Presentation for UKILN conference, 25th April 2017
Linlithgow, Scotland

Raingardens & Lakes

Sustainable urban drainage in the protection & improvement of urban lochs

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Exploring ‘SUDS for lakes’

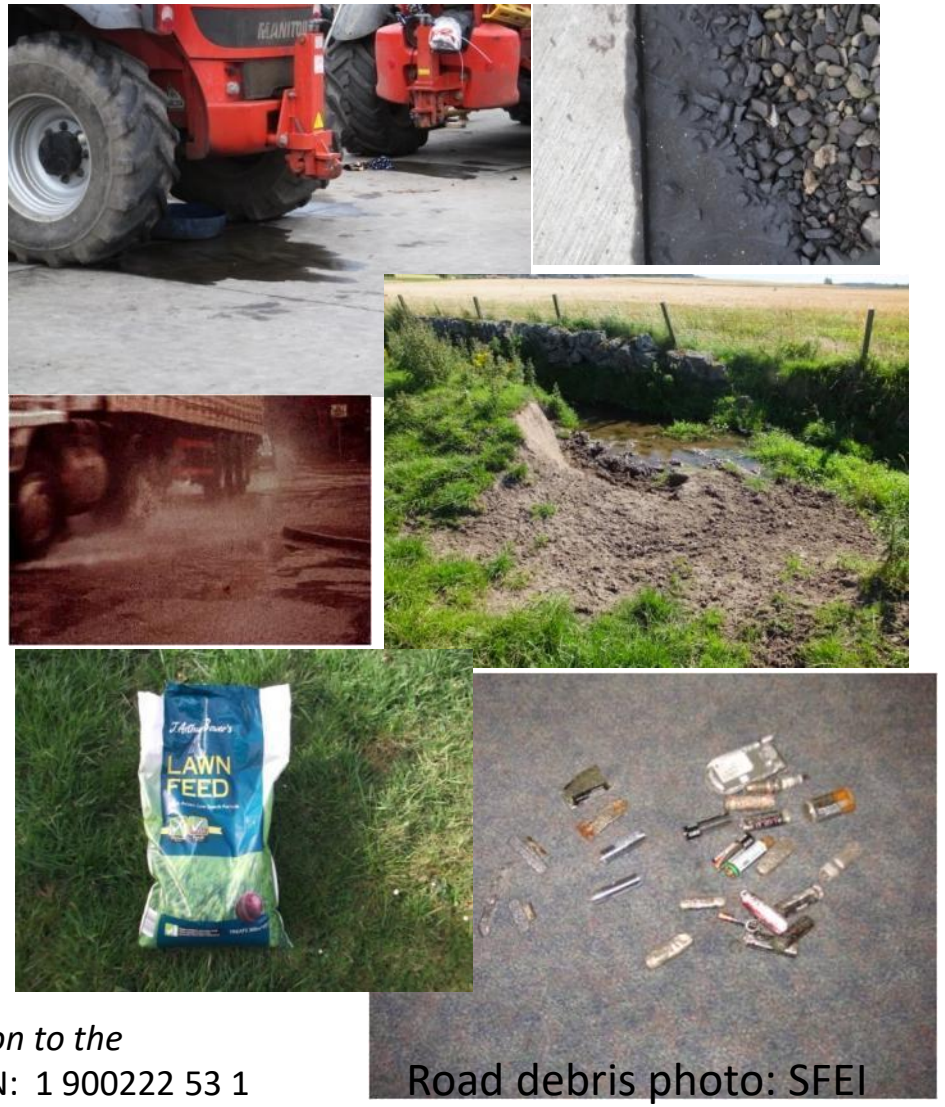
1. What are SUDS supposed to achieve?
2. SUDS & the control of nutrient inputs to lakes (a) separately sewered systems
3. SUDS & the control of nutrient inputs to lakes (b) combined sewer systems
4. Language and perceptions

