0069 – Non Refereed Paper

On-site versus off-site - the business case for stormwater treatment in infill areas in Blacktown

Mark Liebman[1], [2], Natalie Payne[1], John Molteno [1]

[1] Blacktown City Council, NSW, Australia, [2] Sustainability Workshop, NSW, Australia

Abstract

Since 2006 Blacktown City Council, through its DCP, had required developers to construct treatment measures on-site to achieve best practice. Council had become increasingly aware of a number of problems associated with on-site stormwater treatment systems principally being a concern about the likely lack of maintenance. In the paper we will discuss the actual and perceived problems in detail.

Council recently completed an independent review of its stormwater DCP. The review benchmarked the DCP requirements against other organisations, interviewed industry stakeholders to understand their problems and reviewed DA assessment times and the complexity of the submission process.

Following the review Council developed an action plan. One of the key actions was to investigate the feasibility of constructing off-site centralised stormwater treatment systems in lieu of constructing on site.

This paper documents the feasibility study and the associated business case. It will document the design development of the treatment concepts including the use of very large pump stations and grassy bioretention systems and explain the drivers for these unusual design choices. It will explain how Council modelled development precincts to predict the impact of upzoning under LEP changes and how we determined the quantum of "treatment" required to off-set the pollution.

It will describe the business case and the economic costs of constructing both on and off-site and include full life cycle costing analysis. This will show that the life cycle costs of off-site scheme are likely to be significantly lower than on-site schemes but highlight some of the risks of large centralised schemes.

The paper will also describe the planning mechanism by which the scheme is to operate and discuss the costs and benefits of Section 94 versus a voluntary approach whereby developers would be given a choice to either build on-site or pay a contribution to Council via voluntary planning agreement.

Introduction

Context

This paper deals with infill development; it describes an approach to managing stormwater quality when a vacant lot is developed (i.e. infill) or a brown field site is redeveloped due to upzoning. It does not deal with greenfield development. As such it describes a stormwater retrofit strategy for managing water quality leaving developed (established) brownfield catchments rather than the development of a greenfield stormwater management strategy.

There is often a significant difference between the health of greenfield and brownfield catchments. In brownfield catchments, creeks are often highly degraded due to the extent of directly connected impervious surfaces (Walsh et al, 2005; Tippler et al, 2012) and Blacktown's creeks are no exception (Blacktown City Council, 2014). There has been some controversy and resistance to off-set schemes in greenfield areas and the authors of this paper agree that an offset scheme in a greenfield context would need to be very carefully assessed.

The context at Blacktown and described hereafter is shown in Figure 1 which was extracted from Hoban et al (2014):

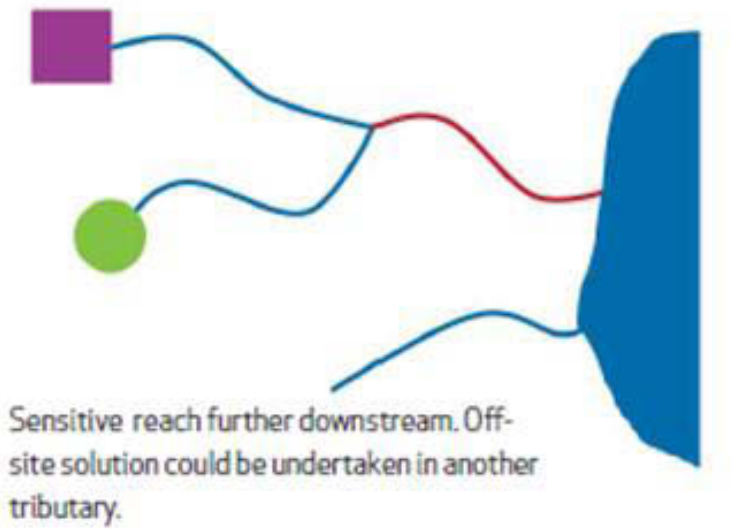

Figure 1 (courtesy Hoban et al, 2014) showing how an offset scheme might work where there is no immediately sensitive downstream receptor. The purple square represents new development and the green square represents a stormwater treatment system on an adjacent developed sub-catchment which does not yet have any treatment.

