538-865-2	UK	Mersey Forest Study + various			Open space (with a focus on forested areas)	residential	brownfields	Hedonic Pricing + stated preference		£per household per year for a 12 000 ha increase in ancient semi-natural woodland. % increase in house price.	N/A	Varies from 600m - 1km	Overall: paper says average increase of 2.6 - 11.3% if well managed. Specific Studies (references in summary): 1% increase in open space = 0.3 - 0.5% increase in average house prices in that ward 1ha of open space within 1km of housing equates to increased prices of 0.08% on-park properties: increased by 11.3% Netherlands - views of parks increase property by 8% and nearby properties by 6% Ave premium: within 450m 10.1% for city parks, 9% for local parks, 2.6% for amenity greenspace. 1% increase in greenspace equates to 1% increase in property prices	Comprehensive review of evidence of the net economic benefits (direct and indirect) of greenspace. Focusses mainly of large forested areas and includes economic benefits relating to growth and investment, land and property values, aesthetics, regional and local economic regeneration, tourism, health and well-being, water management, products from the land, biodiversity, climate change adaptation and mitigation, and evidence gaps. • Evidence gaps included: areas as 'labour market employment and productivity' and 'recreation and leisure' (as opposed to tourism) themes. As 'quality of place' is a compound concept with no established definition, there has been little economic research addressing it directly to date. • Land values: o Summarises many of the studies already included in this literature review. o Having a well-managed greenspace nearby was found to result in average property premiums of 2.6% to 11.3%. In terms of a marginal change an extra percentage point increase in greenspace land-use share in the Census ward increases property prices by around 1%. o property price increase is not in itself unambiguously a benefit, especially as it may disadvantage prospective buyers
Ashley R M., Christensson A., de Beer J., Walker, L., Moore, S. and Saul, A. 2009. Selling sustainability in SKINT. SKINT INTERREG IIIb project report	USA	nation-wide	N/A	water quality, water quantity and volume control	Specific SuDS devices not specified, but generally seems to relate to trees and flood management.	residential	brownfields	Hedonic pricing + WTP	2009	Increase in property value	US$8,870 (Portland)	Not specified.	Range: 2 - 10%; increase CNT = 3.5% increase; in floodplain = 2 - 5% decrease	Literature review and development of a green infrastructure methodology (SSIS) to assess contributions towards sustainability. Based on a combination of the CNT and GINW approaches. Quantifies a matrix of benefits into a series of indicators relating to low, medium and high benefits. • At the present time it would seem that the idea of presenting the benefits of options to decision-makers, ideally monetised, couched in "sustainability" language, offers the best possibility to get options adopted that are as sustainable as possible. Important in this are the recently emerging ideas about multifunctionality, multivalue and getting more from less in investments in adapting to climate change. • Appendices outline the evaluation criteria which are used in the SSIS model.

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	Country	City/ Region	(including criteria such as topography, catchment form, soils, rainfall)	Objectives (water quality, quantity, volume control)	Rain gardens, swales, wetlands, ponds, rain tanks, permeable paving, green roofs, riparian planting, parks, natural bush areas	Residential, commercial, industrial, rural-residential, rural	Brownfields, greenfields, single retrofit	Valuation Approach	Study Period (years)	Unit of Analysis	$ change in house price	Magnitude/ Range of effect	% change in house price	
Braden J B., Johnstone D M. 2004. Downstream economic benefits from storm-water management. J. Water Resources Planning & Management. 130(6) 498-505	USA	Chicago				Residential	brownfields	Value transfer	2004	Increase in dowstream property values per hectare			benefits from flood alleviation and water quality improvement equates to 2 - 5% of property value	Need to purchase paper for further details
Center for Neighborhood Technology (CNT). 2007. The value of green infrastructure; a guide to recognizing its economic, environmental and social benefits.	USA	Maine; Chesapeake Bay; Mid-West	Various	water quality, volume control and flood protection	Not specifically stated, but says it relates to GI within the urban context.	Residential	brownfields	Hedonic pricing	various	% increase in home value		Not specified	2 - 10% for new street tree plantings; 0 - 7%, with a recommended value of 3.5% (Philadelphia - very extensive study); 3.5% - 5% (King County, Washington)	Definition: Green infrastructure (GI) is a network of decentralized stormwater management practices, such as green roofs, trees, rain gardens and permeable pavement, that can capture and infiltrate rain where it falls, thus reducing stormwater runoff and improving the health of surrounding waterways. • This guide focuses on GI's benefits within the urban context. • Very useful document for overall benefits of GI and methodology for quantifying benefits under each broad 'benefit category'. note the difficulty in isolating the effect of improved aesthetics and avoiding double-counting of benefits such as air quality, water quality, energy usage (often relating to heat stress) and flood control that also impact property values. Mean value of 3.5% recommended. Includes a TEV calculator tool.
City of Portland. 2010. Portland's Green Infrastructure: Quantifying the Health, Energy, and Community Liveability Benefits, City of Portland Bureau of Environmental Services	USA	Portland; Seattle; California	Portland/ Seattle - similar climatic conditions (rainfall)	water quality, volume control and flood protection	Trees,street planters, rain gardens, culvert removal, ecoroofs, planting in natural areas	Residential	brownfields	Hedonic pricing + WTP	various	$ increase in home value and % increase in home value.	$7,953 increase in home value per tree in front of the house	Not specified ("close to GI")	3% to 5% increase in home values experienced due to combined Green streets + Swales + Culvert Removal 3% - 13% for riparian planting/ stream restoration.	Purpose of the report was to document the expert review of existing data and to quantify (to the extent possible) key ecosystem benefits associated with each G2G (Grey to Green) BMP, focusing on the "other benefits" categories that are more social and economic in nature Improved property values from tree planting . improved values for proximity to green streets, swales, and culvert removal.
Clements, J. and Juliana, A (Stratus Consulting). 2013. The Green Edge. How Commercial Property Investment in Green Infrastructure Creates Value	USA	Various case studies		water quality, volume control and flood protection	Trees,street planters, rain gardens, infiltration, ecoroofs, planting in natural areas	Mix of commercial and residential		WTP, Hedonic Pricing, Market prices	various	% benefit to property owner at point of sale. % increase in rental income annually		not specified	• Apartment buildings with green roofs received a 16% rental premium. • Retail customers are WTP 8% - 12% more for products in shopping centres with mature tree canopies. • Wide range of studies found that landscaping and trees increase residential property values by 2% - 5% and add 16% to average rentals for multifamily units. • Can add 7% to the average rental rate for	Potential increased property value and rental income from a package of green infrastructure property improvements for an apartment building and retail centre. Also investigated stormwater fees and one off tax credits for apartment buildings. Benefits around stormwater fee credits, rebates, development incentives and tax benefits also discussed.
Economic Valuation of Cities as Water Supply Catchments	USA	Portland Oregon + Texas	N/ A	N/ A	N/ A	N/ A	N/ A	Hedonic pricing	N/ A	Increase in property prices close to wetlands. Increase in prices per acre foot for recreational and aesthetic values of	N/ A	N/ A	N/ A	Unable to obtain report. Information here taken from the BeST literature review. Increase in property prices as a result of Increasing the size of the nearest wetland to a residence by one acre and also by reducing it to 1000 feet. Homeowners' marginal recreational and aesthetic value of lake water estimates per acre foot
Foster J., Lowe A., and Winkelman S. 2011. The value of green infrastructure for urban climate adaptation. Center for Clean Air Policy. Washington DC. Page 19	USA	New York	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	Summarises studies already documented in previous literature. Note that the study finds that, on average, ecoroofs are 40% more expensive over their life cycle than 'conventional' roofs, but that energy savings and economic benefits can out-weigh this (energy savings can be 15 – 45% of the annual energy consumption – mainly lower cooling costs).
Johnstone D M., Braden J B., and Price T H. 2006. Downstream economic benefits of conservation development. J. Water Res. Planning and Mgmt. 132(1): 35-43	USA	Chicago	Blackberry Creek Watershed west of Chicago, Ill. - 189 km2 catchment area. Urbanising watershed.	flood management	wetlands, riparian planting	Mix of commercial and residential	brownfields and greenfields	Benefits transfer method + Flood Estimation Method	Modelled to 2020	Increased property values		Properties within 100 year ARI floodplain	BTM: 0.4 - 2.5% increase for properties in floodplain FEM: 1.7 - 2.5% increase for properties in floodplain	Increased property values as a result of conservative design practices that reduced the risk of flooding
Larson E K. and Perrings C. 2013. The value of water-related amenities in an arid city: the case of the Phoenix metropolitan area. Landscape and urban planning. 109: 45-55	USA	Phoenix	Very arid environment and not relevant to Porirua. Interesting observations from study.	Water reuse	open space and open space areas with water (e.g. Lakes)	Residential (single family homes - dataset of 47,000)	brownfields	Hedonic pricing	2000	Effect of different types of green space on property prices	not quantified	Not quantified	Not quantified	Literature generally shows that proximity to parks would be a benefit, as they provide many ecosystem services such as recreation, greenery, access to biodiversity, and aesthetics. But while living close to parks may provide easier access to these services, it may also increase the exposure to potential disamenities associated with parks, such as crime and noise. • Separated parks into two sizes: small parks (playgrounds and fields) and larger parks (hiking) • Small parks were considered to reduce property values whilst larger parks had a positive influence. • Troy and Grove (2008) demonstrated that consideration of neighborhood crime rates altered homeowners' willingness to live close to parks. • Proximity to water-intensive locations such as lakes, golf courses, and small parks positively influences house prices
New York City Department of Environmental Protection (NYCDEP). 2010. The NYC Green Infrastructure Plan	USA	New York City	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	N/ A	BeST literature review included this reference, but no information found with respect to economic benefits of the HYC Green Infra Plan. Updated 2013 NYC DEP Annual report on implementation of the GIF discusses a "Co-Benefits" study and calculator. Property values/ aesthetics are not included in the study. Information below is taken from the BeST review: Increase in property values of the two block adjacent to the new Hudson River Park. Increase in property value as a result of the addition of a partially and fully vegetated acres in New York. Other benefits to new Yorkers over a 20 year period (reduced energy cost, increased property values and improved health)

Case Study Details	Jurisdiction		Geography/ Topography	Stormwater Design	WSUD practices	Landuse	Development Context	Property Price Information						Additional Economic Information/ Incentives/ Other Comments
	Country	City/ Region	(including criteria such as topography, catchment form, soils, rainfall)	Objectives (water quality, quantity, volume control)	Rain gardens, swales, wetlands, ponds, rain tanks, permeable paving, green roofs, riparian planting, parks, natural bush areas	Residential, commercial, industrial, rural-residential, rural	Brownfields, greenfields, single retrofit	Valuation Approach	Study Period (years)	Unit of Analysis	$ change in house price	Magnitude/ Range of effect	% change in house price	
Trust for Public Land. 2010. The Economic Benefits of the Park and Recreation System in Mecklenburg County, North Carolina, Washington, DC: Center for City Park Excellence.	USA	Mecklenburg County, North Carolina	N/A	N/A	Open space/ parkland	Residential	brownfields	Hedonic pricing	2005 - 2009	% Increase property value	Ave additional $8,032 per sale	first 500 feet (152 m)	3.33%	Hedonic analysis of property values relating to parkland areas in Mecklenburg County. Property value near parks is affected primarily by 2 factors: distance and the quality of the space. • Does not consider the effect of small parks (under an acre). • Direct income received through increased property tax (rates) as a result of increased value of certain residences. • Direct savings to the community through the use of the County's free parkland and recreation opportunities.
Wise S., Braden J., Ghalayini D. et al. 2010. Integrating Valuation Methods to Recognize Green Infrastructure's Multiple Benefits. Low Impact Development 2010: Redefining Water in the City © 2010 ASCE. P1123-1143.	USA	San Francisco	N/A	N/A	N/A	N/A	N/A	Hedonic pricing	N/A	Increase in property values	N/A	N/A	N/A	Unable to obtain report. Information here taken from the BeST literature review. Higher property value of houses within 500 feet of a park in comparison to properties that are more than 1000 feet from a park. Increased property values based on proximity to a pond. Increased property sales as a result of street trees.
Sander, H. Polasky, S and Haight, R. 2010. The value of urban tree cover: A hedonic property price model in Ramsey and Dakota Counties, Minnesota, USA. Ecological Economics 69 (2010) 1646–1656	USA	Ramsy and Dakota Counties, Minnesota		N/A	Urban trees	Residential (single family homes - dataset of 9992 homes with mean price of $287,637)	brownfields	Hedonic Pricing	2005	Tree cover measured as percentage tree cover on parcels within 100, 250, 750 and 1000m		100m and 250m	10% increase in tree cover within 100m of an average home increases the sale price by 0.48% and within 250m increases it by 0.29%.	A number of other studies cited, including: o Anderson and Cordell (1988) – hedonic pricing – trees in front yards of residential single family homes in Athens, Georgia USA – 3.5% - 4.5% increase in sales price. o Dombrow et al (2000) – hedonic pricing – dummy variable to indicate a single family residential home with mature trees in Baton Rouge, Louisiana USA – 2% increase in sales price. o Veseley (2007) – contingent valuation – WTP to avoid 20% decrease in urban tree estate in New Zealand – household average WTP was NZD184 (2003) for a three year period.
Environment Agency. 2005. Social Impacts of Stormwater Management Techniques including river management and SUDS. Science Summary SC020009/SS	Various	N/A	N/A	N/A	Ponds, swales	Residential	brownfields	N/A	2005	qualitative analysis of social perceptions of SuDS.	N/A	N/A	N/A	General attractiveness of areas with SuDS: • The amenity, recreational value and aesthetics of new schemes seem to be of major importance in determining public acceptability, while function, efficiency and maintenance are primarily important in areas facing flooding problems • The report uncovers a general preference for sustainable urban water management and for river restoration schemes compared with more conventional, 'hard engineering' approaches such as culverting rivers to channel them under roads and railways. • Research examined cases examined within residential areas and in particular related to the application of SUDS, mainly ponds, and river management schemes

