PAVING
CASE
STUDY

October 2015

Uniclass L534:L217

- Concrete Block Permeable Paving, SuDS & Amenity
- Treating, Storing & Controlling Water Runoff
- Enhancing Habitats & Protecting Wildlife
- Permeable Paving over the longer term

# HAZELEY ACADEMY
# MILTON KEYNES

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Interpave
THE PRECAST CONCRETE PAVING
AND KERB ASSOCIATION

# Introduction

By 2015, local flora and fauna is well established in the linear wetland system along the western edge.

The Hazeley Academy (formerly Hazeley School) is a purpose-built, state of the art secondary school designed by Architecture MK on the Hazeley grid square in Milton Keynes. The project incorporates a sustainable drainage system (SuDS) scheme designed by Robert Bray Associates, incorporating extensive areas of concrete block permeable paving as source control.

Although the main phases were completed in 2007, further building expansion has continued. Interpave first visited the project during construction in 2002 and has published several articles and studies. This latest case study follows a 2015 revisit and focuses on the positive ecological impacts of SuDS with permeable paving, notably monitoring research of Great Crested Newts carried out by Bernwood ESC from 2002 to 2014, and longer term performance and maintenance in practice, as outlined by the Academy Site Manager.

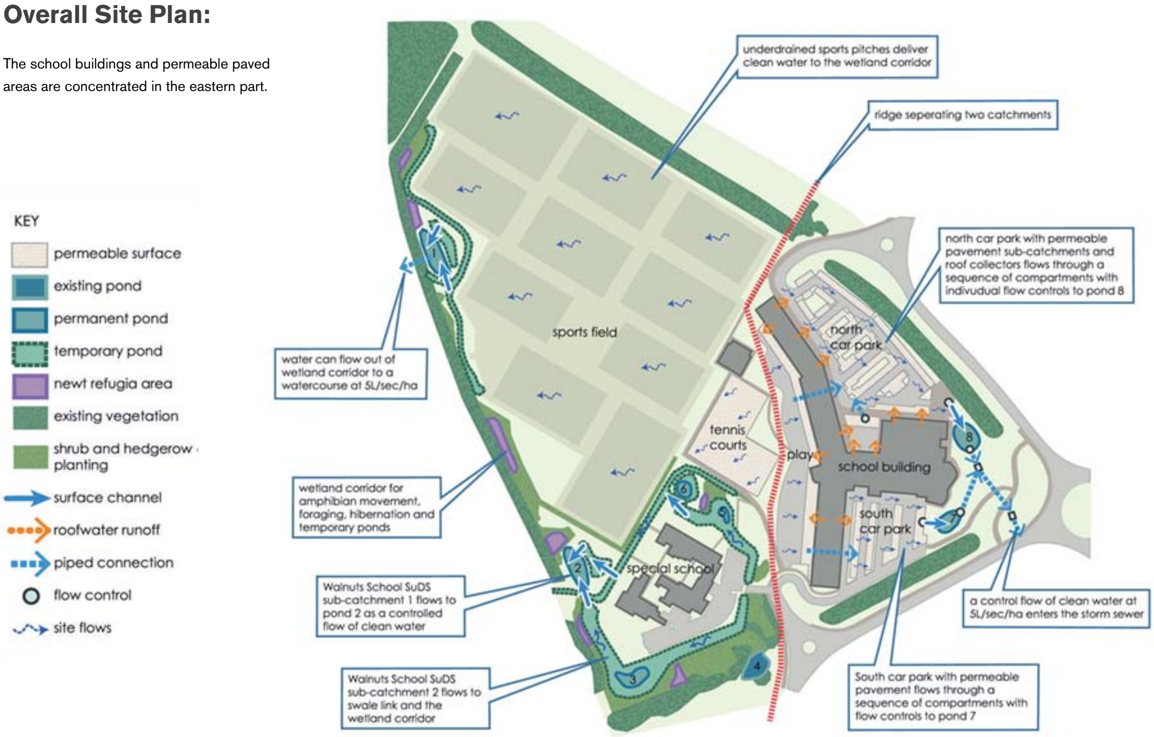
## Context

Located across the top of a hill, the school site as a whole can be considered as two distinct catchment areas divided by a ridgeline. The topsoil is shallow and sub-soils are heavy clays, regarded as impermeable by the drainage system designers. The site is a natural habitat for Great Crested Newts – a 'Protected Species' under national and European legislation.

