Mainstreaming WSUD in Tasmania – A Model for Achieving Best Practice in Regional Centres

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ABSTRACT

Stormwater infrastructure in Tasmania like elsewhere in Australia has developed historically as drainage and conveyance. In recent years there has been increasing interest in developing a more integrated approach to stormwater management including Water Sensitive Urban Design (WSUD) while continuing to acknowledge the imperative for flood management.

To encourage the uptake of WSUD in Southern Tasmania the government backed Derwent Estuary Program (DEP) as well as its council and business partners have implemented several high profile and award winning WSUD projects around the Derwent estuary. These projects have transpired largely through funding from Australian Government’s grants programs including Caring for our Country, Regional Development Australia Funding and regional Natural Resource Management funding and the engagement of leading stormwater experts including - Storm Consulting, Urban Initiatives and Aquatic Systems Management.

Different WSUD systems have been built or planned to be constructed by mid-2013. This includes wetlands, grassed swales, infiltration trenches and bioretention systems as well innovative WSUD systems not yet used widely in Australia including base-flow wetlands, vegetated gravel trenches and grassed filter strips.

These partnerships and the utilisation of Federal Government competitive grants for stormwater treatment are effective models that could be used by other states and councils in Australia to enhance the uptake of WSUD.

INTRODUCTION

Stormwater infrastructure in Tasmania like elsewhere in Australia has developed historically as a drainage and conveyance system as local authorities have focused on drainage needs and flood mitigation. In recent years there has been increasing interest in developing a more integrated approach to stormwater management while continuing to acknowledge the imperative for flood management. Yet despite increasing awareness of stormwater use and initiatives to reduce water pollution, including the adoption of stormwater best management practices by many councils in the state, there is no established plan or framework to ensure stormwater management is taken up on a consistent and broader basis in Tasmania. This has led to incremental and somewhat fragmented
management approaches with different stormwater practices employed all over state, which create further impact on the quality and quantity of receiving waters (EPA Division, 2010).

To improve stormwater management in Southern Tasmania, the state government backed DEP has a dedicated stormwater project aimed at improving water quality by developing and implementing resources and programs for local government, business, industry, schools and the community.

The DEP has been at the forefront of stormwater management in Tasmania, particularly through coordination of initiatives to reduce stormwater pollution in the Derwent estuary. During the past ten years, the DEP has undertaken a number of projects representing best practice stormwater management (DEP, 2010). These have included:

- Facilitating a Stormwater Task Force (with representatives from all of the greater Hobart councils).
- Coordinating a stormwater and urban rivulet monitoring program.
- Producing Tasmania’s first Water Sensitive Urban Design manual.
- Developing a model stormwater management plan for the region.
- Organising stormwater training workshops and forums.
- Providing advice on grant applications valued at over $1,000,000.

Another goal for the DEP’s Stormwater Project is to seed Water Sensitive Urban Design (WSUD) opportunities in Southern Tasmania. This project aims to encourage and support the uptake of Water Sensitive Urban Design around the Derwent estuary, focusing on high-profile sites providing a balance in pollution treatment and landscape design. The DEP’s stormwater officer has provided assistance/preparation of funding applications, technical advice, tools and training, working with a consortium of expert stormwater designers, engineers and landscape architects. New partners or stormwater champions were sought to implement WSUD projects in a range of settings such as new subdivisions, shopping centres, roads, industrial sites, schools and recreational areas. These stormwater champions ranged from local governments, roads & transport, a university, major industries and commercial/retail operations.

These WSUD partnerships have been very successful with many of these projects built or planned to be constructed by 2013. While others have received substantial Australian Government funding through competitive grants and recognition from environment and landscaping awards. This paper discusses these projects, the partnerships with stormwater champions, consortium of experts and stakeholders. It represents an effective model that could be used in other states by regional authorities and councils to enhance the uptake of WSUD and to achieve water quality improvements and other benefits in their municipality or region.

