Annex 1

Additional Evidence for SuDS

Properties at significant SW flood risk today

1. The Environment Agency's (EA) report: "Review of 2007 summer floods" identified surface water drainage as being the source of flooding for two-thirds of homes during the 2007 summer floods, as drains and sewers were overwhelmed. This percentage clearly depends on soil types, catchment and urban environment. It was modelled by the Hogsmill Integrated Urban Drainage Pilot as being roughly 30%.

2. The EA's evidence is that the amount of flooding does not correlate directly to rainfall because of the complex relationship with drainage, soil conditions and catchment areas.

3. The EA estimates[1] that in 2007 around £1bn of the £3.5bn costs of flooding fell to business with the remaining £2.5bn falling to the domestic sector. This equates to business 29% and domestic 71%. Business costs through loss of business are based on ABI assessments of insurance claims and are thought to be an underestimate as in some areas they were acute.

4. The Impact Assessment (IA) assumes that a range of 56,000 (low case) to 76,000 (high case) properties at risk from surface water flooding. Evidence from two surface water flooding studies – the Kingston and Richmond SWMP and the Ravensbourne Delivery Plan (a comprehensive assessment of flood risks from all sources in this catchment in SE London) - was used by Halcrow to calculate the likely number of flooded properties for a range of event probabilities to determine an annualised value.

5. The annualised number of properties weighs the number at each event probability with the likelihood of that event occurring in any one year. Through integration a 'typical' number of properties for any year can be determined. Halcrow's analysis also draws on the EA national mapping product which shows spatial extents at low, intermediate and high susceptibility to surface water flooding.

6. This analysis suggests that 2% of the properties susceptible to surface water flooding are at risk on an annual basis.

7. In England, the EA's long term investment strategy (LTIS) indicates that 3.8 million properties are susceptible to surface water flooding in England (a figure derived from national flood susceptibility mapping). Of these, some 1 million are also at risk from fluvial or coastal flooding[2].

Annual average damage per at-risk property

8. The IA makes an assumption that the average damage per flood event is in the range £23,290 (low) to £29,430 (high). Evidence for this is derived from Lewes IUD pilot project (£23290), Foresight Future Flooding (£22,630), Ravensbourne Delivery Plan (£23,000 to £25,000), Richmond and Kingston first edition SWMP (£30,000).

Growth in damage due to climate change and urbanisation

9. The IA makes an assumption that the overall potential increase in aggregate flood damage will be between 60 and 220% by year 50. Of this half is due to climate change and half due to increased urbanisation.

---

[1] EA (2007), The costs of the summer 2007 floods in England, http://publications.environment-agency.gov.uk/pdf/SCHO1109BRJA-e-e.pdf

[2] EA (2009), Investing for the future: Flood and coastal risk management strategy in England: A long term investment strategy

10. There is no standardised methodology for determining the impact the climate change (greater rainfall depth, intensity and storm frequency) will have on surface water flooding. Most practitioners deploy standardised Defra guidance suggesting 10-30% uplift on rainfall intensity and depth3. The Foresight update report undertaken for the Pitt Review4 indicates winter rainfall could increase by as much as 40% and this has been used to produce the worst case prediction of climate change.

11. Defra supported fifteen pilot projects on integrated urban drainage, to better understand the cause of flooding in urban areas, and test SUDS amongst other tools for reducing flood impact. A variety of modelling tools were applied to calculate surface water flood risk, a product of flood likelihood and consequence. Halcrow analysis used evidence from the Hogsmill, River Aire and West Garforth Integrated Urban Development pilot studies, as well as those used in the Foresight Report to determine a potential range of increases in flood damages owing to precipitation changes. For a 20% uplift in rainfall the increase in flood damage predicted was in the order of 30%. For a 40% increase in rainfall (worst case uplift) the evidence indicates that flood damages could increase by a factor of 110%.

12. The river Aire IUD pilot and Foresight report indicated that urbanisation could cause a similar increase in damages to climate change. However, changes in the house-building market and planning regime make this figure very difficult to predict.

13. Evidence from the London Assembly and The North Brent IUD is that the increase in impermeability bears only an indirect relationship to population increase. According to the Environment Committee of the London Assembly, around two-thirds of London's front gardens are now either partially or wholly covered in an assortment of paving, bricks, concrete and other hard surfacing. Visual observations from photographs and site visits in the Brent catchment suggest that in excess of 50% of the properties have converted front gardens into driveways/parking areas. Three sample areas were examined and typically 70% of front gardens are substantially paved, this increases to nearly 90% in some streets. Accordingly, modelled impermeable areas have increased by around 33% between the old model (1990) and new models.

14. The standard for SUDS is to reduce peak flow rates and volumes to greenfield levels for critical rain storms. This can generally be taken to be a 1 in 100 yr 6 hour storm. Modelling was undertaken for Ashford Borough Council's Local Development Framework which estimates a brownfield runoff rate for this critical storm as roughly 36 l/ha/s. Ashford is a relatively dry part of England and the average critical brownfield runoff rate can be assumed to be higher. Thus wherever SUDS can be used for brownfield sites to bring levels back to greenfield sites (2-5 l/ha/s) considerable additional protection is provided.

15. Predictions made at the time of the Floods and Water Management Bill were that the overall total number of property units developed per annum would be around 260,000 in total – i.e. including both residential and non-residential units. Updated information suggests that this figure should be revised to 420,000 units.

