

STORMWATER 2010
National Conference of the Stormwater Industry Association
Conference Proceedings

CAN WE MOVE BEYOND THE CREDIT CRUNCH? WSUD IN OPEN SPACE

Author/s:

Shaun Leinster, Director, DesignFlow
Andrew O'Neill, Environmental Scientist, DesignFlow
Chris Tanner, Director, Bligh Tanner
Alan Hoban, Program Manager, Water by Design (SEQ Healthy Waterways Partnership)
Shaun Walsh, Director, Place

ABSTRACT

Water Sensitive Urban Design (WSUD) is the preferred approach for mitigating the impacts of urbanisation on the natural water cycle and is used to reconnect communities with the landscape and management of local water. Physically integrating WSUD elements into the surrounding landscape usually requires space. In urban developments, WSUD elements often compete for space with other demands such as additional housing lots, roads, pathways, service corridors, environmental reserves, open space and flood management.

The management of urban stormwater is most often the responsibility of stormwater engineers and addressed after the urban planning process is complete. This often leads to poor integration of stormwater management measures into the urban form and public realm. Even where spatial integration may appear to be resolved in two dimensions, translation of this into three dimensions can result in unraveling of this integration due to engineering constraints not fully appreciated at the planning stage. Where the urban footprint cannot be revisited, this can lead to trade-offs between the effectiveness of stormwater treatment and landscape amenity. This lack of landscape and public realm integration has resulted in local authorities generally not supporting the 'crediting' of stormwater management infrastructure as part of the creditable public open space for new developments.

Leinster et al (2009) and O'Neill et al (2008) introduced the idea of 'WSUD squeeze', which is the phenomenon of reducing the WSUD and flood management elements into the smallest footprint possible even if this involves delivering poor landscape and unsafe outcomes (steep batters and deep walls etc.). The current public open space policy across Australia seems to be promoting WSUD squeeze. There is a need to revisit this policy position to avoid continued poor WSUD and open space outcomes. Leinster et al (2009) suggested that WSUD can form part of open space, even creditable open space (i.e. contribute toward the minimum parkland requirements), provided a number of important design rules are met.

To further develop the thinking around WSUD and open space policy, two important pieces of work have recently been completed by Water by Design and Mackay Regional Council. This paper presents the findings of this work by:

- exploring the issues associated with integrating WSUD into multiple-use open spaces
- identifying the common objectives of good open space design and WSUD
- describing the WSUD squeeze phenomenon and the relationship to current public open space policy
- proposing frameworks and design standards to allow WSUD and flood management features to form part of creditable open space

STORMWATER 2010
National Conference of the Stormwater Industry Association
Conference Proceedings

INTRODUCTION

Water Sensitive Urban Design (WSUD) is the preferred approach for mitigating the impacts of urbanisation on the natural water cycle and is used to reconnect communities with the landscape and management of local water. WSUD systems such as vegetated stormwater treatment systems and flood storages are often placed in public open spaces. There are a number of advantages associated with this:

- using land efficiently by allowing multiple uses of space within a constrained land supply
- creating functional landscape features and contributing to public open space amenity
- activating public open space with multiple uses and activities on more than one level (i.e. interest in wetland habitat)
- creating opportunities for passive irrigation and stormwater harvesting to improve local water-use efficiency
- providing opportunities for public education and awareness raising about the water cycle and contributing to sense of place and community ownership
- reducing maintenance costs for local authorities by having less land to maintain.

Reviewing the generally accepted objectives associated with WSUD and public open space we find there is strong relationship. As illustrated in Table 1, environmental protection, amenity, connection and safety are objectives common to both WSUD and public open space. The only objective that differs is that public open space provides 'active' recreational opportunities (i.e. sporting, exercise).

Table 1: Objectives of public open space and WSUD

Public open space	Water Sensitive Urban Design	
		amenity
Provide active recreational opportunities		connectivity
connectivity		environment
protection and enhancement		safety
	infrastructure (rooftop)	

STORMWATER 2010
National Conference of the Stormwater Industry Association
Conference Proceedings

The interrelationship of these objectives suggests that WSUD should be included as a fundamental part of public open space. However, there are a number of perceived disadvantages or concerns to including WSUD in public open space. These include:

- WSUD detracts from open space values
- perceived increased public risk around detained or ponded water, or for water in flowing channels
- concerns that stormwater within treatment systems is dirty
- concerns that WSUD requires intensive and expensive maintenance
- risks of poorly conceived, poorly designed and/or poorly delivered infrastructure that may fail or require costly rectification.