COMMUNITY COASTCARE WSUD PROJECT

In June 2009 the DEP received a grant from the Australian Government’s Caring for our Country Community Coastcare program for project titled Improving Biodiversity and Water Quality in the Derwent Estuary. One of the project objectives is to increase the application of WSUD through the
implementation and promotion of WSUD at five high-profile sites around the Derwent estuary working in collaboration with industries, roads & transport and education partners, including:

- University of Tasmania at the Sandy Bay campus;
- Southern Water at the Huntingfield Works Depot;
- Cadbury Factory in Claremont;
- Centro Shopping Centre in Glenorchy.

A variety of WSUD projects were to be scoped and designed at these sites, focusing primarily on car park and road run-off, however opportunities to implement green roofs were also investigated at several sites. A consortium of project proponents and WSUD specialists were assembled to develop, share and promote these projects, and at least two on-ground demonstration projects would be implemented as part of this application. The remaining projects were to be submitted for capital funding within the proponent’s respective organisations.

Two engineering consulting firms, Urban Initiatives and Aquatic Systems Management were engaged as the WSUD specialists. They developed a report titled Initial Site Appraisal of Opportunities and Constraints for Using WSUD at Each of Four Sites, prepared in March 2010 and then a Design Development Report. They suggested the following WSUD systems for these project sites.

**Site 1 – Cadbury’s Car-park:** This car park site was on the site for the Cadbury factory in Claremont, Glenorchy. The car park covers an area approximately of 1.6Ha and generally drains to a drain on the south east side. The car park received a high usage with up to 1000 visitors per day. The runoff from this area was likely to be contaminated with a range of pollutants such as nutrients, oils and greases including PAH’s and heavy metals. The concept was developed to harvest and reuse the runoff from the catchment for landscape water or reserve watering. Installation of education and interpretation signage at this high profile site was recommended.

**Site 2 – Centro Glenorchy Car-park:** The site was a large Council owned car park servicing the Glenorchy Shopping Centre incorporating the Centro development and Village Cinemas. The Glenorchy shopping centre is a large site that attracts a high customer use. The car park at this site is almost totally paved and covered approximately 1.1 Ha. The volume of traffic for this site was high. The drainage system has been placed over the pre-existing creek (Barossa Creek). Currently the runoff from the areas discharges to a piped local stormwater system that discharges to the Barossa Creek and thence to the Derwent Estuary.

**Site 3 – Southern Water Depot Car-park, Huntingfield, Kingborough:** This site was a works depot that sits immediately adjacent to Coffee Creek, Huntingfield, Kingborough. Whilst most of the site stormwater is directed to the point of connection at the rear of the site to the existing in-stream retention pond in Coffee Creek to the south east, a number of stormwater drains from the site drain directly to the front of the site and fall via side entry pits in Patriarch Drive. The site had a very restricted footprint with a number of underground and above ground services. An available area identified between pavement and site perimeter fencing was found to be steeply battered. Consequently, the most suitable area for incorporation of WSUD devices was in fact on the neighboring Coffee Creek drainage reserve.
Site 4 – Regent Street Car-park UTAS Sandy Bay Campus: This was a small site at the University of Tasmania, Sandy Bay Campus, but is high profile being next to the student facilities. It was a high traffic zone with a lot of car movements. Further details are provided below.

Two of these projects went on to detailed design for construction: Cadbury’s Car-park and University of Tasmania Sandy Bay Car-park, the remaining projects were to be submitted to the partners for capital funding in the near future.

The first WSUD project, completed in April 2011, was a large bioretention system at University of Tasmania (UTAS) at Sandy Bay in Hobart. This site had a number of challenges for conventional WSUD design. The drainage grade was very steep and is unsuited to standard vegetated swales systems. To further complicate matters, a rivulet passed under the site through a 1200mm diameter pipe and given that the upstream catchment is large, overland flow is an important issue.

A student car park and pavement area around the University buildings - including the forecourt of the Student Café – drained into the proposed WSUD treatment area. Whilst little anthropogenic litter was observed, leaf litter was considered an issue that required management.

