sharing knowledge
building best practice

RP697: SUDS updated guidance on technical design and construction

Briefing paper on requirements for SUDS research

April 2004

Version - Final

1. BACKGROUND

CIRIA and HR Wallingford are undertaking CIRIA Project RP697 *SUDS – updated guidance on technical design and construction* to review and update best practice on SUDS, with the aim of producing a SUDS compendium dealing with the design, construction and management of Sustainable Drainage Systems (SUDS). In order to do this it's important to understand the end users requirements for guidance. However, basic research on some of these issues may not be available, and CIRIA has therefore also been tasked with determining what industry believe are gaps in SUDS research so that these can be tackled at a strategic level to help ensure that practitioners have the relevant information to make informed business decisions.

This briefing paper covers industry's requirements for research, there is an accompanying briefing paper that covers the specific requirements for RP697. The process of obtaining feedback from stakeholders on research gaps mainly focused on the use of workshops, a consultation exercise was undertaken, however, the majority of respondents focused on questions regarding guidance requirements. Consultation workshops were held in London and Durham with a feedback workshop in Coventry (sponsored by WaPUG). Information from the workshops and consultation will help influence the development of a strategic approach to SUDS research. Attendance of the workshops included those primarily involved with the design and management of SUDS. Professionals from local authorities, regulators, consultancies, research organisations and the construction industry were represented at the events.

1.1 Aim of workshops

The overall aim of the sessions dealing with research was to establish a portfolio of research, prioritised to help the industry implement and manage SUDS. A similar process has already been undertaken by the Environment Agency in November 2002, where Environmental regulators suggested and prioritised their own research needs.

The objectives of the workshops were to:

- Share information and experiences about existing research projects
- Identify different stakeholders requirements for research
- Prioritisation of research requirements
- Proposal development.

2. CURRENT RESEARCH PROJECTS

Currently within the UK, research can be broadly categorised as either science or guidance. Research and science projects predominantly involve academia and focus on natural and social sciences. Projects include investigations into SUDS performance, the hydrological, ecological and societal benefits of SUDS. Guidance normally involves the collation of the science and dissemination providing practical guidance facilitating successful implementation in developments. Guidance projects would include the development of design manuals, decision tools, videos etc

A comprehensive list of current research projects is posted on the CIRIA SUDS website www.ciria.org/suds. Table 1 provides a summary of some of the current research projects being undertaken.

Table 1: Summary of current research

Organisations	Notes
EA	***Yorkshire Ponds Project – Pennine Water*** Project to establish the ecological, physical conditions in ponds built to mitigate the hydraulic effects of commercial and highway development.
	Bourne Stream Project Catchment partnership to look at retro-fitting options in a small, highly developed catchment.
	UK SUDS Database – HR Wallingford Development of an online database collating information on SUDS sites across the UK providing information on location, design, operation and maintenance, cost performance. www.suds-sites.net
	English Science Group – Chair Proff Chris Pratt The Agency is collaborating with a small number of English Universities to establish a research group that will share knowledge and experiences on SUDS.
	Catchment zoning of SUDS
SNIFFER/SEPA	***Scottish Universities SUDS monitoring programme*** Undertaking studies looking at sedimentation, biodiversity and social issues.
	SUDS Database in Scotland This is maintained by SNIFFER and lists the SUDS sites in Scotland.
	Review of CIRIA SUDS guidance (C521) This has been undertaken in collaboration with SEPA, SNIFFER and Hyder Consulting,
	DEX community engagement study
	SE Wedge – development site The South East Wedge development has been driven by a multi stakeholder group of local authorities and regulators to ensure that the environmental potential of the development is maximised through the integration of amenity, natural habitat and urban drainage.
CIRIA	***RP664: Model agreements for sustainable water management systems*** To develop model operation and maintenance agreements for sustainable drainage systems and rainwater/greywater use systems.
	RP663: SUDS techniques – hydraulic, structural and water quality issues To improve designers and planners understanding of the hydrological, hydraulic, ecological and water quality issues of the various SUDS techniques.
	RP697: SUDS – updated guidance on technical design and construction To undertake a review of previous guidance on SUDS and provide a compendium of information providing guidance on the design as well as the construction of SUDS.
	RP698: SUDS – promoting good practice A project to promote good practice in sustainable drainage through a website, biannual newsletter and articles in related press
	RP699 Designing for exceedance in urban drainage systems – good practice To provide guidance on the planning and design of urban drainage systems to reduce the impacts of exceedance from urban drainage systems.
HR Wallingford	***Post-Project Monitoring of BMPs/SUDS to Determine Performance and Whole Life Costs*** Assessment of performance of a range of sustainable drainage techniques, and the relationship with design and maintenance. Qualitative and quantitative monitoring to verify system whole life costs.
	Use of SUDS in high density developments Evaluate SUDS in terms of land take and consider development layout options to maximise potential for SUDS
	Guide on drainage development sites
	Greenfield development stage
	Sustainable urban drainage: economic incentives, social impacts and ecological benefits Guidance will be produced on whole life costs, social impacts and ecological benefits.
	Benefits and performance of sustainable urban Drainage systems To gather information on the technical performance and environmental benefits of using SUDS, through field monitoring of operational sites. Where possible, the project will identify the impact of degradation of SUDS on performance, and the effectiveness of maintenance activities.
Academia	Imperial University – WaND (Water cycle management in new developments) Oxford Brookes – Sustainable Urban Form Consortium University of Sheffield – Looking at retrofitting of CSOs University of Bradford – Whole life costs of sewers University of Bradford - AUDACIOUS Middlesex university – DayWater project University of Coventry and Unviserity of Abertay - SUDSNet