In response to these disadvantages, the concept of including WSUD in 'creditable' portion of public open space has not been supported by government and local authorities, with a few exceptions. This is leading to a perverse outcome called the "WSUD Squeeze".

WSUD 'SQUEEZE'

Leinster et al (2009) and O'Neill et al (2008) introduced the idea of 'WSUD squeeze', which is the phenomenon of reducing the WSUD and flood management elements into the smallest footprint possible even if this involves delivering poor landscape and unsafe outcomes (steep batters and deep walls etc.). There appears to be two reasons for WSUD squeeze:

- **Poor Design** - The design of WSUD is most often the responsibility of stormwater engineers and addressed after the urban planning process is complete. This often leads to poor integration of WSUD measures into the urban form and public realm. Even where spatial integration may appear to be resolved in two dimensions, translation of this into three dimensions can result in unraveling of this integration due to engineering constraints not fully appreciated at the planning stage. An example is designers not allowing enough space for the edges or batters associated with WSUD systems when defining the development layout. Where the development layout cannot be revisited, this can lead to trade-offs between the effectiveness of WSUD and landscape amenity. Due to the lack of space in the development layout for proper interfaces and batters from the WSUD systems to the surrounding landscape, walls or very steep batters are used resulting in little or no landscape amenity.
- **Current Public Open Space Policy** – Poor design, as well as the other issues listed in the introduction to this paper, has resulted in local authorities generally not supporting the 'crediting' of WSUD infrastructure as part of the creditable public open space for new developments. This appears to be confounding the WSUD squeeze problem. Because WSUD systems are generally not created as open space, the development industry is looking to "squeeze" these systems into the smallest space possible to preserve development yield.

The result of WSUD Squeeze is poor WSUD and parkland outcomes. Stormwater and flood management systems are created as deep areas in the landscape with steep batters and sometimes walls with the aim of reducing the area of WSUD systems. For example the deeper the flood storage, then the smaller the area and therefore the smaller impact on development yield. The resulting WSUD systems provide no landscape amenity

STORMWATER 2010
National Conference of the Stormwater Industry Association
Conference Proceedings

or recreational benefit as illustrated in Figure 1. Furthermore, the systems are unsafe and almost impossible to maintain.



Figure 1: Examples of WSUD Squeeze

The WSUD Squeeze Cycle

So it appears the WSUD and public open space design has entered into a WSUD Squeeze Cycle (Figure 2):

- Poor design has lead to poor outcomes being delivered in some situations.
- Poor outcomes have caused policy makers to exclude WSUD from public open space through reactionary policy.
- In many situations this public open space policy is resulting in WSUD features being squeezed into as smallest footprint possible resulting in poor landscape and parkland outcomes.

There is a need to revisit public open space policy to break this cycle and avoid continued poor WSUD and open space outcomes.

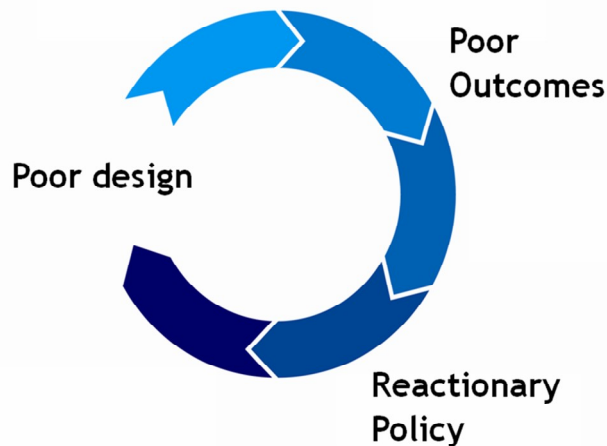


Figure 2: The WSUD Squeeze Cycle

REWARD GOOD DESIGN

Leinster et al (2009) suggested that WSUD can form part of open space, even creditable open space (i.e. contribute toward the minimum parkland requirements), provided a number of important design rules are met. These rules are based on rewarding good WSUD and public open space design. In 2010, South East Queensland Healthy Waterways Partnership - Water by Design completed a discussion paper which expanded upon this notion of crediting WSUD as public open space to establish a framework which may be used to inform public open space policy. The basis of the framework is to ensure new public open space policy ensures WSUD systems are:

- designed well and function properly;
- integrated into public open space to provide amenity and recreational outcomes;
- well connected with surrounding parkland and urban spaces
- safe; and
- easily maintained.

