BULLETIN

FEB 2016

Urban Flood Risk Management: The Blue-Green Approach

The UK was hit by devastating storms at the end of 2015. One way to provide measures to manage the risk of flooding and reintroduce a more natural water cycle in urban environments is the Blue-Green approach.

December 2015 was an extraordinary month in both meteorological and hydrological terms, with some of the most widespread and severe flooding ever witnessed in the UK. Slow-moving low pressure systems driven by sustained moist south-westerly air brought prolonged heavy rainfall to northern and western areas of the UK with the persistent unsettled weather (including the named storms 'Desmond', 'Eva' and 'Frank') causing widespread and repeated river (fluvial) and surface water (pluvial) flooding.

The floods of December 2015 were not the first and undoubtedly not the last. Flooding is a part of nature and the risk will always remain. The Environment Agency's (EA) 2009 National Flood Risk Assessment estimates around 5.2 million properties in England, or one in six properties (16%), are at risk of flooding. More than 5 million people live and work in 2.4 million properties that are at risk of flooding from rivers or the sea (tidal), one million of which are also at risk of surface water flooding. A further 2.8 million properties are susceptible to surface water flooding alone.

SURFACE WATER FLOODING

This type of flooding can occur after short-duration, intense rainfall which cannot be managed quickly enough by traditional drainage systems or infiltrated to ground. Seen by many as an invisible hazard, surface water flooding can often strike with little warning in areas not usually prone to flooding as it is dependent on the precise location of the cloudburst rather than heavy, prolonged rainfall over a whole catchment.

The risk of surface water flooding in the UK and across the globe is projected to increase significantly, particularly in urbanised areas, towns and cities where there are large areas of impermeable surfaces and where future development is likely to be concentrated. Our climate is changing and is likely to continue to change for many years to come. It is predicted that with climate change (which could lead to more frequent short-duration, high intensity rainfall, higher river flows and higher coastal storm surges) and development pressures, flood risk in the UK is going to increase, with potentially the most significant changes likely to happen in the latter half of the century. It is clear that we need to adapt to a future with more surface water runoff.

HISTORIC INFRASTRUCTURE

Although construction methods and materials have progressed and evolved over thousands of years, the fundamental mechanisms of drainage systems remains the same. Surface water has been and still is to this day predominately

managed by traditional drainage systems such as drains, pipes, culverts, tunnels and sewers more commonly known as 'grey infrastructure'. The primary objective of traditional drainage systems is to remove rainwater as quickly as possible from where it falls and directing it to the nearest watercourse or via sewers to a water treatment facility. So what's the problem? Removing rainwater as quickly as possible can potentially cause sudden rises in flow rates and water levels in local watercourses. In addition, rainwater diverted to piped systems reduces the amount of water infiltrating into the ground. As a result, groundwater levels can potentially fall and dry weather flows in watercourses are reduced. Surface water runoff can also contain contaminants such as oil and toxic metals. Although often at low levels, cumulatively they can result in poor water quality in receiving watercourses.

THE BLUE-GREEN APPROACH

The Blue-Green approach aims to reintroduce a more natural water cycle into urban environments and provide measures to manage the risk of flooding while backing the concept of multi-functional land use to generate benefits for the environment, society and the economy. The natural water cycle is characterised by high evaporation, high infiltration, and low surface water runoff. This cycle typically occurs in rural areas where there is an abundance of permeable surfaces (grass and soils). The case in urban environments is almost the complete opposite, there is significantly more surface water runoff, less infiltration and less evaporation; a recipe for flooding.