To establish an effective WSUD retrofit to service the area the consultants proposed provision of two broad planted swales along the car park to reduce leaf litter from the surrounding vegetation, and the insertion of three kerb drain entries to divert the runoff into the treatment systems. They also recommended provision of cobbled swales with planted sedge margins between the elements. This cobbled channel then discharges along with the final cut from the kerb to an elevated bioretention filter cell built within a rock or gabion wall retaining structure. Under this design, discharge went to an existing drainage pit.

Figure 1. UTas Bioretention System

The design allows the student and wider community will see cobbled drainage lines and broad planted swales while being able to view the planted bioretention filter area.
In November 2011 *Improving Biodiversity and Water Quality in the Derwent Estuary* won the first ‘Tasmania WSUD’ award from the Australian Institute of Landscape Architect. The jury commended the project for its analytical approach and design methodology, which provides valuable insights and support for broader-scale application, and which highlights the value of evidence-based landscape design processes for building community understanding and support for WSUD initiatives.

**Figure 2. UTas Bioretention Filter Cell**

**ACTIONS TO IMPROVE DERWENT ESTUARY WATER QUALITY & AQUATIC ECOSYSTEMS**

Based on the success of the previous project the DEP submitted another application to Australian Government’s Caring for our Country Program Round Three for a project titled *Actions to Improve Derwent Estuary Water Quality and Aquatic Ecosystems*. This application which again was successful and was for major stormwater funding that included both design and construction of all the WSUD and stormwater treatment systems detailed in the submission including:

- Stormwater treatment project at Cleary’s Gates council depot with Hobart City Council;
- WSUD project at Windermere Bay/Box Hill Road with Glenorchy City Council;
- WSUD project at Simmons Park with Clarence Council;
- WSUD project at Mertonvale Circuit with Kingborough Council;
- Enviropod litter trap project with Brighton Council

These projects were all with councils that were within the Derwent estuary, furthermore these councils also agreed to contribute funding to assist with the construction of WSUD/stormwater treatment systems.
The projects for Cleary’s Gates Depot, Mertonvale Circuit and for Brighton Council were all for proprietary stormwater devices, looking at off-the-shelf solutions including litter traps, gross pollutant traps and proprietary filtration devices. The other sites Windermere Bay/Box Hill Road and Simmons Park were parklands or open spaces and consequently had great opportunities for WSUD integration.

To get an informed idea view of the most appropriate treatment option for both these sites the DEP engaged Storm Consulting to undertake a preliminary review considering a number of treatment systems for each site and undertake an assessment and identify those options considered most suitable. For each site a table of the management options was created.

Windermere Bay/Box Hill Road

Windermere Bay/Box Hill it was broadly broken into: pretreatment (GPTs), secondary treatment either subsurface treatment (including vegetated gravel channel, subsurface wetlands, permeable pipe) or surface treatment (including rock cascade/creek, vegetated swale, grassed filter strip). The different scenarios were MUSIC modelled to determine the treatment system requirements to achieve the best practice pollutant reduction and better estimate costs. From the preliminary assessment the following treatment options were short listed.

- GTP + vegetated gravel trench treatment train configuration achieving removal rates of 84% for % TSS, 56% for TP, TN for 14%.

- GTP + vegetated swale treatment train configuration achieving removal rates of 87% for TSS, 55% for TP, TN for 14%.

- GTP + grassed filter strip treatment train configuration achieving removal rates of 90% for TSS, 64% for TP, TN for 23%.

The catchment is quite large and there is not adequate treatment area available to achieve best practice water quality improvement targets. However they did represent a significant improvement in the quality of water discharged to the Derwent estuary which amount to a considerable annual load reduction. Each option would provide similar water quality benefits however will differ on its impact on the landscape.