Increased pressure on the sewerage system

16. Pressure on the sewerage system was anticipated to increase by 35% on a business as usual case by MWH and 29% if there were no new connections to the system (ie through SuDS). These estimates are calculated on a 30 year basis. The four main pressures on the sewer system are:

---

[4] Further information available at http://www.environment-agency.gov.uk/research/library/publications/40697.aspx

- Deterioration of the structure of the existing system;
- Annual increase in connected properties estimated at 0.83%
- Increase in winter precipitation estimated at 0.28%
- Urban creep estimated at 0.3-0.6%

17. Providing additional capacity can be done in many ways – for example by storing sewerage prior to treatment or, more cost-effectively, diverting existing surface water sewers to the surface water body before they reach the combined sewer system. It is not possible at present to make a direct link between the value of sewers and the value of the additional capacity needed.

18. On the basis of this we have estimated that blanket use of SuDS: might equate to a saving 2% of the total sewerage network ie £3.48bn over 45 years, though this figure is not included in the monetised estimates in the main body of this IA.

Estimated new development units per annum

19. Government collects statistics on all aspects of housing and planning in England and these are published via the Housing and Planning Statistics for 2010. Key evidence is:

20. Net additions to the stock (new build plus conversions and change of use, less demolitions) rose from 132,000 net additions per annum in 2000-01, to a peak of 207,370 in 2007-08 before falling to 128,680 in 2009-10. At the time of writing house prices have not recovered, depressing the market for new build.

21. The assumption made is that housing will rise again to roughly 140K dwellings per annum.

22. Housing densities for new build are typically being set at ~30 houses per hectare (eg South West) – 40 houses per hectare (e.g. Ashford), though these may change with the change in policy on minimum housing density targets.

23. This gives an average of around 165,000 new residential dwellings/year over the period, equating to around 47,000 hectares/year.

24. In 2009, on a provisional estimate, 80 per cent of dwellings (including conversions) were built on previously-developed land, unchanged from 2008. The target is for 60% to be built on previously-developed land.

25. The Construction Statistics Annual 2010, chapter 3 provides information about the structure of the construction industry. This shows that house building accounts for 37% of the value of the building industry with the non-residential sector accounting for 63%.

26. This suggests that non-residential build could account for 1.7x the hectares of residential build.

Additional construction costs

27. The construction costs of SuDS are available from a wide range of sources as detailed below. The cost of both piped solutions and SuDS are inherently variable, depending on the distance from sewers, and topography etc. However the following conclusions can be drawn:

- The cost of providing storage via SuDS is considerably cheaper to construct than via sewers and underground storage where public open space can be used, leading to very large reductions up to 50%;
- Cost-effective SuDS options are available for a wide variety of situations – in particular the use of storage in permeable paving and roads provides affordable solutions in areas where there is little or no public open space;
- Requiring greenfield runoff can require an uplift in costs of around 5% in the most difficult areas.
- Consideration of SuDS at an early stage is necessary to realise the cost savings.

28. Information about the cost of constructing SUDS has been derived primarily from case studies with estimates of comparative costs, generally using the UKWIR model. The UKWIR model automates the whole life costing approach and allows users to systematically and consistently identify and combine capital costs and ongoing expenditures for individual components. This allows the cost influence of the impact of different maintenance 'levels of service' to be tested. This model also takes account of all waste classification and management issues including a range of disposal options and sediment accumulation rates. (CIRIA proposal 2541 November 2007)

29. The cost of constructing a SUDS scheme is inherently variable and will depend heavily on the size of the contributing catchment area. There has been particular concern from some stakeholders about the likely costs of construction on difficult sites – particularly ones which have high land costs, are on brownfield sites and/or clay subsoils.

30. Land costs are likely to be the most significant factor influencing the cost of implementing a SUDS scheme. In some cases, the effective cost of the land for a scheme can be zero, e.g. where the site has dual use, such as a car park or recreational area, or where the scheme forms part of a required public open space area. However, in high density settings the value of land can far outweigh construction costs and the land-take associated with specific SUDS components may determine the selection of drainage options at a particular site. Permeable paving and use of public land as storm water storage both reduce land take costs.

31. Many of the existing case studies are on greenfield sites. However, there is separate evidence that the cost of SuDS can be kept affordable through the use of permeable paving. To investigate these points more close, a bespoke research project is underway to identify comparative costs in buildings in Wakefield, Ipswich and Islington.

32. Design costs are generally <5% of total costs though this varies depending on how early the SUDS are considered. Details of the costs from these sources is given below:

Case Studies

Ramshill Residential Development

33. Ramshill is a residential development of 287 dwellings on a green field site, constructed in early 2000s which has been operating for about 5 years.

34. Although greenfield, this is not a naturally easy site. There is a permeable subsoil but with clayey top soils, and limited natural space to the front of the buildings. There are natural but steep falls to a roadside ditch with no onsite sewers ditches or watercourses. The downstream ditch has severe capacity constraints and the nearest main river is 2km away crossing a mainline railway and the A3(T).

35. The SUDS solution has on-plot soakaways and a site infiltration basin. These two elements are not linked and there are no SUDS conduits between each. Conventional pipes are used for site surface water conveyance.