When this is done well then these WSUD systems can be credited as part of the public open space, provided the active recreational function of the public open space is preserved.

POLICY FRAMEWORK: WSUD AS PART OF CREDITABLE OPEN SPACE

The following sections provide a policy framework that can be used to assist revise public open space policy to encourage integrated design of WSUD with parklands. This framework is provided as a suggestion only and is

STORMWATER 2010
National Conference of the Stormwater Industry Association
Conference Proceedings

based on Water by Design (2010) and the draft planning scheme policy no. 12 of the Mackay Regional Council planning scheme.

Local authorities may consider one or all of following WSUD elements as part of creditable public open space provided an integrated design approach is adopted and the criteria outlined in the relevant sections below is achieved:

- Stormwater treatment
- Flood detention storages (and land subject to flooding)
- Waterways and drainage

Stormwater Treatment

The following stormwater treatment systems will be considered for public open space credit:

- Constructed wetlands
- Bioretention systems (or bioretention basins, bioretention swales, raingardens, bioretention systems, bioretention pods)
- Infiltration systems
- Vegetated swales

To be considered for credit, the local authority must be satisfied the stormwater treatment system meets the criteria listed in Table 2 as a minimum. This must be demonstrated by a Concept Landscape and Earthworks Plan that illustrates how each of the criteria is achieved.

Other stormwater treatment systems may be considered for public open space credit provided the systems are densely vegetated (sedges, tall grasses, macrophytes, shrubs or trees), meet the criteria outline below and provide landscape amenity and passive recreation. Local authorities should retain the right to not credit stormwater treatment systems as public open space if other design elements associated with the stormwater treatment system mean the system do not provide a recreational function.

STORMWATER 2010
National Conference of the Stormwater Industry Association
Conference Proceedings

Table 2: Public open space credit criteria for stormwater treatment systems

Design Element or Consideration	Performance Criteria
a) Co-location with active open space	<p>For a stormwater treatment to be considered for contribution credit the system must be co-located and integrated with an adjoining active open space area. The area of potential creditable stormwater treatment is equal to the area of the adjacent active open space area. For example, if a 1ha constructed wetland is located adjacent to a 1ha active open space and the other criteria listed below are achieved, then the full 2ha maybe be considered as creditable public open space. If a 1ha wetland is located adjacent to a 0.25ha active open space then only a combined total of 0.5ha is creditable.</p> <p>For certain park types (district or regional sporting facilities), the area of WSUD treatment shall be restricted to allow the primary function of the sporting facility to be fulfilled.</p>
b) Connection	<p>Clear and legible pedestrian connections must be provided between the stormwater treatment system and adjacent active open space and urban areas. As a minimum, pedestrian access should be provided to a minimum of 50% of perimeter of the stormwater treatment system to promote passive recreation. This pedestrian access must be connected to the active open space areas and any regional pedestrian linkages.</p>
c) Recreational opportunity	<p>The passive recreation opportunities associated with the stormwater treatment system must be maximised through embellishment. Embellishments should be provided at an equivalent rate or funding level as per the adjoining active open space and include boardwalks / pathways, signage, habitat hides, viewing platforms, seating artwork or other embellishments at Council's discretion.</p>
d) Interface (depth, batters and vegetation)	<p>The stormwater treatment system and adjacent active open space must have a strong visual connection and be integrated with the broader terrestrial landscape while ensuring public safety. This requires the following to be achieved:</p> <ul style="list-style-type: none"> • Level difference between adjacent active open space at surface level or normal water level in storm water treatment system to be a maximum of 2.5m. • 1 in 4 batters or flatter • Dense vegetation on batters (sedges, grasses, shrubs and trees) integrated with

STORMWATER 2010
National Conference of the Stormwater Industry Association
Conference Proceedings

