SUDSnet International Conference

- Multiple Benefits from Surface Water Management

September 4th-6th 2012

Coventry TechnoCentre

University of Coventry, UK



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Contents

Acknowledgements:

Thanks to all our speakers and delegates for your support of SUDSnet and your valuable contribution to this event.

Special thanks to:

Coventry University who are supporting SUDSnet 2012 with a grant to further International recognition and impact.

Urban Water Technology Centre, University of Abertay Dundee, for administrative support (Ms Leanne Gallagher) and University of Abertay Dundee for management of the on-line registration system.

CIRIA, and other regulatory and industry partners for consultation and support on this and previous events

Conference Organisers:

Dr Sue Charlesworth, Coventry (apx119@coventry.ac.uk)

and

Dr Rebecca Wade, Abertay (r.wade@abertay.ac.uk)

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- Multiple Benefits from Surface Water Management

Event Programme (Overview of sessions)

Tuesday 4th Sept 2012

9 – 9.30am Registration and Coffee
9.30 am Pre-Conference Postgraduate Research Session 1 + 2

12:40 – 2pm **Registration, Networking and Lunch**
2pm Welcome address: SUDSnet International Conference 2012 Keynote presentation: Prof Bruce K. Ferguson, University of Georgia, USA.

2.30-4.10pm
Session 1 - SUDS and Water Management Planning.

4.30-6pm **Parallel Session A**
Session 2 - SUDS Design
Session 3 - Understanding and Communicating Urban Water Management and Diffuse Pollution Issues

7pm **Tuesday Evening** - Conference Dinner at Coventry TechnoCentre

Wednesday 5th Sept 2012

8.30- 9am Registration and Coffee
9 am Welcome address: SUDSnet International Conference 2012
Keynote presentation: Floris Boogaard, Tauw bv, Amsterdam, Netherlands

9.30-10.30 **Parallel Session B**
Session 4 - SUDS Performance
Session 5 - SUDS Treatment 1

11am-12pm **Parallel Session C**
Session 6 - SUDS Treatment 2
Session 7 - SUDS and Green Infrastructure, Amenity and Ecosystem Services 1

12.30 – 2pm **Networking and Lunch**

2.00-5.30pm
Session 8 - Workshop session - getting added value from SUDS and contributing to low carbon development
Session 9 - SUDS and Green Infrastructure, Amenity and Ecosystem Services 2
Session 10 - Future developments in SUDS (presentation and discussion)

5.30pm **Close of main conference sessions**

Thursday 6th Sept 2012 – Field Trip 9am - 5pm

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Delegate list

SURNAME	FORENAME	AFFILIATION
Badger	Matthew	Scottish Water
Boogaard	Floris	TU Delft
Boyle	Nicola	Coventry University
Bray	Bob	Robert Bray Associates
Brown	Caroline	Heriot Watt University
Buchan	Doug	Scottish Water
Buntine	Bronwyn	Kent County Council
Casal	Arturo	Exeter University
Charlesworth	Sue	SUDSnet / Coventry University
Coupe	Stephen	Coventry University
Crosskey	Shaun	Brett Landscaping & Building Products
Dalgleish	Ian	Atkins Ltd
Dawson	Julian	The James Hutton Insitute
Dearden	Rachel	British Geological Survey
Duffy	Alison	University of Abertay Dundee
Dyelola	Kemi	Coventry University
Ekeleme	Ijeoma	Coventry University
Ellis	Bryan	Middlesex University
Faraj	Amal	Coventry University
Ferguson	Bruce	University of Georgia
Fowler	Stuart	Coventry University
Gibson	Stephen	Ramboll UK Ltd
Gill	Andrew	Brett Landscaping & Building Products
Hawkins	Sam	Marshalls Drainage
Hall	Nick	Pinnacle
Henman	Jenny	Yorkshire Water Services Ltd
Howe	John	Brett Landscaping & Building Products
Jefferies	Chris	University of Abertay Dundee
Jose	Roshni	University of Abertay Dundee
Lashford	Craig	Coventry University
Leadbetter	Andrew	Peterborough City Council
Lucey	Maria	Scottish Water / University of Abertay Dundee
Lucke	Terry	University of the Sunshine Coast
Lundy	Lian	Middlesex University
Mathala	Lawrence	University of Bolton
Mbanaso	Fredrick	Coventry University
McCloy	Anthony	McCloy Consulting
Morton	Gary	ACO Technologies PLC
Mullaney	Jennifer	University of the Sunshine Coast
Newton	Chris	Exeter University
Nnadi	Ernest	Coventry University
Perales	Sara	PMEnginyeria
Quinn	Ruth	University of Greenwich
Robinson	Peter	AECOM
Rodriguez-Hernandez	Jorge	ETSICCP
Roe	Jenny	Heriot Watt University
Roinas	Georgios	University of Portsmouth
Sañudo-Fontaneda	Luis Angel	ETSICCP
Shaffer	Paul	CIRIA / SUDSDRAIN
Smith	Kerry	Scottish Water
Taylor	Daryl	JBA Consulting
Tingle	Stephen	Tingle Consulting Ltd
Tsavdaris	Alexandros	University of Portsmouth
Wade	Rebecca	SUDSnet / University of Abertay Dundee
Walker	Louise	University of Leeds
Warwick	Frank	Coventry University
Willis	Sass	Cambrigeshire County Council
Woods-Ballard	Bridget	HR Wallingford Ltd

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Event Programme - Detail

Tuesday 4th Sept 2012

9 – 9.30am **Registration and Coffee**

9.30am Pre-Conference Postgraduate Research Session

9.40am Ruth Quinn & Alejandro Dussaillant. **Predicting pollutant retention in SUDS, with a rain garden application**

10:00am Fredrick Mbanaso et.al. **Laboratory-based experiments to investigate the impact of glyphosate-containing herbicide on pollution attenuation and biodegradation in a model pervious paving system.**

10:20am Jenny Mullaney et.al. **Pervious paving systems: potential use for promoting street tree health, reducing pavement damage and reducing stormwater flows**

10:40am Georgios Roinas et.al. **Fate of Hydrocarbon Pollutants in Source and Non-Source Control SUDs systems**

11.00am **Coffee break**

11:20am Craig Lashford et.al. **Sustainable Drainage Systems: A sustainable flood management plan?**

11:40am Roshni Jose et.al. **Ecosystem Services and Urban Water**

12.00am Stewart Fowler et.al. **Evaluating the amenity of Sustainable Urban Drainage Systems**

12:30 – 2pm **Registration, Networking and Lunch**

2pm Welcome address: SUDSnet International Conference 2012

2.05pm Keynote presentation: Prof Bruce K. Ferguson, University of Georgia, USA. **Toward Alignment of Stormwater Flow with Urban Space and Value**

Session 1 - SUDS and Water Management Planning.

2.30pm Bridget Woods-Ballard. **National and British Standards for SUDS – update on developments and current consultations.**

2.50pm Bronwyn Buntine. **SuDS for all partners.**

3.10pm Frank Warwick and Sue Charlesworth. **Decision support for SUDS Approval Bodies when assessing SUDS feasibility.**

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3.30pm Alison Duffy, Doug Buchan and Maria Lucey**. Vesting Public SUDS in Scotland - Effective and Transparent Governance: learning by doing and doing by learning.**

3.50pm Celeste Morgan & Sass Willis. **Making SABs work in Practice – the experience of Cambridgeshire**

4.10pm **Coffee break and networking**

PARRALLEL SESSION A

Session 2 - SUDS Design (parallel session – Main Room)

4.30pm Stephen Gibson. **Maximising recycling, effective attenuation and multi-stage water treatment – A case example at Mount Vernon Hospital, London.**

4.50pm Stephen Tingle. **Advancing SuDS capital and maintenance works within cross sector multi-lot technical service procurement.**

5.10pm Kiran Tota-Maharaj, Piotr Grabowiecki, Akintunde Babatunde & S.J. Coupe. **Exploring the potential of constructed wetlands for low-carbon water-sourced heating, cooling and stormwater reuse.**

5.30pm Floris Boogaard, J Blanksby, P Kregting, W Bakker & A Poole. **Developing new perspectives on approaches to the management of inlets to traditional urban drainage systems.**

Session 3 - Understanding and Communicating Urban Water Management and Diffuse Pollution Issues (parallel session – Room 2)

4.30pm J Bryan Ellis, Christophe Viavattene & Jennifer Chlebek. **SUDS Modelling For Surface Water Management**

4.50pm Julian Dawson. **The CREW project on Urban Diffuse Pollution.**

5.10pm Chris Jefferies, N Berwick, D Cernagovs & F Boogaard. **Watertown – a computer game for city water planners**

5.30pm **Questions/discussion**

6pm **Close of Day**

7pm **Tuesday Evening** - Conference Dinner at Coventry TechnoCentre

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Wednesday 5th Sept 2012

8.30- 9am Registration and Coffee

9 am Welcome address: SUDSnet International Conference 2012. Day 2.

9.05am Keynote presentation: Floris Boogaard, Tauw bv, Amsterdam, Netherlands
Transnational knowledge exchange on SUDS

PARRALLEL SESSION B

Session 4 - SUDS Performance (parallel session – Main Room)

9.30am L.A. Sañudo-Fontaneda, J. Rodriguez-Hernandez, D. Castro-Fresno & A. Vega-Zamanillo. **Laboratory study of the infiltration performance of three surfacing materials used on permeable pavements**

9.50am Terry Lucke & Simon Beecham. **Field Investigation of Reduction in Infiltration Capacity in a Permeable Pavement System Due To Clogging**

10.10am Gordon Rowlands. **Filter drains on the UK's high speed road network.**

10.30am **Coffee break**

Session 5 - SUDS Treatment 1 (parallel session – Room 2)

9.30am Sue Charlesworth, F. Mbanaso and S Coupe. **Laboratory-based experiments to determine the impacts of applying glyphosate-containing herbicide onto a model porous paving rig.**

9.50am Steve Coupe, F.S Mbanaso, S.M. Charlesworth & E.O Nnadi. **The Impact of Glyphosate Containing Herbicides on the Biological properties of Permeable Pavements**

10.10am Lian Lundy, M Fairley, M Revitt, F Coulon, S Tyrrel, T Hess, J Harris, A Nelson, K Richards & J Barlow. **An evaluation of the removal of sediments and associated pollutants by channel drainage systems.**

10.30am **Coffee break**

PARRALLEL SESSION C

Session 6 - SUDS Treatment 2 (parallel session – Room 2)

11am Kiran Tota-Maharaj, S.J. Coupe & Piotr Grabowiecki. **Functionality of Geotextile Membranes within Permeable Pavements for Biodegradation, Infiltration and Water Detention of Concentrated Urban Stormwater Runoff**

11.20am Alexandros Tsavdaris, John B. Williams, Steve Mitchell & Catherine Mant. **An Investigation on the hydraulic and treatment performance of vegetated SuDS systems**

11.40am Ian Dalgleish. **The real benefit of SUDS: Treatment stages, SUDS efficiency and a review of international monitoring of SUDS**.