In the Blacktown context, for local catchments, the percentage of directly connected impervious area in four urban renewal precincts will increase from 57% to 70% (BCC et al, 2014) as a result of planned upzoning and densification. With a baseline of 57% DCI, it is unlikely that further development would cause a

further decline (locally) in either abundance or diversity of macroinvertebrates. However as one proceeds further downstream into higher order creeks the percentage of directly connected impervious area decreases again as predominantly rural catchments are included in the total catchment. This means that downstream, reaches can be more sensitive to development than upstream reaches.

There is agreement with Hoban et al (2014) where it has been found that an offset scheme in a brownfield context can deliver economic and ecological benefits (to sensitive downstream reaches of a river basin). In Figure 1 the red reach can be protected by treatment on either sub-catchment as both are developed.

The caveat to accepting Figure 1 is the proviso that waterway stability issues still need to be addressed (Wong in Cardno, 2015) locally and one way of doing this is via an enhanced OSD system which also features waterway stability controls in its design – for example the latest version of the Upper Parramatta River Catchment Management Trust Handbook, version 4, December 2005 which has extended detention for flows up to the 1.5 year ARI and will come close to achieving a stream erosion index of 1 which is Council's stretch target.

Background

The Blacktown Development Control Plan (DCP) includes water sensitive urban design and integrated water cycle development controls on new development in applicable areas in 2011. This part of the DCP is called Part J (formerly Part R).

At the time the DCP was being prepared, Council was also involved in the development of the North West Growth Centre and the Western Sydney Employment Area both of which had their own DCPs requiring water sensitive urban design (WSUD) on new developments.

In order to create a consistent and complete approach to WSUD across the entire local government area, WSUD was adopted into the Blacktown DCP in 2011. The DCP required new developments to reduce their post development mean annual load of pollution by adopting best practice stormwater treatment targets i.e. 85%, 65%, 45% reductions of total suspended solids (TSS), total phosphorus (TP) and total nitrogen (TN) respectively. Hydrocarbons are also targeted for removal. Business and industrial developments needed to conserve water and reduce their non-potable water demand by 80%.

The WSUD DCP had at its core, a direction from Council's Executives that Council would be unwilling to pay for maintenance of Council owned, centralised stormwater treatment devices as a means of achieving the treatment targets in the DCP. At that time, source control was also a buzz word and a policy directive of the NSW EPA.

With this context, the DCP was framed so that it required new development to achieve the best practice treatment targets by carrying out works on site. Most often this involved the construction of bioretention systems or filter cartridge systems together with traditional on-site stormwater detention (OSD). The 80% non potable water conservation target for commercial and industrial development

is typically met through construction of a rainwater tank supplying non-potable needs. Note that residential development needs to comply with the state government's BASIX water conservation targets and this is also generally achieved by installation of a rainwater tank.

The same principles which have made on-site stormwater detention attractive to Councils also made on-site treatment of stormwater attractive. That is:

- Responsibility for carrying out maintenance would not reside with Council and instead Council embarked on the employment of a WSUD Compliance Officer whose role is to ensure maintenance is being carried out on private developments.
- A costly and lengthy off-site strategic assessment would not need to be developed – the strategy was on-site.
- The on-site approach is defendable from a legal perspective – it is about treating impacts at their source and aims at maintaining the status quo.

The period of time between 2011 and 2014 saw numerous developments in the Blacktown LGA constructed with on-site stormwater treatment systems. A range of responses were applied but the majority of new developments opted for either bioretention or filter cartridges.

However developers and their consultants reported a number of problems complying with the new DCP which are discussed in more detail later but related most often to the time taken to assess the developments and the cost impost.

Extensive stakeholder consultation revealed a negative opinion of the on-site treatment approach with the development community identifying that the policy was flawed because it resulted in the mixing of clean and dirty water in the gutter at the point of discharge and therefore did not achieve the clean water outcome intended (Ryan in Cardno, 2015, Appendix B). This idea resonated with Council planners. There appeared to be little appreciation or understanding by the affected development community (including Council's planners) of a load based pollution control approach. This was a surprising finding as it is the basis of the best practice policy adopted by most Councils and wastewater managers on the eastern sea board of Australia.

In late 2013, in response to mounting pressure from developers and evidence of some poor outcomes, Council funded an independent review of the DA assessment process including a benchmarking of the policy followed by a comprehensive review of the DCP. There was also a strong perception by Council's Officers that maintenance was not being undertaken together with a growing awareness of the maintenance burden which was sometimes being borne by single households which Council was reluctant to enforce. Generally however it is noted maintenance was to be carried out by bodies corporate and business and industrial operators rather than individuals. The 2011 WSUD DCP was prepared at a time when integrated development which features smaller individually titled lots without a body corporate was not as prolific as it has become in the last three years. BLEP 2015 makes allowance for attached

dwellings (row housing) to replace integrated housing but limits this type of development to medium density zoned land where the previous LEP didn't.