The western catchment, which consists of permeable surfaced tennis courts and grass playing fields, drains via open detention basins/ponds and a linear wetland system to two outfalls on the north-west boundary and then to a natural watercourse. This case study concentrates on the eastern catchment area which includes the main buildings and three distinct external areas characterized by concrete block permeable paving.

## Overall Site Plan:

The school buildings and permeable paved areas are concentrated in the eastern part.



# Permeable
# Paving

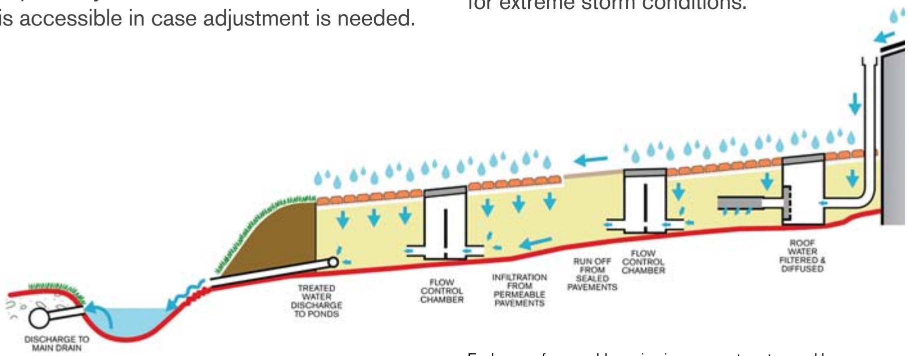
## Eastern Areas

The two areas to the north east and south east are similar to each other and generally consist of footpaths, car parking, cycle racks and other paved areas, on land sloping away from the school building. They are surfaced in impermeable asphalt and concrete block permeable paving (CBPP) with runoff from the asphalt draining onto the permeable paving.

Because of the site slopes, the permeable pavement sub-base is divided into compartments by walls extending up from the underlying subgrade to the surface. Fin drains collect water to flow from each higher compartment to its lower neighbour, importantly via a flow control chamber that is accessible in case adjustment is needed.

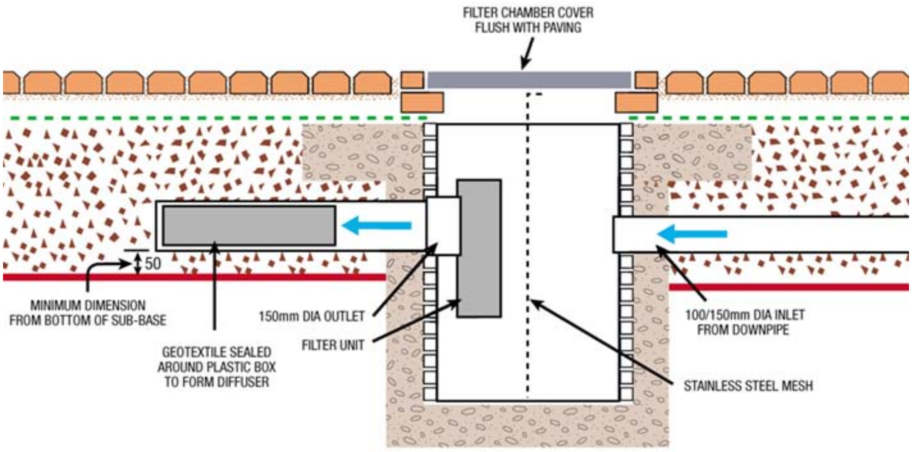
This sequence is repeated so that water progressively moves down the hill from compartment to compartment providing a controlled flow. Excess water is allowed to flow straight to the next compartment via overflows just under the block-paved surface, within the laying course.

Roof water in down-pipes is also added to the permeable pavement sub-base through filter chambers and then diffuser boxes. At the bottom of the terrace of compartments, water discharges into two separate retention basins (ponds) and finally runs attenuated into a new storm water sewer already installed as part of the Milton Keynes drainage infrastructure. Flood routes are provided by overflow swales and flush kerbs for extreme storm conditions.