The preferred option was selected by council based on which is considered to be most consistent with the future plans for the park and giving consideration to land use and maintenance implications. For example the swale and filter strip would require mowing and this cannot occur for some time post a rainfall event. However the gravel trench would require weeding as it will be like a meandering garden.
Figure 3. Options Proposed for Windermere Bay (Storm Consulting Pty 2011a)

Glenorchy City Council chose the gravel trench as it took up the least space and it could be easily maintained by its parks staff and under its current budget. This system is going through to detailed design for construction by mid-2013.

Figure 4. Example of Vegetated Gravel Trench Proposed for Windermere Bay
**Simmons Park**

Tidal inundation through two 900 mm stormwater pipes that run through Simmons Park removed the possibility of ephemeral surface treatments such as swales or bio-retention systems (at the existing pipe level), as well as infiltration systems such as rapid infiltration basins (due to the lack of hydraulic gradient and the affect of salt water on these systems).

The remaining feasible treatment option in Simmons Park was a surface wetland with a downstream hydraulic control which excludes the salt/brackish water inflow. Due to the anticipated depth of the wetland and the complexity of the level control and outlet arrangement the cost involved with the design and construction of the wetland were likely to be high. In addition to this, the size of wetland required to achieve significant water quality improvement was typically around 2% of the impervious catchment area. In the case of Simmons Park the impervious area was approximately 78 ha. This would require a wetland area of around 1.6 ha to achieve "best practice" water quality. As the entire area of Simmons Park was only approximately 2.3 ha, obviously achieving best practice is not a feasible option in this case.

Storm Consulting recommended smaller decentralised treatment systems further up in the catchment would be more effective at improving water quality at the Simmons Park. The road runoff from the adjacent Esplanade Road, entered pits on the park-side connected to the 900 mm pipes or as overland flows into Simmons Park. These park-side pits were located in low lying areas which could easily be modified into WSUD systems, with the existing pit connections acting as the "high flow" bypasses.

There are four separate areas of Esplanade Road which appear to drain directly to Simmons Park with surface areas of approximately 1100 m$^2$, 850 m$^2$, 530 m$^2$ and 1200 m$^2$ respectively. This was a total area of approximately 3,700 m$^2$ of runoff that could be intercepted and treated with WSUD systems. Options for the WSUD systems for these areas included:

- Drainage via swale. The disadvantage of this option was that it would remove the water from the landscape. This may, in the long term, affect the health of the existing trees in this location as they have grown accustomed to receiving some runoff from road runoff. For this reason this option was discounted.

- Swale and Bioretention, only suitable for 530 m$^2$ catchment. A narrow swale would convey water towards the existing grated pits with a bio-retention system created at the downstream end.

The preferred option for all of Esplanade Road was an infiltration trench system. This would comprise an engineered trench which would provide subsurface storage for water (either through fill material porosity or, through the use of a propriety product such as stormtech arches). This subsurface water could infiltrate to the landscape over an extended period. This would reduce surface runoff and would provide beneficial soil moisture to current and future landscaping within the area. The infiltration trench would be located within the existing road verge along the park boundary.
The surface of the infiltration trench would comprise a shallow depression extending along the area. The longitudinal surface of the infiltration trench would be stepped to provide "perched" water at the surface during rainfall events which would significantly increase the length of time available for road runoff to infiltrate into the landscape. The infiltration trench could be landscape planted or grassed depending on Clarence Councils requirements and maintenance expectations. High flows that exceed the infiltration capacity would be diverted to other catchments with infiltration trenches and subsequently discharged to the existing 900 mm pipes at the location of the existing grated pits. Alternatively the high flows can spill out of the surcharged infiltration trench and flow in a dispersed manner through the park similar to what occurs no in normal rainfall events.

The infiltration systems proposed by Storm Consulting for the runoff from Esplanade Road provided a good example of the type of decentralised treatment systems that could be promoted for use further up in the catchment and elsewhere within Tasmania/Australia. It was also a system that fitted well in the current grant budget. For these reasons Clarence chose this option and will be doing the detailed design for construction by mid -2013.
REGIONAL DEVELOPMENT AUSTRALIA FUNDING – GLENORCHY’S GASP! Project

One of DEPs partner councils - Glenorchy City Council has received two grants from the Regional Development Australia Funding for the Glenorchy Art & Sculpture Park (GASP!), located on public foreshore at Elwick Bay. A new 2.5 km boardwalk and foreshore paths, pavilions and amenities has been built and further boardwalks and a new ferry jetty planned through 2012. As part of the GASP! Project stormwater from surrounding foreshore areas would be managed and treated.