3. PROCESS

The workshops proved to be the most effective method of obtaining information on the industry's perceived gaps in research. Three workshops were run during January 2004, these consisted of two consultation workshops run in London and Durham and a feedback workshop in Coventry (sponsored by WaPUG). Seventy people attended the consultation workshops and nearly thirty delegates attended the feedback workshop. The breakdown of delegates by sector is represented in the chart below.

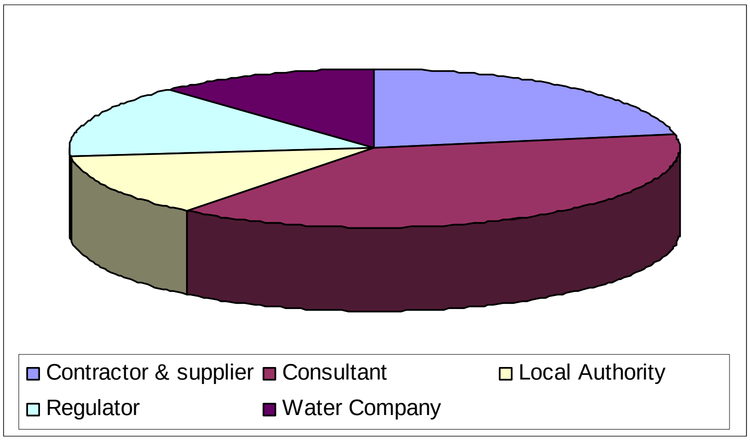

Figure1: Breakdown of delegates attendance by sector

4. WORKSHOP METHODOLOGY

The workshops were split into two sessions, the morning session covered specific guidance requirements to help influence the development of the guidance document from RP697, the afternoon session focused more on the identifying gaps in general research. The afternoon session followed logically from the session to determine requirements for research, as some of the suggestions for guidance require further research to be completed first.

During the consultation workshops delegates were split into stakeholder based groups, these were:

- construction industry (developers, manufacturers, suppliers and contractors)
- consultants
- local authorities
- regulators and water companies.

These groupings were dependent on the stakeholder representation being available, during the Durham workshop local authorities were combined with regulators and water companies. Within their stakeholder groups, delegates were asked to freely brainstorm research ideas. Delegates were asked to determine whether their research ideas related to:

1. planning
2. design
3. construction
4. management and maintenance
5. other.

