Design and Performance of Stormwater Control Measures for Stream Protection

Little Stringybark & Dobsons Creek Projects
Fact Sheet Series: 6

The Little Stringybark Creek (LSC) and Dobsons Creek projects were long-term catchment-scale experiments designed to test if Stormwater Control Measures (SCMs)—primarily rainwater tanks, raingardens and infiltration systems—applied across an urban catchment can help restore stream condition. Commencing in 2008, the projects were led by The University of Melbourne and Melbourne Water, in collaboration with local government, industry, and property owners. We monitored changes to stream water quality, hydrology, and ecology (Fact Sheet 10), and also assessed techniques for local government collaboration (Fact Sheets 3 & 4), community engagement (Fact Sheet 5), as well as SCM design, performance and maintenance (Fact Sheets 6 & 7).

About the fact sheets

These fact sheets summarise our scientific and practical findings and insights on catchment-scale stormwater management over the long-term LSC and Dobsons Creek projects. We hope that they might inform and guide the planning and delivery of future waterways management projects for improved stream health.

Installing SCMs

The two projects collectively constructed close to 1,000 SCMs (620 at LSC and 372 at Dobsons Creek). The majority of these were located on private land and mainly consisted of rainwater tanks designed for water harvesting for reuse (e.g. toilet flushing) and localised infiltration. Participation by homeowners was encouraged through multiple incentive programs (see Fact Sheet 5). Public land installations included a wider variety of SCMs such as rainwater tanks, raingardens, vegetated infiltration basins, swales, and membrane filters. These public SCMs were designed, constructed, and operated in collaboration with local government and varied in surface area (2 m^2- 1900 m^2) and the area of impervious surface they treated (80 m^2- 5 ha).

Findings and insights

1. Be willing to adapt the design of SCMs
2. Plan for the unexpected
3. Balance the form and function of SCMs
4. SCM performance is strongly influenced by local sub-surface conditions
5. Build resilience into an SCM network
6. Use a mix of SCM types for better outcomes
7. Observe SCM performance in action.
8. Retrofitting an urban catchment can be expensive and challenging
9. Look for opportunities to install lower cost or simplified SCMs
10. SCMs should selectively pre-treat different sediment types

See over for more details


Infiltration raingarden
Wicks Reserve, The Basin

Melbourne Waterway Research-Practice Partnership
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1. Be willing to adapt the design of SCMs. As our knowledge of SCM performance, maintenance requirements, and public acceptance improved over time, we applied our learnings to adapt and tailor the designs of SCMs to suit individual site conditions. These adaptations made SCMs easier and cheaper to install, and perform better, with less required maintenance. For example, the use of slow-release rainwater tanks (designed to release captured water very slowly to adjacent garden or lawn areas) was a response to the challenge of maximising demand for harvested water and meeting infiltration targets on private land. Slow-release tanks were a more cost-effective and space-efficient solution than a combined tank and infiltration system. In another example, the inlets for roadside SCMs were redesigned to be steeper, to reduce the frequency of stormwater bypassing them due to sediment build up.

2. Plan for the unexpected. Every effort was made to ensure that SCMs would function as designed, well into the future. However, in practice, various situations compromised their expected (modelled) level of performance. Issues like poor construction techniques, changes in the local catchment conditions (e.g. newly topped gravel driveway), discovery of civil infrastructure (e.g. gas pipes) and environmental factors (e.g. local soil conditions) all unexpectedly influenced the performance of SCMs. The project team learnt to manage expectations on SCM performance and be prepared to make changes during or post construction. Importantly, contingency funding should be available for situations where additional or rectification works are required.

3. Balance the form and function of SCMs. The visual appeal of any SCM on public land is the primary relationship most community members (or residents, in the case of SCMs on private land) will have with it. To establish and maintain community support, it's important that SCMs are aesthetically pleasing. This includes keeping them well maintained (e.g. weed and litter removal). However, an SCM's visual amenity should not come at the cost of its functionality. In the LSC project, the inlets for the first curbside SCMs were rock-lined to make them visually appealing. However, the rock hindered the removal of accumulated sediment, creating a significant maintenance barrier and resulting in poor performance. Retrofitting these SCMs with concrete inlets made them significantly easier to maintain and were accepted by the community.

4. SCM performance is strongly influenced by local sub-surface conditions. Infiltration rates varied significantly across the catchment in both projects. Some of these differences are due to natural variation in soil characteristics, but it may also be a result of engineered modification of the catchment, including the 'urban karst' (Bonneau et al. 2017), which results from human-made subsurface pathways (e.g. stormwater and sewer pipes and associated high permeability trenches). As a result, the infiltration rates of SCMs were found to be highly variable. The choice of SCM design should consider the local soil characteristics and sub-surface infrastructure. For example, a proprietary passive watering system installed on nature strips was found (after monitoring) to be ill-suited to the predominantly heavy clay soils of the LSC catchment (in Mount Evelyn). Additionally, infiltration systems were found to be less effective when positioned close to the stream or in a flood plain, where higher sub-surface water levels reduced the potential for infiltration.