Address diffuse pollution & flood risk, and create amenity habitats

1. WHAT ARE SUDS SUPPOSED TO ACHIEVE?

Helping to manage diffuse pollution*

- *Anthropogenic background contamination from a catchment; "**Landscape or atmospheric contamination mobilised by weather conditions**"
- Contamination is everywhere: farmland runoff; urban runoff; golf courses; etc (*not just in SUDS features!*)
- ***SUDS are intended to capture***, & where possible degrade contaminants, instead of random contamination leading to pollution of rivers and lakes



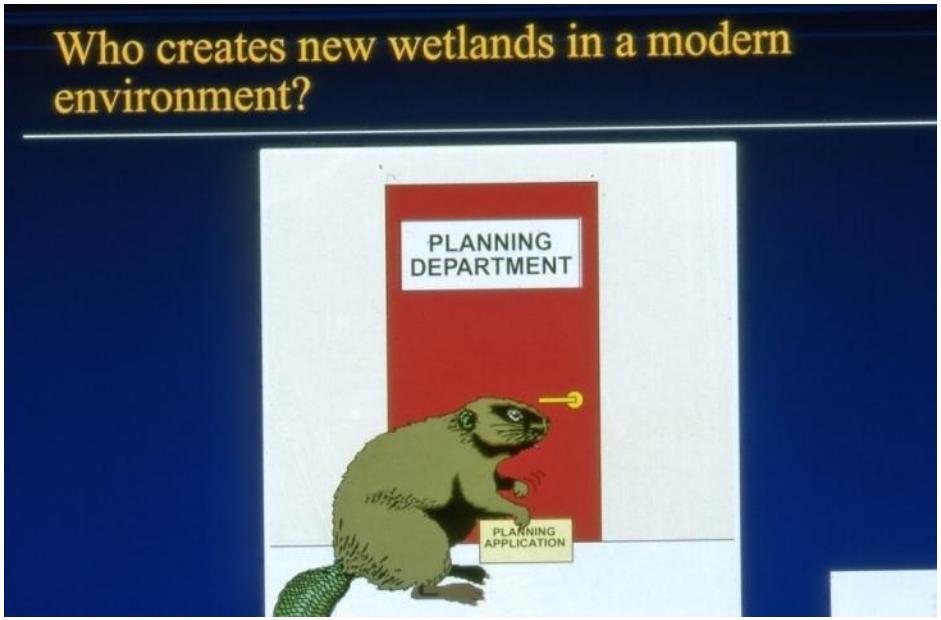
Road debris photo: SFEI

Campbell et al (2004). *Diffuse Pollution: An Introduction to the Problems and Solutions*. IWA Publishing, London. ISBN: 1 900222 53 1

SUDS & Floods

- **Pluvial flooding**: when *rainstorm intensity exceeds the capacity of the drainage system*
- Making space for water in that context is about ***temporary storage capacity*** within the drainage system & infrastructure
- That may include disconnection from sewer systems

Making places for nature (creating amenity habitats)



1997 conference in Malmo; now – 20 years later – we've got SUDS *and* beavers in Britain!

2003 WEWS Act & associated regulations created **a legal requirement for SUDS in Scotland** for new development – for green infrastructure options that's a legal requirement for habitat creation. On planning proposals, ask for that!

The challenges of an urban catchment

Urban catchments: 2 types (prior to SUDS)

diagrams from http://www.ecy.wa.gov/programs/wq/permits/cso.html

Separate sewers

Combined sewers

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SUDS & NUTRIENTS FROM SEPARATE SYSTEMS

Nutrient risks in separately sewered catchments

Example nutrient sources

- Lawns (public & private)
- Allotments
- Sports fields
- Building sites
- Foul drainage plumbed into surface water drains
- Nitrogen oxides from engine exhausts (rain)