36. The capital cost of the main SuDS elements was £350,000: £600,000 less than the traditional piped approach. Design costs were £100,000 primarily consisting of option analysis to satisfy the numerous stakeholders. The design of the final SuDS scheme itself is circa £20,000 (CIRIA report for Defra to information national standards RMP 5406).

Lamb Drove in Cambourne

37. Some analysis was undertaken as part of the FLOWS project for a 1 ha, 35 home site at Lamb Drove in Cambourne, summarised in the following box. The costs of sustainable and conventional systems would have been very similar, with SuDS potentially providing a more cost-effective solution, had the sustainable option not had to be 'retrofitted' onto an already final drainage scheme design.

38. Although the site was greenfield it is not the easiest site for SuDS. It is moderately steep (1:30 to 1:50) and lies on clay. Open storage and attenuation systems are therefore used instead of infiltration. Permeable pavements were used where required by spatial constraints preventing the use of open storage SuDS. Site layout is medium density (35 units/ha)

39. Lack of skills and confidence in implementing the SuDS solution also contributed to higher costs. The SuDS at Lamb Drove achieve 100% of the required flow rate reduction by providing attenuation storage within the site and the immediately adjoining greenway land. This represents a saving as there is no reliance on strategic balancing lakes, which have associated capital costs, maintenance and land take requirements. Also, Lamb Drove SuDS does not connect to the adopted public sewer and therefore avoids any connection charges and annual charges on storm water disposal. These cost savings are unaccounted in the cost comparison.

40. Additional efficiencies could have been achieved if the Lamb Drove SUDS had been integrated into the original residential design rather than retrofitted to an existing design and if the SUDS for Lamb Drove had been part of a wider Integrated Urban Drainage Strategy for Cambourne Development based on similar SUDS principles.

Basic Cost Comparison	**Total**	**Per home**
Traditional Drainage (est.)	£208,600	£5,960
SUDS (actual*)	£197,600**	£5,646
Estimated cost saving	£ 11,000	£ 314

*Excluded: Additional avoidable costs encountered in pilot are excluded from above: Design fees arising from amendments and delays £ 37,300
Construction costs arising from amendments and £ 41,600 delays

Maintenance of soft measures (swales etc) Not known but expected to be minimal (to be incorporated in landscape maintenance regime)
**Included: The following is included in SUDS costs: commuted sum for maintenance of permeable paving £17,400 (CIRIA proposal 2541, 2007)

Matchborough First School

41. Capital cost savings of 20% were realised at Matchborough First School in Redditch. Maintenance costs were reduced from just under £4000 (2003 prices) to marginal costs. Costs were reduced by the existence of ample land for storm water drainage.

42. A SUDS retrofit design completed in 2003, which included swales, detention basins and a constructed wetland. The original design involved conventional drainage, however, during construction it was discovered that this would not work. SUDS was used to overcome the problems and to remove the need for a pumping station (with the ongoing maintenance costs that involves).

43. The school development was originally designed with conventional drainage that flowed to a pumping station where it was pumped to a sewer. However, one playground area was not actually able to drain by gravity to the pumping station.

44. The system was designed to cope with a 1 in 100 year return period storm event, and overland flow routes were provided for events exceeding this.

Items	**SUDS, £**	**Traditional drainage, £**
Trenches, pipework, drainage channels, manholes, headwall etc	£30 905	£72 960
Pumping station	£0	£10880
Sewer connection	£0	£750
Land drainage to playing field	£32 110	£32 110
Construction of swales, basins and wetlands	£25 000	£0
Site level adjustments to accommodate SUDS as retrofit	£5000	£0
Total capital costs	£93 015	£116 700
Annual sewer connection	£0	£3180
Annual pumping station maintenance	£0	£800
SUDS maintenance	Marginal – landscaping maintenance already undertaken for grounds	£0
Total operating costs	Marginal	£3980

(CIRIA W12 2006)

Comparative construction costs

45. Five comparative costings were commissioned in order to inform this IA:

- The development of 150 properties on a 0.3 ha brownfield site on Caledonian Road in Islington at very high densities;
- The development of 7 ha of greenfield site in Newport, Shropshire;
- The redevelopment of 11 ha of brownfield site also in Newport
- The development of Redhill School in Worcester.
- The development of a sustainably drained railway terminal on contaminated land in Telford.

Islington – Brownfield dense site

46. The Caledonian site development is of particular interest to developers with contaminated highly dense sites where infiltration is not possible and the emphasis is on reducing the run-off rate, rather than reducing much of the volume.

	150 l/s/ha		50 l/s/ha		8 l/s/ha	
	Traditional Drainage	S.U.D.S.	Traditional Drainage	S.U.D.S.	Traditional Drainage	S.U.D.S.
Cost	39,300	19,700	65,300	19,700	107,300	41,300
Preliminaries	3,900	2,000	6,500	2,000	10,700	4,100
Contingency	2,000	1,000	3,300	1,000	5,400	2,100
Estimated Construction Total	**45,200**	**22,700**	**75,100**	**22,700**	**123,400**	**47,500**

47. The construction estimates show that building SuDS to a greenfield standard is 5% more expensive than building the traditional drainage to typical brownfield runoff. However, it should be noted that the capacity of the sewers and flood concerns means that higher standards are normally required.