5. Build resilience into an SCM network. It is reasonable to expect that a network of SCMs will, from time to time, experience reduced performance in one or more SCMs. Issues such as undetected or unresolved maintenance issues, storm damage, system age, design failures, staffing changes, and reduced maintenance budgets can all impact the performance of SCMs. Even when the LSC project was at its peak, with intensive monitoring and strong support and participation from project partners, some components of the SCM network were non-operational, sometimes for significant periods (up to 12 months). It is important to plan for performance interruptions and build an SCM network with sufficient resilience such that the short- or long-term occurrence of individual, non-operational SCMs does not compromise the network's ability to achieve its overall performance objectives. Establishing a treatment train (a sequence of SCMs) so that stormwater passes through multiple treatments is one way to approach this. Alternatively, managers could build more (or larger) SCMs than required or use a variety of SCMs in the network that have different likely causes of failure (e.g. sediment deposition (clogging) vs. mechanical failure). To address the risk of reduced maintenance budgets, the management costs for SCMs could be shared across multiple agencies. Finally, it is important to note that building resilience into an SCM network does not remove the need for a sound maintenance program; it simply provides a buffer in the system, so it can cope with any delays in addressing non-operational SCMs.

6. Use a mix of SCM types for better outcomes. Each type of SCM (e.g. rainwater tanks, infiltration basins, curbside swales, street trees, raingardens, porous paving) has its own strengths and limitations with respect to cost, ease of maintenance, and potential to deliver environmental benefits. For example, streetscape systems have great potential to intercept, detain and infiltrate large amounts of stormwater, however both projects found that they had limited capacity to reduce runoff volumes due to the lack of a nearby demand for water. In contrast, the rainwater tanks installed on private land were able to reduce runoff volumes because they were co-located with regular water demands (e.g. toilet flushing, washing machines). Similarly, works on public and private land each have their own benefits and drawbacks. The work in Dobsons Creek catchment was found to be most effective with a mix of works on public and private land. The streetscape and parkland retrofits were cheaper to implement than the SCMs installed on private land, but these on-lot solutions have negligible operation and maintenance costs for the agencies because they are managed by the property owner (although there is a risk to this, see Fact Sheet 7).

7. Observe SCM performance in action.

Inspecting an SCM during a rainfall event can reveal much about its performance that would be missed post event (or not be identified from design drawings alone). An ‘in action’ site visit provides an opportunity to observe the movement of stormwater in, over or around the SCM, helping to reveal and identify the cause of existing and potential performance strengths and weaknesses. Ideally, such observations should take place for both large and small rainfall events, and regularly enough to ensure that, for example, changes in the catchment or the age of the SCM have not altered performance. Alternatively, if in-person visits are not feasible, cameras could be installed to monitor SCMs over multiple events.

8. Retrofitting an urban catchment can be expensive and challenging.

Despite projected economy-of-scale cost savings and cost sharing with private property owners, retrofitting the LSC and Dobsons Creek catchments with SCMs was an expensive and time-consuming undertaking. Catchment-scale retrofits therefore might best be reserved for high priority areas (e.g. catchments that have retained high ecological value or are more susceptible to flooding). Alternatively, catchment-scale retrofits could be progressively implemented as infill development and renewal works occur in existing urban areas. Nonetheless, management authorities should consider that it is both cheaper and more feasible to implement SCMs when urban development first occurs.

9. Look for opportunities to install lower cost or simplified SCMs.

The LSC project installed a number of simple, low-cost SCMs in an attempt to maximise the treated catchment area within budgetary constraints. This was made possible by looking for novel ways to reduce design and construction costs. Some examples include developing standardized design drawings for frequently constructed SCMs and minimizing the depths of excavations (i.e., building up rather than down and reusing excavated material on site). The performance of these systems was comparable to, and sometimes exceeded, the more complex and costly designs.

10. SCMs should selectively pre-treat different sediment types.

Coarse-grained sediments, such as sand and gravel, are important for stream structure and health but they are often trapped within SCMs and removed as waste. Conversely, silts and clays often pass through SCMs and negatively impact the receiving waterway. It is these fine sediments that should be retained, along with the contaminants and nutrients often bound to them. Where possible, SCM design should consider opportunities for passing coarse-grained sediments whilst retaining fines, for example, through the use of selective screens or grates.

For more details on the outcomes of this project, please refer to:

- Walsh, C. J., D. G. Bos, M. J. Burns, M. Imberger and T. D. Fletcher (2023), “Restoring the health of urban streams through stormwater management: A synthesis of the Little Stringybark and Dobsons Creek research projects”, Technical report 23.2, Melbourne Waterway Research-Practice Partnership.
- Bonneau, J., T. D. Fletcher, J. F. Costelloe and M. J. Burns (2017). "Stormwater infiltration and the ‘urban karst’ – A review." Journal of Hydrology 552: 141-150.
- Bonneau, J., Fletcher, T. D., Costelloe, J. F., Poelsma, P. J., James, R. B., & Burns, M. J. (2018). Where does infiltrated stormwater go? Interactions with vegetation and subsurface anthropogenic features. Journal of Hydrology, 567, 121-132.
- Fletcher, T.D. & Bos, D.G. (2023) Stormwater infiltration: insights and guidance from 10 years of research. May 2023. Melbourne Waterway Research-Practice Partnership Technical Report 23.1
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