Rural Literature

Moller, S.I. 2012. The Economic Value of Environmental Amenities and Restoration for Rural Land in New Zealand. Ecosystems Consultants Report No. 2012/02, 22 + vi	New Zealand	and International				Rural land								Literature review of range of effects on rural property prices. Key references detailed here.
Polykov 2012 (from Moller, S)	Australia	rural Victoria			Native bush remants/ replanting	Rural land								The value of lifestyle properties is maximized when their proportion of area occupied by native vegetation is about 40%, at which point it increases property value by about $13,500/ha (AUD 2011) or by about 12% of the average property price. However, tree cover exceeding 80% reduces property value below the value of property with no tree
Pannell and Wilkinson 2009: p. 2686 (from Moller, S.)	Australia				Native bush remants/ replanting	Rural land								lifestyle landholders hold positive views about re-vegetating part of their properties, but that 'most lifestyle landholders have a strong reluctance to make environmentally beneficial changes that occupy the majority of their land'

Additional Reading

Potential Additional Literature (all studies cited in above literature - could provide further detail of some case studies)		
Tapsuwan et al, 2007	AUS	Capitalized amentiy value of urban wetlands: a hedonic property price approach to urban wetlands in Perth, Western Australia
D, H. MacDonald, N. D. Crossman, P. Mahmoudi, L. O. Taylor, D. M. Summers and P. C. Boxall, 2010	AUS	The Value of Public and Private Green Spaces Under Water Restrictions. Landscape and Urban Planning 95: 192 - 200
Bourassa, S.C., Hoesli, M. and Sun, J. 2003	NZ	The Price of Aesthetic Externalities (water views)
Veseley, E-T. 2007	NZ	Green for green: the perceived value of quantitative change in the urban tree estate of New Zealand. Ecological Economics 63, 605–615.
Mourat, S., Atkinson, G., Collins, M., Gibbons, S., MacKerron, G. and Resende, G. 2010	UK	Economic assessment of ecosystem related UK cultural services. UK NEA Economic Analysis Report. The Economics Team of the UK National Ecosystem Assessment, London School of Economics. [http://uknea.unep-wcmc.org/Resources/ tabid/82/Default .aspx]
CABE, 2004	UK	The value of public space. Commission for Architecture and the Built Environment, London. [www. cabe.org.uk/publications/the-value-of-public-space]
CABE, 2005	UK	Does money grow on trees? Commission for Architecture and the Built Environment, London. [www. cabe.org.uk/publications/does-money-grow-on-trees]
Dunse, N., White, M. and Dehring, C. 2007	UK	Urban parks, open space and residential property values. RICS Research Paper Series. Royal Institute of Chartered Surveyors, London.
GLA Economics (Smith) , 2003	UK	Working paper 3: valuing greenness. Is there a segmented preference for housing attributes in London? Greater London Authority, London.
Brown, G.M., and H.O. Pollakowski. 1976	USA	Economic Valuation of Shoreline. The Review of Economics and Statistics 59, 1976, 272-278.
Costanza, R., M. Wilson, A. Troy, A. Voinov, S. Liu and J. D'Agostino. 2006.	USA	The Value of New Jersey's Ecosystem Services and Natural Capital (part 2). Gund Institute for Ecological Economics, University of Vermont
Conway, D., C.Q. Li, J. Wolch, C. Kahle and M. Jerrett	USA	A Spatial Autcorrelation Approach for Examining the Effects of Urban Greenspace on Residential Property Values. Journal of Real Estate and Financial Economics 41, no.2, pp. 150-169.
Kaufman, D. and N. R. Cloutier. 2006	USA	The Impacts of Small Brownfield and Greenspaces on Residential Property Values. Journal of Real Estate Finance and Economics, vol.33 19-30
Wachter, 2004	USA	The Determinants of Neighborhood Transforma ons in Philadelphia – Iden ca on and Analysis: the New Kensington Pilot Study. The Wharton School, University of Pennsylvania
Wachter and Wong, 2008	USA	What is a Tree Worth? Green-City Strategies, Signaling and Housing Prices. Real Estate Economics. 36(2): 213-239.
Donovan and Butry, 2009	USA	Market Based Approaches to Tree Valuation. Arborist News. 2008(August): 52 - 55
Ward et al., 2008	USA	The effect of LID on Property Values. Proceedings of the Water Environment Federation, Sustainability 2008, pp318 - 323(6)
Steiner, C. and Loomis, J.B., 1996.	USA	Estimating the Benefits of Urban Stream Restoration using Hedonic Price Method. Rivers 5(4): 267 - 278

4. SUMMARY OF EFFECTS OF WSUD/ GREEN SPACE ON PROPERTY PRICES

4.1 General Discussion of Results

Table 1, together with Appendix A, provide a comprehensive summary of the currently available literature on the effect of green space and WSUD on property prices. Whilst the review encompassed all types of property (i.e. single family homes, apartments, commercial and industrial buildings, and rural areas), the majority of the literature was focused on hedonic analyses of single family homes. Table 2 summarises the percentage change in house prices in proximity to WSUD infrastructure or green space. The majority of studies in the literature focused on single family homes in order to reduce the number of variables within the hedonic analyses. As a result, only single family house studies were included in the Table 2. The effect of green space/ infrastructure on other property types is discussed further in Section 4.2. Whilst the distance from the green space has not been fully quantified in the table, the literature shows a consistent increase in house prices in close proximity to green spaces world-wide. Whilst a few papers did record a decrease in house values (see Section 4.2), the point of discussion in the literature lies more around quantifying this increase rather than debating the positive effect of green spaces on house prices.

In general, there are a significant number of studies which have been undertaken in the USA, United Kingdom and Europe. Studies within the USA show a 1.5 – 4.95% increase in house prices within close proximity to green spaces. Not only is this is the most conservative estimate, but it also encompasses a wide range of different types of green spaces, from formal urban parks to riparian areas, to individual trees, to wetlands and ponds. Studies in the UK are a mix of open space (woodland areas), urban parks and SuDS areas (e.g. ponds and wetlands). Studies undertaken on the effects of WSUD and green space in Australia and New Zealand show significantly higher increases in house price in proximity to those areas. It is noted that there are no New Zealand studies aimed specifically at WSUD solutions – they focus on increases in house prices adjacent to urban parks, coastal and countryside areas. Literature reviewed for remainder of the regions (Australia, UK/ Europe and USA) are far more focused on WSUD solutions such as ponds, wetlands, stream restoration and rain gardens, and are therefore likely to be more relevant to this project than the New Zealand literature.

Table 2 Percentage change in house prices due to their proximity to green infrastructure/ spaces

Country/ Region	Average %	Low %	High %*	Comments**
New Zealand	6.04%	5%	7.08%	• Dataset: 4 studies • Urban parks, water views, sunshine hours, riparian revegetation/ daylighting, floodplains • Proximity: within 500m of green space
Australia	7.92%	7.72%	8.12%	• Dataset: 5 studies

Country/ Region	Average %	Low %	High %*	Comments**
				• Open space, urban parks, street trees, rain gardens, riparian planting/ restoration, wetlands, rain tanks • Proximity: within 50m, 100m and 200m of green space
UK and Europe	4.93%	4.31%	5.55%	• Dataset: 16 studies • Open space (natural areas), urban parks, riparian planting, ponds/ wetlands, swales • Proximity: generally within 500m of green space; 1 study to within 1km of green space
USA	3.05	1.51%	4.95	• Dataset: 13 studies • Open space (natural areas), urban parks, trees, tree planters, rain gardens, green roofs, infiltration, wetlands, riparian planting • Proximity: generally not specified, but some studies indicate within 100, 150 and 200m of green infrastructure

* High % increase in property prices usually equates to property adjacent to the green space.
** Studies relating to coastal water views, apartments, commercial and rural property not included.

4.2 Observations from the Literature

A number of specific observations were noted from the literature which are important to consider when taking account of the effect of green infrastructure and green space on property prices. Some of the key observations are bulleted below:

- Economic methodologies: Whist a number of different economic valuation methods are discussed in the literature, in general, the hedonic pricing method (HPM) seems to provide the most comprehensive and realistic view of the effect of green infrastructure/ space on property values. However, they are time and data intensive, and the methodology needs to account for omitted variable bias (i.e. accurately accounting for other variables which could cause an increase in property values, e.g. proximity to the CBD or different forms of housing/ property). It is precisely because of this bias that the differences in property values resulting from green infrastructure/ space is so site or case-study specific. McConnell and Walls (2005: p62 – as cited in Rohani, 2013) warn that policymakers looking for a specific dollar figure to attach to the value of open space may find it difficult to use the existing literature. Rather, the literature provides us with a general direction of this effect, along with potential variability between locations as well as economic parameters which require assessment. This study has therefore documented the general trends identified through the literature, along with the economic methodologies used and their limitations.

- Transferability: The literature warns that the results or benefits of HPM studies should not be "transferred" to other locations. This is mainly due to the lack of

homogeneity around housing when analyzing housing markets (and the omitted variable bias as discussed earlier). This is further supported by the discussion above ("Economic Methodologies) and the NZ Treasury (Guidelines for Social Cost Benefit Analysis, 2015) recommendation of using benefit transfers only as a screening tool prior to econometric analysis of some sort (as is being done in this project). There are numerous attributes that need to be considered in a HPM analysis (e.g. proximity to the CBD, other centres, the coast, schools; neighbourhood characteristics; dwelling characteristics; environmental variables; type of green space, etc) (Nunns *et al*., 2016) and these will differ for each neighbourhood, city, region and country.

- Datasets – Property Type: As mentioned above, HPM studies are data intensive. The majority of the HPM papers reviewed were based on the review of property sales data from single family homes (as summarized in Table 1 and discussed in Section 4.1) within established urban areas.

- Apartments: Three studies explicitly stated that they referred to the sale of apartments. A study in New Zealand (Nunns *et al*., 2016) stated that, based on an apartment in Auckland with an average value of $500,000, those apartments 500m away from a regional park are 13.7% less than those closer to the park, and 16.4% less than those closer to a local park. Nunn et al. (2016) found no significant difference for houses. The paper suggests that this is likely due to the fact that almost all residential property sales in Auckland are close to parks (over 95% of sales are within 500m of at least one local or neighbourhood park). The conclusion drawn was that potentially Auckland has more parks than other cities world-wide, and therefore the effect of greenspace on property values is not recognized through the sale price of houses. Further research is needed to determine whether or not this finding would hold true for the Porirua Whaitua.

  Two additional studies in Europe and the USA also investigated the effect of green infrastructure/ space on apartments. One in Cologne, Germany (Kolbe and Wustemann, 2014) found that a 1% increase in urban parks (within a 500m buffer) equates to a 0.1% increase in apartment prices. Kolbe and Wustermann (2014) also found that apartments within 500m of fallow land (i.e. open grassland) leads to a -1.46% decrease in the property value. The study concludes that poor quality open space can lead to decreases in property values. This observation is reinforced by much of the literature (e.g. Forest Research, 2010; Gibbons, *et al*., 2014; Mell, *et al*., 2012; Larson and Perrings, 2013). Clements and Juliana (Stratus Consulting – 2013) reviewed a number of case studies in the USA and found that apartment buildings close to green space and or/ with green roofs received higher rental values (16% higher for apartments with green roofs and 16% higher for multifamily units in close proximity to green space).

- Commercial Property: Clements and Juliana (2013) also state that commercial buildings in close proximity to green space can add 7% to the average rental rate for office buildings, and that retail customers are willing to pay 8% - 12% more for products in shopping centres with mature tree canopies. Mell, *et al*. (2012) found

that business owners are willing to pay for green investments provided they are functional, natural and attractive spaces. However, the City of London (2013) found that there was little evidence of the effect of green spaces on a businesses' decision to locate in a certain area.

- Rural Property: Polykov (2012) (as cited in Moller, 2012) examined rural land in Victoria, Australia and found that the value of lifestyle properties were maximized when 40% of the property area was occupied by native vegetation, leading to a 12% increase in average property price. Once tree cover exceeds 80% of the property cover, the value of the property will start to reduce to below that of the value of the property without any tree cover. Moller (2012) summarises the key range of effects on rural property prices.

- Proximity and Aesthetics: Table 2 and the literature shows a moderate to strong trend (Koijnendijk *et al*., 2013) that property which borders green space/ infrastructure generally has higher values than property which is further away. The studies tend to focus on a proximity effect ranging from bordering on the green space; to 100m away; to 200m away to 500m away. The majority of studies agree that the closer a property is to the green area, the higher the value. This effect beomes neutral between 600m to 1km away from the green area.

  On the other hand, poor quality green space can lead to a decrease in property values. Furthermore, green space can have a negative effect on property values in those areas where crime rates are perceived to be high and/or where people feel unsafe. Koijnendijk *et al*. (2013) stated that negative impacts on property prices relate to crime levels in the neighbourhood, as well as lighting and noise impacts. Lack of maintenance of green areas can cause property values to decrease in the long term. Mell et al. (2012) states that one of the most prominent positive factors that influenced a resident's willingness to pay more for a house relates to the attractiveness and aesthetic quality of the green space. Panduro and Veie (2012) found that green areas which buffer residential land from industrial areas also have a negative impact on property prices. Samarasinghe and Sharp (2010) documented that property in Auckland which is located within flood plains is valued at between 2.3% and 6.2% lower than property which is located outside a flood plain area. Zhang and Fogarty (2016) also documented that properties with increased flood risks and within floodplains had decreased property values.