Treatment trains of SUDS features

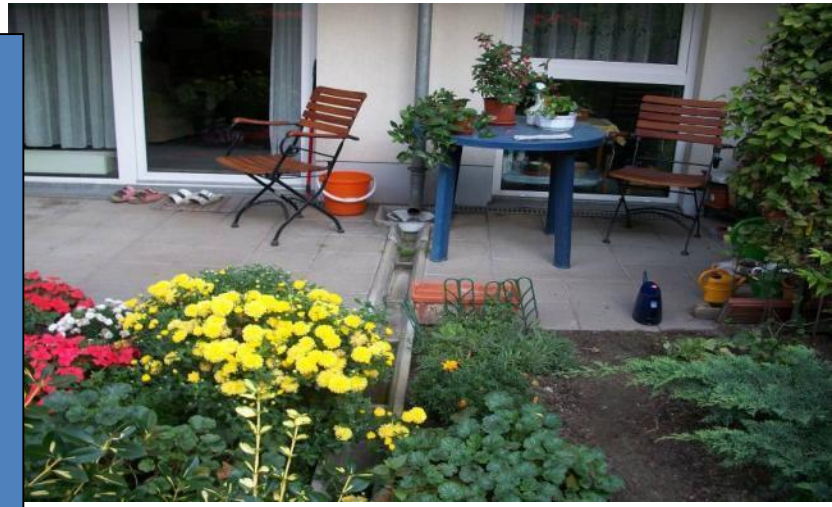
Wrong connections of foul into surface water will be more apparent in SUDS than pipes & can be fixed

X

How to stop foul into surface wrong-connections? Source control SUDS would show the problem at source where it would quickly be corrected!

(*Left*) Typical wrong-connection pollution where Foul drainage discharges without any treatment into small streams.

(*Right*) roof drainage discharging in Open channels across patio or lawn in Berlin 2009.



Biofiltration for nutrient removal in stormwater

- **Phosphate** capture by sedimentation and adsorption on soil filter media, and some uptake in plants
- **Nitrate** removal by reduction in a submerged zone, prior to discharge