48. No allowance has been made for either the SuDS properties or costs of the green roofs. This is because they are incorporated in all London buildings as part of planning requirements, and there is no standard agreement about the storage/attenuation allowance to be made.

Newport greenfield site

49. The Daniels Cross site was developed with traditional drainage in 1998, and incorporates little public space. The purpose of the research was therefore to assess how SuDS could have been incorporated within the existing design and compare the costs of build.

50. The SuDS concept relies upon attenuation storage and slow conveyance, and costs include porous paving of the adopted cul-de-sacs and driveways. Roof water ‘disconnection’ discharging to garden swales or filter drains. Adoptable swales and detention basins forming a continuous, slow conveyance system along the same routes as the surface water sewers.

51. Space for the swale was created by either eliminating one footway or taking a strip of front garden into the public realm.

52. The research showed that a non-infiltration SuDS system could have been fitted to the existing design at a reduction of 12%. However the design does not cost the removal of the front garden. A better result would have been achieved by the inclusion of SuDS at the design stage, and much better use could have been made of the permeability of the soil.

Newport brownfield site

53. The Marlborough Road site was built using a traditional piped solution on impermeable clay. The purpose of the research was therefore to assess how SuDS could have been incorporated within the existing design and compare the costs of build.

54. The SuDS concept relies upon attenuation storage and slow conveyance. Costs include using swales with under-drainage wherever there are currently verges, local basins wherever there are surfaced open areas; porous paving of the adopted cul-de-sacs and driveways. Roof water ‘disconnection’ discharging to garden swales or filter drains. Adoptable swales and detention basins forming a continuous, slow conveyance system along the same routes as the surface water sewers, and development of a pond on existing public open space.

55. The SuDS was found to be marginally lower than that of the traditional piped system, and in this case the change to frontages is minimal.

The Redhill School

56. A SuDS solution was built and then a traditional piped solution designed and costed in detail. It is particularly useful because it enables us to compare the cost of a SuDS which discharges at greenfield rate of 8 l/s/ha with the cost of a traditional piped solution discharging at typical brownfield rates of 150l/s/ha. The full results are provided below.

	150 l/s/ha		50 l/s/ha		8 l/s/ha	
	Traditional Drainage	S.U.D.S.	Traditional Drainage	S.U.D.S.	Traditional Drainage	S.U.D.S.
Cost	99,100	46,900	151,000	46,900	237,000	55,100
Less Amenity Works on S.U.D.S.		-2,400		-2,400		-2,400
Preliminaries	9,900	4,900	15,100	4,900	23,700	5,800
Contingency	5,000	2,500	7,600	2,500	11,900	2,900
Estimated Construction Total	**114,000**	**51,900**	**173,700**	**51,900**	**272,600**	**61,400**

57. This comparison of the cheapest piped solution with the most expensive SuDS solution still gives a saving of 41%.

58. In this scenario there was no additional land-take due to SuDS because existing recreational areas were used to store storm water.

Telford Railway Freight Terminal

59. A SuDS solution was built and then a traditional piped solution designed and costed in detail. In view of the very heavy machinery and contaminated land water was conveyed from impermeable surfaces to storage and slow conveyance features. There was marginal infiltration in non-contaminated areas. Storage provides greenfield runoff sufficient for a 1 in 30 event with safe storm management for a 1 in 100 year event.

- The total estimated cost for the SuDS features is £51,088.
- The total estimated cost for the sewer comparator is £372,259.

Evidence from the Scottish Experience

Roads

60. The Scottish Working Party on SUDS in roads has developed guidance drawing on experience so far of requirements to incorporate SUDS within new developments. As part of this they have developed a model to allow costs comparisons between traditional asphalt roads and those with permeable paving and swales. The table below shows the modeled cost comparisons.

61. The SuDS approaches provided attenuation for a 1 in 30 year rainfall event – that is to the same standard as a standard sewer rather than standard SuDS.

Roads and SUDS description	% Overall construction cost compared to conventional to road type (1	% saving	% drainage cost.
(1) Asphalt surfaced road, 2m wide asphalt surfaced footways each side, conventional road gullies and piped drainage system.	100		25
(2) Permeable block paving, 2m wide asphalt surfaced footways each side, NO INFILTRATION	70	30	30
(3) Permeable block paving, 2m wide asphalt surfaced footways each side, WITH INFILTRATION	56	44	11
(4) Asphalt surfaced road, 2m wide asphalt surfaced footway one side, 2m grass filter strip and filter drain other side	87	13	22
(5) Asphalt surfaced road, 2m wide asphalt surfaced footway one side, 2m grass filter strip and swale with drop kerb entry other side	76	24	11
(6) Asphalt surfaced road, 2m wide asphalt surfaced footway one side, 2m grass filter strip and swale with road gullies	85	15	13
(7) Asphalt surfaced road, 2m wide asphalt surfaced footways each side, conventional road gullies and filter drain one side	97	3	22

Interpave

62. The Interpave work on pavement whole life costs (Interpave, 2006) concludes that permeable paving systems offer the lowest Whole Life Costs (when compared to asphalt, reinforced concrete and pavement quality concrete surfaces) at CBR values of both 3% and 6%, while offering the well-recognised visual attractions of block paving. Even here, the cost of the traditional paving does not include an allowance for storage.