- Views: Views, especially water and coastal views, lead to the highest increase in house values. Rohani (2012) investigated mean land values throught a HPM study in Auckland and found that houses with coastal views had an increased value of 50%. Panduro and Veie (2013) found that lake views increased house prices by 7% in Aalborg, Denmark, and Forest Research Found that views of natural landscapes in England's North West were 18% higher than those houses with no views. Saraev (2012) documented that house values in the Netherlands increased by 8% if they had a view of a park.

- Green Infrastructure/ Space – Type and Amenity Functions: Along with proximity, another key variable which affects house values is the type of green space. Not only does the purpose of the green space influence house value, but also its size. Table 3 summarises the percentage change in house value based on the type of green space. The larger-scale urban parks and natural areas tend to have a higher effect on house value than small-scale green areas. This is consistent with the EFTEC (2013) report which states that houses in close proximity to open spaces which provide a range of amenities and are 'multi-use' spaces, realize benefits to the community more quickly and have a higher impact on house values. This is likely due to the use of liveability and amenity as a proxy for "green space" in the literature. In general, high quality, multi-purpose green space areas lead to higher property values than isolated green 'pockets' or poor quality green 'buffer' areas. Whilst not quantified, a good example of this effect could be Auckland's Waiatarua Reserve. In 2003 Auckland City Council received funding from Infrastructure Auckland to retrofit wetlands into Waiatarua Reserve to treat stormwater from the Ellerslie Waiatarua catchment which discharges into the Waitemata Harbour (http://www.scoop.co.nz/stories/AK0302/S00134.htm; accessed on 25 August 2017). In addition, the project assisted in reducing flooding within the catchment. Nowadays, in addition to providing an important stormwater management function, the reserve is well used by the community and includes features such as walkways and a playground. The area would provide a good case-study site for a hedonic analysis of a 'catchment-based' stormwater approach. In terms of "at source" WSUD green space areas, Long Bay could be a good example for an Auckland-based HPM study. Long Bay is currently being developed and includes a suite of "at source" solutions such as rain gardens, swales and rain tanks. Property values in Long Bay could be compared with property in the neighbouring catchment of Torbay, although age of housing and housing type could prove to be a significant variable in any HPM study. However, due to the concerns voiced in the literature around transferability of HPM studies, the transferability of any HPM study on these Auckland sites to the Porirua Whaitua would require careful thought.

Table 3 Approximate percentage increase in house values based on the type of "green space".

Green Space/ Infrastructure	**Approx. increase in House value (% change)***	**Comments**
Parks/ Open Space	8.62% 0.9% - 11.3% (ave: 5%) 3.33%	Trees and parks (Australia) City and local parks; natural green space areas such as woodlands (UK & Europe) Parkland (USA)
AVERAGE FOR PARKS	5.65%	
Catchment-scale WSUD (ponds & wetlands)	17% 0.3 – 3% 2% - 10%	Wetlands (Australia) Ponds/ lakes (UK & Europe) Ponds (flood management) (USA)

Green Space/ Infrastructure	Approx. increase in House value (% change)*	Comments
AVERAGE FOR PONDS/ WETLANDS	6.46%	
At Source WSUD (swales, rain gardens, trees, green roofs)	4% - 6% 4.27% 7% 0% - 7% (ave: 3.81%) 0.29% - 0.48% 1.9% - 9%	Rain gardens (Australia) Broadleaf trees (Australia) Swales and rain gardens (UK & Europe) Green Infrastructure (swales, rain gardens, trees) (USA) Trees (USA) Trees (USA)
AVERAGE FOR 'AT SOURCE' WSUD	4.08%	
Stream planting/ restoration/ daylighting	6.2% - 15.71% 4.7% 7% 0.4% – 13%	New Zealand Australia UK & Europe USA
AVERAGE FOR STREAMS	7.84	
Water Views	6% - 18% 43% – 50%	Lake views (UK & Europe) Coastal views (New Zealand)

* Based on the same dataset as Table 1.

5. ADDITIONAL ECONOMIC CONSIDERATIONS – IMPLEMENTATION AND FUNDING

Whilst not directly within the scope of the literature review, some of the literature included information on total economic valuation (TEV) of green infrastructure, along with a comprehensive assessment of the benefits of green infrastructure (of which increases in house values is only one). Rohani (2013) and the Botanic Gardens of South Australia (undated - http://gievidencebase.botanicgardens.sa.gov.au/contents/1030) provide an overview of TEV and other economic valuation methods. Building Natural Value for sustainable economic development (Section 5 – Land and Property Values; The Green Infrastructure Toolkit, undated) provides a toolbox of methods for valuing green infrastructure, including a calculator which can be found at: http://www.greeninfrastructurenw.co.uk/html/index.php?page=projects&GreenInfrastructureValuationToolkit=true

Whilst Saraev (2012) provides an assessment of the net economic benefits (direct and indirect), the focus of the paper is on green space rather than green infrastructure or WSUD. Ashley et al. (2009) and the Centre for Neighborhood Technology (2007) both provide a comprehensive review of the benefits of green infrastructure (GI), along with the development of GI calculators. Both "TEV" calculators or models are very comprehensive and could be reviewed for their applicability as a calculator or methodology of assessment for the Porirua Whaitua.

Clements and Juliana (2013) also investigated the benefits of WSUD in relation to funding of the on-going maintenance costs associated with WSUD solutions. Clements and Juliana (2013 p.9 + 10) state that "*a substantial portion of green infrastructure costs can be recouped directly through tax credits, stormwater fee credits, rebates and development incentives*". Some of the examples of these credits cited in Clements and Juliana (2013) include:

- Recently passed legislation in New York City which provides a one year tax credit (up to US$200,000) for property owners who include a green roof on at least 50% of the structure.
- Businesses in Philadelphia are eligible for a credit of 25% (up to a maximum of US$100,000) of green roof installation costs.
- Milwaukee provides up to US$10 per square foot for green roof projects.
- King County (Washington) pays 50% of the costs of green infrastructure retrofit projects (up to US$20,000).
- Portland (Oregon) has a green roof bonus scheme in its zoning code – an additional 3 square foot of area is allowed for every 1 square foot of green roof installed, provided the green roof covers at least 60% of the roof area.
- Chicago, Austin and Santa Monica all provide discounts to builders who use green infrastructure practices.

The Trust for Public Land (2010) additionally states that the increased property values realized as a result of their proximity to WSUD solutions also increases rates collected by

government which can help to off-set on-going maintenance costs. This benefit could be further investigated to determine if it would hold true for New Zealand property values.

Finally, there is also a clear preference in the literature for a "user pays" or "polluter-pays" approach to on-going funding. Ira (2014) suggests that a "use-pays" type of funding system could include, for example, development and financial contribution systems, impervious surface charges and credits. These contribution systems are further discussed, within an Auckland context, by Ira (2014). The premise behind this type of funding regime is that it is economically efficient, assists in creating behavioural change within the community, and facilitates increased awareness of stormwater effects (Ira, 2014). These types of incentive or charging schemes would need to be supported by relevant legislative reviews and changes, such as the addition of a by-law which focusses on WSUD solutions.

EFTEC (2013 p. 14 + 76) makes some observations around the implementation of WSUD for decision-makers. Some of those relevant to the Porirua Whaitua, include:

- Green infrastructure makes a contribution to the resilience and sustainability of economic growth through reducing risks from, for example, flooding and the urban heat island effect.
- There is strong evidence that WSUD projects which are integrated with other amenity projects, multi-use spaces or strategies for urban regeneration are likely to provide benefits faster.
- Investment in maintenance and improvement of green infrastructure networks needs to be sustained.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 House Prices

This report summarises a comprehensive, systematic review of national and international literature, focusing on the effect of water sensitive design solutions on house prices. Approximately 74 studies were investigated through the literature review, and those found to be directly relevant to the study are summarized in Table 1. The majority of the studies used a HPM to assess the impact of green infrastructure/ space on house prices. The following general trends were observed:

- The literature shows a consistent increase in house prices in close proximity to green infrastructure/spaces world-wide.
- There is significant variability world-wide around the quantum of increase in house prices. Studies in the USA show an average increase in house prices of 3.05% for those houses in close proximity to green space; whilst studies in the UK and Europe show an average increase of 4.93%, Australia shows a 7.92% average increase and New Zealand studies demonstrate a 6.04% average increase (Table 2).
- Whilst only 3 studies were found investigating the effect of green infrastructure/ space on apartment prices, apartment prices (and rentals which are a proxy for capital values) also increase when in close proximity to open space.
- Bush and riparian replanting on rural properties increase property values and are maximized when 40% of the property area is occupied by native vegetation.
- There is a moderate to strong trend that houses which borders on green space has higher values than property which is further away. The majority of studies investigate this "proximity" effect up to about 200m from the green area, whilst some investigate it as far as up to 600m away.
- The effect of views, especially where water is involved, leads to the highest increase in property values.
- Poor quality green areas lead to a decrease in property values. Other negative effects on property values include green areas located in areas of high crime rates. Lighting and noise impacts also affect property values negatively. Finally, lack of on-going maintenance can cause property values to decrease in the long term.
- Whilst a number of general conclusions can be drawn from the literature, they tend to be very "site specific" and the lack of homogeneity around housing and green space means that the variables which affect house prices will interact differently for different places.
- Different types of green space affect the quantum of increases in house values differently. Table 3 documents this variability. The larger-scale urban parks and natural areas tend to have a higher effect on house value than small-scale green areas.
- The literature highlights that liveability and amenity can be taken as a proxy for "green space". Whilst specifying liveability is a challenge, general trends in the literature demonstrate that high quality, multi-purpose green space areas lead to higher property values than isolated green 'pockets' or poor quality green 'buffer' areas. The approach for quantifying how WSUD can affect liveability within the New Zealand context is a gap which could be further explored.

6.2 Implementation

Implementation of WSUD solutions, along with defining potential on-going funding sources is outside the scope of this literature review. However, as discussed in Section 5, many of the papers reviewed discuss this issue. Some of the key conclusions reached include:

- The TEV method is the most appropriate method to undertake a full economic analysis of WSUD solutions. In this regard, Ashley et al. (2009) and the Centre for Neighborhood Technology (2007) both provide a comprehensive review of the benefits of green infrastructure (GI), along with the development of GI calculators
- Clements and Juliana (2013) state that a large portion of green infrastructure costs can be recovered through stormwater fee credits, tax credits, rebates and development incentives.
- Increased property values realized as a result of their proximity to WSUD solutions also increases rates collected by governments.
- WSUD projects which promote integration and multi-use of space realise property price benefits faster.
- Investment in maintenance and improvement of green infrastructure networks needs to be sustained in the long term to prevent a decline in house values.

6.3 Recommendations

This literature review has provided a comprehensive overview of national and international literature on the effect of WSUD and green space on property prices. Whilst this summary does tabulate the percentage change in house values as a result of proximity to WSUD solutions, the variability between case-studies and countries is significant. The literature therefore provides us with a general direction of change in values, along with potential variability between locations as well as economic parameters which require assessment.

Based on these economic assessment parameters and the lessons learnt through the literature on HPM studies, an assessment of the effect of WSUD solutions on property prices could be undertaken in New Zealand. Ideally, locally-sourced case studies (i.e. within the Wellington Region) should be used. Failing that, this report has documented potential Auckland case study sites which could be used for a HPM analysis.

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APPENDIX A – SUMMARY OF LITERATURE[1]

AUSTRALIA

Rossetti. 2013. Valuation of Australia's Green Infrastructure: Hedonic Pricing Model using the Enhanced Vegetation Index. Monash University Thesis.

- Increase in property values as a result of the presence of street trees. - uses Enhanced Vegetation Index (EVI) as a proxy for green infrastructure. Georgia, USA - 4.5% increase which had a subsequent effect of increasing tax revenue for the city by roughly 0.46% (Anderson & Cordell, 1988). Economic/ health benefits by reducing severity of heat waves, improves air quality.
- 8.62% increase in house prices with one standard deviation increase in EVI using year fixed effects.
- 15.57% increase using state-year fixed effects (acknowledges that this is over estimated through their model, but is NB as it accounts for differences between large and small states).
- $ increase in house values and prices - AUD$32,139 - $57,991
- HPM: is an indirect valuation method that analyses the variance in property prices that relate to changes in the characteristics that are packaged with the property.
- Nation-wide study: implicit price of aggregate green infrastructure at nation-wide level through fluctuations in housing prices. The dataset used for this study consists of 2,531,803 observations of housing sales transactions between the years 2000 and 2010.
- A central issue for many hedonic models is omitted variable bias. To reduce this bias the study included spatial fixed effects and excluded property types. Commercial properties were excluded – only residential houses were included (units and apartments were excluded as well). Average property area of 869.7m2.
- In Perth, Western Australia, it was found that the presence of street trees increases property values by $16,889 (4.27%) (Pandit et al., 2012).
- In Arizona consumers were willing to pay a 20% premium to live in densely vegetated wildlife corridors (Katz, Colby, Osgood, Bark-Hodgins, & Stromberg, 2005).
- A study in the Netherlands found that environmental factors can increase housing prices by up to 28%, including an 8% premium for a park view and a 5%-12% for a more 'attractive' environmental view (Luttik, 2000).
- The mere presence of trees was found to increase housing prices from 1.7% and 4.5% (Dombrow, Rodriguez, & Sirmans, 2000) (Anderson & Cordell, 1988).
- Finally, Hatton MacDonald et al. (2010) found that consistently low quality parks have a negative impact on housing prices.

Polyakov, M., Fogarty, J., Zhang, F., Pandit, P. and Pannell, D.J. 2017. The value of restoring urban drains to living streams

- Homes within 200m of the stream restoration site increased in value by 4.7% of single family homes once the stream was fully restored and established.

[1] NOTE: The majority of this information has been taken directly (i.e. cut and pasted) from each of the relevant papers.