Design Element or Consideration	Performance Criteria
	<p>broader landscape with appropriate sight lines for viewing</p> <ul style="list-style-type: none"> • No fences. If design requires fencing at the interface to the stormwater treatment system to manage public safety then the stormwater treatment system cannot be credited as public open space. • No walls. Preference for no walls (Note local authority may consider small walls provided the walls are small, safe and integrated broader landscape)
e) Setbacks	<p>Minimum setback from normal water level of any permanent water or top of extended detention to allotment boundaries shall be no less than 15 m.</p>
f) Pedestrian pathways	<p>It is preferred that pathways be located above the 5 yr ARI flood level. In certain situations Council may allow pathways between the 1yr ARI and 5yr ARI if the applicant demonstrates that the following design criteria are satisfied:</p> <ul style="list-style-type: none"> • Relevant local authority cycleway and pathway design policy • Demonstrated low risk of algal slime formation on path surface • Cross-fall of the path is min. 1:40, max 1:30 • Adequate provision of subsoil drainage and interceptor trenches
g) Engineering design	<p>Design of WSUD elements needs to meet the relevant stormwater management objectives (TSS 80%, TP 60% and TN 45% in South East Queensland) and be in accordance with best practice design guidelines including South-East Queensland WSUD Technical Design Guidelines (Water by Design).</p> <p>For potential inclusion as creditable open space, satisfactory solutions should be developed to demonstrate compliance with engineering criteria:</p> <ul style="list-style-type: none"> • Water depth at normal water level (dry conditions) $\leq 0.5\text{m}$ (can be deeper in open water zones of constructed wetlands) • Water depth under operating conditions (extended detention depth) $\leq 0.5\text{m}$ above surface level or normal water level • Water depth (m) during 20 yr ARI storm event $\leq 1.2\text{m}$ above surface level or normal water level • Flow velocity under any event $< 1\text{m/s}$

STORMWATER 2010
National Conference of the Stormwater Industry Association
Conference Proceedings

Design Element or Consideration	Performance Criteria
	<ul style="list-style-type: none"> • Depth by velocity product under all events $\leq 0.4 \text{ m}^2/\text{s}$
h) Maintenance	<p>Maintenance vehicle access to the site and stormwater treatment system must be provided as follows:</p> <ul style="list-style-type: none"> • Minimum 2.5m width • Trafficable (concrete, compacted gravel or other as agreed to with Council) • Integrated with pedestrian pathway system
i) Crime	<p>As WSUD elements are vegetated, landscape design must consider CPTED principles, e.g. planting, lighting, sight lines, road frontage, and other requirements of the Mackay Engineering Design Guidelines Landscape PSP 15.11. Refer to the Crime Prevention through Environmental Design Guidelines for Queensland (Queensland Police Service, 2007) for more information.</p>
j) Pest management	<p>The risks presented by vectors (mosquitoes) and fauna such as snakes and crocodiles must be considered. Compliance with this criteria is demonstrated by carrying out a risk assessment for any pests that may impact users of the POS. This may include (but not be limited to):</p> <ul style="list-style-type: none"> • Undertaking pest and fauna management plans by experts which includes a risk assessment, monitoring and development of management actions • Incorporating best practice mosquito control design measures as per the guidance provided in the following or local equivalent: <ul style="list-style-type: none"> - Guidelines to Minimise Mosquito and Biting Midge Problems in New Development Areas (Queensland Health, 2002) - Mosquito Management Code of Practice (LGAQ, 2002) • Incorporating buffers such as open turf between vegetated / ponded areas and pathways and properties to improve visibility of fauna such as snakes.

STORMWATER 2010
National Conference of the Stormwater Industry Association
Conference Proceedings

Flood detention storages (and land subject to flooding)

Flood detention storage or land subject to flooding may be considered for public open space credit. Where this is the case, Table 3 outlines the desired flood protection for different types of public open space and Table 4 outlines the design criteria that needs to be achieved as a minimum.

Where a combined flood storage and stormwater treatment system is adopted (i.e. flood storage located above stormwater treatment system) then the criteria outlined in Table 2 and 4 will apply.