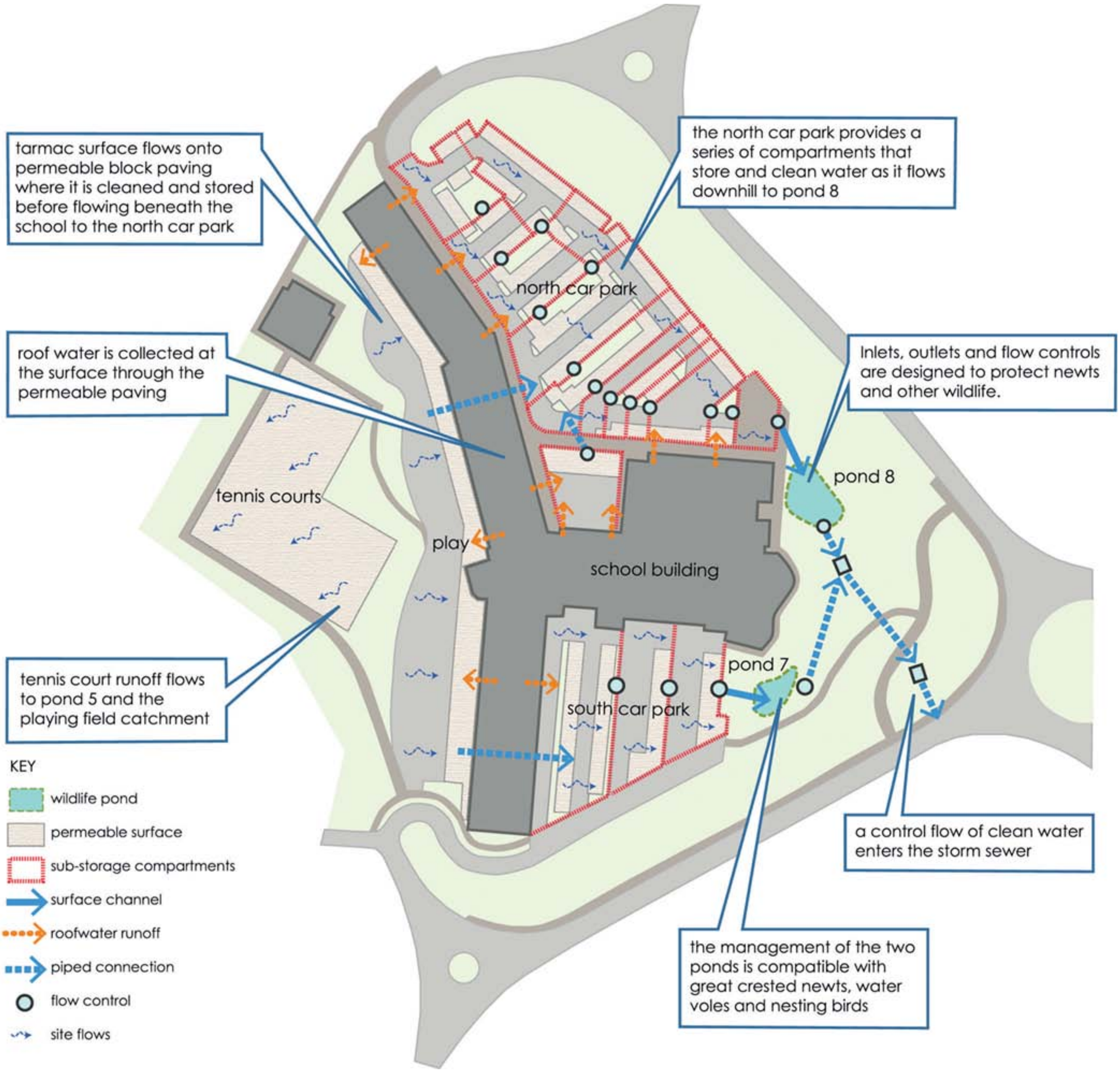

Each area of permeable paving is a compartment served by a flow control chamber, within a sub-catchment.

Roof water is piped into filter chambers, then dissipated through diffuser boxes into the permeable sub-base. Later phases discharge onto concrete flags with profiles to channel water.



## Site Plan of the school building area

– with concrete block permeable paving shown pink and the two wildlife ponds that they feed blue.

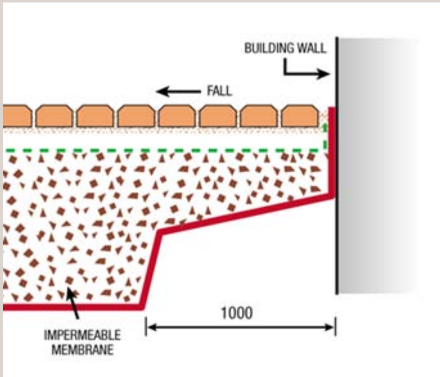


## Western Areas

Immediately to the west of the school building, a large play area is constructed of impermeable asphalt and CBPP. The asphalt drains its surface water onto the CBPP while rainwater down-pipes from the roofs also discharge into the CBPP that directly abuts the building. On later phases of the building, down-pipes discharge onto concrete flags with raised profiles channeling the water away from the building on the surface.