Session 7 - SUDS, Green Infrastructure, Amenity & Ecosystem Services 1 (parallel session – Main Room)

11am Lian Lundy, Bob Bray, Bryan Ellis & Mike Revitt. **A multi-disciplinary evaluation of an urban rain garden.**

11.20am Jenny Roe, Scott Arthur & Caroline Brown. **SUDS in schools: exploring the impact on health, wellbeing, and learning in children and young people.**

11.40am Miguel Fornés-Bonavía-Bachák[a]; Jorge Rodriguez-Hernandez & Daniel Castro-Fresno. **Analysis for the implementation of Sustainable Urban Drainage Systems in three different locations in Spain**.

12pm S. Perales Momparler & C. Jefferies. **AQUAVAL: Demonstration SUDS in the Mediterranean region of Valencia.**

12.30 – 2pm Networking and Lunch

Session 8 - **2-3pm** Workshop session - getting added value from SUDS and contributing to low carbon development

3pm **Coffee Break**

Session 9 - SUDS, Green Infrastructure, Amenity & Ecosystem Services 2

3.20pm Louise Walker & Richard Ashley. **Can UK cities ever become 'water sensitive'?**

3.40pm Peter Robinson. **Green Networks Integrated Urban Infrastructure.**

4Pm Alison Duffy, D.Bowie & J. Dalrymple. **SUDS and Trees – Integrating landscaping and surface water strategies.**

4.20pm Celeste Morgan & Louise Clarke**. Bringing Water Sensitive Urban Design to the UK**

Session 10 - Future developments in SUDS (presentation and discussion)

4.40pm Paul Shaffer (presentation) and discussion session with Keynote speakers, and SUDSnet organisers: Rebecca Wade & Sue Charlesworth.

5.30pm **Close of main conference sessions**

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Thursday 6th Sept 2012

Field trip 9am - 5pm (Please note; you must have registered separately for the field visit)

The planned Field visit locations are:

1. Coleford - Formpave factory and permeable paving demonstration site - **Please note this site requires PPE** as we have to go through the factory to get to the permeable paving test site (please let us know if you can supply your own PPE or require us to bring some for you)

2. M40/J15, Longbridge Island - vegetated highways SUDS (Site access and permission is still to be confirmed)

3. Lunch (packed lunches provided) and return to Coventry Campus

4. Retrofit small scale SUDS in Cities: led by Simon Watkins (landscape architect and SUDS designer) who will talk about retrofitting small patches of SUDS in cities. We will meet in Coventry and walk to some examples of this on Coventry University campus (Ellen Terry building). The campus SUDS comprises Marshall's block PPS, resin PPS, rain gardens and trees (also an amenity as it can be used as an outside classroom) and there's a building with a green roof just around the corner.

Abstracts – Pre-Conference Postgraduate Research Session

Predicting pollutant retention in SUDS, with a rain garden application

Ruth Quinn, Alejandro Dussaillant,
Corresponding Author Ruth Quinn
University of Greenwich, Chatham, Kent, UK

A major problem of increased urbanisation is the rise in pollution caused by urban runoff. The chief components of this pollution are hydrocarbons, nutrients and heavy metals such as Cadmium, Copper and Lead. A solution to this problem can be found through the use of sustainable urban drainage systems such as rain gardens. Rain gardens are landscaped gardens situated in a shallow depression of a relatively small area which receives storm water runoff from impervious surfaces. Their popularity in the U.K is sure to grow with the introduction of legislation such as 'The Flood and Water Management Act 2010' because of this and the growing pollution caused by urban runoff, research into these facilities is of increasing importance in the U.K and worldwide.

Previous research has focused primarily on the degree to which groundwater is replenished by these systems and computer models have been developed to quantify the extent of that recharge i.e. RECARGA and RECHARGE. However these models do not simulate the generation or treatment of water quality parameters such as pollutant loading and removal. The ability of rain garden to retain pollutants has been well documented through various experiments however a computer model with the ability to predict the retention in a layered system is lacking.

In this paper, a simple model is presented specifically for the transport and retention prediction of urban runoff heavy metal contaminants in a rain garden system. It consists of two parts; a water model and pollutant retention section. To describe flow behaviour a dual-permeability approach is proposed which will facilitate the prediction not only matrix but of macropore flow which has a large impact on heavy metal capture. The water model has successfully simulated literature case studies regarding water balance and flows in the matrix region, based on strong gradient cases, pulse infiltration and layered soil profiles as would be expected in a rain garden situation. It has also proven accurate when tested for varying input flows in a layered soil profile in the macropore region.

This water modelling segment is combined with the retention section. This utilizes isotherms previously proven accurate in heavy metal retention models such as the linear, Langmuir and Freundlich isotherms and couples them with the advection-diffusion equation. By combining both the retention and transport factors not only can the complete retention profile of the metal through the soil be predicted but characteristics of the system (soil, depth of layers etc.) and environmental factors (heavy metal concentration, rate of infiltration etc) can also be taken into account. This section has also been tested and shown favourable results against previous experimental data. This computer model will undoubtedly provide a valuable tool for the design and implementation of bioretention facilities in urban environments.

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Laboratory-based experiments to investigate the impact of glyphosate-containing herbicide on pollution attenuation and biodegradation in a model pervious paving system.

Mbanaso*, F.U., Coupe, S.J., Charlesworth, S.M. Sustainable Drainage Applied Research Group, Coventry University, CV1 5FB *Corresponding author

Abstract

An experimental investigation was carried out to determine the effect of glyphosate-containing herbicides (GCH) on the hydrocarbon retention and biodegradation processes known to occur in pervious pavement systems (PPS). The pervious paving system (PPS) rigs were based on the four-layered design detailed in CIRIA C582 and enabled the pollutant retention capacity of the PPS to be investigated as well as the biodegradation of these pollutants by microorganisms. The use of test rigs also revealed the impact of GCH on PPS eukaryotic organisms, by the monitoring of protist bioindicators. Results showed that the GCH disrupted the retention of hydrocarbon by the geotextiles relative to the rigs with mineral oil only added, as 9.3% and 24.5% of added hydrocarbon were found in herbicide only rigs and herbicide plus oil rigs respectively. PPS contaminated by mineral oil had previously been shown to retain 98.7 % of added oils and over several weeks, biodegrade this oil in-situ. Where GCH was added to experimental models, much higher concentrations of heavy metals, including Pb, Cu, and Zn, were released from the PPS in effluent, particularly where GCH and mineral oil were added together. The source of the majority of the metal contamination was thought to be the waste mineral oil that had been used in a vehicle engine. The herbicide generally increased the total activity of microbial communities in rig systems and had a stimulating effect on bacterial and fungal population numbers. Although the protists, which are part of the microbial community directly or indirectly responsible for biodegradation, were initially strongly affected by the herbicide, they showed resilience by quickly recovering and increasing their population compared with rigs without added herbicide, including the rigs with mineral oil added to them. However, the presence of herbicide was associated with a decrease in the species richness of recorded protist taxa and a predominance of robust, cosmopolitan or ubiquitous protist genera.

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Pervious paving systems: potential use for promoting street tree health, reducing pavement damage and reducing stormwater flows

Jenny Mullaney[1], Terry Lucke[1], Tim Johnson[2], Don Cameron[2], Greg Moore[3]
[1] *School of Science and Engineering, University of the Sunshine Coast, Maroochydore, QLD, 4558, Australia*
(jennifer.mullaney@research.usc.edu.au)
[2] *School of Natural and Built Environment, University of South Australia, Mawson Lakes Campus, 5095, Adelaide, South Australia, Australia*
[3]*National Trust and Victoria Significant Tree Register Committee Chair, Melbourne, 3000, Victoria, Australia*

Abstract

Street trees are an everyday part of life that are regularly incorporated into typical residential street and shopping area landscaping designs by councils and city planners. Street trees provide many environmental and stormwater management benefits including increased aesthetic values, reduced heat island effects and stormwater runoff reduction. However urban areas can be hostile environments for street trees and a trees health can often suffer due to a lack of desirable conditions. Impervious pavements prevent water and oxygen, vital for tree growth, from infiltrating to the tree roots. This can often result in costly damage to infrastructure as tree roots search out new moisture sources. Permeable pavements are a relatively new technology that allows water and oxygen to infiltrate through the pavement surface and into the soil below. Permeable pavements may offer a viable solution to enhance street tree performance and to reduce pavement damage by tree roots, as well as reducing stormwater flows. A field study is currently underway at the University of the Sunshine Coast to investigate whether permeable pavements with varying sub-base depths can reduce infrastructure damage and increase street tree health. A parallel study is being conducted at the University of South Australia to investigate whether street trees with permeable pavement surrounds can be used to manipulate the growth and distribution of tree roots in urban environments to minimise the effects of reactive soil movements. This paper describes the experimental design and presents the interim results of these studies.

Keywords: SUDS, Permeable pavements, Street trees, stormwater reduction, pollution reduction, root damage

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Fate of Hydrocarbon Pollutants in Source and Non-Source Control SUDs systems

Georgios Roinas[a]*, Cath Mant[a], John B. Williams[a]
[a] University of Portsmouth, School of Civil Engineering and Surveying, Portland Building, Portland Street, Portsmouth, Hants, PO1 3AH, UK.
* *corresponding author*. Tel.: +44 (0)23 9284 2428 georgios.roinas@port.ac.uk

Abstract

Source control is an accepted part of SUDs philosophy and has been shown to provide effective control of water quantity. However there are limited studies of the contribution source control makes to pollutant removal, especially in trafficked areas. This study examines the fate of organic pollutants, Total Petroleum Hydrocarbons (TPH) and Polycyclic Aromatic Hydrocarbons (PAHs) in a range of paired source and non-source control full-scale SUDs systems to assess the influence of source control techniques.