Dunfermline Eastern Expansion

63. Dunfermline Eastern Expansion (DEX) is a 50 ha development of residential, retail, commercial, industrial, leisure and public open space which commenced construction in 1996 on a Greenfield site. The development relies on retention ponds as the regional treatment component and the systems investigated include four ponds and a constructed wetland. The SUDS were designed to attenuate a 100 year rainfall event. The lead developer commissioned a five-year SuDS study.

64. A cost comparison between traditional drainage and SUDS in Scotland concluded that the capital costs of traditional drainage are more than double the capital costs of SUDS on the dunfermline site.

65. However, it should be noted that the construction costs do not take account of the land-take costs – detention ponds were sited on public open land.

(Duffy A., Jefferies C., Waddell G., Shanks G., Blackwood D. & Watkins A. (2008). A Cost Comparison of Traditional Drainage and SUDS in Scotland. *Water Science and Technology* – 57(9):1451-9)

Information from SUDSNet

66. As part of the evidence gathering for this IA, Defra asked SuDSNet to request information from its members. SuDSnet is run jointly by the University of Abertay, Dundee and by Coventry University. It provides a UK-wide network for researchers, practitioners, agencies, developers and all those who are interested in Sustainable Urban Drainage Systems.

Costs for brownfield – impermeable site

67. Gifford has provided sustainable drainage for a typical 10 house estate in Oxfordshire, bia swale and adoptable permeable paving system, with storm retention crates underneath. The site was a brownfield site – it is on clay pretty impermeable and used to be very water logged. The storm crates run off into a highway drain. The costs are considered pretty similar to those for tarmac. However, it is important not to require specific brands as this increases costs. (Information from Gifford – Engineering Consultants)

Cost of Permeable Paving

68. Herriot-Watt University carried out a technical consultation which touched on the cost of permeable paving. - 4 out of 5 of technical respondents to a survey believed that permeable hard-standing is intrinsically more expensive than impermeable options, but only 6% of respondents classified this cost differential as “significant”.[5]

Cost of Rainwater Harvesting Systems

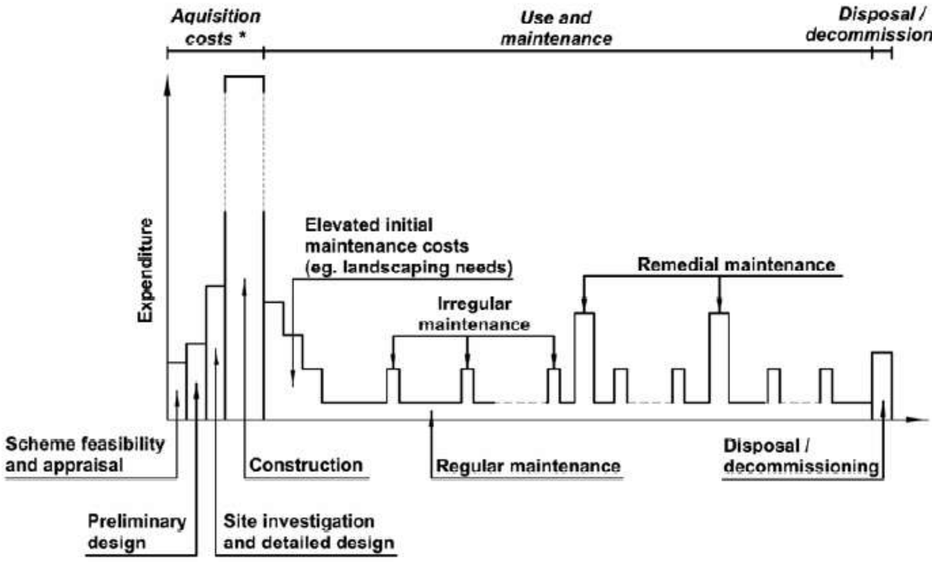
69. The Whole Life Costs of the simulated RainWater Harvesting systems have been modelled by Leeds University and found to be significantly higher than the WLCs of the equivalent mains-only systems, often by several thousand pounds (Richard Roebuck’s PhD Thesis: A Whole Life Costing Approach for Rainwater Harvesting Systems).

[5] Herriot-Watt University report to Scottish Government on “Extent and cost of designing and constructing small areas of hard-standing around new and existing domestic and non-domestic buildings”

Maintenance Costs

	% traditional costs	Comments
Lambs Drove	23% increase	Maintenance undertaken as part of open space maintenance. No silt removal.
DEX	20-25% decrease	Main focus on pond maintenance cf attenuation tank.
Scottish SuDS retrofit project	50% decrease	No further details.
Matchborough First School	Maintenance considered marginal and incorporated within the landscaping regime.	

70. Observed operation and maintenance costs tend to be dependent on the expected level of service of residents living close to the facilities i.e. whether a manicured appearance or more 'natural' vegetation is acceptable.



71. Information about the cost of operating and maintaining surface water sewers and SuDS is very limited, but the pattern of costs is well established – commissioning to remove silt from construction followed by landscaping, litter picking, occasional remedial maintenance (see later info on permeable paving) and removal of silt.
Advice from CIRIA is that standard SuDS components - ponds, basins swales have an indefinte life when well constructed and appropriately maintained. Permeable roads need replacement of the geotextile layers every 10-20 years.