Delegates were asked to avoid issues that related to policy and make their suggestions punchy. Once research ideas were brainstormed delegates were asked to help group suggestions into strategic themes. Around 250 separate research ideas were suggested with around 50 themes being created. The results of these can be found in the results section.

5 RESULTS

Table 2: Planning research suggestions

Planning policy
Standard planning condition to require SUDS as first alternative
Desk top study on LA's introducing SUDS to planning applications
Planning conditions must reflect SUDS requirements - model conditions
Planning policy to drive use of SUDS in development, model/policy statement

SUDS suitability
Technique for LPA's to assess land to be released for SUDS suitability; decision tool?
Where/when to use SUDS
Data collection, data management and decision support tools to aid drainage planning

Assessing financial benefits of SUDS
Quantifying the financial benefits of SUDS for developers
Comparative study on cost savings between sewerage and sewerage charges against SUDS system

Impact on drainage and flood risk
Identifying potential for improving existing flood risk through development (opportunistically); assessment method/protocol
Use of flood risk assessment in developing site layout
Identify difficulties with planning process which prevents use of SUDS (and success)
Drainage impact studies covering run off at a catchment level - start with most sensitive catchments

Contribution of SUDS at catchment level
Implications of Water Framework Directive
Implications of Water Framework Directive on catchment
Possibility that EA will impose discharge consents

Decision support for SUDS
Technical tools for design/simulation of SUDS systems under design and extreme conditions
Use of GIS, remote serving and other terrain modeling tools for determining overland drainage patterns.

Effective planning policy
Identify difficulties with planning process which prevents use of SUDS (and success)
Effectiveness of planning policy and practice
Consideration of PPG on integrated water management.
High Density Housing and SUDS
What assessment is necessary for the pre planning application stage
Development footprint - how far is that footprint reduced through SUDS.
Solution assessment procedure.
Research as to extent that SUDS is being considered by LPAs at site allocation stage.

Table 3: Design research suggestions

Performance
Hydraulic performance of SUDS for extreme events
Capability of SUDS of handling accidental pollution spills
Performance of different types of SUDS: hydraulic, pollution, different situations
Matrix/flow chart to assess type of SUDS for specific site/development
Empirical design method for small development in straight forward situations
Run-off from existing site and run-off from proposed site
Design methodology for assessing performance of UD systems
Joint permeability in CBP surfaces (time related)
Sub-base performance when saturated
More research of permeable paving to achieve high loading I.e HGV's

Detailed modeling
Empirical modeling tool: hydraulic, pollution, for use as a rough check proposed designs
Co-ordination between supply/demand for recycling of rainwater
Tools needed - SUDS "normal" performance, extreme events performance, simple tools

Water quality
Improve life of soakaway "self cleaning"
Design efficiency of swales in removing pollution
Assessing impact of pollution of aquifers from SUDS devices
Efficiency of infiltration trenches in removing pollutants
Quantification of effectiveness of SUDS/ design requirements on receiving streams and rivers -hydraulic, w. quality, ecology
WQ effects of reducing VT
Investigate the effect of siltation and/or biological growth on geotextiles

Designing to maximise amenity and environment
Landscape issues in designing SUDS
How to maximise ecological value without compromising primary (Quantity/Quality) purpose.
Conflict between hard engineering and "soft" engineering in Design of SUDS
Pollution impacts on ECOL/Amenity objectives in SUDS.
Rooting depth, characteristics and transpiration rates for the range of native species trees and shrubs, perennials etc.

Development of SUDS criteria
Design criteria
What design / flow criteria
Design of standard rainfall events.
Impact of soil suitability on infiltration
Design criteria using historic rainfall + local ground conditions
Quantification of effectiveness of SUDS/ design requirements on receiving streams and rivers -hydraulic, w. quality, ecology
Stress the need to match the solution to the existing site performance (or better) Identify methodology to establish worse case.
Establish methodology to isolate worst case ie. Recommending a series of storms and return periods ie duration, intensity.
Research different/alternative methods of maintenance. (esp. - disposal of contaminated sediments)

Designing control structures
Low – tech control structure, (environmentally sympathetic)

Hydraulics of SUDS
Greenfield run - off of small sites - volume, peak, hydrograph (timing), seasonal
Hydraulic + water quality performance of permeable pavements
Hydraulic and water quality performance of SUDS components
Hydraulic performance of inlet and outlet structures.