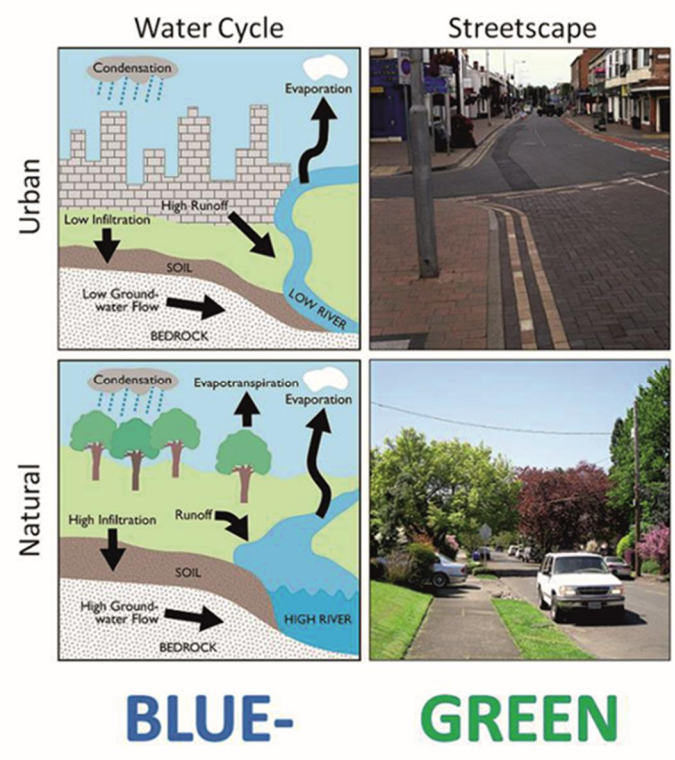

Image: Blue-Green Cities Research Project - University of Nottingham

Blue infrastructure typically includes features such as ponds, shallow vegetated channels (swales), detention basins and wetlands. On the other hand, Green infrastructure refers to natural land and plant based ecological treatment systems. This comprises green open space, recreation grounds/parks, woodlands, and domestic gardens.

Both Blue and Green infrastructure are designed to slow water down (attenuate) before it enters watercourses, provide areas to store or harvest water for re-use and encourage water to infiltrate into the ground. These features also act as natural cleaning agents, reducing the quantity of sediment and level of contaminants within surface water runoff through settlement or biological breakdown of pollutants.

Blue and Green infrastructure fall under the umbrella of Sustainable Drainage Systems (SuDS), a term used in the United Kingdom, known as low-impact development or Best Management Practice (BMP) in the United States and Water Sensitive Urban Design (WSUD) in Australia. In the UK SuDS gained prominence following the Sir Michael Pitt Review which concluded that SuDS are an effective way to reduce, in particular, the risk of surface water flooding. In the wake of the review, proposals to increase the uptake of SuDS were included in the Flood and Water Management Act 2010. The Act necessitates better management of flood risk and gave a new responsibility to the Environment Agency for developing a National Strategy for Flood

and Coastal Erosion Risk Management (FCERM), and a new responsibility to county councils and unitary authorities, as Lead Local Flood Authorities (LLFAs), to co-ordinate flood risk management in their respective area.

Schedule 3 of the Act, initiated on 6 April 2015, states the requirement for the inclusion of SuDS to manage surface water runoff in construction with drainage implications such as residential and commercial developments. It removes the automatic right, established by the Water Industry Act 1991, to connect into public sewers and instead gives powers to LLFAs as SuDS Approving Bodies (SABs) to approve new drainage systems for undeveloped or redeveloped sites and highways.

CASE STUDY: LAMB DROVE

New development, particularly those on greenfield land (undeveloped land) offers an important opportunity to manage surface water better than has been done traditionally and to employ the blue-green approach. Lamb Drove is a residential development of 35 units (developed and owned by Cambridge Housing Society) on a 1ha greenfield site, situated in the town of Cambourne, Cambridgeshire, UK. The aim of the Lamb Drove scheme was to showcase practical and innovative SuDS techniques within a new residential development. The overarching philosophy behind the SuDS scheme was to control all surface water runoff on site starting at its source via a management train of different SuDS features.

Roofwater is collected in water butts, or directed to vegetated swales. Rain falling on roads or paths passes through permeable paving, where it is filtered and stored in a permeable layer of crushed rock. Water then travels through a series of swales, detention basins and wetlands till it reaches a final retention pond. Here it is stored before being released at a controlled discharge rate to a receiving watercourse.

The scheme demonstrates an innovative approach to managing surface water runoff within the bounds of a new residential development site. Swales and detention basins have resulted in an improved quality of water leaving the site, whilst providing a visually enhanced landscape. Key lessons learned from the scheme include: Keeping SuDS simple and at the surface; the most cost-effective SuDS are likely to be achieved through landforming and by

