August 2019

Uniclass L534:L217

- Project re-visit 13 years after completion
- Independently monitored over a 3-year period
- Lower construction & maintenance costs
- Robustness & low-maintenance of permeable paving

# LAMB DROVE
# DEMONSTRATING SUDS WITH PERMEABLE PAVING

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Interpave
THE PRECAST CONCRETE PAVING AND KERB ASSOCIATION

# Introduction

**The Lamb Drove SuDS Monitoring project in Cambourne, Cambridgeshire, is important for a number of reasons.**

**Despite the modest size of the site, it demonstrates the use of as many Sustainable Drainage System (SuDS) techniques as possible, including concrete block permeable paving, used in combination with other elements to form an effective management train.**

**Despite being retro-fitted to a conventional housing layout, the SuDS are fully integrated with the landscape and have proved to be effective in managing rainfall as well as popular with residents.**

**Perhaps most importantly, it demonstrates that SuDS work and should cost less than conventional piped drainage in terms of construction, maintenance and whole-life costs. It also highlights the robust performance of concrete block permeable paving with minimal maintenance requirements – and lower whole-life costs.**

## Background

Completed in 2006, Lamb Drove was selected as a SuDS Showcase project within the FLOWS (Living with Flood Risk in a Changing Climate) programme funded by the European Regional Development Fund (ERDF). Cambridgeshire County Council subsequently commissioned Royal HaskoningDHV to carry out a SuDS monitoring project from 2008 to 2011, measuring the performance of the SuDS over time.

This research aimed to assess the outcomes of using various SuDS techniques in a management train, compared with those of a conventional piped drainage system nearby.

This case study replaces Interpave's May 2012 *Permeable Paving Case Study – SuDS in Cambridgeshire, Comparing Costs and Performance*. It includes photos and observations from a 2018 site visit, made by Interpave with the SuDS designer Bob Bray (Robert Bray Associates), for comparison with others taken in 2012. The cover photos were taken in 2018 (12 years after completion).

Typical measurement equipment used for the SuDS monitoring project.

## Context

Cambourne is a settlement located on high ground and its surface water runoff contributes to a watercourse that has caused flooding to nearby villages. By agreement with the Environment Agency, runoff from Cambourne is limited to the greenfield rate of 2 l/s/hectare (development area).

The Lamb Drove 'Study Site' is around one hectare and contains 35 dwellings owned and managed by CHS Group. It has been compared with a conventionally drained 'Control Site' (see page 9) that is similar in size, density and location.

The Lamb Drove site slopes down from north-west to south-east and is bounded by a public footpath to the north and a proposed golf course to the east. Ground conditions are largely impermeable clay.

## SuDS Design

The SuDS scheme was designed by Royal HaskoningDHV with Robert Bray Associates and applied to an existing, conventional housing layout based around two cul-de-sacs. Two SuDS management trains serve distinct sub-catchments A and B (shown in separate site plans), incorporating the following SuDS techniques:

- Concrete block permeable pavements
- Water butts
- Green roof
- Swales
- Filter strips
- Underdrained swales
- Detention basins
- Retention pond.

## Sub-catchment A Site Plan

## Retrofit Layout

Despite the spatial constraints of retro-fitting SuDS to a conventional housing layout, natural flow routes have been optimised through the site for low and high flows, as well as for exceedance. SuDS have been integrated with landscape design adding amenity interest and biodiversity to an otherwise unremarkable scheme, and a holistic approach taken with the design.

Underdrained swales have been used for dry surfaces near homes while swales elsewhere provide opportunities for wildlife.

## Concrete Block Permeable Paving

Concrete block permeable paving was chosen as a SuDS source control and robust pervious surface for the two distinct access roads. It collects, cleans and stores the most polluted runoff from the site. There is a flow control on each of the two permeable paved access roads to optimise water storage, reducing the need for additional storage further down the site.

Although other Interpave case studies have demonstrated the potential for permeable paving to accept roof water, it was previously agreed that roofs would drain via conventional piped drainage directly to on-site swales and basins. However, other impermeable areas, such as driveways, simply discharge onto the concrete block permeable paving.

## Sub-catchment B Site Plan

## The Designer's Perspective

**Bob Bray of Robert Bray Associates discusses the SuDS design at Lamb Drove.**

The FLOWS Project at Lamb Drove provided a unique opportunity to demonstrate the principles and practice of SuDS on a relatively common type of housing layout, with a dwelling density of 35 houses per hectare. The SuDS design was unusual for its time and is still an exemplar in that runoff is collected at, or brought to, the surface before flowing naturally as a temporary stream through the development.

Source control – using concrete block permeable paving and underdrained swales – proved essential to ensure that only clean water reaches surface SuDS features, including amenity space and wildlife areas. Pipes have only been used as short connections between SuDS features, not as the main conveyance system for runoff.