Independent Review of the DA Assessment Process – December 2013

Council commissioned a panel of experts, coordinated by Cardno. The panel of experts included Laurie Rose, OAM as a development industry representative, Professor Tony Wong, Chief Executive of the CRC for Water Sensitive Cities and Dr Roberta Ryan who is the Chief Executive of the Australian Centre of Excellence in Local Government and who is a public policy expert with a history of working with the community on stormwater issues. Cardno also carried a time and motion study and benchmarking exercise.

The review included a time and motion study, a benchmarking exercise to compare Council's requirements and assessment times against other similar organisations and face to face and telephone interviews conducted by Dr Ryan with a range of developers and their consultants.

The review found that:

a. When benchmarked against similar "developing" councils and regulatory organisations the performance targets included in Part J were neither too onerous nor too complex.
b. With respect to time – Council's performance is significantly better than the State and Sydney average.
c. When a stormwater assessment is required this increases the time required for a DA by 25% to 30%.
d. The overall assessment time for these developments grew to 100 days which is in excess of expectations.
e. The interviews identified the potential to simplify requirements – e.g. have a deemed to comply solution.
f. From the stakeholder engagement survey there was consensus that it may be Council's rigorous approach to DA assessment of WSUD elements rather than the policy that is too onerous.
g. There were frequent internal changes in philosophy with respect to WSUD assessment and inadequate communication of these changes causing confusion and ultimately delays.

Comprehensive Review of Part R

Following the Expert panel review in late 2013, Council prepared and funded an action plan to implement the advice of the review panel in addition to a range of other measures to comprehensively revise the DCP to both deliver more affordable alternatives and to simplify the DA assessment process for most development applications.

The key actions in the action plan were:

a. Testing the feasibility and costs and benefits of constructing regional, off-site stormwater treatment measures and comparing to the on-site costs.

b. Development of an on-line deemed to comply tool which will enable many developers to submit an on-line deemed to comply solution instead of using MUSIC.
c. Development of standard drawings to support the deemed to comply tool and simplify the assessment process and standard conditions of consent, and
d. Revision of the WSUD Handbook (Blacktown City Council 2013) and incorporation within the Engineering Guide for Development.

The remainder of this paper focuses on point a. above - i.e. testing the feasibility and costs and benefits of constructing regional, off site stormwater treatment measures and comparing to the on-site costs of doing the same.

The Potential Impact of Infill Development

The newly gazetted Blacktown Local Environment Plan (BLEP 2015) defines land uses across the LGA and through densification via up-zoning will achieve the State Government's targets for accommodating a further 55,0000 residents in the infill areas of Blacktown. The development will be focussed around four Urban Renewal Precincts in Blacktown, Seven Hills, Rooty Hill and Mount Druitt.

The impacts of the revised Blacktown LEP (2015) on impervious area and stormwater pollution have been modelled using a GIS and the MUSIC water quality model.

Planned new development in the four Urban Renewal Precincts that have so far been identified by Council will result in an additional 2 million square metres of impervious area and an additional one billion litres of stormwater draining directly to Blacktown's creeks every year.

Table 1, below, summarises the additional pollutant loads that will occur, between now and the mid 2030s, from new development across the four Urban Renewal Precincts in the established areas of Blacktown (i.e. outside of the North West Growth Centre).

Table 1 Additional Pollutant Loads arising from densification

Parameter	Blacktown	Seven Hills	Mt Druitt	Rooty Hill	Total
Flow (ML/yr)	640 (+14%)	132 (+15%)	200 (+8%)	167 (+20%)	1,139 (+13%)
Suspended Solids (kg/yr)	158,000 (+21%)	30,000 (+21%)	41,000 (+11%)	35,000 (+26%)	264,000 (+19%)
Phosphorus (kg/yr)	210 (+17%)	46 (+19%)	71 (+11%)	58 (+25%)	385 (+16%)
Nitrogen (kg/yr)	1,430 (+15%)	310 (+17%)	500 (+11%)	420 (+24%)	2,660 (+15%)
Gross Pollutants (kg/yr)	16,000 (+13%)	3,300 (+14%)	4,600 (+7%)	4,500 (+19%)	28,400 (+12%)

In addition, the increase in pollutant loading will carry significant loads of heavy metals, including Zinc and Copper which are the most toxic elements of stormwater and which directly threaten biodiversity. Plastic particulate pollution is a major emerging pollution issue and is also present in stormwater and consequently in our environment.