Humphreys Rivulet has poor water quality and discharges to Elwick Bay adjacent to Grove Reserve. DEP requested determination on the feasibility for a proposed wetland in Grove Reserve. Storm Consulting were engaged to undertake this assessment to enhance the quality of water flowing onto the Derwent estuary from Humphreys Rivulet as well as enhance the aesthetic values of the site and education opportunities.

A wetland was considered inappropriate for storm event flows as the available area is inadequate for the size required. However, elevated levels of nutrient, particularly nitrogen, were observed in the base flow of Humphreys Rivulet. Adequate land area was available in Grove Reserve to treat these base flows.

The Humphreys Rivulet has low gradient as it nears Elwick Bay. Therefore getting water from the Rivulet, into the wetland, then drain back into the Bay would be a challenge. The easy solution is to simply install a sump and pump the water across to the proposed wetland. However, this can increase costs considerably especially operational costs. The ideal hydraulic configuration would be one that is driven by gravity. That means the off-take from the Rivulet would need to slide upstream far enough to overcome head-loss in the off-take, treatment and delivery system. Each component is described in detail below:

**Rivulet Off-take:** Designing this off-take must deliver the design flows however the key issue is sediment loads coming down the Rivulet can smother and block the off-take. The off-take device must allow flooding over the top and cannot be a hydraulic control that will raise flood levels in the Rivulet.
The solution proposed was a concrete spoon drain on the stream bed perpendicular to the direction of flow. The drain was configured with a dual outlet to the GPT to cap driving head required to deliver the design flow rate. Trash bars will prevent debris from blocking the inlet. The profile of the spoon drain is configured to allow flushing of any sediment accumulating in the drain and is at bed level to negate any hydraulic impacts. The gradients are subtle to achieve this however the overall concrete area is limited to minimize the footprint of the structure.

**Gross Pollutant Trapping:** The device must have minimal head-loss, be effective at retention of sediment and litter and be located to allow easy access for maintenance.

Based on these criteria a CDS GPT by Rocla was selected for the site. It is located in public grounds and treats the design flow rate. Appropriate maintenance of this device will minimise blocking of the pipeline and the need for sediment removal in the wetland.

**Pipeline:** The key issue with the pipeline is crossing Brooker Highway. Traffic disruption during construction should be minimized and there are both existing and proposed multi services with potential vertical conflict. Sediment accumulation in the pipe is also a potential issue.

The solution is to install a small diameter pipe to minimize construction cost. This pipe was less than typical minimum diameter stormwater pipe which can attract blocking issues with debris. To compensate an upstream GPT is proposed to remove any potential blocking materials. Horizontal boring is proposed under the highway to minimize traffic disruption. The smaller pipe diameter reduces the potential for vertical conflict with services along Brooker Highway. However, a concept was provided where pits on either side of the highway allow a pipe to be constructed underneath all the services. There is potential for sediment to accumulate in the pits and pipe connecting therefore upstream sediment retention is very important as well as facilitating occasional maintenance of the pits.

**Wetland:** The purpose of the wetland is to create pleasing aesthetics whilst removing nutrients, particularly nitrogen.

The solution was to create a free water surface wetland. Nitrogen requires both nitrification and denitrification process to occur to eventually convert the nitrogen into its gaseous form and be released into the atmosphere. To optimize this process in a free water surface wetland 3 cells were proposed. Creation of high oxygen areas with cascades between wetland cells and creation of low oxygen areas with deeper water zones to encourage nitrification and de-nitrification to eventually convert the nitrogen into its gaseous form and be released into the atmosphere. Sediment removal is proposed in a GPT which allows us to maximize the area for nutrient removal.
The Grove Wetlands proposal was submitted as a project for Caring for our Country Round 4 and another wetland is proposed for Stage 2 of the GASP! Project.