Sites have been selected to cover housing developments, car parks and trunk roads serves by a range of SUDs options, such as porous asphalt, swales, detention basins and ponds. Soil samples and water samples have been taken bi-monthly over a 14 month period. Soils have been through Accelerated Solvent Extraction (ASE) and water samples through Solid Phase Extraction (SPE) prior to injection onto a GC-MS. Regular monitoring of the accumulations of pollutants in soil layers (0-20mm, 20-40mm and 40-60mm) has been supplemented by targeted monitoring of storm events and combined with general measurements of water quality (BOD, COD, TSS, VSS, conductivity and pH).

To date the source control systems have generally had lower pollutant levels in runoff compared to non-source control, but these are not statistically significant. However some PAHs have higher concentrations in non-source control systems, possibly due to weathering of recently laid porous asphalt. Road runoff was generally more polluted than housing developments, and significantly higher levels of certain PAHs (e.g. pyrene) were seen in urban roads compared to the trunk road network, possibly reflecting traffic patterns. Sampling of TPH profiles in soils have shown transportation of pollutants down through the water column.

The outcomes of this project will increase the understanding of how these organic pollutants behave in SUDs systems and the factors affecting their accumulations. This will allow any risks posed by the accumulation levels to be assessed and provide design guidance about the most appropriate systems for treating these pollutants.

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Sustainable drainage systems: A sustainable flood management plan?

Craig Lashford, Dr Susanne Charlesworth , Dr Matthew Blackett , Frank Warwick
SUDS Applied Research Group, Coventry University, Coventry, CV1 5LW
Tel: +44. 2476 887688 craig.lashford@coventry.ac.uk

Abstract

This research project examines the effectiveness of a SuDS management train at the proposed Canley regeneration site, Coventry. The plan is to demolish 30 houses and replace them with 731 new dwellings over 16ha. *WinDes*® drainage software will be used to model the site's response to various rainfall events after development but without SuDS. Once the expected risk of flooding has been ascertained, SuDS devices can then be defined in *WinDes*® to investigate their ability to reduce runoff over a range of rainfall scenarios. Multiple combinations of devices will be linked together to assess their use as a management train to evaluate the most effective combination, and ultimately to provide a 'best fit' scenario for the site. On completion of this project a wider knowledge of the use of a SuDS management trains ability to reduce water quantity at new developments will be gained, along with the methodology for development of a best fit management plan for small scale sites.

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Ecosystem Services and Urban Water

Roshni Jose*, Rebecca Wade, and Chris Jefferies

Urban Water Technology Centre, University of Abertay Dundee, Dundee, UK. DD1 1HG
*r.jose@abertay.ac.uk

Abstract:

This paper presents initial efforts to define the Ecosystem Services (ES) associated with Sustainable Urban Drainage Systems (SUDS). Pilot studies carried out at sites in Scotland (Dunfermline and Dundee) helped to identify the different ES associated with SUDS systems. The SUDS systems which are considered for evaluation are Wetlands, Ponds, Detention Basin and Swales as they are rich in vegetation. A comparative assessment has been carried out at non-vegetated sites like Permeable Paving and Filter Drain.

According to Millennium Ecosystem Assessment (MEA) there are four categories of ES; provisioning services, regulating services, cultural services and supporting services. Supporting services are necessary for the production of all other ES. Supporting services related to SUDS are primary production, oxygen production, soil formation, water cycle, nutrient cycling and habitat. Provisioning services are the products obtained from the ES such as food, water, renewable energy, fuel and genetic resource. Regulating services are the benefits obtained from regulation of ES such as climate regulation, water regulation, erosion control, water purification, air quality maintenance, pollination, noise, soil quality and water quality. The non-material benefits which humans receive from the ecosystem are knows as cultural services, e.g. Sense of well being, religious well being, physical well being, educational value, aesthetics, recreation, wild species diversity etc.

Vegetated SUDS systems include grasses, reeds, silver birch, willow trees, yellow and red dog weeds, cotoneaster and many other plant species. There are also many bird and insect species (e.g. coots, ducks, swan, bugs, flies). The ponds and the wetlands enhance a sense of well being, educational value and recreation values. Thus, SUDS provide multi-functional benefits in context to the ES assessment and valuation. Preliminary results suggest that SUDS do not provide many provisioning services. However, they contribute to supporting services, provisioning services and cultural services.

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Evaluating the Amenity of Sustainable Urban Drainage Systems

Stewart Fowler, Frank Warwick* and Susanne Charlesworth

SUDS Applied Research Group, Coventry University, Priory Street, Coventry, CV1 5FB

*** corresponding author**

Abstract

The sustainable drainage systems (SUDS) triangle places equal emphasis on the quantity and quality of runoff, together with amenity benefit. There has been much work in the literature on the quality and quantity performance of drainage systems, but there appears to be a relative lack of research into the amenity benefits of SUDS. The aim of this study was the creation of a framework to evaluate the amenity of SUDS based on a scoring mechanism. The term 'amenity' was defined by the selection of nine key elements sourced from the literature, and these elements were constructed into a multicriteria based framework. The framework combined consultation with members of the public, site managers and researcher observation and was applied to two SUDS in the field; a permeable paved car park and a green roof.

Application of a weighting scheme established that the car park had a slightly higher amenity value (65%) than the green roof (62%). The framework was shown to produce reliable amenity values through the completion of a framework validation exercise. The framework approach also enabled suggestions for the improvement of amenity value for each SUDS device.

Key Words: Sustainable Urban Drainage Systems (SUDS), amenity, multicriteria framework

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Invited Keynote presentation:

Prof Bruce K. Ferguson, University of Georgia, USA

Toward Alignment of Stormwater Flow with Urban Space and Value

Abstract

In the last 50 years stormwater management and urban design have been developing simultaneously, and in parallel directions of knowledge, diversity, and complexity. Stormwater has been developing new technologies and connecting into natural environmental processes. Urban design has been renovating cities with the growing guidance of social science. Place — location — organizes relationships between people, and between people and the environment. Stormwater and its associations with the rest of nature are a dimension of a place's identity, which can be articulated by design which makes it readable. In an overall watershed system, stormwater flows and practices are aligned with urban spaces and human values in a downstream flow sequence. This simple framework allows practitioners to navigate conceptually through the system, and to focus appropriate objectives and structures on each project site. Over time stormwater has been calling on the urban districts where stormwater originates to help meet water quantity and quality requirements; in turn urban design has been calling on stormwater's perimeter features and downstream areas to contribute to human-centered values. The measure of a city's success is the human value of safe, active human use; competing claims for a water-centered agenda are balanced and reconciled with it by integral spatial organization, placement under overt human care and maintenance, and human contact and interaction. Over time specialized stormwater and human-oriented facilities tend to become less important; in their places are multi-functional facilities which demand creative, site-specific, multi-disciplinary application.

Biography

Bruce K. Ferguson is Franklin Professor of Landscape Architecture and former Director of the School of Environmental Design at the University of Georgia. He has served as a visiting professor at the University of Texas in Austin and at Tsinghua University in Beijing. He has authored approximately 200 scientific and professional articles, and the books *Stormwater Infiltration* (1994), *Introduction to Stormwater* (1998), and *Porous Pavements* (2005). He has twice served as Faculty in Residence at Design Workshop, the firm which won the American Society of Landscape Architects' 2009 Firm of the Year award. He works with Design Workshop and other firms on interdisciplinary teams designing projects throughout North America and overseas. He earned the AB degree at Dartmouth College and the MLA degree at the University of Pennsylvania. He is a Fellow of the American Society of Landscape Architects, a Past President of the Council of Educators in Landscape Architecture, and a recipient of the Council's Outstanding Educator Award, North America's highest award for career contributions to landscape architectural education.

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SESSION 1 – SUDS and Water Management Planning

SuDS for all partners

Bronwyn Buntine, Sustainable Drainage Engineer, **Kent County Council,** Planning and Environment. **t:** 01622 696793 **e:** bronwyn.buntine@kent.gov.uk

Abstract

The means by which sustainable drainage elements are incorporated into development is dependent upon the aspiration for the urban environment and the vision of the urban planners at the local authority level. A County Council however does not have a spatial planning role and is dependent upon the relationship with its district council partners who review and approve planning applications to deliver schemes which will also meet drainage objectives. Consultation has highlighted the differences in planning approaches across Kent, as different communities are subject to differing development pressures and different ideas about development context. An approach which clearly demonstrated how sustainable drainage elements could be incorporated into the streetscape and highway design needed definition. This paper presents the steps in development of guidance for integrating sustainable drainage into development planning, starting at the necessary consultation with planners, involving the experience of highway engineers and the development of guidance for integrating SuDS into planning.

This guidance has importance irrespective of the status of the draft National Standards, by incorporating all the important elements which need to be considered by planners to ensure inclusion of sustainable drainage within any proposed scheme. It is specifically about promoting SuDS beyond the engineer and developing guidance which is aspirational, beyond simply water management.

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Decision support for SUDS Approval Bodies when assessing SUDS feasibility

Frank Warwick and Susanne Charlesworth. *SUDS Applied Research Group, Coventry University, Priory Street, Coventry, CV1 5FB*

Abstract

Implementation of the Flood and Water Management Act (2010) will place increased responsibility on local councils in England and Wales for planning approval and future maintenance of sustainable drainage (SUDS) installations. The operation of decision-making SUDS Approval Bodies (SABs), and their integration into the planning system, is currently under discussion. Local planning authorities (LPAs) have limited experience in assessing SUDS design, installation and maintenance, and there are limited numbers of demonstration SUDS installations in England. The need for capacity building in local authorities has been recognised, as well as a need for high level information to guide decision making.

In conjunction with Coventry City Council, this research has developed a series of maps using a Geographical Information System (GIS) to indicate feasible locations for SUDS devices in Coventry. The maps cover new developments, both on greenfield and previously developed land, and retrofit of existing developments, for 5 main categories of SUDS: infiltration, detention, conveyance, filtration and source control. These maps are intended to provide initial guidance to planners and SABs on the type of SUDS likely to be suitable in specific areas of the city.

To determine the types of SUDS suitable in particular locations, the factors driving feasibility of SUDS in an urbanised LPA area were evaluated. The spatial relationships between characteristics such as geology, soil type, groundwater, land use, planning constraints and potential land and water contamination were analysed using a GIS, based on sources of information that are readily available to local authorities. The use of GIS ensured that the maps are scaleable, and can be viewed at differing resolutions from the full LPA area down to individual development and regeneration sites.