While many of the smaller creeks have already been extinguished by urban development and replaced with concrete low flow pipes or channels, the larger receiving waters such as Eastern Creek, Ropes Creek, Bells Creek, South Creek and the Parramatta River have a high value to society and are high value aquatic ecosystems. These are the “red” reaches shown earlier in Figure 1. They are the places where the people of Blacktown recreate and they are some of the last refuges of aquatic life in Blacktown City.

Issues with On-Site Treatment

The 2006 DCP required developers meet their water quality targets by constructing stormwater treatment measures on-site. The measures would then need to be operated by the landowners. Council became aware of increasing difficulties with the on-site approach.

Some of the problems are highlighted below:

- It would take about 30% longer to assess a DA which had a Part R element.
- Many existing on-site systems are simply shoe-horned into developments and decrease liveability. The integrated outcomes sought by the integrated water cycle DCP were simply not being delivered by developers. While the

integration of filter cartridges into OSD systems was common place this does little for reducing heat island effects or reducing flow volumes and protecting waterway stability.

Plate 1 showing how bioretention and OSD are frequently shoe horned into developments and how safety fences isolate them rather than facilitating integration into the development. Image courtesy Steve Araj.

Due to the recent introduction into Blacktown of a water sensitive approach to development many developers lacked the skills and expertise required to achieve a true integrated approach onsite. Additionally smaller developers have not had to traditionally work with disciplines such as landscape architects who understand how to deliver integrated outcomes.

Plate 2 showing a vegetated stormwater system which is not maintained and which sterilises the limited open space on this development. Image courtesy Steve Araj.

- A number of existing systems are very deep and not practical to maintain, for example one bioretention system on a industrial site was 3m deep and had near vertical retaining walls. Not only is light penetration limited but maintenance is going to be extremely difficult.

- In some cases where a site falls away from the street to the rear of the lot, Council has stipulated that the site needed to be regraded adverse to the natural fall to ensure that there would be street access for inspections by Council's WSUD Compliance Officer. This resulted in substantial retaining walls along the boundary which are not just a cost impost on developers they can have a significant impact on neighbours by changing the landform and giving views of walls etc.

- On occasion a developer would elect to construct a filter cartridge system on each lot in an integrated development. This reflected a trend away from strata titled developments where a body corporate would maintain a centralised on-site treatment system toward individual titles on smaller lots. This left a single family responsible for the maintenance of their own system. Often families who buy town houses are first home buyers and are financially stretched in Sydney's over priced housing market. Maintenance of their filter cartridge would be fairly low down on a priority list. It is known that Council would also be politically reluctant to enforce maintenance on these families in

addition to asking for a stormwater levy contribution.

Testing the Feasibility of Off Site Stormwater Treatment Systems

One of four key actions in the Part R review was to test the feasibility and business case for an off-site regional stormwater treatment approach which would be funded by developer contributions and operated and maintained by Council. This involved:

1. Mapping the impacts of the revised LEP on imperviousness and modelling the increase in pollutant loads using MUSIC. Once the pollutant loads were defined, treatment targets for each urban renewal precinct were defined. These are based on Council's current best practice targets again being retention of 85% TSS, 65% TP and 45% TN. This exercise defined how much pollution needed to be removed from the receiving waters.
2. Screening the LGA for suitable spatial opportunities for stormwater treatment. This was done using a GIS and by mapping various constraints to develop a long list of potential projects which was gradually whittled down to a short list of 20 projects through consultation with relevant Council staff who have an in depth knowledge of the LGA. At this stage the pollutant retention capacity of the projects was unknown and it was simply hoped that about 20 projects would be sufficient to achieve the treatment targets and offset the pollution to the degree required by Council's policy.
3. Once spatial locations were refined we began the design process. The designs developed through a genuinely collaborative and iterative approach between Council and its consultant, Footprint Engineering. There was much learning done on key cost drivers and governing constraints.

   Early on the project team learnt that it was going to be more cost effective to pump even up to 2 m^3/s, over short distances, than to excavate large deep holes adjacent to creeks which would be required to allow gravity systems to operate. This was a critical learnt outcome and framed a large number of the final projects. However it is worth noting that wherever we could achieve shallow surface treatment systems using gravity only, these projects were given a higher ranking and were preferential to projects which needed to pump.