Although the basic layout had been previously agreed for planning purposes, it was still possible to design two rainwater sub-catchments, each with a sequence of SuDS techniques in series to form 'management trains'. These everyday flow routes through the development were supplemented by overflow routes and exceedance pathways to protect the community in the event of blockage or exceptional rainfall events.

As water travels through the development it is important that it can pass slowly from one SuDS feature to the next. This slow flow requires different inlet and outlet designs, that allow flow control mechanisms where necessary, and an overflow or exceedance route for very high flows. Our design involved protection of the inlet and outlet with a steel basket filled with stone. This simple device prevents blockage by large floating debris, such as plastic bags and leaves, and has now been used on many sites without report of blockage.

It was possible to integrate all the SuDS components into a coherent landscape design so that residents can understand how the system works and site management is obvious, simple and cost effective. The idea of 'passive maintenance' assumes most care required for the SuDS is general site maintenance, including litter collection, grass cutting and sweeping of hard surfaces. Inspection and cleaning of inlets, outlets and flow controls remains the only dedicated SuDS management.

The monitoring exercise is the most thorough undertaken in the UK to date and confirms not only that the SuDS manage flows, volumes and water quality effectively but also that residents like the SuDS environment as it slowly matures into the future. Considering that the SuDS at Lamb Drove demonstrate a 10% cost saving over conventional piped drainage, are simple and cost effective to maintain and that the enhanced performance has been confirmed by 3 years of detailed monitoring, it is surprising that the SuDS approach has been so long in gaining general acceptance in the development community.



Underdrained swales pass between homes and are kept in good order with simple maintenance. Some also provide exceedance routes to open space beyond.

## Permeable Paving Over Time

The Monitoring Report confirms that only limited manual sweeping of the permeable paving has taken place – less than originally specified. In addition, it was noted that a part of the pavement may have been heavily mechanically cleaned by a road sweeper in error. It is important to exclude permeable paving from inappropriate operations that remove the 2/6.3mm aggregate jointing material (maintenance guidance is available from Interpave).

Nonetheless the Monitoring Report concludes that: *"The permeable pavement infiltration study specifically illustrates the robustness of the performance of this feature to limited maintenance. The infiltration capacity of the permeable pavement is able to adequately cope with the highest recorded rainfall intensity at the Study Site."*

Monitoring of pollutants, biodiversity and resident satisfaction is testament to concrete block permeable paving delivering a gradual flow of treated water to open SuDS features further down the management train.



Concrete block permeable paved carriageway in Catchment A, accepting runoff from conventional block paved drives and parking areas. Concrete kerbs laid flat delineate road edges.




***" Source control – using concrete block permeable paving and underdrained swales – proved essential to ensure that only clean water reaches surface SuDS features, including amenity space and wildlife areas "***


Conventional block paved road, driveways and parking areas in Catchment B all drain onto the permeable paved central carriageway.


## SuDS Over Time

An Environment Agency requirement of 2 l/s/hectare has been achieved locally using open space for the enjoyment of residents and without recourse to additional measures. The project demonstrates the real value of integrating SuDS with public open space and their capabilities to deliver a controlled flow of clean water at lower costs.

The SuDS design at Lamb Drove was designed to be easily looked after and generally as part of everyday site maintenance. Most of the work required can therefore be considered as site care rather than dedicated SuDS maintenance.


Water is retained in Basin B, a landscaped area for amenity and wildlife. Residents and visitors are informed about the SuDS scheme and how it works by a graphic still in place today.


Wildflower meadow planting, prior to annual cut and removal of vegetation to 'wildlife piles'.

## The Control Site

Friar Way is a similar size, density and layout to the nearby Study Site, Lamb Drove. It is served by a central access road with two lateral parking courtyards, all paved with impervious materials. A 'country footpath' bounding two sides of the site provides the only soft landscape and tree planting. Within the site, public space is ill-defined and of little amenity value, particularly the two unloved 'courtyards' used for sporadic car parking and inappropriate material storage.

All hard surfaces drain into numerous gulleys, piped directly to main drains. This arrangement provides no water attenuation or storage, or removal of pollutants from runoff. The development is a clear illustration of missing an opportunity to introduce multi-functional SuDS, particularly bearing in mind cost savings, as outlined in BS8582:2013, *Code of practice for surface water management of development sites and The SuDS Manual (2015)*, as confirmed by the Monitoring Report.

The access road is characterised by continuous asphalt surfaces, served by numerous road gulleys discharging directly to piped drainage.

The impermeable block-paved courtyards offer negligible amenity value and no green space – a missed opportunity for SuDS.

