BUILDING WATER SENSITIVITY INTO URBAN ENVIRONMENTS

Lessons from Portland

CASE IN POINT 2019

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ABSTRACT

Since the 1980s, there has been increased recognition of the importance and value of the natural environment and natural systems for the continued growth and development of society. In part, this recognition has resulted both from increased understanding of natural systems themselves, as well as from challenges such as population growth climate change, environmental degradation, and urbanization which threaten human development. A key factor influencing the response to these challenges is the sustainable management of water in urban areas for continued human development. One approach that has been identified to support cities in reaching this goal is water sensitive urban design (WSUD).

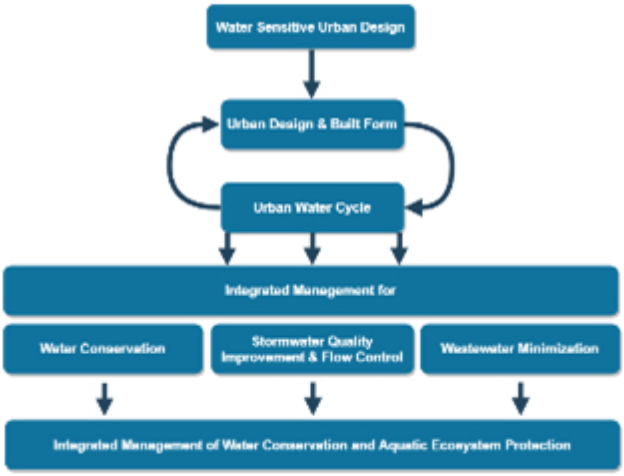
1.0 INTRODUCTION

For the first time in history, the majority of the human population is located in urban areas (Donofrio, Kuhn, McWalter, & Winsor, 2009, p. 179). Since the 1980s there has been increased recognition of the importance and value of the natural environment and natural systems needed for the continued growth and development of society. This recognition has resulted both from increased understanding of natural systems as well as from challenges such as population growth, climate change, environmental degradation, and urbanization (Costanza, 1989) (Donofrio, Kuhn, McWalter, & Winsor, 2009). The response to these challenges requires the adoption of sustainable and resilient design strategies for cities and water resources. One approach that has been identified to help cities achieve this goal is water sensitive urban design (WSUD).

1.1 WHAT IS WSUD?

WSUD is an evolving approach to holistically integrate stormwater, groundwater, and wastewater management with urban design for the purpose of minimizing environmental degradation while enhancing water quality treatment, wildlife habitat, and recreation appeal (JSCWSC, 2009). WSUD has accrued a variety of definitions in the literature which is reflective of the wide coverage of applications that WSUD's frameworks have come to provide (Wong, 2006). The *Inter-government Agreement on National Water Initiatives* (2004) defines WSUD as "the integration of urban planning with the management, protection and conservation of the urban water cycle, that ensures that urban water management is sensitive to natural hydrological and ecological processes". Wong and Ashely (2006) state that the term WSUD" ...comprises two parts – 'Water Sensitive' and 'Urban Design'. Urban Design is an established field

Figure 2: Conceptualization of WSUD and its Integration into the Urban Water Cycle



related to both the planning and architectural design of urban environments, encompassing issues that have traditionally existed outside of water management but nevertheless interact and have implications to environmental effects on land and water (Wong T. H., 2006). The terminology 'Water Sensitive' reflect the integration of environmental science and engineering with the management of water and aquatic environments in urban areas.

WSUD is most commonly referred to as the Australian terminology for a design philosophy that has become popular in many other parts of the world (Eckart, McPhee, & Bolisetti, 2017). Other names for WSUD, or similar design philosophies, include low impact development (LID) in the United States and Canada, and sustainable urban drainage systems (SuSD) in Europe.

1.2 IMPORTANCE & PRINCIPLES OF WSUD


Figure 3: Curbside planters

Donofrio and Kuhn (2009) note "WSUD increasingly is becoming a key component in establishing appropriate sustainable supply planning in urban areas around the globe, as well as in contributing to flood prevention and water quality protection" (p. 179). WSUD has the potential to address a number of stressors that many urban areas are faced with. Some of these include:

- cost of repairing and replacing aging infrastructure;
- infrastructure capacity limits and servicing; and
- Drainage challenges
- CSOs