Surface water travels through the CBPP jointing and laying course materials and into the permeable aggregate sub-base to be stored and slowly released into the next stage. The building itself is effectively a dam, except at its extreme ends, and water is collected from the sub-base by perforated pipes for transfer under the building, via flow control chambers, where it joins the Eastern Area SuDS management train.

Any storm water that exceeds the designed storage volume is allowed to flood around the ends of the building or through an overflow grating (with a protective inlet to prevent trapping newts) into pipes under the building once a water level approximately 50mm above the block paving surface has been reached.

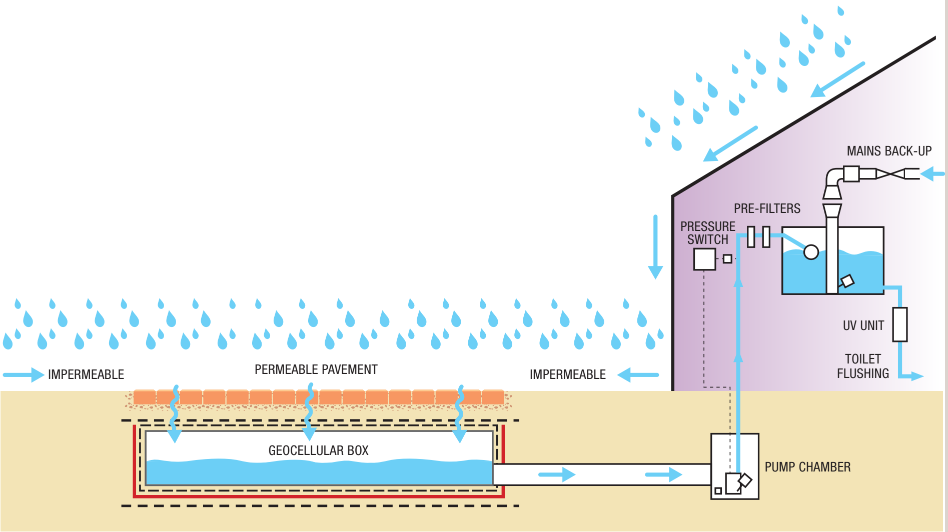



Concrete block permeable paving runs right up to the building but the permeable sub-base is curtailed 1 metre away with a clay protection to the foundation, as water is contained within the sub-base.

## Rainwater Harvesting

Other sections of the western CBPP, related to later building phases, were designed to collect direct rainfall and runoff from adjacent hard games surfaces and roofs for rainwater harvesting. Below the paving, geocellular storage boxes and a geomembrane form an open-topped tank.

This arrangement filters and treats the water before it passes into storage and surplus overflows to the SuDS system. Although the system is not currently operational in the building, cleaned rainwater is available to be pumped from the storage boxes to a header tank for toilet flushing in the school buildings.




Facility for the use of treated water from the permeable pavement for toilet flushing.

> “Apart from the wildlife ponds themselves, no other SuDS techniques were used on the lower part of the site in addition to the permeable pavements for pollutant removal.”

# **SuDS** Design Philosophy

Because infiltration was not an option (due to clay soils), SuDS techniques were employed on this project predominantly to meet the then recommendations of the Environment Agency and PPG25, including requirements for attenuation and full treatment.

While the sloping site initially appeared to present a potential challenge for CBPP, which is well suited to flat sites, the sequence of compartment permeable pavements – each with flow control – actually provides a retention time enabling biological treatment of runoff with bio-remediation of organic pollutants like oils, milk and animal excrement. Flow controls were used for both compartments (to accommodate levels) and sub-catchments (for demonstrable volume storage).

The resulting pollutant removal substantially improves water quality for the two ponds to encourage long-term population by wildlife – notably newts. The ponds themselves are highly vegetated and designed to filter the water, particularly during times of low flow, effectively acting as a ‘polishing’ feature or a further stage in the SuDS ‘management train’. In addition to providing wildlife habitats, the ponds and related areas offer a valuable teaching and learning resource, recognised in school design guidance (such as BB99).

How does the project deliver the three keystones of SuDS?

- QUANTITY – attenuation ensures green-field runoff rates from the site
- QUALITY – the primary objective to protect wildlife and amenity
- AMENITY – indigenous wildlife habitats and attractive features, notably ponds.