# Monitoring Report Conclusions

## Comparing Costs

Overall, both capital and maintenance costs – and therefore whole-of-life costs – associated with the Study Site were much lower than those for the conventional piped drainage system Control Site. The Monitoring Report noted capital cost savings of £314 per home and also suggested 20 – 25% lower maintenance costs than traditional drainage on the Control Site. Having said that, further cost savings are unaccounted for in these cost comparisons, as follows.

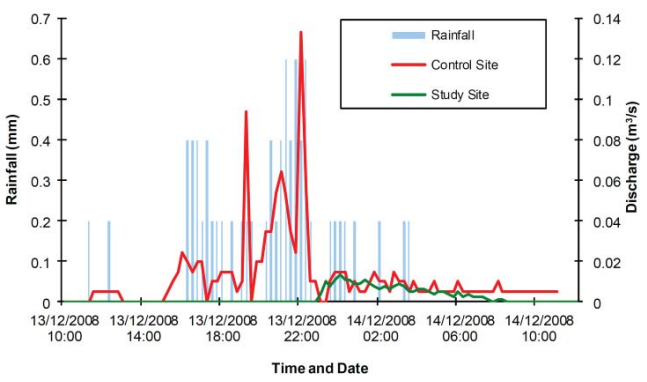
The SuDS at Lamb Drove achieve 100% of the required flow rate reduction by providing attenuation storage within the site and the immediately adjoining greenway land. This represents a saving as there is no reliance on strategic balancing lakes, which have associated capital costs, maintenance and land take requirements. Also, Lamb Drove SuDS do not connect to the adopted public sewer and therefore avoid any connection and annual charges for storm water disposal.

Rather than retrofitting, integration of SuDS holistically within the scheme design from the start would have produced further savings, as would a wider SuDS strategy for the whole Cambourne development. Some additional SuDS features were also included for demonstration purposes, not out of necessity.

## Summary of Findings

**Quantity** - The Study Site has attenuated surface water flows and significantly reduced peak flows have been observed when compared with the Control Site, as shown (below left). The monitoring programme has clearly shown the successive attenuation and reduction of both flow and volume through each stage of the SuDS management train.

**Quality** - The SuDS system has improved the quality of water discharged from the Study Site when compared with the Control Site, for example as shown (below right). Results have shown that the Study Site has seen reductions in concentrations of a variety of pollutants and other water quality indicators.

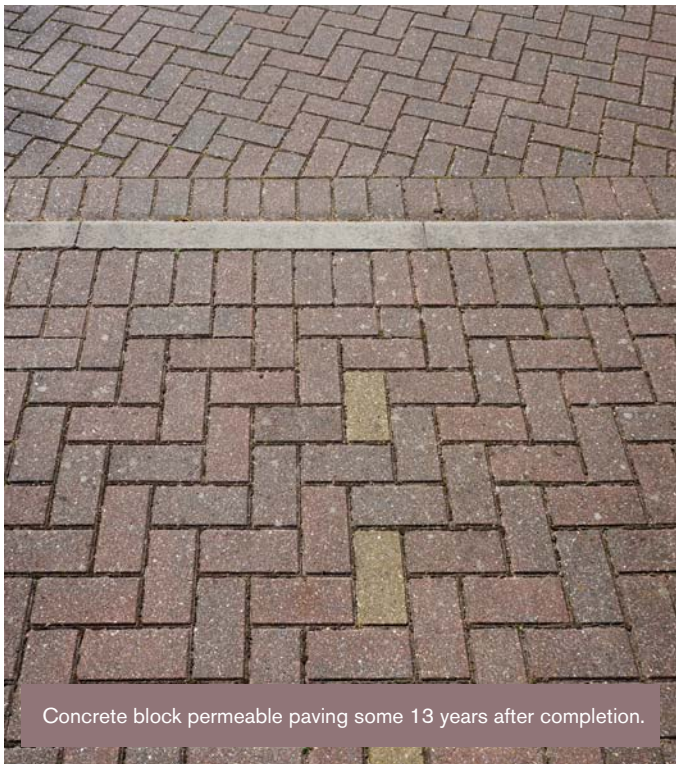




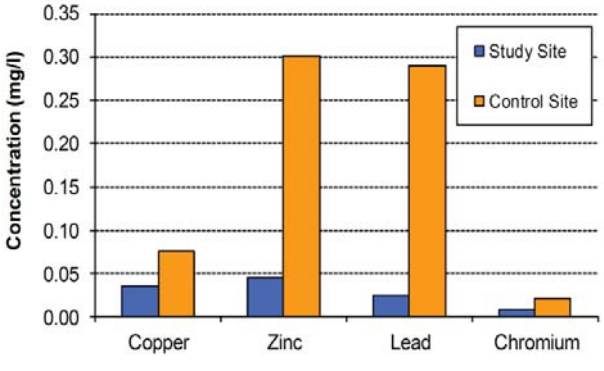

**Biodiversity** - The Study Site has shown a higher number and diversity of species present over the three habitat surveys than the Control Site. The Study Site represents a more natural management regime and this is represented in the range of species present on the site.