Lamb Drove in Cambourne

72. The overall cost to maintain the SUDS scheme at Lamb Drove has been £1,312 per year for the 35 house site – equating to £37/ unit. This includes:

- Litter removal;
- Swales vegetation cutting;

- Filter Strip vegetation cutting;
- Under-drained Swales;
- Detention basin and ponds(vegetation cutting) and
- Retention pond (vegetation cutting).

73. Most of the maintenance is carried out as part of the overall space maintenance, so this is an overestimate but it is also an underestimate as it does not make allowance for silt removal and longer term replacements (Lamb Drove SUDS Showcase Project, Cambourne – Final Monitoring Report).

Dunfermline Eastern Expansion

74. Cost research carried out on the Dunfermline Eastern Expansion (DEX) with data collected relating to maintenance activities carried out over a five year period concluded that on average, the annual cost of maintaining SUDS is approximately 20 – 25% lower than for the equivalent traditional drainage system.

Scottish Water SUDS retrofit

75. Commissioned by Scottish Water and undertaken in the Ayrshire region of Scotland this project looked at the issues surrounding retrofitting in order to reduce combined sewer overflows. As a retrofit project the capital costs are not relevant here.

76. However the project also considered the maintenance and operation costs associated with plans for two retrofits: for an industrial and a residential site.

77. It estimated a reduction in maintenance and treatment costs at both sites due to reduced pumping and treatment costs for sewage in the combined sewer, for the residential site a 50% reduction was estimated (CIRIA RP922 - Retrofitting Surface Water Management Measures).

Effectiveness of SuDS

78. We estimate that 30% of the additional surface water flooding risk could be mitigated by using SuDS throughout. This estimation is based on figures derived by Foresight and the EA. 50% of the additional risk is expected to be due to continuing urbanisation. However, the SuDS impact is unlikely to be total. It is assumed that some 60% of the increase due to urbanisation could be prevented by the use of SuDS.

79. The EA has estimated the contribution of SuDS to reducing damages at about 20% and early Foresight research estimated a combination of measures reducing damages at 40%. A base mitigation rate of 30% is used in the analysis, for options which apply to all development within particular planning categories. However, this is varied for options which a) target “infill” (minor urban development on brownfield sites), for which there is evidence that SuDS are likely to be most beneficial; and b) options which have an element of discretionary or risk-based targeting of SuDS at priority sites and situations.

80. The evidence that Sustainable Drainage Systems can make a real difference to both water quality, and surface water flooding was brought together in a major research project in 2007 - Collating the urban drainage evidence base, a joint venture between CIRIA, HR Wallingford and MWH.

81. This has been supplemented by a controlled experiment in Lamb Drove in Cambourne. There is considerable experience of designing SUDS to withstand extreme weather, but relatively limited evidence of water quality treatment of SUDS during extreme weather.

82. The hydraulic performance of SUDS has been research fairly extensively in UK, both theoretically (HR Wallingford and others) and field data collection (CEH and others). In general terms, the hydraulic performance of SUDS for extreme events is not a major issue of concern in terms of uncertainty regarding their performance. Their behaviour for frequent events is less certain and data continues to be needed and collected.

83. Traditional drainage is sized using rainfall of only 15 to 30 minutes, critical rainfall events for SUDS are usually between 3 and 24 hours. This tends to result in relatively low impact flooding if and when the storage gets completely filled. In addition to the type of failure being very different and probably of lesser impact, SUDS schemes retain the runoff for longer, while pipe based systems pass all this flow downstream. This means that areas downstream at risk of flooding receive all the water from an upstream pipe based system, but only a limited amount of water from a SUDS scheme. (Collating the urban drainage evidence base).

Lamb Drove Monitoring Project

84. A controlled experiment was carried out which compares water quality and attenuation of water after rainfall at two sites – Lamb Drove (SuDS) and Friar Way (traditional drainage). Results from the first years monitoring are as follows.

- In comparison to the control site the SuDS site shows significant attenuation in discharge following rainfall events.
- The SuDS features act to delay discharge of water from the site.
- In higher intensity rainfall events there is less delay in peak flows through the SuDS system but the reduction in flow volumes is still very pronounced.

(Lamb Drove SUDS Showcase Project, Cambourne Interim Monitoring Report)

% of uncontrolled development

85. The link between planning decisions and buildings is not straight forward. Planning decisions in and definitions are shown below:

Type of development	No of planning decisions in England in 2009	Of which – dwellings (and householder developments)	Of which offices; general industry; retail distribution ; other
Major/large scale	2,300	600 (26%)	1700 (74%)
Major/all	12,300	5,000 (41%)	7300 (59%)
Major +minor	130,100	49,800 (38%)	80,300 (62%)
All	414,800	237,800	177,000

86. This suggests that non-residential build could account for 1.6 -2.8 times the hectares of residential build.

	Residential	Non-residential
Major large scale development	200 or more units or greater than 4 hectares.	>10,000m^2 floor space or more than 2 hectares.
Other Major development	10-199 units or 0.5-2 hectares.	1000-9999 m^2 floor space or 1-2 hectares

87. Our assumptions are that the average size of permitted development with drainage implications is 0.04 hectares, that a minor development is 0.2 hectares, a major development 1 hectare and a large scale major development 10 hectares.