Assessments of the pollutants removed by the permeable pavements and their design were derived from CIRIA document C609: *Sustainable Drainage Systems – Hydraulic, Structural and Water Quality Advice* (of which the SuDS designer was a co-author). Apart from the wildlife ponds themselves, no other SuDS techniques were used on the lower part of the site in addition to the permeable pavements for pollutant removal.

Treated rainwater runoff from the paving above flows gradually into the two wildlife ponds.

> “The post development monitoring surveys show an overall increase in the population of Great Crested Newts on site and suggest that ‘Favourable Conservation Status’ on site has been achieved.”

# **Protecting** Native Wildlife

All life depends on water but some animals and plants rely on aquatic habitats for daily survival. Amphibians – including frogs, toads and newts – return to water to breed, lay eggs and hatch tadpoles.

They are particularly susceptible to water quality because they have permeable skins and, as tadpoles, use external gills to breathe under water. Also, recent research shows that tiny amounts of pollutants can disrupt immune systems in frogs causing deformities and population decline. They are the aquatic equivalent of ‘canaries in cages’.

In addition, amphibians are threatened by man-made hazards along migration routes between breeding ponds and feeding habitats. Obstacles such as kerbs direct them towards drainage gratings and gulley pots used in traditional drainage systems, where they – along with other creatures including reptiles and small mammals – are trapped in lethal toxic liquors.

## Techniques Applied

The protection techniques used on the Hazeley project include:

- Source control techniques at the head of the management train to protect ponds and other habitats further down the train from day-to-day pollution and ‘catastrophic’ events
- Elimination of road gulleys by use of permeable pavements to collect runoff including roof drainage
- Open channels – whether hard or soft – and short, direct pipe links without traps, allowing access out for wildlife
- Low flows characteristic of SuDS to avoid highly engineered outfalls
- Screening of outlets to prevent animals being swept into pipes and control structures.

Concrete block permeable paving allows water to pass through without the need for gulleys or other wildlife traps.


The lower school pond in 2015.

"Road gulleys are eliminated – protecting wildlife – by using permeable paving to collect runoff including roof drainage."

# Newts at Hazeley

Bernwood ECS have carried out pre- and post-development monitoring of Great Crested Newts at the Hazeley site from 2002 to 2014, providing an insight into the beneficial impact of SuDS on this protected species, summarised here.

Prior to development, the land was disused arable in long-term fallow condition, containing several ponds, three of which were utilised for breeding by Great Crested Newts. Over 80 newts were translocated on site under licence to allow development and a total of ten ponds interlinked with swales were created around the margins of the school complex, as part of Robert Bray Associate's SuDS scheme. The two ponds nearest to the school are deeper, lined and fed by treated water from the concrete block permeable paving.

### Increase in Population

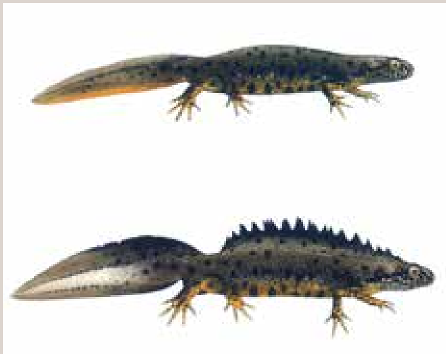
The post development monitoring surveys show an overall increase in the population of Great Crested Newts on site and suggest that 'Favourable Conservation Status' on site has been achieved.

Emily Dickins of Bernwood ECS added:

*"Of the two ponds related to permeable paving, the larger produced a peak count of 14 Great Crested Newts with an average yearly peak count of 6, while the smaller, lower pond gave a yearly peak count of 34 and average of 8.*

*"Having said that, they were probably under-counted due to the ponds' depth and turbidity, judging by the numbers of Great Crested Newts seen on the banks during surveys. These ponds were very good for smooth newts too. I see permeable paving as a very useful tool in creating and maintaining wetland habitats near development sites with careful design – the simpler the better."*

The upper, larger school pond in 2015.



Great Crested Newts, image: courtesy of Robert Bray Associates

More concrete block permeable paving has recently been added to the original areas, serving additional buildings.

# Permeable Paving over the Longer Term

Interpave interviewed Academy Site Manager Ian Francis about his experience with concrete block permeable paving at Hazeley, summarised here.