- Bannister Creek catchment is a highly modified system covering 23 square kilometres in the suburbs of Canning Vale, Lynwood, Ferndale, and Parkwood in metropolitan Perth.
- Across the catchment there is a mix of residential housing, commercial property, and light industry.
- Flood mitigation and water quality improvement of the existing stream – 320m restoration of the main "drain". Also included walkways.
- Important to consider the following aspects:
    - temporal aspect of the restoration project
    - Fixed spatial effects
    - fixed distance of 200m
    - Existence of repeat sales in the study database
    - Functional form of the hedonic model
    - Omitted variables
- Following the restoration project the allowable dollar return to the water utility increases by $500,000 0.056 1⁄4 $28,000.
- Paper also includes a cost benefits analysis.

Polyakov, M., Iftekhar, S., and Fogarty, J. 2013 The amenity value of water sensitive urban infrastructures: A case study on rain gardens. Poster Presentation

- The aim of this study is to estimate the non-market values of rain gardens. We then combine information on the non- market values with estimates of the bio-physical and ecological benefits of rain gardens to derive to measure whether the total benefits of rain gardens are greater than the total cost.
- Data: Sales date, price, locations, and characteristics of 4,437 single family homes sold between January 2008 and September 2014 in Sydney Construction date and location of 41 intersections in Sydney residential areas with rain-gardens constructed.
- Within 50m of a rain garden – increase in median house prices by 6% ($54,000)
- 50 – 100m of a rain garden – increase in median house prices by 4% ($36,000)
- single family homes only
- Comparing the effect of intersection with rain-gardens with the effect of street trees estimated by Pandit et al (2013):
    - Effect of an intersection with rain-gardens within 50 m of the house is comparable to the effect of 1.5 trees on the street verge next to the house
    - Effect of an intersection with rain-gardens between 50 and 100 m from the house is comparable to the effect of 1 tree on the street verge next to the house

Pandit, R., Polyakov, M., Tapsuwan, S. and Moran, T. (2013). The effect of street trees on property value in Perth, Western Australia, Landscape and Urban Planning 110, 134-142.

- Two types of trees are analysed: broad-leaved and palm trees. Tree locations are differentiated according to whether they are situated within a property boundary (private space), on an adjacent street verge (public space), or on the neighbouring property (neighbouring private space).
- 23 northern suburbs of Perth (affluent to newly established housing for middle-class people). Dominated by residential housing, but also a mix of industrial, recreational

and commercial land uses. Significant environmental amenities are present (Swan River, the sea, bush reserves).

- No statistically significant effect of palm trees on the house sale price regardless of their location – either on one's property, neighbouring properties or on street verges. We found positive and sizable effects of broad- leaved trees on sale price only when such trees were located on street verges, while trees on the property and trees on neighbouring properties did not have statistically significant effects. The marginal implicit price of a broad-leaved tree on the street verge is about AU$16,889, which corresponds to approximately 4.27% increase in the median value of the property (AU$395,000) in our study area.
- Broad- leaved trees are valued differently depending on whether they are located within the property boundary (private space), on the neighbouring property, or on the street verge adjacent to the property (public space). No increase in value is found for trees located within private space or neighbouring property.
- Included a spatial model but does not state at what distance to the trees the increase occurs.

Jones, R. N., Symons, J. and Young, C. K. 2015. Assessing the Economic Value of Green Infrastructure: Green Paper. Climate Change Working Paper No. 24. Victoria Institute of Strategic Economic Studies, Victoria University, Melbourne.

- The main differences between green infrastructure and conventional infrastructure are:
    - The high proportion of intrinsic value to total value.
    - A large contribution to social and environmental values rather than conventional economic
    - values.
    - The relatively low substitutability of some assets.
    - The biological aspect of growing assets, goods and services.
    - Its long-lived nature and maintenance of value over long time periods.
- General narrative around valuing assets and green infrastructure as well as social discounting and rates of time preference.

CRC for Water Sensitive Cities. 2016. Enhancing the Economic Evaluation of WSUD.

- Information presented here briefly summarises the Polyakov et al and Rossetti studies. No new studies presented.
- Includes interesting information around the framework for economic evaluation of WSUD and the approach to TEV.

Zhang, F and Fogarty, J. 2016. Nonmarket valuation of water sensitive cities: current knowledge and issues. CRC for Water Sensitive Cities Report.

- General report around non-market valuation techniques and literature for the 3 waters.
- Farber (1992) estimated that the costs of the environmental risk caused by both point and nonpoint source pollution in the USA could be as high as 2.7 percent of GDP.
- Property value changes in the USA following urban stream restoration measures, including flood protection measures, are calculated in Streiner and Loomis (1995).

The authors found that flood damage reductions and stream stabilizations together can add around 3 to 5 % to the value of properties (parameters of the study are not defined but hedonic pricing was used).

- Although no specific monetary values were reported, Bartosova et al. (2000) found increases in food risks could decrease the value of residential properties within the 100-year floodplain in Wisconsin, USA.
- The hedonic price method is used in Harrison et al. (2001) to estimate the housing discount for homes in the 100- year flood plain. The data for the study relate to the period 1980-97 and are for Alachua County in Florida, USA. The discount for being in the 100-year flood plain was found to be around $3,000. The authors also note that the net present value of the additional insurance premiums associated with a home on the 100-year flood plain are more than the discount in the capital price of a home on the flood plain.
- Overview includes information on quantifying recreational benefits from improved water quality (pg 33).

Daniels, P., Porter, M., Bodsworth, P. and Coleman, S. (2012). Externalities in Sustainable Regional Water Strategies: A Compendium of Externality Impacts and Valuations. Urban Water Security Research Alliance Technical Report No. 42.

- Report summarizing economic valuation of economic externalities.
- Focusses mainly on water supply solutions (rain tanks indicated as a supply method).
- Not directly relevant to the property price literature review.
- Hedonic pricing studies using Hedonic pricing (direct use values):
    - homes near restored streams had higher prices than similar homes on unrestored streams, California (Streiner and Loomis (1995):- 3 – 13%
    - Properties with frontage onto a constructed wetland in Melbourne attracted a higher price than average block price (Lloyd (2001):- 17%
    - price of a house located within 300m of any body of water raises (US Dept of Housing and Urban Development (1991): 28%
    - Residential housing with open water frontage in Brisbane (Campbell (2001): -80%

Botanic Gardens of South Australia. DATE. Green Infrastructure Evidence Base (Chapter 5 - Economic Benefits)

- In a variety of studies the presence of trees has been found to increase the selling price of a residential unit from 1.9% (Dombrow et al., 2000) to 3-5% (Anderson and Cordell, 1988) to 7% (Payne, 1973). In a study of Philadelphia's revitalized neighbourhoods, houses adjacent to street tree plantings were seen to gain a 9% premium (Wachter and Gillen, 2006).
- Another recent study by (Sander et al., 2010) used hedonic property price modelling to estimate the value of urban tree cover's value in Minnesota, predicting housing value as a function of a number of environmental variables, including tree cover. The results showed that a 10 percent increase in tree cover within 100 metres increases average home sale price by $1371 (0.48%) and within 250 metres by $836 (0.29%).

NEW ZEALAND

Kerr, G. and Sharp, B 2003. Transfer of choice model benefits: a case study of stream mitigation. Occasional Paper No. 4. ISSN 1447-6975

Use of choice modelling to determine a method for establishing "appropriate off-set mitigation" in the Auckland region for loss of streams resulting from earthworking activities. Project also looked at establishing community preferences regarding alternative states of Auckland streams (i.e. how Aucklanders value their streams). Choice modelling entails several key steps:

5. Salient attribute identification
6. Choice model design
7. Data collection
8. Data analysis
9. Application to policy

Key salient attributes:

- Water clarity
- Safety
- Flow of water
- Quality of the stream bank
- Access
- Surrounding land use
- Habitat for wildlife
- Natural shape of the stream
- People creating degradation should be held responsible (user-pays)

Table 1: Choice Attributes

Attribute	Attribute values: Natural Stream	Attribute values: Degraded stream
Water clarity	Clear, Muddy	Clear, Muddy
Native fish species	1,3,5	2, 3, 4
Fish habitat	2km, 3km, 4km	1km, 2km, 3km
Native streamside vegetation	Little or none, Moderate, Plentiful	Little or none, Moderate, Plentiful
Channel form	Natural	Straightened, Natural
Cost to household	$0/year, $20/year, $50/year	

Note: Currency is New Zealand Dollars

Response rates were 44% in North Shore and 40% in South Auckland, with 308 interviews completed on the North Shore and 311 completed in South Auckland. Surveying was undertaken in January and February 2003.

Table 3: Part worths ($/household)

		North Shore Mean	95% confidence interval	South Auckland Mean	95% confidence interval
Natural Stream	Water clarity	$66	$43~$110	$67	$42~$114
	Native fish species	$11	$6~$20	$5	$0~$12
	Fish habitat	-$1	-$12~$9	-$3	-$15~$8
	Moderate vegetation	$28	-$1~$68	$16	-$10~$49
	Plentiful vegetation	$21	$2~$50	$41	$17~$75
Degraded Stream	Water clarity	$48	$28~$84	$73	$47~$123
	Native fish species	$4	-$6~$17	$0	-$13~$14
	Fish habitat	$13	$5~$27	$5	-$6~$18
	Moderate vegetation	$21	-$5~$53	$36	$8~$76
	Plentiful vegetation	$20	$0~$48	$55	$28~$97
	Channel	$58	$38~$97	$42	$21~$73

New Zealand Dollars, first quarter 2003.

Based on this a benefits transfer model was developed. Again it used North Shore and South Auckland residents – two very different socio-economic and cultural groups.

Direct transfer and benefit function transfer are both possible using the Auckland Stream study results, but there are insufficient data to apply meta-analysis. Used BFT. Validity - there are no cases where North Shore and South Auckland part worth confidence intervals do not overlap and none of the distributions of part worth differences is significantly different from zero at the 5% level, although degraded stream plentiful trees is significant at the 10% level. Pooled models/ transfers – similar to Table 3.

Table 8: Pooled model part worth differences

45-year old homeowner with a degree. Household income more than $50,000 p.a. 3 people in household.	Part Worth Differences (North minus South)	95% confidence interval
Natural Stream Fish Species	$7	$1 ~ $15
Natural Stream Fish Habitat	$41	$16 ~ $70
Natural Stream Plentiful Vegetation	-$7	-$31 ~ $14
Degraded Stream Plentiful Vegetation	-$28	-$54 ~ -$0
Degraded Stream Channel	$61	$27 ~ $103

New Zealand Dollars, first quarter 2003.

Relates to amount that could be charged by Council for off-set mitigation of stream loss.

Nunns, P., Allpress, J and Balderston, K (2016). How do Aucklanders value their parks? A hedonic analysis of the impact of proximity to open space on residential property values. Auckland Council technical report, TR2016/031

This research examines how much Aucklanders value their parks, by investigating whether home-buyers are willing to pay more to live close to them. One important consideration when analysing housing markets is that housing (and land for housing) is not homogenous. It differs on a wide range of attributes, such as:

- Location – e.g. proximity to the city centre, other major employment centres, and regional amenities such as coastlines
- Neighbourhood characteristics – e.g. the presence of parks, historic buildings, or
- popular schools
- Dwelling characteristics – e.g. building typology, size, views, and condition.

Hedonic analysis of recent Auckland residential property sales, focusing on the impact of a variety of amenities and disamenities – most notably the role of parks and open spaces. Researchers asked themselves three key research questions:

1. Does proximity to parks have a positive effect on sale prices for residential properties?
2. Does the impact of proximity to parks vary by park size or park type – e.g. is there evidence that regional parks have different effects than smaller local parks?1
3. Does the impact of proximity to parks vary between different types of dwellings – e.g. are apartment prices more affected than standalone house prices?

Also investigate the impact of a variety of other dwelling and neighbourhood characteristics that may be relevant to land use policy in Auckland, such as proximity of houses to industrial zones, which is expected to have a negative impact on property values.

Looked at both apartments and houses. Residential areas only. Park proximity has a positive effect on apartment prices, but not on prices for houses or flats, i.e. they compared two apartments that were equivalent in all respects except distance to the nearest park, we would expect the apartment that was closer to the park to command a higher price. Looked at both regional and local park proximity.

- An average apartment immediately adjacent to the nearest regional or local / neighbourhood is expected to sell for roughly $500,000. By contrast, an average apartment 500 metres away from the nearest regional park is expected to be 13.7 per cent less valuable, while an average apartment 500 metres away from the nearest local / neighbourhood park is expected to be 16.4 per cent less valuable.
- proximity to parks appears to have a different effect on other dwelling types
- analysis suggests that almost all residential property sales in Auckland are close to parks. Over 95 per cent of property sales are within 500 metres of at least one local or neighbourhood park, and there are only 306 property sales that were further than one kilometre from the nearest park – therefore, compared to other cities, Auckland may just have few places that aren't close to parks.
- proximity to industrial zoned land appears to have a negative impact on residential property values
- study found that other key determinants of residential property price sales include:
    - distance to the city centre
    - distance to the coast

- land area
- floor area
- presence of garage
- presence of deck or balcony
- pre-1940 status
- views
- number of pre-1940 buildings in meshblock

One implication of this study is that results from studies in other cities – such as a positive relationship between park proximity and house prices – may not necessarily occur in the New Zealand context, possibly due to differences in urban form or other social and economic factors.

Report provides a literature review of other hedonic pricing studies (Appendix B) & states that there are no other ones in NZ relating to public parks and green spaces. [Reinforced by this literature review].