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Vesting Public SUDS in Scotland - Effective and Transparent Governance: learning by doing and doing by learning.

Alison Duffy*, Doug Buchan, Maria Lucey**.**
***a.duffy@abertay.ac.uk**, **University of Abertay Bell St, Dundee, DD1 1HG.**
****doug.buchan@scottishwater.co.uk**, **maria.lucey@scottishwater.co.uk**, **Scottish Water, Balmore Road, Glasgow, Scotland.**

Abstract

Achieving sustainable solutions is one of the greatest challenges of the 21st century. Unsustainable practices such as draining surface water to underground structures which are resulting in unmanageable problems in terms of future global pressures are deep rooted in our societal fabric i.e. culture, habits, institutional structures, infrastructure and economic investment (Rotmans et *al*, 2001). In response to the Water Framework Directive (EC, 2000), changes in Scottish legislation (Water Environment and Water Services Act, 2003) require Scottish Water (the drainage authority) to vest and maintain public SUDS. This was a first for any UK water company at the time. By taking the lead and introducing technical standards to guide designers and contractors (Sewers for Scotland, 2nd Edition, WRc, plc, 2007), Scottish Water enabled the creation of a SUDS vesting process. Scottish Water is committed to acting responsibly in the delivery of its services and to making the right choices in terms of service and cost. This is particularly important for SUDS assets as their operational lives are measured in decades and Scottish Water needed to understand how they could evolve to a more sustainable future asset base.

Prior to the development of SUDS technical standards, Scottish Water had specialist knowledge of the design, operation and maintenance of below ground drainage (pipes and underground storage) and a culture which presumed against the vesting of above ground assets. There was also considerable lobbying from the developer community for Scottish Water to begin transferring SUDS into their ownership. However, an initial investment by Scottish Water had to be made that put SUDS vesting procedures and processes in place. This was not an easy task considering the large number of internal stakeholders who needed to be prepared for their role in facilitating the process. The presentation/paper will discuss the transition to vesting public SUDS from an interactive governance perspective. A key feature of interactive governance is the facilitation of exchange of information and knowledge to stimulate social learning to deliver changes in practices (McElroy, 2002). Social learning is where investigation and learning take place at the same time (Grin et *al*, 2010) and is often referred to as double loop learning (learning by doing and doing by learning). Scottish Water is emerging out of a four year long knowledge acquisition and capacity building journey that has enabled them to transform from a risk averse to a risk management approach to vesting SUDS. Through internal stakeholder social learning programmes which have contributed to a positive shift in customer focused performance and external customer led negotiations, Scottish Water have begun to adopt SUDS assets which deliver solutions that are both fit for purpose and value for money for all parties.

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Making SABs work in Practice – the experience of Cambridgeshire

Co-presented by Celeste Morgan, Director (AECOM) and
Sass Willis (Cambridgeshire County Council).

Corresponding author email: celeste.morgan@aecom.com

Abstract:

Cambridgeshire County Council have taken a proactive approach to their imminent SAB duties by actively taking 'get ready' measures. One such measure includes development of approval and adoption guidance, ensuring relevant stakeholders are engaged in the process. Cambridgeshire commissioned AECOM to develop the guidance (currently at first draft stage), who have held interactive sessions with key statutory and non-statutory consultees, county and local planning authority staff and developers to shape the SuDS vision for Cambridgeshire and importantly create a SAB process that works.

Working ahead of government guidance, we are actively identifying and addressing process issues, which we hope to be able to share with other Lead Local Flood Authorities.

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SESSION 2 – SUDS DESIGN

Maximising recycling, effective attenuation and multi-stage water treatment – A case example at Mount Vernon Hospital, London

S. Gibson, Ramboll Ltd

Corresponding author email stephen.gibson@ramboll.co.uk

Abstract:
Available spending on civil infrastructure such as boulevards and car parks at hospital sites is often limited. Yet they are critical to providing an essential facility to those working and visiting. With this in mind, Hillingdon NHS Trust looked to create a new welcoming main hospital entrance, bus boulevard and car park as cost effectively and sustainably as possible.

The site contained an arrangement of WW2 preformed concrete wards. The ground was relatively impermeable with flooding in the vicinity. Traditional construction at the site had historically involved demolishing and removing all existing buildings off site and then importing materials to construction new impermeable asphalt surfaces.

Ramboll designed a sustainable drainage system, with a multistage treatment and integrated attenuation arrangement. A fundamental objective was to maximise the reuse of existing crushed building materials in the new design. There are no civil design standards or advice available in the UK directly applicable to such an arrangement - both in relation to structural strength and water quality performance. The design was therefore based on applying basic design principles to the specific situation and agreeing specific constraints such as maximum vehicle loading.

The design aims also included minimising regular maintenance costs, providing an opportunity for greater biodiversity and minimising the CO2 footprint of the project work.

A key element was the production of a material performance specification criteria and design which would be adequate, but achievable, using a conventional mobile crushing and screening system. This was to provide the appropriate hydraulic and structural material quality for use in the French drains, capping layer and subbase layer.

Research into water and sediment quality has been ongoing by the University of Portsmouth. Less formal, visual checks have been undertaken by Ramboll, to identify any defects. Many lessons have been learned from this experience which can be used to inform future designs.

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Advancing SuDS capital and maintenance works within cross sector multi-lot technical service procurement.

Stephen Tingle B Eng., C Eng., M.I.C.E., Director: Tingle Consulting Ltd.
Phone: +44 (0)141-956-1800. E: tingle.consulting@gmail.com. Web: www.tingleconsulting.co.uk

Abstract

This paper sets out some of the new challenges and opportunities for SuDS implementation within a period of austerity. To reduce common costs central procurement needs to advance SuDS implementation, pooling Contract documentation expertise, from different sectors, enabling the efficient dissemination of technical demands from one sector to another for specific geographic areas.

Moving away from multiple single sector frameworks, each declaring virtual efficiency savings, to multi-lot common real efficiencies is possible, but faces significant administrative and political challenges. Central government, 3 decades ago, sought to reduce the size of the public sector, and unbalanced the organic interdependence between the public and private sector. From this point on, the real cost of UK infrastructure has risen to being close to, or indeed the highest, in the EU. There is of course the new Scottish Hydro Nation approach, that merits consideration, as part of this approach includes for an increasingly profit focused public sector, targeting international work which would provide new public income streams.

Efficiency savings from staff reductions only materially become real after 2015, due to the offsetting costs of pension arrangements. COSLA has confirmed that current staff reductions in the Scottish Public sector are only expected to provide savings in the medium to long term. Real savings currently arise from doing less, and will continue, until structural reform of the public sector and its' procurement procedures are advanced much further.

Different public bodies have different procurement teams, commissioning different frameworks, to different remits, but in common catchment areas. We need to ensure that these framework remits have as much in common as practicable, within an agreed overall policy context, so as to comply with local statute, and EU procurement law, delivering visible common outcomes and common savings, within common catchment areas.

The essential problem to multi-lot framework agreements is one of getting adequate interdependent remits across each lot, so that joined up thinking does not take place at higher cost after any contract award, else the cost of infrastructure in the UK will increase still further.

There has been a major growth in knowledge constraint, alongside knowledge management, over the last decade, and it is envisaged that there could be resistance to greater SuDS implementation if it suggested that iconic central procurement was anything less than an exemplar approach, so it must be improved for any change to take place.

Options for rebalancing the SuDS positioning for advancement within the development of multi-lot procurement frameworks, must focus on 2 key parts of any contract, namely general relevant information, that informs the Tenderer, and key specification requirements that better inform the Tenderer of the post award contract requirements. Other specialist sectors should follow this approach, but SuDS should opportunistically lead the way.

New SuDS information/guidelines must be limited to scoping standard guidance for Tender documentation, which whilst often readily available in some format, requires background preparation and agreement by the various parties that will manage the Contract Post Award. There is a clear need to pathfind simple yet effective SuDS technical guidance for central procurement in the immediate future.

Simple and cheap general information that can be provided to multi lot Tenderers include the longest surface water pathway routes from ArcHydro (Virtual Watercourses), and its mini catchment boundaries. The nature of the potential contract work for any lot, in any area is instantly much more defined, and can be better priced.

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Exploring the potential of constructed wetlands for low-carbon water-sourced heating, cooling and stormwater reuse

Kiran Tota-Maharaj[1*], Piotr Grabowiecki[2], Akintunde Babatunde[3] and S.J. Coupe[4]

[1*]University of Salford Manchester, Civil Engineering Research Centre, Newton Building, Salford, Greater Manchester, M5 4WT, United Kingdom
Email: K.Tota-Maharaj@salford.ac.uk, Tele: +44(0) 161 295 3693, Fax: +44(0) 161 295 5575
[2]Institute of Geophysics, Polish Academy of Sciences, Ksiecia Janusza 64, 01-452, Warsaw, Poland
[3]University of Cardiff, School of Engineering, Queen's Building, The Parade Cardiff CF24 3AA, Wales, United Kingdom
[4]Sustainable Drainage Applied Research Group, Coventry University, Priory Street, Coventry, CV1 5FB, UK.

Abstract

Urban runoff and wastewater consists of various concentrations of pollutants such as phosphorus, nitrogen and contributes to water quality problems. Constructed wetlands have shown a great potential in reducing runoff and concentrations of pollutants which can have harmful effects on downstream water supplies. Water-sourced heat pumps (WSHP) are a well established renewable energy tool which can effectively utilise heat transfer from a wetland to a nearby building. Two constructed wetland were designed and tested for treating municipal wastewater. The experiments were conducted at the University of Salford green house laboratory. The wetlands were vertical flow types, designed to operate similarly to natural wetlands. One wetland was integrated with a water-sourced heat pump and the other a standalone wetland system assessing their feasibility for water quality treatment and as a potential energy source to heat and cool nearby buildings. The wetland linked to the WSHP sub-base fluctuated with heating and cooling temperatures ranging from 4-9 °C in a cooling cycle and 23-27 °C in a heating mode respectively. The experiment was conducted for a 10 month period from (June 2011- March 2012) using municipal wastewater collected from United Utilities (Greater Manchester) every fortnight. Water quality was determined for the removal of biochemical oxygen demand, chemical oxygen demand, suspended solids, and nutrients (phosphates, nitrates and ammonia).The laboratory pilot-scaled experimental wetlands purified the highly concentrated wastewater breaking down the nutrients and organic content ranging from 70-99%. The overall outcome of this research contributes to the novel design and development of combined engineered wetland systems and water-sourced heat pumps as a sustainable eco-friendly technology with the potential of efficiently treating concentrated stormwater/wastewater and acting as a source of energy.