Infiltration rates for pervious surfaces and sub-base
Use of recycled materials (eg construction/soakaway materials)
Specifications of porous pavement/subbase
Specification guidance for permeable subbase ie cleanliness of materials. Recycled materials.
Porosity rates for different types of paving/soakaway materials.

Water reuse
Re-use effect on capacity of storage elements Design guidance for SUDS for re-use Design of collection & reuse systems Investigating water quality of rainwater harvested from surface water systems Opportunities for above ground rainwater storage to avoid pumping Assessing the costs/benefits of re-use/recycling systems

Guidance on Greenroofs
Guidance on greenroofs Maintenance of greenroofs Design criteria Database of component availability and performance Green roof designs / criteria

Interaction with ground conditions
Determine effect of sustained loading of traffic on sub soil retention systems, Sub-base design for trafficked areas

No grouping
Sizing and design of sediment traps/sediment forebays Research to backup guidance on when petrol interceptors are required Case histories for guidance not to be prescriptive.; Designing the balance between quantity, quality, amenity. Method for accrediting SUDS Assessing impact of extreme events on SUDS (droughts and cold snaps) Approved list of consulting engineers Detail on quality improvement from SUDS components European standard for design Investigate the efficiency of different forms of permeable surface construction on pollutant control - time related Simple flow chart; specification of materials to be used; historical analysis of existing sites; especially extreme events. Structural design of underground geocellular attenuation/infiltration structures

Table 4: Construction research suggestions

Guides on suitability and installation
Training programme for developers, contractors, ground work sub contractors Suitability of various systems for differing soil types Contractors guide on how to install SUDS systems

Construction good practice and SUDS
Appropriate environment protection during construction Identification of construction No/No's Choice off plant for installing SUDS Sequencing of construction and/or protection of work to prevent silting etc. during construction, good practice doc Dealing with run-off during construction, pollution etc. Standard specification similar to sewers for adoption What are the implications of construction methods on soil structure and infiltration rates Research protection techniques for SUDS during construction - by canvassing practitioners Contractor construction accreditation scheme - construction techniques Research info impact of process and plant Identifying best practice for communication with contractor, - understanding contractors demands.

SUDS construction management
Comparative costs of construction and management of different drainage options Susceptibility of different systems to construction and end performance Effects of SUDS programming needs on construction costs

Standardising SUDS components
Construction issues. Development of standard components for SUDS Report on the number of component types + where implemented

Contractor issues
What SUDS elements do contractors find easy to install? Best ways of encouraging contractors to manage site operations to reduce impact on suds Skills audit for SUDS construction Simple construction = good construction

Specification of materials
Guidance on material specification Assessing sustainable resources/materials Use of recycled materials in SUDS - are any acceptable. Specification of materials; do's and don'ts; site supervision Track rack performance for SUDS

Cost comparisons
Cost comparison of different SUDS Comparison costs of alternative drainage solutions (conveyance, storage, infiltration) for varying rainfall events

No groupings
Approved list of contractors experienced in SUDS construction. European standards for design and construction. Investigate 'real' SUDS installation to determine the effect of construction activity and 'poor' specification. Laying course material for concrete block paviours

Table 5: Management and maintenance research suggestions

Maintenance guides and advice
Guidance on managing wetlands Effects of different methods of cleaning for permeable pavements Movement of "fines" adjacent to structure Guide on renewal/clearance/rehabilitating of SUDS infrastructure Maintenance do's and don'ts; health and safety booklet; for contractors and general public. Maintenance and management requirements for individual SUDS components Development of SUDS rehabilitation strategies

Herbaceous management regime
Type of plants used in and around SUDS Life expectancy of planted areas Management of invasive species

Ownership/Funding
Arrangement for ownership/maintenance, good practice guidance Who checks that maintenance is being done? Enforcement regime Funding of maintenance; who by, how (to avoid major expense that cannot be met