   This approach meant that potential projects were not constrained by vertical geometry which until now has been considered a major stormwater retrofit constraint.

   The stormwater industry has traditionally shied away from mechanical pumping systems due mainly to reliability and maintenance cost issues. Modern water pumps practically need no maintenance and are relatively cheap and combined with the digital revolution, pump controls can be

manipulated to deliver carefully controlled outcomes from anywhere and at any time.

Use of complex pumping equipment is not new to Council where we recently gained experience through the design, construction and commissioning of a large stormwater harvesting scheme at Blacktown International Sports Park which uses 4 pump stations and a disinfection system to harvest and reticulate 200 ML/annum.

The relatively cheap cost of pumping compared to earth works is driven by the cost of disposal of virgin earth natural material (VENM) which in turn is impacted by a State Government landfill tax much more than by the actual cost of excavation which is relatively cheap. This holds true even when considering pumping costs over a 50 year life. It also holds true even when considering that a new zone substation may be required to provide the electrical capacity to turn on very large pumps and to then connect the zone substation to the high voltage network.

This means that for example a bioretention system can be located several metres above a creek invert where a pump can raise the creek water into the bioretention basin instead of excavating the basin several metres down to tie into the creek invert.

The other advantages of having stormwater treatment systems raised above creeks is to protect them from flooding and enable them to drain back into the creek system under gravity.

Another key learning related to the distance between the point of extraction/pumping from a creek and a proposed treatment location. If the proposed treatment system was to be located far away from a creek, say more than 100m, it became cost prohibitive due to the high cost of constructing large diameter rising mains.

Another key learning was that there was great potential to co-locate treatment systems on sports fields. Many of Council's sports fields are located in the floodplain and close to creeks. The fields are generally closed during wet weather due to their clay foundations and for some time following wet weather to ensure their integrity and protect them from compaction. This provided the chance to use these spaces to also treat water by using grassy bioretention systems.

Grassy bioretention systems have been used in several locations over the years, at Kiama (Dunphy et al, 2005), at Regents Park by Liebman for Mirvac and at Sydney Smith Park by Peterson for Holroyd Council.

Recent research has shown that, in a laboratory setting, turf is effective for nutrient removal, particularly (TN), with performance better than or equal to species commonly used in bioretention systems such as *Carex appressa* and *Juncus* species (Payne, et al, 2014). These findings support preliminary findings previously reported by Pham et al (2012). In another laboratory study by Barrett et al (2013), turf planted in different

types of filter media was shown to be effective in reducing concentrations of both total phosphorus (TP) and TN. In a field study of two turfed bioretention system in North Carolina, USA, Passeport et al (2011) reported effective removal of TN and TP for both systems.

The proposal is to simply replace the clay based grassy fields with a grassed surface on top of a sand filter media which sits on top of a subsoil drainage manifold. Delivery of water to the surface of the playing fields would be via HydroCon pipes located around the periphery of the fields. A typical system is shown in Attachment 1.

4. Once concept designs for the short list of projects were developed the collective ability of the projects to offset new pollution and achieve the treatment targets were assessed in MUSIC. It was found that the list of projects was sufficient to more than achieve the treatment targets.
5. The short list of projects was again refined and resulted in the scheme selecting 11 final projects to off-set the predicted pollution loads. The projects are located across the LGA but with some focus around Blacktown.
6. The scheme was put forward to Council Executives and a panel of experts for peer review together with two proposals for how contributions could be collected. The first proposal was to collect contributions based on the traditional Section 94 contribution model and the second proposal was to allow developers to elect to either construct works on-site or to enter into a voluntary agreement with Council and pay Council a contribution to carry out the works on their behalf. The second, voluntary approach also initially included a commuted sum for maintenance over the life of the precinct scale treatment systems. This was still more affordable than the capital costs alone of the on-site treatment systems. Council decided not to include the commuted maintenance sum in the voluntary contribution for political reasons. Council equally committed to funding the maintenance of precinct scale systems from rates and from a rate windfall through densification of the LGA.
7. The December 2013 panel of experts was reconvened in December 2014 to carry out a peer review of the business case and feasibility study. They met with Council Executives and the project team and after accepting the merits of the business case and the feasibility study, it was decided to proceed with a Section 94 contributions approach where a Section 94 Contributions Plan would be ready in the near future and to adopt the voluntary planning agreement approach (without any maintenance contribution) elsewhere until such time as a Section 94 Contributions Plan could be prepared. Attachment 2 shows the proposed planning areas – voluntary and Section 94 and the location of the proposed treatment systems.