Keywords: Engineered Wetlands, Vertical Flow, Water Reuse, Water-Sourced Heat Pump, Sustainable Energy Efficiency

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Developing new perspectives on approaches to the management of inlets to traditional urban drainage systems.

Boogaard F.C.[*+***], Blanksby J.**, Kregting P ***, Bakker W ****, Poole A.[*****]
* *Delft university of Technology. Department of Sanitary Engineering, Faculty of Civil Engineering and Geosciences, Delft University of Technology, P.O. Box 5048, NL-2600 GA, Delft, the Netherlands*
** Pennine Water Group, Department of Civil and Structural Engineering, University of Sheffield, UK
*** Tauw bv, Zekeringstraat 43 g, 1014 BV AMSTERDAM, *the* Netherlands
Email corresponding author: Floris.Boogaard@tauw.nl, f.c.boogaard@tudelft.nl
**** Waternet Amsterdam
***** City of Bradford Metropolitan District Council

KEYWORDS:
Gullies, Transnational knowledge exchange, innovative SUDS, stormwater quality, maintenance, design, monitoring,

Abstract
Gullies are the by far the major link between urban surfaces and the traditional drainage systems that dominate the drainage of our major urban areas. It has not been common practice to consider the performance of these inlets in urban design and implementation processes. Research part funded by the SKINT project has set out to better understand the performance of gullies in conveying water from surfaces into drainage systems, and their role in solids management. This is leading to new perspectives on how inlets could be designed, constructed and managed. This paper outlines the results of this research done in laboratory and field and suggests improvements of urban drainage systems in urban areas.

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SESSION 3 - Understanding and Communicating Urban Water Management and Diffuse Pollution Issues

SUDS MODELLING FOR SURFACE WATER MANAGEMENT

J Bryan Ellis*, Christophe Viavattene# and Jennifer Chlebek+
***Urban Pollution Research Centre, Middlesex University, #Flood Hazard Research Centre, Middlesex University, +Ove Arup, Solihull.**

Abstract:
The Flood & Water Management Act requires that local authorities should identify "critical drainage areas" to quantify "hotspot" flood and pollution risks associated with extreme event urban surface water runoff. The identification of such critical areas within Surface Water Management Plans (SWMPs) must then be addressed by implementation of appropriate mitigating controls in compliance of catchment management planning under the EU Water Framework Directive (WDF). A GIS-based 1D/2D modelling analysis (using STORM/FloodArea) and integrated with a drainage assessment tool has been developed to identify critical urban drainage areas and their flood/pollution potential. In addition, the modelling approach further integrates a SUDS selection and location tool (SUDSLOC) to provide a robust and stakeholder-friendly surface water management framework.

The modelling approach is illustrated by reference to a 440ha residential catchment in North Coventry and which has been tested for a number of extreme storm events (> 1:30 RI). The SUDSLOC tool identified infiltration basins as appropriate drainage controls for exceedance storm flows which were strategically located within the catchment to achieve maximum reduction in peak flows and to minimise sewer surcharging. The further application of a unit area pollution (UAP) modelling approach enables the quantification of the spatial load distribution of various pollutants associated with urban landuse activities. This identifies pollution "hotspots" which can be integrated into the SUDSLOC modelling to assess the mitigating water quality effect of the selected SUDS devices. The performance of the SUDS controls is assessed based on the choice of differing digital elevation modelling (DEM) scenarios. The uncertainties and limitations of the modelling approach as a reliable and sustainable surface water management framework will also be discussed.

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The CREW project: Urban Diffuse Pollution Control

Julian Dawson & Andrew Cuthbert (James Hutton Institute), and
Rebecca Wade (University of Abertay Dundee)

Corresponding author: Julian.Dawson@hutton.ac.uk

Abstract:

CREW is the Centre of Expertise for Waters, a partnership between the James Hutton Institute and all Scottish Higher Education Institutes which ensures that water research and expertise is available and accessible to the Scottish Government, to support the development and implementation of water policy in Scotland. This paper will present a background to the CREW project on Urban Diffuse Pollution Control which is currently running under this programme.

Managing water within urban spaces is an essential infrastructure requirement, historically undertaken in isolation from other urban functions and spatial requirements. More sustainable approaches to urban water management are being applied which can have multiple functions and benefits.

The presentation will ask the question: Can SUDS mitigate urban diffuse pollution? On-going research must develop integrated tools that are relevant to understanding sources, pathways and mitigation of diffuse pollutants; assess which methods best identify sources and pathways for a given urban environment and/or readily available information; and evaluate mitigation strategies that can meet diffuse pollution prevention and multiple benefits in terms of cost, energy and water sustainability. The CREW project is designed to assist the Scottish Government to recognise the multiple benefits associated with urban disuse pollution control. A case study (in a Scottish urban area) incorporating scenario testing of sustainable mitigation measures and their multiple benefits will test the findings of the review.

The CREW project is collaboration between The University of Abertay and The James Hutton Institute, in partnership with The University of Middlesex, The University of Dundee, the British Geological Survey, and Creative Drainage.

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Watertown – a computer game for city water planners

Jefferies C[1*]., Berwick N[1]., Cernagovs D[1]. and, Boogaard F[2].

[1]*Urban Water Technology Centre, University of Abertay, Bell Street, Dundee, DD1 1HG, UK*
[2] *Technical University of Delft, Postbus 5, 2600 AA Delft, Nederland.*

** Corresponding author c.jefferies@abertay.ac.uk*

Abstract

This paper outlines a novel approach to communicating flooding and water quality problems in cities using computer game technology. WaterTown is an accessible and visually attractive computer tool intended to communicate water management issues to a varied audience. The game has three main strands; flooding caused by a range of problems such as increased precipitation due to climate change, construction of towns and cities, pollution of lakes and rivers, and, damage to historic buildings due to soil drying out.

Most of the current tools for interpreting the results of technical investigations can only be used by professionals in the field or by lay-people who have had training. This even applies to the most common means of presenting spatial data which is to use Geographical Information Systems (GIS) platforms which, although having the ability to incorporate a great deal of information, are not readily understood by the untrained eye. Further, there is little common language between the urban planner, who has to deal with general concepts, and the hydraulic modeller who addresses every detail as far as the resources available for a model are available. This means that many important decisions are made on the basis of imperfect information which can easily be wrongly interpreted. The gamer must make decisions about planning water in urban areas in a non-technical way while at the same time implicitly addressing technical considerations. It is targeted at senior school students, but should also appeal to local politicians and be 'fun' for the relevant professional.

The video game has been developed using Maya software which is the basic tool for creating life-like special effects and complex 3D animations and is commonly used within the movie and animation industries. Similar outputs can be developed in most 3D packages but Maya has specific supporting tools which model the physics of water movement to produce very realistic representations of running water in city environments.

WaterTown has been developed to help city planners understand the issues caused by progressive development and redevelopment of urban areas which result in diverse problems such as low river banks and bridges and sewers which overflow causing pollution. The development of WaterTown has been driven by recent changes in legislation and policy at a European level, particularly the recent EU Floods Directive. At a regional level, changes in ownership and management responsibilities of sustainable drainage within different regions of the UK have been a strong driver for improved engagement with water issues in cities. WaterTown is a product of the EU Interreg IVb programme North Sea Skills Integration and New Technologies (SKINT), one aim of which is to widen public consultation and dissemination of water issues in cities.

Key Words: Urban Planning, Computer Game, Flood, Sustainable Drainage, SUDS.

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Invited Keynote presentation:

ir. F.C. (Floris) Boogaard consultant **Tauw bv, Netherlands, and Delft University of Technology, Netherlands.**

Transnational knowledge exchange on SUDS
Case study: permeable pavement

Boogaard F.C.[*+***], Blanksby J.**, Chris Jefferies***
* *Delft university of Technology. Department of Sanitary Engineering, Faculty of Civil Engineering and Geosciences, Delft University of Technology, P.O. Box 5048, NL-2600 GA, Delft, the Netherlands* ** Pennine Water Group, Department of Civil and Structural Engineering, University of Sheffield, UK *** Tauw bv, Zekeringstraat 43 g, 1014 BV AMSTERDAM, *the* Netherlands **** Urban Water Technology Centre, University of Abertay Dundee DD1 1HG
Email corresponding author: Floris.Boogaard@tauw.nl, f.c.boogaard@tudelft.nl

Abstract:
Transnational knowledge exchange is an essential part of raising awareness of the performance of SUDS in different circumstances or countries. Although the concepts of sustainable urban drainage systems (SUDS) are widely understood, little attention has been given to how to optimize these systems to improve the hydraulic benefits and removal efficiency of SUDS to achieve water quality and quantity standards or other aspirations. Under the flag of the project Skills Integration and New Technologies (SKINT) UK, Norway, Germany and the Netherlands, experiences in SUDS are being exchanged by international activities such as workshops, fieldtrips, job rotation, serious gaming and augmented reality etc.
Examples of well constructed SUDS are easy to find and it is always best to show good examples to demonstrate beneficial changes in practice. However, examining the reasons why SUDS may not deliver optimum performance can be useful in illustrating the consequences of poor design and construction of SUDS. Examples include: reduction of the infiltration or storage capacity, reduction of the discharge capacity and pollution of soil and groundwater. This is illustrated by an on-site monitoring and evaluation programme, and a review of case studies in the Netherlands and Scotland. Specific examples are given including one permeable pavement which was clogged immediately after construction. In general the infiltration rate of these infiltration facilities can be high after construction but in other cases, the infiltration capacity deteriorated over the years and in some cases has become little different than that of regular pavement. Common highlights and failures in the design, construction and maintenance of SUDS were gathered from several international locations and recommendations are given.

Keywords: Transnational knowledge exchange, innovative SUDS, stormwater quality, maintenance, design, monitoring, permeable pavement.