Care of the permeable paving forms a part of the general maintenance programme for the Academy, carried out by a small non-specialist team using day-to-day equipment. It is not treated as anything unusual or apportioned a specific budget, and sweeping/vacuuming machines are not used. In areas prone to moss growth, this is killed to avoid seeds spreading and removed every 3 years or so with power-washing equipment already used for other purposes around the school. It is essential to top up joints between blocks with the correct jointing material (which is held in stock) after cleaning. Joints are also topped-up on new areas of paving when taken over from contractors.

The roof-water filter chambers within the pavement are easily cleaned annually as part of non-specialised maintenance.

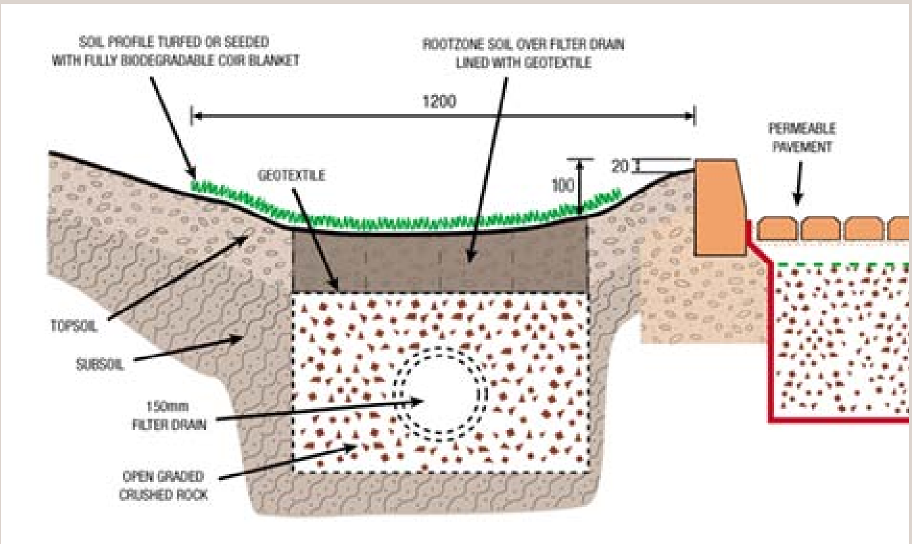
These have proved more successful for the large rainwater downpipes than the surface discharge arrangements (which are more suitable for smaller downpipes). The concrete block permeable paving behaves well in cold weather – far better than asphalt – and rock salt provides cheap, simple and effective de-icing.

Correct design and installation is key to the long-term performance of permeable paving such as profiled verge details to prevent silt runoff from vegetated areas. Where there have been localised, minor areas of surface silting-up and ponding – e.g. runoff from incomplete, new planted areas) these are simple to rectify by cleaning the joints.

Ian Francis commented: *"Concrete block permeable paving has proved to be ideal for any hard surfaces around schools and far better than asphalt."*

Under-drained, profiled verges at the foot of banks prevent silt and debris from being carried onto the permeable pavement where blockage might occur.

Profiled verge just after permeable paving installation.



# **Key** Points

This is an unusual project which focuses on water quality and wildlife, as well as hydraulic and structural engineering requirements. It is carefully thought through, taking a holistic approach, and offers an impressive demonstration of:

- Concrete block permeable paving providing a controlled flow of clean water for wildlife habitats
- Protection of wildlife with an absence of gulleys and other traps
- Effective water treatment generally without the need for other SuDS techniques such as swales or filter strips, minimizing land-take
- Application of permeable paving on sloping ground with terraced compartments using flow control chambers
- Acceptance of roof water and runoff from adjacent sealed paving into permeable pavements
- Problem-free use of permeable pavements close to buildings
- Straightforward, non-specialised maintenance of concrete block permeable paving.

## Acknowledgements

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- Bob Bray, Robert Bray Associates
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- Ian Francis, Hazeley Academy

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(except where indicated otherwise)

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THE PRECAST CONCRETE PAVING
AND KERB ASSOCIATION

www.paving.org.uk

The Old Rectory, Main Street, Glenfield, Leicester LE3 8DG United Kingdom
e: info@paving.org.uk t: 0116 232 5170 f: 0116 232 5197

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mpa British Precast

t: 0116 232 5170
f: 0116 232 5197
e: info@britishprecast.org
www.britishprecast.org

Interlay
THE ASSOCIATION OF PAVING CONTRACTORS

t: 0116 232 5191
f: 0116 232 5197
e: info@interlay.org.uk
www.interlay.org.uk