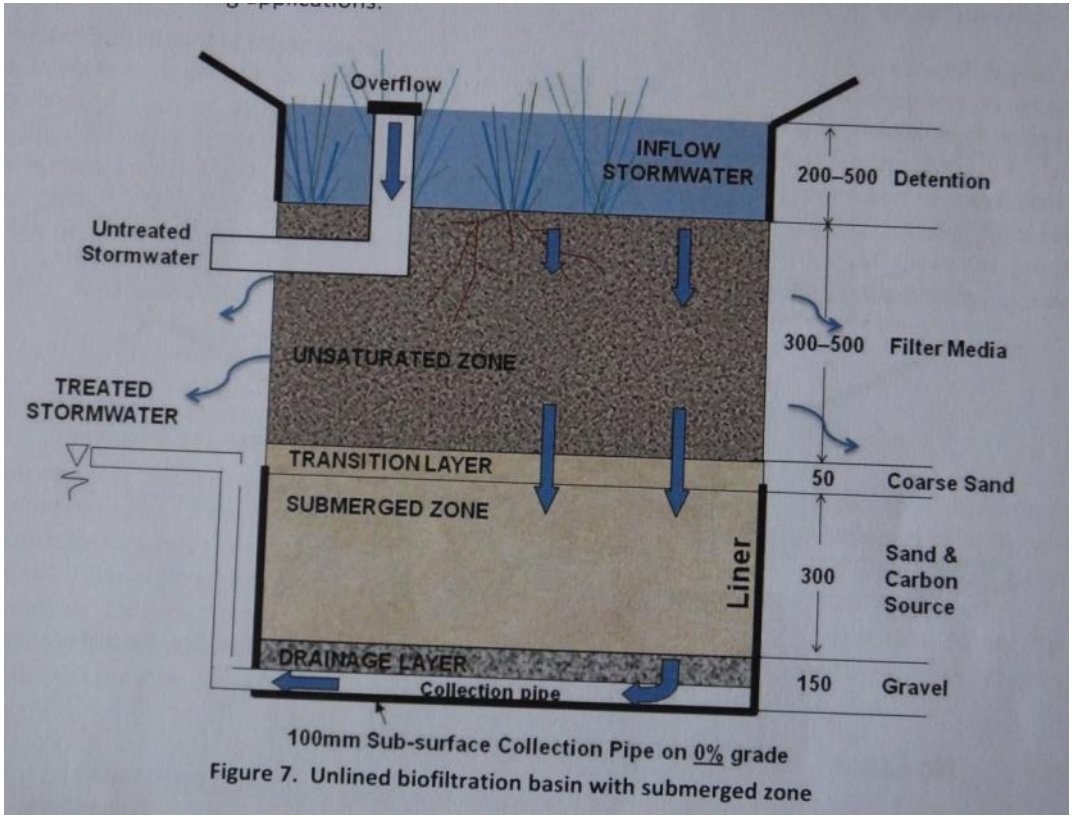


Figure 7. Unlined biofiltration basin with submerged zone

Source: FAWB (2009). Adoption Guidelines for Stormwater Biofiltration Systems, Facility for Advancing Water Biofiltration, Monash University, June 2009, Australia

Biofiltration units: not designed for flow attenuation

- The extracts here are from a FAWB best practice guidance published in Melbourne, Australia. *Top right*: lined biofiltration unit, *lower right* infiltration option (exfiltration from the unit hopefully). **Note the large overflow pipe & v limited temporary storage**

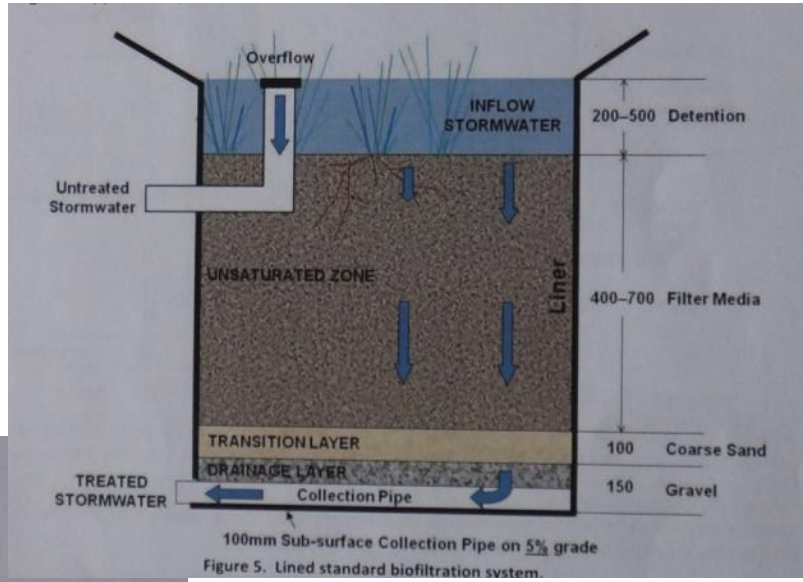


Figure 5. Lined standard biofiltration system.

FAWB
Facility for Advancing
Water Biofiltration

1.1.1 Hydrologic function

Stormwater runoff from urban areas tends to have short, sharp peak flows and substantially larger volumes in comparison to runoff from undeveloped areas. A primary goal of best-practice stormwater management is to reduce runoff peaks, volumes and frequencies. Biofiltration systems can achieve this, for two reasons:

- Depending on their size relative to the catchment, and their infiltration properties, they may reduce below 1-year Average Recurrence Interval (ARI) peak flows by around 80%. Instead of runoff being delivered directly to the local waterway via the conventional drainage network, it is collected on the surface of the biofiltration system and slow filters through the soil media; and
- They reduce runoff volumes by typically around 30%, on average: a portion of every runoff event is retained by the filter media – this will then be lost via evapotranspiration and/or exfiltration, depending on the design of the system. Small runoff events may even be completely absorbed by the biofiltration system (i.e., there is no discharge from the underdrain). Therefore, and particularly in the case of unlined systems with an elevated underdrain or no underdrain at all, they may substantially reduce runoff frequency to receiving waters, thus protecting aquatic ecosystems from frequent disturbance.