Table 3: Desired flood protection criteria for public open space

Feature	Level of flood protection		
	>1 yr ARI	>5 yr ARI	>50 yr ARI
Informal Recreation areas (i.e. turf or planting including non-competitive active recreation)	X		
Pathways and robust fixed furniture	X		
Key pathways, cycle paths and fixed furniture		X	
Car parks		X	
Sporting fields (as used for organised competition)		X	
Sports with fixed surfaces (tennis / basketball / netball)			X
Fixed infrastructure (toilets, BBQs, clubrooms, playgrounds)			X

NOTE: The level of flood protection (ARI's) to be adjusted to suit local authority requirements

Table 4 – Public open space credit criteria for flood detention storage and land subject to flooding

Design Element or Consideration	Performance Criteria
a) Connection	Clear and legible pedestrian connections must be provided between the land in question and adjacent public open space and/or urban areas. As a minimum, 1

STORMWATER 2010
National Conference of the Stormwater Industry Association
Conference Proceedings

Design Element or Consideration	Performance Criteria
	pedestrian access should be provided through the public open space with additional access points provided at regular intervals to promote connectivity.
b) Recreational opportunity	The recreation opportunities associated with the land in question must be maximised through embellishment. Embellishments should be provided as a guide at an equivalent funding rate as per a standard parklands.
c) Interface (depth, batters and vegetation)	<p>The flood storage (or land subject to flooding) and adjacent active open space must have a strong visual connection and be integrated with the broader terrestrial landscape while ensuring public safety. This requires the following to be achieved:</p> <ul style="list-style-type: none"> • Level difference between the surface of the flood storage (or land subject to flooding and adjacent urban zone or public open space to be a maximum of 2.0m. • 1 in 6 batters or flatter for safe maintenance access and ease of landscape establishment. Steeper batters can be proposed if there is a demonstrated need that is suitably treated and these batters only constitute a portion of the flood storage perimeter. Steeper batters are approved at the discretion of Council. • No fences. If design requires fencing at the interface to the stormwater treatment system to manage public safety then the stormwater treatment system cannot be credited as public open space. • No walls. Preference for no walls (Note local authority may consider small walls provided the walls are small, safe and integrated broader landscape)
d) Useability	<p>For informal active recreation (non-competitive) and picnic or similar uses the following applies:</p> <ul style="list-style-type: none"> • Minimum width 30m x 50m • The 1yr ARI must not enter the public open space but rather discharge to the adjacent stormwater treatment system or waterway (or underground storage). Events greater than the 1yr ARI must either backwater or surcharge onto the public open space thus avoiding high velocity flows across the public open space.

STORMWATER 2010
National Conference of the Stormwater Industry Association
Conference Proceedings

Design Element or Consideration	Performance Criteria
	<ul style="list-style-type: none"> • Public open space must be useable within 24 hours after inundation. This will require one of the following <ul style="list-style-type: none"> - Surface grades of 4% or greater - Surface grades of 1.5% to 4% with suitable under-drainage (note surface grades of less than 1.5% will not be accepted)
e) Pedestrian pathways	<p>Pathways should generally be placed about the 5yr ARI. Council may allow pathways between the 1yr ARI and 5yr ARI if the following design criteria are satisfied:</p> <ul style="list-style-type: none"> • The relevant cycleway and pathway design policies are met • Demonstrated low risk of algal slime formation on path surface • Cross-fall of the path is min. 1:40, max 1:30 • Adequate provision of subsoil drainage and interceptor trenches adjacent to pathways
f) Engineering design (including hydraulic design for safety)	<p>For potential inclusion as creditable public open space, satisfactory solutions should be developed to demonstrate compliance with engineering criteria:</p> <ul style="list-style-type: none"> • Design of flood storage needs to occur in accordance with Queensland Urban Drainage Manual or relevant Council flood management policy • No inlet or outlet pipes greater than 100mm in diameter should discharge to the land in question. Stormwater pipes larger than 100mm diameter should outlet into land below the 1 yr ARI flood level (i.e. stormwater treatment system or waterway). This ensures flood waters enter the land in question via 'surcharge' or backwatering (refer Useability). • Any hydraulic structures such as inlet and outlet pipes, grates, pits, and headwalls must provide adequate provisions for safety and in some cases the risk assessment provided in QUDM should be completed. • Public safety must be ensured through compliance with the following hydraulic criteria: <ul style="list-style-type: none"> - Water depth (m) during 20 yr ARI storm event $\leq 0.6\text{m}$