88. At the time of the Floods and Water Management Act it was unknown how widespread SUDS schemes were in new developments. Analysis for the previous IA was that of the increase in potential damages under the baseline, between 53% and 54% is avoided through existing policy measures (including planning policy, PPS25, and voluntary adoption of SuDS). These proportions are based on a variety of assumptions regarding the proportions of various scales and types of developments which current policy measures succeed in controlling. This left an assumption that 46-47% of damage was "uncontrolled". Of the uncontrolled damage, 24-25% is in respect of new "major" developments, 65-68% is from new "minor" developments, and 7-11% is due to "urban creep" (e.g. infill) development.

89. In order to improve this evidence base a small telephone survey was therefore conducted in January 2011: 25 planning authorities were contacted to assess what proportion of new developments had SUDS. The councils were chosen to represent district and unitary authorities in urban and rural settings. Seven of the councils were unable to estimate the percentage of new developments with SuDS and these were replaced by matching councils.

90. Results so far suggest that on average 38% of minor developments and 58% of major developments are now being built with SuDS systems. It is not clear to what standards they are being built to.

91. Again the earlier Halcrow analysis assumed that 40% of build was accounted for by Minor Development with the remaining 60% accounted for by Major Development. This implies that 50% of build does not have SUDS.

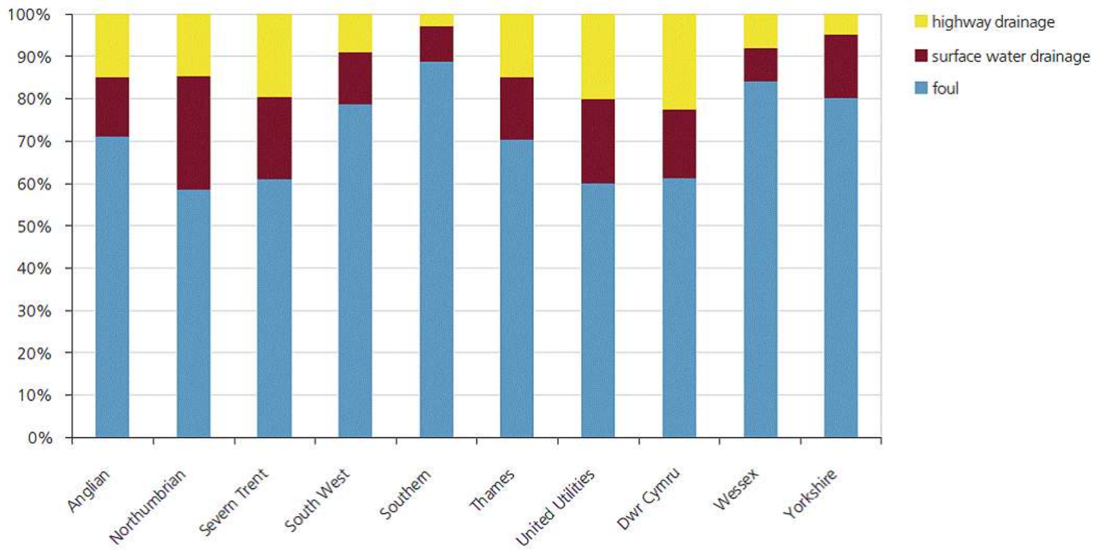
Traditional Drainage – Maintenance Costs

92. The level of the surface water drainage rebate which is available to household customers if they demonstrate that their property does not drain to the public sewerage system is based on an allocation of regulatory costs on an average accounting basis.

93. The allocation requires splitting elements of the Regulatory Asset Value (RAV) between surface water drainage, highway drainage and foul sewerage/ treatment. The RAV is a regulatory construct and because of factors such as the "privatisation discount" will not bear a close relationship to replacement value of the assets assumed to be utilised in providing the surface water drainage service. The Surface Water Drainage cost allocation includes a regulated return on the RAV, some allowance for depreciation on "non infrastructure" assets (typically above ground assets) and an allocation of opex and overheads.

94. There is a significant variation in the allocation rules that individual companies apply. The total cost allocated by the ten sewerage companies in England and Wales in 2005-06 for surface water drainage services including non households was of the order of £600m. The £30 rebate is consistent with an allocation of these costs across the customer base around 20million customers.

Figure 23: Structure of the sewerage bill for different companies – expressed as proportion of revenue recovered from the different elements of the sewerage bill



Source: Ofwat

95. In addition to this, there is a further cost also in the order of £600m from the allocation of highway drainage. There is no rebate to customers available as all customers benefit from the overall network from highways, some of which will be connected and some of which will not be.

96. OFWAT are currently carrying out further research in this area[6].

97. Therefore the costs of drainage are in the order of £1.2bn per year or 30 to 40% of the sewerage bill based on average historic costs. However, the future costs could be much

[6] http://www.defra.gov.uk/environment/quality/water/industry/walkerreview/documents/final-report.pdf

higher if the worst case scenario of climate change, urban creep and surface water from new development is realised. For example if the entire sewerage network was required to be upsized in order to deliver the desired protection from flooding for all properties it would cost in the region of £170 billion to replace the 309,000 km of public sewers. Our project completing by April will give us more detailed credible evidence of what the future may hold.