Covenants for ensuring maintenance of SUDS
Management (Legal). Robust covenants to ensure cost recovery for maintenance costs

Whole Life Costings
Commuted sum methodology doc. Whole life costing (Maintenance) Life expectancy of SUDS techniques Cost/ease of repair or maintenance Whole life cost Actual costs vs. predicted Annual management costs

Life Cycle Analysis of SUDS
Maintenance and management strategies for each SUDS type Disposal route for silt - the sustainable solution Life cycle of SUDS rq'd design life unplanned maintenance Maintenance requirements for life time of SUDS. Develop long term cost implications for all elements of management in order to calculated commuted sums. "Lifetime" costings vs. other construction methods

Monitoring the impact of maintenance
Research effects of siltation/ sedimentation of existing systems Research different/alternative methods of maintenance. (esp. - disposal of contaminated sediments) Co-ordination of monitoring of SUDS to improve good practice. Assessing the long term performance of systems + practical maintenance Investigate the efficiency of various maintenance activities on SUDS (esp permeable pavements) Investigate whether agreed maintenance activities are actually being carried out at what frequency and to what effect.

Long term monitoring of SUDS performance
Wet/dry performance of sub-base in permeable car park The long term impact of void filling on permeable car parks Long terms sedimentation of SUDS systems Long term monitoring of completed schemes to give assurances for future design - component replacement periods Developing a robust methodology to Measuring the infiltration capacity of infiltration drainage systems Water quality changes in different types of SUDS Effects of maintenance on long term performance Post installation monitoring of installed systems Investigation of factors that contribute to poor water quality performance

Post project appraisal
The effectiveness of current methods for soakaway design Comparative study of different designs on same site Post project appraisal against theoretical performance Independent reporting on existing schemes What makes a good system?

Health and safety liability for SUDS
Health and Safety implications relating to design and ownership Extent of legal liability for Public safety. Health issues related to SUDS Managing risks associated with surface storage

Waste management for SUDS
Management of waste from SUDS. Quality monitoring Waste disposal and frequency of maintenance and impact on ecology Assessing siltation of permeable pavements and appropriate factors of safety

Assessment of costs
Assessment of costs benefits of SUDS Evaluate impact of SUDS on property value Community involvement in SUDS to achieve max benefits. Costs/Benefits of SUDS

No groupings
Ecological performance (fear of becoming 'untouchable' Bird strike risk around airports Climate change issues? - apply factor of safety? Research where SUDS have been adopted in other countries. Model warranty agreement for design and construction National qualifications or recompenisable training schemes in SUDS management

Table 6: Other research suggestions

Financial instruments for SUDS
Assessment and Justification of commuted sums Calculation of commuted sums Could you apply PFI to SUDS Identify the different methods of funding the maintenance of SUDS Research into most effective long term ownership model for SUDS and funding. Essential. Comparative study on cost savings between sewerage and sewerage charges against SUDS system

Education and awareness
Training and educational needs of wider SUDS stakeholders. Nice to have Educating planners and designers, what is SUDS? Nothing wrong with piped SUDS Education clarification Development of national SUDS training courses Training programme for designers and checkers

Study of social attitudes and impacts of flooding
Social, economic, health and environmental impacts of sacrificial areas Public acceptability of local area flooding in extreme events Survey on local authority view points

Development of case study information
Identifying innovative SUDS designs etc. Case studies of different designs (those that have and have not worked). Capability of SUDS techniques to deliver water quality objectives (i.e. specific design criteria)

Engaging stakeholders
Getting the right people involved at the right time. How to engage Planners and landscape architects in the SUDS way! Planning strategy involving the right people Integration of Building Regulations Research into how SUDS are promoted and implemented by planners across the country with view to ease implementation across LA Boarders. Community attitudes to SUDS. (New + retrofit) Research methods used outside U.K.; what has worked well for others Guidelines to CPA / WA for private company to adopt SUDS

5.1 Prioritisation of research suggestions

Following the brainstorming sessions, delegates were asked to prioritise research ideas and themes. The prioritisation was base on what delegates thought was *essential*, *useful* and *nice to have*. The prioritised research ideas are presented in the table below. These prioritised research needs were fed back to delegates of the feedback workshop where they were asked to develop proposals for the research and again prioritise the worked up proposals. (Due to differing methodologies in prioritising the research suggestions it is not possible to list the research orders in order).