Moller, S.I. 2012. The Economic Value of Environmental Amenities and Restoration for Rural Land in New Zealand. Ecosystems Consultants Report No. 2012/02, 22 + vi pages.
This review of five New Zealand and eighteen overseas case studies identified instances where people preferred property that:

1. offers good views, especially overlooking water (sea, lakes, rivers and estuaries)
2. has a diversity rather than uniformity of views
3. is relatively close to cities or towns that supply services, employment and schools
4. provides reliable vehicle access and proximity to an airport
5. provides or is close to recreational opportunities (swimming, boating, fishing, tramping, skiing)
6. is near the coast
7. has a reliable water supply
8. includes some forest, though is not predominantly forested
9. provides a diverse landscape with fragmented forest patches and more complex natural forest edges
10. is close to wildlife habitat, wilderness and/or protected natural areas
11. is contributing active restoration of biodiversity and ecosystems
12. is close to but not immediately next to rivers and wetlands
13. is not at risk of flooding
14. does not have odours or insects
15. has productive potential (forestry or agriculture).

International studies gave a general indication of the impact of proximity to environmental amenities such as forests, wetlands, and the coast on land prices. Due to the case-specific nature of results, especially as they are linked to specific locations, these results must be treated with caution when removed from their original geographical contexts. However, the international literature gives a reasonable estimate of the likely direction of value impacts related to the proximity to environmental amenities, and the relative importance of different environmental amenities, in New Zealand.

- Stated preference studies suggest New Zealanders generally place a high value on environmental restoration and biodiversity
- Contingent valuation surveys investigating the value of a hypothetical scheme supporting biodiversity enhancement through the planting of native trees on public and private land showed a significant willingness-to-pay for these schemes
- International case studies provide an imperfect alternative, indicating the general impact of proximity to environmental amenities on land prices. Revealed preference studies from the US and Australia provide evidence that the proximity to environmental amenities providing recreational and scenic values, including forests, the coast, and restored coastal wetlands has a positive impact on land prices. However, estimated values vary between studies from different geographical locations. The case-specific nature of results implies that the international literature is useful as an indication of the general direction and relative importance of particular effects. However, the specific magnitude of these effects in terms of a dollar value cannot be directly applied to a New Zealand context.

Additional references/ review can be used to summarise rural hedonic studies in Australia/ US.

Rohani, M. 2012. Impact of Hauraki Gulf amenity on the land price of neighbourhood properties. An empirical Hedonic Pricing Method case study North Shore, Auckland Auckland Council Working Paper 2012/001

Not directly relevant to WSUD - prices skewed by coastal views rather than native wetlands, trees, WSUD, etc. Hedonic pricing study.

- Property prices are 50% higher for wide coastal views; 43% higher for coastal property.
- Important parameter when calculating distance from an "amenity" to use network access distance rather than linear distance.

Rohani, M. 2013. Freshwater Values Framework. A Review of Water Valuation Methods Utilised within Total Economic Valuation. Auckland Council working report, WR2013/001

Valuation Method	Description of Method	Potentially useful for valuating		Data Sources	Main benefits	Main disadvantages
		Water usage	Water services			
1. Hedonic Price Method (HPM) RP	Using econometric analysis of data on real property transactions with varying availability of water supply or quality	-Irrigation -Industrial water supply -Municipal water supply -Recreation and amenity	At-source demands for changes in water quantity or quality	Property values and characteristics including environmental quality	Uses real market data	-Can estimate use values only -Requires extensive property market data -Cannot predict the changes in use values due to environmental changes without prior information -Current evidence suggests it is not suitable for use in benefits transfer

Bicknell, K.B. and Gan, C. 1997. The Value of Waterway Enhancement in Christchurch - A Preliminary Analysis

Simplified hedonic pricing model to consider the effect of the Christchurch Waterways restoration programme on property prices.

- A simplified regression model is specified, where sales price is hypothesised to be a function of house-specific characteristics, and proximity to the waterway (regression equation on page 14 of the paper).

- Limited housing characteristics (floor area and section size) used due to data limitations – may introduce specification bias, but floor area seems to be the most significant explanatory variable in larger models. Data set approx. 50 houses.
- Houses adjacent to the restored stream sold for $34,721 more than properties located across the street.
- Houses on the same block as the stream sold for $13,696 more than distant properties (not specified).
- Improved property values of 15.71% and 6.2% respectively.

Shaver, E., 2009. Low Impact Design Versus Conventional Development: Literature Review of Developer-related Costs and Profit Margins. Prepared by Aqua Terra International Ltd. for Auckland Regional Council. Auckland Regional Council Technical Report 2009/045.
Update of TP124 – LID Guidelines for Auckland. Same 3 case studies and information presented. Looks at profit from a developer perspective.

- Heron Point: 39% conventional; 38% WSUD (neutral)
- Palm Heights: 26% conventional; 18% WSUD (not viable) [smaller lot sizes impacted on property prices]
- Wainoi Downs: 15% conventional; 23% WSUD (viable)

Long Bay and Flat Bush Case studies
Information included but no economic data (other than costs for some areas).

Fleming, D., Grimes,A., Lebreton, L., Maré, D. and Nunns, P. 2017. Valuing Sunshine. Motu Working Paper 17-13
Sunlight study in Wellington which relates an increase in property prices per hour of sunlight. Not relevant to this literature, but includes some additional references for open space hedonic studies which have now been included.

- 2.4% increase in property prices per hour of sunshine.

Samarasinghe, O and Sharp, B. 2010. Flood prone risk and amenity values: a spatial hedonic analysis. The Australian Journal of Agricultural and Resource Economics, 54, pp. 457–475
Data based on 2241 property sales in the North Shore area in 2006.
Estimated that 3% of houses are effected by floodplains. Results show that the sale price of a residential property situated within a flood prone area is significantly lower than a comparable property located outside. Moreover, we find that the discount associated with location in flood prone area is dependent on whether publicly available flood plain maps were available at the time of sale. Our results show that the discount associated with the location in a flood risk zone is lowered by the release of additional public information provided by the flood plain maps.

Flood variable:

- 6.2% lower if a property is sold before the flood maps are available.
- 2.3% lower than a house outside a floodplain if the maps are available to the public.

Environmental variable:

- landscape quality was not found to impact property prices.
- water views commanded approximately 28% more than properties without appreciable views.
- slight to moderate water views were estimated to be 4% - 10%.
- property prices appear to fall with distance from local parks, but not statistically significantly at the 90% level.

INTERNATIONAL

Konijnendijk, C. C., Annerstedt, M., Nielsen, A. B., & Maruthaveeran, S. (2013). Benefits of urban parks: a systematic review. A report for IPFRA. IFPRA.

Different ways of estimating the economic value of nature have been explored over time. Especially in an urban setting, a way of indirectly assessing the economic value of green spaces is to study the impact of these spaces on house prices. If for example parks are valued by property buyers, this would be reflected in the premium they are willing to pay for the house or apartment.

- review of 30 studies that addressed the impact of parks on property prices, Crompton (2001) went as far back as the 1940s
- Among the 30 studies, the author found only 5 not supporting the proximity principle i.e. that having a park nearby raises property prices - price increase of 20% seems a reasonable starting point
- Luttik (2000) in the Netherlands found that overlooking attractive landscapes and water resulted in a price premium of 8-12 respectively 6-12%
- meta-analysis by Brander and Koetse (2011) concluded that open spaces in general, as well as specifically parks generally raise the value of nearby properties, be it houses or apartments.
- In their meta-analysis, Brander and Koetse (2011) found a 0.1% increase in house price with a 10 m decrease in distance from the park.
- precise impact on property value ranges widely among cities and countrie
- Not only property owners but also renters are affected, as Hoshino and Kuriyama (2010) found for one of Tokyo's wards. Their study of 2370 dwellings found a positive price effect (i.e. higher rents) when a nearby park was situated within 450 m
- Medium-sized parks in particular led to higher increases. Park size is a factor, but studies indicate that even smaller green patches can have a positive influence. Kumagai and Yamada (2012) found a positive impact on land prices also for smaller green patches, although land prices increased proportionally with larger green patch coverage ratios.
- Kong et al. (2007) found higher house values for those properties with green space within a 300 m radius.
- 16,000 property house sales, Tajima (2003) noted that a doubling of distance to parks led to a 6% drop in property price.
- Although Dehring and Dunse (2006) found proximity to parks raised prices of houses and flats in Aberdeen, they did not find an effect for lower density type housing
- Studied in the Chinese cities of Guangzhou and Shenzhen by Jim and Chen (2006, 2007; and Chen and Jim, 2010) showed that the visibility of urban parks is generally

valued positively by property owners. A survey among 358 households in Shenzhen indicated an increase of close to 5% of house sale prices due to park visibility.

- In Guangzhou, the price increase found was 7.1%, with only water bodies scoring higher than parks.
- *Incidentally parks have a negative impact on property values:* Troy and Grove (2008), for example, mention that crime rates in the neighbourhood are an important factor (Baltimore, Maryland).
- Studies in China (Shenzen and Jinan) highlighted potential negative effects such as noise by users, unruly behaviour, as well as crime and lighting (Chen and Jim 2010 and Kong et al 2007 respectively)
- Strength of studies – moderate to strong
- Based on this quality assessment, there is *moderate to strong* evidence that urban parks have a positive impact on the value of nearby property (houses, apartments, land), although it is important to keep the limitations of the hedonic pricing methods – applied in the large majority of the studies - in mind. Parks have a greater impact on property values than other types of green spaces. The positive impact relates to both possibilities for recreational use and views over the parks. Positive impacts increase with proximity to the park and drops quite rapidly with increasing distance to the park.

Panduro, T.E and Veie, K.L. 2013. Classification and valuation of urban green spaces - a hedonic price valuation. Working Paper 2013:4. De Økonomiske Råds. ISSN 0907-2977
Categorization of green space into eight different types and quantify their impact on housing prices in the city of Aalborg using the hedonic house price method. Study found that green space is not a uniform environmental amenity but rather a set of distinct goods with very different impacts on the housing price

- hedonic house price model is estimated using the Generalized Additive Model (GAM).
- Model distinguishes between single family homes and terraced housing/ apartments.
- what matters in valuation studies, are people's perception of the amenity

Table 2. Types of green space and criteria for categorization.

Accessibility	Park	Lake	Nature	Churchyard	Sports field	Common area	Agriculture field	Green Buffer
External	H	H	H	H	H	M	L	L
Internal	H	M	M	M	H	H	L	L
Social	H	H	H	M	H	M	L	L
Maintenance	H	M	L	H	M	H/M	M	L
Neighbor land use	R	R	R	R	R	R	(R)	I

Note: H: High level, M: Medium level, L: Low level. For neighboring land use: R: Residential/Commercial, I: Industry/Infrastructure

Table 6: Green space Appreciation Index

Percentage change in price associated with a 100 m decline in distance		Distance from green space					
		600 m	500 m	400 m	300 m	200 m	100 m
Houses	Park	0.5	0.9	1.4	1.8	2.3	2.7
	Nature[(a)]	0.2	0.3	0.5	0.6	0.8	0.9
	Green buffer	Cut-off at 300 m			-1.3	-2.5	-3.8
	Church yard[(a)]				0.9	1.8	2.7
Apartments	Park	0.3	0.7	1.0	1.4	1.7	2.1
	Green buffer	Cut-off at 300 m			-1.0	-2.0	-3.0
	Church yard				-2.3	-4.6	-7.0
Note	[(a)] Significant at a 10 percent level.						

- Houses with a view of a lake are more expensive with approx. seven percent higher prices.
- For apartments the access to parks is also associated with higher prices. Having a view of a park is associated with a price premium of almost 6 percent.
- Parks and lakes were rated as having high recreational potential. In our estimations we find that both Parks and Lakes are associated with a large price premium. In contrast, Sport fields and Agriculture fields were hypothesized to have more limited recreational value and we found no significant effect of proximity to these types

Zhou Q., Panduro T E., Thorsen B J., Arnbjerg-Nielsen K. 2013. Adaption to Extreme Rainfall with Open Urban Drainage System: An Integrated Hydrological Cost-Benefit Analysis. Environmental Management (2013) 51:586–601 DOI 10.1007/s00267-012-0010-8.

Assessment of adaptation of drainage systems for climate change and extreme flood events as well as hedonic valuation model to capture economic gains and losses more water bodies in green areas.

- Economic Methods: The house price function was estimated using four dif- ferent models. One was a simple non-spatial OLS estima- tion whereas the three other models contained a spatial autoregressive error term which corrects for the presence of spatial autocorrelation. Due to problems of endogeneity, the spatial models are estimated using maximum likelihood (ML) and the GMM estimator.
- It was found that the group of green areas that contained features such as lakes and trees could be aggregated into one. The impacts of proximity to these green areas as well as the impact of their size were captured in the hedonic price function with the proximity to the nearest green area measured in beeline distance and size in hectares.
- A second group of urban green spaces was identified as areas without trees or lakes, i.e., typically open grass areas with no other features.
- allowed for spatial autocorrelation in the error term.
- Aarhus City – study area is Risskov - one of the wealthiest residential areas in Aarhus with high property value.

- Apartments not considered, only single family housing: 12,339 properties sold between 2000 and April 2010.
- marginal value of accessibility to the urban green areas, which included lakes or tree cover or both, decreased with 0.6 % of the property price for every 100 meters a house was removed from such an area.
- The marginal value of an increase in the size of the nearest such urban green area was 0.01 % of the house price for every additional hectare
- The urban green areas not including lakes or tree cover affected the very nearby properties negatively
- access to nearby lakes, including those not integrated in a green area, was exponentially related to the house price which means that a 1 % increase in distance to a lake will reduce the property value with 1.7 %

Kolbe, J and Wustemann, H. 2014. Estimating the value of urban green space: A hedonic pricing analysis of the housing market in Cologne, Germany. Acta Universitatis Lodziensis. Folia Oeconomica 5 (307), 2014.