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SESSION 4 –SUDS Performance

Laboratory study of the infiltration performance of three surfacing materials used on permeable pavements

L.A. Sañudo-Fontaneda[1*], J. Rodriguez-Hernandez[1], D. Castro-Fresno[1], A. Vega-Zamanillo[2]

[1] *Construction Technology Research Group (GITECO). Department of Transports, Projects and Processes Technology. Universidad de Cantabria. Avenida de los Castros s/n, E.T.S. de Ingenieros de Caminos, Canales y Puertos. Santander, 39005, Cantabria, Spain.*
[2] *Highways Research Group.* Department of Transports, Projects and Processes Technology. Universidad de Cantabria. *Avenida de los Castros s/n,* E.T.S. de Ingenieros de Caminos, Canales y Puertos. Santander, 39005, Cantabria, Spain.
[*]*Corresponding author e-mail:* sanudola@unican.es

Abstract
Permeable pavements are one the most used Sustainable Urban Drainage Systems in stormwater management. There are a lot of researches about the infiltration performance of materials used in each one of the permeable pavement layers, especially focused on the surface layer. However, there is a lack of a comprehensive laboratory test to study the infiltration capacity of a permeable surface encompassing the most influential variables during their operational life. This paper presents a laboratory study of three surfacing materials of 50cm x 50cm (solid paving blocks with gaps, porous concrete and porous asphalt) under different scenarios of clogging (surface newly built and clogged surface) and surface slopes (0, 3, 5, 7 and 10%) through the use of the Cantabrian Fixed (CF) Infiltrometer. Runoff from adjacent impervious areas and direct rainfall over the permeable surface were simulated in the laboratory device, considering an intensity of 60mm/hr (with 50 years return period in Santander, Spain). Moreover, maintenance was simulated by using a light brushing to find out the infiltration capacity recovery of each clogged surface. All the tests were developed by using the same base layer and geotextile with the aim to compare the infiltration behaviour between the three surfacing materials. The experimental results of the study were analyzed descriptively with two different objectives. The first one was to quantify the infiltration behaviour of each surface through the cumulative infiltration rates obtained every 10cm of the surfacing material. And the second one was to obtain an indicator of the infiltration capacity in terms of the residual runoff values after 50cm of permeable surface. All the surfacing materials had a great infiltration behaviour (>90%) without clogging, highlighting continuous surfaces with voids. Maintenance used in the study demonstrated high efficiency to recover infiltration capacity of clogged surfaces in paving blocks and low efficiency in the other surfaces.

Keywords: Permeable surfaces; SUDS; stormwater management; infiltration; clogging; slopes.

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Field Investigation of Reduction in Infiltration Capacity in a Permeable Pavement System Due To Clogging

Terry Lucke[1] and Simon Beecham[2]
[1] *School of Science and Engineering, University of the Sunshine Coast, AUSTRALIA*
[2]*School of Natural and Built Environments, University of South Australia, AUSTRALIA*
(terry.lucke@usc.edu.au)

Abstract
Permeable paving can be used as an alternative to conventional impervious hard surfaces, such as roads, carparks, footpaths and pedestrian areas and this results in many stormwater management and environmental benefits. However, there is a general perception that permeable pavements tend to clog quickly and result in high maintenance and replacement costs. This study investigated a permeable interlocking concrete pavement (PICP) system that has been in service for over eight years in Australia. The broad aims of this study were to quantify the reduction in infiltration capacity that occurred in the pavement over time due to clogging. The study clearly demonstrated that the infiltration rate of permeable pavements decreases over time with the results showing a decrease in infiltration capacity of between 63.3% and 100%. However, while pavement clogging clearly resulted in reduced permeability over time, the overall infiltration performance of the PICP system was still satisfactory after eight year's continuous service.

Keywords: Permeable pavements, infiltration, clogging, stormwater runoff, geofabric

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Filter drains on the UK's high speed road network

Dr. Gordon Rowlands, Technical Services Manager, Carnell
Gordon Rowlands [Gordon.Rowlands@carnellgroup.co.uk]

Abstract:
Filter drains are established as one of the most effective sustainable drainage systems available to drainage engineers. It is not commonly appreciated that 50% of the UK's high speed road network is serviced by filter drains - the HA network in England alone has around 7,000 km of filter drains.

This paper draws on Carnell's experience built up over 10 years, of assessing, maintaining and improving filter drains with innovative technology that will be of broader interest to the SUDS community, as well as well as those working in the highway sector.

Results will be presented to show the success of on-site refurbishment of filter drains, which has now exceeded over 400km in total. Given the potential amount of refurbishment work that could be undertaken and the severe constraints on budgets, road operators need a range of tools to help assess priorities for filter drain refurbishment before committing to any spend. The paper will review Carnell's development and use of

- predictive modelling to assess silt loadings in highway run-off
- vacuum extraction for the speedy and reliable sampling of filter drains
- use of GPR ground penetrating radar as a non-intrusive condition assessment tool

In reviewing these assessment tools, the paper will also touch on the three key aspects of filter drains that make them so important, all of which are concerned with protection - for the road user, the road asset, and the receiving water network.

The paper will conclude with practical guidance on the use of recycled aggregates and the options for waste management, both of which can make an important contribution to sustainability at the construction stage and during subsequent refurbishment.

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SESSION 5 – SUDS Treatment 1

Laboratory-based experiments to determine the impacts of applying glyphosate-containing herbicide onto a model porous paving rig.

Charlesworth S., F. Mbanaso and S Coupe. SUDS Applied Research Group, Coventry University, Coventry, CV1 5FB.

Abstract:

Recent legislation has promoted the use of Sustainable Drainage Systems (SUDS) in individual houses (Future Water, October 2008) and new build housing estates (Floods and Water Management Act). These pieces of legislation will integrate SUDS devices such as Porous Paving Systems (PPS) into housing estates where their management will fall to the individual householder. There are currently no guidelines for the application of herbicides to remove weeds growing on the PPS surface. Whilst it is well known that herbicides break down fairly readily in the environment, particularly when in contact with soil, it is not known how the application of herbicide will affect the ability of the PPS to break down hydrocarbons or trap particulate-associated pollutants. Research carried out at Coventry University (e.g. Coupe et al., 2003) showed that biofilms are central to this water quality role and that they are adversely affected by herbicide addition.

This paper reports on small-scale laboratory-based experiments, where used engine oil was added to the surface of PPS rigs containing geotextile on which a mature biofilm had been allowed to develop. Glyphosate-containing herbicide (GCH) was then applied, followed by simulated rainfall, causing three related impacts which allowed pollutants such as hydrocarbon and heavy metals to be released in the PPS effluent. Firstly, the herbicide reduced the micro-ecology of the biofilm virtually to zero immediately post-application of the GCH, thus completely compromising its ability to deal with any pollutants. Secondly, because of the removal of the biofilm, the geotextile's role in acting as a hydrobrake enabled the pollutants carried in the water percolating through the structure to be pushed through more effectively. Lastly, the surfactant passed through the test rigs, appearing as a foam in the sample bottles. It is believed that it mobilised pollutants already present in the rig structure, allowing them to pass out of the rig in the effluent.

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The Impact of Glyphosate Containing Herbicides on the Biological properties of Permeable Pavements

Coupe, S.J., Mbanaso, F.S., Charlesworth, S.M. and Nnadi, E.O.

Sustainable Drainage Applied Research Group, Coventry University CV1 5FB
s.coupe@coventry.ac.uk

Abstract:
This presentation reports on research into the impact of commonly used herbicides on the biology of Permeable Pavement Systems (PPS). Glyphosate Containing Herbicides (GCH) are routinely applied to urban and suburban hard surfaces for weed control, including areas with PPS.
As PPS are a key element in the SUDS design toolbox, the simulation of GCH addition to PPS in a laboratory environment, was intended to gain information on the possible environmental impact, of routine weed control. An effective level of retention and bioremediation of minerals oils and the retention of heavy metals have been shown to occur in PPS over many years, but the effect of GCH on PPS microbiology is largely unknown and is the focus of this presentation.

Biologically, the PPS microbiological community was shown to be capable of rapidly degrading the herbicide, as demonstrated by respirometer measurements. However, indicator organisms that are sensitive to pollution (protists) were increased in abundance but showed a decrease in biodiversity relative to PPS with oil added alone.

Research continues into possible modifications of PPS that could improve the bioremediation of GCH. The development of a bioindicator system for herbicide pollution in SUDS may be possible following the highly specific response of protists to GCH pollution.

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An evaluation of the removal of sediments and associated pollutants by channel drainage systems

L Lundy[1], M Fairley[2], M Revitt[1], F Coulon[3], S Tyrrel[3], T Hess[3], J Harris[3], A Nelson[3], K Richards[3] and J Barlow[3]

[1]Middlesex University, The Burroughs, London, NW4 4BT
[2]ACO Technologies plc, Shefford, Bedfordshire, SG17 5TE
[3]Cranfield University, Cranfield, Bedfordshire, MK43 0AL

Abstract:
The term sustainable drainage system (SuDS) relates to a wide range of system types; from large storage systems such as constructed wetlands and detention ponds, through infiltration systems (e.g. infiltration basins and soakaways), to primarily flow transfer systems such as swales and filter strips to alternative surfacing materials (e.g. permeable paving and porous asphalt). The use of SuDS enables water to be managed from combined water quantity, quality and amenity perspectives, with various system types offering differing opportunities to contribute to each of these water management objectives. Within the context of SuDS currently encompassing a wide range of both green (e.g. green roofs) and grey (e.g. porous asphalt) infrastructure, this study aims to assess the water quality impacts associated with the use of level and shallow gradient channel drains. To support this evaluation, samples are being collected from drainage channels located in five different car parks with sediments subsequently analysed for a range of parameters including particle size distribution, metals (Cd, Pb, Cu, Zn, Cr and Ni) and organics (polyaromatic hydrocarbons). The results are used to inform an initial assessment of the potential role channel drains may play as part of a SuDS treatment train in locations where land availability is limited (such as retrofitting in urban areas and new car-park developments).