The Business Case for Off-Site Regional Treatment of Stormwater in Infill Areas

Council has analysed the costs and benefits of an off-site, precinct scale approach to managing stormwater as an alternative to the current on-site approach for each new development.

Under the proposed off-site, precinct scale scheme, it is predicted that by making a contribution to Council in lieu of constructing works on-site, developments in the proposed Blacktown Seven Hills Contribution Plan area would save between 9% and 83%. On average, developers will save 42% of the cost of constructing treatment measures on-site. Developments in the Rooty Hill and Mount Druitt area would save between 30% and 87% and on average save 55% compared to the current on-site approach. Land holding costs would decrease as developments are approved more rapidly.

Collectively, households and bodies corporate and operators of commercial and industrial developments would save $3.8 million per annum as they would no longer have to pay for the on-going maintenance of the on-site treatment systems.

Instead of homeowners and operators paying for maintenance of the on-site systems, Council would need to pay for maintenance of the off-site schemes which would all be located on existing Council land. Council's rate base will expand in line with higher development densities. By 2030, the cost to Council for operation would be in the order of $600,000 per annum. Though the proposed scheme increases costs for Council on long-term maintenance of regional off-site systems, it provides an annual operational cost saving to society as a whole of 85%. Council executive officers consider Council can fund the increased maintenance through a larger rates base which will develop in the infill areas.

The proposed scheme, at its maximum, would involve the construction of about $56 million in stormwater infrastructure.

The proposed Section 94 Contribution Rate is $82,413/hectare of development and the rate under the proposed voluntary planning agreement scheme is $62,890/hectare. The rates differ primarily because Section 94 projects must be located to effect a reduction in pollution of the Section 94 catchment. This restricts where projects can occur. The voluntary planning approach allows projects to occur where they are most efficient and where opportunities are greatest and so are more cost effective.

Actual treatment costs on a per kg basis compared very closely with the more recent costs identified by Melbourne Water for their offset scheme.

Table 2 Costs of Treating each kilogram of pollutant.

Pollutant	Capital cost to remove ($/kg)	Discounted Maintenance Cost ($/kg)	50 year whole of life cycle cost to remove ($/kg)
TSS	62	20	82
TP	41,400	15,000	56,400
TN	5,900	2,400	8,300
Melbourne Water developer off-set cost for TN removal	6,645	N/A	N/A

Table 2 shows the discounted maintenance costs comprise about 25% of the total life cycle cost.

Table 3 below shows the performance of the scheme in relation to current levels of pollutant loads. It is predicted there will be significant reductions in pollutant loads when benchmarked against current (2015) levels.

Pollutant	Treatment Target for new development (% reduction on annual average load)	Overall reduction in pollution compared to the current (2015) levels of development (% reduction in average annual load)
TSS	85	47
TP	65	42
TN	45	39

Table 3 Benchmarking the annual average load reduction of the precinct scale scheme against 2015 levels.

The study found that on-site schemes have a maintenance dominated life cycle profile in that maintenance costs typically comprise at least 50% of the discounted life cycle cost.

The Table 3, below, compares the cost of on-site against the contribution that would need to be made for an off-site scheme to offset the equivalent level of pollution from the development.

Type of Development investigated	Site Area (ha)	Cost under existing on-site scheme	Estimated Cost Under Proposed S94 Contribution Plan	Cost saving (%)	Estimated Cost Under Proposed Voluntary Scheme	Cost saving (%)
13 Townhouses	0.328	$29,750	$27,031	9%	$17,221	31%
25 Townhouses	0.778	$104,380	$64,117	39%	$40,847	53%
6 Townhouses	0.213	$45,500	$17,553	61%	$11,183	71%
Warehouse	0.093	$45,270	$7,664	83%	$4,883	87%
*Commercial	0.347	$47,500	$40,097	16%	$29,718	30%
*Industrial	1.977	$275,900	$177,930	36%	$118,797	49%
50 Townhouses	1.742	$286,700	$143,563	50%	$91,459	62%
			Average saving	42%		55%

Table 3 Comparison of on-site versus off-site stormwater treatment

* The off-site cost for these developments includes an on-site GPT and Hydrocarbon trap because they are larger than 2,000m^2 and zoned business or industrial.