Table 7: Prioritised research suggestions

Planning research suggestions
Determining the suitability of SUDS for different soils
Development of planning policy and guidance to drive implementation of SUDS
Maximising the contribution of SUDS at catchment and regional level
Decision tools for drainage
Design research suggestions
Guidance on the design and management of green roofs
Establishing SUDS design criteria
Design of control structures
Guidance on integrating SUDS and rainwater harvesting
Determining the pollution potential of SUDS

Construction research suggestions	
Training for construction personnel	
Good practice for construction	
Management/maintenance research suggestions	
Monitoring performance of SUDS maintenance	
Report on health and safety and legal liability	
Development of specific guidance on maintenance for SUDS	
Guidance on waste management for SUDS	
Assessment and monitoring of SUDS systems	
Other research suggestions	
Methodology and assessment of cost benefit for SUDS	
Whole catchment performance for varying rainfall	
Studies into cost	
Developing a suite of SUDS case studies	
Perception study – how safe are SUDS	

6. DEVELOPMENT OF RESEARCH SUGGESTIONS

During the feedback workshop delegates were asked to form pairs to develop proposals. Delegates were asked to provide information on:

Notes/objectives – this sets out the scope and the aims of the research.

Has it been done – this is to ascertain whether this project will duplicate any existing work, or whether there are opportunities for synergies to be exploited.

Type of project – this is determine whether the project is scientific research, practical guidance, a decisions tool or a project to disseminate findings.

Delivery team – this is advice on the potential for different organisation to undertake the work, eg universities (research), consultants (short term, single client work), project consortium (combination of disciplines) collaborative projects (long term consensus based research).

6.1 Developed research proposals

The tables below represent the proposals that were developed by the delegates at the feedback workshop. Following the development of the proposals all the delegates were asked to prioritise the proposals, the ranking for the proposals are in the top right of the table.

Title	**Establishing SUDS design criteria**	**1**
Status	Some as aspects have been undertaken, eg CIRIA 156	
Type of project	Science	
Delivery team	Project consortium	
Notes	• Some criteria already available • Gaps to be filled and criteria rationalised • Much of the gaps will be filled by this project • Needs a review/research into relationship between design events and TSR, particularly related to longer duration events and dry period allowance to design for emptying • The issue of “critical duration” event needs to be addressed (very different for small developments and the river catchment). • Development of a sample time series for system testing. • Issues of combined probability with conditions in the receptor.	

Title	Maximising the contribution of SUDS at catchment and regional level	2
Status	Not been undertaken, but useful to look at watershed planning in the US	
Type of project	Guidance	
Delivery team	Collaborative project	
Notes	• Review WFD, planning white paper for synergy – give case study/theoretical dem/ example to demonstrate SUDS compliance/opportunity • Project partners: ODPM, EA, DEFRA, RDAs & LGOs • Implications of the WFD: legislation for EU member state; water resource/quality driven • Qualitative discharge consents: a possibility hence • Regional approach – assess importance: also forms part of SEA & RDA etc. • RSS – regional planning – how should it lead: new planning legislation SEA & RDA key drivers • Need for umbrella research to highlight the opportunity for SUDS to feed into current (WFD) and emerging (SEA &RSS) policy guidance at national and international level • Promotion of SUDS at site allocation stage – consider broader, regional benefits: geology; catchment location; water table depth; proximity to watercourse • SUDS as part of sequential test • Develop regional catchment drainage strategy to form briefing pack for development frameworks	

Title	Studies into cost	2
Status	Some work has been undertaken.	
Type of project	Decision tools	
Delivery team	Collaborative project (regulators and water utilities)	
Notes	• Development of national framework for calculation of WLC • Look at existing costs/ techniques – review- breakdown into individual elements – spreadsheet application – various proposals reviewed to achieve optimum solution. • Note: (linked with “methodology and assessment of cost benefit for SUDS”).	