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SESSION 6 – SUDS Treatment 2

Functionality of Geotextile Membranes within Permeable Pavements for Biodegradation, Infiltration and Water Detention of Concentrated Urban Stormwater Runoff

K. Tota-Maharaj[1*], S.J. Coupe[2] and Piotr Grabowiecki[3],

[1]Sustainable Water Management Group, Civil Engineering Research Centre (CERC), School of Computing, Science and Engineering, The University of Salford Manchester, Newton Building, Greater Manchester, M5 4WT, UK, [2]Sustainable Drainage Applied Research Group, Coventry University, Priory Street, Coventry, CV1 5FB, UK., [3]Institute of Geophysics, Polish Academy of Sciences, Ksiecia Janusza 64, 01-452, Warsaw, Poland
**Corresponding author, e-mail k.tota-maharaj@salford.ac.uk, Tele: +44(0) 161 295 3693*

Abstract:
A geotextile layers within permeable paving are used to increase the structural properties to withstand higher loadings, poor ground conditions and prevent migration upwards of fine sediments and peak flow reduction. Permeable pavement systems (PPS) are increasingly used to meet both hydrological and water quality requirements for stormwater reuse. The aim of these experimental pavement test rigs is to analyse different models of pavements layouts and structures for (i) no geotextile membrane, (ii) one upper geotextile and (iii) an upper and lower geotextile membrane, in order to determine the best method for treating and storing the stormwater and to analyse the benefits of water quality improvements with geotextiles. Influent concentrated urban stormwater consisted of diluted municipal wastewater mixed with glyphosphate herbicide and applied weekly. Water quality was studied in the experiments under laboratory conditions. The assessment of the pollutant removal efficiency resulted in promising removal efficiencies. Pollutant removal rates for the permeable pavements were found to be statistically higher when compared to the pavement system without a geotextile membrane. Even thou the water quality removal for nitrate-nitrogen, nitrite-nitrogen and ammonia-nitrogen ranged from 66-80 %, for the pavement without geotextiles, the pavements with an upper and lower geotextile membrane performed exceptionally better for biochemical oxygen demand (BOD), chemical oxygen demand (COD) and suspended solids (SS) removal. Ortho-phosphate-phosphorus concentrations were increased with the addition of glyphsate herbicide. Despite the generally higher concentrations of phosphate ions and ortho-phosphate-phosphorus, the tanked pavement system filtration performance was good. The permeable pavement system without any geotextile membrane provided the lowest removal rate for SS, BOD and COD. The permeable pavements with both an upper and an upper/lower geotextile membrane provided a valuable function with respect to water quality improvement.

KEYWORDS: Geotextiles, Pervious Pavements, Permeable Pavements, Stormwater runoff, Urban Hydrology, Water storage, Peak flow reduction, Water quality.

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An Investigation on the hydraulic and treatment performance of vegetated SuDS systems

Alexandros Tsavdaris*, Dr. John B. Williams, Dr. Steve Mitchell, Dr. Catherine Mant

University of Portsmouth, School of Civil Engineering and Surveying, Portland Building, Portland Street, Portsmouth, Hants, PO1 3AH, UK.

* Corresponding author. Tel.: +44 (0)23 9284 2428 john.williams@port.ac.uk

Abstract:
Among the various sources of pollution, storm-water runoff from urban areas is considered to be a major contributor to many different types of contamination in adjacent receiving water-bodies. A cost-effective solution to efficiently treat and manage surface water runoff is the use of detention ponds. When properly designed, detention ponds offer improved treatment via sedimentation and also biodegradation. However, most studies focus either on the hydraulic performance aspect or the water quality aspect of such systems resulting in a missing link, concerning an efficient design. In addition, these systems are extremely dynamic and it is very difficult to achieve an adequate evaluation and characterization of their performance. An in depth assessment of detention ponds in terms of hydraulic efficiency and water treatment performance could possibly enable the development of a design code, which would conceivably provide the “optimum” pond configuration. The aim of this ongoing study is to develop a greater understanding regarding the hydraulic behaviour and treatment performance of vegetated detention ponds, based on extensive water/sediment quality monitoring and CFD evaluation of a pond system located at Waterlooville (Hampshire). Results obtained to date have suggested that the pond is working well under storm conditions concerning the reduction of water quality indicators. Settling solids so far are predominantly fines with high volatile substances content and no significant differences between size fractions in terms of metal concentrations. The CFD model examines 3 different flow scenarios in terms of flow depth and discharge and the initial results assist in the identification of dead zones and recirculation regions within the system. By the end of the study, the effect of the vegetation will also be considered along with the examination of other pond shapes in order to possibly reveal an efficient design in terms of evenly distributed flow.

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The real benefit of SUDS: Treatment stages, SUDS efficiency and a review of international monitoring of SUDS

Ian Dalgleish CSci, CEnv, CWEM, MCIWEM, Environmental Scientist, Water and Environment, **ATKINS**

Abstract:
We have an ideal opportunity now through requirements of the Water Framework Directive and Flood and Water Management Act to quantify performance of SUDS and to incorporate understanding of the treatment processes of SUDS to understand how well our solutions perform.
The current focus on treatment stages in the draft National Standards for SUDS leaves catchment managers and the Environment Agency without a method to quantify actual improvements to our watercourses that is a requirement of WFD monitoring point compliance. This paper will consider using physical processes within SUDS as a method for suggesting treatment stages. It will then go on to discuss a review of international methods for monitoring SUDS and discuss ways to obtain and present monitoring information. It will then take a typical example of run-off from an industrial estate to give an example of what is required to determine a source of pollutant to meet WFD standards.
Finally this paper will suggest a possible use of monitoring for the SAB to provide some useful data during construction and to build their local evidence database for use and application of SUDS.

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SESSION 7 - SUDS, Green Infrastructure, Amenity & Ecosystem Services 1

A multi-disciplinary evaluation of an urban rain garden

Lian Lundy*, Bob Bray**, Bryan Ellis* and Mike Revitt*
*Middlesex University, The Burroughs, Hendon, London NW1 4BT
**Robert Bray Associates Ltd, Fairfield, Coronation Road, Rodborough, Stroud, Glos, GL5 3SB

Abstract:
In response to the increasing range of policy drivers (e.g. FWMA (2010), EU WFD (2000), UK NEA (2010)), interest continues to develop in the multiple benefits associated with the use of sustainable urban drainage systems (SuDS). An example of this is the public/private partnership responsible for the installation and subsequent monitoring of the 1st urban rain garden in the UK designed to known hydraulic criteria. This small-scale system receives runoff from a roof area of $30m^2$, has a design storage volume of $2.1m^3$ and has been monitored to determine both water quantity and social/amenity impacts. Flows into and out of the system have been recorded using tipping bucket gauges and key stakeholders have been interviewed to assess their motivations for participating in the project. Over the initial four month monitoring period, 263 mm of rainfall was recorded resulting in 5,500L of stormwater runoff entering the system. Flow at the outlet was only detected on one occasion indicating that the rain garden is infiltrating the majority of water received. The rain garden was also subjected to an artificial rainfall event during which a total of 8760L entered the rain garden over a 25 minute period. The rain garden was designed to avoid standing water and, on receipt of 1200L, began discharging to a combined sewer. On draw-down, this volume of water infiltrated into the bed substrate at a rate of 300mm/hr. Key stakeholder motivations were identified as drainage asset management, increasing resilience to climate change and enhancing the local environment. The response of local residents to the scheme was overwhelmingly positive, with the presence of a sequence of flowering vegetation consistently identified as of great benefit to the local community. The rain garden demonstrates the feasibility of locating these systems in densely urbanised areas, providing a starting point for the development of a robust UK multi-benefit performance database. Within this context, the design of the system is reviewed in the light of monitoring data collected to date and with regard to optimising the relationship between the surface area contributing to roof runoff and the magnitude and intensity of storms which the system is designed to mitigate.

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FWMA (2010) The National Archives. Flood and Water Management Act. London, UK, 2010, pp 1-84. At: www.legislation.gov.uk/ukpga/2010/29/contents
UK NEA (2010) UK National Ecosystem Assessment – Understanding Nature's Value to Society, At: http://uknea.unep-wcmc.org/

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SUDS in schools: exploring the impact on health, wellbeing, and learning in children and young people.

Dr Jenny Roe, Dr Scott Arthur, Dr Caroline Brown
School of the Built Environment, Heriot-Watt University, Riccarton Campus, Edinburgh EH14 4AS

Abstract

There is currently no peer reviewed research evidence regarding the amenity and health value of SUDS in schools. However, there is evidence to indicate that green space and outdoor classrooms can substantially impact on learning and improve the physical and mental well-being of children and young people (Bentsen et al, in press, Roe and Aspinall 2011). Literature from the 'green health' domain also shows that people derive greater benefit, and value more highly, environments which have greater biodiversity (Fuller et al., 2011). This paper posits that water sensitive design in schools – as well as managing surface water and increasing biodiversity in school playgrounds – also offer substantial health and wellbeing benefits, increaseopportunities for learning and encourage more positive attitudes to the natural environment. The research will draw on case study evidence from across the UK, gathered as part of a 'blue health' study for CREW (Centre for Water Expertise, Scotland), to illustrate this potential. Benefits and barriers will also be identified - including risk perception – based on discussionswith headteachers, stakeholders and designers of SUDS in schools. Conclusions will be drawn regarding the importance of SUDS in schools and the contribution they can make tosustainable development and ecosystems services in the education domain with children and young people, as well as asset managers, being key beneficiaries.

Keywords: SUDS, amenity, schools, water-sensitive design, learning, young people, risk.

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Analysis for the implementation of Sustainable Urban Drainage Systems in three different locations in Spain.

Miguel Fornés-Bonavía-Bachák [a]; Jorge Rodriguez-Hernandez [b]*; Daniel Castro-Fresno [c].

[a] Geographer and MSc in Water & Environmental Management.
[b] PhD MSc Civil Engineer. Assistant Professor. Universidad de Cantabria (Spain).
[c] PhD MSc Civil Engineer. Professor. Universidad de Cantabria (Spain).

*Corresponding author: GITECO-ETSICCP, Avd. los Castros s/n, 39005 Santander, Spain.
e-mail: rodrighj@unican.es; Phone: (+34)-942 201550; Fax (+34) 942 201703

Abstract:
Sustainable urban drainage systems (SUDS) have become the most effective way to deal with water quantity and water quality problems in Europe. Concerns on flooding and diffuse pollution have forced engineers to seek new environmental drainage techniques to response the demands of the new Water Framework Directive. This paper presents an analysis for the implementation of SUDS in three representative locations in Spain: Madrid (Guadarrama Mountains), Valencia (Port-Saplaya) and Santander (San Martín District). These locations were selected by their differences in topographic, climatic and land use characteristics checked by GIS: the first is a protected natural site with two important ski resorts located in the centre of the Iberian Peninsula; the second is a Mediterranean coastal resort with a high density population during summer season, and the third is an historical industrial site reconverted to urban area located in the northern coast of Spain. The findings obtained showed that SUDS may help in the reduction of water pollution and flooding effects, minimising the vulnerability of the analysed locations. As conclusions, several general recommendations are presented for the geographical analysis for the implementation of SUDS. Although in Spain few town councils, universities and engineering firms are working with SUDS, the potential benefits are huge in all the territory.