Remarkably we found the full life cycle costs, including discounted maintenance costs, are on average lower for an off-site precinct scale scheme than the capital costs of an on-site approach let alone the life cycle costs. The business case in support of an off-site regional approach (in the infill areas of Blacktown) “is very convincing.” (Wong, in Cardno, 2015).

Discussion and Conclusions

The business case for off-site treatment of stormwater in the established areas of Blacktown City Council has been convincingly established (Wong in Cardno, 2015). The predicted off-site scheme despite costing about $56 million will be 85% more affordable to society as a whole, i.e. taking into account life cycle costs. 11 precinct scale stormwater treatment and harvesting projects will be

constructed to offset the additional pollution resulting from new urban development. When fully subscribed this project would see the load of pollutants reduced from current levels by 47% for TSS, 42% for TP and 39% for TN.

The treatment systems will use a combination of a grassy bioretention and traditional bioretention systems. HydroCon pipes will be used to deliver water to the surface of these large bioretention systems in such a way that it is hoped erosion and smothering of the bioretention does not occur by capturing of fine silts in the pipes. This is a known problem for some existing large bioretention systems.

BLEP 2015 was prepared to accommodate another 55,000 people but it created significant opportunities from a WSUD perspective. The new LEP focuses development in four dense Urban Renewal Precincts. This will concentrate the impacts of development by focusing increases in directly connected impervious (DCI) areas in a smaller number of well developed (57% DCI) catchments to make then 70% DCI. Denser develop also reduces pressure to sprawl and is arguably the best approach one could adopt mitigate stormwater pollution.

A second major advantage of upzoning and densification is the potential for a rates windfall. This rates windfall then generates extra revenue for Council and has enabled Council to then fund the maintenance of Council owned and operated assets. This is a complete reversal of the 2011 position where Council Executives decided Council would not pay for the maintenance of precinct scale stormwater treatments.

This paper highlights the progression of innovative stormwater policy making at Blacktown City Council. The policy adopted in 2011 brings with it much learning and embeds the results of capacity building. The current proposal for an off-site stormwater scheme will in turn be replaced by a better policy in the future as Blacktown transitions to a water sensitive city.

What would a better policy look like? There is currently much debate amongst the stormwater industry about how to best rehabilitate our creeks and what the right metrics are. It is becoming clearer that addressing water quality is only one key action and that it is equally important to address the flow regime (especially flow frequency and preserving low and high flow spells) to prevent creeks from being scoured of their benthos and their invertebrate inhabitants every time it rains.

The proposed off-site approach, as much as possible, has tried to incorporate stormwater harvesting into every design. However as is commonly found there is a deficit of demand for stormwater (Liebman et al, 2011). Urban development produces so much stormwater we can't possibly harvest and reuse it all under the current paradigm. The 11 projects will harvest 300 million litres of water per annum and together with the large harvesting scheme at the Blacktown International Sports Park will see Council harvest nearly half a billion litres of water per annum. The Office of Water however need not be concerned because this will still not be enough to offset the extra 1.1 billion litres of stormwater arising from new development let alone the existing exacerbated catchment

yield. This will limit the effectiveness of this offset approach creating the opportunity for policy improvements in the future.

The proposed offset scheme is predicted to deliver significant economic benefits to society who will save by avoiding significant maintenance costs. It makes logical sense that it will be more affordable to maintain 11 precinct scale treatment systems instead of thousands of smaller systems. The larger treatment systems located in the public domain bring with them other opportunities and benefits for society including better drained, professional quality sports fields. Some of the larger bioretention systems which are not co-located could be vegetated with native ephemeral vegetation and replace much of the melaleuca vegetation which has been lost from Blacktown. Small wet pools within the bioretention systems could provide significant habitat.

The stormwater harvesting and reuse component of this project also brings with it significant benefits. The scheme is predicted to save Council nearly 300 million litres of potable water per year. The value of this water at current Sydney Water prices is predicted to more than offset the $600k operating costs of the scheme.

The planning has also made an allowance for the purchase of solar cells that can be used to offset the energy consumed by the project – making the pumping associated with the scheme greenhouse and cost neutral. If one considers the thousands of avoided vehicle trips associated with maintenance of hundreds of smaller treatment systems then it becomes clear the precinct scale scheme is much more green house friendly.