STORMWATER 2010
National Conference of the Stormwater Industry Association
Conference Proceedings

Design Element or Consideration	Performance Criteria
	<ul style="list-style-type: none"> - Water depth (m) during 100 yr ARI storm event $\leq 1.0\text{m}$ - Flow velocity under any event $< 1\text{m/s}$ - Depth by velocity product under all events $\leq 0.4 \text{ m}^2/\text{s}$ - Time from rain onset to water ponding in open space ≥ 15 minutes - Time taken from water ponding in open space to maximum depth reached ≥ 30 minutes - Time taken following inundation for POS to be useable ≤ 24 hours (see Useability)
g) Crime	As per Table 3
h) Maintenance	Maintenance access to the land in question must be as per Table 3

Waterways and Drainage

An important objective of the WSUD and public open space design is the retention of natural waterways and the creation of constructed waterways that provide passive recreation and create pedestrian linkages between open space/public parkland. Local authorities should reward designs which preserve waterways (natural or created) where these waterways are carefully designed to achieve the criteria listed in Table 5.

Table 5: POS Criteria for Waterways and Drains

Design Element or Consideration	Performance Criteria
a) Flooding	The creditable part of the waterway must be above the 1 yr ARI and meet the flood criteria outlined in Table 3.
b) Width	Minimum continuous width of 10m (above 1 year ARI) and must provide for pedestrian pathways and trees for shade
c) Connection	The waterways must connect with active public open space or road frontage on a regular basis. Clear and legible pedestrian connections must be provided throughout the

STORMWATER 2010
National Conference of the Stormwater Industry Association
Conference Proceedings

	<p>waterway and between the connections to roads and active POS.</p> <ul style="list-style-type: none"> • Maximum waterway length between connection with road frontage or active pos is 100m • Minimum 75% road frontage to waterway
d) Preserve existing vegetation	Preserve existing terrestrial and landscape vegetation in accordance with relevant Council policies.
e) Natural Channel Design	Where a new drainage channel is required, design should occur in accordance with the principles of natural channel design for this asset to be credited as public open space. Designers should refer to the <i>Natural Channel Design Guidelines</i> (Brisbane City Council) or other contemporary document for guidance.
f) Rehabilitation of natural waterways	<p>In order to have existing natural waterways credited as public open space, a number of additional criteria must be met:</p> <ul style="list-style-type: none"> • A detailed assessment of the waterway should be conducted to assess the health and characteristics of the stream and the riparian zone which should consider ecological and hydrologic stream health factors and pressures. • Rehabilitation of the waterway must be completed where required. The rehabilitation should be designed and undertaken in accordance with best practice guidance available to the industry at the time of the design including <i>A Rehabilitation Manual for Australian Streams</i> (CRC Catchment Hydrology, 2000) and the <i>Technical Guidelines for Waterway Management</i>. Victorian Department of Sustainability and Environment (DSE 2008).
g) Stormwater outfalls	Stormwater outfalls into waterways and channels must be appropriately designed to consider safety, erosion and waterway processes. As a minimum outfalls should be designed in accordance with <i>Stormwater Outfalls to Waterways</i> (Brisbane City Council).

CONCLUSIONS

The current public open space policy across Australia seems to be promoting the WSUD squeeze. There is a need to revisit this policy position to avoid poor WSUD and open space outcomes. New public open space policy needs to encourage and reward good design by allowing WSUD to form part of creditable public open space. Two important pieces of work have recently been completed by Water by Design and Mackay Regional Council. This paper presents the findings of this work by:

STORMWATER 2010
National Conference of the Stormwater Industry Association
Conference Proceedings

- exploring the issues associated with integrating WSUD into multiple-use open spaces
- identifying the common objectives of good open space design and WSUD
- describing the WSUD squeeze phenomenon and the relationship to current public open space policy
- proposing frameworks and design standards to allow WSUD and flood management features to form part of creditable open space

REFERENCES

Leinster S, Hoban A and O'Neill A (2009), *The Credit Crunch: WSUD in Parks*, Water Sensitive Urban Design Conference, Perth

O'Neill A, Hoban A, and Leinster S (2008), *Urban Sensitive Water Design*, Stormwater Industry Association Queensland Conference, Gold Coast.

Water by Design (2010), *Multiple Use of Open Space – Discussion Paper*