- HPM for 85,046 apartment transactions for 1995 – 2012 – relates to parks, forests (at least 30% tree coverage at heights of more than 5m) and farmland (semi-natural areas and wetlands), and considered land-use categories of water (lakes, rivers, canals) and fallow land.
- Details of model in paper.
- Since the effects of environmental variables on housing prices, in contrast to intrinsic variables, are often very small, the accuracy of the environmental variables used in the hedonic price function plays an important role.
- a 1% increase of urban parks in a 500 m buffer around accommodation would lead to an increase in apartment prices of 0.1%
- The presence of water has the highest impact on the price variable and a 1% increase of water would result in positive price changes of 0.16%
- The coverage of fallow land and agricultural land negatively influences the price of the accommodations. According to our findings, a 1% increase of fallow land would result in a 1.46% (2 283.46 EUR) and a 0.18% (281.52 EUR) decrease in apartment prices for farmland.
- The results indicate that the impact of parks and water on transaction prices grows with the buffer size - increasing the coverage of parks by one unit (1%) within a 500 m buffer around the accommodation would result in a rise in apartment prices of 0.1%, or 156.40 EUR.

UNITED KINGDOM

Aecom & Severn Trent Water. 2013. The Ripple Effect - Building resilience of urban water systems to climate change. Technical Report: The Case for Birmingham and Coventry
Series of case studies for retrofitting SuDS into Covertry:

- Daylighting the River Sherbourne: average 24.2% uplift in rent value (riverside property is more valuable)
- Stoney Road green SuDS street retrofit: the uplift in resale value for a property on a tree-lined street equates to an average of 7%
- Water sensitive Southern Gateway (Birmingham): 20% increase in green space would leave to increased residential house values by over 29 million pounds for the planned 2,6000 new and existing residential properties.

Bastien, N., Arthur, S. and McLoughlin, M..J. 2011. Valuing amenity: public perceptions of sustainable drainage systems ponds. 12th International Conference on Urban Drainage, Porto Algre/Brazil, 11-16 September 2011
Economic benefits/ public perception of ponds:

- the use of the method to value a detention basin associated with multipurpose green space found that the device had a positive impact on property values, while a detention basin without any green features was shown to have no discernable impact (Lee et al., 2009)
- contingent valuation approach consists of asking, through a structured interview, the price the respondent would be willing to pay for market or environmental goods
- structured questionnaire conducted using face-to-face interviews in May 2009. 107 questionnaires completed (out of 400). Residents had to live within 5 minutes walk of a pond and were generally from higher socio-economic groups.
- 60% of residents felt the potential benefits of living in close proximity to the pond could offset the perceived disadvantages.
- Weighted average willingness to pay of £18.71/ month, privately or council maintained ponds are clearly outranking Scottish Water owned ponds, reaching a weighted average willingness to pay of £5.62/ month. For all the locations combined, an average £10.95 per month per dwelling for the residents living in close proximity to ponds has been established.
- Residents have identified wildlife as the most important benefit, and this impact on their potential willingness to pay. This finding underlines the need to use treatment trains before runoff is discharged to a pond to manage runoff quantity and quality efficiently, and thus maximise wildlife and amenity potential

City of London Corporation. 2013. Green Spaces: The benefits for London. Report by BOP Consulting for the City of London Corporation

- Study in 2010 by estimated that property within 600m of an urban park added between 1.9% and 2.9% to the total house value.
- Royal Institute of Chartered Surveyors in Aberdeen (Dunse et al (2007) found that location on the edge of a park could add a premium of around 19% to house prices – larger parks have a more significant impact.
- CABE Space (2005) found that in the Netherlands, having a park nearby could raise house prices by 6%, and a view of a park raised them by 8%.

Above studies cited through City of London Corporation (2013).

Business property: some publications cited here point towards a positive correlation between green spaces and businesses location decisions, particularly small businesses. Overall though there is little evidence of the effect of green spaces on businesses' decision to locate in a certain area.

- Survey results from 2009 show that only 4% of businesses and 3% of City executives agreed that "more parks, open space, gardens" are a way to improve the City as a place to do business, and only 13% of workers identified "more parks, open space, gardens" as a priority to improve the City as a place to work.
- These findings stand in stark contrast to the 2007 Greenstat survey, which revealed that 82% of people believe that high quality green parks and spaces encourage people and businesses to locate in a town82. While surprising at first glance, the results may suggest that a differentiation needs to be drawn between the benefits that people attribute to having green space close to where employees live, as opposed to close to where they work.

Table 5: Economic benefits and mechanisms linked to the City of London portfolio

	Evidence		Impact			
	Large spaces	Small spaces	CoL R+W	CoL Bus.	London R+W	London Bus.
Cost savings for government (capture of environment & health benefits)	√	√				
Enhancing land & property value (capture of environment & health benefits by residents)	√√	√√			√√	
Driving tourism & place marketing	√					√
Promoting business locations						

EFTEC. 2013. Green Infrastructure's contribution to economic growth: a review: A Final Report for Defra and Natural England. Defra Project Code: WC0820

Definition of Green Infrastructure: Green Infrastructure (GI) to mean a planned approach to the delivery of nature in the city in order to provide benefits to residents. This includes features such as street trees, gardens, green roofs, community forests, parks, rivers, canals and wetlands.

- Market sales: There has been a recent up surge in interest in the production of food in urban areas. This contributes directly to GDP, but at a tiny scale compared to the city economy.

Case studies

	Glasgow Green Renewal	Birmingham Canalside	Philadelphia Land Care	Stream Restoration, Seoul	Highline Linear Park, NYC
Change	Park improvement	Canal and canal-side improvement	Greening of vacant residential lots	Restoration of stream with footpath, man-made wetland and forest	New elevated urban public park
Investment	£15.5 million	Not quantified	Small - not quantified	Not quantified	$153 million
Anticipated outcome	• Job creation; • tax revenue; • land values; • Visitor spending.	• Job creation; • Land values; • Visitor spending.	• Property value increase.	• Businesses relocate to area; • Tourism spend; • Health benefits.	• Businesses relocate to area; • Jobs created; • Health benefits.
Outcome	• 47% increase in Council Tax receipts; • 28% increase in the number of employees in area; • 230 jobs supported; • 15% increase in rateable value from business.	• 30 FTE jobs created plus 77-96 jobs supported through visitor expenditure; • 25.7 - 57.1 million property value uplift.	• Significant increase in property value in some areas.	• Number of workers increased by 0.8% against a decrease of 2.6% in other areas of central Seoul; • £1.3 million contributed to economy by foreign tourists.	• 103% increase in property values near the park between 2003 - 2011; • 4 million visitors.
Other causal factors considered?	Impact of wider regeneration of the East End of Glasgow not considered.	Impact of the wider regeneration of the area, the state of property market and some additional public funding all relevant and not considered.	Other causes of changes to property prices were considered and the model controlled for these.	Before and after comparison does not allow for displacement or other factors.	Before and after comparison does not allow for displacement or other factors, such as macro-economic conditions.

All five of the case studies above were clearly a success in commercial terms. They were all successful and popular, attracting new business and investment to areas that had previously been perceived as unattractive, or even dangerous. The logic chains around attracting investment and visitor spending seem to be operating in these cases.

However, in real life situations it is often impossible to control for other influencing factors and to accurately attribute the improvement. Wider regeneration investment and the stage in the macro-economic cycle are obvious alternative causal factors. In practice, projects are more likely to be successful when these external factors are contributing. Also in practice GI is often part of a wider investment package and it is impossible to unpick the specific difference made by GI. It is also unrealistic to quantify whether or not the new economic activity is additional from a national perspective, as explained above.

The only case study above that has made a significant attempt to control for other factors is the Philadelphia Land Care Scheme, which uses house prices in similar districts for a comparison. Controlling is easier in this case because there are many similar interventions and thousands of house price sales to compare, so this methodology is not applicable to large iconic programmes. The Philadelphia evidence shows clearly that people value the improved attractiveness/perceived safety of their neighbourhood and this is important. It may also be evidence of increased economic activity but the link to economic growth is not clear.

The Glasgow, Seoul and New York case studies all provide people with access to attractive green space for exercise and recreation, which can be expected to contribute to improved health and later improved productivity. The Seoul case study is unique in that it involves the restoration of a natural system (and the development of some man-made natural systems).

For this reason it is the only case study that illustrates the reduced environmental costs logic chain, reducing air pollution and peaks of summer temperature. This contributes to both the attractiveness of the location and the health of residents, which can be expected to have a long-term impact on productivity.

Key conclusions for national decision makers

- Green infrastructure contributes to both local economic growth and the welfare of the local and visitor population (mental and physical health, environmental quality). This review shows that there is evidence on this contribution and qualitative evidence on people's preferences and experience of using green infrastructure.
- Most of the evidence is the product of comparisons of various factors before and after a green infrastructure project or comparisons of the areas with and without green infrastructure. This applies to both economic growth and wider human welfare benefits.
- To what extent green infrastructure provides an *additional* contribution to national economic growth is not possible to estimate with the available evidence. This gap is important for national policy making, and also identifying the priority green infrastructure features in different areas if making a national plan.
- Additionality (or displacement) analysis is notoriously difficult for most national policies, not only green infrastructure. Therefore, ways to analyse the case for green infrastructure investment will have to be explored, e.g. consider evidence on the wider human welfare impacts (environmental quality and physical and mental health), qualitative evidence and stakeholder engagement.
- In any case, a general improvement in the attractiveness of UK cities is desirable, and much of the mobile investment is global, rather than national, which means increased attractiveness can make a national economic growth contribution.
- In addition, green infrastructure clearly makes a contribution to the resilience, and sustainability, of economic growth in a particular place, through reducing important risks such as flooding and the urban heat island effect. This report does highlight this benefit, but does not focus on it, focussing instead on the pathways to growth in productivity.
- There is compelling evidence that green infrastructure projects that are integrated in with other projects or strategies such as urban regeneration are likely to engage stakeholders and provide more benefits faster. Therefore, it will be efficient to encourage such integration at both the local and nationals.

Forest Research. 2010. Benefits of Green Infrastructure. Report by Forest Research. Forest Research, Farnham.

Although there is no commonly accepted or authoritative definition in the UK, green infrastructure refers to the combined structure, position, connectivity and types of green spaces which together enable delivery of multiple benefits as goods and services. SUDS is a subset of GI.

- Section on inward investment and job creation – page 19 provides some specific examples of investment returns from GI.

- Greener areas have a better image and attract more visitors, bringing with them retail and leisure spending and providing job and rental opportunities (NENW, 2008:9)
- CTLA (2003) have shown that provision of trees can add 15% to 25% to the total value of properties, depending on size, condition, location and species rating.
- According to the North West Development Agency a view of a natural landscape can add up to 18% to property in North West England.
- Garrod (2002) - proximity to at least 20% woodland cover would raise the value of an average house by 7.1%.
- GEN Consulting (2006) found that regeneration using green infrastructure of a run-down area (negative aesthetics and perception) caused house prices to increase by 111% in Glasgow.
- In a study by CABE (2005) it was found that for properties 'on' a local park the average premium was 11.3% and for properties within close proximity to the park the average premium was 7.3% (standard deviation of 9.4%).

- Green infrastructure can improve the aesthetic quality of an area which in turn can increase inward investment, attract businesses and customers and encourage people to spend more time and money in an area.
- Economic growth as a result of investment in green infrastructure can lead to higher levels of employment and tourism, and to lower levels of crime.
- Having a well-managed green space nearby results in average property premiums from 2.6% to 11.3%.
- In terms of a marginal change, a 1% increase in the amount of green space in a vicinity is associated with up to 0.5% increase in the average house price (GLA Economics, 2003). Additionally, increasing housing stock increases the value of council tax generated in the locality (GEN Consulting, 2006:14)

Local economic regeneration is also a benefit of GI.

- The Glasgow Green Renewal project stimulated the development of 500-750 new residential properties, enhanced average house prices and the total value of property transactions by net £3 million–£4.5 million, increased yield in council tax by 47% and increased the value of the land from £100,000 to £300,000 per ha (GEN Consulting, 2006).

- Across England there remains an ongoing struggle to find capital funding for investment in green infrastructure and also to find funding for maintaining green spaces to a good standard (NAO, 2006).
- The current economic climate makes it difficult to invest in, let alone maintain, green infrastructure.
- There is an on-going struggle across England to find capital funding to improve green spaces that are run-down and sustainable sources of revenue funding to maintain spaces to a good standard (NAO, 2006).
- Creation of a park from blank canvas could cost in excess of £3.9 million (CABE, 2009).

Gibbons, S., Mourato, S. and Resende, G.M. 2014. The Amenity Value of English Nature: A Hedonic Price Approach. Environmental and Resource Economics, 57 (2). pp. 175-196. ISSN 0924- 6460

Using a hedonic property price approach, we estimate the amenity value associated with proximity to habitats, designated areas, domestic gardens and other natural amenities in England. First nation-wide study in England.