**SMALL GRANT PROJECTS – SORELL FILTER STRIP**

A thirty minute commute East from Hobart is Sorell Council, within this council area was Orielton Lagoon, one of ten Ramsar sites (wetlands of international importance) in Tasmania. Natural Resource Management (NRM) South provided the council with a small regional grant (~$20,000) to
protect Orielton Lagoon from stormwater pollution. Sorell Council engaged Storm Consulting to develop a suitable solution and design. This was detailed below.

The key issue was to achieve water quality improvements with a limited budget of $20,000 for both design and construction. Typically with a small construction budget designers reduce construction costs, however designers must be more considered in the solution which typically involves more hours and therefore a higher fee. In this case it was both the design fee and construction budgets that were extremely limited. Therefore we needed an effective solution quickly that would require little documentation yet not create significant construction risks with limited documentation.

Gross pollutant traps are typically used to reduce the pollutant load to the receiving waters. Although some litter was noted at the outlet the budget did not allow for installation of a GPT device which could easily cost double the entire project budget. In these cases the trade-off is to increase the burden of maintenance which normally results in higher maintenance costs.

The solution was a grass filter strip with associated level spreaders. The primary pollutants would typically be dissolved pollutants typical of stormwater including nutrients, hydrocarbons, heavy metals, etc. Some sediment and litter was also noted at the outlet. Sediment trapping is achieved in a concrete structure that is also a level spreader. The energy of the stormwater inflows is dissipated as it is spread and this is where most of the sediment settles out. There may be some finer sediment trapped in the grass filter over time, particularly at the upstream end. This will be monitored and removal undertaken only if necessary.

The grass filter strip is an effective treatment system for stormwater quality improvement. It is like a swale however it is very broad and flat so that most of the flow volume passes through the grass at shallow levels. The level spreader ensures the flows are uniform across the grass filter strip to maximize treatment potential.
A collector structure at the downstream end ensures there are no nick points establishing by essentially acting as a level spreader in reverse. The concentrated flows are then diverted to the original outfall via rock armouring. The larger storm events will simply pass over the top of the grass which will armour the bed. Erosion in these large events is not expected to be significant.

Grass filter strips are not common in Australia. The closest elements are swales or buffer strips. The same principles apply for water quality improvement however the grass filter strip maximizes the potential. There has been some research undertaken in USA on these devices and the results for water quality improvement have been impressive. However there are no design guidelines for these systems so an estimate of performance has not formally been made. Based on the research in USA the author suggests that BMP targets would easily be met for sediment and nutrient if regular maintenance is undertaken.

The Sorell Filter Strip was built in late-2011 and has been monitored and maintained by council staff.

**Figure 5. Sorell Filter Strip construction complete**

**CONCLUSION**

WSUD is being increasingly applied in Tasmania as a way of minimising the impacts of urbanisation on waterways and estuaries. The DEP has provided significant impetus for the adoption of WSUD in Tasmania supporting a variety of projects across Southern Tasmania. During the past eight years over forty major WSUD systems have been installed by local councils and industry within the Derwent estuary region. Many of these projects were supported in part by Australian Government grants, in particular Caring for our Country and Regional Development Australia Funding.
Unlike other states, in Tasmania there has been no State Government funding directly available to councils for the development and implementation of WSUD. Consequently the use of Federal Government competitive grants for stormwater treatment has been a major influence in getting WSUD projects built in Tasmania.

The DEP strategy of applying and receiving Federal Government competitive grants and then working in partnership with stormwater champions including councils, businesses and engaging leading stormwater experts has facilitated many innovative and cost-effective WSUD projects and some of these have been recently recognised by Australian Institute of Landscape Architects as best practice for Tasmania.

It is also a very effective model that could be used by other states and councils in Australia to accelerate the implementation of WSUD where funding, resources and expertise are limited.

REFERENCES