Title	Report on health and safety and legal liability	4
Status	Some of the social aspects may be covered by Abertay and HR Wallingford	
Type of project	Guidance and associated dissemination	
Delivery team	Collaborative project (legal, insurance, ROSPA & HSE)	
Notes	• Current benefits/assessment manual (EA) for flood management covers liability issues? • Needs to link “public health” – cross over responsibilities of EHOs. • To understand the extent of the problem, what are the real issues, how can they be managed and mitigated • Consider impact of climate change (eg. Public health re mosquito’s) • Develop a risk assessment methodology/process • Dissemination to insurers and legal practitioners	

Title	Design of control structures	5
Status	Not done before	
Type of project	Science and guidance	
Delivery team	Project consortium	
Notes	• Hydraulic performance of more sympathetic structures • Avoiding the need to use traditional “heavy” engineering • Handling of solids/sediments through structures • Structural performance and stability in different soils • Material durability	

Title	Determining the suitability of SUDS for different soils	5
Status	Not done before	
Type of project	Guidance	
Delivery team	Collaborative project	
Notes	• Simple table • Soil types/ground water conditions: decision table; key objective • SUDS components • Impact of construction on soil properties (eg. Compaction reduces infiltration) • Impact of water on soil properties • Infiltration test methods (standard) large scale • Consider contamination of ground • Consider pollution of ground water	

Title	Perception study - how safe are SUDS	7
Status	Generic risk management work has been undertaken, investigation of health not yet complete.	
Type of project	Scientific work required for the health aspects although final document should be guidance	
Delivery team	Likely to be collaborative project	
Notes	• Safety (ROSPA) • Review and extend ROSPA & HSE on safety including public perception and risk management. In particular intrinsic safety, temptation…consider need for public education • Identification of significant potential health/safety risks (water borne & vector diseases, wiles disease) and change with climate, land use, misuse and spillage. Include risks to public and maintenance worker (HSE) • Contribution to spread of rats and other pests • Produce guidance on managing health risks	

Title	Guidance on waste management for SUDS	8
Status	Not undertaken in the UK, but there is work in the US	
Type of project	Science; guidance; decision tools; dissemination	
Delivery team	Project consortium	
Notes	• Define wastes involved • What regulations are involved • How does it impact on whole life of SUDS • What extent is monitoring required • Type of catchment/input to SUDS • H+S considerations, contaminants, toxins • Disposal route and final destination • Costs – (special[controlled]) and other	

Title	Determining the pollution potential of SUDS	9
Status	Elements have been covered	
Type of project	Science; decision tools; dissemination through network	
Delivery team	Project consortium and collaboration	
Notes	• Pollution impacts of infiltration systems on groundwater • Facilities as “mitigation” and in turn as “potential point sources” themselves • Needs to be related to geology and hydrology • Addressing “removal capabilities/capture of specific pollutants” • Develop matrix of techniques – performance (with risks) • Consider different flow regimes and timescales (superimposition) • Be guided by water framework directive • Stand alone devices Vs a management train • Including spillage, incidents, accidents impact on different devices: (check out highways agency’s spills procedures/response times) • Ecological impacts • Operational impacts (fire brigade/utilities eg.)	

Title	Assessment and monitoring of SUDS systems	10
Status	Some components have been looked at, although overall approach has not been looked at.	
Type of project	Science; guidance; dissemination	
Delivery team	Project consortium	
Notes	• Review and enhance work on evacuation of amenity use and economics of public open space and watercourses (link with costs project). • Review existing methodologies and results for monitoring SUDS (quantity, quality and ecology) and develop for use alongside S.M.A.R.T. criteria. Disseminate monitoring results and protocol to designers, planners and operators.	