**Amenity** - The residents surveys found that they regard the open space around their homes as more pleasing when compared with others parts of Cambourne. It is apparent that the residents of the Study Site have a high regard for the open spaces within the SuDS scheme. This is in line with findings from some other SuDS sites, where the positive impact on the immediate areas had transformed into locally higher property values.

**Concrete Block Permeable Paving** - The permeable pavement infiltration study specifically illustrates the robustness of the performance of this feature to limited maintenance. The infiltration capacity of the permeable pavement is able to adequately cope with the highest recorded rainfall intensity at the Study Site.



Concrete block permeable paving some 13 years after completion.



## Precast Paving and Interpave

Interpave is the Precast Concrete Paving and Kerb Association, promoting and developing concrete products – ranging from domestic uses to the most taxing heavy industrial applications.

Interpave members' products are manufactured under factory-controlled conditions to a high standard, giving the assurance of an engineered product to meet specific design criteria. All Interpave manufacturers are certified to ISO 9001, ISO 14001 and BES 6001. They are all members of British Precast and signatories to its Health and Safety Charter. Similarly, Interpave members sign up to the British Precast Sustainability Charter, the aim of which is to go beyond legislation and take voluntary actions to make their products and operations more sustainable. The annual environmental auditing of members' manufacturing sites helps them achieve best practice.

Interpave and its manufacturer members helped to create the pervious pavements chapter in *The SuDS Manual*, 2015, and its own 2018 *Design and Construction of Concrete Block Permeable Paving* document is aligned with *The SuDS Manual*. The Interpave website www.paving.org.uk provides the definitive source of background and technical information with project case studies celebrating the transformative power of inspired hard landscape.

## Precast Concrete Paving

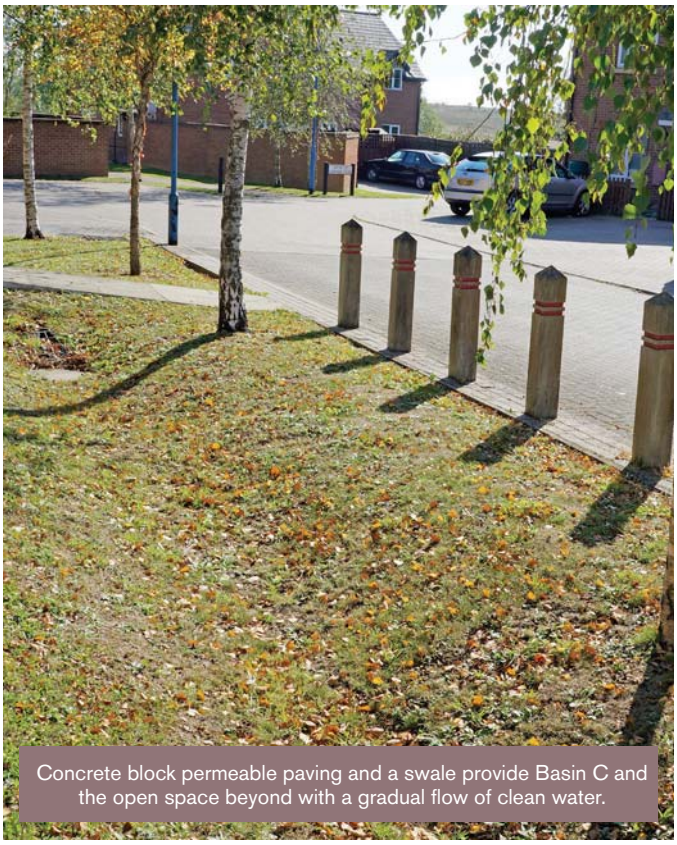
- Visually attractive and able to deliver distinctive local character
- Helping to deliver *'Manual for Streets'* and other guidance
- Capability for clear differentiation between distinct areas
- Accessible to all with consistent slip and skid resistance
- Durable and maintainable with reliable product supply
- Sustainable – in every sense.

**A diversity of shapes, styles, finishes and colours for contemporary design**

## Concrete Block Permeable Paving

- Reducing, attenuating and treating rainwater near the surface
- Direct infiltration to the ground or conveyance to SuDS or sewers
- Multi-functional SuDS meeting current requirements
- Low cost storage using flow controls without additional land-take
- Established technology with decades of proven performance
- Safe, level, puddle-free, shared surfaces for all.

**A gradual supply of clean water for landscape, biodiversity and harvesting**



Concrete block permeable paving and a swale provide Basin C and the open space beyond with a gradual flow of clean water.

Lower swales fed from Basin C at the end of the management train within open space.


## Acknowledgements

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