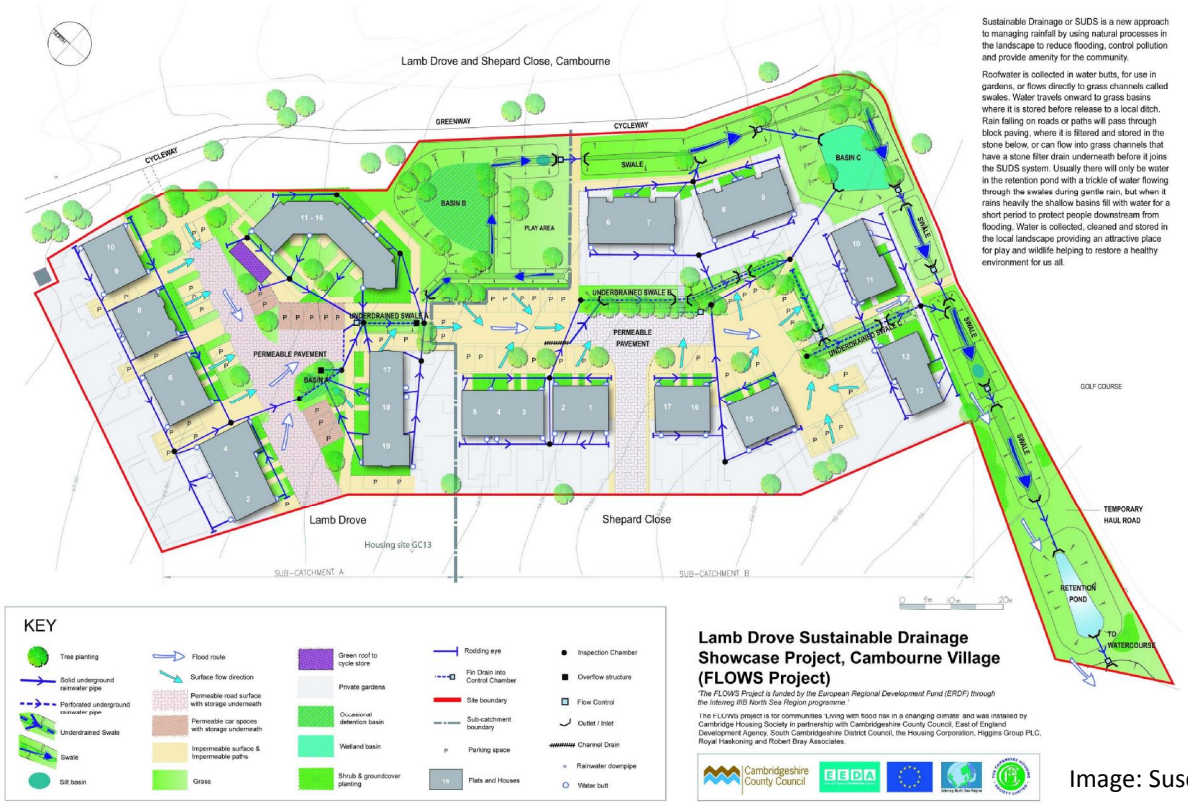

Image: Susdrain

easier to observe the performance of SuDS and carry out maintenance.

The implementation of the Blue-Green approach at new developments is clearly a viable option. However, new development forms only a small part of the current urban areas. Increasingly, the Blue-Green approach is being implemented into the built environment via the method of retrofitting SuDS. The term retrofit is employed when SuDS-type approaches are intended to replace and/or augment an existing drainage system in an urbanised catchment.

CASE STUDY: RAIN GARDENS

A good example of retrofitting SuDS into the existing built environment are the 21 Rain Gardens situated along Ribblesdale Road, Day Brook, Nottingham, UK. The project was a collaboration between the EA, Nottingham City Council, Groundwork Greater Nottingham and Severn Trent Water. Day Brook is a northern suburb of Nottingham, a city located in the heart of England. Within the highly urbanised area, a total of 972 properties fall within the floodplain of the Day Brook, a heavily modified watercourse, with Ribblesdale Road running parallel to its upper reaches.

The Rain Gardens utilise a combination of clean stone aggregate and proprietary water attenuation cells to create storage space beneath a planted topsoil layer. Each Rain Garden has a storage capacity of 15m3, which generates a total storage capacity of 315m3 for all 21 gardens.

Image: Susdrain

They are designed to capture runoff from approximately 5,500m2 of Ribblesdale Road. The Rain Gardens act to reduce the peak rate and volume of runoff draining to the local sewer system and thence the Day Brook. Preliminary hydraulic modelling of the Rain Gardens suggests a 33% (~50m3) reduction in the volume of runoff reaching the sewer system during a 1 in 1 return period storm (100% likelihood of occurrence in any given year).

SUMMARY

The recent floods in the UK highlight a growing need to re-think and adapt the ways in which we manage surface water runoff in urbanised areas. The Blue-Green approach has proven to be effective at new developments and in the case of retrofitting SuDS into the existing built environment. With the recent changes to planning and surface water management policy it is hoped that the Blue-Green approach will become normal, everyday practice.

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This article was published in the February-March edition of Water & Wastewater International.

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