- 1 million housing transactions over 1996 – 2008. our units of analysis are individual houses located across England (130,395 km2), Scotland (78,772 km2) and Wales (20,779 km2)
- Results reveal that the effects of many of these environmental variables are highly statistically significant, and are quite large in economic magnitude
- Gardens, green space and areas of water within the census ward all attract a considerable positive price premium
- There is also a strong positive effect from freshwater and flood plain locations, broadleaved woodland, coniferous woodland and enclosed farmland
- Our preferred regression specifications control for unobserved labour market and other geographical factors using Travel to Work Area fixed effects, and the estimates are fairly insensitive to changes in specification and sample. This provides some reassurance that the hedonic price results provide a useful representation of the values attached to proximity to environmental amenities in England
- 9 broad habitat categories: (1) Marine and coastal margins; (2) Freshwater, wetlands and flood plains; (3) Mountains, moors and heathland; (4) Semi-natural grasslands; (5) Enclosed farmland; (6) Coniferous woodland; (7) Broad-leaved / mixed woodland; (8) Urban; and (9) Inland Bare Ground. Plus 6 landuse variables (incl green space and water)
- Distance to landuse measured in a straight line.
- distinguishing feature of our analysis is the large number of control variables considered
- key finding (Table 4) from this work is that environmental amenities are highly valued by home-owners and have a substantial impact on housing prices

Table 4: Implicit prices for key environmental amenities in England (£ capitalised values)

Environmental amenity	% change in house value with:	Implicit price in relation to average 2008 house price	
	1 percentage point increase in share of land cover:		
Marine and coastal margins	0.04% increase in house prices	£76	
Freshwater, wetlands, floodplains	0.36% increase in house prices	£694	***
Mountains, moors and heathland	0.08% increase in house prices	£161	
Semi-natural grassland	0.01% decrease in house prices	£-27	
Enclosed farmland	0.06% increase in house prices	£115	***
Broadleaved woodland	0.19% increase in house prices	£376	***
Coniferous woodland	0.12% increase in house prices	£232	*
Inland bare ground	0.38% decrease in house prices	£-733***	***
	1 percentage point increase in land use share:		
Domestic gardens	1.02% increase in house prices	£1982	***
Green space	1.04% increase in house prices	£2031	***
Water	0.97% increase in house prices	£1897	***
	Designation:		
Being in the Green Belt *(major metro. areas)*	3.25% increase in house prices	£6967	*
Being in a National Park, relative to mean	17.36% increase in house prices	£33686	***
	1 km increase in distance:		
Distance to coastline	0.14% fall in house prices	-£274	
Distance to rivers	0.93% fall in house prices	-£1811	*
Distance to National Parks	0.24% fall in house prices	-£465	***
Distance to Nature Reserves	0.08% fall in house prices	-£146	
Distance to National Trust land	0.70 % fall in house prices	-£1344	***

Notes: The stars indicate statistical significance levels ***p<0.01, **p<0.05, *p<0.10.
Being in a National Park calculation is based on zero distance from National Park and having a ward share of 100% National Park

Building natural value for sustainable economic development: The Green Infrastructure Toolkit – User Guide (Section 5 Land and Property Values). Undated.

CABE Space's study (2004) on the impact of park improvements on residential values found that:

- properties near a park were on average 5 to 7 per cent more expensive than comparable houses further away
- the highest value increase was 34 per cent
- off-park' impacts - on properties 'within the vicinity of a park' – achieved an average of 7.3 per cent
- on-park' impacts – on properties overlooking a high quality park – saw an 11.3 per cent increase.

- A review of the evidence base suggests that the link between high quality green infrastructure and up-lifts in commercial property value is much less clear cut than for residential.
- RICS in Aberdeen:

The price premium ranges between 0.44 per cent and 19.97 per cent depending on house and park type. The study even suggests that park shape matters - rectangular or oblong (long/narrow) parks being preferable to square or circular (short/wide) parks. A rectangular park, for example, would potentially offer greater opportunities for access – suggesting that accessibility as well as proximity is important to households. The findings are attractive in that they provide a relationship between house type and park type:

	Detached	**Flat**	**Non-detached**
City park	19.97%	7.54%	2.93%
Local park	9.62%	7.92%	9.44%
Open space	2.71%	4.7%	0.44%

US-based research also suggests that distance from the park or open space is valued as important[107]. Interestingly however, immediate adjacency - within 30 metres - of the park or open space can in some instances attract its own relative disadvantages. Lutzenhiser and Netusil's study suggested the largest premiums lie in the 61-120, 121-180 and 301-365 metre distance bands, respectively.

Relationship between property value and distance from a park:

Distance from park (m.)	**%Change**
< or = 30 meters	ns
31 - 120	4.09
121 - 210	2.96
211 - 300	2.28
301 - 400	2.18
401 - 450	1.51

Source: Bolitzer & Netusil, 2000[108]

- Note that this is a user-manual for a GI toolbox of methods – can be used to determine the value of environmental improvements and work out the expected benefit from an uplift in house values (Appendix 1 case study). Calculator for determining property values/ changes at this link:

  http://www.greeninfrastructurenw.co.uk/html/index.php?page=projects&GreenInfrastructureValuationToolkit=true

Mell, I., Kenskin, B., Hehl-Lange, S. and Henneberry, J. 2012. Valuing Attractive Landscapes in the Urban Economy: A Contingent Valuation of Green Investments in The Wicker Riverside, Sheffield. Level II Report (Action 4.2)

A contingent valuation experiment was designed to examine the willingness to pay (WTP) for investments in urban greening of residents, employers and employees, commuters and other users of The Wicker Riverside (Sheffield).

- Regeneration of an existing urban area (mixed use, residential, commercial)
- Contingent Valuation experimental methodology used to assess WTP (details of methodology contained in paper)
- Survey of 510 people
- there was a general consensus that an economic value could be attributed to different Green Infrastructure development options
- green issues such as naturalness, pollution, flood mitigation and access to nature are important influences on WTP
- respondents appear to be WTP more rent or mortgage interest for investments that provide additional or sustained ecological benefits and that provide or enhance the visible greenery of the urban environment
- scenarios most preferred had areas of green space and lots of trees (when visually compared with other scenarios)
- across all income ranges, the greener investment options were preferred to the VALUE investment
- Summarises positive and negative influences on WTP: most prominent positive factors were that investments improved the attractiveness for greener options & that they made the area look more natural. Most negative influences include economic factors – can't afford to pay more for it or already paying too much in rent/ mortgage.
- WTP for GI options: £4.27 and £10.81 (Blonk Street) and £3.87 to £29.21 (Nursery Street).
- Residents, business owners, employees, commuters and different users are all WTP for green investments if they provide functional, natural and attractive urban spaces.

Naumann, S., Davis M., Kaphengst T., Pieterse, M. and Rayment, M. 2011. Design, implementation and cost elements of Green Infrastructure projects. Final report to the European Commission, DG Environment, Contract no. 070307/2010/577182/ETU/F.1, Ecologic institute and GHK Consulting

Definition: is the network of natural and semi-natural areas, features and green spaces in rural and urban, and terrestrial, freshwater, coastal and marine areas, which together enhance ecosystem health and resilience, contribute to biodiversity conservation and benefit human populations through the maintenance and enhancement of ecosystem services. Green infrastructure can be strengthened through strategic and co-ordinated initiatives that focus on maintaining, restoring, improving and connecting existing areas and features as well as creating new areas and features.

- Report provides useful recommendations for policy action at a national, local and regional level to support implementation, these include:
    - Create an overarching and supporting framework at a national level
    - Provide financing and explore potential financing instruments
    - Promote networking, monitoring and research

- Table 21 (page 75) provides a framework for assessment benefits of green infrastructure projects.

Perino, G., Andrews, B, Kontoleon, A and Bateman, I. 2013. The Value of Urban Green Space in Britain: A Methodological Framework for Spatially Referenced Benefit Transfer
Meta-analysis of studies valuing urban greenspace in the UK in five British cities and monetary values are computed. This procedure is repeated for the six future scenarios used in the UK National Ecosystem Assessment and changes in values calculated for the period 2010-60.

- The analysis presents a methodology for estimating the spatial distribution of gains and losses arising from well specified policy changes. It therefore provides an important tool for the analysis of policies varying the amount, location and accessibility of urban greenspace.
- Caveats of the research/ methodology include:
    - a number of the benefits people derive from urban ecosystem services could not or only partially be considered in our analysis (e.g. living in a 'green city' vs living near green space).
    - the inability to condition on greenspace characteristics (apart from size) remains a potentially serious drawback
    - standardised data indicating quality or other features of urban greenspaces is not generally available
    - The ability to credibly model the impacts of such major increases in urbanisation based upon existing data is clearly an open empirical question
- economically deprived neighbourhoods benefit disproportionately from provision of urban greenspace.

Environment Agency. 2005. Social Impacts of Stormwater Management Techniques including river management and SUDS. Science Summary SC020009/SS

- The amenity, recreational value and aesthetics of new schemes seem to be of major importance in determining public acceptability, while function, efficiency and maintenance are primarily important in areas facing flooding problems
- The report uncovers a general preference for sustainable urban water management and for river restoration schemes compared with more conventional, 'hard engineering' approaches such as culverting rivers to channel them under roads and railways.
- Research examined cases examined within residential areas and in particular related to the application of SUDS, mainly ponds, and river management schemes

[Does not contain economic benefits – surveys of public and practioner preferences].

Two interesting pieces of information re SuDS within the report include:

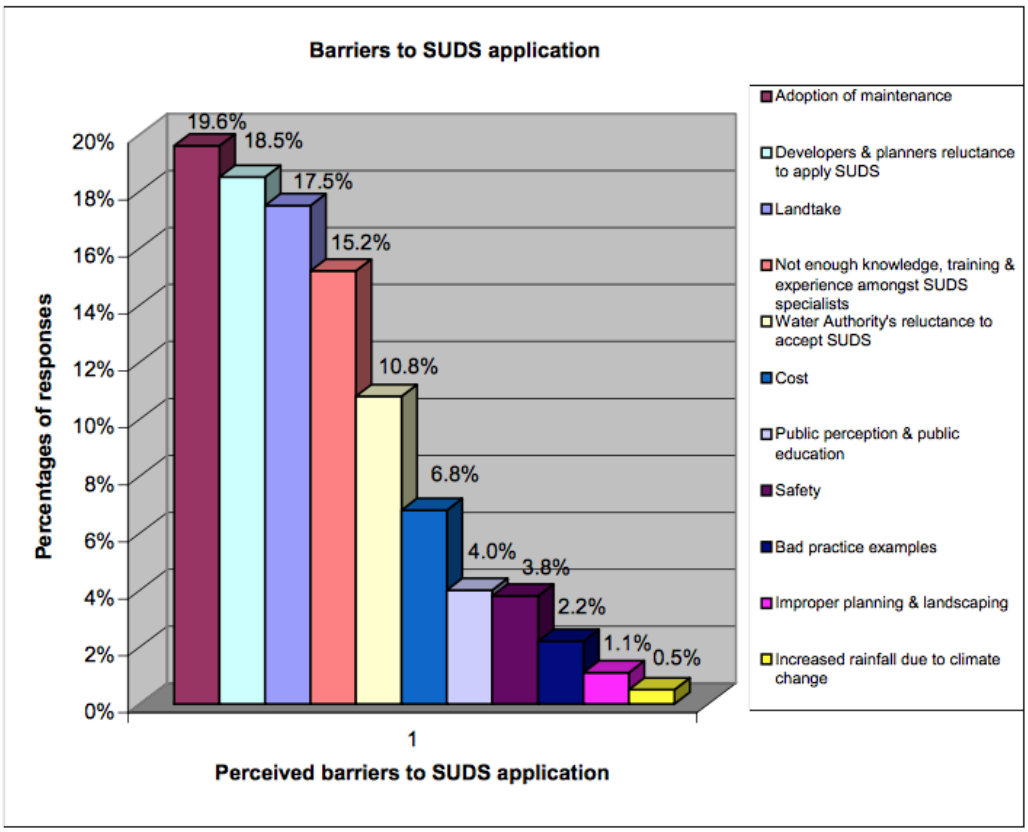
Households served by swales

Surveys were undertaken at two developments in Monifieth, Dundee, which both featured in-garden swales and were of similar (medium to upper) socio-economic status. SUDS drainage arrangements had been implemented at the time of construction of the housing.

Although the majority of participants were not aware of the term "swale" and hadn't been adequately informed about the systems, they were able to identify several purposes of swales including rainwater collection, avoidance of flooding and replacement of traditional drainage. Avoidance of flooding was seen by 40% to be the major advantage of the systems in this area. Interestingly, another 40% could not indicate any advantages.

When participants were asked to outline any perceived disadvantages of the swales, around 30% stated that swales are obstructions for cars and for children. The same percentage stated that the grass cutting is problematic, and that swales use up space in the garden. However, less than half were aware of their maintenance obligation to their in-garden swales. Awareness of the existence and maintenance of roadside swales was also low. According to the majority of the participants the developer should bear the maintenance responsibility, while a small percentage considered that the City Council should do so.

Local residents felt that the information provided was inadequate and 85% requested further information on the systems. Finally, several comments were made with respect to in-garden swales with 35% of participants stating that swales are aesthetically unpleasant constructions, and 25% even characterising them as a nuisance. The comments made with respect to in-garden swales are shown in Figure 29.



Saraev V. 2012. Economic benefits of greenspace - A critical assessment of evidence of net economic benefits. Forestry Commission. ISBN 978-0-85538-865-2

Comprehensive review of evidence of the net economic benefits (direct and indirect) of greenspace. Focusses mainly of large forested areas and includes economic benefits relating to growth and investment, land and property values, aesthetics, regional and local economic regeneration, tourism, health and well-being, water management, products from the land, biodiversity, climate change adaptation and mitigation, and evidence gaps.

- Evidence gaps included: areas as 'labour market employment and productivity' and 'recreation and leisure' (as opposed to tourism) themes. As 'quality of place' is a compound concept with no established definition, there has been little economic research addressing it directly to date.
- Land values:
    - Summarises many of the studies already included in this literature review.
    - Having a well-managed greenspace nearby was found to result in average property premiums of 2.6% to 11.3%. In terms of a marginal change an extra percentage point increase in greenspace land-use share in the Census ward increases property prices by around 1%.
    - property price increase is not in itself unambiguously a benefit, especially as it may disadvantage prospective buyers
    - All of the papers followed best practices and their findings are judged as being sufficiently robust (Eftec, 2010, Annex 3) and can be used in a value transfer approach, i.e.
        - GLA Economics, 2003: with a 1% increase in the amount of greenspace in a ward associated with a 0.3 to 0.5% increase in the average house price in that ward
        - Above study refined through GLA Economics, 2010 that used better greenspace data and a wider range of built environment and locational factors analysed at a finer spatial scale. Each ha of greenspace within 1 km of housing increases house prices by 0.08%. A regional or metropolitan park within 600 m increases total house value between 1.9 and 2.9%.
        - CABE, 2005: on-park properties had a premium of 11.3% (std error 3.86).
        - CABE, 2004: view of parks increased prices by 8% and having a park nearby increased them by 6% (Netherlands).
        - Dunse, White and Dehring, 2007: 1984 – 2002 with 53 674 transactions. The location on the park edge was either insignificant or significantly negative for detached and other houses, which may have been due to the potential negative externalities that can be attributed to parks, such as issues of security and perceptions of danger or anti-social behaviour. For flats the park edge location was significant and positive probably because the positive externality of a view and accessibility is valued higher than any negative effects. Combining the effects of location on the park edge and distance to the park the overall premium for a property located next to a park relative to a similar property 450 metres away is positive across all house types.