Requirement for SAB Staff

98. The tables below set out estimates of how long it might take the SAB to consider a:

- 0.2 hectare site
- 1 hectare site
- 10 hectare site

99. The tabled estimates below were provided by Cambridge Council, and have been reviewed by a different local authority, WAG and internal Defra staff.

0.2 hectare site

Activity	By	Hours
Site visit following notification of proposed development, review run-off destinations.	SAB Engineer	2
Receipt of application, scanned, form checked for completion, process fees.	SAB Admin	2
Send consultation request to stat. Consultees and other interested stakeholders, collate and review responses.	SAB Admin/SAB Engineer	1/1
Review of submitted information: Geotechnical Report Drainage Strategy to National Standards (written to aid assessment) Drawings Calculations Maintenance Schedule	SAB Engineer	3
Seek clarification if information, missing or incorrect.	SAB Engineer/SAB Admin	1/1
Further meeting with applicant to discuss (if required)	SAB Engineer	1
Review re-submitted information	SAB Engineer	1[7]
Issue Approval to LPA or applicant	SAB Admin	1
Total Hours	SAB Admin	5
	SAB Engineer	9

1 hectare site

Activity	By	Hours
Site visit following notification of proposed development, review run-off destinations.	SAB Engineer	3[8]
Receipt of application, scanned, form checked for completion, process fees.	SAB Admin	2
Send consultation request to stat. consultees and other interested parties, collate and review responses.	SAB Admin/SAB Engineer	1/1
Review of submitted information: FRA (Site 1 ha and over requires FRA) Geotechnical Report Drainage Strategy to National Standards (written to aid assessment)	SAB Engineer	10

[7] A different LA suggested that 2 hours might be needed to review the re-submitted information, as this would have to be compared with the previous information to be sure that other details did not change prior to accepting the latest version. “From experience the areas of a drawing that are deemed unsatisfactory are changed due to the clarification points, but also other parts of the drawing (in most cases) also changes, and needs to be reviewed.”

[8] A different LA suggested that the site visit could be carried out within 2 hours.

Drawings Calculations Maintenance Schedule		
Seek clarification if information, missing or incorrect.	SAB Engineer/SAB Admin	1/1
Further meeting with applicant to discuss (if required)	SAB Engineer	2
Review re-submitted information	SAB Engineer	2[9]
Issue Approval to LPA or applicant	SAB Admin	1
Total Hours	SAB Admin	5
	SAB Engineer	19

10 hectare site

Activity	By	Hours
Site visit following notification of proposed development, review run-off destinations.	SAB Engineer	5
Receipt of application, scanned, form checked for completion and process fees.	SAB Admin	2
Send consultation request to stakeholders/statutory consultees, collate and review responses.	SAB Engineer/SAB Admin	1/1
Review of submitted information: FRA (Site 1 ha and over requires FRA) Geotechnical Report Drainage Strategy to National Standards (written to aid assessment) Drawings Calculations Maintenance Schedule	SAB Engineer	20
Seek clarification if information, missing or incorrect.	SAB Engineer/SAB Admin	1/1
Further meeting to discuss issues No. 1 + feedback	SAB Engineer + Planner	4
Further meeting to discuss issues No. 2 + feedback	SAB Engineer	3
Further meeting to discuss issues No. 3 + feedback	SAB Engineer	3
Review re-submitted information	SAB Engineer	7
Issue Approval to LPA, or to applicant	SAB Admin	1
Total Hours	SAB Admin	5
	SAB Engineer	44

100. The Average Salary for a SAB engineer (drawn from the ICE salary scales) is £47,282 and for a SAB administrator £16,500. Employer contributions add an additional 30% to these figures. It should be assumed that a full time employee works roughly 1570 hours per year allowing for holiday etc.

[9] A different LA suggested that 4 hours might be needed to review the re-submitted information.

Biodiversity

101. Natural England provides guidelines on mitigation measures to be used when proposing development that impacts on Great Crested Newts.

Water Quality

102. A controlled experiment was carried out which compares water quality and attenuation of water after rainfall at two sites – Lamb Drove (SuDS) and Friar Way (traditional drainage). Results from the first years monitoring are as follows:

- In comparison to the control site the SuDS site shows significant attenuation in discharge following rainfall events.
- The SuDS features act to delay discharge of water from the site.
- In higher intensity rainfall events there is less delay in peak flows through the SuDS system but the reduction in flow volumes is still very pronounced.
- The SuDS treatment train is acting to improve water quality; this is illustrated through reductions in concentrations of a variety of pollutants and other indicators.
- There are significantly higher concentrations of hydrocarbons at the control site compared to the SuDS site.
- There appears to be some reduction in metals as water progresses through the SuDS system but the most significant result is the reduction in zinc.
- Suspended solids are generally below expected levels except where specific site conditions appear to have affected particular monitoring locations.
- There is also quantitative evidence of a benefit in relation to Phosphorus, Nitrogen, Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD) and Ammonia (Lamb Drove SUDS Showcase Project, Cambourne Interim Monitoring Report).

103. These findings are generally in keeping with those of the wider collation of evidence study. However, the benefit on nutrient loads (phosphorus, nitrogen) is an area where there is disagreement as removal, within SUDS can only be through take-up by vegetation. SUDS have not generally been considered effective in treating these pollutants.

104. The treatment effectiveness of SUDS components vary between the different types and also due to the variation in soil and physical characteristics.