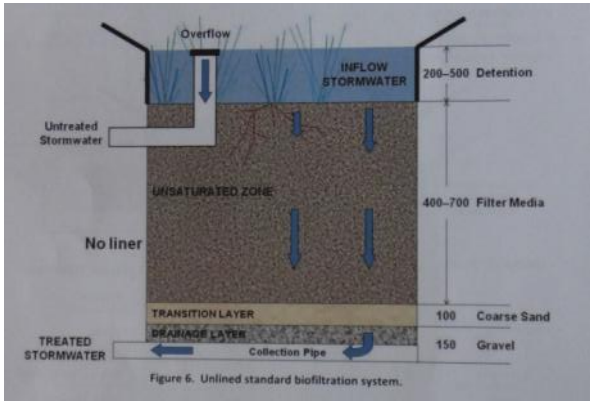


Figure 6. Unlined standard biofiltration system.

Combined sewer overflows..CSOs

SUDS & NUTRIENTS FROM COMBINED SEWERS

CSOs & the combined sewer system

http://www.ecy.wa.gov/programs/wq/permits/cso.html

The combined sewer typically discharges to a **sewage treatment** works, where nutrient removal techniques can be applied.
The quantity of nutrient reaching the treatment system varies with the sewer network (including u/s CSOs) and also the provision of storm tanks & any treatment there at the STW.

The combined sewers overflow in wet weather, discharging to the water environment. Frequency of overflow **very variable**, and depends on location in sewer network, age (infiltration), capacity and development, topography, soil types & water table (infiltration) as well as weather/climate. Treatment options v limited.

Mitigation for CSOs impacts: keep more of the sewage in the sewer for more of the time

Temporary **L**imited **C**apacity for **storage**

- Tank sewers
- Relief sewers
- Storm tanks in parks

Limits imposed by constraints: space, ownership of space, space in right place, budget

EXPENSIVE conventional options*:

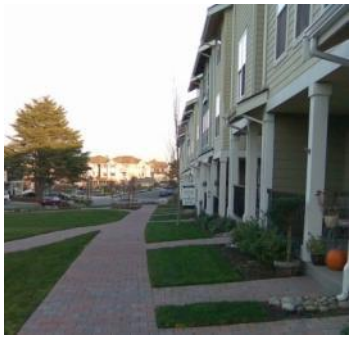
e.g. London Super Sewer (tunnel) to collect flows from 34 CSOs and discharge downstream… cost estimated at £3.6 Billion (£3,600 million)

ALTERNATIVES? SUDS retrofits in S Wales on combined sewers to coastal waters.. Lakes & lochs next?

*Thames Water2011, Site Selection Background Technical Paper, 100-RG-PNC-00000-900030; quoted in paper by David Evans, Ove Arup, at IWA World Congress on Water, Climate and Energy, 2012.

Washington State, USA (e.g. programme to protect/improve Puget Sound)