Figure 4: WSUD project at University of Illinois

Table 1: Common Themes and Principles Linking WSUD

THEME	PRINCIPLES
Water Sensitivity	Should use decentralized methods to make urban water cycle more natural
	Should protect and enhance natural water systems creeks, rivers, wetlands, within urban developments.
	Should improve the quality of water draining from urban developments into creeks, rivers, and bay environments.
	Should integrate water into the landscape to enhance urban design and visual, social, cultural, and ecological values.
Aesthetics	Should provide aesthetic benefit where possible
	Should be adapted to the design of the surrounding area
Functionality	Should restore the urban water balance by maximizing reuse of stormwater, gray water, and recycled water and using LID stormwater management
	Should conserve water resources through conservation, reuse, and overall system efficiency
	Should be flexible and able to adapt to uncertain and changing conditions
	Should reduce peak flows and runoff volume from urban developments while providing for infiltration and groundwater recharge
Usability	Should be able to create usable areas for recreation, conservation, etc.
	Should be able to use stormwater treatment systems in the landscape by incorporating multiple uses that will provide multiple benefits, such as water quality treatment, wildlife habitat, public open space, and recreation
Public Perception & Acceptance	Should minimize cost while adding value—WSUD solutions must be economical and easy. Cost should remain comparable to costs of conventional solutions
	Should consider the demands of stakeholders and involve them in the planning process
Integrative Planning	Should combine function, aesthetics and use
	Should be planned in interdisciplinary cooperation of urban planning, urban design, landscape architecture, and water management

Source: Donofrio, Kuhn, McWalter, & Winsor, 2009 and Hoyer, Dickhaut, Kronawitter, & Weber, 2011.

1.3 WSUD AND WINNIPEG

Sustainable Water and Waste, is one of four Direction Strategies that guide and support *OurWinnipeg, Winnipeg's* current development plan which provides a 25-year vision for the City's planning and development. *Sustainable Water and Waste* includes a number of key initiatives, goals, recommendations, and directions for the City's future. It was developed by Winnipeg's Water and Waste Department and internationally renowned experts in the fields of municipal engineering and urban planning. It was designed to enhance the City's water, wastewater, stormwater management, and solid waste management systems (The City of Winnipeg, 2011, p.3).

Figure 5: Sustainable Water and Waste

A key strategy referenced throughout *Sustainable Water and Waste* is WSUD. WSUD is suggested to have potential to address functional benefits such as reducing runoff, improving water quality, and reducing impacts on natural systems (The City of Winnipeg, 2011).

It is also citied as a strategy to support design and aesthetic elements of Winnipeg, as well as other uses.

1.4 WINNIPEG'S COMBINED SEWER OVERFLOWS (CSO'S)

A key factor in Winnipeg's urban water cycle is its sewers. The Winnipeg sewer system which was originally designed a single piped system, combined all domestic and industrial wastewater, storm drainage, and industrial wastewater for discharge to the rivers (The City of Winnipeg, 2019). With the addition of an interceptor system that directs flow during dry weather to sewage treatment plants for cleaning and disinfecting, this combined sewers still serves older parts of Winnipeg. A challenge for the City is that high precipitation events can exceed the capacity of the sewer. This results in direct discharge of wastewater into the rivers. The welfare of Lake Winnipeg is a second challenge directly related to Winnipeg's CSO's. It is estimated that the annual loading of phosphorus from CSO's is only 0.31% of the total lake loading, however, phosphorus is considered to be the limiting nutrient and therefore is a great concern for the Lake (City of Winnipeg, 2015). Furthermore, while Winnipeg only contributes a fraction of the nutrient load on Lake Winnipeg, it also the largest single point source.

Figure 6: Sustainable Water and Waste

Winnipeg is currently creating a *CSO Master Plan* to manage the effects of CSO's on it's rivers (The City of Winnipeg, 2019). While the plan is still under review it is addresses CSO control limits, environmental sustainability, and best practice CSO control options from other cities. Some lessons may be learned from Portland and its experiences with WSUD and CSO's.

Figure 7: View of Portland, OR

2.0 BACKGROUND

The City of Portland Oregon is a recognized leader in green stormwater management. The City is home to several award-wining BMP project designs, and its municipal program is a highly regarded worldwide (Water Environment Research Foundation, n.d.). Portland's stormwater management program created by the Bureau of Environmental Services in the 1990's is regarded as multi-faceted and highly successful program that achieves not only regulatory compliance, but also education, outreach, and community greening and beautification.

In line with Portland's ongoing Sustainable Stormwater Management Program two projects/initiatives that reflect WSUD elements include: Grey to Green, and Tanner Springs.

Figure 8: Picture of park in Portland

2.1 Grey to Green Initiative

Grey to Green (G2G) was a five-year $50 million dollar initiative enacted between 2008 and 2012, which encouraged collaboration between city departments such as Environmental Services, and community planners to support and enhance the adoption and integration of green infrastructure projects, the creation of green space, and to address stormwater management concerns also helping to alleviate CSO issues.