Keywords: diffuse pollution; flooding; GIS; SUDS; urbanization; Water Framework Directive.

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AQUAVAL: Demonstration SUDS in the Mediterranean region of Valencia.

S. Perales Momparler[1], C. Jefferies[2]

[1] *PMEnginyeria, Avda. Aragón, 18-1-1, 46021, Valencia, ESPAÑA.*
sperales@pmenginyeria.com
[2] *University of Abertay Dundee, Urban Water Technology Centre, Level 5 Kydd Building, Bell Street, Dundee DD1 1HG, Scotland. C.Jefferies@abertay.ac.uk*

Abstract:

The EU LIFE+ Project AQUAVAL will demonstrate innovative solutions to problems related to runoff quantity and quality in the urban environment through the integration of part of the hydraulic infrastructure into the urban landscape using Sustainable Drainage Systems (SUDS). The focus is to decrease the impacts of urban development (e.g. combined sewer overflow (CSO) spills, pollution, flooding, etc.) and adding social and environmental values to the programmed actions.

In the frame of this ambitious project, water management demonstration sites using SUDS as a complement to the existing water infrastructure are being built in two cities in the Valencian Region of Spain. The sites in the cities of Xàtiva and Benaguasil, will provide showcases for Southern European Regions in the development of a sustainable drainage culture.

The effectiveness of these systems in the Mediterranean region will be demonstrated by site monitoring until the end of the project (June 2013). In addition, stormwater management plans and urban-water policies will be drawn up for the two cities to give excellent examples which could be used in other Southern European regions.

This article reviews the need of this type of demonstration projects in Spain (and in general in the South of Europe), the activities and goals achieved so far and the expectations of the impact of the AQUAVAL project in the short, mid and long term.

SESSION 8 – Workshop Session

Getting added value from SUDS and contributing to low carbon development

This workshop session is dedicated to a discussion about new developments in assessing the added values associated with SUDS. Current initiatives focussed on assessing the Ecosystem Services benefits, and carbon savings afforded to us by using sustainable approaches to urban water management are gaining momentum. It is becoming increasingly important to recognise (and value) not only the functional and economic but also the ecological, societal, health and cultural benefits linked to our urban water management decisions.

This session will host a discussion which seeks to identify the opportunities, as well as the barriers and limitations, to realising and valuing these additional benefits – particularly in relation to SUDS design and SUDS operation and maintenance.

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SESSION 9 - SUDS, Green Infrastructure, Amenity & Ecosystem Services 1

Can UK cities ever become 'water sensitive'?

Louise Walker, and Richard M Ashley

Corresponding author: Louise Walker PhD MCIWEM CEnv CSci, Research Officer, Water@Leeds. E: L.Walker@leeds.ac.uk

Abstract:

In the UK there is an apparent professional divide between urban land management and urban water management. This divide has been recognised and addressed elsewhere through philosophies such as Water Sensitive Urban Design (WSUD) in Australia and Low Impact Development (LID) in the USA. Driven initially by the wish to improve receiving water quality; these approaches aim to ensure that stormwater management is prominent in urban land use planning and design. This often means that the stormwater management measures taken are very context specific, and leads to innovation in dealing with local issues. Recent UK initiatives in valuing ecosystem services and provision of urban green infrastructure afford opportunities for cities to meet some of the current and future challenges of urban living including the imaginative management of water quality and quantity. An integrated approach combining land use planning, urban design and water management can provide multiple benefits for the urban population which are highly cost effective. The inclusion of green infrastructure in UK urban areas still predominantly occurs for aesthetic, recreational and biodiversity reasons and is not usually specifically linked with surface water management. If the increased benefits of managing stormwater using green infrastructure can be made more apparent, e.g. through valuation of ecosystem services, a move towards more water sensitive urban environments could be encouraged. There is still however a long way to go before true water sensitive urban design, encompassing the whole of the water cycle is implemented broadly in the UK.

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Green Networks Integrated Urban Infrastructure

Peter Robinson, AECOM Water, Edinburgh, Scotland, United Kingdom

Abstract:

The Green Network Integrated Urban Infrastructure (GNIUI) Project aimed to demonstrate best practice in sustainable drainage and inclusive urban planning, by developing a series of feasibility studies for six candidate sites across three regions in the western central belt of Scotland.

The Project was initiated by the Scottish Environment Protection Agency (SEPA) and co-funded through multi-organisations, to consider a fresh approach to informed masterplanning by considering that 'infrastructure comes first'.

The Project has adopted a series of mission statements as follows:

Provide Integrated Solutions Provide a Shift in Perception Inform Best Practice

Improve Population Health Encourage Economic Development

The project was governed through a Project Board derived from all the Stakeholders and also supported by the Metropolitan Glasgow Strategic Drainage Partnership (MGSDP), a body comprising of SEPA, 7 local authorities, Scottish Water, Scottish Enterprise and other agencies, monitored by the Scottish Government and created to evaluate current approaches and develop innovative and sustainable solutions to identified problems.

The GNIUI project adopted a transparent team working ethos between the design team and the Project Board. Due to the representation on the Project Board, the project encouraged innovative working to consider best practice and also to challenge current design standards and legislation.

The GNIUI project demonstrates that conjunctive design of future developments can provide a number of benefits. Primarily these can be associated with timescales and costs, as conjunctive thinking by specialists across a range of infrastructure considerations allows well informed design to be developed, whilst reducing the risk of advancing work at risk.

Within a national context for Scotland, a number of standard approaches to surface water management have been challenged, with a fresh approach to incorporating the natural water and built environments in a sustainable manner, allowing future best practice to be developed and to change the way regulators, authorities, stakeholders and future communities will perceive the water environment.

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SUDS and Trees – Integrating landscaping and surface water strategies

A.Duffy*, D.Bowie**, J. Dalrymple**
*a.duffy@abertay.sc.uk,University of Abertay Bell St, Dundee, DD1 1HG.
**dean.bowie@greenleaftrees.co.uk, james.dalrymple@greenleaftrees.co.uk, Greenleaf, Haywood Way, Hastings, East Sussex, TN35 4PL

Abstract

Urban trees are in decline not only as competition for infrastructure, utilities and development increases but also as many of the UKs finest urban trees, which are a living legacy from the Victorian era, are now nearing the end of their lives. There is currently a national drive to reverse this trend. All trees are beneficial to an urban environment however larger species trees are a significantly more important element of Green Infrastructure. Large trees provide financial, social and environmental benefits, whilst also making a fundamental contribution to the well-being of almost 80% of the UK population who live and work in urban areas (Armour, *et al*, 2012).

In terms of future global pressures such as climate change, planting new (large species) trees is considered a critical factor in mitigating effects by regulating urban microclimates, attenuating and filtering water, attenuating noise and improving air quality and sequestering carbon (UNEA, 2011). Mature trees also provide a significant habitat resource, enriching biodiversity in urban areas and promoting access to nature.

Greenleaf has for more than a decade conducted research into urban tree planting practices which are providing solutions that assist trees in their battle to establish in towns and cities. The company supplies ustainable tree pit products which provide a healthy underground environment for mature trees to grow and which do not adversely affect the urban landscape such as pavement damage by tree roots (Lucke *et al* 2011). Greenleaf is actively engaged in seeking urban water management solutions which are aligned with WSUD concepts - integrating the SUDS philosophy with green infrastructure. The company is currently advancing development of an urban drainage system called Arborflow, which is designed for use in areas where space is a premium. Key benefits of Arborflow (over and above large species tree benefits) include:

- Creation of additional attenuation which will increase over time as the tree matures to deliver adaptability to help cope with climate change pressures.
- SUDS footprint reduction (for larger site / regional control SUDS i.e. ponds and basins) whilst meeting new open space guidelines and regulations.
- Additional treatment benefits including hydrocarbon retention and reduction.

University of Abertay and Dundee City Council have joined forces with Greenleaf to implement a demonstration project in order to investigate the robustness of the system. The Arborflow system has been implemented as part of an integrated landscaping strategy for managing surface water runoff from a newly constructed car park at a busy city gymnastics centre. The presentation will discuss the study and monitoring regime which will cover system hydraulics, water quality, tree growth and vigour. For example, the system has been adapted by including inspection chambers so that car park runoff quality entering the system and treated runoff leaving the system can be monitored. A control tree has also been planted in nearby public open space so that regular health monitoring for both trees based on guidelines derived by the Dundee City Council Arboriculture Officer can occur. This is an innovative study which, if the overall conclusions are successful, may be replicated in the urban environment and public open spaces across the country.

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Bringing Water Sensitive Urban Design to the UK

Co-presented by Celeste Morgan, Director (AECOM) and Louise Clarke (CIRIA)
Email: celeste.morgan@aecom.com

Abstract:

Water Sensitive Urban Design, originally an Australian concept, is about the integration of management of the whole water cycle within the urban design and planning process. The intention is to involve a range of disciplines in the management of water, to ensure water management solutions tie in with place-making, biodiversity, social and economic objectives and ultimately become more deliverable. The management of surface water is a key element of the WSUD approach, where integration with urban design and landscape architecture creates better and more inspiring solutions that are supported by the community.

CIRIA has commissioned a study to scope the potential for a WSUD approach in the UK, whereby water becomes a key talking point in the up-front design of growth areas and the strategic planning of cities and catchments. In September, we will be able to present a vision for WSUD in the UK and present interim results from the WSUD scoping study, highlighting the business case for WSUD and drivers and barriers for such an approach in the UK. We will also be able to discuss best practice case studies from UK and around the world as part of the presentation.

SESSION 10 – Future Developments in SUDS

Future Developments in SUDS

Paul Shaffer, CIRIA
Email: paul.shaffer@ciria.org

This presentation will give an overview of some new developments and future directions for SUDS research and practice, identifying opportunities and discussing gaps in knowledge. It will also draw on the papers presented at SUDSnet 2012 and will provide a springboard for the final discussion session of the Conference.

Discussion session with Keynote speakers, and SUDSnet organisers: Rebecca Wade & Sue Charlesworth.