Calculated average premium values were 10.1% for city parks, 9.0% for local parks and 2.6% for amenity greenspace.

- Mourato et al, 2010: Largest dataset and done on a nation-wide scale. Key results include:
  - 1% point increase in greenspace land use share increases property prices by around 1%
  - 0.19% increase for woodland habitat
  -
- Finnish study (Tyrväinen and Miettinen, 2000) based on data from the sales of 590 terraced houses in the district of Salo, in Finland, over three years in the mid 1980s, found that having a view of the forest had a positive and significant effect on house prices. With a 1km increase in the distance to the nearest forested area there is an average 5.9% decrease in the market price. Dwellings with views were on average 4.9% more expensive.

CIRIA. 2013. Demonstrating the multiple benefits of SuDS – A business case (Phase 2). CIRIA Research Project RP993

Comprehensive literature review on the economic benefits of SuDS as well as an investigation of implementation and funding alternatives. Much of the literature from the study is included in this review and has been examined "more in-depth" through this Porirua review (with respect to property pricing).

Table 4.4 Examples of hedonic priced and other economic benefits from use of SuDS equivalent in USA (Bradon & Ando, 2012)

Source	Study for	Type of benefit	Underlying methodology	Estimated benefits - $ at 2000 prices
Braden & Johnstone (2004)	Offsite value of stormwater (SW) management	Water quality	Hedonic property value (Benefits transfer BT)	5% for undeveloped riverside properties; 10-15% for developed riverside residential inc. sediment benefits
Johnstone et al (2006)	Comparison of offsite SW management with piped system	Downstream flooding and offsite cost of drainage infrastructure	Hedonic property value, flood insurance costs etc. BT and engineering design	PV = $110-158 per developed acre PV = $340 per developed acre
Hansen & Hellerstein (2007)	Partial value of soil conservation programmes	Opportunity cost of water storage	Sediment removal costs (engineering design)	PV = $0.24 up to $1.38 per ton of sediment kept out

Bradon & Ando (2012) also point out that the use of SuDS equivalents in new housing developments in the USA are 'benign' in that they reduce construction costs to such an extent that they can help to "reduce house prices". They claim that this increases the net sum of "total societal welfare" as both developers and those seeking houses are better off.

UNITED STATES OF AMERICA

Ashley R M., Christensson A., de Beer J., Walker, l., Moore, S. and Saul, A. 2009. Selling sustainability in SKINT. SKINT INTERREG IIIb project report

Literature review and development of a green infrastructure methodology (SSIS) to assess contributions towards sustainability. Based on a combination of the CNT and GINW approaches. Quantifies a matrix of benefits into a series of indicators relating to low, medium and high benefits.

- At the present time it would seem that the idea of presenting the benefits of options to decision-makers, ideally monetised, couched in "sustainability" language, offers the best possibility to get options adopted that are as sustainable as possible. Important in this are the recently emerging ideas about multifunctionality, multivalue and getting more from less in investments in adapting to climate change.
- Appendices outline the evaluation criteria which are used in the SSIS model.
    - Hedonics can be used to assess how flood risk is priced into the real estate market. Insurance premiums paid for flood damage can be used as a proxy for the value of decreased flood risk. Other studies have used CV techniques. The most robust technique uses hedonics to investigate housing price discounts associated with a floodplain location. A 2-5% discount was found for houses within the 100 yr flood plain when compared to those outside.
    - Willingness to Pay studies have shown an increase in property values of 2-10% in areas with new street tree plantings.
    - CNT uses a value of 3.5% increase to property values.

Braden J B., and Johnstone D M. 2004. Downstream economic benefits from storm-water management. Journal of Water Resources Planning & Management. 130(6) 498-505

- Our best estimate of total benefits to property owners (from flood alleviation and water quality improvements) is 2–5% of property value on average for all properties in the flood plain.
- Need to purchase paper for further details.

Center for Neighborhood Technology (CNT). 2002; 2006; 2007 & 2010. The value of green infrastructure; a guide to recognizing its economic, environmental and social benefits.

Definition: Green infrastructure (GI) is a network of decentralized stormwater management practices, such as green roofs, trees, rain gardens and permeable pavement, that can capture and infiltrate rain where it falls, thus reducing stormwater runoff and improving the health of surrounding waterways.

- This guide focuses on GI's benefits within the urban context.
- Very useful document for overall benefits of GI and methodology for quantifying benefits under each broad 'benefit category'.

Quotes several empirical studies which have shown that GI increase property values:

- 2–10 percent for properties with new street tree plantings in front (Wachter 2004; Wachter and Wong 2008)
- Portland, Oregon, found that street trees add $8,870 to sale prices of residential properties and reduce time on market by 1.7 days (Donovan and Butry, 2009)

- Philadelphia (Stratus 2009) – extensive study on property values: authors conclude that property values are notably higher in areas with LID and proximity to trees and other vegetation, they also note the difficulty in isolating the effect of improved aesthetics and avoiding double-counting of benefits such as air quality, water quality, energy usage (often relating to heat stress) and flood control that also impact property values. In this study, a range of 0– 7% is presented as suggested in literature, and a mean increase of 3.5% is chosen.
- Ward et al. (2008) estimate property values in the range of 3.5–5.0 percent higher for LID adjacent properties in King County, Washington.
- CNT has a green values calculator for quickly comparing the performance, costs and some benefits of GI vs conventional. http://greenvalues.cnt.org/national/calculator.php
- Lists other tools (e.g. Street Tree Resource Analysis; i-Tree; National Tree Benefit Calculator; Green roof calculators, etc).

City of Portland. 2010. Portland's Green Infrastructure: Quantifying the Health, Energy, and Community Liveability Benefits, City of Portland Bureau of Environmental Services
Purpose of the report was to document the expert review of existing data and to quantify (to the extent possible) key ecosystem benefits associated with each G2G (Grey to Green) BMP, focusing on the "other benefits" categories that are more social and economic in nature.
BMPs include:

- Ecoroofs
- Green streets (curb planters, infiltration rain gardens)
- Trees
- Invasive removal and revegetation
- Culvert removal
- Land purchase
- Planting in natural areas

Comprehensive summary of economic and social benefits related to LID/ GI infrastructure.
Aesthetics/ Amenity Improvement (metric was property values):

- Positive, 3% to 5% increase in home values experienced due to combined Green streets + Swales + Culvert Removal [based on a Seattle study – Ward et al 2008]. Hedonic Pricing.
- Trees – likely positive but not quantified via percentage. $7,953 Increase in home value per tree in front of house. Benefits to neighbouring home values could add another $7,098 per tree (Donovan and Butry (2008). The value of yard and street trees is shown to increase values, but at some point can begin to diminish values. That is, more trees are not always better if the canopy crowds out sunlight, or is otherwise not considered desirable.
- Invasive removal/ revegetation – uncertain
- Culvert removal (stream daylighting) - positive, 3% to 5% increase in home values experienced due to combined Greenstreets + Swales + Culvert Removal
- Land purchase - positive, 14% increased home value for homes within 800 – 1,000 feet of natural park.

- Planting natural areas - Positive, 3- 13% increases in property values for stream restoration efforts. Study in California and based on WTP.
- Lack of property value studies on ecoroofs so not enough data to determine the amenity and community value of this BMP.

Other observations:

- Property values only capture the level of benefit to nearby property owners. They do not incorporate the value of green infrastructure to people who do not live very close to the green space but who may still enjoy benefits
- Summary above is a summary of the amenity/ aesthetic value based on effect of the BMP on property value. If more than one BMP is in place, it does not typically mean that the home value incremental increases could be added up for a total estimate of improved property value. Rather, if there were several elements affecting home value on one property, it is more likely that the combined effect would be less than the sum of all incremental effects

City of Portland Environmental Services. 2008. Cost Benefit Evaluation of Ecoroofs. 42 pp.

- A study in Vancouver, BC stated that rates at a local hotel for rooms adjacent to a 2,100 SF ecoroof herb garden were $80 more per night than comparable rooms at a local hotel.
- The report also provides costs and net benefits to the private propoerty owner as a result of onetime and ongoing reduction in stormwater management fees, avoided stormwater management facility costs, reduced cooling and heating costs, avoided roof replacement costs, and reduced HVAC equipment sizing costs.

Clements, J. and Juliana, A (Stratus Consulting). 2013. The Green Edge. How Commercial Property Investment in Green Infrastructure Creates Value

- Apartment buildings with green roofs received a 16% rental premium.
- Retail customers are WTP 8% - 12% more for products in shopping centres with mature tree canopies.
- Wide range of studies found that landscaping and trees increase residential property values by 2% - 5% and add 16% to average rentals for multifamily units.
- Can add 7% to the average rental rate for office buildings.
- Other benefits: lower energy costs, tax credits, stormwater fee credits, rebates, development incentives.
- Detailed references in the report, but no details on studies themselves.

Foster J., Lowe A., and Winkelman S. 2011.
The value of green infrastructure for urban climate adaptation. Center for Clean Air Policy. Washington DC. Page 19

Summarises studies already documented in previous literature. Note that the study finds that, on average, ecoroofs are 40% more expensive over their life cycle than 'conventional' roofs, but that energy savings and economic benefits can out-weigh this (energy savings can be 15 – 45% of the annual energy consumption – mainly lower cooling costs).

Johnstone D M., Braden J B., and Price T H. 2006. Downstream economic benefits of conservation development. J. Water Res. Planning and Mgmt. 132(1): 35-43

- Benefits Transfer Method: total benefits based on increased downstream property values of $391,600–2,488,500 due to reduced flooding. These values range between 0.4 and 2.5% of the value of affected properties, depending whether or not they remain in the 0.01 annual probability flood zone (Chicago).
- Flood Estimation Method: This amounts to 1.7–2.5% of the average property value throughout the floodplain area.

Larson E K. and Perrings C. 2013. The value of water-related amenities in an arid city: the case of the Phoenix metropolitan area. Landscape and urban planning. 109: 45-55

Not relevant in terms of climatic conditions, but has some interesting findings around green space:

- One would expect that proximity to parks would be a benefit, as they provide many ecosystem services such as recreation, greenery, access to biodiversity, and aesthetics. But while living close to parks may provide easier access to these services, it may also increase the exposure to potential disamenities associated with parks, such as crime and noise.
- Separated parks into two sizes: small parks (playgrounds and fields) and larger parks (hiking)
- Small parks were considered to reduce property values whilst larger parks had a positive influence.
- Troy and Grove (2008) demonstrated that consideration of neighborhood crime rates altered homeowners' willingness to live close to parks.
- Proximity to water-intensive locations such as lakes, golf courses, and small parks positively influences house prices

New York City Department of Environmental Protection (NYCDEP). 2010. The NYC Green Infrastructure Plan

BeST literature review included this reference, but no information found with respect to economic benefits of the HYC Green Infra Plan. Updated 2013 NYC DEP Annual report on implementation of the GIF discusses a "Co-Benefits" study and calculator. Property values/ aesthetics are not included in the study.

Trust for Public Land. 2010. The Economic Benefits of the Park and Recreation System in Mecklenburg County, North Carolina, Washington, DC: Center for City Park Excellence.

Hedonic analysis of property values relating to parkland areas in Mecklenburg County. Property value near parks is affected primarily by 2 factors: distance and the quality of the space.

- While proximate value (i.e., the "nearness" factor) has been documented for up to 2,000 feet from a large park, most of the value is within the first 500 feet. To be conservative, we have limited our measurement to this shorter distance

- Data collected from residential property sales over a period of 2005 – 2009.
- Our regression showed a 3.33% park effect—an additional $8,032 in average sale value per park-proximate unit (first 500 feet).
- Does not consider the effect of small parks (under an acre).
- Direct income received through increased property tax (rates) as a result of increased value of certain residences.
- Direct savings to the community through the use of the County's free parkland and recreation opportunities.

Sander, H. Polasky, S and Haight, R. 2010. The value of urban tree cover: A hedonic property price model in Ramsey and Dakota Counties, Minnesota, USA. Ecological Economics 69 (2010) 1646–1656

Quantifies the benefit value of urban tree cover in Dakota and Ramsey Counties, Minnesota. Dataset included 9992 single family residential properties that sold in 2005 and ranged in value from $65,000 to $2,870,250 – mean sale price of $287,637.

- Tree cover measured as percentage tree cover on parcels within 100, 250, 750 and 1000m.
- Results show that tree cover within 100m and 250m is positive and statistically significant. 10% increase in tree cover within 100m of an average home increases the sale price by 0.48% and within 250m increases it by 0.29%.
- Beyond 250m tree cover does not contribute significantly to the sale price.
- A number of other studies cited, including:
    - Anderson and Cordell (1988) – hedonic pricing – trees in front yards of residential single family homes in Athens, Georgia USA – 3.5% - 4.5% increase in sales price.
    - Dombrow et al (2000) – hedonic pricing – dummy variable to indicate a single family residential home with mature trees in Baton Rouge, Louisiana USA – 2% increase in sales price.
    - Veseley (2007) – contingent valuation – WTP to avoid 20% decrease in urban tree estate in New Zealand – household average WTP was NZD184 (2003) for a three year period.