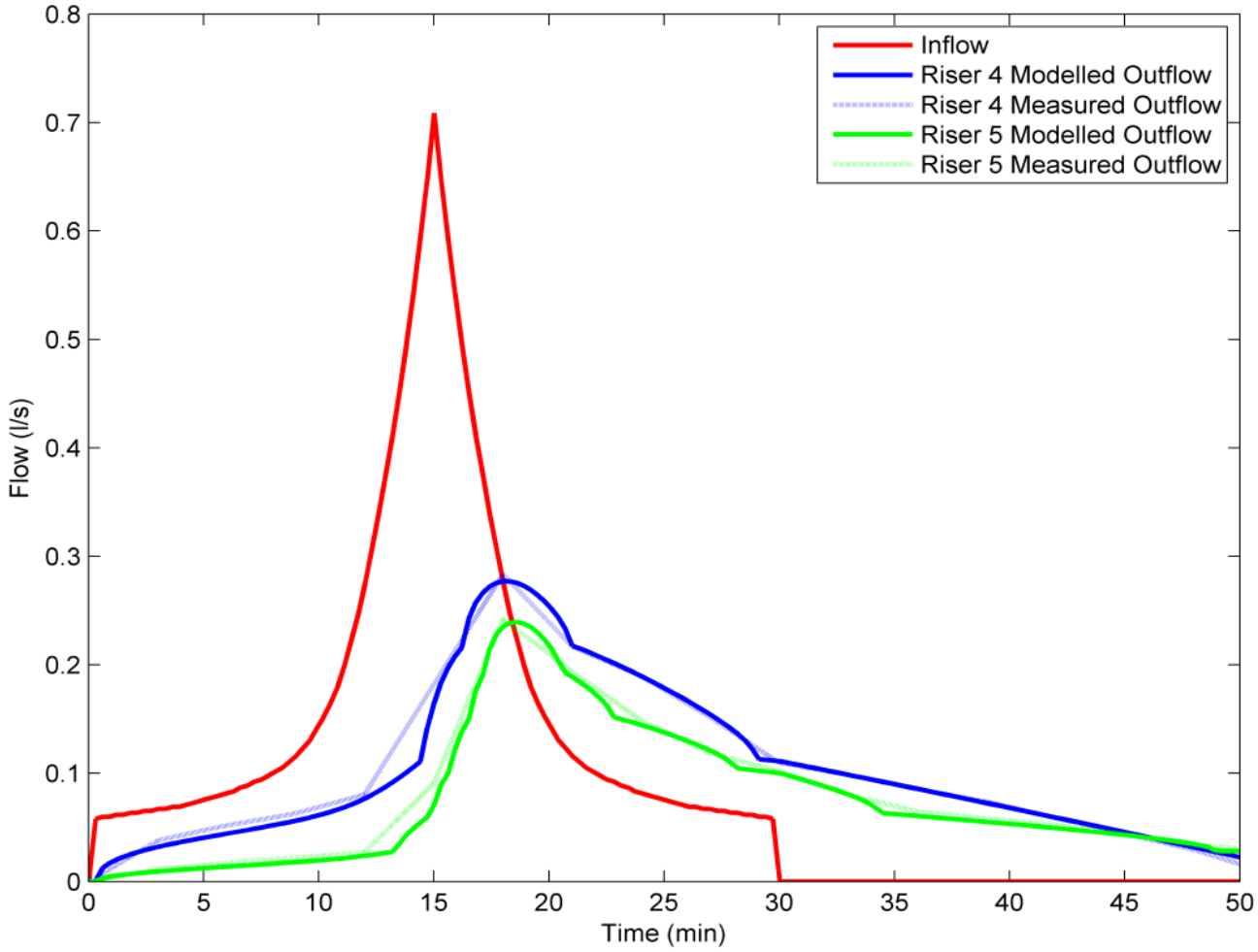
- Strategies for controlling CSOs include separation, storage or treatment of flows.
- More recently, **green stormwater infrastructure** (GSI) has been used alone or in concert with other control strategies **as a cost effective approach for some** CSO reduction projects.
- We are open to using many different tools, including a variety of stormwater control strategies, to ensure the CSOs do not contribute to violations of the water quality standards.
- http://www.ecy.wa.gov/programs/wq/permits/cso.html



Lessons from Seattle applied in China

Raingardens **urban retrofit** programmes led by Prof Nian She, former senior scientist, Seattle, USA

Flow attenuation in drain-down vessel



Lab. trials of 5 different configurations of orifices on outlet flow control:
all achieved reductions from peak inflow

Unpublished data from Stovin *et al* (in prep.) Sheffield University

SUDS to reduce frequency of discharges from combined sewers overflows

Raised bed raingardens with significant storage for slow drain-down could be retrofitted on combined sewer catchments in older districts of many cities. They are designed to accept inflows from the roofs (the largest impervious areas in a development) and attenuate the flow peaks

Award winning raised bed raingarden units

SUDSBOX Raingarden units have been installed since 2015 at 4 premises:

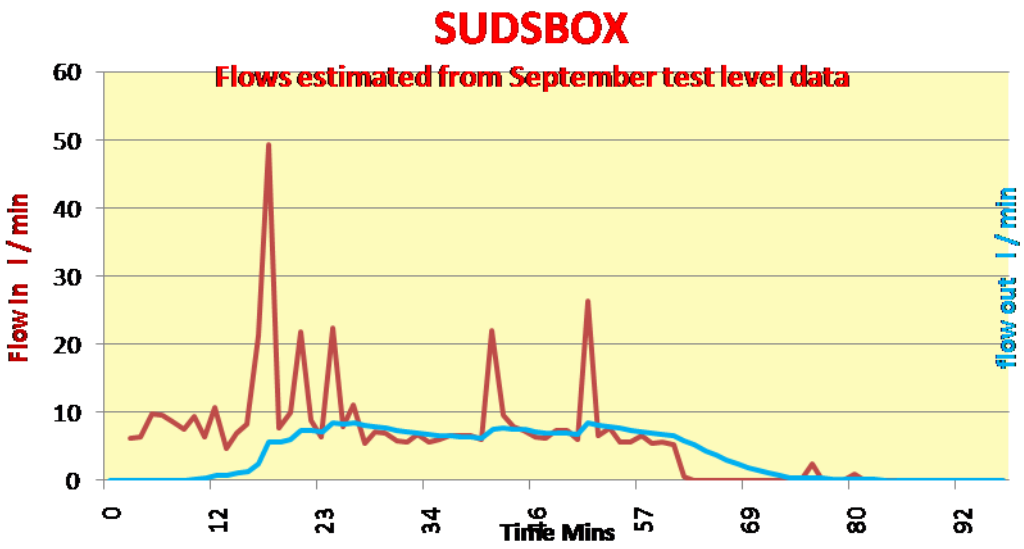
- Private house (*upper right*)
- Central Scotland Green Network Trust (*lower right*)
- Taylor Wimpey show-house
- BRE Ravenscraig Innovation Park

VIBES AWARDS WINNER 2015

VISION IN BUSINESS FOR THE ENVIRONMENT OF SCOTLAND

BRE raingardens implementation project

- Building Research Establishment workshop in May 2017, with regulatory organisations to resolve any issues with a houseplot approach.
- In parallel, C&D Associates are seeking water utility/local authority demonstration projects in England too.
- *Below:* C&D data from pre-installation tests



LANGUAGE AND PERCEPTIONS

RAINGARDENS: SGIF definition 2013

- What is a raingarden? The scoping study undertaken by the Scottish Green Infrastructure Forum (SGIF, 2013; www.sgif.org.uk) defined a raingarden as

  "a vegetated area designed to attenuate rainfall runoff"
- That was inspired by the Melbourne Water *10,000 Raingardens* campaign, which adopted a broad inclusive approach to seeking greater acceptance of all types of green infrastructure technology for managing stormwater.
- Can that positive language reach the public & inspire more creativity?

“I beg your pardon, I never promised you a raingarden…”

“along with the sunshine, there’s (apparently…) got to be a load of concrete sometime”

There are reasons for using concrete (e.g. protection against the erosive force of stormwater from unmitigated impervious catchments) , but the detention areas and indeed many soft engineered sites can be far better…!

Photo credits: *above* Environment Agency (Salmon Brook!); *right*: Garthamlock Gorge detention basin. Apologies to Joe Smith for his original song sung by Lynn Anderson

Community raingardens…

Why use such a broad and inclusive term?

- SUDS manuals exist, green and living roof design guidance too.
- That's fine for technical readership looking to select & build something specific
- But ***does not readily inspire*** the public or builders/developers, who do not understand what the technology is about and what it should include, especially biodiversity and amenity.

- ***10,000 raingardens – be a part of it!***
- **Not** one or two wee demo units here or there
- Everyone can own the idea: build one yourself, buy one, there's one in your new house, there's a community feature on your estate....
- ***Be a part of changing our infrastructure, our approach to the urban landscape and environment***

Conclusions: SUDS for lochs

- SUDS techniques have considerable potential to be important for water quality in urban waterbodies
- On separate sewer catchments with discharges to watercourse, units need to be designed for nutrient capture (FAWB 2009)
- On combined sewers, storage for slower release back into the sewer is becoming a practical option on a plot by plot basis
- Otherwise disconnection as for separate sewers
- Considerable effort required to deliver fit for purpose features and units to give catchment scale benefits for water quality – regulatory innovation

Policy Reference for SEPA: (2015) *Regulatory Method (WAT-RM-08) – Sustainable urban drainage systems (SUDS or SUD systems)*; Scottish Environment Protection Agency, Stirling