Figure 9: Grey to Green

The prime goal of Green to Grey was: "...to expand stormwater management techniques that mimic natural systems, protect and restore natural areas, and improve watershed health. These investments in green infrastructure improve the quality of our neighborhoods, rivers and streams, and help us adapt to a changing climate." (City of Portland, 2010, p. 1).

Apart from the general benefits the City sought to achieve, G2G was also adopted to help address stormwater runoff issues the City was facing. Approximately one half of Portland was serviced by a combined sewer system, with the other half serviced by a separate system. During large precipitation events, stormwater runoff would mix with sewage in the combined system and overload the drains. A portion of this sewage would overflow to the Willamette River, resulting in water quality and health and safety concerns. Another issue was the risk of back up from rainfall into resident property.

In line with Grey to Green, adopted decentralized solutions such as ecoroofs, green streets, swales, raingardens, planters, and disconnected downspouts to retain water from entering the sewer system.

Figure 10: Green Street Plantar

Several programs were initiated to support these efforts including: an Ecoroof Program, a Green Streets Program, a Downspout Disconnection Program, and an Innovative Wet Weather Program. To motivate private property owners to contribute to sustainable stormwater management, Portland offered a stormwater management fee discount for property owners who manage stormwater on their property so that it is not discharged to the city sewer system (Portland Bureau of Environmental Services 2010b). Some owners took this up as an opportunity to improve their living environment with exciting art installations displaying rainwater flushing, dropping, or spreading from the roof to the ground (Fig. 20).

From approximately 2008 to 2013 43 acres of eco roofs, 50,000 street trees and 200 green streets, 80,000 private and public trees, and 400 acres of property was acquired through G2G (Hoyer, Dickhaut, Kronawitter, & Weber, 2011). Key benefits include a variety of health, energy, and community livability benefits. Estimates for hydrological improvement and energy savings reduction from G2G are included in table 2 below. Additional benefits are included in the G2G benefits report which can be found on the City of Portland's website.

Table 2: Estimated Benefits of G2G

Action	Hydrology Improvement	Energy Savings
Ecoroofs	60% peak flow reduction	1, 470 kWh/Acre
Green Streets	93% peak flow reduction	155 kWh/facility
Trees	20% peak flow reduction	1.4 kWh/tree (for street trees)

Source: (City of Portland, 2011)

2.2 CSO East Side Big Pipe Project

Completed in 2011 the Big Pipe Project works with Portland's CSO Program to reduce CSO into adjacent rivers. The Pipe is a large sewer line and tunnel that expanded existing combined sewer infrastructure to nearly eliminated CSO's in the Willamette River and Columbia Slough. The project has resulted in a 94% and 99% reduction in CSO's to each river respectively (City of Portland, 2011).

3.0 Lessons learned

1. The functionality of WSUD strategies which may employ green roofs, infiltration areas, and pervious surface materials can also contribute to the aesthetics of an urban area as well as reduce the load to sewer systems lessening the potential for CSOs.
2. Decentralized stormwater management can be applied through the coordination of initiatives (ex. green roofs) rather than direct planning and construction of grey infrastructure alone (Hoyer, Dickhaut, Kronawitter, & Weber, 2011).
3. While the range in benefits from WSUD can be difficult to measure and quantify, estimates of tangible benefits can be made.
4. Stormwater management fee discounts (as well as other incentives) can potentially be effective tools to encourage stormwater management from private land owners.
5. The facilitation of information and educational resources like cycling and walking tours can provide opportunities for the public to have fun while learning about sustainable best management practices (BMPs), potentially improving public support.
6. Management of site-specific decentralized management methods can function individually or be linked at a district or urban scales(Hoyer, Dickhaut, Kronawitter, & Weber, 2011).
7. Public awareness of decentralized stormwater planning can positively impact inhabitants' image of city and increase participation in taking action.
8. The benefits offered by WSUD need to be considered holistically.
9. Winnipeg should encourage the adoption of WSUD practices so as to better align with the intent of *Sustainable Water and Waste.* This may help the City lesson the effects of its CSO's

Figure 11: Sustainable Water and Waste Cover

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Image Sources

Figure 1: https://urbanecologycmu.wordpress.com/2015/10/22/water-case study-tanner-springs-park/

Figure2: Created by Andrew Treger

Figure 3: https://www.portlandoregon.gov/bes/article/321433

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Figure 5: https://www.winnipeg.ca/interhom/CityHall/OurWinnipeg/pdf/SustainableWaterWaste.pdf

Figure 6: https://www.gettyimages.ca

Figure 7: Figure 2https://citymar.com/?p=1137

Figure 8: https://urbanecologycmu.wordpress.com/2015/10/22/water-case-study-tanner-springs-park/

Figure 9: https://www.portlandoregon.gov/bes/article/321433

Figure 10: https://www.portlandoregon.gov/bes/article/298042

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