Title	Good practice for construction	10
Status	Elements covered in CIRIA guidance and manufacturers leaflets	
Type of project	Guidance	
Delivery team	Experienced contractor	
Notes	• Much of the actual construction are traditional methods probably issues can be addressed from examples of bad practice to be avoided by good specs	

Title	**Developing a suite of SUDS case studies**	12
Status	Some initial attempts to undertake the work. Not comprehensive enough as there are huge range of concepts.	
Type of project	Science; guidance; network	
Delivery team	Project consortium: research organisations, industry stakeholders developers/water companies LAS's	
Notes	• There is a lack of information on SUDS experience. • SUDS are likely to be more dependent on local circumstances and proper installation by contractors (eg ground conditions, silt runoff into ponds and soakaways, weather during construction). • Need suite of examples with published lessons learned to inform better future designs. Need greater confidence in whole life costs. Need more information on longer term effectiveness of SUDS.	

Title	Whole catchment performance for varying rainfall	13
Status	Some ongoing work under EPSRC funds – not leading to implementation tool	
Type of project	Science; guidance; decision tool	
Delivery team	Project consortium	
Notes	• SUDS in an FEH context existing work is not wide enough, does not cover full range of likely practical infrastructure needs. It is generally academic, without adequate field validation, and is not aimed at dissemination of tools/guidance/design criteria to practising drainage engineers. It is not properly linked to EA catchment planning. • The objective of this proposal is to fill some of these deficiencies, and provide links to other initiatives (eg CFMP's; CIRIA design of drainage for exceedance; EPSRC floods call). Pre-construction modelling be compared with results found in case study catchments.	

Title	**Guidance on integrating SUDS and rainwater harvesting**	13
Status	Some work been undertaken (Sthrn Water)	
Type of project	Science; guidance	
Delivery team	Project consortium	
Notes	• Identification of conflicts between the different objectives of SUDS and rainwater harvesting. • Identification of potential uses of rainwater • Identification of potential storage for run-off control • Statistical analysis using TSA- identify risk of exceedance • Implications of failure (homeowner intervention) • Potential for retrofit • Identification of cost/benefits	

Title	**Guidance on the design and management of green roofs for SUDS**	15
Status	Green roofs have been worked at but not from a SUDS perspective.	
Type of project	Guidance; decision tools; dissemination	
Delivery team	Collaborative project	
Notes	• Determination of hydraulics for full range of storm events • Types of planting for attenuation/treatment vs insulation/cooling properties • Design/amenity drivers – impaction ecology, influence of depth of substrate/substrate type on ecology (+ attenuation) • There is a lot of information on the benefits of green roofs – but not for source control/drainage • Costs/benefits/logistics of application to range of roof sizes (single house – large scale industrial roof) • Covenants to ensure drainage function is retained in per??? • Guidance/training on design and construction for housebuilders/designers/SUDS designers • Regulatory (stakeholder agreement on attenuation levels that can be achieved, review monitoring/modelling) • Same management issues as SUDS – lack of industry expertise currently.	

Title	**Monitoring performance of SUDS maintenance**	16
Status	Nothing produced, although short term monitoring is underway by WERF/UKWIR	
Type of project	Science; guidance; dissemination; decision tools	
Delivery team	Project consortium;	
Notes	• Limited experience on some techniques, but others have significant datajets but they may not be comparable • Need monitoring protocols to define parameters • Recognise geography, climate, geology, vegetation, location etc • As "notes"	

Title	Training for construction personnel	16
Status	Not done	
Type of project	Dissemination	
Delivery team	Project consortium	
Notes	• Cover the why as well as the what • Highlight what is different from conventional methods • Expand to cover design detailers • Focussed output – appropriate language; small budget; video (not interactive CD)	

Title	Methodology and assessment of cost benefit for SUDS	16
Status	Unknown	
Type of project	Science	
Delivery team	University	
Notes	• Community • Amenity value +ve • Allocated land +ve • H+S implications –ve (including personal safety) • Maintenance concentrated in one area +ve • Note linked with "studies into costs" House prices • Proximity to development +ve (location of 'open water') • High maintenance charge –ve • Increased initial cost due to "land take" -ve	

Title	Decision tools for drainage	19
Status	Section in RP663 (C609) needs to be tested/	
Type of project	Decision tools	
Delivery team	Collaboration	
Notes	• Simple flowchart to identify best techniques to meet site specific constraints	