The off-site scheme is however not without significant risks. While stormwater pump stations in the UK and Holland which pump 4 or 5 cumecs for weeks at a time are not uncommon they have not been tried and tested in Australia. This scheme proposed to pump up to 2 cumecs in places. Such large pumps require their own electrical infrastructure which can cost in excess of $500,000.

It will be interesting to see how the stormwater industry responds in particular to the voluntary contribution planning option which provides a choice for either works on-site in some areas or paying a contribution.

Reality often collides with the even the most rigorous plans. However underlying the scheme is something very valuable, it is trust by both Councillors and Council Executives in their engineering staff to deliver the projects albeit in a modified form if the need arises. This is perhaps an undefined but very significant benefit of many years of WSUD capacity building by dedicated Council Officers.

References

Barret, M. E., Limouzin, M., Lawler, D. F. (2013) "Effects of media and plant selection of biofiltration performance", *Journal of Environmental Engineering,* 139, 462-470

Blacktown City Council (2013) "Developer Handbook for Water Sensitive Urban Design", Version 1.1, November 2013

Blacktown City Council (2006) Development Control Plan (Part J) found at: http://www.blacktown.nsw.gov.au/Planning_and_Development/Plans_and_Guidelines/Blacktown_Development_Control_Plan_2015 on the 29th July 2015.

Blacktown City Council (2015) Local Environment Plan found at: http://www.legislation.nsw.gov.au/maintop/view/inforce/epi+239+2015+cd+0+N on the 29th July 2015.

Blacktown City Council (2014) "Waterway Health Report Card 2013-2014"

Blacktown City Council and Footprint Engineering, Water Quality Management of Infill Development – Feasibility of Off Site Water Quality Controls (Draft). December 2014, unpublished

Cardno (2014) "Development Application Stormwater Operations Review – Draft Report", February 2014

Cardno (2015) Expert Panel Review, Water Quality Management of Infill Development – Feasibility of Off-Site Water Quality Controls, July 2015

Dunphy A, Beecham S, Jones C, Liebman M, Wells J, Michael P, Confined Water Sensitive Urban Design (WSUD) Stormwater Filtration/Infiltration Systems for Australian Conditions, 10th International Conference on Urban Drainage, Copenhagen, Denmark, 2005

Hoban, Patschke, Gooding, O'Neil, Mullaly, Binney (2014) Water By Design, Off Site Stormwater Quality Solutions Discussion Paper – Healthy Waterways QLD 2014.

Liebman, MB, Jonasson OJ, Wiese RN (2011), The Urban Stormwater Farm, Water Science and Technology, 2011; 64(1):239-46

Passeport, E., Hunt, W. F., Line, D. E., Smith, R. A., Brown, R. A. (2009) " Field study of the ability of two grassed bioretention cells to reduce storm-water runoff pollution" *Journal of Irrigation and Drainage Engineering,* July /August, 505-510

Payne, E. G. I., Pham, T., Cook, P. L. M., Fletcher, T. D., Hatt, B. E., Deletic, A. (2014) "Biofilter design for effective nitrogen removal from stormwater – influence of plant species, inflow hydrology and use of a saturated zone" *Water Science & Technology*, 69(6), 1312-1319

Pham, T., Payne, E. G. I., Fletcher, T. D., Coo, P. L. (2012) "The influence of vegetation in stormwater biofilters on infiltration and nitrogen removal: preliminary

findings" *Proceedings of the 7th International Water Sensitive Urban Design Conference,* Melbourne 21-24 February 2012

Tippler C, Wright I. A & Hanlon A (2012) Is Catchment Imperviousness a KeystoneFactor Degrading Urban Waterways? A Case Study from a Partly Urbanised Catchment (Georges River, South-Eastern Australia). Water, Air, & Soil Pollution, An International Journal of Environmental Pollution ISSN 0049-6979 Volume 223 Number 8 Water Air Soil Pollut (2012) 223:5331-5344 DOI 10.1007/s11270-012-1283-5

Upper Parramatta River Catchment Management Trust Handbook, version 4 December 2005, found at http://www.uprct.nsw.gov.au/osd/osd_download_centre.htm on the 29 July, 2015.

Walsh, C. J., Fletcher, T. D., & Ladson, A. R. (2005). Stream restoration in urban catchments through re-design stormwater systems: looking to the catchment to save the stream. Journal of the North American Benthological Society, 24, 690–750